世界互联网大会
World Internet Conference

科技之魅

CHARM OF SCIENCE AND TECHNOLOGY

世界互联网大会
领先科技奖收录成果集

Collection of Shortlisted Achievements of World Internet Conference Awards for Pioneering Science and Technology

2024 WORLD INTERNET CONFERENCE
乌镇峰会 Wuzhen Summit
世界互联网大会

拥抱以人为本、智能向善的数字未来
——携手构建网络空间命运共同体

Embracing a People-Centered and AI-for-Good Digital Future
– Building a Community with a Shared Future in Cyberspace

写在《科技之魅》的前面

Preface to the Charm of Science and Technology

随着新一轮科技革命和产业变革深入发展，技术创新进入前所未有的密集活跃期。人工智能、量子技术、大数据、6G 通信等互联网领域前沿技术竞相涌现，引发链式变革，推动互联网技术与经济社会发展深度融合，催生新业态，推进生产力飞跃，引领人类迈向更加美好的数字世界。

We are currently witnessing a profound development in the new round of scientific and technological revolution and industrial transformation. Global scientific and technological innovation has entered a period of unprecedented intensity and activity. Cutting-edge internet technologies, such as artificial intelligence, quantum computing, big data, and 6G communications, are advancing rapidly, triggering chain reactions and fostering deeper integration between digital innovation and socioeconomic development. This transformation is creating new business paradigms, boosting productivity, and steering humanity toward a brighter, more connected digital future.

伫立于数字化变革的浪潮之巅，对互联网发展趋势的预见，对科技创新动力的发掘，将为推动社会发展、提升人类福祉起到重要作用。世界互联网大会领先科技奖通过发掘全球互联网领域前沿科技成果，树立科技创新“风向标”，激励全球互联网从业者持续创新。

At the forefront of digital transformation, the ability to foresee internet development trends and the commitment to harness technological innovation are essential for propelling societal progress and enhancing human well-being. The World Internet Conference Awards for Pioneering Science and Technology (WIC Awards) recognizes groundbreaking achievements in the global internet industry, setting a “benchmark” for technological innovation and inspiring continuous breakthroughs among internet professionals worldwide.

作为世界互联网大会领先科技奖评审委员会主席，我欣喜地看到，科技奖的全球影响力持续提升，得到越来越多国家的广泛关注与积极参与。本年度共收到 270 项有效申报，涉及中国、美国、英国、德国、意大利、瑞典、挪威、芬兰、澳大利亚、日本、韩国、新加坡、南非等 24 个国家和地区的海内外主体。申报成果覆盖具身智能、类脑计算、6G、大数据、高性能芯片等前沿科技领域，呈现多学科深度交叉融合、应用场景更加多元的趋势。在基础研究组主任委员美国互联网先驱戴夫·法伯先生，关键技术组主任委员中国工程院院士吴建平先生，工程研发组主任委员韩国互联网之父全吉男先生等 40 位全球互联网领域专家的权威推荐下，55 项优秀成果脱颖而出，收录于本年度《科技之魅》。基于这些成果的进一步开发与转化应用，将在推动全球经济与社会发展、构建网络空间命运共同体中发挥积极作用。

As the chairman of the World Internet Conference Awards for Pioneering and Technology Re-

view Committee, I am thrilled to see the growing global influence of the WIC Awards, attracting increasing attention and enthusiastic participation from countries worldwide. This year, we received 270 valid submissions from participants across 24 countries and regions, such as China, the United States of America, the United Kingdom, Germany, Italy, Sweden, Norway, Finland, Australia, Japan, the Republic of Korea, Singapore and South Africa. These entries span cutting-edge fields including embodied intelligence, brain-inspired computing, 6G, big data, and high-performance chips, reflecting a trend toward deep interdisciplinary integration and more diverse application scenarios. With the recommendations of 40 authoritative experts in the global internet field, including Mr. David Farber, an American Internet pioneer and the Director of the Basic Research Group, Mr. Wu Jianping, an Academician of the Chinese Academy of Engineering and the Director of the Key Technology Group, and Mr. Kilnam Chon, known as the "Father of the Internet" in the Republic of Korea and Director of the Engineering Research and Development Group, 55 leading achievements have been selected and compiled into a collection called "the Charm of Science and Technology". The further development and application of these innovations will actively contribute to driving global economic and social progress and to building a community with a shared future in cyberspace.

科技向新，数智向前。希望《科技之魅》能够持续发挥创新引领作用，以更开拓的精神去探索互联网的未来，以更包容的生态滋养创新动力，不断推动互联网领域前瞻性基础研究、引领性原创成果重大突破，以更多创新技术为人类文明进步作出更大贡献。

As technology advances and digital intelligence strides forward, we hope that "the Charm of Science and Technology" will continue to play a pioneering role in innovation, explore the future of the internet with an open-minded spirit and foster a nurturing ecosystem that fuels creativity. By driving forward-looking foundational research and enabling groundbreaking original achievements, we aim to make greater contributions to the progress of human civilization with more innovative technologies.

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世界互联网大会领先科技奖获奖成果

Leading Achievements of World Internet Conference
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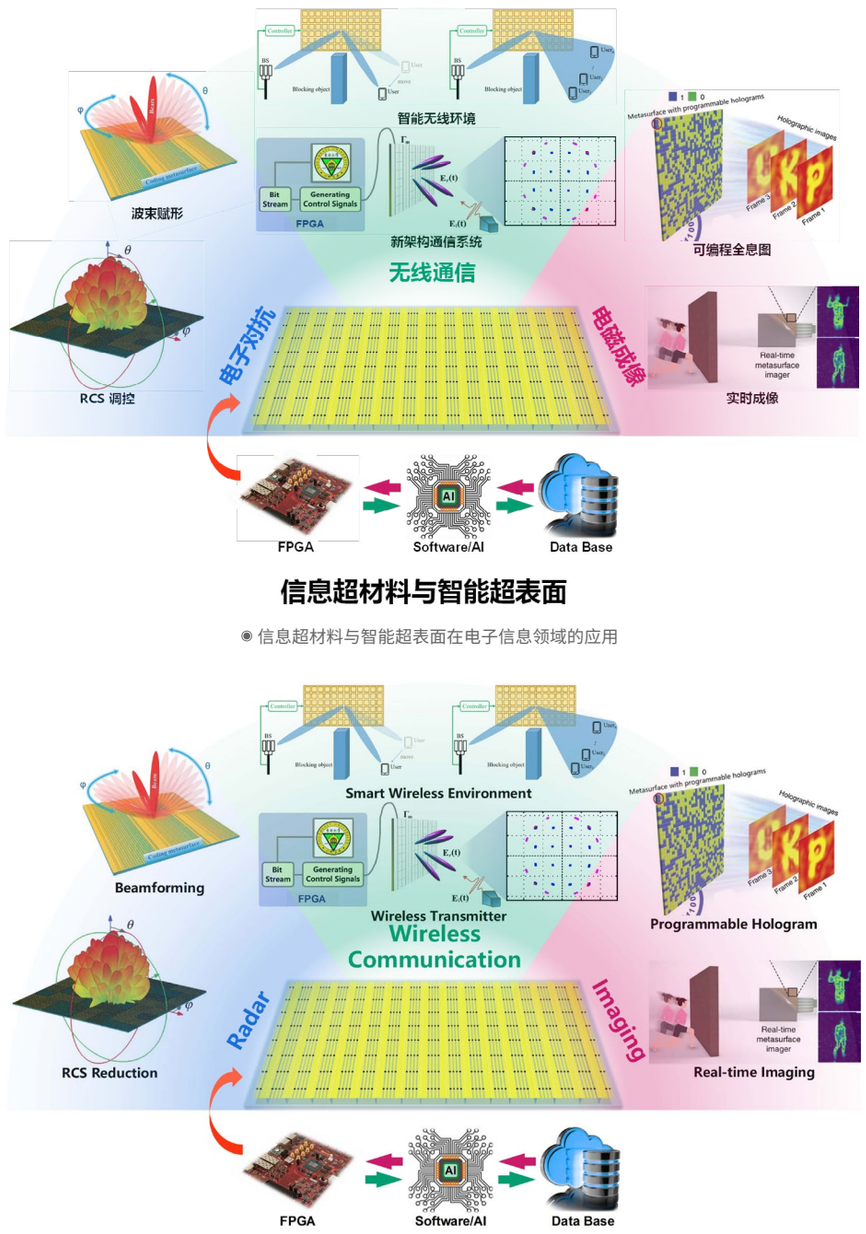
基础研究组
Basic Research Group

信息超材料和智能超表面

Information Metamaterials and Reconfigurable Intelligent Surfaces

东南大学
Southeast University

北京大学
Peking University



信息超材料与智能超表面

◉ 信息超材料与智能超表面在电子信息领域的应用

◉ Applications of Information Metamaterials and Reconfigurable Intelligent Surfaces in the Field of Electronic Information

引言

超材料是物理和信息领域的重大前沿和研究热点。项目组在国际上首创了信息超材料新体系，将电磁物理与数字信息融为一体，可同时操控电磁波与数字信息，取得了一系列具有国际先进性和影响力的成果。

Introduction

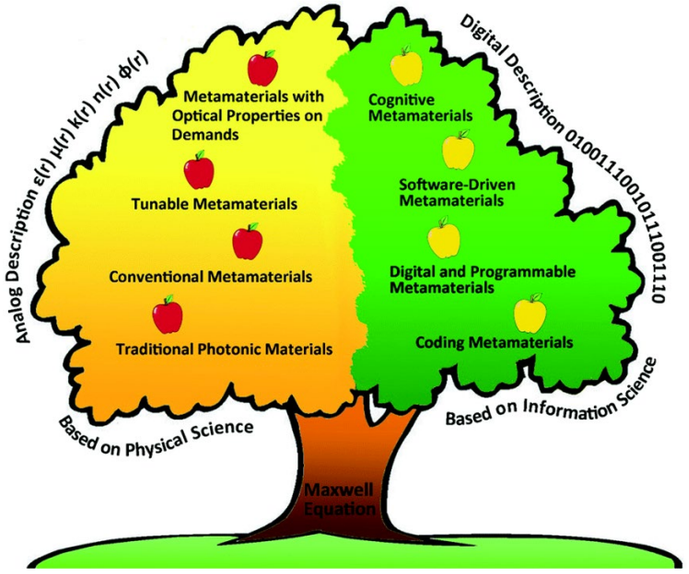
Metamaterial has been research frontier and hotspot in the fields of physics and information science. The research team established a new direction of metamaterial - information metamaterial, which can manipulate electromagnetic waves in real time and process digital information in the electromagnetic space. A series of breakthrough and influential results have been achieved.

创建了融合电磁空间与数字空间的信息超材料新体系

Establishing a New System of Information Metamaterial to Fuse Electromagnetic Space and Digital Space

本成果针对传统超材料理论复杂、实现困难、功能固化等挑战，在国际上首次提出信息超材料的全新理论体系，通过数字编码表征方式，使超材料由“被动”变“主动”，从“模拟”变“数字”，从而融合电磁与数字空间，在操控电磁场和波的同时完成信息的感知、处理与调控。信息超材料具备三大特性：第一，能实时可编程控制电磁场与波，催生智能超表面技术，构建 6G 智能可编程无线环境新范式；第二，可实现电磁空间与数字空间的一体化，为电磁信息论奠定基础，开发出低能耗无线通信系统新架构；第三，可与人工智能深度结合，构建信息超材料神经网络硬件平台，首次实现图像识别、目标定位和无线通信可编程一体化。

Aiming at challenges of the traditional metamaterial technologies such as complicated theories, difficult implementations and fixed functionalities, a new theoretical framework of information metamaterial was established for the first time. Through digital coding representation, the metamaterial has been evolved from passive to active and from analog to digital. Hence the information metamaterial can fuse the electromagnetic space and digital space, and complete the perception, processing and modulation of information while manipulating the electromagnetic fields and waves. The information metamaterial has three key features. Firstly, it can control the electromagnetic waves in real time and in programmable way, fostering reconfigurable intelligent surface (RIS) technology and establishing a new paradigm for 6G intelligent programmable wireless environments. Secondly, it can control the electromagnetic waves and process digital information simultaneously, laying the foundation for electromagnetic information theory and developing a new architecture for low-power wireless communication systems. Thirdly, it can be deeply integrated with artificial intelligence to build up programmable neural network hardware, which can perform image recognition and classification, target detection, and wireless communications in programmable way.



◉ 融合电磁物理世界与数字世界的信息超材料新体系

◉ A New Information Metamaterial System Integrating the Electromagnetic Physics and Digital Worlds

开辟射频与数字一体化新途径，促进变革性技术发展

Opening up a New Path for the Integration of Electromagnetic Wave and Digital Information, and Promoting Transformative Technologies

类似从“模拟电路”到“数字电路”的发展，信息超材料单元的数字化为超材料的表征提供了新方法，其时空编码特性则为融合电磁物理与数字空间奠定基础。通过原创的电磁空间卷积定理、时间时移定理等时空编码设计理论，信息超材料可实现电磁波的全参量高效精确自由调控，推动射频数字一体化，为信息技术发展提供新维度，促生新体制电子信息系统。

Similar to the development from analog circuit to digital circuit, the digitization of information metamaterial unit provides a new method for the characterization of metamaterial, and its space-time-coding features lay the foundation for integrating the electromagnetic physics and digital space. Through the space-time-coding design theories such as electromagnetic space convolution and time shift theorems, the information metamaterial can achieve highly efficient and accurate controls of all parameters of electromagnetic waves, promote the integration of radio frequency and digital baseband, provide a new dimension for developing the information technology, and give birth to new architecture electronic information systems.

基于信息超材料的智能超表面技术已成为 6G 关键技术备选方案之一，入选第四次工业革命研究中心所遴选的“2024 年十大前沿技术”，并在世界经济论坛发布，是中国唯一在商业和研究领域影响力位列前五的技术，成为中国在原创技术及全球产业链领先的潜在突破点。中国企业如中国移动、联通和中兴正与项目组开展合作，推动这一技术形成国际标准。

The RIS technology based on the information metamaterial has become one of the key technologies for 6G communications. It was selected as one of the Top Ten Emerging Technologies in 2024 by the Fourth Industrial Revolution Research Center and released by the World Economic Forum. It is the only technology originating from China, and its influence ranks among the top five in both commercial and research fields. It has become a potential breakthrough for China's leadership in the original technology and the global industrial chain. Chinese enterprises such as China Mobile, China Unicom and ZTE are cooperating with the research team to form international standards.

◉ 研究成果入选中国移动、IMT2030 发布的信息超材料和智能超表面 6G 技术白皮书，并在杭州亚运会上首次示范应用。

◉ China Mobile and IMT2030 published 6G Technique White Papers for Information Metamaterials and RIS, and RISs were demonstrated for the first time in the Hangzhou Asian Games.

研究成果在国际学术界和产业界获得高度认可

The Research Achievements Have Been Highly Recognized in Both Academia and Industry Worldwide

成果的五篇代表作得到了国际学术界的广泛关注与好评，谷歌学术引用共 5811 次，单篇最高引用 2761 次，是 Light Science and Applications 创刊以来引用次数最高的论文，并在多个国际权威期刊发表了信息超材料专刊。成果获多项重要奖项，包括 2024 年陈嘉庚奖、2023 年全国创新争先奖、2024 年 IEEE 通信学会马可尼奖、2023 年首届国际基础科学大会前沿科学奖、2021 年中国高等学校十大科技进展和 2023 年中国通信学会自然科学一等奖等。美国科学院和美国工程院院士、普林斯顿大学 H. Vincent Poor 教授、加拿大工程院院士、IEEE 通信学会主席、德国埃尔朗根纽伦堡大学 Robert Schober 教授、英国皇家学会 Wolfson 院士、澳大利亚科学院院士、Stefanos Pnevmatikos 国际奖获得者、澳大利亚国立大学 Yuri S. Kivshar 教授等著名学者高度评价本成果，认为信息超材料为电磁波调控引入了新方法，并为射频通信系统的性能提升提供了理论依据。

The five representative articles of this achievement have received extensive attention from the academic community. To date, they have a total of 5,811 citations on Google Scholars, and the first article has been cited by 2,761 times, making it the most cited paper in the history of Light Science and Applications. Several renowned academic journals have published special issues on information metamaterials. The achievement has received many honors and awards, including the Tan Kah Kee Science Award in 2024, the IEEE Communications Society Marconi Prize in 2024, the National Innovation and Excellence Award in 2023, the Frontier Science Award in the First International Basic Science Conference in 2023, the Top Ten Scientific and Technological Advances in Chinese Universities in 2021, and the Natural Science Award of China Institute of Communications (first class) in 2023. Many prominent scholars, including H. Vincent Poor (member of the National Academy of Sciences and National Academy of Engineering, professor at Princeton University), Robert Schober (Fellow of the Canadian Academy of Engineering, President of the IEEE Communications Society, professor at University of Erlangen-Nuremberg), Nikolay I. Zheludev (Wolfson Fellow of the Royal Society, Fellow of the European Physical Society, and Editor-in-Chief of Journal of Optics), Yuri S. Kivshar (Fellow of the Australian Academy of Science and recipient of the Stefanos Pnevmatikos International Award), have highlighted this achievement. They commented that the information metamaterials have introduced new methods for electromagnetic wave manipulation and provided a theoretical basis for the performance improvement of radio frequency communication systems.

◉ 本成果获多项重要奖项，包括 2021 年中国高等学校十大科技进展、2023 年全国创新争先奖、2023 年中国通信学会自然科学一等奖、2023 年日内瓦国际发明展金奖、2023 年首届国际基础科学大会前沿科学奖、2024 年 IEEE 通信学会马可尼奖

◉ The achievement received many honors and awards, including the Top Ten Scientific and Technological Advances in Chinese Universities in 2021, the National Innovation and Excellence Award in 2023, the Natural Science Award of China Institute of Communications (First Class) in 2023, the Gold Medal of International Exhibition of Inventions of Geneva in 2023, the Frontier Science Award in the First International Basic Science Conference in 2023, and the IEEE Communications Society Marconi Prize in 2024.

John Pendry 爵士

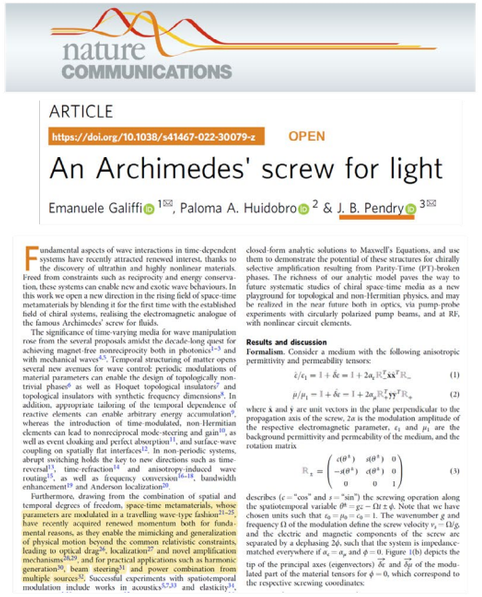
超材料领域的创始人

美国科学院院士

英国帝国理工学院教授

在Nature Communications的论文中指出时空编码超材料为“谐波产生、波束偏折、多源功率合成等场景提供了技术支撑“。

“…, *leading to optical drag, localization and novel amplification mechanisms, and for practical applications such as harmonic generation, beam steering and power combination from multiple sources.*”



nature COMMUNICATIONS

ARTICLE

https://doi.org/10.1038/s41467-022-30079-z OPEN

An Archimedes' screw for light

Emanuele Galiffi[1✉], Paloma A. Huidobro[2] & J. B. Pendry[3✉]

Fundamental aspects of wave interactions in time-dependent systems have recently attracted renewed interest, thanks to the discovery of ultrathin and highly nonlinear materials. Freed from constraints such as reciprocity and energy conservation, these systems can enable new and exotic wave behaviours. In this work we open a new direction in the rising field of space-time metamaterials by blending it for the first time with the established field of chiral systems, realising the electromagnetic analogue of the famous Archimedes' screw for fluids.

The significance of time-varying media for wave manipulation rose from the several proposals amidst the decade-long quest for achieving magnet-free nonreciprocity both in photonics[1–3] and with mechanical waves[4,5]. Temporal structuring of matter opens several new avenues for wave control: periodic modulations of material parameters can enable the design of topologically nontrivial phases[6] as well as Floquet topological insulators[7] and topological insulators with synthetic frequency dimensions[8]. In addition, appropriate tailoring of the temporal dependence of reactive elements can enable arbitrary energy accumulation[9], whereas the introduction of time-modulated, non-Hermitian elements can lead to nonreciprocal mode-steering and gain[10], as well as event cloaking and perfect absorption[11], and surface-wave coupling on spatially flat interfaces[12]. In non-periodic systems, abrupt switching holds the key to new directions such as time-reversal[13], time-refraction[14] and anisotropy-induced wave routing[15], as well as frequency conversion[16–18], bandwidth enhancement[19] and Anderson localization[20].

Furthermore, drawing from the combination of spatial and temporal degrees of freedom, space-time metamaterials, whose parameters are modulated in a travelling wave-type fashion[21–25], have recently acquired renewed momentum both for fundamental reasons, as they enable the mimicking and generalization of physical motion beyond the common relativistic constraints, leading to optical drag[26], localization[27] and novel amplification mechanisms[28,29], and for practical applications such as harmonic generation[30], beam steering[31] and power combination from multiple sources[32]. Successful experiments with spatiotemporal modulation include works in acoustics[5,7,33] and elasticity[34], closed-form analytic solutions to Maxwell's Equations, and use them to demonstrate the potential of these structures for chirally selective amplification resulting from Parity-Time (PT)-broken phases. The richness of our analytic model paves the way to future systematic studies of chiral space-time media as a new playground for topological and non-Hermitian physics, and may be realized in the near future both in optics, via pump-probe experiments with circularly polarized pump beams, and at RF, with nonlinear circuit elements.

Results and discussion

Formalism. Consider a medium with the following anisotropic permittivity and permeability tensors:

$$\epsilon/\epsilon_1 = 1 + \delta\epsilon = 1 + 2n_g\,\mathbb{R}_+^{\xi}\hat{\mathbf{x}}\hat{\mathbf{x}}^T\mathbb{R}_- \quad (1)$$

$$\mu/\mu_1 = 1 + \delta\epsilon = 1 + 2n_g\,\mathbb{R}_+^{\xi}\hat{\mathbf{y}}\hat{\mathbf{y}}^T\mathbb{R}_+ \quad (2)$$

where $\hat{\mathbf{x}}$ and $\hat{\mathbf{y}}$ are unit vectors in the plane perpendicular to the propagation axis of the screw, 2α is the modulation amplitude of the respective electromagnetic parameter, ϵ_1 and μ_1 are the background permittivity and permeability of the medium, and the rotation matrix

$$\mathbb{R}_\pm = \begin{pmatrix} c(\theta^\pm) & s(\theta^\pm) & 0 \\ -s(\theta^\pm) & c(\theta^\pm) & 0 \\ 0 & 0 & 1 \end{pmatrix} \quad (3)$$

describes (c = "cos" and s = "sin") the screwing operation along the spatiotemporal variable $\theta^\pm = gz - \Omega t \pm \phi$. Note that we have chosen units such that $\epsilon_0 = \mu_0 = c_0 = 1$. The wavenumber g and frequency Ω of the modulation define the screw velocity $v_s = \Omega/g$, and the electric and magnetic components of the screw are separated by a dephasing 2ϕ, such that the system is impedance-matched everywhere if $\alpha_\epsilon = \alpha_\mu$ and $\phi = 0$. Figure 1(b) depicts the tip of the principal axes (eigenvectors) $\hat{\delta\epsilon}$ and $\hat{\delta\mu}$ of the modulated part of the material tensors for $\phi = 0$, which correspond to the respective screwing coordinates:

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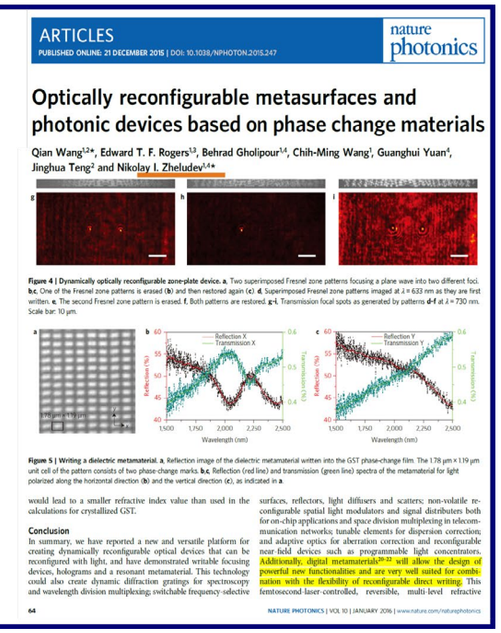
英国南安普顿大学

在Nature Photonics的论文中指出高比特量化数字编码超材料“具有强大的功能，非常适合与可重构直写工艺相结合“。

“*Additionally, digital metamaterials will allow the design of powerful new functionalities and are very well suited for combination with the flexibility of reconfigurable direct writing.*”



ARTICLES

PUBLISHED ONLINE: 21 DECEMBER 2015 | DOI: 10.1038/NPHOTON.2015.247

nature photonics

Optically reconfigurable metasurfaces and photonic devices based on phase change materials

Qian Wang[1,2]*, Edward T. F. Rogers[1,3], Behrad Gholipour[1,4], Chih-Ming Wang[1], Guanghui Yuan[4], Jinghua Teng[2] and Nikolay I. Zheludev[1,4]*

Figure 4 | Dynamically optically reconfigurable zone-plate device. a, Two superimposed Fresnel zone patterns focusing a plane wave into two different foci. **b,c**, One of the Fresnel zone patterns is erased (**b**) and then restored again (**c**). **d**, Superimposed Fresnel zone patterns imaged at λ = 633 nm as they are first written. **e**, The second Fresnel zone pattern is erased. **f**, Both patterns are restored. **g–i**, Transmission focal spots as generated by patterns **d–f** at λ = 730 nm. Scale bar: 10 μm.

Figure 5 | Writing a dielectric metamaterial. a, Reflection image of the dielectric metamaterial written into the GST phase-change film. The 1.78 μm × 1.19 μm unit cell of the pattern consists of two phase-change marks. **b,c**, Reflection (red line) and transmission (green line) spectra of the metamaterial for light polarized along the horizontal direction (**b**) and the vertical direction (**c**), as indicated in **a**.

would lead to a smaller refractive index value than used in the calculations for crystallized GST.

Conclusion

In summary, we have reported a new and versatile platform for creating dynamically reconfigurable optical devices that can be reconfigured with light, and have demonstrated writable focusing devices, holograms and a resonant metamaterial. This technology could also create dynamic diffraction gratings for spectroscopy and wavelength division multiplexing; switchable frequency-selective surfaces, reflectors, light diffusers and scatters; non-volatile reconfigurable spatial light modulators and signal distributers both for on-chip applications and space-division multiplexing in telecommunication networks; tunable elements for dispersion correction; and adaptive optics for aberration correction and reconfigurable near-field devices such as programmable light concentrators. Additionally, digital metamaterials[29–32] will allow the design of powerful new functionalities and are very well suited for combination with the flexibility of reconfigurable direct writing. This femtosecond-laser-controlled, reversible, multi-level refractive

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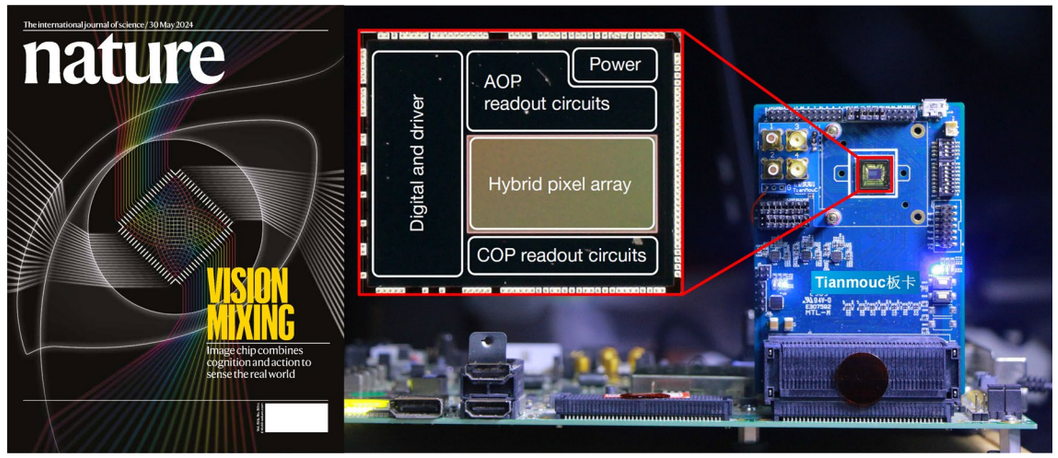
◉ 本项目成果典型引用

◉ Typical Citations of This Achievement

基于原语表示的类脑互补视觉感知芯片

Brain-Inspired Complementary Vision Chip With Primitive-Based Representations



◉ 基于原语表示的类脑互补视觉感知芯片登上自然杂志封面

◉ The brain-inspired complementary vision chip with primitive-based representation has published as the cover paper of Nature journal.

清华大学
Tsinghua University

北京灵汐科技有限公司
Lynxi Technologies, Beijing

中电海康集团有限公司
CETHIK GROUP Co.,Ltd.

引言

智能视觉感知正引领科技变革。传统图像传感器受限于带宽和能耗，其核心指标相互制约，难以满足开放环境需求。团队借鉴人类视觉机制，提出基于原语的互补类脑视觉感知新范式，并研发“天眸芯”，提供了高效鲁棒的视觉感知新方案。

Introduction

Intelligent visual perception is leading a technological revolution. Traditional image sensors are limited by bandwidth and power consumption, with their core metrics mutually constraining each other, making it difficult to meet the demands of open environments. Drawing on human visual mechanisms, the team proposed an innovative complementary sensing paradigm comprising a primitive-based representation and developed the "Tianmouc," providing a new solution for efficient and robust visual perception.

基于原语的类脑互补视觉感知新范式

A New Brain-Inspired Paradigm of Primitive-based Complementary Visual Perception

传统视觉感知器受限于功耗墙和带宽墙，难以同时实现高分辨率、高帧率和高动态范围，无法满足复杂环境需求。

Traditional image sensors are constrained by power and bandwidth walls, making it difficult to simultaneously achieve high resolution, high frame rates, and high dynamic range, which cannot meet the demands of complex open environments.

团队借鉴人类视觉系统，提出基于原语的类脑互补视觉感知新范式，并研发“天眸芯”，在理论、芯片、算法、软件和系统应用方面取得重大突破，成果作为封面文章发表于《自然》。

The team drew inspiration from the human visual system and proposed a new brain-inspired paradigm of primitive-based complementary visual perception, developing the "Tianmouc". The team has achieved significant breakthroughs in theory, chip, algorithm, software, and system applications, with the results published as a cover article in Nature.

该范式将视觉信息拆解为基于视觉原语的表示，通过有机组合形成“认知”与“动作”两条优势互补、信息完备的视觉感知通路，突破传统性能瓶颈。基于此范式研发天眸芯，实现在极低带宽和功耗下的高速、高精度、高动态范围感知，能够高效应对极端场景。

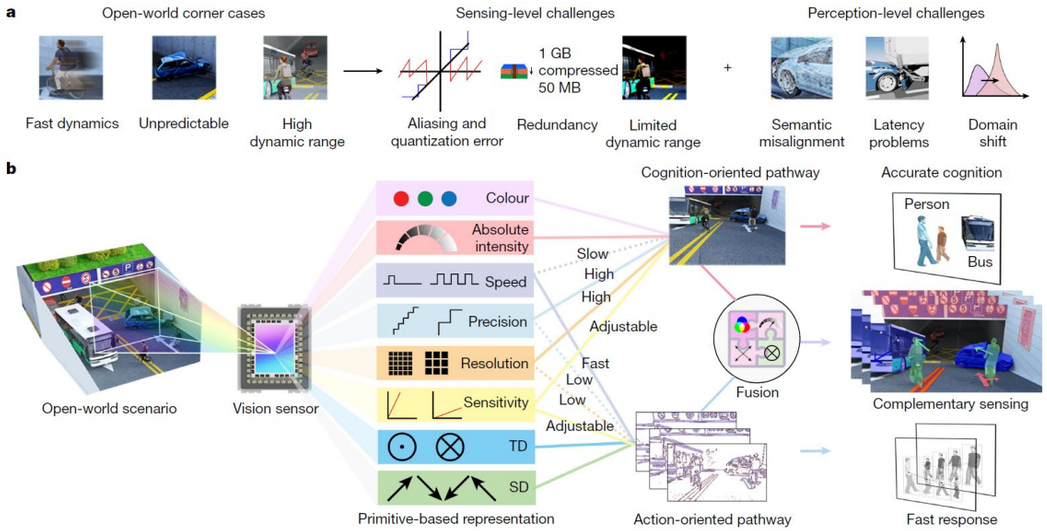
This paradigm disassembles visual information into primitive-based representations, forming two complementary, information-complete visual perception pathways of "cognition-oriented" and "action-oriented", thereby overcoming performance bottlenecks of traditional image sensors. Based on this paradigm, the Tianmouc was developed to achieve high-speed, high-precision, and high dynamic range perception under low bandwidth and power consumption, effectively tackling with extreme scenarios.

构建了包括软件、算法、数据与仿真的完整生态，实现全新的感知 - 决策范式。搭建的车载感知系统在开放道路实现低延迟、高性能实时感知推理，展现了在无人系统领域的巨大潜力。

The team established a complete ecosystem including software, algorithms, data, and simulation platforms, realizing a novel perception-decision paradigm. The team constructed an automotive perception system that demonstrated low-latency, high-performance real-time perception reasoning on open roads, demonstrating enormous potential in the field of unmanned systems.

基于该成果团队已申请专利 68 项，其中包括国际专利，并已获得了 37 项授权。

The team has applied for 68 patents, including international patents, and has received authorization for 37 of them.



◉ 基于原语的类脑互补视觉感知新范式

◉ A New Paradigm of Brain-Inspired Complementary Visual Sensing Based on Primitive-Based Representation

面向开放世界，天眸芯提供高效且鲁棒的解决方案

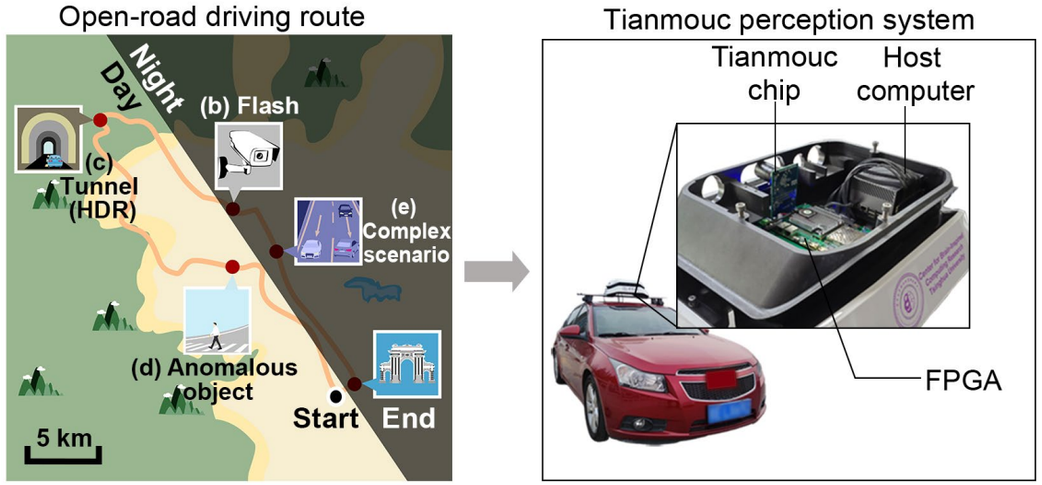
Facing the Open World, Tianmouc Provides Efficient and Robust Solutions

受人类视觉系统启发，团队构建了基于视觉原语的类脑互补感知新范式，将视觉信息拆分为不同的基础原语，并有机组合形成信息完备的互补双感知通路。基于该范式，设计实现了类脑互补感知芯片“天眸芯”。通过异构像素阵列等独特架构设计，实现像素级视觉原语和互补双通路，能够在高分辨率下捕捉色彩信息，同时低延迟地捕捉稀疏的时空差分视觉，实现高效互补的视觉感知。高效解决了长时间高帧率、高精度图像拍摄的传统难题。

Inspired by the human visual system, the team has developed a new paradigm of brain-inspired complementary perception based on primitive-based data representation, which decomposes visual information into different fundamental primitives and organically combines them to form complementary dual pathways. Based on this paradigm, they designed and implemented "Tianmouc" . Through unique architectural designs, such as a hybrid pixel array, it achieves this paradigm, capable of capturing color information at high resolution while also sensing the sparse spatiotemporal difference with low latency. Tianmouc enables efficient complementary visual perception, effectively addressing the traditional challenges of capturing high-frame-rate, high-precision images over extended periods.

此突破开辟了类脑感知和原语数据表示的新领域，并可扩展至听觉、触觉、嗅觉等传感器研发，为理解人类感知提供新视角。为机器视觉领域注入新活力，推动消费成像设备、工业自动化、自动驾驶及智能机器人等关键应用的发展，展现了巨大市场潜力。

This breakthrough opens up new fields for brain-inspired perception, and can be extended to the development of sensors for auditory, tactile, olfactory, and other sensors, providing new perspectives for understanding human perception. It injects new vitality into the field of machine vision, promotes the development of key applications such as consumer imaging devices, industrial automation, autonomous driving, and intelligent robotics, and demonstrates enormous market potential.



◉ 天眸芯在车载系统上在多种极端场景下进行了感知任务验证，说明了其在自动驾驶领域的巨大应用潜力

◉ Tianmouc has undergone validation of perception tasks under various extreme scenarios within automotive systems, highlighting its significant potential for application in the field of autonomous driving.

登顶自然期刊封面，收获国际学界好评

Published as the Cover Paper of the Nature Journal, Receiving Praise from the Global Academic Community

“天眸芯”论文《面向开放世界感知的类脑互补视觉芯片》于 2024 年 5 月 30 日作为封面文章在《自然》期刊发表，引发学术界和主流媒体的广泛关注。

The paper "A vision chip with complementary pathways for open-world sensing" relative to Tianmouc was published as a cover article in the Nature journal on May 30, 2024, attracting widespread attention from the academic community and mainstream media.

至今，中国大陆学术机构作为第一完成单位在《自然》上发表的封面文章仅有约二十篇。这标志着学术界对本工作的高度认可。论文审稿人之一、美国 Sandia 国家实验室类脑团队负责人 Craig Vineyard 认为“这一成果具有显著创新与贡献”“双通路提供了其它方案所缺乏的能力”。

So far, there have been only about twenty cover articles published in Nature finished by academic institutions in mainland China as the primary institution. This marks a high recognition of this work by the academic community. One of the paper's reviewers, Craig Vineyard, head of the brain-inspired team at the Sandia National Laboratories in the United States, believes that "resulting Tianmouc chip is an exciting and novel hybrid approach "

主流媒体也对“天眸芯”广泛报道，包括 40 余家权威新闻媒体，如新华社、中央电视台、人民日报、光明日报等。在权威论文影响力统计机构 Altmetric 中，天眸芯论文的影响力位列前 5%，关注度位列前 1%。

Mainstream media have also extensively reported on Tianmouc, including over 40 authoritative news outlets such as Xinhua News Agency, CCTV, People's Daily, Guangming Daily. According to Altmetric, an authoritative paper impact statistics organization, the impact of the paper ranks in the top 5%, while its attention is in the top 1%.

团队由于天机芯和天眸芯的成就，荣获英特尔技术委员会评选的 2024 年“英特尔中国学术成就奖（卓越研究）”，进一步证明了其在领域内的卓越贡献和影响力。

The team was also awarded the 2024 "Intel China Academic Achievement Award - Outstanding Research" by the Intel Technical Committee for their achievements in the Tianjic and Tianmouc, further demonstrating their outstanding contributions and influence in the field of brain-inspired intelligence.

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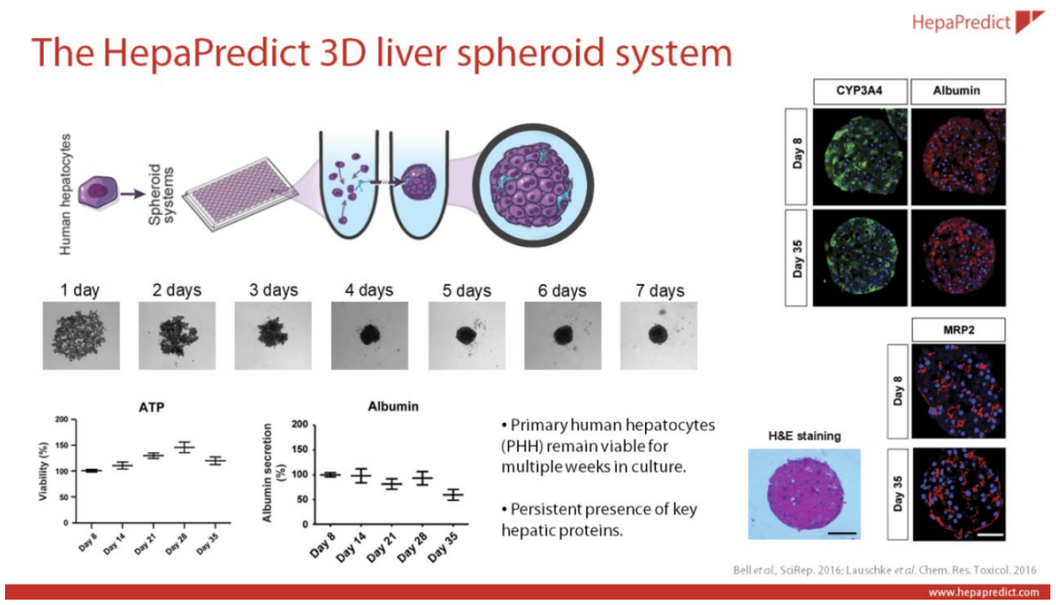
◉ 中央电视台报道天眸芯成果

◉ The CCTV reported on the achievements of Tianmouc

用于药物发现和开发的预测性三维肝脏模型

3D Human Tissue Models for Translational Pharmacology and Toxicology



◉ 体外培养的 3D 球体与体内肝细胞高度相似，为药物开发提供了最具生理相关性的肝脏系统。 3D 球体在长期培养过程中具有稳定的形态和表型。它们的长期存活性和功能性使慢性暴露研究成为可能，从而支持了对慢性药物性肝损伤的药物筛选。

◉ 3D spheroids cultured in vitro closely resemble liver cells in vivo thus providing a most physiological hepatic system for use in drug development. 3D spheroids have a stable morphology and phenotype during long-term culture. Their prolonged viability and functionality enable chronic exposure studies thus facilitating drug screening for chronic DILI.

Hepa Predict 股份有限公司
Hepa Predict AB

HepaPredict

引言

Hepa Predict 利用尖端的 3D 肝脏球体系统构建高度生理相关的预测模型，使培养的肝细胞能够准确反映体内观察到的表型和功能，从而为药物开发提供可靠的支持。该球体系统已与人工智能相结合，加速了从计算假设生成到实验验证的开发进程。我们用此系统验证了巴瑞替尼治疗 COVID-19 的有效性，从理论假设到临床验证仅用了 16 个月。这一成果在一定程度上促使巴瑞克替尼获得了美国食品和药物管理局的批准和世界卫生组织的认可，挽救了无数生命，节省了数十亿美元的医疗开支。

Introduction

In order to constitute a relevant hepatic in vitro system, cultured hepatocytes need to accurately reflect phenotypes and functionality seen in vivo. Hepa Predict utilizes a cutting-edge 3D liver spheroid system to offer predictive models with high physiological relevance for drug development. Among other successes, the spheroid system has been coupled to AI to accelerate the development from computational hypothesis generation to experimental validation. For instance, our 3D models have validated AI-based repurposing of baricitinib against COVID-19 from theoretical hypothesis to clinical validation in just 16 months, compared with the many years that such developments typically take. Based in part on our data, baricitinib has received FDA approval and WHO endorsement and has saved billions of dollars and many lives.

通过其创新的 3D 肝脏球体系统，Hepa Predict 在预测药物反应、代谢和毒性方面实现了前所未有的准确性

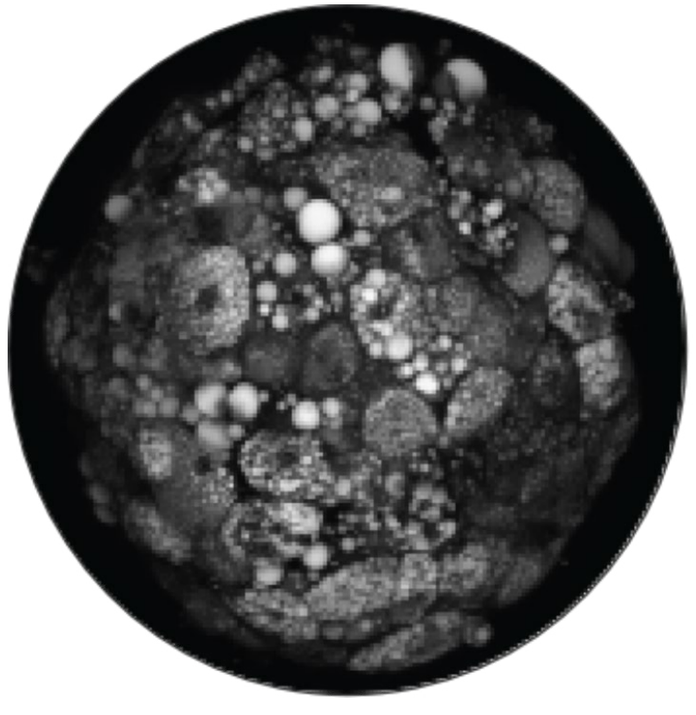
Through its Innovative 3D Liver Spheroid System, Hepa Predict Achieves Unprecedented Accuracy in Predicting Drug Response, Metabolism and Toxicity

通常情况下，主要采用动物实验和 2D 肝细胞系统来研究人类药物的代谢和毒性。然而，这些模型由于物种差异较大以及传统 2D 单层培养中的肝细胞会迅速去分化并失去其表型和特定的肝细胞功能，存在重大局限性。Hepa Predict 的 3D 肝脏球体系统克服了传统药物毒性测试中的技术难题，解决了 2D 细胞模型缺乏生理相关性的问题。

Hepa Predict has overcome the technical challenge of traditional drug toxicity testing, where 2D cell models lack physiological relevance. Mainly animal studies and 2D hepatocyte systems have been used for the examination of human drug metabolism and toxicity. Yet, these models have major limitations due to extensive species differences and because hepatocytes in conventional 2D monolayer cultures rapidly dedifferentiate and lose their phenotype and hepatocyte-specific functions.

Hepa Predict 提供了一种具有创新性且相对完善的长期稳定 3D 原代人肝球体培养系统。该 3D 球体系统利用原代人肝细胞，在 3D 培养环境中能够维持高度生理性的表型长达数周。相比在短时间内即失去体内表达特征的 2D 模型，这一 3D 球体系统表现出显著优势，为构建更具生理相关性的肝脏系统提供了创新性的突破。该系统的长期存活性和功能性使其成为理想的长期研究工具，能够准确预测体内代谢和毒性。这种高度生理复制的 3D 肝脏球体系统在药物发现和开发中实现了精准预测，特别是在长期毒性评估、药代动力学研究以及个体间差异模拟方面取得了突破性进展。值得注意的是，通过多组学方法，3D 球体系统可以生成详细且全面的数据集。这些数据集能够提供连贯的实验结果，使研究人员可以基于这些数据更好地预测或推测某些因素对细胞过程的影响或效果。在多中心试验中进行的全面基准测试表明，Hepa Predict 的系统在灵敏度和特异性方面具有优势，这说明了其在毒理分析领域的国际领先地位。此外，其独特的技术减少了化合物的吸收，提升了毒理学解读的准确性，进一步提升了其创新能力。

Hepa Predict offers a novel, well established long-term stable 3D primary human liver spheroid culture platform. The 3D spheroid system utilizes primary human hepatocytes, which are able to maintain a highly physiological phenotype for several weeks in 3D culture. The 3D spheroid system significantly outperforms 2D models that lose their in vivo expression signatures within a short time, and thus provides a novel step into a more physiological hepatic system. The prolonged viability and functionality of the system are an optimal tool for long-term studies, enabling accurate prediction of in vivo metabolism and toxicity. This highly physiologically replicated 3D liver spheroid system enables precise predictions in drug discovery and development, particularly achieving breakthroughs in long-term toxicity assessments, pharmacokinetics, and simulations of inter-individual variability. Importantly, through multi-omics approaches, the 3D spheroid platform is a reliable tool for the generation of comprehensive data sets, which provide cohesive results to enable predictions of large-scale effects on cellular processes. Comprehensive benchmarking in multi-center trials has demonstrated that Hepa Predict's system has its advantages in both sensitivity and specificity, showcasing its international leadership in toxicological analysis. Additionally, its unique technology reduces compound absorption and enhances the accuracy of toxicological interpretations, further consolidating its innovativeness.



◉ 3D 球状体的长期存活性和功能性使其成为长期研究的理想工具

◉ The Prolonged Viability and Functionality of 3D Spheroids Are an Optimal Tool for Long-term Studies

3D 球状体具有科学价值，可提供与人体组织更为相似的模拟效果

The Scientific Value of 3D Spheroids Lies in Their Ability to Provide a Closer Approximation to Human Tissue

新型 3D 球体系统为研究人体组织和疾病提供了更多生理相关模型，从而彻底改变了研究，显着增进了我们对复杂生物过程的理解。与传统的 2D 细胞培养物不同，3D 球体系统可以更好地模拟体内环境，从而可以更准确地研究细胞行为、药物反应和组织相互作用。这项创新推动了生物医学研究，改进了药物发现和毒性测试，减少了对动物模型的依赖，并加速了有效疗法的开发。从经济角度来看，使用 3D 球体系统可以提高临床前研究的可预测性并降低临床试验中的高失败率，从而降低药物开发相关的成本。从社会角度来看，这些进步促进了更安全、更有效的治疗方法的开发，提高了医疗保健的整体质量，并更有效地应对全球健康挑战，从而为公共卫生做出了贡献。

Novel 3D spheroid systems have revolutionized research by providing more physiologically relevant models for studying human tissues and diseases, significantly advancing our understanding of complex biological processes. Unlike traditional 2D cell cultures, 3D spheroid systems better mimic the in vivo environment, allowing for more accurate investigations into cellular behaviors, drug responses, and tissue interactions. This innovation has propelled biomedical research, leading to improved drug discovery and toxicity testing, reducing the reliance on animal models, and accelerating the development of effective therapies. Economically, the use of 3D spheroid systems can lower the costs associated with drug development by increasing the predictability of preclinical studies and reducing high failure rates in clinical trials. Socially, these advancements contribute to public health by fostering the development of safer and more effective treatments, enhancing the overall quality of healthcare, and addressing global health challenges more efficiently.

本成果的完成人沃尔克·劳施克（Volker Lauschke），除了在 Hepa Predict 的工作外，在理论和学术领域展现了原创见解和创新的研究方法。他担任瑞典卡罗林斯卡学院的转化药理学全职教授，并且是德国 Dr. Margarete Fischer-Bosch 临床药理学研究所副所长。其团队利用 3D 细胞培养系统、微流控技术和生物信息学方法，在非酒精性脂肪肝病、2 型糖尿病等复杂代谢性疾病的研究与治疗策略上取得了显著突破，并开发了新型治疗方案，这在药理学领域是前所未有的进展。此外，开发机器学习工具以增强个性化药物治疗并预测药物毒性，构成了方法学上的突破，显著支持了精准医学的发展。劳施克的成就不仅在理论上推动了药理学、分子生物学和生物信息学的发展，而且在实际应用中推动了药物发现和个性化医疗的进步，对经济建设和社会发展产生了深远影响。

Besides his work at Hepa Predict, Volker Lauschke is Full Professor for translational pharmacology at Karolinska Institutet, Sweden, and Deputy Director of the Dr. Margarete Fischer-Bosch Institute of Clinical Pharmacology, Germany. His research has demonstrated original insights and innovative research methodologies in both theoretical and academic realms. His team's utilization of 3D cell culture systems, microfluidic technology, and bioinformatic approaches to address complex metabolic diseases such as non-alcoholic fatty liver disease and type 2 diabetes, and develop novel therapeutic strategies, represents an unprecedented advancement in pharmacology. Furthermore, the development of machine learning tools to enhance personalized drug therapy and predict drug toxicity constitutes a methodological breakthrough, significantly supporting precision medicine. Lauschke's achievements have not only propelled the development of pharmacology, molecular biology, and bioinformatics theoretically but also fostered advancements in drug discovery and personalized medicine in practical applications, exerting profound impacts on economic construction and social development.

◉ 沃尔克·劳施克
◉ Volker M. Lauschke

Hepa Predict 的 3D 肝脏模型以其卓越的创新性和准确性获得了国际科学界的广泛认可

Hepa Predict's 3D Liver Model has Gained Extensive Recognition in the International Scientific Community Due to Its Remarkable Innovation and Accuracy

Hepa Predict 的 3D 肝脏模型因其卓越的创新和预测能力而在药物发现和开发领域获得了广泛的国际认可。其研究成果不仅发表在众多顶级学术期刊上，还成功获得 FDA、EFSA 等国际监管机构的申请和认证，证明了其在药物评价方面的可靠性和有效性。这些模型被全球制药公司和研究机构广泛采用，显示出较高的国际接受度。通过提供更可靠的药物测试系统，3D 球体系统加速了新疗法和医学治疗的批准，影响了全球监管框架。美国、日本和欧盟成员国等制药工业先进的国家尤其从这些创新中受益，增强了其前沿研发能力。此外，发展中国家采用 3D 球体技术有可能提高当地研究标准并将这些国家融入全球科学界。 3D 球状体系统的国际传播促进了更加互联的科学生态系统，在这个生态系统中，知识共享和合作能够更有效地应对全球健康挑战。通过国际会议、出版物和培训项目，3D 球状体系统的影响力持续增长，弥合了不同领域之间的差距，推动了医学研究与开发的统一进程。

Hepa Predict's 3D liver model has gained significant international recognition in the field of drug discovery and development due to their remarkable innovation and predictive capabilities. Its research achievements have not only been published in numerous top-tier academic journals, but have also received successful application and certification from international regulatory agencies such as the FDA and EFSA, demonstrating its reliability and effectiveness in drug evaluation. Moreover, these models are widely adopted by global pharmaceutical companies and research institutions, showcasing a high level of international acceptance. By providing a more reliable platform for drug testing, 3D spheroid systems have accelerated the approval of new therapies and medical treatments, impacting regulatory frameworks globally. Countries with advanced pharmaceutical industries, such as the United States, Japan, and members of the European Union, have particularly benefited from these innovations, enhancing their capacity for cutting-edge research and development. Furthermore, the adoption of 3D spheroid technology in developing nations has the potential to elevate local research standards and integrate these countries into the global scientific community. This international dissemination of 3D spheroid systems fosters a more interconnected scientific ecosystem, where shared knowledge and collaborative efforts can address worldwide health challenges more effectively. Through international conferences, publications, and training programs, the influence of 3D spheroid systems continues to grow, bridging gaps and promoting a unified approach to medical research and development.

Key publications:

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3. Hendriks et al. Sci. Rep. **2016**, 6, 35434.
4. Vorrink et al. FASEB J. **2017**, 31, 2696–2708.
5. Bell et al. Drug Metab Disp. **2017**, 45, 419–429.
6. Bell et al. Toxicol. Sci. **2018**, 162, 655–666.
7. Vorrink et al. Toxicol. Sci. **2018**, 163, 655–665.
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10. Morgantini et al. Nature Metab. **2019**, 1, 445–459.
11. Hurrell et al. Cells. **2020**, 9, 964.
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14. Oliva-Vilarnau et al. Adv Sci. **2021**, 7, 2000248.
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18. Azzimato et al. Gastroenterol. **2021**, 161, 1982-1997.
19. Preiss et al. AAPS J. **2022**, 24, 41.
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21. Tredup et al. ACS Chem Biol. **2023**, Epub ahead of print.
22. Novak et al. ACS Chem Biol. **2023**, Epub ahead of print.
23. Oliva-Vilarnau et al. Biochem Pharm. **2023**, 215, 115755.
24. Barreby et al. Nature Metab. **2023**, Epub ahead of print.

◉ 主要出版物　◉ Key Publications

世界互联网大会
领先科技奖获奖成果集

Leading Achievements of
World Internet Conference Awards for
Pioneering Science and Technology

01

世界互联网大会
领先科技奖获奖成果

Leading Achievements of
World Internet Conference
Awards for Pioneering Science and Technology

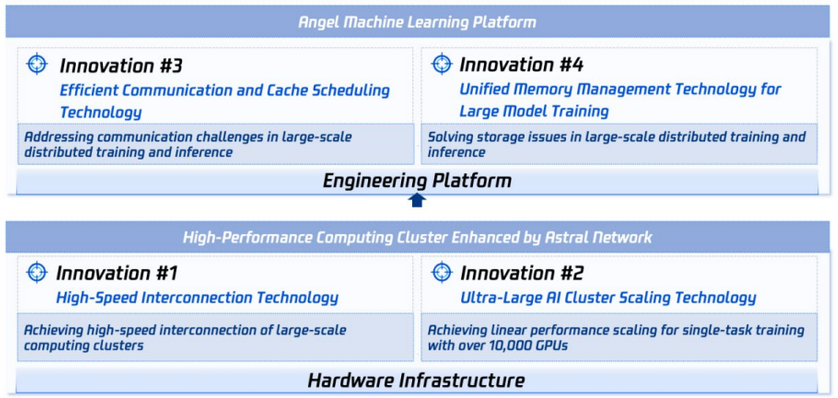
关键技术组
Key Technology Group

Angel 大规模机器学习平台关键技术与应用

Key Technologies and Applications of the Angel Large-Scale Machine Learning Platform

◉ 面向超大规模数据和模型的 Angel 机器学习平台

Driving Ultra-Large Scale Model Development with Groundbreaking Technological Innovations



◉ Angel Machine Learning Platform for Ultra-Large-Scale Data and Models

腾讯科技（深圳）有限公司
Tencent Technology (Shenzhen) Company Limited

北京大学
Peking University

北京科技大学
University of Science and Technology Beijing

引言

项目突破 TB 级机器学习模型分布式训练和推理、大规模应用部署等关键技术，构建的 Angel 机器学习平台在中国率先实现底层硬件到关键软件技术的自主研发，显著推动实体产业和数字经济发展，提升社会效率，产生重大经济效益。

Introduction

The project achieved breakthroughs in key technologies such as distributed training and inference of TB-level machine learning models, and large-scale application deployment. The Angel machine learning platform, independently developed in China from underlying hardware to critical software technologies, has significantly advanced the development of physical industries and the digital economy. It has enhanced societal efficiency and generated substantial economic benefits.

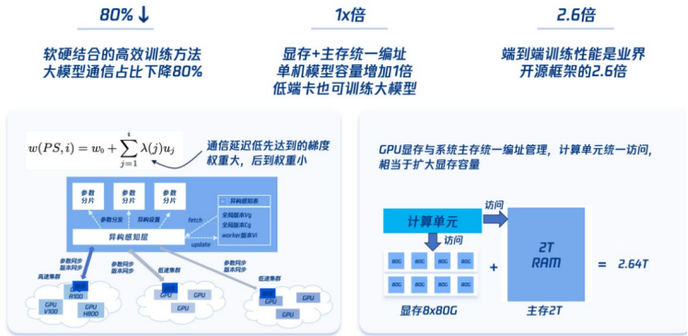
Angel 平台关键技术攻克超大规模机器学习难题

Key Technologies of the Angel Platform Overcoming Challenges in Ultra-Large-Scale Machine Learning

Angel 机器学习平台针对 TB 级模型分布式训练和推理、应用部署难的挑战，在框架性能、网络互联、平台规模三方面实现了突破。平台开发了高性能分布式框架，提出了显存 + 主存统一存储管理、算子优化及并行计算等技术，训练性能是业界 2.6 倍。通过显存共享和性能优化等提升推理吞吐，推理性能是业界 2.3 倍。大幅提升了模型训练与推理效率。同时，通过研制全链路硬件和研发高效软件算法，构建了万卡大规模 RDMA 高速网络。实现了万卡算力的高速互联，通信性能提升 30%，成本下降 70%，有效支撑了大模型训练推理的算力需求。此外，平台实现线性扩展突破单任务万卡规模，通信开销降低 80%，多机多卡加速比达 99%，GPU 利用率达到 62%，超越业界水平，并实现大模型任务 99.5% 的稳定性。

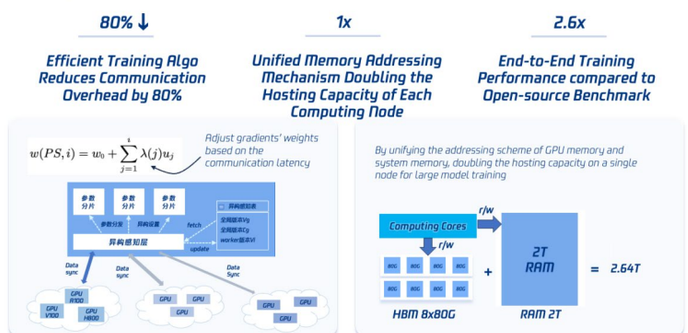
The Angel machine learning platform addresses the challenges of distributed training and inference for terabyte-scale models, as well as the difficulties in application deployment. It has achieved breakthroughs in three key areas: framework performance, network interconnection, and platform scalability. The platform has developed a high-performance distributed framework, introducing technologies such as unified memory management for GPU and system memory, operator optimization, and parallel computing. Its training performance is 2.6 times that of industry standards. By leveraging shared GPU memory and performance optimizations, inference throughput has been increased, with inference performance being 2.3 times that of industry standards. These advancements significantly enhance the efficiency of model training and inference. Moreover, through the development of end-to-end hardware solutions and efficient software algorithms, a large-scale RDMA high-speed network comprising tens of thousands of GPU units has been constructed. This network achieves high-speed interconnection for thousands of computing nodes, improving communication performance by 30% while reducing costs by 70%. This effectively meets the computational power demands for large model training and inference. Additionally, the platform realizes linear scalability beyond a single task with over ten thousand GPU cards, reduces communication overhead by 80%, achieves a multi-machine multi-GPU acceleration ratio of 99%, GPU utilization rate reaches 62%, surpassing industry standards, and ensures a task stability rate of 99.5% for large models.

软硬件结合优化，训练框架性能是业界开源框架 2.6 倍

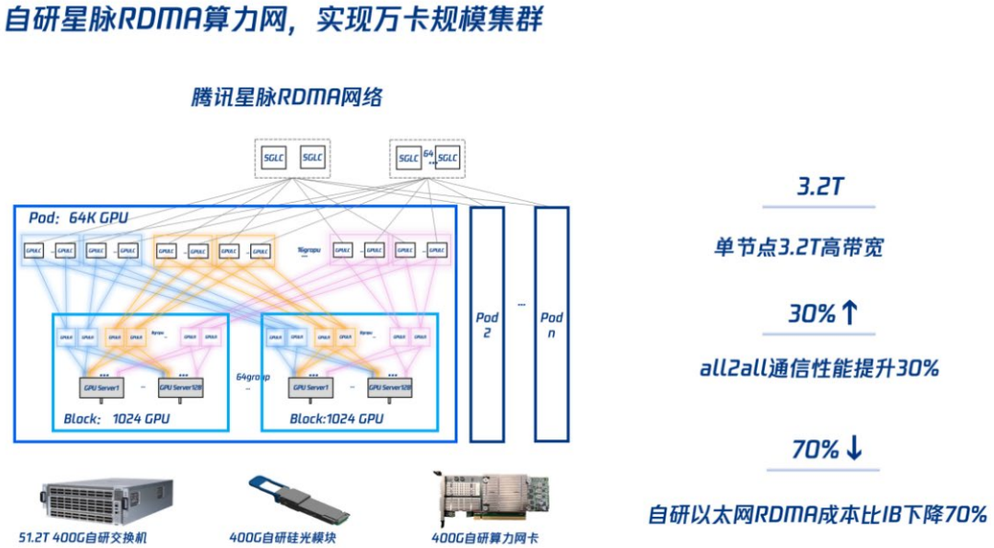


◉ 自研 Angel 框架性能大幅领先开源框架

Synergistic co-design of Software and Hardware for Enhanced Model Training Performance

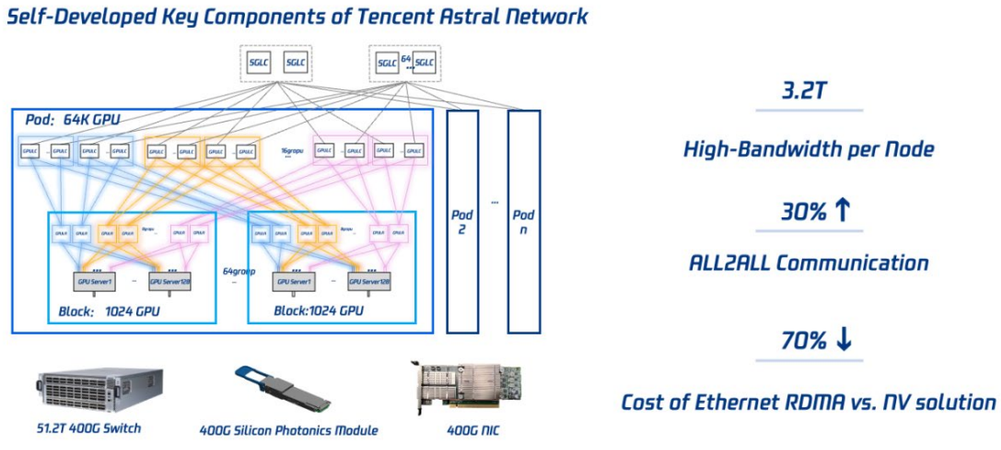


◉ The Angel framework significantly outperforms open-source benchmark



◉ 自研星脉网络显著提升通信性能，支持万卡 GPU 集群高速互联

Tencent's Astral RDMA Network technology for 10,000+ GPU AI Clusters



◉ Tencent Astral Network Supporting High-speed Interconnection for Clusters with 10,000+ GPU Units

推动产业数智化升级，促进数字经济发展

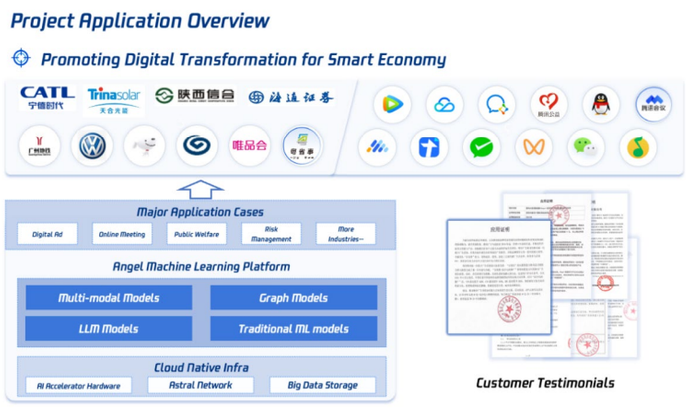
Driving Industrial Digitalization and Promoting the Development of the Digital Economy

项目构建的 Angel 机器学习平台在多个领域得到广泛应用：在支撑产业发展方面，Angel 平台通过腾讯云对生态输出，服务广州地铁、宁德时代等，助力千行百业进行数智化升级；在促进数字经济发展方面，基于 Angel 平台的腾讯新一代广告系统，已服务京东，唯品会、阿里等行业领军企业；在提升社会效率上，Angel 平台助力腾讯会议提供更高效、更流畅的在线会议智能化体验，疫情期间帮助企业复工复产，全球在线会议规模创纪录；

在公益领域，利用平台提供的图网络模型有效打击黑产，利用 AI 赋能文化公益事业，还助力药物研发、具身智能等前沿研究。近三年，项目直接收入达 182.38 亿元，不仅推动了产业升级，还显著提升了社会运行效率，创造了显著的经济和社会效益。

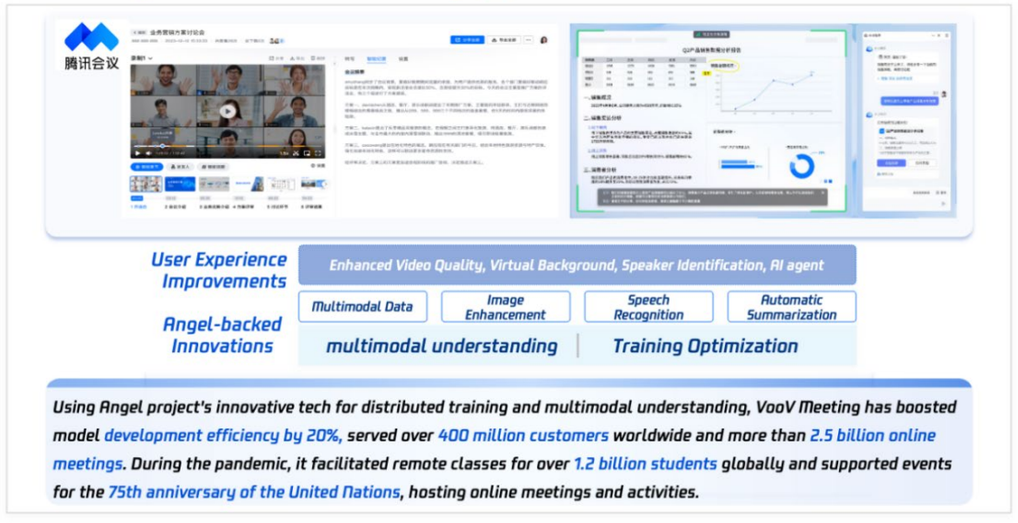
The Angel machine learning platform developed by Tencent has been widely applied across various sectors. In terms of supporting industrial development, the Angel platform is delivered through Tencent Cloud to serve ecosystems such as Guangzhou Metro and CATL, aiding numerous industries in their digital transformation. Regarding the promotion of digital economy development, Tencent's next-generation advertising system based on the Angel platform has already been employed by leading enterprises such as JD.com, Vipshop, and Alibaba. In enhancing societal efficiency, the Angel platform supports Tencent Meeting in providing a more efficient and seamless intelligent online conferencing experience. During the pandemic, it facilitated companies in resuming work and production, with global online conference participation reaching record levels. In the realm of public welfare, the platform leverages its graph network model to effectively combat illicit activities and empowers cultural public welfare initiatives with AI. It also contributes to advanced research areas like drug development and embodied intelligence. Over the past three years, this project has generated direct revenue amounting to 18.238 billion RMB. It not only drives industrial upgrades but also significantly enhances societal operational efficiency, creating substantial economic and social benefits.

◉ 项目应用概况



◉ Project Application Overview

◉ 支撑腾讯会议实现数字化体验升级



◉ Supporting VooV Meeting to Achieve a Digital Experience Upgrade

成果屡获国际认可，引领技术进步推动产业创新

Achievements Recognized Internationally, Leading Technological Advancement and Driving Industry Innovation

项目在推动技术进步和引领产业创新等方面成果显著：项目技术成果多次登顶国际权威领域榜单，获得 20 余项国际竞赛冠军，发表国际学术论文 74 篇。Angel 平台是中国首个从 Linux Foundation 毕业的顶级 AI 开源项目，获得了 2019 年度最受欢迎中国开源软件，平台吸引了众多外部开发者和企业用户，促进了技术的广泛应用和产业的协同发展。此外，腾讯基于 Angel 平台全链路自研的混元大模型，是在中国众多头部 AI 研发企业中率先采用先进的混合专家模型 (MoE) 结构并投产的超万亿参数规模大模型，第三方评测显示腾讯混元处于中国大模型第一梯队，整体表现高于国际大模型均线。

The project has yielded significant results in advancing technology and leading industry innovation. The technological achievements of the project have frequently topped authoritative international rankings, winning over 20 international competition championships and resulting in the publication of 74 international academic papers. Angel is China's first top-tier AI open-source project to graduate from the Linux Foundation, earning the title of 'Most Popular Chinese Open Source Software' in 2019. The platform has attracted numerous external developers and enterprise users, promoting widespread technological application and industry collaboration. Furthermore, Tencent's self-developed full-stack Hunyuan large model based on the Angel platform is among the first from leading Chinese AI research enterprises to adopt advanced Mixture of Experts (MoE) architecture and be deployed into production with a scale exceeding one trillion parameters. Third-party evaluations indicate that Tencent's Hunyuan ranks in the top tier of LLMs in China, with overall performance surpassing the international average for LLMs.

◉ 成果屡获国际认可，引领技术进步推动产业创新

◉ Achievements Recognized Internationally, Leading Technological Advancement and Driving Industry Innovation

项目成果获行业专家和权威机构的广泛认可

Project Achievements Recognized by Industry Experts and Authoritative Institutions

项目成果《面向大规模数据的 Angel 机器学习平台关键技术及应用》获得中国电子学会科技进步一等奖，《十亿级用户大规模弹性云网络》获得深圳市科技进步一等奖。Angel 平台还支持了中国医疗影像新一代人工智能开放创新平台建设；腾讯作为中国人工智能标准化总体组副组长单位，参与编制了 9 项中国 \ 行业 \IEEE 标准。

The project achievement titled "Key Technologies and Applications of the Angel Machine Learning Platform for Large-scale Data" won the first prize in Scientific and Technological Progress awarded by the China Institute of Electronics. Additionally, "Elastic Cloud Network for One Billion Users" won the first prize in Scientific and Technological Progress awarded by Shenzhen. The Angel platform has also supported the construction of a new generation artificial intelligence open innovation platform for Chinese medical imaging. Tencent, serving as the deputy leader of China's Artificial Intelligence Standardization Group, has participated in drafting nine standards for China, industry, and IEEE.

◉ 项目成果获行业专家和权威机构的广泛认可

◉ Project Achievements Widely Recognized by Industry Experts and Authoritative Institutions

ACE-6G：面向 6G 的语义通信技术平台

ACE-6G: AI Communication Empowered Semantic Platform for 6G

◉ 面向 6G 的语义通信技术平台

◉ AI Communication Empowered Semantic Platform for 6G

鹏城实验室
Pengcheng Laboratory

北京邮电大学
Beijing University of Posts and Telecommunications

引言

鹏城实验室联合北京邮电大学，突破非线性信源信道联合编码及多用户语义通信新空口等技术，构建了 ACE-6G：面向 6G 的语义通信技术平台，频谱利用率相比传统技术进一步提升了 2~3 倍，赋能 5G 链路实现 6G 泛在连接传输能力，为 6G 关键技术标准化提供有力支撑。

Introduction

Pengcheng Laboratory and Beijing University of Posts and Telecommunications have made breakthroughs in nonlinear joint source and channel coding technology and the novel air interface technology of multi-user semantic communication and so on, and built ACE-6G: AI Communication Empowered Semantic Platform for 6G, which further improves the bandwidth efficiency by 2~3 times compared with traditional technologies, empowers 5G links to achieve 6G ubiquitous connection transmission capabilities, and provides strong support for the standardization of 6G key technologies.

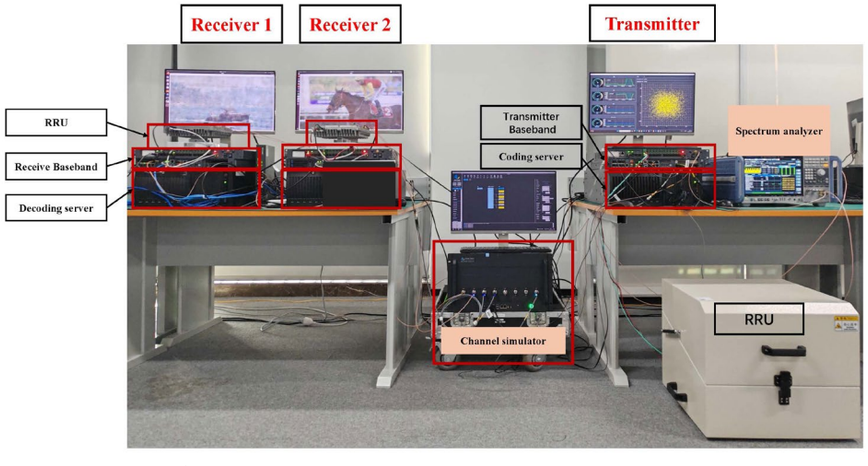
突破恶劣信道环境传输难题，实现泛在智慧互联

Breaking Through Transmission Problems in Harsh Channel Environments and Achieving Ubiquitous Smart Interconnection

本成果针对 6G 泛在智联对网络通信柔性适变要求强、恶劣信道环境传输性能要求高以及沉浸式通信带宽需求大等三个关键难题展开研究，提出了基于语义知识库的语义通信架构，设计了语义知识库使能的零样本多层级特征传输方法，实现低增量知识库更新，可降低业务传输时延 90% 以上；突破基于非线性变换编码的信源信道联合编码技术，相比 5G 技术，传输带宽可节省 50%，改善了传统通信方式在低信噪比传输时的“断崖”效应；研发基于新维度资源的多用户语义通信原型系统，拓展了语义模型域资源新维度，突破多用户语义通信新空口技术，频谱利用率相比传统技术提升了 2~3 倍。

For the challenges of intelligent interconnection's requirements for network communication flexibility and adaptability, high-performance transmission in harsh channel environments, and high bandwidth requirements, the ACE-6G research team has proposed a semantic communication architecture based on a semantic knowledge base and designed a zero-shot multi-level feature transmission method enabled by semantic knowledge base, which realizes low-incremental knowledge base updates and reduces the communication service transmission latency by more than 90%. A breakthrough in joint source and channel coding technology based on nonlinear transform coding is made, which achieves that compared with 5G technology, the transmission bandwidth can be saved by 50%, which improves the “cliff effect” of traditional methods in low signal-to-noise ratio transmission. A multi-user semantic communication prototype system based on new resource is developed, which incorporates the new dimension of semantic model domain resources and breaks through the new air interface technology of multi-user semantic communication. It can increase the spectrum utilization rate by at least 1 time compared with traditional technologies.

◉ 面向 6G 的语义通信技术实物验证平台



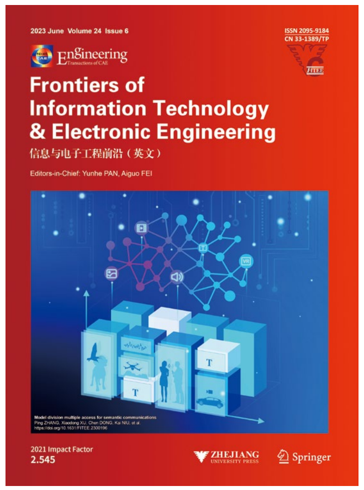
◉ Semantic Communication Technology Physical Verification Platform for 6G

聚焦 6G 智能与通信标准化，赋能行业应用

Focusing on 6G Intelligence and Communication Standardization to Empower Industry Applications

本成果以突破 6G 智能通信融合的新范式，挖掘更高层次的语义信息特征，研发了面向 6G 的语义通信技术。发表语义通信高水平期刊 / 会议论文 50 余篇，并且实现了语义通信技术在无人机低空经济、智能网联无人车及星地直连等场景的创新应用。在 IMT-2030（6G）工作组牵头成立了语义通信任务组，完成了 CCSA 标准研究项目，发布了面向 6G 的语义知识库技术白皮书，得到了包括中国移动、华为、中兴等十余家知名企业和高校的支持，推动了面向 6G 的语义通信国际标准化进程。另外，研究团队提交了发明专利申请 100 余项，目前 32 项已授权，提交 PCT 专利申请 2 项，与中国移动等联合成立新型研发机构，面向 6G 基础理论和共性关键技术展开攻关、产业路径探索。

The achievement aims to break through the new paradigm of integration of 6G intelligence and communication, explores higher-level semantic information features, and develops semantic communication technology for 6G. The ACE-6G research team has published more than 50 high-level journal/conference papers on semantic communication, and realized the innovative application of semantic communication technology in scenarios such as low-altitude economy, intelligent networked unmanned vehicles, and satellite-to-ground direct connection. The ACE-6G research team has made a lead to found the semantic communication task group in IMT-2030 (6G) working group, completed the CCSA standardization research project, and released the technical white paper for semantic knowledge base, which has been supported by more than 10 well-known enterprises and universities, including China Mobile, Huawei and ZTE. It can promote the international standardization process of semantic communication for 6G. Moreover, the research team has submitted a total of 100 invention patents, 32 of which have been authorized so far, and submitted 2 PCT patent applications. A new R&D institution has been jointly established with China Mobile and others to develop 6G basic theories and common key technologies, as well as explore industrial paths.



◉ ACE-6G 部分获奖、论文发表及专利授权情况

◉ Part of the Awards, Published Papers and Authorized Patents Based on ACE-6G

开辟 6G 技术新路径，启发语义通信原创性研究

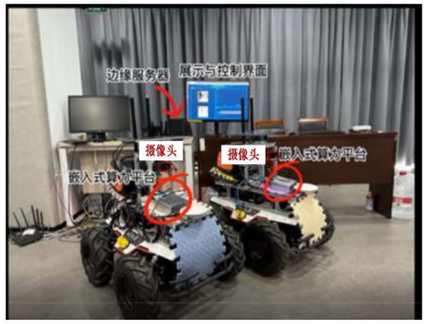
Opening New Paths for 6G and Inspiring Original Research on Semantic Communication

本成果面向 6G 通信与智能深度融合发展趋势，提出基于语义知识库的语义通信架构，实现了信源信道联合编解码技术、多用户语义通信技术在低空经济、高清视频传输、卫星通信等场景的示范应用。针对无人机通信对机载处理算力要求高，网络回传带宽消耗大的挑战，实现语义模型的增量更新和实时传输技术，减少机载算力需求 15% 以上，降低网络回传带宽需求 70% 以上，解决了限制低空经济发展的关键难题。

Facing the development trend of deep integration of 6G communication and intelligence, this achievement has proposed a semantic communication architecture based on semantic knowledge base, and realized the demonstration application of joint source-channel coding technology and multi-user semantic communication technology in low-altitude economy, high-definition video transmission, satellite communication and other scenarios. In view of the challenges of unmanned aerial vehicle communication with high requirements for airborne processing computing power and large consumption of network backhaul bandwidth, the incremental update and real-time transmission technology of semantic model are realized to reduce the demand for airborne computing power by more than 15% and the network backhaul bandwidth requirement by more than 70%, which no longer limits the development of low-altitude economy.

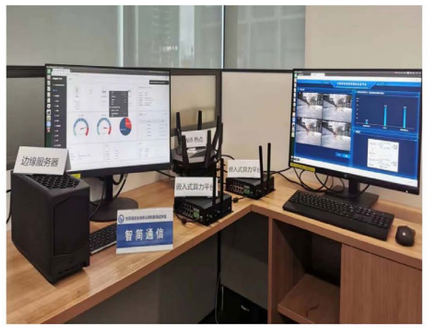
针对无人车智能网联中高清视频无线传输需求，研究团队突破基于非线性变换编码的信源信道联合编解码技术，在丢包率 30% 的恶劣无线信道环境中，接收端达到相同业务质量时，相比传统无线通信方式，语义通信的传输带宽可节省 50% 以上。语义通信架构及相应的关键技术可以为未来 6G 移动通信系统构建高效的传输能力、频谱效率和更好的业务体验，为服务数字经济的网络基础设施建设提供重要支撑。

In order to meet the wireless transmission requirements of high-definition video in the intelligent network of unmanned vehicles, the research team has made a breakthrough in joint source-channel coding technology based on nonlinear transformation coding, which can save more than 50% of the transmission bandwidth of semantic communication compared with traditional wireless communication methods when the receiver achieves the same service quality in a harsh wireless channel environment with a packet loss rate of 30%. The semantic communication architecture and corresponding key technologies can build efficient transmission capacity, achieve high spectrum efficiency and better service experience for the 6G, and provide important support for the construction of network infrastructure for the digital economy.



（a）实物平台展示图

（b）平台界面



（c）系统调试环境1

（d）系统调试环境2

◉ 面向车联网的语义通信关键技术验证

◉ Verification of Key Technologies of Semantic Communication for Internet of Vehicles

◉ 面向低空经济的语义通信技术应用

◉ Application of Semantic Communication Technology for Low-Altitude Economy

超大规模算力并网、算网大脑技术创新与应用

Technology Innovation and Application of Ultra-Large-Scale Computility Integration and Computility Network Brain

◉ 业界首次系统提出了超大规模算力并网、算网大脑的整体架构和技术体系，并在算网融合调度、一体化编排、网络能力开放、算力对接模式等方向打造了原创性技术簇，创新任务式服务，提升社会算力资源利用率。

◉ For the first time in the industry, China Mobile systematically proposed the overall architecture and technical system of ultra-large-scale Computility Grid Integration and Brain of Computility Network. It has developed original technology clusters in areas such as integrated scheduling and unified orchestration of Computility Network, network capability openness, and computility interconnection models, innovated task as a service, and improved the utilization of societal computility resources.

中国移动通信集团有限公司
China Mobile Communications Group Co., Ltd.

清华大学
Tsinghua University

芜湖市大数据建设投资运营有限公司
Wuhu Big Data Construction Investment and Operation Co.,Ltd.

引言

算力网络、算网大脑、算力并网是中国移动提出的全新理念和技术体系，旨在探索通信技术（CT）与信息技术（IT）的深度融合，为用户提供“一点接入、即取即用”的算网服务。

Introduction

Computility Network, Brain of Computility Network, and Computility Grid Integration are new concepts and technical systems pioneered by China Mobile, aimed at exploring the deep integration of Communication Technology (CT) and Information Technology (IT), to provide users with 'one-point access, on-demand use' Computility Network services.

开创性建立算力网络整体架构和技术体系

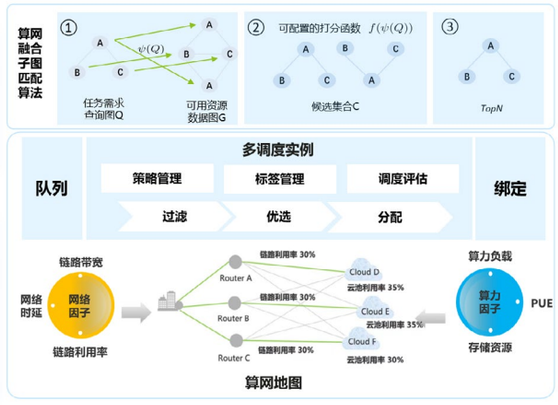
Pioneering the Establishment of an Overall Architecture and Technical System for the Computility Network

中国移动于 2021 年开创性提出算力网络全新理念及架构，打造了算网大脑系统。算网大脑是算力网络的核心中枢，南向纳管广域算网资源，北向支撑算网运营。

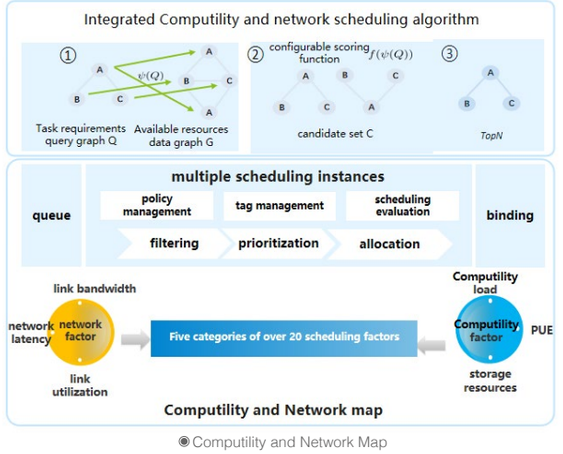
In 2021, China Mobile pioneered the new concept and architecture of the Computility Network and developed the Brain of Computility Network. The Brain of Computility Network serves as the core hub of the Computility Network, managing wide-area Computility Network resources in the southbound direction and supporting Computility Network operations in the northbound direction.

算网大脑在资源调度方面，创新算网融合调度技术，基于大规模管控和存算分离技术，实现算网资源秒级感知、秒级数据查询。打造高性能调度器，支持日均亿次调度；在能力编排方面，基于高效路由匹配算法打造能力网关，接入 2200+ 算网原子能力，实现算网资源一体化编排；在网络传输方面，提出面向数据设计的离散事件仿真引擎，实现十万节点级别的算力网络高效仿真、故障精准探测；构建超大规模骨干控制器，结合多路负载均衡和广域高吞吐等技术，提升长距离传输带宽利用率超过 90%；在智能能力方面，构建以交互入口、智能中枢、感知控制为核心的算网大脑智能能力，实现用户业务需求的意图解析、智能编排调度。

In terms of resource scheduling, the Brain of Computility Network innovates with converged scheduling technology for the Computility Network, based on large-scale management and storage-computation separation technologies, achieving second-level perception and data querying of Computility Network resources. It builds high-performance schedulers that support an average of hundreds of millions of scheduling tasks daily; in terms of capability orchestration, it develops capability gateways based on efficient routing matching algorithms, integrating over 2,200 atomic capabilities of the Computility Network, thereby realizing integrated orchestration of Computility Network resources; in terms of network transmission, it proposes a discrete event simulation engine designed for data, achieving efficient simulation of Computility Network at the level of tens of thousands of nodes and precise fault detection; it constructs ultra-large-scale backbone controllers, combining multi-path load balancing and wide-area high-throughput technology to increase long-distance transmission bandwidth utilization to over 90%; in terms of intelligent capabilities, it builds intelligent capabilities of the Brain of Computility Network centered on interaction entry points, intelligent hubs, and sensing control, achieving intent parsing and intelligent orchestration scheduling based on user business requirements.



◉ 算网地图



◉ Computility and Network Map

中国移动率先发起了“算力并网行动”，打造了运营层对接、编排管理层对接、云原生算力纳管、资源层算力纳管四种技术对接模式，支持统一纳管通、智、超、量四种异构算力。通过汇聚社会算力，打破信息孤岛，推动算力成为普惠级社会服务，赋能千行百业。

China Mobile took the lead in initiating the 'Computility Grid Integration Action', developing four technical docking methods: operational layer docking, orchestration management layer docking, cloud-native computility management and resource layer computility management. These methods support the unified management of four types of heterogeneous Computility: General Computing, Intelligent Computing, Supercomputing Computing, and Quantum Computing. By aggregating social Computility and breaking down information silos, it promotes Computility as a universal social service and empowering various industries.

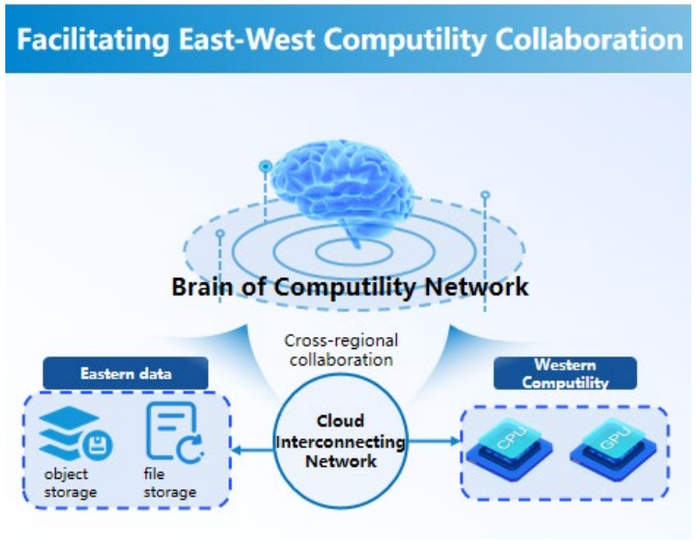
打造任务式服务，支撑算力服务平台建设

Developing Task as a Service(TaaS) to Support the Construction of Computility Service Platforms

基于算网大脑创新丰富度和开通效率业界双领先的算网融合服务，包括东数西算类、数据快递、中训边推等，已应用于医疗、影视、互联网等多个行业。数据快递提供端到端低延时、高可靠的弹性网络服务，助力数据要素流通；东数西算类服务例如东视西渲，算网大脑根据客户需求调度西部贵阳低成本算力执行东部渲染任务，整体成本降低 10% 以上，在渲染任务运行过程中，算网大脑实时监测全局状态、动态调整资源，保障任务达成。

Based on the innovative richness and activation efficiency of the Brain of Computility Network, which leads the industry, the converged Computility Network services include East Data West Computing, Data Express, Central Training Edge Inference, among others. These services have been applied across multiple sectors, including healthcare, film and television, and the internet. Data Express provides end-to-end low-latency, highly reliable elastic network services, facilitating the circulation of data elements. For example, East data west Computing services, such as East video West Rendering, leverage the Brain of Computility Network to schedule low-cost Computility resources from Guiyang in the western region to execute rendering tasks originating in the east, reducing overall costs by more than 10%. During the execution of rendering tasks, the Brain of Computility Network continuously monitors the global status and dynamically adjusts resources to ensure task completion.

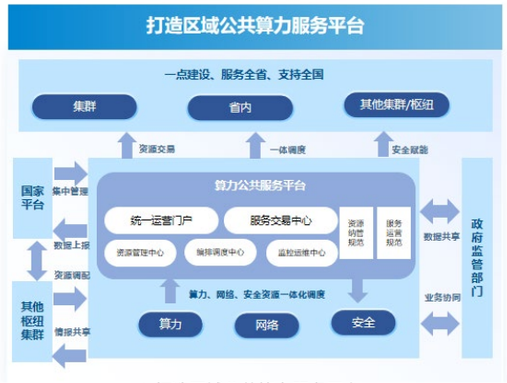
◉ 助力东西部算力协同



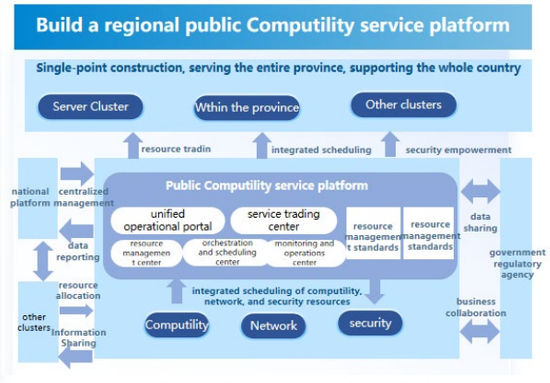
◉ Facilitating East-West Computility Collaboration

同时，算网大脑支撑多个区域级算力服务平台的规划与建设，落地通算、智算、超算、量算“四算合一”的长三角枢纽芜湖集群算力公共服务平台，打造算力调度服务标杆，助力一体化算力网构建。

Meanwhile, the Computility Network Brain supports the planning and construction of multiple regional Computility service platforms, implementing the ‘four-in-one’ integration of General Computing, Intelligent Computing, Supercomputing Computing, and Quantum Computing in the Yangtze River Delta Hub Wuhu Cluster Public Computility Service Platform. This effort aims to create a benchmark for Computility scheduling services, assisting in the construction of an integrated Computility network.



◉ 打造区域公共算力服务平台



◉ Building a Regional Public Computility Service Platform

引领业界算网理念和技术创新，获得广泛认可

Leading the Industry in Computility Network Concepts and Technological Innovation, Gaining Widespread Recognition

中国移动在产业界率先提出算力网络、算力并网、算网大脑并进行研发和大规模商用，引领了算力、网络产业的融合及创新发展。荣获 2024 国际信息社会世界峰会（WSIS）Winner 奖、2023 年中国通信学会科学技术奖二等奖等行业内十余个奖项。牵头在 CCSA 立项并编制《算力网络运营管理总体技术要求》等系列标准，作为主要参编单位发布《算网大脑基础能力要求》系列标准并通过中国信息通信研究院首批资质测评；累计完成行业标准 10 余本、企业标准 10 余本、发布相关白皮书 4 本、已授权专利 20 余篇。

China Mobile was the first in the industry to propose and develop Computility Network, Computility Grid Integration, and Brain of Computility Network, leading the integration and innovative development of the Computility Network industries. It has won over ten awards within the industry, including the 2024 World Summit on the Information Society (WSIS) Winner Award and the Second Prize of the 2023 China Institute of Communications Science and Technology Award. China Mobile took the lead in initiating and compiling a series of standards, including the 'General Technical Requirements for Computility Network Operations Management' in the China Communications Standards Association (CCSA). As a primary contributor, it also published the 'Basic Capability Requirements for the Brain of Computility Network' series of standards and passed the first batch of qualification evaluations by the China Academy of Information and Communications Technology (CAICT). To date, China Mobile has completed over ten industry standards, over ten corporate standards, published four related white papers, and obtained over twenty authorized patents.

文心智能体技术
ERNIE AGENT

◉ 文心智能体技术框架

◉ THE ERNIE AGENT Technical Framework

北京百度网讯科技有限公司
Beijing Baidu Netcom Science Technology Co., Ltd.

引言

文心智能体技术受人脑快思考慢思考启发，在基础模型之上进一步进行思考增强训练，构建了具备理解、规划、反思与进化能力的思考模型，能够做到可靠执行，自主进化。文心智能体技术促进文心大模型能力全面提升，加速应用爆发。

Introduction

The ERNIE agent technology is inspired by the human brain's fast and slow thinking processes. The ERNIE agent is built based on the thinking model trained on the foundation model enhanced with thinking training, and has equipped with capabilities of understanding, planning, rethinking and evolving. The ERNIE agent technology augments ERNIE foundation model's capabilities and accelerates the explosion of AI applications.

基于思考模型的智能体技术

Innovative Agent Technology Based on Thinking Model

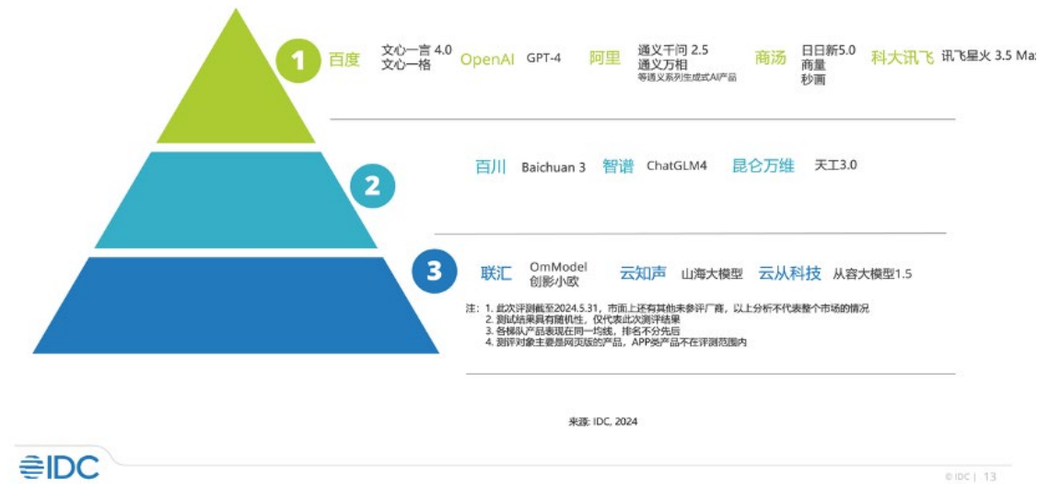
文心智能体技术，受到人脑快思考慢思考的启发，在基础大模型之上进一步研制了基于思考模型的慢思考机制，更理性、更准确。思考模型，通过思考过程的有监督精调、行为决策的偏好学习、结果反思的增强学习等思考增强训练，具备更强大的理解、规划、反思与进化能力，能够做到可靠执行，自我进化，并一定程度上将思考过程白盒化，从而让机器像人一样思考和行动，自主的完成复杂任务，并能够在环境中持续学习实现自主进化。

The ERNIE agent technology, inspired by the human brain's fast and slow thinking processes, has further developed a slow thinking mechanism based on a thinking model trained on the foundational model, making it more rational and accurate. The thinking model, through thinking-enhanced training such as supervised fine-tuning of the thinking process, preference learning in behavior decision-making, and reinforcement learning through output rethinking, possesses more powerful capabilities in understanding, planning, rethinking and evolving. It ensures reliable execution and autonomous evolution, allowing machines to think and act like humans, autonomously completing complex tasks while continuously learning and evolving in the environment.

文心智能体技术的突破，促进了文心大模型能力的全面提升。IDC、沙利文、中国软件评测中心等多家权威评测显示，文心大模型位居中国以及国际第一梯队。

The breakthrough in ERNIE agent technology has significantly enhanced the capabilities of ERNIE foundation model. According to authoritative evaluations by IDC, Frost & Sullivan and the China Software Testing Center, ERNIE 4.0's performance exceeds the average performance of international foundation models, ranking first in China and among the top globally.

主流基础大模型产品评估结果对比



◉ IDC《中国大模型市场主流产品评估，2024》

◉ IDC Evaluation of Mainstream Large Models in the Chinese Market in 2024

促进 AI 应用爆发，平台化赋能千行百业

Facilitating the Burst of AI Applications, Empowering Thousands of Industries

智能体技术充分释放大模型的潜力，促进人工智能的大规模产业应用。截至 9 月底，有 30 万创作者在文心一言 APP 上创建并上线了 40 万个功能丰富的智能体，智能体调用量达 8 亿；技术成果应用于推广营销、客户服务、企业办公、代码编程等行业场景，赋能产业智能化升级。

The ERNIE Agents are applied in the fields of intelligent assistant, customer service, enterprise intelligence, etc., fully unleashing the potential of large models, promoting the large-scale industrial application of AI. By the end of September, on the New APP, 300,000 creators had created 400,000 agents, equipped with multiple functions. Agents' daily request reached a total of 800 million times.

基于智能体技术构建文心智能体平台进一步降低开发门槛，赋能千行百业。开发者基于自身行业领域、应用场景，采用多样化的能力、工具，打造大模型时代的 AI 原生应用，截至 9 月底，已吸引 60 万开发者，10 万家企业，日均分发超 800 万次。

The Agent Builder is built based on agent technology to further reduce the threshold of development and eliminate the last barrier of agent application from development to distribution. Developers can use diversified capabilities and tools based on their own industry fields and application scenarios to create AI-native applications in the era of large models. The platform provides developers with a distribution path of Baidu's ecosystem matrix. By the end of September, it had attracted 600,000 developers and 100,000 enterprises, with an average daily distribution of over 8 million.

◉ 百度搜索 AI 问答

◉ AI Q&A on Baidu Search

◉ 文心智能体平台

◉ Agent Builder

重塑工作生活，加速产业升级

Reshaping Work and Life, Accelerating Industrial Upgrading

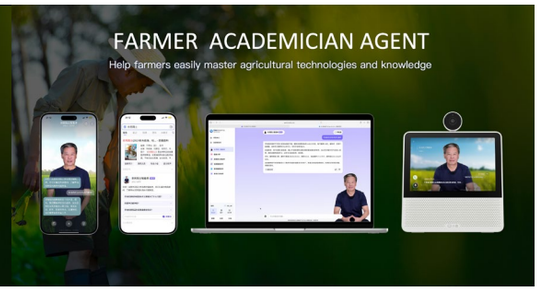
智能体技术正在加速大模型深度融入社会各行业的各个环节，助力企业与社会服务智能化升级。在政务领域，AI 法律咨询助手可为劳动者提供便捷的法律服务；在农业领域，农民院士智能体能随时随地给农民传授种植知识技能，让科技助农惠农更便捷。在教育领域，智能体技术可以为师生提供更加智能化、个性化的教学和学习体验。此外，智能体技术还可以应用到辅助编程场景，不仅降低普通人开发应用的门槛，也降低了专业程序员的工作量，大幅提升了人机交互的效率。

Agent technology is driving the deep integration of large model technology into various sectors in society, thereby empowering the upgrading of businesses and social services to be more intelligent. In terms of government services, AI-powered legal consultants offer workers convenient and effective legal services, bolstering public trust and satisfaction with the government. All in all, government services become more intelligent thanks to agent technology. In agriculture, the Farmer Academician Agent can teach farmers planting knowledge and skills anytime, anywhere, making it more convenient for technology to assist and benefit farmers. In education, agent technology offers teachers and students a more intelligent and personalized teaching and learning experience respectively. Furthermore, agent technology can be used to help programming, not only lowering the threshold for ordinary people to develop applications, but also decreasing the workload of professional programmers, and substantially enhancing the efficiency of human-computer interaction.

智能体技术还推动了传统产业转型，以及智能家居、智能电商等新兴产业的蓬勃发展，并创造了智能体工程师、训练师等新岗位，带动人才培养模式创新，为产业结构升级提供了强大的人才支撑。

The traditional industries have achieved innovation in production methods and management modes, relying on the widespread application of agent technology. At the same time, emerging industries such as smart home and smart e-commerce have rapidly risen, and also give birth to new job opportunities, such as agent engineers, agent trainers, agent evaluators, and many new positions for the production, maintenance, and supervision of agents. These new positions will not only enrich people's career choices, but will also promote innovation in talent cultivation modes.

◉ 农民院士智能体

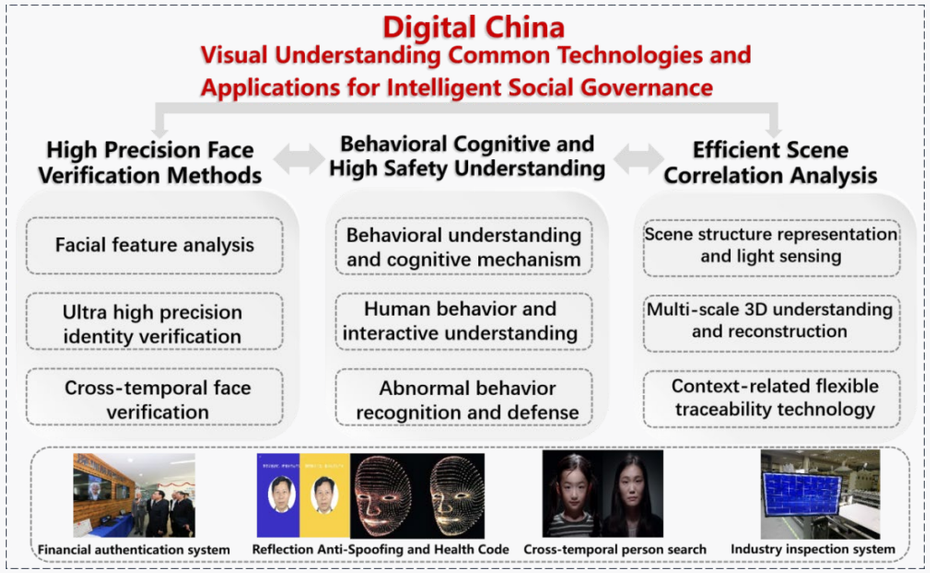


◉ Farmer Academician Agent

社会治理智能化的视觉理解共性技术及应用

Visual Understanding Common Technologies and Applications for Intelligent Social Governance

◉ 通过人工智社会治理智能化共性技术体系与创新应用平台能辅助预测性维护



◉ Common Technology Systems and Innovative Application Platforms of Intelligent Social Governance

上海交通大学
Shanghai Jiao Tong University

华东师范大学
East China Normal University

引言

围绕人物 - 行为 - 场景的一体化视觉表达与理解重大科学问题，研制面向社会治理智能化的视觉理解应用创新平台，形成健康码、数字金融远程服务等重大科技成果，为社会治理智能化创新模式提供共性技术保障。

Introduction

The project focuses on the major scientific issues of the correlation of persona-behavior-scene visual representation and understanding, develops a visual understanding application platform for social governance intelligence. We form major scientific and technological achievements that benefit people's lives, such as health codes, finding and preventing human trafficking, and digital financial remote services, and provide a common technical guarantee for the intelligent innovation model of social governance.

人物 - 行为 - 场景一体化的社会治理智能化

Intelligent Social Governance based on the Correlation of Persona-Behavior-Scene Visual Representation

团队在社会治理智能化领域攻克了多个国际难题，实现了关键技术创新。

The team has overcome several international challenges in the field of intelligent social governance, achieving key technological innovations.

1）首创了高精准人物视觉识别技术，通过超高精度身份核实、多层次跨时空人脸验证、细粒度表情分析等技术，支持了金融支付系统中亿级用户核身和千万级跨时空寻人应用，奠定了全球领先地位。

1) High Precision Face Verification Methods: The project pioneered high-precision face visual recognition algorithms through ultra-precision identity verification, multi-level subcontract across time and space efficient face verification, and fine-grained facial feature analysis. These innovations have supported identity verification for 100 million users in financial payment systems and 10 million cross-temporal person searches, establishing a global leadership position.

2）在行为认知与高安全理解领域提出了创新性的行为概念理解和社会行为认知机理，并开发了异常行为识别与防御技术，极大提升了社会治理中的行为安全性与管理精细化水平。

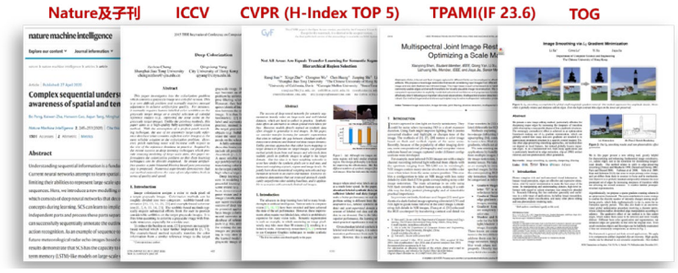
2) Behavioral Cognitive Mechanism and High Safety Understanding: The project introduced a novel concept of behavior understanding, proposed the cognitive mechanism of social behavior, and developed anomaly behavior detection and defense technologies, greatly enhancing behavior security and management precision in social governance.

3）构建了高效场景关联解析技术平台，涵盖场景结构表达、三维场景理解与重建、情景关联跟踪等核心技术，有效支撑了社会智能治理和疫情防控等重大应用。

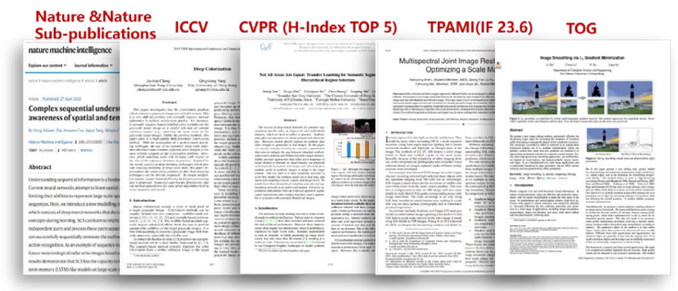
3) Efficient Scene Correlation Analysis: The project built an efficient platform for scene association analysis, incorporating scene structure representation, 3D scene understanding, and reconstruction, situational tracking, etc., which effectively supported major applications in intelligent social governance and pandemic prevention and control.

发表 Nature 及子刊等论文 318 篇，授权发明专利 298 项（国际专利 127 项），部分成果获 2020 年上海市科技进步奖特等奖，2024 年吴文俊人工智能自然科学一等奖。

The team has published 318 papers in Nature and top-tier journals, with 298 patents granted (including 127 international patents). Some of these achievements obtained the Special Prize of the 2020 Shanghai Science and Technology Progress Award and the First Prize of the 2024 Wu Wenjun 2024 Artificial Intelligence Natural Science of CAAI.



◉ 发表高水平论文 318 篇



◉ Published 318 Papers in Nature and Top-tier Journals

金融、公共健康等领域的智能化社会治理服务

Intelligent Social Governance Services in Finance, Public Health, and Other Fields

该项目在人物行为与场景解析技术领域取得了广泛应用和显著成果，特别在保障人民生命财产安全方面贡献突出。超高精度身份核实技术于 2015 年率先应用于微众银行，推动互联网银行新业态发展，并广泛应用于微信、手机 QQ 等平台，覆盖 140 多个行业，成功走向海外市场。跨年龄人脸识别寻人系统协助中国找回 1713 名失踪人员，创造了国务院打拐办最大规模的成功案例。项目的深度安全技术在全国首个健康码的推广中发挥关键作用，截至 2022 年，健康码服务 14 亿用户，总计亮码超 815 亿人次。行为理解与场景解析技术助力社会安防，首届进博会实现无感入场，获得高度评价。

The project has achieved widespread application and significant achievements in the field of human behavior and scene analysis technology, particularly in safeguarding people's lives and property. The ultra-high precision identity verification technology was first applied by WeBank in 2015, driving the development of new business models in Internet banking. It has been widely adopted by platforms like WeChat and QQ, spanning over 140 industries and successfully expanding into international markets. The cross-age facial recognition system for locating missing persons has helped China recover 1,713 individuals, marking the largest success case for the State Council's anti-trafficking office. The project's anti-spoofing technologies played a key role in the nationwide rollout of the first health code, which, by 2022, had served 1.4 billion users with over 81.5 billion health code scans. Behavior understanding and scene analysis technologies have enhanced social security, with the first China International Import Expo achieving seamless entry, earning high praise.

项目累计新增产值 27.19 亿元，降低成本 75.66 亿元，显著提升社会治理与公共安全水平，社会和经济效益巨大。

The project has generated an additional output value of 2.719 billion RMB, reduced costs by 7.566 billion RMB, and significantly improved social governance and public safety, delivering immense social and economic benefits.

该项目在健康码、智慧社区、AI 寻人、数字金融等领域取得了重大突破，推动了技术进步和产业结构优化升级。在疫情防控中，项目创新应用远程核身技术，助力健康码的快速普及，收到多个政府部门的感谢信。AI 寻人系统成功协助多地警方找回千余名走失人员，解决了因健康或年龄无法身份认证的难题，产生了巨大的社会效益。项目开发的金融级别远程核身系统，首次在银行系统中商用，推动互联网金融新业态的形成，促进金融智能化转型。此外，智慧社区治理系统提升了城市公共安全水平，成功应用于多个大型活动。远程会议和教学平台通过人像分割等技术，支持了规模化无接触工作新模式，年参会人次超 40 亿，成为中国最大的远程会议系统。这些成果显著推动了技术进步，优化了产业结构，助力社会向智能化、数字化转型。

This project has made significant breakthroughs in areas such as health codes, smart communities, AI-based missing person searches, and digital finance, driving technological advancements and optimizing industrial structure upgrades. During the COVID-19 pandemic, the project innovatively applied remote identity verification technology, contributing to the rapid adoption of health codes, and received letters of appreciation from various government departments. The AI missing person search system has successfully assisted local police in locating over a thousand missing individuals, addressing challenges related to identity verification for those unable to do so due to health or age, resulting in tremendous social benefits. The financial remote identity verification system developed by the project was commercially implemented in the banking sector for the first time, fostering the creation of new Internet finance models and promoting the intelligent transformation of the financial sector. Moreover, the smart community governance system has enhanced urban public safety, successfully being deployed in several large-scale events. The remote conferencing and education platforms, utilizing technologies such as portrait segmentation, have supported large-scale, contactless work models, with over 4 billion annual participants, making it the largest remote conferencing system in China. These achievements have significantly advanced technological progress, optimized industrial structures, and facilitated the transition toward a more intelligent and digital society.

项目学术评价与技术鉴定

Academic Evaluation and Technical Appraisal

中国电子学会组织的科技成果鉴定会认为，上海交通大学等单位完成的“面向社会治理智能化的视觉理解关键技术及应用”项目技术复杂度高，研制难度大，具备重大创新性，总体技术达国际先进水平，其中光线活体远程核身、跨时空多模态人物特征理解等技术达到国际领先。国际学术界对项目组的多项研究给予高度评价，部分成果获得上海市科技进步特等奖、吴文俊人工智能自然科学一等奖、中国计算机图形学杰出奖、科学探索奖等系列奖项。

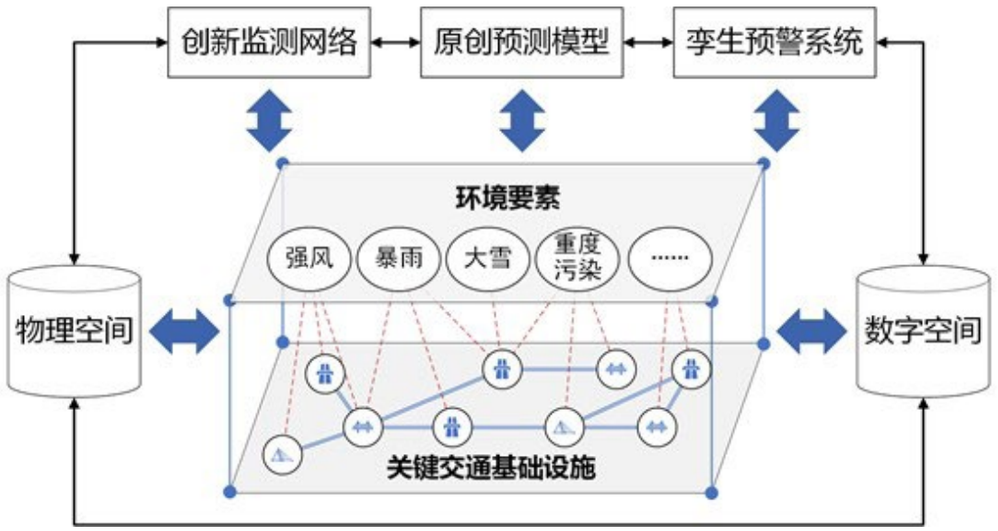
The Science and Technology Achievement Appraisal Meeting, organized by the China Electronics Society, concluded that the project "Key Technologies and Applications for Visual Understanding in Intelligent Social Governance," completed by Shanghai Jiao Tong University and other institutions, demonstrates high technical complexity and significant innovation, with substantial challenges in development. The overall technology has reached an advanced international level, with specific technologies such as remote liveness detection under varying lighting conditions and cross-temporal and multimodal human feature understanding achieving global leadership. The international academic community has highly praised several aspects of the project team's research, and some achievements have been awarded prestigious honors, including the Special Prize of the Shanghai Science and Technology Progress Award, the First Prize of Wu Wenjun Artificial Intelligence Natural Science of CAAI, the China Computer Graphics Excellence Award, and the Science Exploration Award.

◉ 前期部分成果所获荣誉奖项

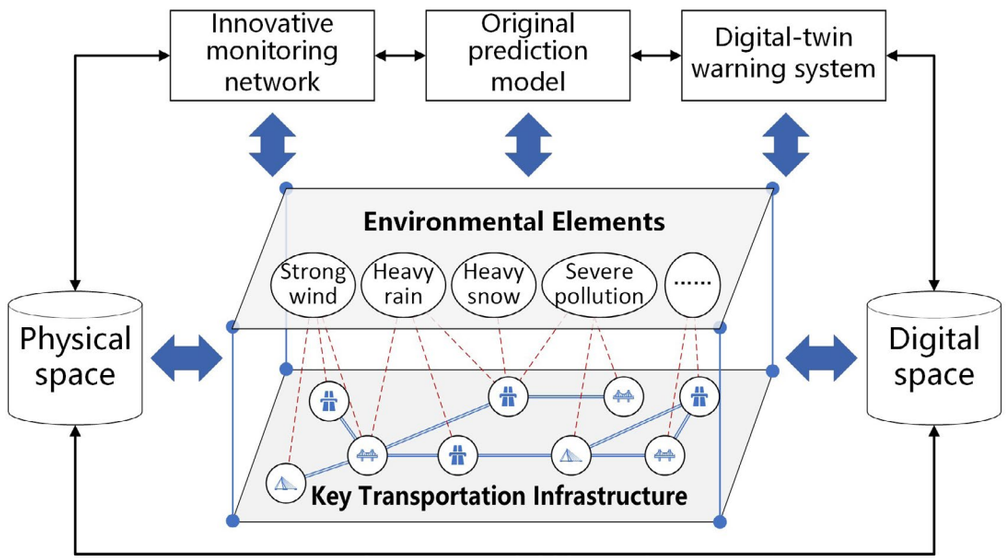
◉ Some of the previous achievements won honorary awards

关键交通基础设施环境数字孪生预测技术及产业化

Environmental Digital Twin Prediction Technology and Its Industrialization of Key Transportation Infrastructure



◉ 关键交通基础设施环境数字孪生



◉ Environmental Digital Twin of Key Transportation Infrastructure

中南大学
Central South University

利兹大学
University of Leeds

威胜集团有限公司
Wasion Group Limited

引言

本项目发明了关键交通基础设施环境数字建模、预测、预警等成套技术，授权中、美、欧、日、俄、澳、新等 136 件发明专利，荣获 8 项日内瓦、纽伦堡等专利金奖，产品覆盖全球 50 余个国家，有力推动世界交通数字化发展。

Introduction

This project has invented a group of technologies for digital modeling, prediction, and early warning of key transportation infrastructure environments, authorized 136 invention patents in China, the United States, Europe, Japan, Russia, Australia, and Singapore, and won 8 patent gold medals in Geneva, Nuremberg, etc. The products cover more than 50 countries around the world, effectively promoting the digital development of world transportation.

解决 3 大预测技术难题，形成自主知识产权

Overcoming Three Prediction Technology Problems and Forming Independent Intellectual Property Rights

针对“要素不全”问题，发明了融合视觉、遥感、雷达、无人机等模式的交通环境要素测量技术，建全了关键基础设施时空环境数字要素模型库。

Facing the problem of "incomplete elements", a traffic environment element measurement technology that integrates vision, remote sensing, radar, drones, and other modes has been invented, and a digital element model library for the spatiotemporal environment of key infrastructure has been completed.

针对“精度低”问题，提出了耦合“大气模拟”与“时空互偿”的交通环境要素智能预测技术，突破了超短时、短时、中长时、长时等不同尺度的预测精度瓶颈。

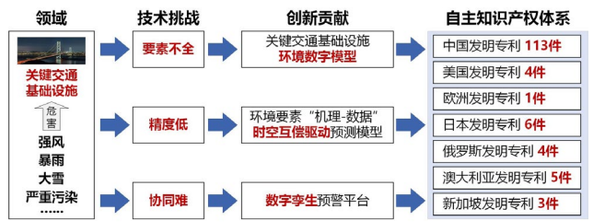
Facing the problem of "low accuracy", an intelligent prediction technology of traffic environment elements that couples "atmospheric simulation" and "spatiotemporal compensation" is proposed, breaking through the bottleneck of prediction accuracy at different scales such as ultra-short time, short time, medium time, and long time.

针对“协同难”问题，研建了具备环境可视化、预警信息发布、历史事件回溯等功能的数字孪生平台，实现了基础设施、监测系统、预测 / 预警流程的互联互通。

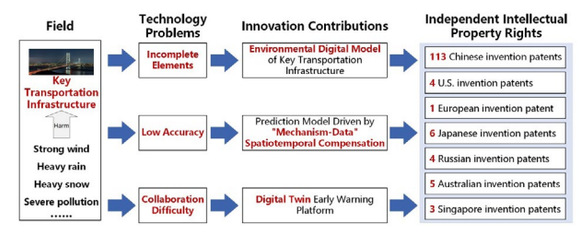
Facing the problem of "collaboration difficulty", a digital twin platform with functions such as environmental visualization, early-warning information release, and historical event review has been developed to realize the interconnection of infrastructure, monitoring systems, and prediction/early warning processes.

本项目出版 2 部“城市大数据”和“交通机器人”领域的全球首部英文专著；授权 113 件中国发明专利及 23 件美国、欧洲、日本、俄罗斯、澳大利亚、新加坡等国际发明专利，形成了自主知识产权体系。

This project published 2 of the world's first English monographs in the fields of "Urban Big Data" and "Traffic Robots"; authorized 113 Chinese invention patents and 23 international invention patents from the United States, Europe, Japan, Russia, Australia, Singapore, etc., forming independent intellectual property rights.



◉ 成果形成自主知识产权体系



◉ The project forms an independent intellectual property system

国际大规模推广应用，逐步形成示范效应

Promoted Internationally and Forming a Demonstration Effect Gradually

原创技术转化应用于 3 款核心产品，应用到中国、美国、英国、新加坡等 50 余个国家。成果有效提升了关键交通基础设施对恶劣环境的感知、预警与防控能力，助力气候韧性基础设施建设，延长了基础设施的使用寿命，产生了显著的社会与经济效益。

The original technology has been transformed into 3 core products and applied to more than 50 countries including China, the United States, the United Kingdom, and Singapore. The results have effectively improved key transportation infrastructure's ability to perceive, warn, and prevent harsh environments, which facilitates the construction of climate-resilient infrastructure, extends the service life of infrastructure, and generates significant social and economic benefits.

本项目主持获 8 项瑞士日内瓦（2 次）、德国纽伦堡（3 次）、法国巴黎等国际专利金奖以及 12 项教育部技术发明奖、教育部自然科学奖、吴文俊人工智能科技奖等重要奖励。

The project has won 8 international patent gold medals in Geneva, Switzerland (2 times), Nuremberg, Germany (3 times), and Paris, France, as well as 12 important awards such as the Ministry of Education's Technology Invention Award, the Ministry of Education's Natural Science Award, and the Wu Wenjun Artificial Intelligence Science and Technology Award.

◉ 多次荣获国际专利金奖

◉ Won international patent gold medals many times

被 34 位院士正面评价，获英国皇家工程院荣誉

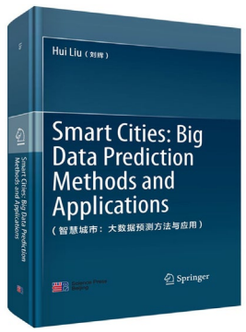
Positively Commented by 34 Academicians and Won Honor from the Royal Academy of Engineering

9 位国际学会主席、34 位中 / 美 / 英 / 加等国院士、美国总统奖、麦克阿瑟天才奖得主等同行在 Nature 等权威期刊引用并公开评价，认为本项目“是最重要的技术突破之一”“克服了传统局部视角的不足，在灵活性、计算效率、鲁棒性等方面都优于其他现有方法”。

The project has been cited and publicly praised in authoritative journals like Nature by 9 international society presidents, 34 academicians from countries including China, the United States, the United Kingdom, and Canada, the PACASE Award winner, and MacArthur Fellow. They consider the project as "...insight on the foremost forecasting techniques", and "...integrating different models to overcome the relevant problems of the different, individual perspectives, giving better performance in terms of flexibility, computing efficiency, robustness".

项目负责人入选英国皇家工程院杰出国际工程师奖（每年全球所有领域不超过 12 人）。出版的英文专著入选第三届 Springer·Nature “中国新发展奖”，Springer 公开的颁奖词认为“扩展了智慧城市的现有技术体系。原创的解决方案被广泛应用，对构建城市智慧大脑与推动可持续发展做出突出贡献”。

The project leader is selected for the Distinguished International Associates of the Royal Academy of Engineering (no more than 12 winners in all fields around the world each year). The published English monograph was selected for the third Springer · Nature "China New Development Award". Springer's public award speech believed that "This book expands the existing technology system of smart cities, and original solutions are widely used, making outstanding contributions to the construction of urban smart brains and the promotion of sustainable development".



◉ “中国新发展奖”获奖专著《Smart Cities: Big Data Prediction Methods and Applications》

◉ "China New Development Award" Winner Monograph: "Smart Cities: Big Data Prediction Methods and Applications"

认知决策智能体技术创新及应用

Innovations and Applications of Cognitive Decision-Making Intelligence

蚂蚁科技集团股份有限公司
ANT GROUP

引言

项目由蚂蚁集团历时八年技术攻关完成，解决了人工智能在生活服务，金融、医疗等严谨行业落地时面临的多项技术难题，在大模型、图学习、知识图谱、运筹优化、智能体等关键技术上实现了重大突破，产业化应用效果显著。

Introduction

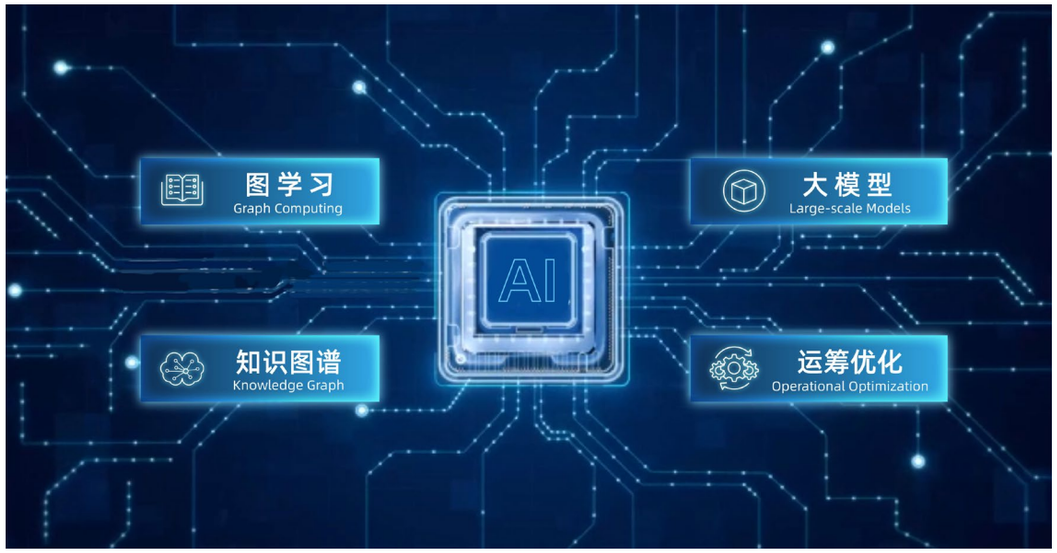
The project was developed by Ant Group over eight years of technological research, which solved many technical problems faced by artificial intelligence in the implementation of life services, finance, healthcare and other industries. Significant breakthroughs were made in key technologies such as Large-scale Models, Graph Learning, Knowledge Graph, Operational Optimization, and AI agents, resulting in significant industrial application effects.

项目攻克了 AI 在生活服务、医疗等行业的应用难题

The Project Has Overcome the Challenges of Applying AI in Industries such as Life Services and Healthcare

项目攻克了人工智能在生活服务、金融、医疗等行业落地时，面临领域认知能力弱、复杂推理能力差、端到端落地难三大挑战。实现了多项技术创新：

The project has overcome three major challenges in the Applications of artificial intelligence in industries such as life services, finance, and healthcare: weak domain cognitive ability, poor complex reasoning ability, and difficult end-to-end landing. It has achieved multiple technological innovations:



◉ 项目在多项人工智能技术上具有显著创新

◉ The project has significant innovation in multiple artificial intelligence technologies

1. 研发了万亿参数的可信大模型基座，并结合数万种行业工具与千亿级专业语料，形成了医疗、金融等领域大模型，显著提升了大模型在垂直行业的认知力和行动力。

1. We developed a trillion-parameter trustworthy large model foundation, which in conjunction with hundreds of billions of specialized corpus and tens of thousands of industry tools, has created large models for fields such as healthcare and finance. This has significantly enhanced the cognitive and operational capabilities of large models in vertical industries.

2. 研发了高性能知识决策引擎，通过图学习、知识图谱、运筹优化等技术创新，实现了基于万亿规模用户行为、行业知识和专家经验的实时推理决策。

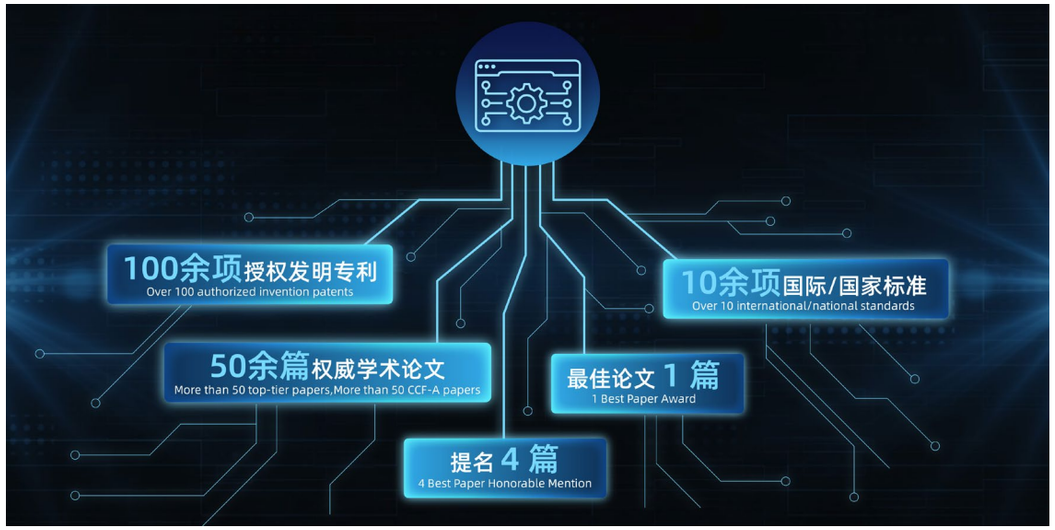
2. We developed a high-performance Knowledge Decision Engine. Through innovations in techniques such as graph learning, knowledge graphs, and operational optimization, real-time inference and decision-making have been realized based on trillions of user behaviors, industry knowledge, and expert experience.

3. 研发了行业智能体应用平台，基于高效的知识力、认知力、决策力和行动力，构建专家级推理决策框架，实现了端到端产业应用。平台支撑了 AI 生活管家“支小宝”、AI 金融管家“蚂小财”，以及首个可陪诊数字健康人“安诊儿”等多个应用。

3. We developed an industrial AI agent application platform, supporting the rapid construction of specialized AI agents, and bridging the last mile of AI application. The platform supports several applications, including AI Life Assistant “Zhi Xiaobao”, AI Financial Manager “Ma Xiaocai”, and the first digital hospital companion “Angel”.

项目获授权发明专利 100 余项，发表论文 50 余篇，部分成果获浙江省科技进步一等奖、吴文俊人工智能科技进步一等奖、中国电子学会科技进步一等奖等多个奖项。

The project has been granted over 100 authorized invention patents, published more than 50 top-tier papers, and some achievements have won multiple authoritative awards such as the First Prize of Zhejiang Science and Technology Progress Award, the First Prize of CIE Science andTechnology Progress Award.



◉ 项目主要成果　◉ The Main Achievements of the Project

项目已广泛应用于医疗、金融等行业

The Project Has Been Widely Applied in Industries such as Medical, Finance

项目已广泛应用于生活服务、医疗、金融等行业，显著推动人工智能真正落地产业，经济效益显著。具体如下：

As of now, the project has been widely applied in more than 1000 institutions in industries such as life service, healthcare, and finance. As follows:

1. 在生活服务领域，项目支撑打造了国内首个服务型 AI 原生应用“支小宝”。

1. In the field of life services, the project has developed the first service-oriented AI native application “Zhi Xiaobao”.

◉ AI 生活管家“支小宝”　◉ AI Life Assistant - Zhi Xiaobao

2. 在医疗领域，项目已服务于上海仁济医院、上海市一医院、浙江省卫健委等多家医院和机构，基于项目打造的数字健康人安诊儿已服务浙江 1000 多家医疗机构，帮助人工导诊咨询量减少 50%。

2. In the healthcare fields, the project has served multiple hospitals and institutions such as Shanghai Renji Hospital, Shanghai General Hospital, and so on. The digital hospital companion “Angle” has provided services to over 1000 healthcare institutions in Zhejiang, helped reduce the consultation volume for manual guidance by 50%.

◉ 数字健康人“安诊儿”
◉ Digital Health Companion "Angel"

3. 在金融决策领域，项目显著提升了对小微企业的关键画像与信贷风险的刻画能力，实现了准入、额度、利率等的精细化智能决策，有效缓解了小微企业融资难的问题。

3. In the financial decision-making field, the project has significantly improved the ability to depict key portraits and credit risks of micro-enterprises, achieving fine intelligent decision-making for access, loan limits, and interest rates, effectively alleviating the financing difficulties of micro-enterprises.

项目在促进行业开放和协同发展方面发挥了积极作用

The Project Has Played a Positive Role in Promoting the Opening Up and Coordinated Development of the Industry

项目通过推动标准制定、开放行业数据集等方式，在促进金融、医疗等行业开放、协同发展，支撑行业数字化转型方面发挥了积极作用。

By promoting standards development, open industry datasets, and other means, the project has played an active role in promoting the opening and collaborative development of industries, supporting industry digital transformation.

1. 主持和参与国际 / 国家标准十余项，覆盖知识图谱、图学习、大模型等多个技术领域。

1. Hosting and participating in more than ten international/national standards, covering knowledge graphs, graph learning, large models, and other technological fields.

2. 自建或联合行业合作伙伴共建多个数据集并面向全行业开放，助力 AI 赋能行业。

2. Build or collaborate with industry partners to jointly build multiple datasets and open them to the entire industry, helping AI empower the industry.

专为 Windows 11 AI PC 打造的拥有行业领先 45TOPS NPU 算力的 PC 平台——骁龙 X Elite

Snapdragon X Elite: PC Platform Built for Windows 11 AI PC with Industry-Leading 45TOPS NPU

高通无线通信技术（中国）有限公司
Qualcomm Wireless Communication Technologies (China) Limited

Qualcomm 高通

引言

高通公司于 2023 年 10 月推出专为 AI PC 打造的骁龙 X Elite 平台，凭借领先的 CPU 性能、终端侧 AI 推理和长达多天的电池续航，赋能 PC 厂商打造了全新 Windows 11 AI PC 品类，旨在支持高负载智能任务，带来终端侧 AI 赋能的生产力、创作和娱乐体验。

Introduction

Qualcomm introduced the Snapdragon X Elite platform built for AI PC in October 2023. With leading CPU performance, on-device AI inferencing, and up to multiple days of battery life, Snapdragon X Elite is powering PC OEMs to build brand new Windows 11 AI PCs, and support the intelligent and power-intensive tasks, delivering productivity, creativity, and entertainment experiences enabled by on-device AI.

重塑 PC，树立性能、能效和智能体验新标杆

PC Reborn, Setting New Benchmarks for Performance, Efficiency, and Intelligent Experiences

骁龙 X Elite 拥有一系列创新技术和行业领先性：采用定制的集成高通 Oryon CPU，拥有 12 个高性能内核，主频达 3.8GHz，双核增强技术可将两个高性能内核提升到 4.3GHz，是首个主频达到 4GHz 以上的 ARM 架构 CPU 核心；具有突出的能效表现，相同功耗下性能大幅领先 X86 架构竞品；达到相同峰值性能时，功耗相比竞品也有着大幅领先优势；集成 Adreno GPU，能够以出色能效实现每秒 4.6 万亿次浮点运算的图形性能。

Snapdragon X Elite features a series of industry-leading innovations: a) the customized integrated Qualcomm Oryon CPU with 12 high-performance cores running up to 3.8 GHz, with dual-core boost technology to lift the clock speeds up to 4.3 GHz, making it the first CPU core on ARM architecture to hit over 4 GHz; b) outstanding power efficiency, delivering significantly better performance than the X86 competitions at the same power, and match their peak performance at significantly less power consumption; c) integrated Qualcomm Adreno GPU, delivering graphics performance of up to 4.6 TFLOPS with incredible power efficiency.

骁龙 X Elite 采用全新异构高通 AI 引擎，拥有行业领先的高达 45TOPS 算力 NPU，实现高性能、低功耗 AI 运算，助力打造智能的个性化体验，带来诸多突破性 AI PC 新特性。此外，该平台引入高通移动技术专长，支持 10Gbps 5G 下载速度、高通 FastConnect 7800 支持的 Wi-Fi 7、Snapdragon Seamless、18-bit 先进摄像头 ISP、Snapdragon Sound 骁龙畅听技术，带来业界领先的连接、流传输和音视频体验，支持随时随地实现办公和创作。

Snapdragon X Elite adopts the brand-new heterogeneous Qualcomm AI engine. With a NPU of industry leading 45TOPS computing power, Snapdragon X Elite delivers high-performance, low-power AI inferencing, empowering intelligent and personalized user experiences, and bringing groundbreaking AI PC features. Leveraging Qualcomm's extensive mobile technology expertise, Snapdragon X Elite also features up to 10Gbps 5G download speeds, Wi-Fi 7 powered by Qualcomm FastConnect 7800, Snapdragon Seamless, 18-bit advanced camera ISP, and Snapdragon Sound, to bring industry leading connectivity, streaming, audio and video experience, enabling productivity and creativity anytime, anywhere.

◉ 骁龙 X Elite 重塑 PC 性能

◉ Snapdragon X Elite is making PC performance reborn

支持首批 Windows 11 AI PC 商用，引领 AI PC 品类发展

Supporting the First Wave Windows 11 AI PCs Going to Market, Advancing the AI PC Development

骁龙 X Elite 是支持首批 Windows 11 AI PC 的独家平台。Windows 11 AI PC 是微软最新推出的全新 Windows PC 品类，是 Windows 平台数十年来最大的变革，将推动重塑 PC，让 Windows 生态系统重新获得创新和性能领导地位。

The first wave of Windows 11 AI PCs is exclusively supported by Snapdragon X Elite. Windows 11 AI PC is a new category of Windows PCs that marks the most significant change to the Windows platform in decades, which is making the PC reborn and restoring Windows ecosystem's industry leadership in innovation and performance.

目前，宏碁、华硕、戴尔、惠普、联想、微软和三星等全球领先 OEM 已推出超 20 款搭载骁龙 X 系列的 Windows 11 AI PC，带来了诸多跨生产力、创造力和娱乐等方面的出色 AI 用例，不仅在为个人用户带来体验变革，也正在赋能企业用户利用 AI PC 提升生产力、降低成本、提高服务质量，让 AI 应用于各行各业，加快企业和行业数字化转型。

Over 20 Windows 11 AI PCs powered by Snapdragon X series were announced from leading global OEMs including Acer, ASUS, Dell, HP, Lenovo, Microsoft, and Samsung, bringing many great AI use cases across productivity, creativity, and entertainment. Snapdragon-powered AI PCs are not only bringing transformation to individual user experience, but also enabling enterprise users to boost productivity, reduce costs and improve quality of service with AI PCs. This will enable AI to be applied across industries and accelerate the enterprise and industry digital transformation.

未来，骁龙 X 系列平台将赋能

跨所有 PC 产品形态的丰富 AI PC 产品，驱动 AI PC 品类终端快速发展。据 Canalys 最新数据，2024 年第二季度 AI PC 出货量为 880 万台，占本季度 PC 总出货量 14%。随着利用 NPU 的应用范围不断扩大，以及对性能和效率的益处越来越清晰，AI PC 的价值定位将保持强劲。

In the future, Snapdragon X series platforms will power a broad spectrum of AI PCs in all form factors and drive rapid development of the AI PC category. According to Canalys' latest data, AI PCs are expected to account for 14% of the total PC shipments with 8.8 million units in the second quarter of 2024. As the adoption of NPU continues to expand and the benefits in performance and efficiency become increasingly clear, the value positioning of AI PCs will remain powerful.

◉ 骁龙 X 系列平台赋能的 Windows 11 AI PC 设备

◉ Windows 11 AI PCs Powered by Snapdragon X series

赋能全新行业发展机遇和智能终端产业变革

Bringing New Opportunities for PC Industry and Empowering Industry Transformation of Intelligent Edge Devices

Canalys 在今年 1 月发布的 AI PC 报告中预测，AI PC 的问世有望重振 PC 市场并改变用户体验，可谓是行业的分水岭。骁龙 X Elite 旨在赋能面向各种用户和各种产品外形的 AI PC。为此，高通与整个 PC 生态系统协作，确保针对骁龙优化价值链的每个环节，包括与主要 ODM、IBV 和 IHV 厂商合作，帮助推动创新，重新构想 PC 终端形态、固件和软件，带动产业链共同升级。通过为开发者提供工具和支持，以及领先 AI 软硬件技术和丰富的骁龙 X Elite 设备规模，高通公司正在加速下一代 AI PC 应用开发。越来越多的 Windows 应用正在骁龙平台上原生运行。

In Canalys' Now and Next for AI-capable PCs report, it is predicted that the advent of AI PCs is expected to restore the PC market and evolve the user experiences, marking a turning point for the industry. Snapdragon X Elite is designed to power AI PCs for all kinds of users, in all kinds of form factors. Qualcomm collaborates with partners across the entire PC ecosystem to ensure every part of the value chain is optimized for Snapdragon, including working with key ODMs, IBVs, IHVs to help drive innovation, and re-imagine PC form factors, firmware, and software, driving the PC industry chain to upgrade together. With best-in-class AI hardware and software technologies and rich Snapdragon X Elite powered devices, Qualcomm is also providing tools and supports to developers to accelerate next generation AI PC application development. Now, more and more Windows applications are running native on Snapdragon.

高通将利用全面的解决方案，赋能全球范围内的智能终端产业变革，推动生成式 AI 技术和以 AI PC 为代表的智能生产工具在全球经济发展和社会生产生活中的应用和普及，广泛赋能垂直行业领域的数字化转型，驱动形成新质生产力，为全球经济发展提供新动能。

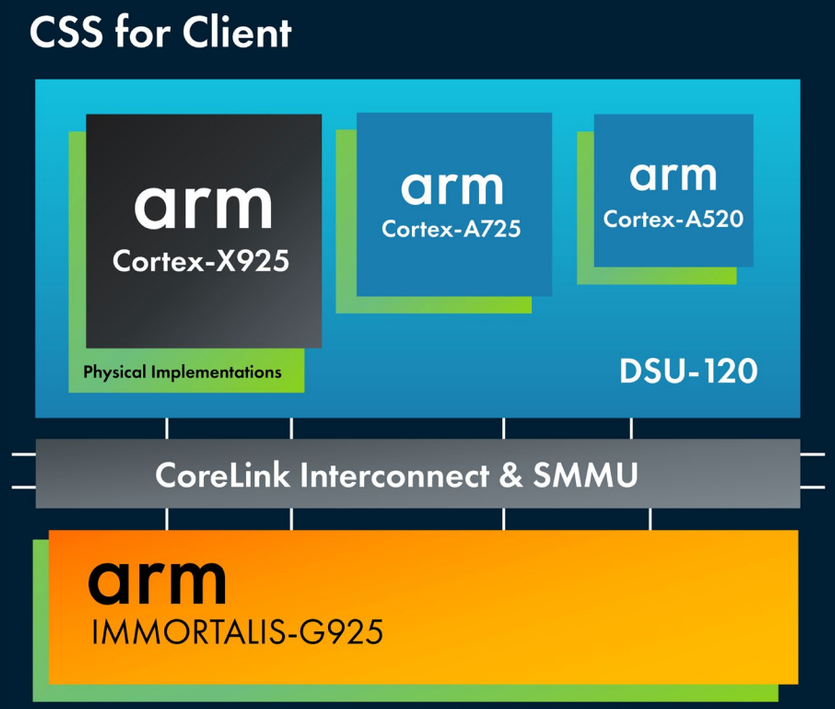
Qualcomm will leverage its comprehensive solution offerings to empower the industry transformation of intelligent edge devices on a global scale, promote the adoption and popularization of generative AI and smart productivity tools such as AI PCs in global economy growth, social life and production. This will broadly empower the industry and enterprise digital transformations and drive the development of new quality productive forces, so as to cultivate new catalysts for global economic growth.

◉ 骁龙 X Elite 为 PC 行业赋能全新可能性

◉ Snapdragon X Elite empowers new possibilities for the PC industry

Arm 终端计算子系统 (CSS)：重新定义移动端 AI 体验

Arm CSS for Client: Redefining Mobile AI Experiences



◉ Arm 终端 CSS 具备最新的 Armv9.2 CPU、Arm Immortalis GPU、基于三纳米工艺生产就绪的 CPU 和 GPU 物理实现，以及 CoreLink 系统互连和系统内存管理单元 (SMMU)

◉ Arm Compute Subsystems (CSS) for Client, integrating the latest Armv9.2 CPUs, Arm's Immortalis GPU, as well as production ready physical implementations for CPU and GPU on 3nm, and the latest Corelink System Interconnect and System Memory Management Units (SMMUs).

Arm 公司
Arm Limited

引言

随着人工智能 (AI) 浪潮席来，Arm 推出了重新定义移动端 AI 体验的终端计算子系统 (CSS)，为开发者和最终用户提供更多机会，实现消费电子设备性能、效率和可扩展性的跨越式提升。

Introduction

As AI era accelerates, Arm is redefining mobile experiences with the release of AI-optimized CSS for Client. It is designed to deliver greater uplift of performance, efficiency, and scalability for consumer devices, benefiting developers and end-users.

Arm 终端 CSS 持续突破移动端 AI 体验的极限

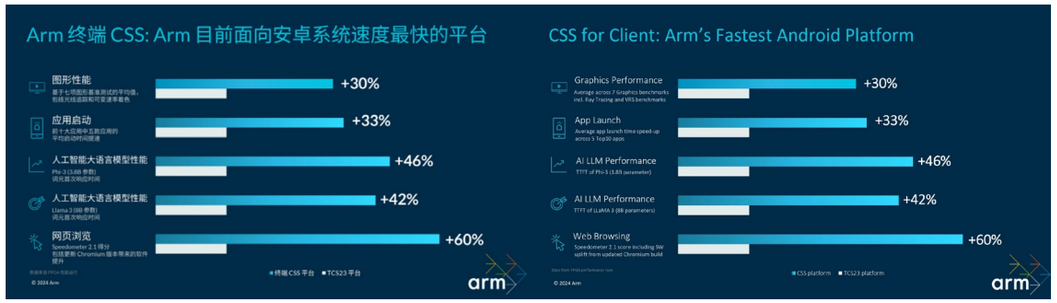
Arm CSS for Client: Pushing the Boundaries of AI Performance for Premium Mobile

为满足移动端的 AI 需求，Arm 推出了包括 Arm®v9.2 Cortex® CPU 集群、 Arm Immortalis™ 与 Arm Mali™ GPU、基于三纳米工艺生产就绪的 CPU 和 GPU 物理实现、CoreLink™ 系统互连和系统内存管理单元 (SMMU)，以及助力软件开发者取得 Arm CPU 上最佳性能的 Arm Kleidi 在内的终端计算子系统 CSS（简称“终端 CSS”）。与 2023 Arm 全面计算解决方案 (TCS23) 平台相比，终端 CSS 在关键基准和一般计算用例取得了显著的技术进步，是 Arm 目前面向安卓系统速度最快的计算平台。

Arm CSS for Client targets consumer devices, integrating the latest Armv9.2 CPUs, Arm's Immortalis GPU, production ready physical implementations for CPU and GPU on 3nm, as well as the latest Corelink System Interconnect and System Memory Management Units (SMMUs) and the Kleidi software providing developers with frictionless access to the best performance possible on Arm CPUs. CSS for Client is Arm's fastest platform for Android to date, with significant improvements across key benchmarks and general compute use cases compared to the TCS23 platform.

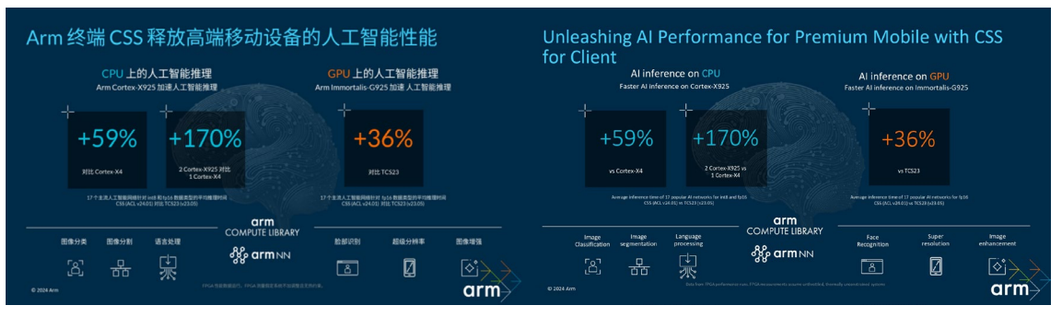
Arm 终端 CSS 将计算和图形性能提升了 30% 以上，以满足要求实际用例中严苛的安卓工作负载，同时 AI 推理速度提高了 59%，可适用于更广泛的 AI/ 机器学习 (ML) 和计算视觉工作负载。Cortex-X925 在 AI 性能方面提升了 41%，可显著提高如大语言模型 (LLM) 等设备端生成式 AI 的响应能力。而新的 Immortalis-G925 GPU 在多个 AI 网络上提升了 34% 的性能。Arm 正在构建以终端 CSS 为基础的消费电子计算平台，来满足用户当前和未来的 AI 体验需求。

Arm CSS for Client can address demanding real-life Android workloads with a greater than 30 percent increase on compute and graphics performance and 59 percent faster AI inference for broader AI/ML workloads. Additionally, the new Cortex-X925 CPU provides a 41 percent performance uplift to improve the responsiveness of on-device GenAI, while the Immortalis-G925 GPU can deliver 34 percent more performance for multiple AI networks. Through the platform, Arm is building the future of consumer computing for the AI-based experiences of today and tomorrow.



◉ Arm 终端 CSS 为 AI、大模型、图形与网页浏览等用户体验带来显著提升

◉ Arm CSS for Client significantly enhances user experience in AI, large language models (LLMs), graphics, and web browsing



◉ Arm 终端 CSS 提升 AI 推理

◉ AI Inference Improvements with Arm CSS for Client

Arm 终端 CSS：赋能下一代端侧 AI 新体验

Arm CSS for Client: Enablement of New-Generation On-device AI Experiences

Arm 终端 CSS 是为各类消费电子设备打造的新一代 AI 体验专用平台，使用户能够在其移动设备上获得更出色的安卓体验。Armv9.2 CPU 集群采用了 2+4+2 CPU 配置，大大提高了 CSS 平台上重要用例的性能，包括 APP 启动、及 AI 性能；CoreLink 将 L3 缓存大小从 8MB 增加到 16MB，并在集群中的所有内核之间共享，有助于进一步加快繁重工作负载的计算速度；Arm Immortalis-G925 选用 14 个着色器内核和 4MB 共享 L2 缓存，以充分利用 3nm 工艺所带来的面积缩减优势。凭借基于第五代 GPU 架构、面向旗舰智能手机所设计的 Arm Immortalis-G925，Arm 终端 CSS 在图形和主机级别的游戏性能方面实现了显著提升。

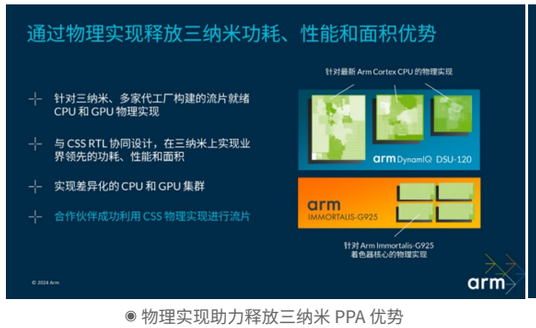
CSS for Client is the purpose-built platform for the next generation of AI experiences across a broad spectrum of consumer devices. On mobile, users will experience Android like never before. Armv9.2 CPUs have chosen 2+4+2 CPU cluster which helps improve performance of important use cases like app launch and AI performance on the CSS platform. CoreLink increases the L3 cache size from 8MB to 16MB, which is shared across all cores in the cluster, will contribute to a further speed-up for compute heavy workloads. On the GPU side, Arm Immortalis-G925 has opted to implement 14 shader cores with 4MB of shared L2 cache to make use of area reduction with 3nm process. CSS for Client achieves stunning graphics and console-level gaming performance through the Immortalis-G925 for flagship smartphone devices, which is built on the 5th Gen GPU architecture.

作为终端 CSS 的一部分，Arm 携手领先的代工厂合作伙伴，协同设计并交付 CPU 和 GPU 物理实现，其中包括流片就绪的 Cortex-X925 CPU 以及 Immortalis-G925 三纳米工艺的物理实现。这有助于 Arm 的合作伙伴在三纳米工艺上取得 同类最佳的平台功率，性能和面积 (PPA) 优势，并通过生产就绪的芯片解决方案来缩短芯片的开发与部署时间。此外，Arm 的合作伙伴能够灵活地使用 Arm 终端 CSS 来构建特定市场、具有差异化特色的 CPU 集群和 GPU。

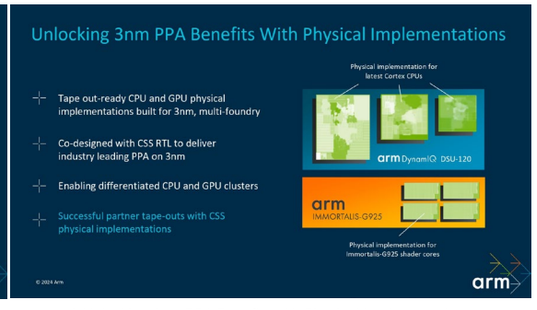
As part of CSS for Client, working with leading foundry partners, Arm is co-designing and delivering CPU and GPU physical implementations, which includes tape-out ready Cortex-X925 CPU and Immortalis-G925 physical implementations for 3nm. This helps partners to access the full PPA (power, performance and area) benefits on the 3nm process, while shortening silicon development and deployment timelines through the production-ready silicon solutions. It also gives partners the flexibility to build market-specific, differentiated CPU clusters and GPUs using CSS for Client.

通过释放更多 PPA 优势、实现更多 AI 功能和应用体验，终端 CSS 将助力 Arm 合作伙伴打造更先进的芯片，从而带动 Arm 生态系统的不断突破与进步。

With maximizing the PPA benefits, enabling more AI capabilities and application experience for premium platforms, Arm CSS for Client can help Arm's partners to create advance SoCs, driving the evolution of Arm ecosystem.



◉ 物理实现助力释放三纳米 PPA 优势



◉ Unlocking 3nm PPA Benefits with Physical Implementations

Arm 终端 CSS 为无处不在的 AI 奠定技术基础

Arm CSS for Client: the Technology Foundation for AI Everywhere

作为 AI 的创新基础技术，众多企业都在使用 Arm 计算平台。迄今为止，合作伙伴基于 Arm 架构的芯片出货量已超过 2,900 亿颗。

Arm architecture is the world's pervasiveness computing platform being the foundation of AI innovation. As of now, Arm partners have been shipping 290 billion Arm-based chips to the market.

随着 AI 工作负载的计算强度及复杂度持续增长，Arm 终端 CSS 最新的 Armv9.2 CPU 集群能够带来更强的计算与图形性能、更高的推理效率、更多的 AI 应用，以及更低的能耗，为实现新一代 AI 奠定扎实基础。这些优势可扩展到旗舰智能手机、AI PC、主流移动设备、XR 和可穿戴设备等各类消费电子设备。

As AI workloads continue to get more compute intensive and complex, Arm is laying the foundation for next-generation AI, with more compute and graphic performance, better interfering efficiency, more AI applications enabled, and lower power consumption at the heart of the latest Armv9.2 CPU cluster. These benefits are scalable across a broad range of consumer devices, from flagship smartphones and AI PCs right through to mainstream mobile, XR and wearable devices as part of Arm's commitment to enable AI everywhere.

Arm 持续推动 AI 技术发展，预计到 2025 年年底，超过 1,000 亿台基于 Arm 架构的设备将可支持 AI 应用。Armv9 CPU 技术广泛应用于旗舰 AI 智能手机所搭载的芯片中，其中包括搭载 Google Tensor G3 芯片的 Google Pixel 8 和 Pixel 8 Pro、红米 K60 至尊版，以及搭载 MediaTek 天玑 9300 芯片的 vivo X100。

Arm is driving the AI evolution and expects that more than 100 billion Arm-based devices will be AI ready by 2025. Armv9 CPU technology has been adopted in silicon across leading AI-enabled flagship smartphones, including Google Pixel 8 and Pixel 8 Pro (Google Tensor G3 chipset), Xiaomi Redmi K60 Ultra, and vivo X100 (MediaTek Dimensity 9300 chipset).

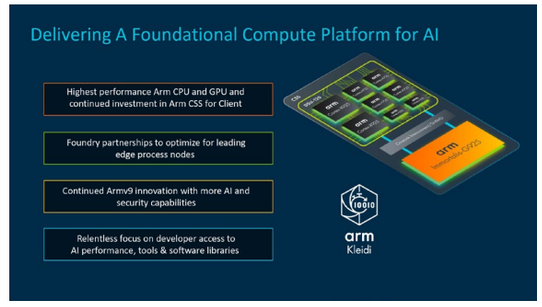
在快速发展的 AI 时代，Arm 为全球 2000 万开发者推出了一项广泛的软件和软件社区参与计划 Arm Kleidi，帮助开发者们获得产品开发时所需要的性能、工具和软件库，顺利打造出更好的 AI 产品和服务。

In the ever-evolving, fast paced age of AI, Arm is steadfast in support for the over 20 millions of developers worldwide and ensuring that they have access to the performance, tools and software libraries needed to seamlessly create the next wave of stunning AI-enabled experiences. This is why Arm launched Arm Kleidi, a broad program of software and software community engagements for accelerating AI.

Arm 终端 CSS 将成为下一代智能手机、电脑的旗舰计算平台，提供极致的性能和领先的 AI 体验，助力生态伙伴抓住 AI 时代的广阔机遇，在 Arm 平台共同构建 AI 的未来。

Arm CSS for Client is the platform for the next-generation of smartphones and PCs. With these technology improvements, ecosystem partners will be able to seize the opportunity of AI by enabling advanced features to build future on-device AI experiences, on Arm .

◉ Arm 终端 CSS 实现面向 AI 的基础计算平台



◉ Arm CSS for Client delivers a foundational compute platform for AI

◉ Arm 是未来 AI 的基石

◉ The future of AI is built on Arm

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Leading Achievements of
World Internet Conference Awards for
Pioneering Science and Technology

01

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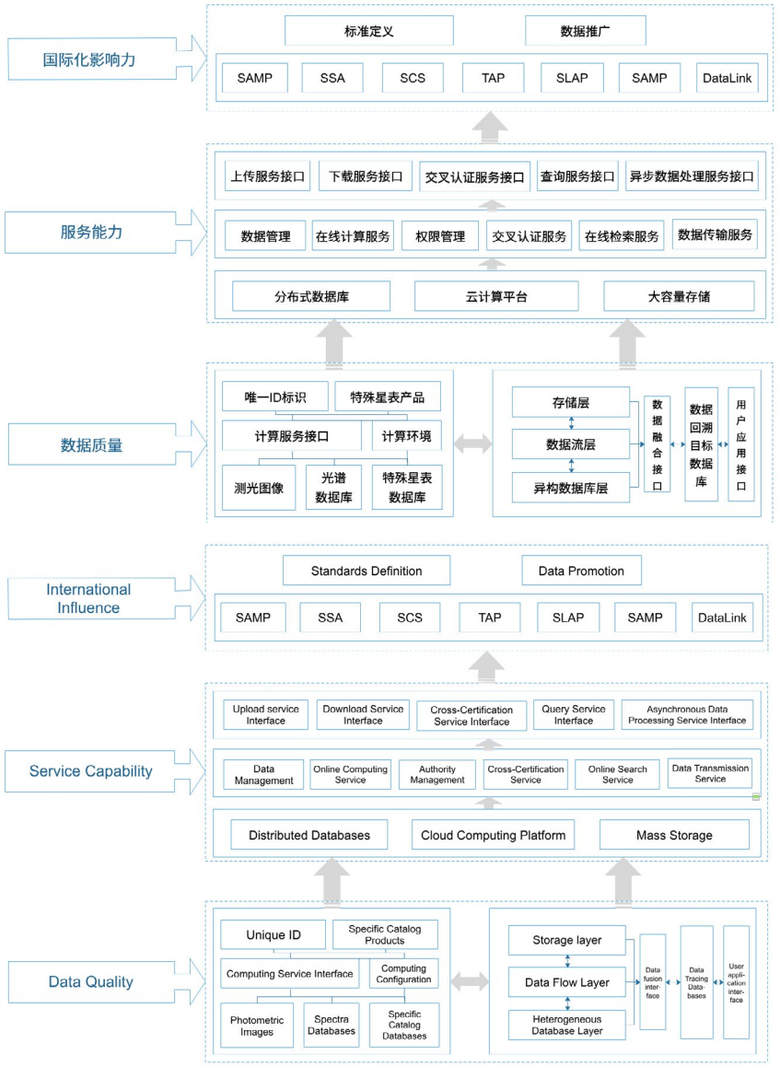
工程研发组
Engineering Research and
Development Group

LAMOST 天体光谱数据处理和发布平台

LAMOST Astronomical Spectral Data Processing and Release System



◉从数据质量（唯一 ID、可溯源性）、服务能力（大规模交叉证认系统、在线数据表异步处理系统升级优化）和国际化影响力（协议兼容、拓宽国际合作渠道、组织全球培训课程、接入国际权威组织）三个方面出发构建权威数据库。

◉The authoritative database is constructed from three key aspects: data quality (unique ID and traceability), service capability (upgraded and optimized large-scale cross-identification system and asynchronous online data table processing system), and international impact (protocol compatibility, expanding international cooperation channels, organizing global training courses, and integration with international authoritative organizations).

中国科学院国家天文台
National Astronomical Observatories, Chinese Academy of Sciences (NAOC)

引言

光谱巡天是大样本天文学研究的基础，可靠的、采样均匀的光谱是天文学研究的重要数据来源，也是人类建立宇宙模型的理论基础。LAMOST 天体光谱数据处理和发布了多达 2200 万条光谱数据，成为国际天文界主要的互联网光谱数据源之一。

Introduction

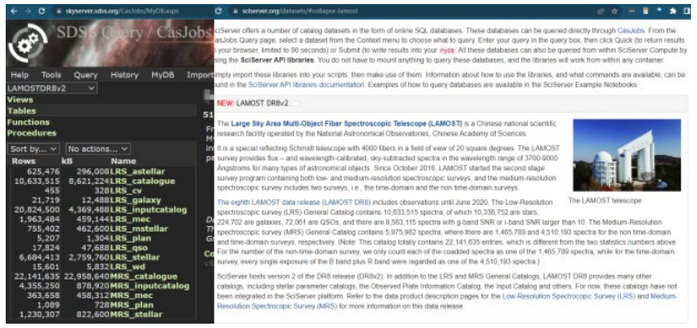
Spectral surveys are the foundation of large-sample astronomical research. Reliable and uniformly sampled spectra are crucial data sources for astronomical studies and form the theoretical basis for humanity's construction of cosmological models. the LAMOST Astronomical Spectral Data Processing and Release System has published up to 22 million spectra, making it one of the primary internet-based spectral data sources in the international astronomical community.

LAMOST 天体光谱数据处理和发布平台提供的数据和服务持续提升国际影响力

The Data and Services Provided by the LAMOST Astronomical Spectral Data Processing and Release System Have Continuously Enhanced its International Impact

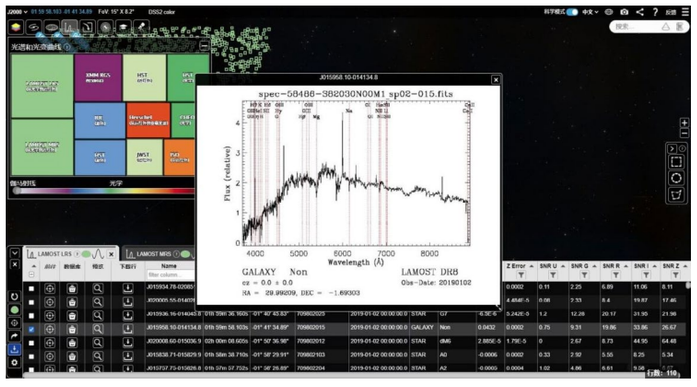
通过不断提升 LAMOST 光谱数据产品的质量和增加数据可追溯性，LAMOST 光谱数据正在逐步达到世界领先水平，也代表了中国天文数据领域的现有水平。同时，我们根据用户需求持续完善数据发布系统，提升数据检索效率。实现 LAMOST 的在线数据表异步处理系统，使用户可以上传和处理大量数据，满足科学家对于不同规模数据的检索和研究需求。由于数据的可靠性和易访问性，LAMOST 天体光谱数据处理和发布平台与国际天文界主要的互联网数据库进行了同步汇入，包括法国斯特拉斯堡数据库 CDS，欧空局数据库 ESASKY，德国虚拟天文台 GVO、美国约翰霍普金斯 SDSS 数据库等。截至目前，LAMOST 用户包括全球 1800 位专业天文学家，使用该数据源每年发表两百余篇顶刊论文，加深了人类对银河系的结构、形成和演化的认识。

By continuously improving the quality of LAMOST spectral data products and enhancing data traceability, LAMOST spectral data is gradually reaching a world-leading level, representing the current state of astronomical data in China. At the same time, we have been continuously refining the data release system based on user needs, enhancing data retrieval efficiency. The implementation of the LAMOST online asynchronous data table processing system enables users to upload and process large amounts of data, meeting the retrieval and research demands of scientists for datasets of various scales. Due to the reliability and accessibility of the data, the LAMOST Astronomical Spectral Data Release System has been integrated with major international astronomical internet databases, including the CDS Strasbourg database in France, ESA's ESASKY, the German Virtual Observatory (GVO), and the SDSS database at Johns Hopkins University in the United States. To date, LAMOST has served a user base of 1,800 professional astronomers worldwide, leading to the publication of over 200 high-impact journal papers annually, deepening humanity's understanding of the structure, formation, and evolution of the Milky Way.



◉LAMOST 星表已汇入美国约翰霍普金斯 SDSS 数据库

◉LAMOST Catalog Integrated into the SDSS Database at Johns Hopkins University, USA



◉LAMOST 星表已汇入法国斯特拉斯堡数据库 CDS 系统

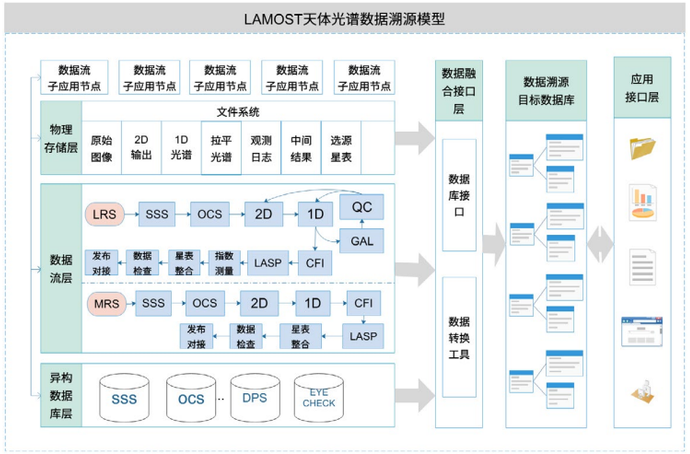
◉LAMOST Catalog Integrated into the CDS System at Strasbourg, France

LAMOST 天体光谱数据处理和发布平台的创新性设计

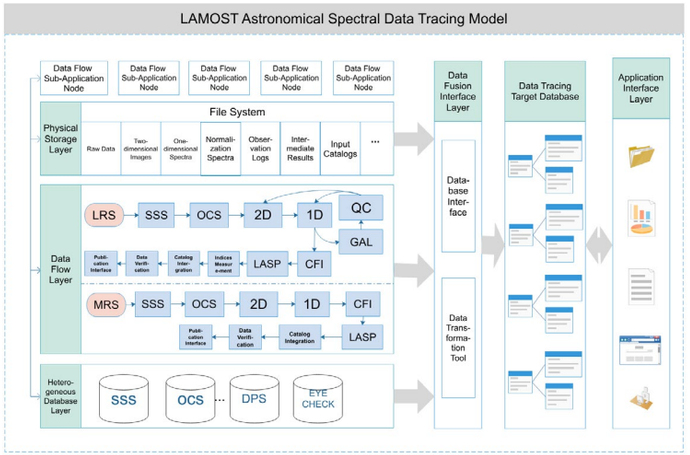
Innovative Design of the LAMOST Astronomical Spectral Data Processing and Release System

创建独特的标识系统，将光谱数据投影到测光图像中，对每个星体中心坐标进行计算，构建唯一的 ID 标识。这将大大简化了天文学家在不同的星表中进行多星表交叉查询的任务，提高光谱数据的关联性和一致性。通过构建数据追溯模型，将数据采集和处理过程全流程信息有效融合，确保每个环节实现信息追溯。在用户界面提供新的数据分析与追溯工具，实现对各类光谱数据的单目标追溯和批量统计图表。同时，我们还构建了用于帮助用户将 LAMOST 与其他知名星表（如 Gaia、Pan-STARRS 等）进行交叉验证的系统，确保用户能够在其他星表中找到相对应的目标。LAMOST 的互联网数据库还实现了国际虚拟天文台联盟（IVOA）的标准互操作协议，确保国际上广泛使用的数据分析软件能够方便访问 LAMOST 数据。

A unique identification system has been created to project spectral data onto photometric images, calculating the central coordinates of each celestial object and constructing a unique ID identifier. This significantly simplifies the task of astronomers performing cross-matching across multiple catalogs, enhancing the relevance and consistency of the spectra. By building a data traceability model, the system effectively integrates full-process information from data acquisition to processing, ensuring traceability at every stage. New data analysis and traceability tools are provided in the user interface, allowing single-object traceability and batch statistical charts for various types of spectral data. Additionally, we have developed a system to assist users in cross-verifying LAMOST data with other well-known catalogs, such as Gaia and Pan-STARRS, ensuring users can find corresponding targets in other catalogs. The LAMOST internet database has also implemented the interoperability protocols of the International Virtual Observatory Alliance (IVOA), ensuring that widely used international data analysis software can easily access LAMOST data.



◉ LAMOST 天体光谱的数据结构及溯源系统

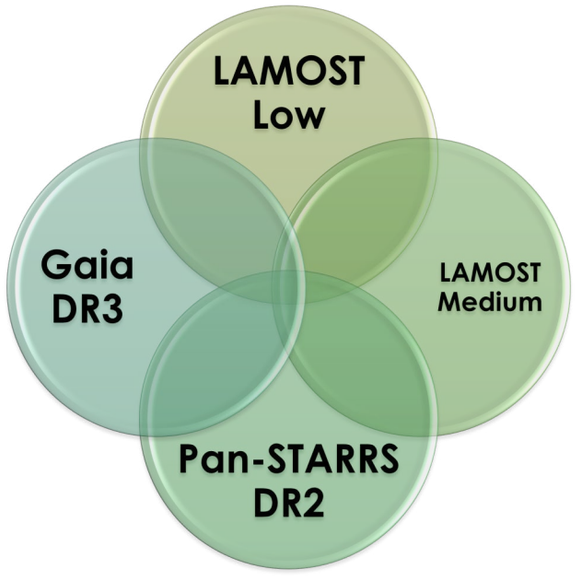


◉ Data Structure and Traceability System of LAMOST Astronomical Spectral Data

LAMOST 天体光谱数据处理和发布已经成为具有权威性的恒星光谱数据库平台

The LAMOST Spectral Data Processing and Release System Has Become an Authoritative Stellar Spectral Database System

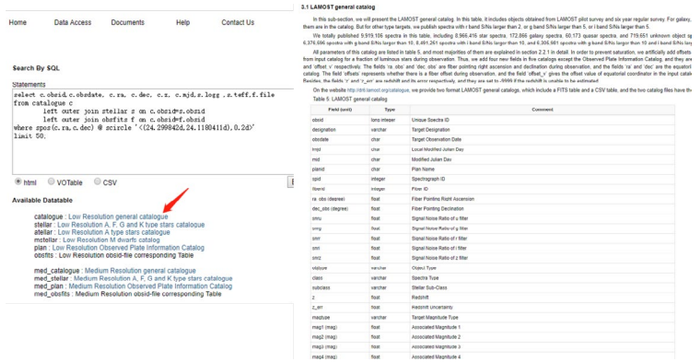
经过 10 余年的建设，LAMOST 天体光谱数据处理和发布所提供的优质的数据成为银河系研究的重要工具被国际天文界认可。利用 LAMOST 数据发表的重要成果中超过 40% 的作者都直接使用本平台下载的数据。这些成果更新了人类对银河系大小、整体形状、内部结构、化学组成、形成历史等方方面面的认识。这个数据发布平台不仅对科学研究发展提供支撑，也对高等教育和科学普及产生了重要影响。多个高校的天文学实践课程使用本网站作为平台，还有的社会组织举办的的人工智能大赛也采用本网站数据作为数据源。一些高中生利用本平台的数据做科创项目，曾获第 39 届北京青少年科技创新大赛一等奖。鉴于其突出的社会效益，LAMOST 天体光谱数据处理和发布获得 2020 年北京市科技进步二等奖。



◉ LAMOST 与其他知名星表（如 Gaia、Pan-STARRS 等）进行交叉验证的系统

◉System for Cross-Verification Between LAMOST and Other Well-Known Star Catalogs (e.g., Gaia, Pan-STARRS, etc.)

After more than 10 years of development, the LAMOST Spectral Data Processing and Release System has become a vital tool for Galactic research and is widely recognized by the international astronomical community for the high-quality data it provides. Over 40% of the authors of significant research results using LAMOST data directly download the data from this system. These studies have advanced our understanding of various aspects of the Milky Way, including its size, overall shape, internal structure, chemical composition, and formation history. The system not only supports scientific research but also has a significant impact on higher education and public science outreach. Many universities use the platform in their astronomy practical courses, and some organizations utilize its data for artificial intelligence competitions. High school students have also used the system's data for science and technology innovation projects, with one project winning first prize at the 39th Beijing Youth Science and Technology Innovation Competition. In recognition of its outstanding societal benefits, the LAMOST Spectral Data Processing and Release System was awarded the second prize in the 2020 Beijing Science and Technology Progress Awards.



◉ LAMOST 的数据检索与下载系统

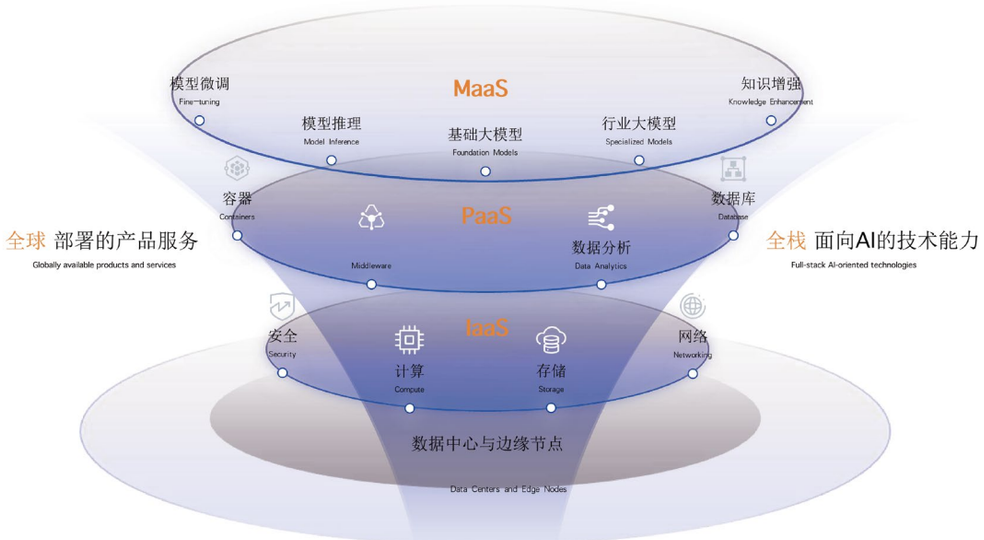
◉LAMOST Data Retrieval and Download System

◉ 各学者通过 LAMOST 数据平台取得的获奖证书

◉Certificates Awarded to Scholars for Achievements Using the LAMOST Data System

面向 AI 的云计算基础设施

AI-Oriented Cloud Computing Infrastructure



◉ 通过计算、存储、网络等底层硬科技的持续创新，阿里云为 AI 浪潮提供技术领先的普惠计算服务。

◉ Through continuous innovation in core technologies including computing, storage, and networking, Alibaba Cloud offers technologically leading and inclusive computing services for the AI era.

阿里云计算有限公司
Alibaba Cloud Computing Co., Ltd.

阿里云

引言

以海量训练数据和超高参数量的复杂模型为基础，通过强大的计算能力来抽象数据中的信息，已成为实现通用人工智能（AGI）的主流路线，这使得高效利用算力问题变得尤为紧迫，需要对云计算软硬件技术架构进行系统性升级。

2009 年，阿里云提出了“数据中心即一台计算机”的前瞻性理念。如今在 AI 时代，这一技术体系的重要性愈发凸显。作为超级计算平台，云计算不仅能高效整合各类异构计算资源，还能突破单一芯片性能的局限，协同完成大规模 AI 智能计算任务，从而实现更高层次的计算效能。

Introduction

Based on massive training datasets and complex models with ultra-high parameter counts, leveraging powerful computational capabilities to abstract information from data has become the mainstream approach toward achieving General Artificial Intelligence (AGI). This makes the efficient utilization of computational power particularly urgent, necessitating a systematic upgrade of the cloud computing software and hardware architectural frameworks.

In 2009, Alibaba Cloud proposed the visionary concept that “A data center is a single computer.” Today, in the era of AI, such a technical framework has become even more essential. Serving as a supercomputer, cloud computing can efficiently integrate heterogeneous computing resources, breaking through the performance limitations of individual chips, and collaboratively accomplish large-scale intelligent computing tasks.

全新打造了面向 AI 的云计算基础设施

A Brand New AI-oriented Cloud Computing Infrastructure Has been Developed

不同于传统 IT 时代，AI 时代对基础设施的性能、效率要求更高，CPU 主导的计算体系已快速向 GPU 主导的 AI 计算体系转移。阿里云正以 AI 为中心，全面重构底层硬件、计算、存储、网络、数据库、大数据，并与 AI 场景有机适配、融合，加速模型的开发和应用，打造 AI 时代的云计算基础设施。

In contrast to the traditional IT era, the AI era demands higher performance and efficiency from infrastructure. The computing architecture, once dominated by CPUs, has rapidly shifted towards a GPU-centric AI computing system. Alibaba Cloud is reconstructing its underlying hardware, computing, storage, networking, databases, and big data with AI at the core, integrating and adapting these elements organically to AI scenarios. This accelerates model development and application, building cloud computing infrastructure for the AI era.

最新上线的磐久 AI 服务器，支持单机 16 GPUs；为 AI 设计的高性能网络架构 HPN7.0，可稳定连接超过 10 万个 GPU ，模型端到端训练性能提升 10% 以上；阿里云 CPFS 文件存储，数据吞吐 20TB/s，为 AI 智算提供指数级扩展存储能力；基于全新的计算存储网络技术体系打造出全新一代智能计算产品灵骏，为 AI 应用提供集群级加速计算服务；容器计算服务首次推出 GPU 容器算力，通过拓扑感知调度，实现计算亲和度和性能的提升；人工智能平台 PAI，已实现万卡级别的训练推理一体化弹性调度，AI 算力有效利用率超 90%。

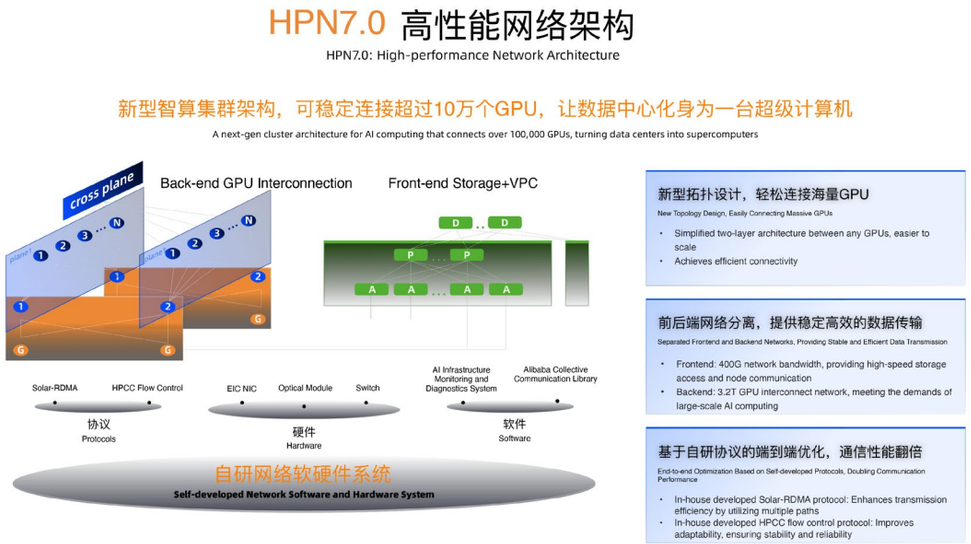
The newly launched Panjiu AI server supports up to 16 GPUs per machine. The high-performance network architecture HPN7.0, designed for AI, can stably connect over 100,000 GPUs, increasing end-to-end training performance by more than 10%. Alibaba Cloud's CPFS (Cloud Parallel File System) provides data throughput of 20TB/s, offering exponentially scalable storage capacity for AI computations. The new generation of intelligent computing products, Lingjun, is built on a novel computing, storage, and networking technology system, providing cluster-level accelerated computing services for AI applications. The container computing service has introduced GPU container computing power for the first time, enhancing computational affinity and performance through topology-aware scheduling. The artificial intelligence platform PAI (Platform of Artificial Intelligence) has achieved integrated elastic scheduling for training and inference at the ten-thousand GPU level, with effective AI computing power utilization exceeding 90%.

本项目以行业领先的市场地位出现在 Forrester、Gartner 等知名机构的分析报告中；相关核心技术探索进展被 SIGCOMM、HPCA、ICDE、ACM 等多个学术顶级会议收录。

This project has gained industry recognition, appearing in analytical reports from well-known organizations such as Forrester and Gartner, while advancements in related core technology exploration have been included in several top academic conferences, including SIGCOMM, HPCA, ICDE, and ACM.

◉ 云计算体系全栈创新，打造 AI 基础设施新范式

◉ Next-Generation Cloud Architecture: A New Paradigm Built for AI



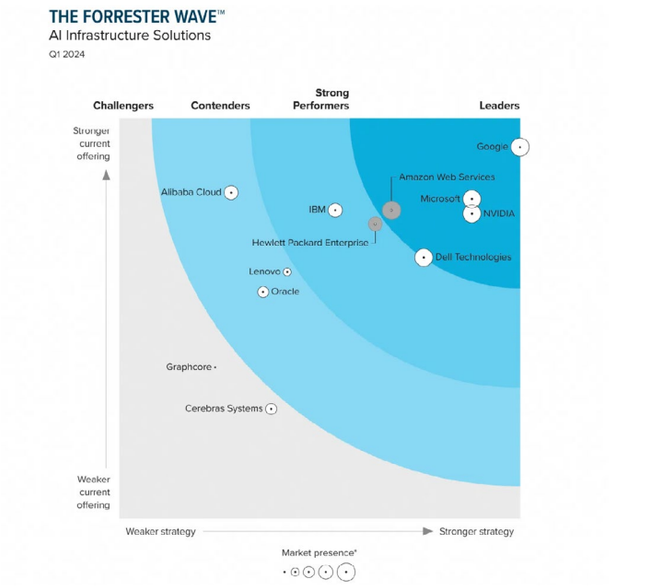
◉ HPN7.0 高性能网络架构（被 SIGCOMM 2024 收录）

◉ HPN7.0: High-performance Network Architecture (Accepted by SIGCOMM 2024)

支撑 AI 行业创新发展

Supporting the Innovative Development of the AI Industry

基于本项目成果的产品方案服务了 50% 以上中国大模型企业 / 机构。中国有 80% 的科技公司和 50% 以上的大模型初创公司使用阿里云 AI 基础设施服务，服务的 AI 原生企业市值已经超过 840 亿人民币，上层企业用户开源的模型累计下载量超过 3200 万次，多个模型位在相关性能评测榜单名列前茅。阿里云的 AI 基础设施不仅在技术层面提供了强有力的支撑，还通过构建开放生态、参与国际交流等多种方式，全面推动了大模型应用的创新与发展。



◉ Forrester 2024 全球 AI 基础设施解决方案研究报告，阿里云进入竞争者象限。

◉ Forrester 2024 Global AI Infrastructure Solutions Research Report, Alibaba Cloud enters the challenger quadrant.

Based on the outcomes of this project, the product solutions serve over 50% of China's large model enterprises and institutions. In China, 80% of technology companies and over 50% of large model startups use Alibaba Cloud's AI infrastructure services. The market capitalization of the AI-native enterprises served has exceeded 84 billion RMB, and the cumulative download count of open-source models by upper-layer enterprise users has surpassed 32 million times. Multiple models rank at the top of relevant performance evaluation charts. Alibaba Cloud's AI infrastructure not only provides strong technical support but also promotes innovation and development in large model applications through various means, including building an open ecosystem and participating in international exchanges.

从学术突破到行业赋能

From Academic Breakthroughs to Industry Empowerment

带动 AI Infra 领域科研创新：面向 AI 训练、存储等大规模高复杂度场景的流量控制算法 HPCC 入选 SIGCOMM 2019，人工智能集群架构设计入选 HPCA 2020，实现十万卡级扩展性的 AI 集群网络 HPN 7.0 入选 SIGCOMM 2024，为全球 AI 网络基础设施的设计及实践提供了全新高性能标准。

Driving Research and Innovation in AI Infrastructure: The flow control algorithm HPCC, aimed at large-scale and high-complexity scenarios such as AI training and storage, was selected for SIGCOMM 2019. The design of an artificial intelligence cluster architecture was chosen for HPCA 2020, and the AI cluster network HPN 7.0, which achieves scalability at the level of hundreds of thousands of nodes, was selected for SIGCOMM 2024. These contributions provide a new high-performance standard for the design and practice of global AI network infrastructure.

促进 AI 应用创新：2022 年携手小鹏打造自动驾驶智算中心扶摇，使小鹏的自动驾驶核心模型训练时长从 7 天缩短至 1 小时内，带来 170 倍的迭代速度提升。2023 年助力吉利打造星睿智算中心，帮助吉利自动驾驶业务整体研发效率提升 20%。2023 年助力复旦大学打造的 CFFF 科研智算平台，平台荣获了 2023 年中国算力大会“创新先锋”案例、2023 年中国国际服务贸易交易会“智赋百业领航型案例”等诸多荣誉。2024 年，在巴黎奥运会上，阿里云不仅支持了视频转播全面上云，而且使用全栈 AI 技术能力重塑观赛体验。

Promoting Innovation in AI Applications: In 2022, we collaborated with Xiaopeng Motors to create the autonomous driving intelligent computing center "Fuyiao", significantly reducing the training time for Xiaopeng's core autonomous driving model from 7 days to under 1 hour, resulting in a 170-fold increase in iteration speed. In 2023, we assisted Geely in establishing the Xingrui intelligent computing center, which improved the overall R&D efficiency of Geely's autonomous driving business by 20%. Additionally, in 2023, we supported Fudan University in developing the CFFF research computing platform, which received numerous accolades, including the "Innovation Pioneer" case at the 2023 China Computing Power Conference and "Smart Empowerment Leading Case" at the 2023 China International Trade in Services Expo. In 2024, at the Paris. Olympics, Alibaba Cloud not only supported the full migration of video broadcasting to the cloud but also reshaped the viewing experience using comprehensive AI technology capabilities.

◉ 巴黎奥运全栈上云，AI 重塑赛事体验

◉ Paris 2024 Goes Fully Cloud-Native, and AI Reshaping the Event Experience

◉ 微软 Copilot
◉ Microsoft Copilot

微软 Copilot: 新一代人工智能副驾驶

Microsoft Copilot, Embrace the AI New Era

微软（中国）有限公司
Microsoft China Co., Ltd.

Microsoft

引言

微软持续赋能企业、组织和个人。通过智能 Copilot 副驾驶，微软不断加强全球用户与最前沿 AI 大模型的连接，推动生产力与创新力的双重提升。

Introduction

Microsoft continues to empower enterprises, organizations, and individuals. Through the intelligent Copilot , Microsoft strengthens the connection between global users and cutting-edge AI models, driving dual enhancement of productivity and innovation.

微软智能 Copilot 副驾驶 ® 已成为新一代 AI 的用户界面

Microsoft Intelligent Copilot®: The User Interface of Next-Gen AI

以 2022 年 6 月 Github Copilot 的推出为起点，微软持续加速 Copilot 迭代升级，并将其融入核心产品。截至今年 9 月，Copilot 已搭载了 GPT-4o 等领先模型，集成了多项创新功能。例如 Copilot Pages 与数据中枢 BizChat 无缝集成，将网页数据、工作数据和各种业务数据整合到用户的工作流中，开创性地构建出多用户实时、持续的 AI 协作模式，大幅提升了生产力。

Starting with the launch of GitHub Copilot in June 2022, Microsoft has continuously accelerated the iteration and integration of Copilot into its core products. As of September this year, Copilot is equipped with leading models such as GPT-4o and includes numerous innovative features. For example, Copilot Pages seamlessly integrates with the BizChat data hub, consolidating web data, work data, and various business data into the user's workflow. This pioneering multi-user real-time, continuous AI collaboration model greatly enhances productivity.

此外，微软通过 GitHub Copilot 帮助开发人员将代码编写速度提高了 55%。已有超过 180 万开发者使用 GitHub Copilot，超过 27000 家组织选择了 GitHub Copilot for Business。

Furthermore, Microsoft has helped developers increase coding speed by 55% through GitHub Copilot. Over 1.8 million developers are using GitHub Copilot, and more than 27,000 organizations have chosen GitHub Copilot for Business.

2024 年 5 月，微软与生态伙伴发布了 Copilot+PC。这款设备配备了神经处理单元（NPU），每秒可执行 45 万亿次操作（TOPS），专为加速 AI 和机器学习任务而设计，重新定义了从芯片到操作系统，从应用层到云端的个人计算体验，展现了智能化终端的全新形态。

In May 2024, Microsoft and its ecosystem partners launched Copilot+PC. This device is equipped with a Neural Processing Unit (NPU) that can execute 45 trillion operations per second (TOPS), designed to accelerate AI and machine learning tasks. It redefines personal computing experiences from chip to operating system, from application layer to cloud, showcasing a new form of intelligent terminals.

◉ 通过 GitHub Copilot，开发人员可将编程速度提高 55%，实现生产力提升

◉ With GitHub Copilot, developers can increase their coding speed by 55%, boosting productivity

◉ 微软与生态伙伴发布 Copilot+PC，专为加速 AI 和机器学习任务而设计

◉ Microsoft, in collaboration with its ecosystem partners, has released Copilot+PC, designed specifically to accelerate AI and machine learning tasks.

Copilot 助力全球生产力提升

Copilot Enhances Global Productivity

Copilot for Microsoft 365 已在 160 多个国家和地区发布。60% 的财富 500 强公司正在使用该服务。自 2024 年初以来，Copilot 新增了超过 150 项功能帮助用户通过 Microsoft 365 套件（如 Word、Excel 和 PowerPoint）获得实时、精准的辅助服务，包括自动生成文档内容和图片、数据分析与报告生成、编程辅助等，极大提高了生产效率，降低企业运营成本，实现显著的经济效益。

Copilot for Microsoft 365 has been released in over 160 countries and regions. 60% of Fortune 500 companies are using this service. Since early 2024, Copilot has added over 150 features, helping users obtain real-time, precise assistance through Microsoft 365 suites (such as Word, Excel, and PowerPoint). These features include automatic generation of document content and images, data analysis and report generation, programming assistance, and more, significantly improving productivity, reducing operating costs, and achieving substantial economic benefits.

释放创造力，使用户能够更专注创新

Unleashing Creativity, Focusing on Innovation

2024 年，微软发布的年度《工作趋势指数报告（WTI）》揭示了 AI 在全球范围内对工作和管理的深刻影响。报告显示：70% 的 Copilot 用户表示工作效率实现提升，68% 的用户认为工作质量得到改善，软件工程师的编程速度提高了 55%，77% 的用户表示会持续使用 Copilot。在 Copilot 的辅助下，人们得以从重复性任务中解放出来，并将更多精力投入创新，使创意从构思到成果的过程显著加速，从而充分释放每个人的创造力。凭

借实时信息获取、与主流操作系统及软件无缝集成、强大的低代码开发能力及企业级安全保障，Copilot 为用户释放了更多时间和精力，推动从创意到成果的加速转化，充分释放了个人创造力。

In 2024, Microsoft's annual Work Trend Index Report (WTI) revealed the profound impact of AI on work and management globally. The report shows that 70% of Copilot users experienced increased work efficiency, 68% saw improved work quality, coding speed for software engineers increased by 55%, and 77% of users expressed continued use of Copilot. With Copilot's assistance, people are liberated from repetitive tasks, allowing more focus on innovation, significantly accelerating the process from concept to fruition, and fully unleashing each individual's creativity. With real-time information retrieval, seamless integration with mainstream operating systems and software, powerful low-code development capabilities, and enterprise-grade security, Copilot frees up more time and energy for users, driving the accelerated transition from ideas to results, and fully unleashing personal creativity.

◉ AI 正在重塑创造性工作的未来。在 Copilot 的助力下，亿万用户的创造力将得到进一步的释放和升级。

◉ AI is reshaping the future of creative work. With the help of Copilot, the creativity of billions of users will be further unleashed and elevated.

超大规模视联孪生平台技术创新与规模化应用

Technological Innovation and Large-Scale Application of Ultra-Large-Scale Vision Twin Platforms

◉ 视联孪生、虚实可视、关联洞察、推演决策

◉ Vision Twin, Virtual-Real Visualization, Connected Insights, Simulated Decision-Making.

中国电信集团有限公司
China Telecom Corporation Ltd.

引言

中国电信构筑全域“1+31+x”的一张网、一朵云、一个平台、一张实时实景孪生图的视联孪生基座，搭载星辰海纳视觉大模型激活视频数据要素价值，攻克视频位置分散、画面割裂、数据孤岛等难题，引领中国视联孪生规模化应用。

Introduction

China Telecom has constructed the national '1+31+X' framework comprising one network, one cloud, one platform, and one real-time visual twin map as the base for the Vision Twin system across the entire region. By integrating the Xingchen Haina visual large model, it activates the value of video data elements, overcoming challenges such as dispersed video locations, fragmented footage, and data silos, which leads to the large-scale application of Vision Twin technology in China.

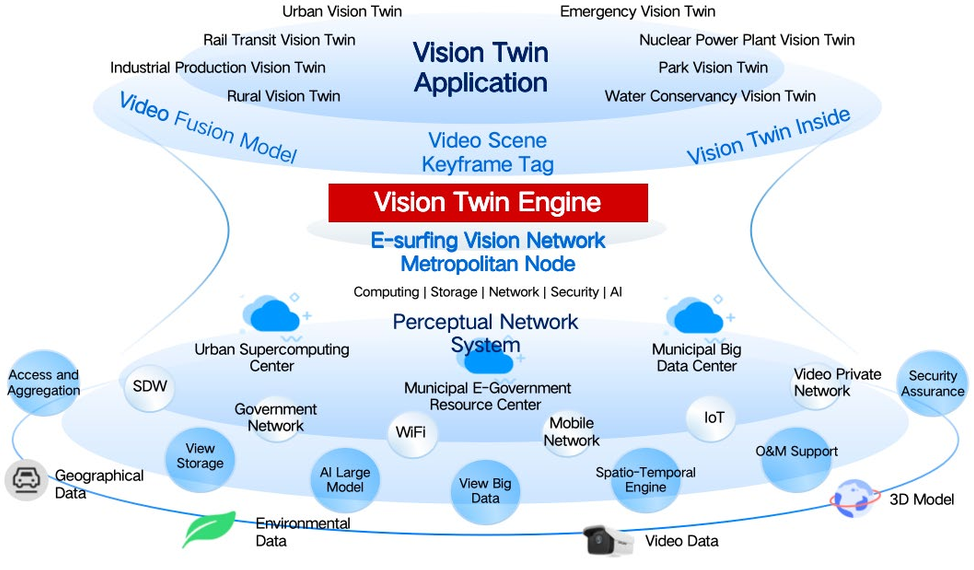
四大技术突破赋能视联孪生商业模式变革

Four Technological Breakthroughs Empower the Transformation of Vision Twin Business Models

本项目是中国视联网行业的又一个重大突破和创新，以视联孪生引擎为核心，通过实时、全域多场景视频融合算法创新，实现视频矫正和透视变换，还原视频的空间结构信息，构筑三维实景世界，解决视频割裂、看不懂的问题；以星辰海纳大模型为 L0 层基础大模型，通过视频场景关键帧标签算法创新，实现对全域 7000 万视频终端关键帧自动、精准的场景理解与语义标签化，打通动态场景中人、车、物全要素，极大提升视频内容语义理解的能力，解决视频数据体量大、类型多、价值密度低、场景化应用响应慢的难题；搭载全域覆盖的中国电信天翼视联网，通过超大规模视频数据承载技术创新，实现算力等基础资源协同联动；通过场景化模型 + 视联孪生 inside 创新模式，高质量规模化赋能千行百业。

This project represents another significant breakthrough and innovation in China's Vision Network industry. Centred around the Vision Twin engine, it employs real-time, all-encompassing multi-scenario video fusion algorithm innovations to achieve video correction and perspective transformation, restoring spatial structure information and constructing a three-dimensional real-world environment, thereby addressing fragmented videos and unclear content issues. Utilising the Xingchen Haina large model as the foundational L0 layer, it innovates on keyframe labelling algorithms to achieve automatic and precise scene understanding and semantic labelling of keyframes across 70 million video terminals, seamlessly integrating elements such as people, vehicles, and objects in dynamic scenes. This greatly enhances the capability for semantic understanding of video content and resolves challenges related to large volumes of video data, diverse types, low-value density, and slow response times for scene-based applications. Supported by China Telecom's extensive Tianyi Vision Network, the project innovates in large-scale video data transmission technologies to enable collaborative resource synergy. A scenario-based model and the Vision Twin Inside innovative approach empower many industries with high-quality, large-scale solutions.

◉ 中国电信视联孪生创新体系



◉ China Telecom Vision Twin Innovation System

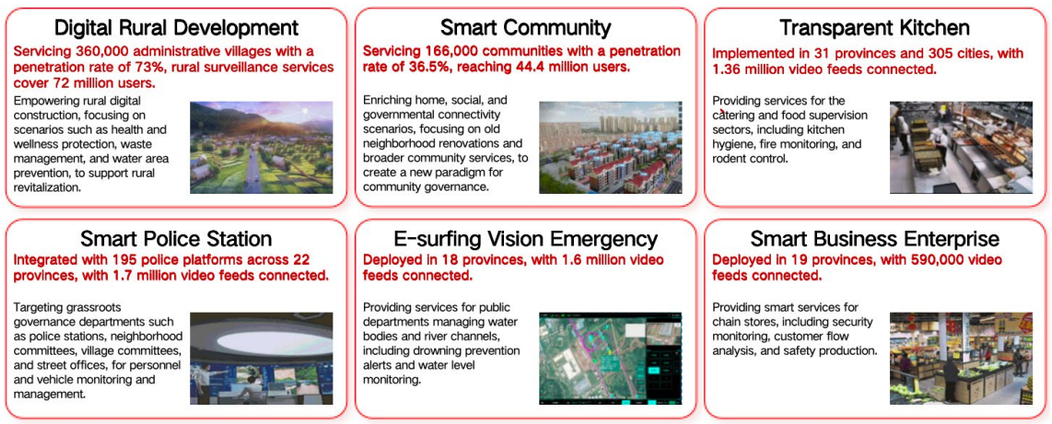
重塑千行万业、规模应用、极致效能

Reinventing Thousands of Industries, Applications at Scale, and Extreme Performance

本项目以搭载大模型能力的视算孪生引擎为核心，构建全空间要素时空一体感知、分析、预测和管控的产品体系，实现了经济效益和社会效益双丰收。本项目成果近三年产品直接收入近 100 亿元，其中 2021 年累计直接收入超 15 亿元，2022 年累计直接收入超 35 亿元，2023 年累计直接收入超 45.9 亿元。截止至 2024 年 5 月，本项目成果已拥有 9800 万户视联网用户、覆盖全国 36 万个行政村和 16 万个社区，提供了视联孪生基座和超过 700 万创新行业应用，为各垂直行业创新应用和规模化发展提供端到端的视联孪生服务能力，直接拉动产业链产值超过 300 亿元。中国电信牵头成立视联百川生态联盟，共筑视联孪生应用共同体，助力实时实景数字中国建设，对推动数字经济和社会高质量发展具有重要意义。

This project centres on the Vision Twin Engine, powered by large model capabilities, to create a product system for comprehensive spatial-temporal perception, analysis, prediction, and control of all spatial elements, achieving significant economic and social benefits. Over the past three years, the project has generated nearly 10 billion yuan in direct product revenue, with over 1.5 billion yuan in 2021, over 3.5 billion yuan in 2022, and over 4.59 billion yuan in 2023. As of May 2024, the project has attracted 98 million Vision Network users, covering 360,000 administrative villages and 160,000 communities nationwide. It provides a foundational platform for Vision Twin and over 7 million innovative industry applications, It offers end-to-end Vision Twin service capabilities for vertical industry innovation and scalable development, directly driving the industry chain's output value by over 30 billion yuan. China Telecom has initiated the establishment of the Vision Baichuan Ecological Alliance, building a community for Vision Twin applications, contributing to the construction of a real-time, realistic digital China, and playing a significant role in promoting the high-quality development of the digital economy and society.

◉ 视联孪生规模化应用



◉ Large-scale Applications of Vision Twin

共筑视联全域协同生态体系

Building a Collaborative Ecosystem for Vision Across All Domains

中国电信作为视联网领域的先行者，秉承客户为中心，构建全域生态协同体系，推动视联孪生技术创新成果转化和规模发展。主导 / 参与国际 20 余项标准制定，包括推动 ITU-T SG16 成立“视频监控业务与系统”，负责组织推进视频监控系列标准研究，维护标准化路线图，组织认证测试；主导成立 ISO/IEC JTC1 SC29 VCM 专家组，SAC TC28 SC29 DCM 组，形成前沿技术前瞻影响力。本项目基于研究成果重磅发布《中国电信视联网云化技术白皮书》，申请发明专利 40 余项、软件著作权 60 余项，并将专利标准联动，推动创新成果转化。相关成果获得“中国通信学会科学技术三等奖”、“中国电信 2022 年度科技进步二等奖”、“数博会 2023 年优秀科技成果”等重要奖项。

As a pioneer in Vision Network, China Telecom adheres to a customer-centric approach, building a comprehensive ecological collaboration system to promote the transformation and large-scale development of Vision Twin technology innovation achievements. It has led or participated in formulating over 20 international standards, including establishing the ITU-T SG16 "Video Surveillance Services and Systems." It is responsible for organising and advancing research on video surveillance series standards, maintaining the standardisation roadmap, and coordinating certification testing. China Telecom also led the establishment of expert groups for ISO/IEC JTC1 SC29 VCM and SAC TC28 SC29 DCM, shaping a forward-looking influence in cutting-edge technology. Based on its research achievements, the project has prominently released the "China Telecom Vision Network Cloud Technology White Paper," filed over 40 invention patents and more than 60 software copyrights, and linked patent standards to drive the transformation of innovation results. Related achievements have received significant awards, including the "Third Prize for Science and Technology from the China Communications Society," the "Second Prize for Technological Progress from China Telecom 2022," and the "Outstanding Scientific and Technological Achievement at the 2023 Digital Expo."

◉ 视联孪生科技管理创新成果

◉ The achievements of Vision Twin Technology Management Innovation

◉ 2024 年 4 月，超算互联网（www.scnet.cn）正式上线

◉ Scnet.cn officially goes live in April 2024

超算互联网平台

www.scnet.cn

国家高性能计算机工程技术研究中心
National HPC Engineering Technology Reaserch Center

NHPCETC

引言

算力网是支撑数字经济高质量发展的关键基础设施，目前面临算力融合互联、供需对接、普惠易用等挑战。超算互联网以互联网思维运营超算基础设施，统筹调度算力资源，是中国首个实现连接算力产业链各方资源和能力的国家级算力服务平台。

Introduction

Computing power network is a key infrastructure supporting the high-quality development of the digital economy, and it is currently facing challenges such as computing power integration and interconnection, supply and demand docking, and universal and easy to use. Scnet.cn operates the supercomputing infrastructure with an Internet mindset and coordinates the scheduling of computing resources. It is the first national-level computing service platform in China that connects the resources and capabilities of all parties in the computing industry chain.

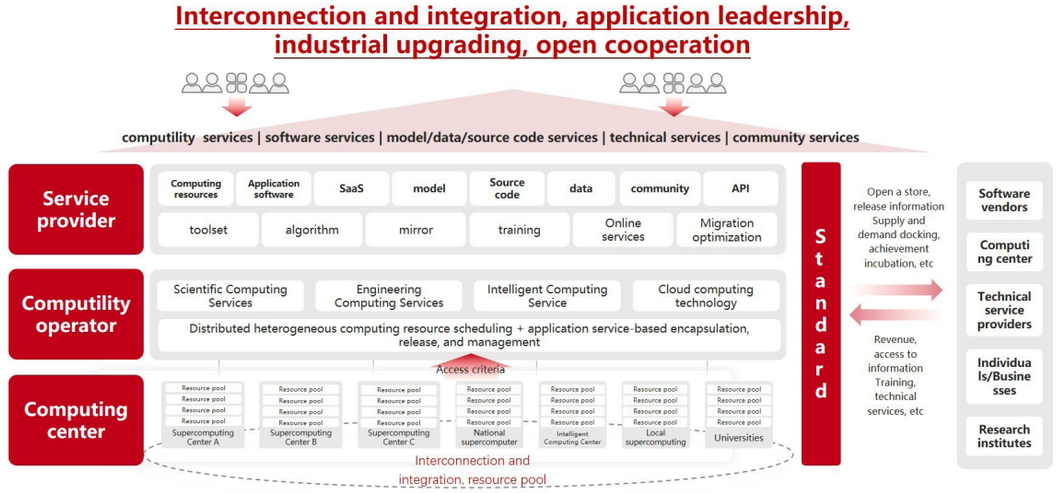
发布首个跨域算力服务平台，形成算力、应用资源高地

The First Cross-domain Computing Service Platform is Released to Form a Highland of Computing Power and Application Resources

建设一体化算力服务和调度平台，支持超算中心、智算中心、通算中心等多种算力中心入网，已连接中国 14 省 20 城市 20 余家算力中心，包括一体化大数据中心、超算中心等。通过应用封装、算力标准化、异构算力融合调度等技术屏蔽硬件资源差异，实现多元异构资源的统一建模、调度、编排管理以及对外服务。

An integrated computing service and dispatching platform has been built to support a variety of computing centers such as supercomputing centers, intelligent computing centers, and general computing centers to be connected to the network, which has connected more than 20 computing centers in 20 cities in 14 provinces in China, including integrated big data centers and supercomputing centers. Through application packaging, computing power standardization, heterogeneous computing power fusion scheduling and other technologies, hardware resource differences are shielded, and unified modeling, scheduling, arrangement and management of diverse and heterogeneous resources are realized, as well as external services.

◉ 超算互联网架构



◉ Scnet.cn architecture

构建算力生态协作网，形成算力服务新模式

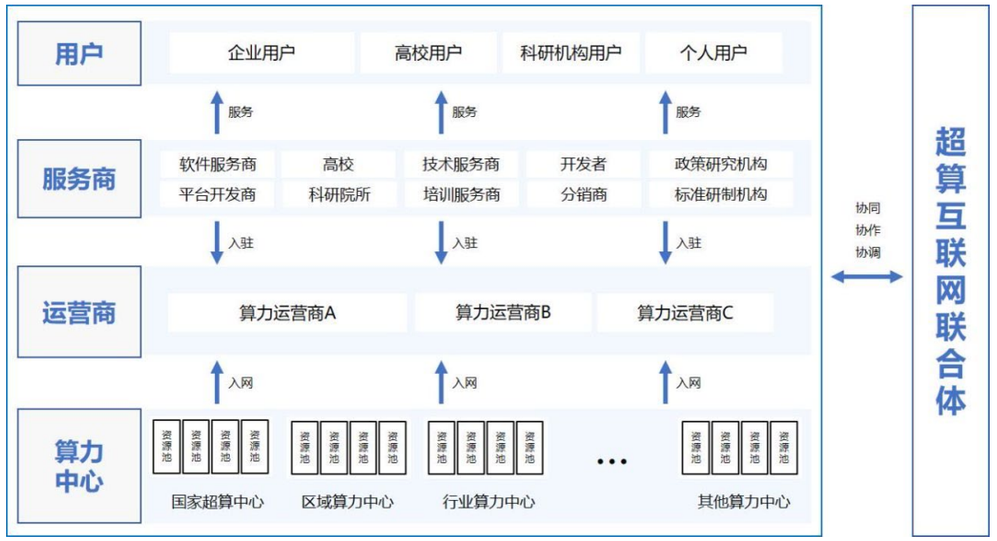
Build a Computing Ecological Collaborative Network to Form a New Model of Computing Service

完成共性工具库、数据集、应用软件库建设，建立异构环境下标准化的应用适配、封装、发布、交易体系。联合 270 余家各类应用服务商，面向 100 余个行业提供 1000 余个应用场景服务，促进供需高效对接，形成算力产业的生态大协作平台。通过规范算力的接入和调度、服务和运营等，全面支撑算力领域标准体系建设。目前超算互联网联合体已经成立，发布了《超算互联网白皮书》，完成了 2 项中国国家标准、5 项团体标准立项，研究算力统一度量、算力并网、统一计费、统一交易、统一结算相关标准，促进算力服务标准化、普惠化，提升算力资源的易用性。

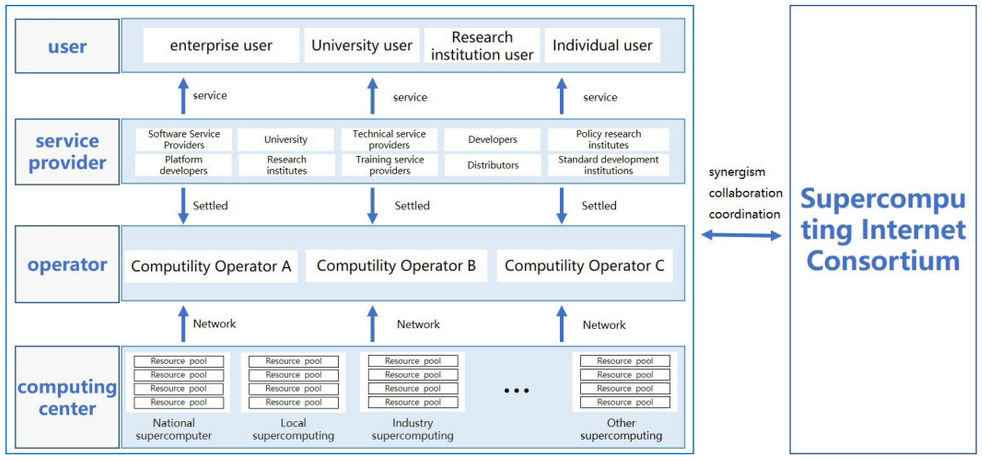
Complete the construction of common tool library, data set and application software library, and establish a standardized application adaptation, packaging, publishing and trading system under heterogeneous environment. It has cooperated with more than 270 application service providers of various types to provide more than 1,000 application scenario services for more than 100 industries, promoting the efficient docking of supply and demand, and forming an ecological cooperation platform for the computing industry. By standardizing the access and scheduling, service and operation of computing power, it comprehensively supports the construction of a standard system in the field of computing power. At present, the supercomputing Internet Consortium has been established, and the "Supercomputing Internet White Paper" has been released, completed two Chinese national standards and five group standards, studied the unified measurement of computing power, computing power grid connection, unified billing, unified transaction, unified settlement related standards, promote the standardization of computing power services, universal benefits, and improve the usability of computing resources.

◉ 超算互联网官网

◉ www.scnet.cn



◉ 连接各方的一体化算力网促进超算产业可持续发展



◉ The integrated computing power network connecting all parties promotes the sustainable development of the supercomputing industry

促进算力成为普惠、易用、强劲的新质生产力

Promote Computing to Become a New Quality Productivity that is Universal, Easy to use, and Powerful

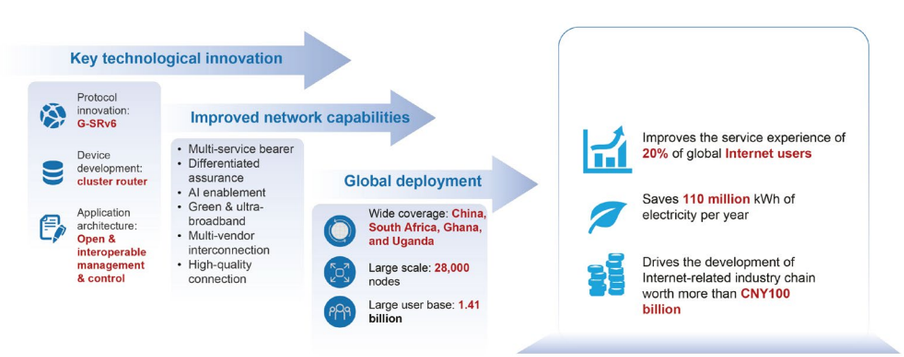
截至目前，超算互联网已形成资源多元、领域全面、模式先进的算力应用池。联网运行后，共发布各类算力商品 6000+ 款，服务 12+ 万用户，用户使用各类算力的易用性显著提高、成本明显降低。与社会同类算力相比，超算互联网算力成本平均低 20%-30%。超算互联网的建设运营坚持以网络化、普惠化、标准化为目标，以可持续的发展理念助力算力网高质量发展，推动算力成为赋能千行百业的新质生产力。

Up to now, Scnet.cn has formed a computing power application pool with diversified resources, comprehensive fields and advanced models. After the operation of the Internet, a total of more than 6,000 types of computing products have been released, serving more than 120,000 users, significantly improving the ease of use and reducing the cost of various types of computing power for users. Compared with similar social computing power, the cost of Scnet.cn computing power is 20%-30% lower on average. The construction and operation of the supercomputing Internet adhere to the goals of networking, universalization and standardization, and uses the concept of sustainable development to help the high-quality development of the computing power network, and promote the computing power to become a new quality productivity that empowers thousands of industries.

基于新型 SRv6 的新一代互联网关键技术创新、产业发展及国际化应用

Innovation, Industry Development, and International Application of New Type SRv6-Based Next-Generation Key Internet Technology

◉ 基于 G-SRv6 打造高品质新一代互联网



◉Build high-quality next-generation Internet based on G-SRv6

中国移动通信集团有限公司
China Mobile Communications Group Co., Ltd.

MTN 集团
MTN Group Limited

华为技术有限公司
Huawei Technologies Co., Ltd.

引言

中国移动联合 MTN、华为围绕新型 SRv6（G-SRv6）和集群路由器开展互联网关键技术创新和应用，完成“协议创新、设备研制、应用架构、规模部署”的创新闭环，促进全球互联网向新一代演进，同时通过创新技术在“一带一路”国家的部署进一步消除人类数字鸿沟。

Introduction

China Mobile, together with MTN and Huawei, carried out a project in which they innovated and applied key Internet technologies based on new type SRv6 (G-SRv6) and cluster routers, completing the closed-loop innovation process of protocol innovation, device development, application architecture, and large-scale deployment. This pioneering effort drives the Internet to evolve toward its next generation while further bridging the digital divide by deploying innovative technology in the Belt and Road countries.

协议、设备、架构全面突破，加速新一代互联网升级

Made Breakthroughs in Protocols, Devices, and Architectures, Accelerating Upgrade to Next-Generation Internet

原创 G-SRv6 技术，大幅压缩 SRv6 报文头长度，解决原生 SRv6 报文开销大、转发效率低、硬件要求高等关键难题，对加快互联网智能化、确定性演进升级具有重要促进意义，被全球互联网标准组织 IETF 接纳为国际标准。

The original G-SRv6 technology greatly reduces the length of SRv6 headers and solves the key problems including high packet overhead, low forwarding efficiency, and high hardware requirements of native SRv6. G-SRv6 plays a pivotal role in accelerating the intelligent and deterministic evolution and upgrade of the Internet and has been accepted by the IETF as an international standard.

推出全球首款容量最大可达 512Tbps 的集群路由器，全面支持 G-SRv6 等“IPv6+”相关技术。创新性将 AI 能力嵌入核心路由器设备，可在转发端口自动发现并处理常见异常情况，有效提升互联网业务的可靠性和安全性。

The project unveils the world's first cluster router with a maximum capacity of 512 Tbps. It fully supports IPv6 Enhanced technologies such as G-SRv6. With AI capabilities innovatively embedded into core routers, forwarding interfaces are able to automatically detect and handle common exceptions, effectively improving the reliability and security of Internet services.

率先开发直接纳管多达四个不同厂商设备的 SDN 控制器，有效解决多厂商并存带来的跨厂商互通、一体化管理、新业务上线等问题，对 G-SRv6 和集群路由器超大规模组网进行集中、高效管理。

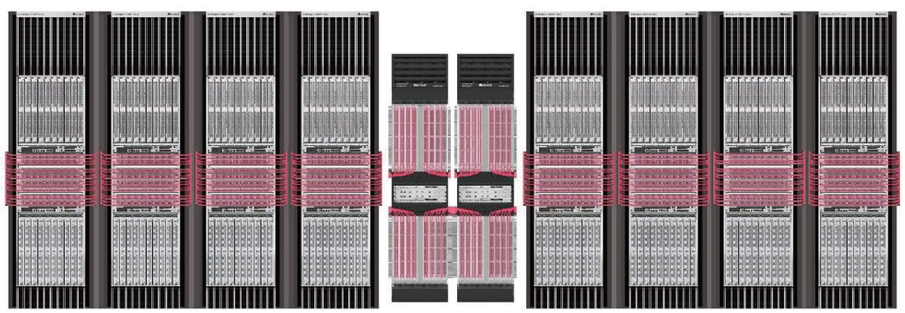
This project is the first to develop an SDN controller that can directly manage devices from up to four different vendors. This effectively overcomes the difficulties in cross-vendor interoperability, integrated management, and new service rollout caused by the coexistence of multi-vendor devices, enabling centralized and efficient management of ultra-large-scale networks with G-SRv6 and cluster routers deployed.

基于上述标准突破和技术创新，该项目共形成 289 项发明专利、109 项国际标准以及 119 篇高水平论文，为新一代互联网加速升级打下了坚实基础。

Building upon the preceding standard breakthroughs and technological innovation, this project generates 289 patents for invention, 109 international standards, and 119 high-level papers, accelerating the upgrade to next-generation Internet.

◉ 原创 G-SRv6 技术体系，加速互联网演进升级

◉Original G-SRv6 Technology System, Accelerating Internet Evolution and Upgrade



◉ 突破超大容量集群路由器关键技术

◉Breakthroughs in The Key Technologies of Ultra-Large-Capacity Cluster Routers

促进互联网创新发展、绿色节能，消除人类数字鸿沟

Promote Internet Innovation and Development and Enable Green Internet Industry, Bridging the Digital Divide

中国移动和 MTN 基于 G-SRv6 打造的承载网络，共承载约 10.8 亿移动用户、3 亿有线宽带用户、3000 万政企用户数据流量，提升了全球近 1/5 互联网用户的业务体验，带来直接经济效益超百亿人民币。

The G-SRv6-powered bearer networks of China Mobile and MTN carry the data traffic of nearly 1.08 billion mobile users, 300 million wired broadband users, and 30 million government and enterprise users in total. The networks have improved the service experience of nearly 20% of global Internet users and generated direct economic benefits of more than CNY10 billion.

在南非，MTN 利用 G-SRv6 实现流量灵活选路、智能均衡，将链路利用率从 77% 降低到 43%、网络丢包率降低至原来的 1/3，有效解决欠发达地区基础设施薄弱、供电及线路中断频发带来的网络拥塞问题，进一步消除了人类数字鸿沟。

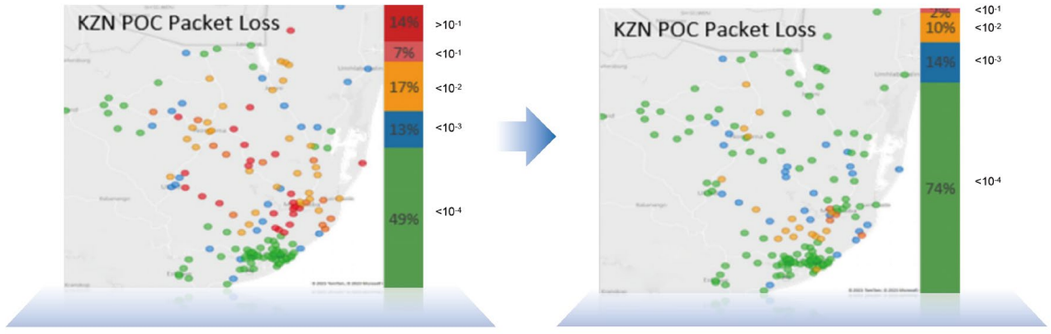
In South Africa, MTN uses G-SRv6 to implement flexible path selection and intelligent load balancing for traffic, reducing the link usage from 77% to 43% and the packet loss rate to 1/3 of the original rate. This effectively relieves network congestion arising from weak infrastructure and frequent power-cuts and line interruptions in underdeveloped areas, further bridging the digital divide.

中国移动基于 G-SRv6 为不同业务提供时延、丢包、可靠性、确定性等各不相同的网络服务，赋能千行百业数字化转型。例如实现境内时延降低 27%、至欧洲和北美方向时延优化 32% 和 18%。

Leveraging G-SRv6, China Mobile provides network services with different SLA requirements (e.g., delay, packet loss, reliability, deterministic quality), enabling digital transformation across industries. For example, China Mobile reduces the latency of services in China by 27% and that of services destined for Europe and North America by 32% and 18%, respectively.

另外，G-SRv6 相比原生 SRv6 可节省约 9% 的带宽流量、集群路由器单 bit 能耗相比现网设备成倍降低至 0.22W/G，通过这两个关键技术的规模部署，预估每年共节省 1.1 亿度电，减少的碳排放量相当于植树近百万棵。

Compared with native SRv6, G-SRv6 consumes 9% less bandwidth. The per-bit power consumption of the cluster router is as low as 0.22 W/G, which is at least three times lower than that of live-network devices. Deploying G-SRv6 and cluster routers saves about 110 million kWh of electricity each year and reduces global carbon emissions, equivalent to planting nearly one million trees.



◉ MTN 在南非部署 G-SRv6，提供稳定网络接入、消除人类数字鸿沟

◉MTN Deploys G-SRv6 in South Africa to Provide Stable Network Access and Bridge the Digital Divide

◉ 中国移动基于 G-SRv6 打造智能化、确定性网络服务

◉China Mobile Provides Intelligent and Deterministic Network Services Based on G-SRv6

构建全球规模最大的 SRv6 骨干网，推动国际标准及产业上下游发展

Build World's Largest SRv6 Backbone Network and Drive Standardization and Development of Upstream and Downstream Industry Chains

中国移动联合 MTN 和华为积极推进 G-SRv6 标准体系构建，通过在 IETF 新成立 srv6ops 等工作组，最大范围吸引全球各运营商、设备商以及芯片厂商的积极支持，共同推动互联网技术标准化发展。近五年共计发布 RFC 标准 171 篇、新文稿贡献 402 篇，有效促进全球互联网向新一代演进。

China Mobile, together with MTN and Huawei, actively promotes the building of the G-SRv6 standards system. They obtain maximal support from global carriers, device vendors, and chip vendors through the setup of working groups such as srv6ops in the IETF, jointly promoting the standardization of Internet technologies. In the past five years,this project has released 171 RFCs and contributed 402 new drafts, driving the Internet to evolve toward its next generation.

作为全球 IETF 标准贡献度最多的运营商，中国移动结合 G-SRv6 与集群路由器，构建了全球规模最大的 SRv6 骨干网，覆盖中国全境、省际带宽超 600Tbps，有力支撑算力网络、“东数西算”等战略发展。

As the world's largest carrier contributor to IETF standards, China Mobile builds the world's largest SRv6 backbone network based on G-SRv6 and cluster routers. This backbone network covers the entire territory of China and provides an inter-provincial bandwidth of over 600 Tbps, effectively supporting the development of computing networks and "east-to-west computing resource transfer."

在产业影响力方面，该项目带动集成电路生产、制造及光电子、新材料等 1000 余家企业发展，总产值近 300 亿人民币；赋能生产制造路由器的设备厂商，据 Omdia 统计，2023 年华为路由器销售收入约 300 亿人民币；带动互联网专线、VPN 专线、互联网加速服务等业务的发展，中国移动和 MTN 每年收益约 450 亿人民币。

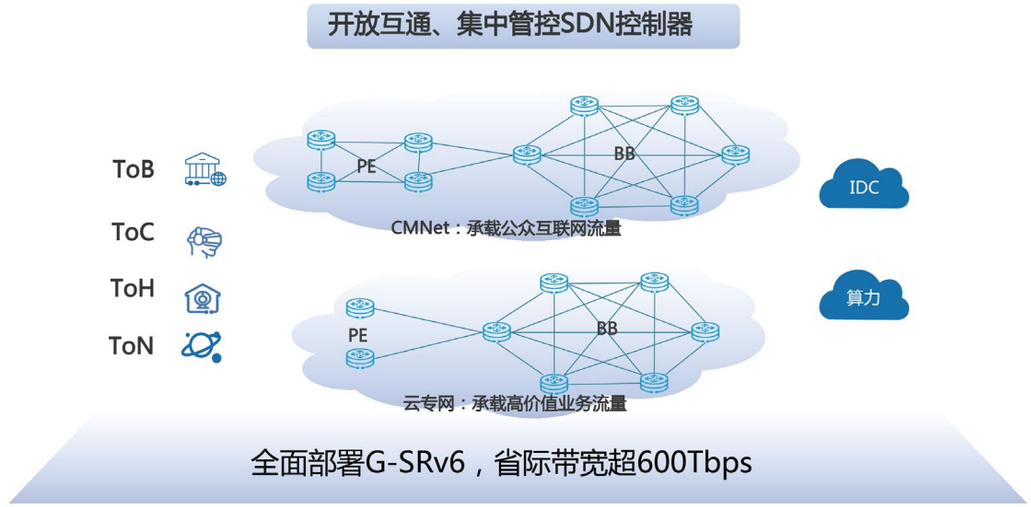
This project drives the development of more than 1,000 enterprises in integrated

circuit production, manufacturing, optoelectronics, and new materials, with a total output value of nearly CNY30 billion. It empowers device vendors that manufacture routers. According to Omdia statistics, Huawei's router sales revenue in 2023 is about CNY30 billion. It boosts the development of Internet private line, VPN private line, and Internet acceleration services. China Mobile and MTN collectively generate around CNY45 billion in annual revenue.

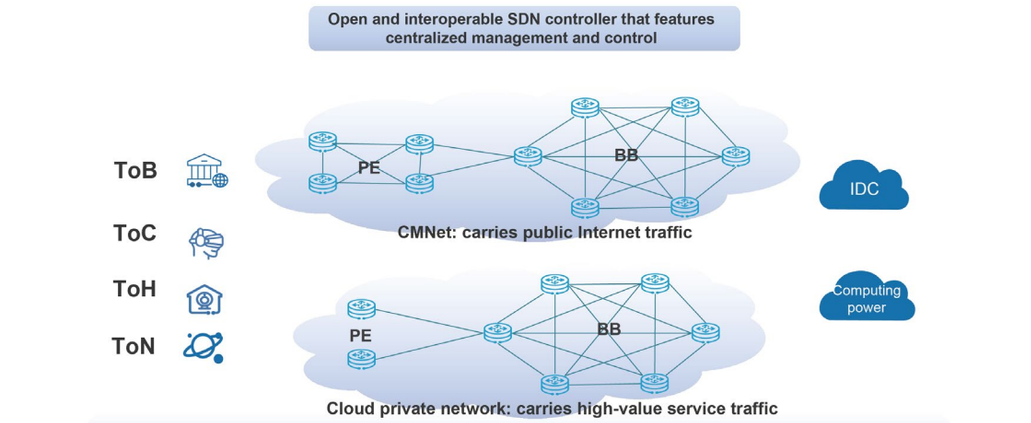
◉推动互联网国际标准发展

Submitted more than 100 international standard proposals, and initiated or released more than 20 RFCs. China Mobile ranks first among global carriers and ranks top 5 among all global companies by overall IETF standard contribution.

◉Promote the Development of International Internet Standards



◉中国移动打造全球规模最大 SRv6 骨干网



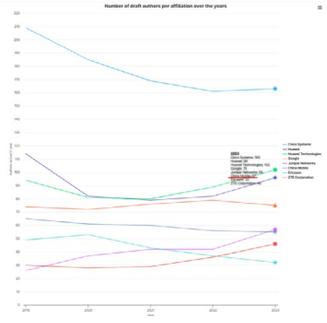
◉China Mobile Builds the World's Largest SRv6 Backbone Network

◉附件

2023 年 6 月人民网报道：中国移动“全网 IPv6 活跃连接数达 9.52 亿、打造全球规模最大的 SRv6 骨干网。” http://m2.people.cn/news/default.html?s=Ml8yXzQwNDcyNDU4XzEzNDc2OF8xNjg3ODUyMjQ0

2024 年 4 月 C114 报道：华为联合中国移动率先部署全球容量最大 512T 集群路由器。https://www.c114.com.cn/topic/241/a1261581.html

全球 IETF 标准贡献度最多的运营商佐证：https://datatracker.ietf.org/stats/document/yearly/affiliation/?time=5y&type=draft



人形机器人具身智能关键技术

Key Technologies for Embodied Intelligence in Humanoid Robots

◉ 优必选发布人形机器人工业场景解决方案，集合了优必选在具身智能技术领域的最新研发成果，是全球首个面向多任务工业场景的通用人形机器人解决方案

◉ UBTECH has unveiled an Humanoid Robot Industrial Application Solution,which integrates the company's cutting-edge R&D achievements in the field of embodied intelligence technology,making it the world's first general humanoid robot solution for multi-task industrial scenarios.

深圳市优必选科技股份有限公司
UBTECH ROBOTICS CORP LTD

优必选 UBTECH

引言

人形机器人有望成为继计算机、智能手机、新能源汽车后的颠覆性产品，是具身智能的终极形态。优必选基于人形机器人全栈式技术，开发面向通用任务的规划大模型、语义 VSLAM、学习型运动控制等具身智能关键技术，赋予人形机器人聪明的大脑和敏捷的小脑，加速其产业化进程。

Introduction

Humanoid robots are expected to become another disruptive product after computers, smartphones and new energy vehicles, and they are the ultimate form of embodied intelligence. Leveraging its full-stack humanoid robotic technologies, UBTECH has developed embodied intelligence technologies, including Large Language Model for General Task Planning, Semantic VSLAM Navigation Technology, and Learning-based Whole-body Motion Control Technology. These advancements endow humanoid robots with smart brains and agile cerebellums, thereby accelerating their industrialization process.

面向通用任务的规划大模型、语义 VSLAM、学习型运动控制

Large Language Model for General Task Planning, Semantic VSLAM Navigation Technology, Learning-based Full-body Motion Control Technology

优必选在人形机器人具身智能关键技术领域攻关，为人形机器人的商业化提供了技术储备。

UBTECH has achieved significant advancements in the key technologies of embodied intelligence for humanoid robots, laying the technical foundation for the commercialization of such robots.

在面向通用任务的规划大模型方面，利用仿真场景与真实数据构建具身智能数据，将传感器数据与机器人的对应动作对齐，融合训练面向通用任务的多模态规划大模型。人形机器人具备了高级意图理解和细粒度任务规划能力，其创新应用和实现难度在全球范围内属于行业第一梯队水平。

In the aspect of Large Language Model for General Task Planning, UBTECH uses simulation and real-world data to craft datasets for embodied intelligence and trains a multi-modal large language model. This enables sensor data to align with the motion of robots and achieves effective planning. By utilizing the advanced planning model technology for general tasks, robots gains the ability in intention understanding and fine-grained task planning. The innovative applications and the complexity of implementation of these technologies rank among the first tier in the global industry.

在语义 VSLAM 导航技术方面，该成果设计了语义感知信息与传统 VSLAM 紧耦合方法，拓展高维语义信息，构建空间拓扑网络，提升人形机器人对空间的理解能力。基于语义信息的最近邻点规划，实现由粗到精的二阶段语义导航，目前该方法系人形机器人行业首创技术。

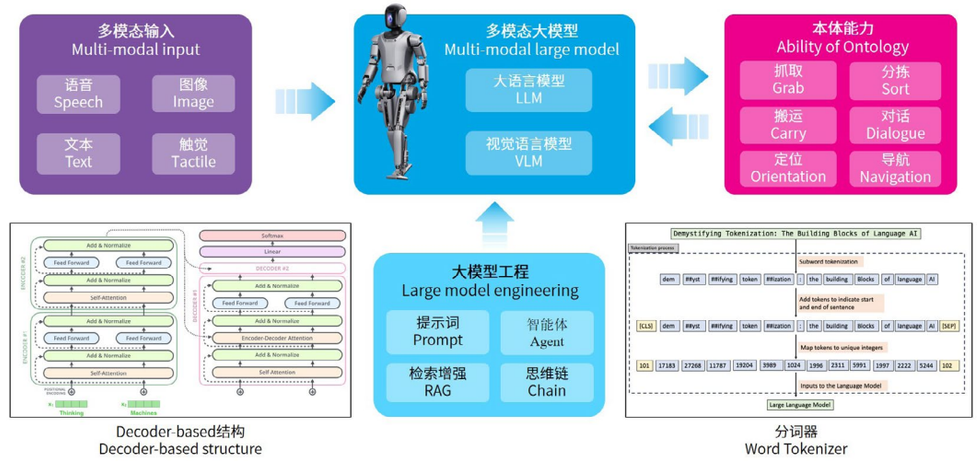
In the aspect of Semantic VSLAM Navigation Technology, this achievement designs a tightly coupled method of semantic perception information and traditional VSLAM, and expands the high-dimensional semantic information of the VSLAM maps. In addition, the nearest neighbor point planning of semantic information realizes a coarse to fine two-stage semantic navigation , improving the precision of humanoid robots during terminal operations. Currently, this method is an industry-first technology in the humanoid robotics field.

在学习型全身运动控制技术方面，针对人形机器人不同场景的运动需求，混合、级联模仿学习与强化学习策略，形成感控一体、端到端学习型的全身运动控制框架。该框架支持了人形机器人上肢灵巧操作和下肢稳定行走，提升了其对于复杂非结构化任务的泛化执行能力。

In the aspect of Learning-based Whole-body Motion Control Technology, in order to meet the motion requirements of humanoid robots for different task scenarios, we have designed an end-to-end learning-based whole-body motion control framework integrating sensing and control. This framework combines imitation learning and reinforcement learning strategies through mixing and cascading. By implementing this framework, the humanoid robot has dexterous manipulation skills in its upper limbs and stable walking abilities in its lower limbs, enhancing humanoid robots' generalized execution capabilities for complex non-structured tasks.

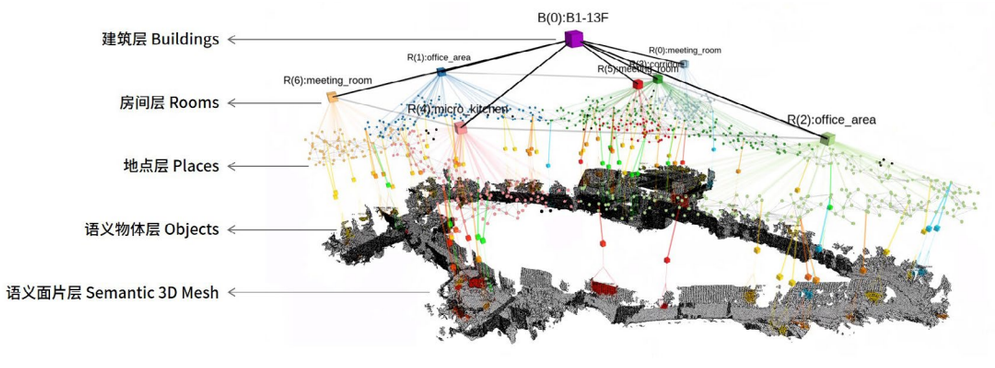
搭建多模态大模型体系，在组合微调基础上，打造人形机器人“大脑”

Build a Multi-Modal Large Model System, and Build a Humanoid Robot "Brailn" on the Basis of Combination and Fine-Tuning



◉ 优必选自研面向通用任务的规划大模型，提高人形机器人通用任务规划能力

◉ Large Language Model for General Task Planning Can Improve Humanoid Robots' General Task Planning Skills

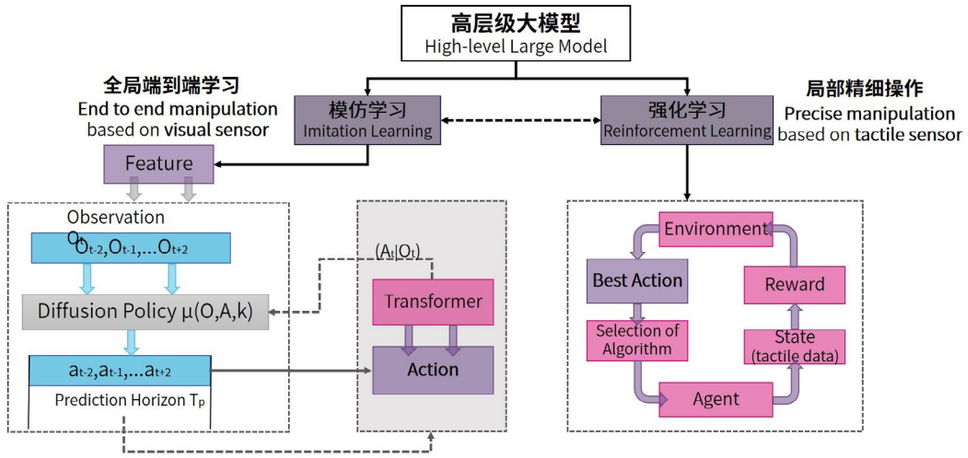


◉构建多层次空间理解能力的语义 VSLAM 系统

◉Semantic VSLAM System for Building Multi-Level Spatial Understanding

针对不同工业场景任务需求，融合强化学习、模仿学习，开发训练具身小脑

For different industrial scenarios, we integrate reinforcement learning and Imitation learning to develop and train embodied Intelligent “cerebellums”



◉优必选自研学习型全身运动控制技术提高人形机器人动作执行泛化性

◉UBTECH's Learning-based Whole-body Motion Control Technology can enhance humanoid robots' generalized execution capabilities

布局人形机器人全栈式技术，率先实现人形机器人应用落地

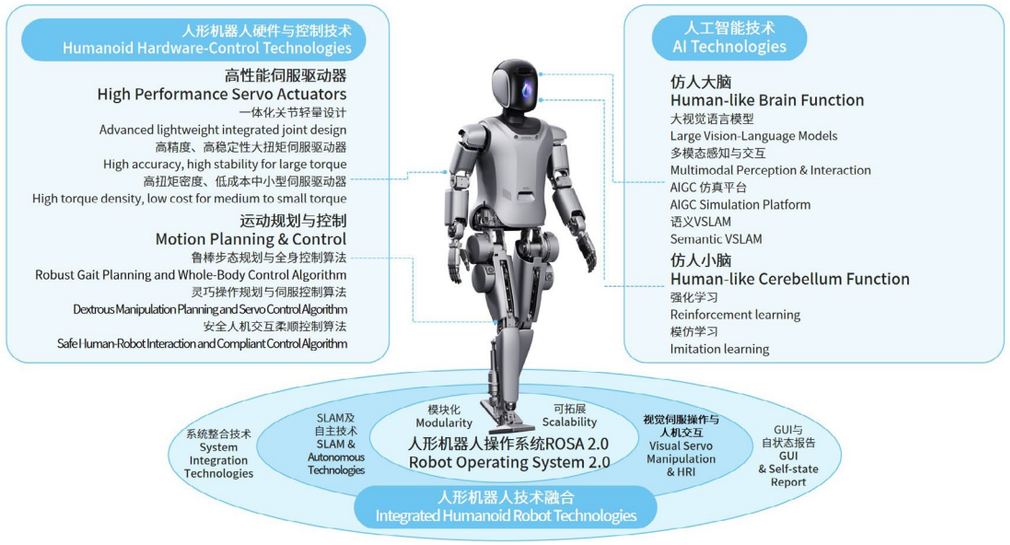
Develop a Full-Stack Technology Layout for Humanoid Robots, Taking the Lead in Realizing Practical Applications of Humanoid Robots

优必选是全球极少数具备人形机器人全栈式技术能力的公司，也是全球极少数完成小扭矩到大扭矩的伺服驱动器批量生产的公司，研发的人形机器人 Walker 是中国首个商业化双足真人尺寸人形机器人。截止 2024 年 6 月 20 日，该成果获得全球授权专利 670 件。公司还主导和参与近 40 项智能机器人有关的全球标准。

UBTECH is one of the few companies that owns self-developed full-stack humanoid robotic technologies in the world. UBTECH is also one of the few companies in the world to accomplish mass production of small torque to large torque servo actuators. According to the Frost & Sullivan Report, UBTECH's Humanoid Robot Walker is China's first commercialized bipedal life-sized humanoid robot. As of June 20, 2024, this project has secured 670 authorized patents globally. UBTECH also leads and participates in nearly 40 global standards related to intelligent robots.

优必选聚焦工业制造、商用服务和家庭陪伴三大场景，并率先实现了人形机器人落地应用。在商用服务场景，Walker 落地在中国科技馆、人工智能教育基地以及沙特 NEOM 新未来城等地，还参与了春晚和大运会闭幕式的表演。优必选作为 2020 年迪拜世博会中国馆“官方唯一智能机器人合作伙伴”，其人形机器人在 182 天里为到访中国馆的近 176 万游客提供智能服务，创造了人类历史上人形机器人首次真正商业化落地应用。今年以来，优必选聚焦汽车、3C 等制造业重点领域，提升人形机器人工具操作与任务执行能力，在全球率先与多家企业合作，在典型制造场景实现规模化深度应用，构建人形机器人应用生态。

We are currently leading the deployment of humanoid robots globally, with our focus on three scenarios, which are industrial manufacturing, commercial services, and household companionship. Regarding commercial service scenarios, Walker has provided intelligence services in the China Science and Technology Museum, in the AI Education Base and in NEOM in Saudi Arabia. UBTECH Walker has also participated in performances during the Spring Festival Gala and the Ceremony of Universiade.In addition, UBTECH served as the "Official Exclusive Intelligent Robot Partner" of the China Pavilion at the Expo 2020 in Dubai. Its humanoid robots provided intelligent services to nearly 1.76 million visitors of the China Pavilion in over 182 days, creating the first-ever true long-term commercialized application of humanoid robots in human history. UBTECH has focused on key manufacturing areas, such as the automotive and 3C industries during this year, enhancing the tool operation and task execution capabilities of humanoid robots, and achieving deep integration applications in typical manufacturing scenarios. UBTECH has collaborated with multiple enterprises and achieved in-depth application in typical manufacturing scenarios, aiming to build a humanoid robot application ecosystem.



◉优必选自主研发人形机器人全栈式技术

◉UBTECH's Self-Developed Full-Stack Humanoid Robot Technologies

打造面向多任务工业场景的人形机器人应用范式

Develop an Application Paradigm for Humanoid Robots Oriented towards Multi-Task Industrial Scenarios

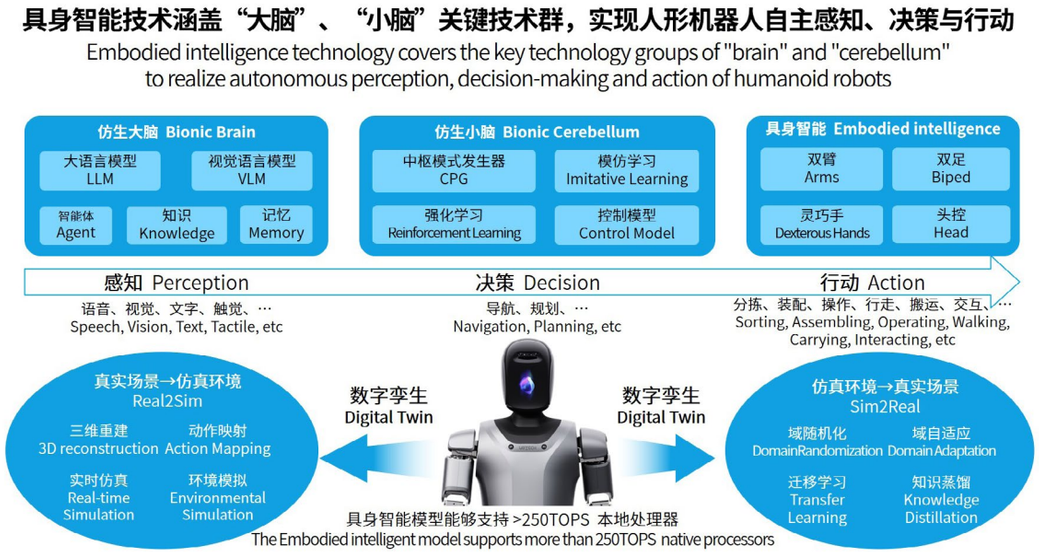
优必选先后与东风柳汽、吉利汽车、一汽红旗、一汽 - 大众青岛分公司、奥迪一汽等汽车企业，3C 企业富士康、物流企业顺丰在内的多家企业合作，共同打造人形机器人示范应用。截止目前，优必选是全球唯一一家与多家车企宣布战略合作，并进入车厂实训的人形机器人企业，Walker S 系列已经获得了车厂超过 500 台的意向订单。

UBTECH is one of the few companies that owns self-developed full-stack humanoid robotic technologies in the world. UBTECH is also UBTECH has collaborated with multiple enterprises, including Dongfeng Liuzhou Motor, Geely Auto, Hongqi Auto, FAW-Volkswagen

Qingdao Branch, Audi FAW, Foxconn, and SF Express, to jointly create demonstrative applications for humanoid robots. Up to now, UBTECH is the only humanoid robot enterprise globally that has announced strategic cooperation with multiple electric vehicle manufacturers. Furthermore, the Walker Series have been introduced into vehicle manufacturing assembly lines as "interns" to assist in car production. In addition, UBTECH has already received over 500 intent orders from electric vehicle manufacturers.

优必选在人形机器人具身智能关键技术领域攻关，为人形机器人的商业化提供了应用示范：以新能源汽车制造为起点，强化硬件稳定性与可靠性，随后拓展至 3-5 个专用场景应用，实现商业化并降低成本，再跨行业扩展，最终进化为多任务通用型工业人形机器人。

UBTECH has made breakthroughs in the key technologies of embodied intelligence for humanoid robots, providing application demonstrations for the commercialization of humanoid robots. Starting from the manufacturing of new energy vehicles, we will strengthen the stability and reliability of hardware, and then expand to 3-5 dedicated scenario applications to achieve commercialization and reduce costs. Subsequently, we will expand across industries and eventually evolve into a multi-task general-purpose industrial humanoid robot.

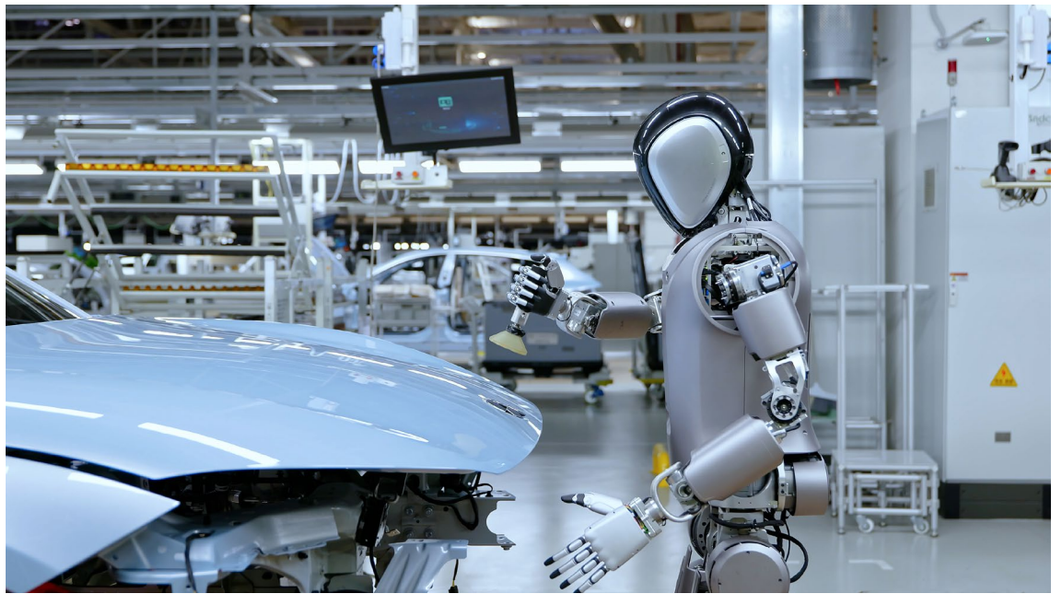


◉ 优必选面向多任务工业场景的通用人形机器人解决方案

◉ UBTECH's General Humanoid Robot Solution for Multi-task Industrial Scenarios

◉ 优必选工业版人形机器人 Walker S Lite 在极氪 5G 智慧工厂执行搬运任务

◉ UBTECH humanoid robot Walker S Lite is working in Zeekr's intelligent factory to complete handling tasks.

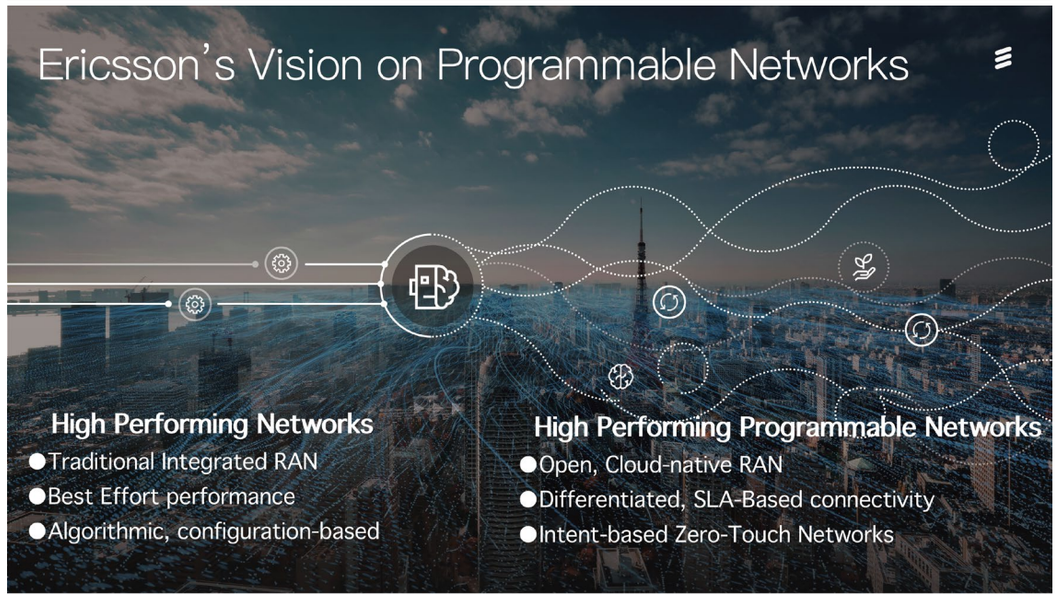


◉ 优必选工业版人形机器人 Walker S 在新能源车厂执行贴车标任务

◉ UBTECH humanoid robot Walker S was deployed in the electric vehicle production line to complete affixing car logos.

5G 可编程网络

5G Programmable Networks



◉ 爱立信 5G 可编程网络愿景

◉ Ericsson's Vision for 5G Programmable Networks

爱立信（中国）通信有限公司
Ericsson (China) Communications Co., Ltd.

ERICSSON

引言

5G 网络在设计之初就希望开放网络能力，按需为用户提供个性化的服务，为运营商创造新收入。爱立信的“5G 可编程网络”产品解决了这两个难题，推出了面向 APP 开放能力的全球网络平台（GNP）和意图驱动的端到端 5G 网络系统。

Introduction

The 5G network was designed with the goal of opening network capabilities to deliver personalized services on-demand and create new revenue streams for operators. Ericsson's '5G Programmable Networks' product addresses these challenges by introducing the Global Network Platform (GNP), which opens up capabilities for applications (APPs), and an intent-driven end-to-end 5G network system.

5G 可编程网络助力运营商构建差异化、高性能、开放的网络

The 5G Programmable Networks Help Operators Build a Differentiated, High-performance, and Open Network

GNP 平台通过网络能力开放 API 为 APP 开放 5G 网络，向全球开发者社区提供先进的 5G 网络功能，开发人员无需了解复杂的网络技术即可创建增强的服务；赋能 APP 调用特定的网络资源，例如服务质量、速度、延迟和位置。目前，平台已拥有近 140 万开发者，极大丰富了 GNP 网络 API 生态。

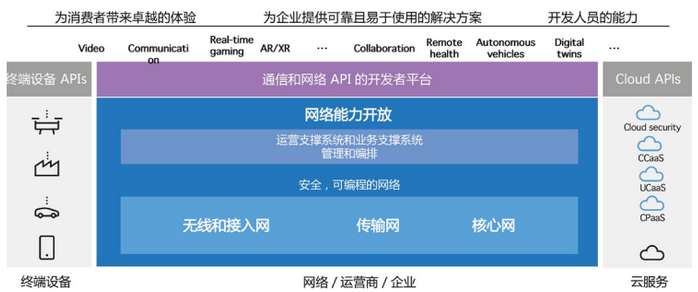
The GNP platform opens up 5G network capabilities to applications through open APIs, providing advanced 5G network functionalities to the global developer community. Developers can create enhanced services without knowledge of complex network technologies. The platform empowers applications to access specific network resources, such as service quality, speed, latency, and location. Currently, the platform has nearly 1.4 million developers, greatly enriching the GNP network API ecosystem.

意图驱动的端到端 5G 网络，包括全新设计的 5G 基站，意图管理平台，智能运营引擎等，基于 AI 和大模型技术对意图进行分解和冲突检测，可实现从业务意图到无线资源调度的毫秒级执行能力，为应用提供端到端的差异化体验保障。爱立信的 5G 产品融合了多项国际专利技术和国际标准，在频谱资源有限和无线环境复杂的情况下，实现了对 5G 网络的实时编程，保障用户体验。

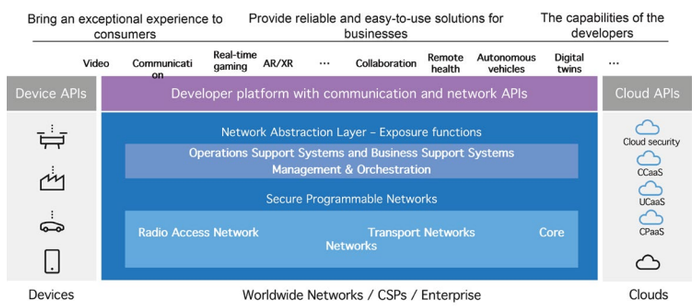
The intent-driven end-to-end 5G network, which includes newly designed 5G base stations, intent management platforms, intelligent operation engines, etc., leverages AI and LLM technologies to decompose and detect conflicts in intents. It enables millisecond-level execution from business intent to wireless resource scheduling, providing end-to-end differentiated experience assurance for applications. Ericsson's 5G products incorporate multiple international patented technologies and international standards. In situations where spectrum resources are limited and wireless environments are complex, real-time programming of the 5G network is realized, ensuring an optimal user experience.

该产品为运营商奠定了提供个性化服务和创造新增长的基础。

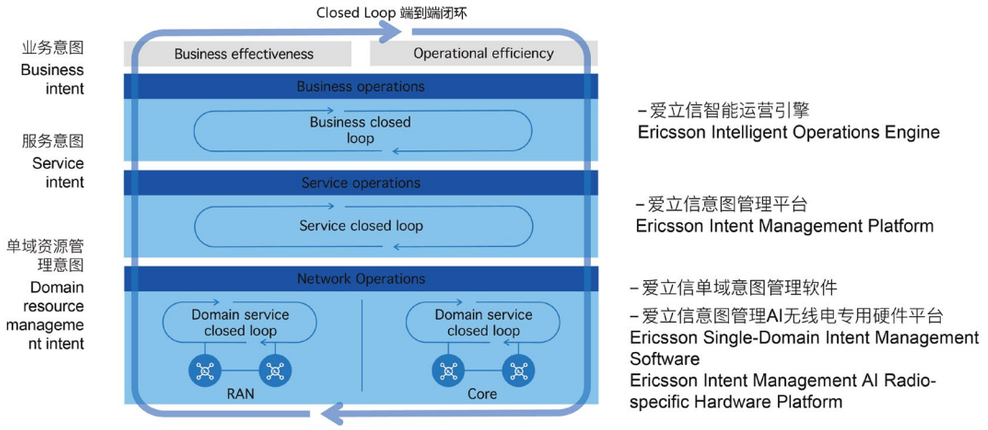
This product establishes the foundation for operators to provide personalized services and create new growth opportunities.



◉ 爱立信 5G 可编程网络构架



◉ Ericsson's 5G Programmable Networks Architecture



◉ 意图驱动的自智化管理

◉ Intent-Driven Autonomous Management

5G 可编程网络开放生态，助力运营商开拓新市场

The Open Ecosystem of 5G Programmable Networks Empowers Operators to Explore New Markets

运营商将 5G 进行商业变现的意愿非常明确，爱立信预测，到 2030 年，运营商如果能在 5G 主动启用积极的分级定价策略和为应用提供个性化的网络质量保障服务，可以获得总计 1310 亿美元的直接收入。爱立信的可编程网络为运营商获取额外的收入提供了必要的基础支撑。

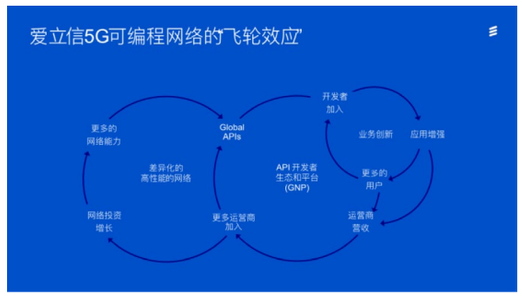
Operators have a clear intention to monetize 5G networks. Ericsson predicts that by 2030, if operators proactively implement aggressive tiered pricing strategies and offer personalized network quality assurance services for applications, they could achieve a total direct revenue of $131 billion. Ericsson's programmable network provides the essential foundational support needed for operators to generate additional income.

如果未来运营商能继续通过网络 API 扩展垂直行业，如医疗健康，制造业，自动驾驶等，麦肯锡预测在未来五到七年中，网络 API 可能会为运营商带来约 1000 亿到 3000 亿 美元的连接和边缘计算相关收入。

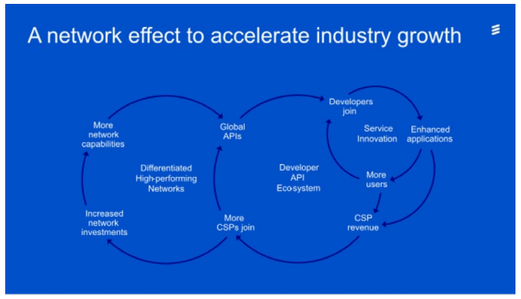
If operators continue to expand into vertical industries such as healthcare, manufacturing, and autonomous driving through network APIs in the future, McKinsey predicts that over the next five to seven years, network APIs could generate approximately $100 billion to $300 billion in connectivity and edge computing-related revenue for operators.

作为国际标准 CAMARA 的创始者之一，爱立信积极参与了 CAMARA 的 26 个 API 工作组和 6 个通用工作组。全球 40 多家领先运营商已经同意采用 CAMARA 的 API 标准。爱立信的 GNP 平台现在已经拥有 140 万的开发者社区，提供的 800 万软件标准库文件，发布了 59 个 SDK 工具。GNP 已经为 12 万的商业客户服务，形成了多元化的 API 业务生态。

As one of the founders of the international standard CAMARA, Ericsson has actively participated in 26 API working groups and 6 general working groups of CAMARA. Over 40 leading global operators have agreed to adopt Camara's API standards. Ericsson's GNP platform now boasts a developer community of 1.4 million, provides 8 million software standard library files, and has released 59 SDK tools. GNP has served 120,000 commercial customers, forming a diversified API business ecosystem.



◉ 飞轮效应为行业带来新增长动力



◉ The Flywheel Effect Brings New Growth Momentum to the Industry

5G 可编程网络全球广泛商用，屡获国际大奖

5G Programmable Networks are Widely Commercially Deployed Globally and Have Won Numerous International Awards

2023 年，爱立信携手合作伙伴，以意图驱动自智网络项目荣获了全球电信管理论坛 TMF 最佳创新与未来技术国际大奖。

In 2023, Ericsson, in collaboration with its partners, won the Global Telecom Management Forum's (TMF) Best Innovation and Future Technology International Award for their Intent-Driven Autonomous Networks project.

2023 年，沃达丰基于 GNP 平台在英国转播皇家加冕典礼，为全球观众提供高质量、低延迟的流媒体直播，同时为数千名现场与会者提供不间断的连接。 德国电信 RTL Deutschland 也在电视广播中使用 5G 网络切片取代昂贵而复杂的卫星广播车辆的需求来简化移动电视制作。

In the same year, Vodafone utilized the GNP platform in the UK to broadcast the Royal Coronation Ceremony, providing global viewers with high-quality, low-latency streaming live coverage, while also offering uninterrupted connectivity to thousands of attendees on-site. Additionally, Deutsche Telekom's RTL Deutschland utilized 5G network slicing in television broadcasting, replacing the need for expensive and complex satellite broadcast vehicles to simplify mobile TV production.

爱立信的基于 AI 的意图驱动运营方案已在客户部署试验中获得成功，马来西亚运营商 Digital Nasional Berhad (DNB) 利用该技术成功地为客户提供了具有性能保证的定制化 5G 服务。爱立信与马来西亚 DNB 合作在 GLOTEL 获得了“Managed Service Mastery”奖项，以表彰爱立信利用全新的基于意图的运营引擎为 DNB 带来的优秀用户体验和收益。AI 赋能的基于意图的运营引擎已经被澳大利亚 Telstra、西班牙 Telefonicoa、加拿大 ROGERS、瑞典 Telia 等运营商应用。

Ericsson's AI-driven, intent-based operational solution has proven successful in customer deployment trials. Malaysian operator Digital Nasional Berhad (DNB) successfully leveraged the technology to provide customers with performance-guaranteed, customized 5G services. In collaboration with DNB, Ericsson was awarded the 'Managed Service Mastery' prize at GLOTEL, recognizing the superior user experience and revenue driven by Ericsson's novel intent-based operational engine for DNB. This AI-powered intent-based operational engine has also been adopted by operators such as Australia's Telstra, Spain's Telefonica, Canada's ROGERS, and Sweden's Telia.

世界互联网大会
领先科技奖收录成果集

Collection of World Internet Conference
Awards for Pioneering Science
and Technology

02

世界互联网大会
领先科技奖收录成果

Collection of Shortlisted Achievements of
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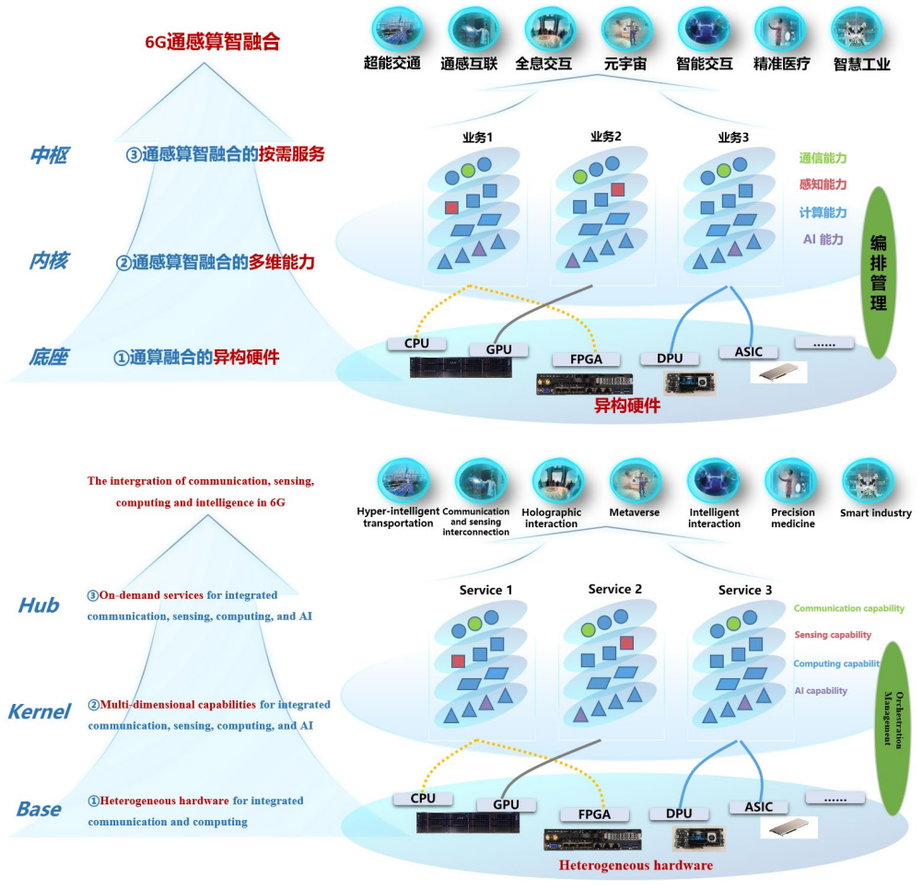
基础研究组
Basic Research Group

6G 通感算智融合机理研究

Research on the Integration Mechanism of Communication, Sensing, Computing, and Intelligence in 6G



◉ 6G 通感算智融合机理

◉ Integration Mechanism of Communication, Sensing, Computing, and Intelligence in 6G

中国移动通信集团有限公司
China Mobile Communications Group Co., Ltd.

北京邮电大学
Beijing University of Posts and Telecommunications

中关村泛联移动通信技术创新应用研究院
ZGC Institute of Ubiquitous-X Innovation and Applications

肯特大学
University of Kent

引言

针对 6G 全要素融合与多场景服务的系统优化复杂难题，阐明 6G 通感算智融合机理，突破智简网络、协作通感、内生 AI、服务化等关键技术，研制 6G 通感算智融合技术平台，孵化原创技术，探索产业新范式，推动 6G 创新全过程。

Introduction

To address the complex challenges of system optimization in the full-factor integration and multi-scenario services of 6G systems, the integration mechanism of communication, sensing, computing, and intelligence (CSCI) in 6G is elucidated. Breakthroughs are achieved in key technologies such as intelligent and concise networks, cooperative communication and sensing integration, native AI, and service-based architectures (SBA). A platform for 6G CSCI integration technology is developed, original technologies are incubated, new industry paradigms are explored, and the entire process of 6G innovation is promoted.

6G 通感算智融合创新，突破系统综合优化难题

Innovation on the Integration of Communication, Sensing, Computing, and Intelligence in 6G, Breaking through the Challenges of Comprehensive System Optimization

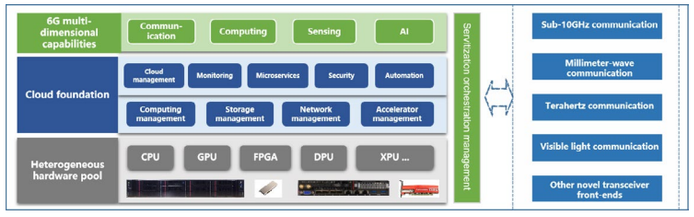
本成果在 6G 领域取得重大突破，系统性的阐明了 6G 通感算智融合机理，有效解决 6G 全要素融合、多场景服务、差异化需求带来的系统综合优化复杂的难题。该机理包含三部分：一是底座，由通用计算的 CPU、智能计算的 GPU 以及专用处理芯片构成的异构硬件云平台。二是内核，以模块化方式承载的通、感、算、智等多维能力。三是中枢，通过服务化技术实现服务的灵活调用与按需组合，简化网络复杂性。

This research has achieved a significant breakthrough in 6G, systematically elucidating the integration mechanism of 6G CSCI. It effectively addressed the complex challenges of comprehensive system optimization arising from the full-factor integration, multi-scenario services, and diverse demands of 6G. The mechanism comprises three parts: firstly, the “base”, a cloud-based heterogeneous hardware platform composed of central processing units (CPUs) for general computing, graphics processing units (GPUs) for intelligent computing, and specialized processing chips; secondly, the “kernel”, which carries multi-dimensional capabilities of the CSCI integration in a modular manner; and thirdly, the “hub”, which simplifies network complexity through SBA technology to enable flexible scheduling and on-demand combination of services.

基于该机理成功研制了 6G 通感算智融合技术平台。该平台是通感算智融合技术的系统化实现，具有共享性、灵活性和开放性特点，为开展前沿性和基础性研究、孵化原创技术提供试验验证平台以及多层次、开放的产业联合研发和试验环境，实现产业新范式探索，推动 6G 创新全过程。

Based on this mechanism, the 6G CSCI integration technology platform has been successfully developed. This platform, a systematic implementation of CSCI integration, features sharing, flexibility, and openness. It provides a testbed for conducting cutting-edge and fundamental research, incubating original technologies, and fostering multi-level, open industrial joint research and experimentation. This platform facilitates the exploration of new industrial paradigms and promotes the entire 6G innovation process.

◉ 6G 通感算智融合技术平台架构



◉ Architecture of Communication, Sensing, Computing, and Intelligence Integration Technology Platform in 6G

6G 融合机理引领创新，促行业革新与服务升级

The Integration Mechanism of 6G Driving Innovation, Fostering Industrial Transformation and Service Upgrades

该成果提出的 6G 通感算智融合机理为网络基础设计提供支撑，孵化了以下原创技术创新：

The proposed 6G CSCI integration mechanism provides a foundation for network infrastructure design and has incubated the following original technological innovations:

针对硬件资源云化底座，研制高实时、高性能的 6G 云化异构硬件，为通感算智融合提供了坚实的底层资源支持。

Cloud-based heterogeneous hardware base: High-real-time, high-performance 6G

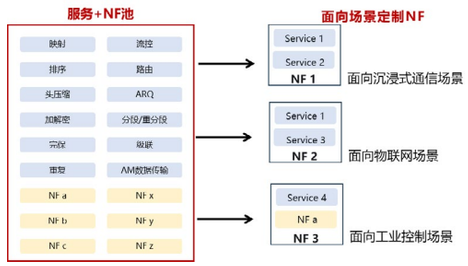
cloud-based heterogeneous hardware has been developed, providing a solid underlying resource support for CSCI integration.

针对多维能力融合内核，提出网络协作通感理论，突破连续空间超分辨多目标感知、协作多节点数据智能融合等技术，充分发挥协作感知优势，低成本实现感知精度两倍提升； 构建通算智融合的网络内生 AI 能力，突破 AIaaS（AI as a Service）服务编排与任务管理技术，以较低的成本，对内提升通信系统性能，对外按需高效提供高质量的 AI 服务。

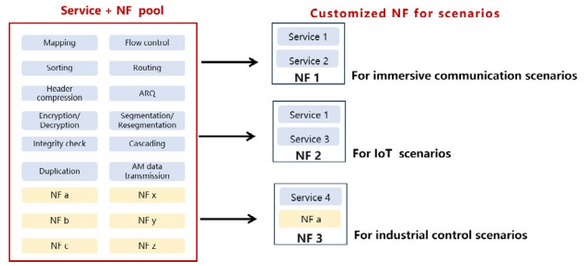
Multi-dimensional capability integration kernel: A network cooperative communication and sensing theory has been proposed, breaking through technologies such as continuous space super-resolution multi-target sensing and cooperative multi-node data intelligent integration. This fully leverages the advantages of cooperative sensing to achieve a twofold improvement in sensing accuracy at a low cost. Establishing a network native AI capability that integrates communication, computing and intelligence, breaking through AIaaS (AI as a Service) service orchestration and task management technology, and improving communication system performance at a lower cost, while efficiently providing high-quality AI services on demand.

针对网络按需服务中枢，提出基于服务化的原子服务聚合技术，面向场景将服务按需组合为网络功能（NF），将复杂的接口交互转变为内部实现，有效提升交互效率，提供低时延、高灵活度的网络。

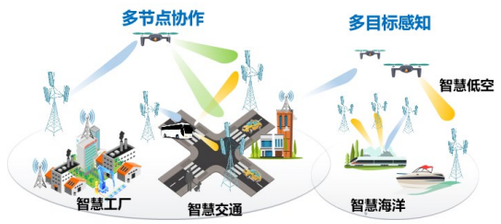
Network on-demand service hub: An atomic service aggregation technology based on SBA has been proposed. This enables services to be combined into network functions (NFs) based on specific scenarios, and to transform complex interface interactions into internal implementations. It will effectively improves interaction efficiency and provides a low-latency, highly flexible network.



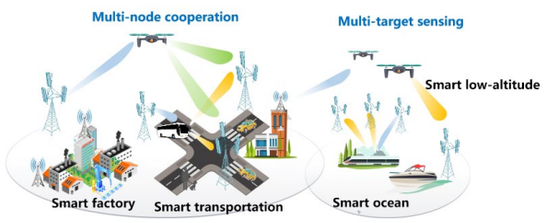
◉ 基于服务化的原子聚合技术



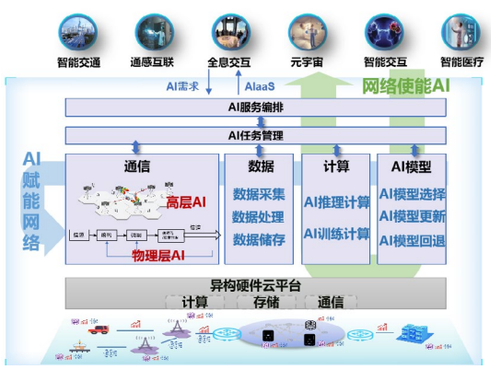
◉ SBA Atomic Aggregation Technology



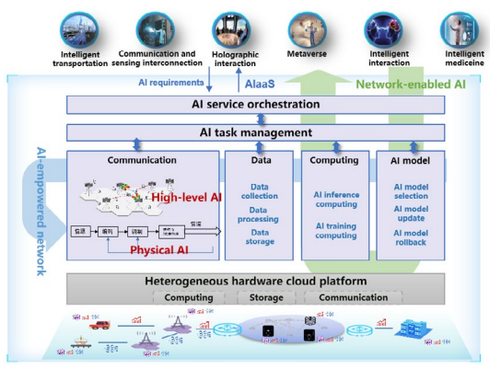
◉ 基于网络协作通感的多节点协作与多目标感知技术



◉ Multi-Node Cooperation and Multi-Target Sensing Technology Based on Network Cooperative Communication and Sensing



◉ 基于网络内生 AI 的 AIaaS 服务编排与任务管理技术



◉ AIaaS Service Orchestration and Task Management Technology Based on Network-Native AI

6G 融合机理成果颇丰，获国际认可与多项荣誉

Abundant Achievements in 6G Integration Mechanisms, Receiving International Recognition and Honors

该成果在 6G 领域形成深厚的技术积累，阐述 6G 通感算智融合机理，突破网络协作通感、网络内生 AI 等标志性技术创新。出版 3 本 6G 专著，获中国通信标准化协会理事长闻库、中国工程院院士张平、中国科学院院士尤肖虎、华为 Fellow 童文联袂力荐。相关研究成果发表于 IEEE Journal on Selected Areas in Communications（IF：16.4） 及 Engineering（IF：12.834）等顶级期刊，得到尹浩、张平、王江舟等院士的高度肯定。入选中国通信学会 2023 未来网络领先科技成果、2022 年度信息通信领域重大科技进展十大成果、2022 年“科创中国”系列榜单先导技术，联合创新成果“环境感知增强的数字孪生信道平台”获第 49 届日内瓦国际发明展“金奖”等。研制的 6G 通感算智融合技术平台，成功入选“2024 年国有企业数字技术十大成果”和“2024 中关村论坛重大成果”。

This research has cultivated profound technical expertise in 6G, elucidating the integration mechanism of CSCI in 6G. It has achieved groundbreaking innovations in network cooperative communication and sensing, network native AI, and other landmark technologies. Three dedicated monographs on 6G have been published, receiving enthusiastic recommendations from Wen Ku, Chairman of the China Communications Standardization Association, Academician Zhang Ping of the Chinese Academy of Engineering, Academician You Xiaohu of the Chinese Academy of Sciences, and Huawei Fellow Tong Wen. Relevant research findings have been published in top-tier journals such as the IEEE Journal on Selected Areas in Communications (IF: 16.4) and Engineering (IF: 12.834), receiving high commendations from academicians Yin Hao, Zhang Ping, and Wang Jiangzhou. This research has been recognized as “Future Network Leading Innovation and Technology Achievements in 2023” by the Chinese Society for Communications, “Top Ten Scientific and Technological Progresses in the Information and Communication Field in 2022”, and Pioneering Technologies in the 2022 "Innovation China" Series Rankings (Industrial Foundation Field). The project "environment-aware enhanced digital twin channel platform " has won the “Gold Medal” at the 49th Geneva International Invention Exhibition. The integration platform of CSCI in 6G has been recognized as “Major Scientific and Technological Achievements of Zhongguancun Forum” in 2024, and “Top Ten Digital Technology Achievements of State-Owned Enterprises” in 2024.

◉ 出版 3 本 6G 专著

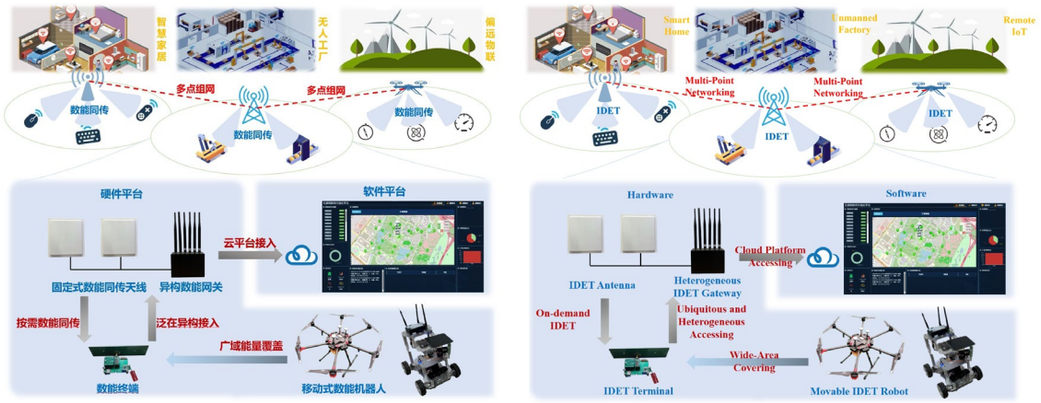
◉ Published Three Monographs on 6G

◉ 荣获全球多项重量级奖项

◉ Awarded Multiple Prestigious Global Honors

基于无线能量传输的无源智联机理

Basic Principles of Passive Intelligent Connectivity Assisted by Wireless Energy Transfer



◉ 基于无线能量传输的无源智联机理

◉ Basic Principles of Passive Intelligent Connectivity Assisted by Wireless Energy Transfer

南京大学
Nanjing University

电子科技大学
University of Electronic Science and Technology of China

伦敦大学学院
University College London

引言

项目研究团队利用无线射频能量传输技术，在为小微物联设备进行数据传输的同时提供可靠的能量供给服务，实现万物智联的永不掉线，为数据与能量一体化传输技术在未来万物智联场景下的应用实现产生了重要的推进作用。

Introduction

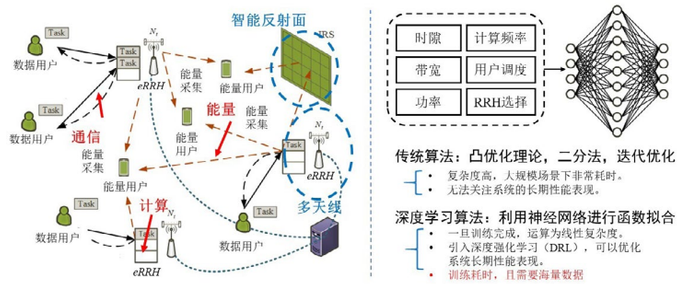
This research utilizes radio frequency (RF)-based wireless energy transfer technology to provide reliable energy supplement towards battery-powered small devices while transmitting data information. This ensures continuous connectivity in the Internet of Everything (IoE), significantly advancing the application of integrated data and energy transfer (IDET) technology in future IoE scenarios.

在网络与接入层面揭示了无源智联机理

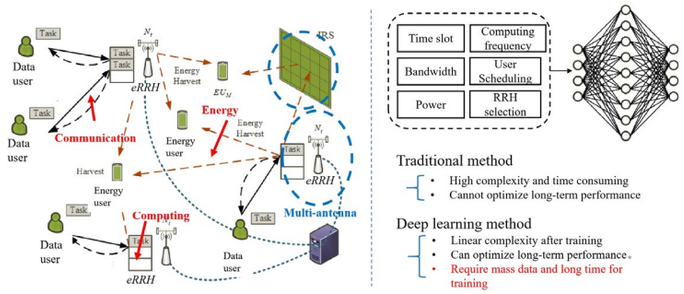
Revealed the Mechanism of Passive Intelligent Connectivity on the Network and Medium Access Layers

创新性的针对多样化场景设计高维度的数能联合资源分配算法，更加高效的利用空、时、频、码、功率等更高维度的通信资源，合理协调无线数据和无线能量在网络中的传输。同时首次面向无源分布式场景设计智能数能接入控制算法，利用分布式学习的方式动态的即时做出接入决策，有效的在避免碰撞的同时提升数据与能量的传输效率。首次面向广域无源物联场景设计了基于无人机的空地联合数能动态组网策略，对无人机的飞行轨迹规划、节点服务调度、以及节点的数能实时性需求进行有机的统一，有效的提升了万物智联无源节点的服务效率。

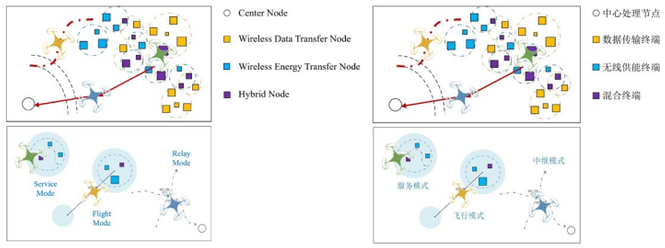
Innovatively, a high-dimensional integrated data and energy resource allocation algorithm was designed for diverse scenarios, efficiently utilizing higher-dimensional communication resources such as space, time, frequency, code, and power. This allows for the rational coordination of wireless data and energy transfer within the network. Additionally, for the first time, an intelligent data and energy access control algorithm was developed for passive distributed scenarios. Using distributed machine learning, the system dynamically realizes real-time access decision making, effectively avoiding collisions while improving the efficiency of integrated data and energy transfer. Furthermore, a UAV (unmanned aerial vehicle)-based space-ground integrated data and energy networking strategy was developed, specifically for wide-area passive IoT (Internet of Things) scenarios. This strategy integrates the flight path planning of UAVs, service scheduling of nodes, and the real-time data and energy requirements of nodes. As a result, it significantly enhances the service efficiency of passive nodes in the IoE ecosystem.



◉ 高维度联合数能资源分配算法



◉ High-Dimensional Integrated Data and Energy Resource Allocation Algorithm



◉ 多无人机空地联合数能组网策略

◉ Multi-UAV Space-Ground Integrated Data and Energy Networking

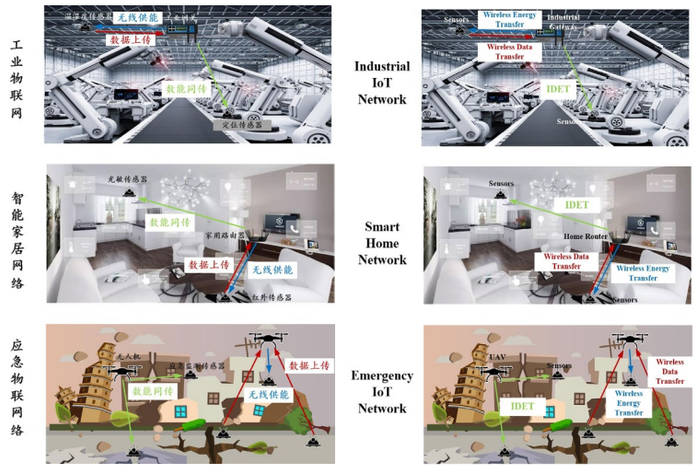
为无源物联场景提供定制化的数能传输服务

Providing Customized Data and Energy Transfer Services for Passive IoT Scenarios

研究提出了针对空、时、频、码、功率等多个维度的联合低复杂度数能资源分配方案，解决了在资源域数据传输和能量传输如何权衡的关键问题，缓解了二者之间此消彼长的矛盾局面，有效提升了 2 倍以上的数据能量联合传输性能；并通过设计数能联合接入控制协议有效的对物联节点进行高效调度，提升节点的工作效率，数据传输性能提升 2 倍以上；研究面向广域物联场景设计基于无人机的数能动态组网策略，有效解决了广域低功耗物联设备的能量供应与数据回传问题，同时降低了 50% 的全网总能耗，并降低了 50% 以上的全网节点服务时间。此外，本成果在多样化物联场景（例如智能家居、无人工厂等）取得了较好应用，有效降低了站点的维护成本，服务社会经济的正向增长。

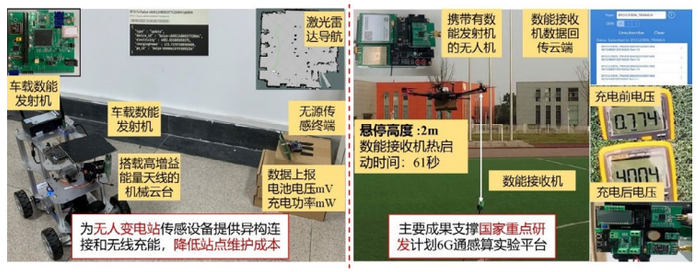
The research proposes a low-complexity integrated data and energy resource allocation scheme across multiple dimensions, including space, time, frequency, code, and power. This addresses the key issue of coordinating data and energy transfer within the resource domain, effectively mitigating the trade-offs between them. The scheme has improved integrated data and energy transfer performance by over two times. By designing an integrated data and energy access control protocol, the system efficiently schedules IoT nodes, doubling the efficiency of data transmission. The research also develops a dynamic networking strategy based on UAVs, specifically for wide-area IoT scenarios, effectively solving the challenges of energy supplement and data backhaul for low-power IoT devices in large-scale deployments. This strategy has reduced the overall network energy consumption by 50% and decreased node service time by over 50%. Moreover, the outcomes of

this research have been successfully applied in diverse IoT scenarios, such as smart homes and unmanned factories, significantly reducing site maintenance costs and contributing to positive socio-economic growth.

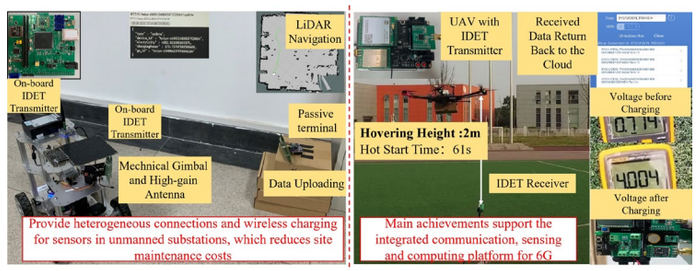


◉ 多样化海量物联应用需求与场景

◉ Diverse and Massive IoT Application Demands and Scenarios



◉ 研究成果空地数能传输系统有效服务国家关键基础设施



◉ Space-ground Integrated Data and Energy Transfer System Efficiently Serving Key Infrastructures

研究成果被国外媒体报道，多次获得国际奖项

The Research has Been Reported by International Media and has Received Multiple International Awards

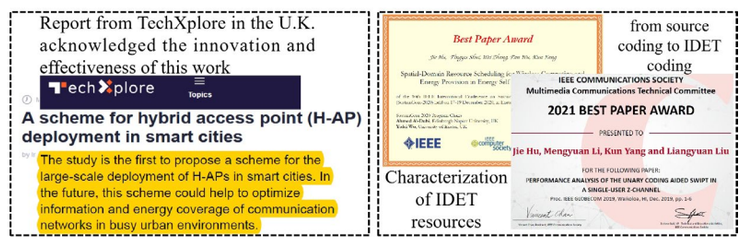
本成果完成团队在国际上率先提出了“数能一体化网络：Data and Energy Integrated Networks, DEIN”的概念，出版了该方面的第一本英文（Springer）和中文专著，并受 Springer 出版社邀请撰写数能一体化网络教材。相关研究内容已在相关领域顶级期刊（如 IEEE TWC、IEEE TCOM）与国际会议上发表论文 50 余篇，获得了 IEEE 通信协会多媒体通信技术专委会最佳论文奖（2021）、IEEE SustainCom2020 最佳论文奖以及 IEEE CSE2023 最佳论文奖等，并得到了包含美国科学 / 工程院两院院士、IEEE Life Fellow H. Vincent Poor 教授、澳大利亚科学 / 工程院两院院士、IEEE Fellow Branka Vucetic 教授等在内的多位著名专家的正面引用与评价。此外，本研究成果被英国媒体 TechXplore 进行了报道，肯定了本成果提出的基站域数能资源协作方案的有效性与首创性。

This achievement marks the team's pioneering inception of the concept "Data and Energy Integrated Networks (DEIN)" on the international stage. The team has published the first English monograph on the subject with Springer (2018) and a Chinese monograph with Science Press (2020). Additionally, the team was invited by Springer to author a textbook on DEIN, which was published at August 2024. The research results have been widely disseminated through the publication of over 50 papers in top-tier journals (such as IEEE TWC, IEEE TCOM) and international conferences. The team has received prestigious awards, including the IEEE Communications Society Best Paper Award from the Multimedia Communications Technical Committee (2021), the IEEE SustainCom2020 Best Paper Award, and the IEEE CSE2023 Best Paper Award, etc. The research has obtained recognition from renowned experts, such as Professor H. Vincent Poor, a member of the US National Academy of Sciences and Engineering and an IEEE Life Fellow, and Professor Branka Vucetic, a Fellow of the Australian Academy of Science and Engineering and IEEE Fellow. Furthermore, this research has been featured by the UK-based media TechXplore, which acknowledged the innovation and effectiveness of the base station domain's data and energy resource collaboration scheme introduced by this work.

◉ 世界著名专家的正面引用与评价

◉ Positive Citations and Evaluations from World Renowned Experts

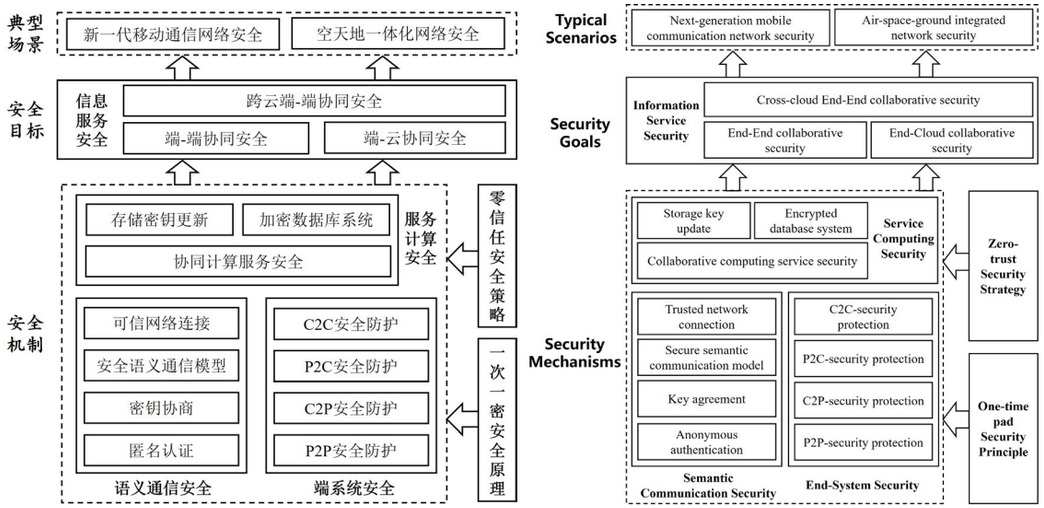
◉ 国际报道与学术获奖



◉ International Coverage and Academic Awards

新一代无线网络的安全范式：“云 - 网 - 端”协同安全

Security Paradigm for Next-Generation Wireless Networks: Cloud-Network-End Collaborative Security



◉ “云 - 网 - 端”协同安全理论体系

◉ Cloud-Network-End collaborative security theoretical system

西安电子科技大学
Xidian University

引言

云网融合是新一代无线网络的主流技术路线。传统无线网络安全属于局部安全，无法满足新一代无线网络体系化安全需求。项目建立了“云 - 网 - 端”协同安全架构，形成体系化安全防护机制，构成新一代无线网络的安全范式。

Introduction

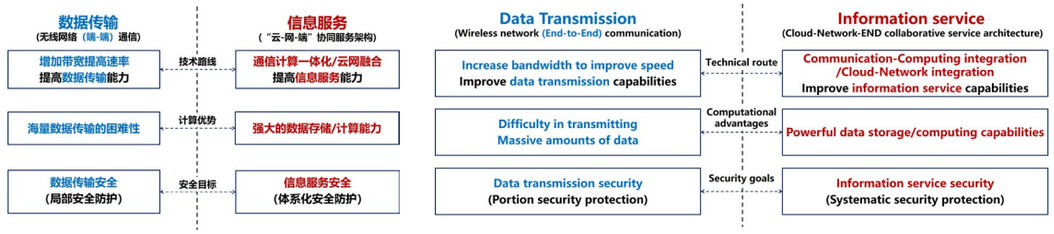
Cloud-network integration is the mainstream technology route for next-generation wireless networks. Traditional wireless network security belongs to the portion security that cannot address the systematic security requirements of the next-generation wireless networks. This achievement has established a Cloud-Network-End collaborative security architecture, formed a systematic security protection mechanism, and constituted a security paradigm for next-generation wireless networks.

建立无线网络“云 - 网 - 端”协同安全架构

Establish a Cloud-Network-End Collaborative Security Architecture for Wireless Networks

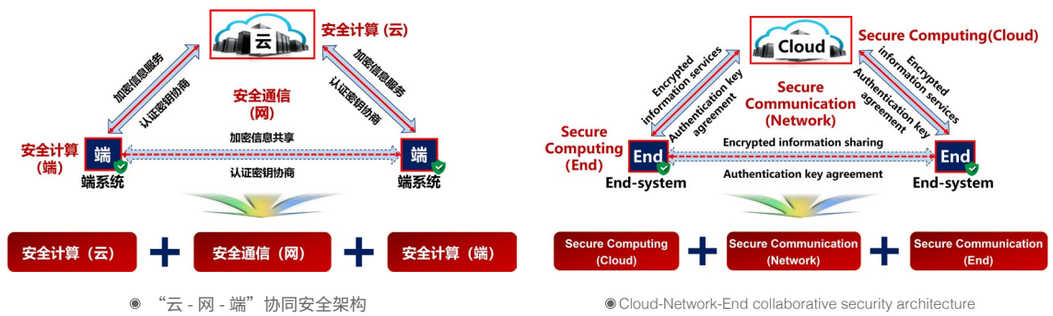
与云计算、AI 等先进计算相结合，是新一代无线网络突破香农容量限制约、提高通信能力的重要途径，构成以计算为基础的通信范式。无线网络与云计算相融合产生“云 - 网 - 端”协同服务架构，以端（云）到端非交互协同计算为基础，支持任务驱动的端（云）到端通信。信息服务成为新一代无线网络典型的数据共享模式。传统无线网络安全以通信安全为核心，属于局部安全，不满足新一代无线网络体系化的安全需求。围绕新一代无线网络的通信安全、计算安全问题，基于一次一密安全原理，采用零信任安全策略，提出“云 - 网 - 端”协同安全架构，建立语义通信安全机制、服务计算安全机制，支持信息服务安全，构成体系化的安全机制，形成新一代无线网络的安全范式。

Combined with advanced computing such as cloud computing and AI, it is an important way for next-generation wireless networks to break through the Shannon capacity limit and improve communication capabilities, forming a computing-based communication paradigm. The integration of wireless networks and cloud computing produces a Cloud-Network-End collaborative service architecture, which is based on End(or Cloud)-End non-interactive collaborative computing and supports task-driven End(or Cloud)-End communication. Information services have become a typical data-sharing mode for next-generation wireless networks. Traditional wireless network security is centered on communication security that is portion security, which cannot address the systematic security requirements of next-generation wireless networks. A Cloud-Network-End collaborative security architecture is proposed focusing on the communication security and computing security issues of next-generation wireless networks, based on the one-time pad security principle and adopting the zero-trust security strategy. The architecture established semantic communication security and service computing security mechanisms to support information service security. Finally, a systematic security mechanism and a security paradigm for next-generation wireless networks emerged.



◉ 无线网络的数据共享模式：数据传输与信息服务

◉ Data sharing model of wireless network: data transmission and information services



◉ “云 - 网 - 端”协同安全架构

◉ Cloud-Network-End collaborative security architecture

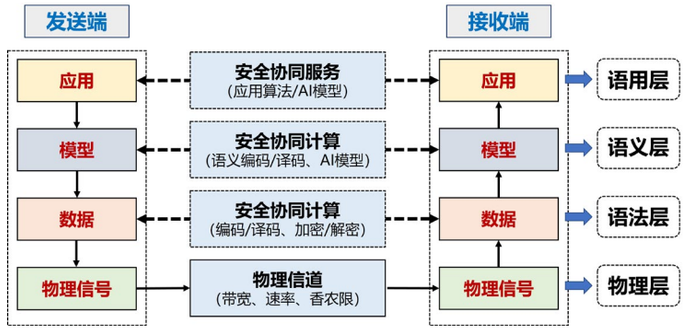
构成新一代无线网络安全的新范式

Constitute a New Security Paradigm for Next-generation Wireless Networks

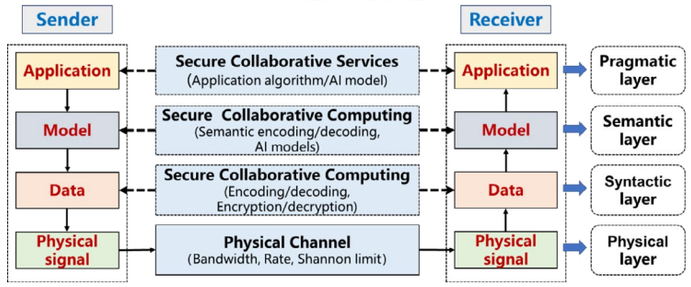
将匿名性纳入无线网络认证过程，提出无线匿名认证协议，匿名认证已成为无线网络的典型认证模式。将传统的连接安全与端系统安全相关联，提出通用可组合安全的可信网络连接模型，构成新一代无线网络的核心安全机制。以任务驱动的端（云）到端安全通信为目标，将“云 - 网 - 端”协同安全架构与棘轮安全机制相结合，提出非交互的密钥更新机制，为新一代无线网络密钥更新难题提供有效解决方案。与 AI 技术相结合构建无线网络的非交互协同安全计算机制，提出面向信息服务的端（云）到端安全语义通信模型，保障新一代无线网络的可靠性、安全性与可用性。以跨云数据安全共享为基础，建立异构网络安全融合框架，是异构无线网络安全融合的重要途径。

We have incorporated anonymity into the wireless network authentication process and proposed a wireless anonymous authentication protocol. Anonymous authentication has become a typical authentication mode for wireless networks. This achievement has associated traditional connection security with End-system security to propose a universal composable-secure and trusted network connection model, which has constituted the core security mechanism of next-generation wireless networks. Aiming at the task-driven End(or Cloud)-End secure communication, the Cloud-Network-End collaborative security architecture is combined with the ratchet security mechanism, and a non-interactive key update mechanism is proposed to provide an effective solution to the key update problem of next-generation wireless networks. Combined with AI technology, a non-interactive collaborative secure computing mechanism for wireless net-

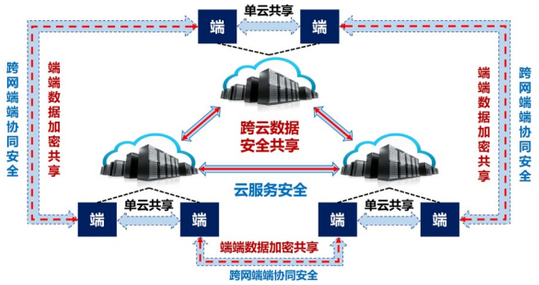
works is constructed, and an End(or Cloud)-End secure semantic communication model for information services is proposed to ensure the reliability, security, and availability of next-generation wireless networks. This achievement established a heterogeneous network security fusion framework based on cross-cloud secure data-sharing, which is an important way to integrate heterogeneous wireless network security.



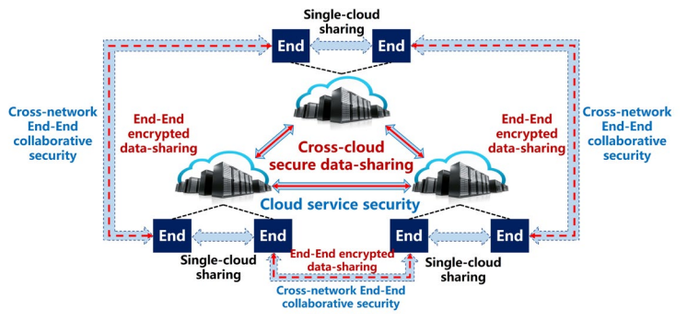
◉ 安全语义通信模型



◉ Secure Semantic Communication Model



◉ 以跨云数据安全共享为基础的异构网络安全融合框架



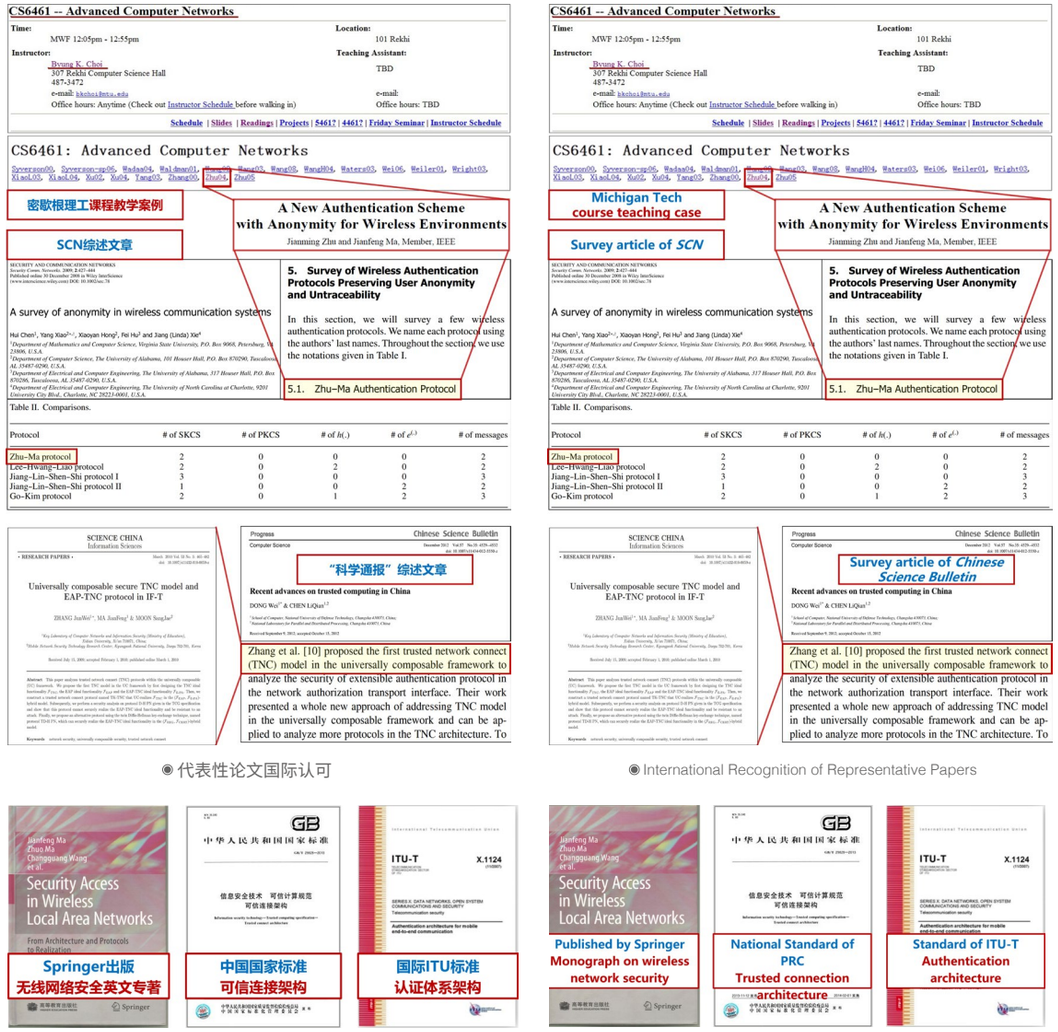
◉ Secure Heterogeneous Network Integration Framework Based on Cross-Cloud Secure Data-Sharing

成果受到学术界、工业界的广泛关注与认可

This Achievement Has Generated Considerable Attention and Recognition from Academia and Industry

以新一代无线网络安全为主题，受邀在华为“罗马广场、STW、网络安全年会、GTS 思博论坛”、中国电子学会等相关学术会议做大会报告。在清华大学北京信息科学与技术国家研究中心系列交叉论坛的特约报告在线观看超 39 万人，相关论文受邀发表于清华学报（英文版）。代表性论文 Google 引用共 2000 余次，合作制定了国际 ITU 标准。提出的匿名认证协议被 SCN（Wiley）综述文章认为是首个无线网络匿名认证协议，被密歇根理工等作为典型方案用于课程教学。提出的可信网络连接模型被“科学通报”综述文章认为是首个通用可组合的可信网络连接模型，制定了可信网络连接中国国家标准。相关成果在 2013 年、2020 年分别获中国国家技术发明二等奖。应邀为中国网络安全蓝皮书撰写发展报告。

With the theme of next-generation wireless network security, achievement completers were invited to give a keynote speech at Huawei's "Roman Forum, STW, Cyber Security Annual Conference, GTS Sibo Forum," the Chinese Institute of Electronics, and other related academic conferences. The special report at the series of cross-disciplinary forums of the Beijing National Research Center for Information Science and Technology of Tsinghua University has been viewed online by more than 390,000 people, and the relevant paper was invited to be published in Tsinghua Science and Technology. The representative papers of this achievement have been cited more than 2,000 times on Google Scholar. In addition, we have jointly formulated an international ITU-T standard. The SCN (Wiley) survey article pointed out the proposed anonymous authentication protocol to be the first anonymous authentication protocol for wireless networks. Michigan Technological University and others use it as a typical case for course teaching. The Science Bulletin survey article pointed out the proposed trusted network connection model to be the first universally composable trusted network connection model. Moreover, we have formulated a Chinese national standard for trusted network connection. The achievement won the second prize of the “National Technological Invention Award of China” in 2013 and 2020, respectively. Achievement completers were invited to write a development report for the Blue book on Analysis and prediction of China's network security situation.



◉ 代表性论文国际认可

◉ International Recognition of Representative Papers

◉ 无线网络安全专著与标准

◉ Monographs and Standards for Wireless Network Security

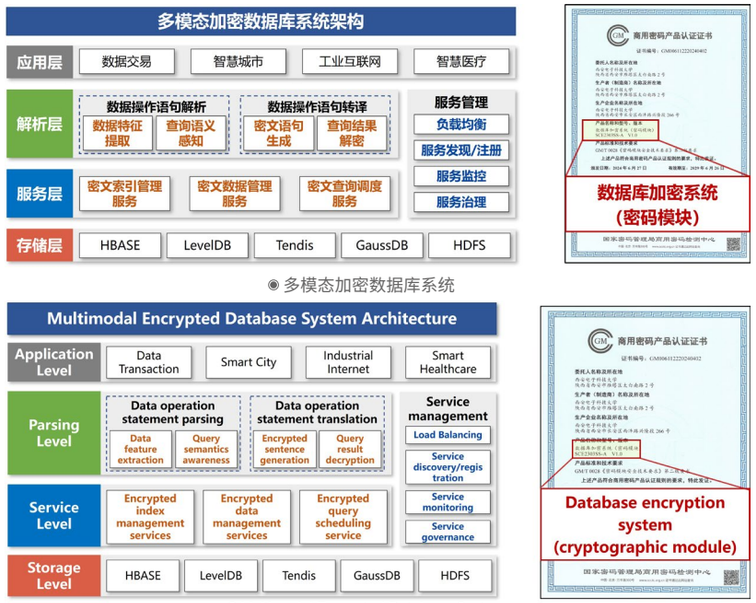
构成云网融合背景下无线网络安全的理论基础

Form the Theoretical Foundation for Wireless Network Security in Cloud-Network Integration

基于端云协同安全技术研制“秦盾”云加密数据库，通过中国密码局的密码服务软件测评。建立存储密钥更新机制，研制多模态加密数据库，无缝兼容主流大数据平台。以端系统安全技术为基础，联合研制航空电子安全防护系统，应用于中国大型客机 C919，保障机载信息系统安全。以“云-网 - 端”协同安全架构为基础，建立无人机 / 船的安全防护体系，研制智能无人系统广域安全协同服务平台，实现无人系统跨域远距离安

全通信、数据安全共享和协同安全服务。

Based on the End-Cloud collaborative security technology, we developed the Qin-Shield cloud encrypted database, which has passed the cryptographic service software evaluation of the National Cryptography Administration. In addition, we have established a storage key update mechanism and developed a multi-modal encrypted database, which can be seamlessly compatible with mainstream big data platforms. Based on the End-system security technology, an avionics security protection system was jointly developed and applied to China's large passenger aircraft, C919, to ensure the security of airborne information systems. Based on the Cloud-Network-End collaborative security architecture, a security protection system for drones/ships was established, and a wide-area security collaborative service platform for intelligent unmanned systems was developed to achieve cross-domain long-distance secure communication, data-sharing, and collaborative services for unmanned systems.



◉ 多模态加密数据库系统

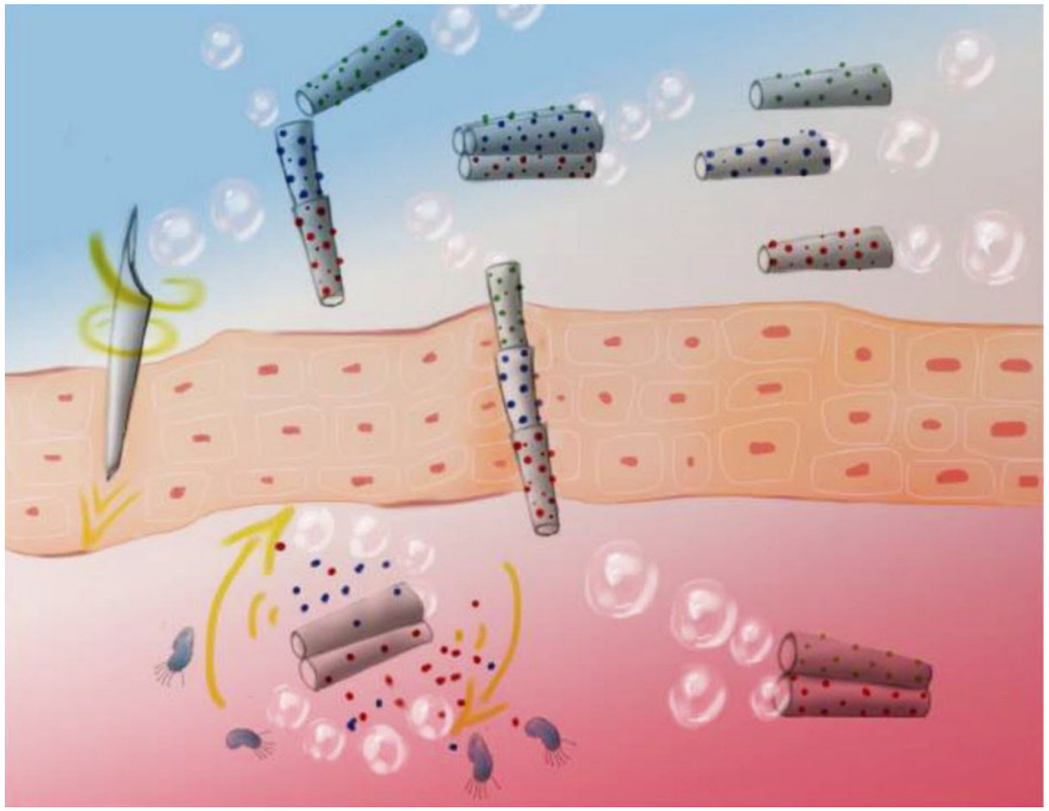
◉ Multimodal Encrypted Database System

◉ 无人系统跨域远距离安全通信、数据安全共享和协同安全服务测试

◉ Experimental Evaluation of Cross-Domain Long-Distance Secure Communication, Data-Sharing and Collaborative Services for Unmanned Systems

微纳马达制备及催化运动机制

Micro-/Nano-Motors and Their Catalytic Locomotion Mechanism



◉微纳管状马达可以驱动微纳机器人在生物体、集成电路等微小、封闭环境内的特定目标位置执行任务，是“超越摩尔”概念在智能微系统领域的具体体现，在生物医学、物联网、芯片制造等行业具有重要的应用前景。

◉Micro/nano-tubular motors can drive micro/nano-robots to perform tasks at specific target locations in small and confined environments, such as within living organisms and integrated circuits. This reflects the concept of "Beyond Moore" in the field of intelligent microsystems, with significant application potential in the fields of biomedicine, IoT, chip manufacturing, etc.

复旦大学
Fudan University

引言

如何高效驱动微纳机器人，是当前微纳机器领域的重要研究方向之一。本团队发展了基于集成电路工艺的自卷曲技术，实现了微纳管状马达的可控制备，阐释了微纳马达运动行为准则，极大推动了智能微纳机器人系统的实用化。

Introduction

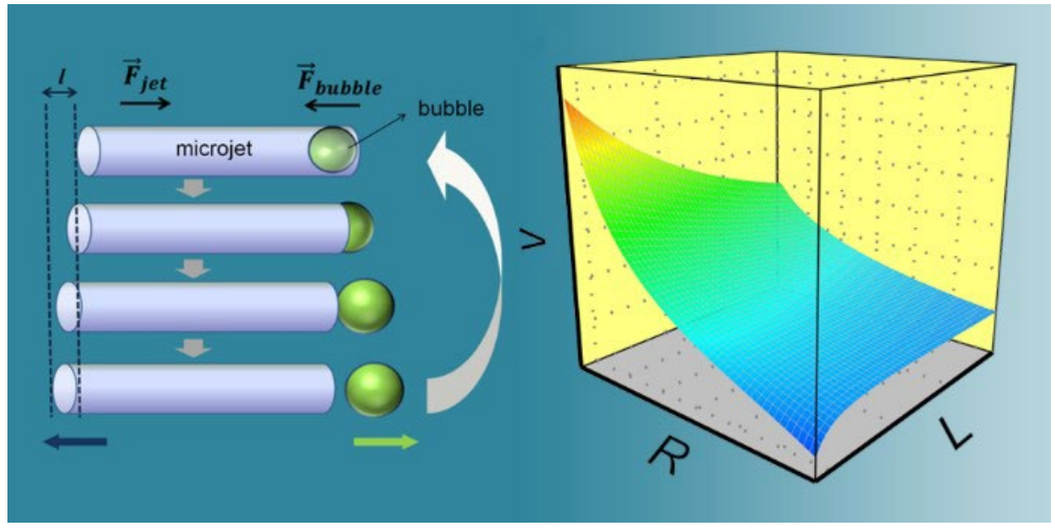
The efficient propulsion of micro/nano-robots is a key research direction in the field of micro/nano-machines. Our team has developed a controllable fabrication method for micro/nano-tubular motors based on integrated circuit technology and elucidated the principles of their motion behavior. This work significantly advances the practical application of intelligent micro/nano-robot systems.

首次采用集成电路工艺构建了微纳管状马达

The First Micro/nano-tubular Motor Fabricated by Integrated Circuit Technology

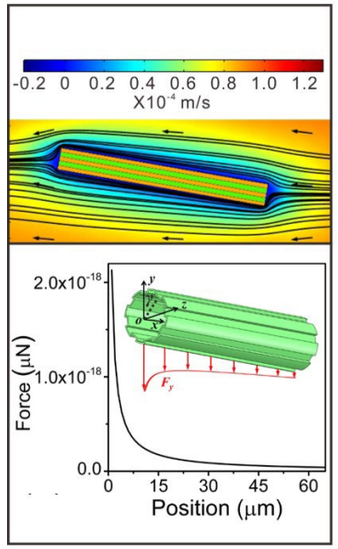
微纳机器人是通过外场驱动、并在目标位置执行任务的前沿机器人，是“超越摩尔”概念在智能微系统领域的具体体现。为了高效驱动低雷诺数环境下的微纳机器人，研究团队在国际上首次利用基于集成电路工艺的贵金属薄膜自卷曲组装技术制备了微纳管状马达。微纳管状马达通过催化反应实现高效的化学能 - 机械能转换。研究团队从理论和实验上解释了微纳管状马达的动力学行为，建立了普适的形变及多稳态运动行为准则。在运动机制研究基础上，研究团队进一步引入精细结构提升微纳马达能量转化效率、运动速率和定向运动的准直性，并阐释了内在原理。微纳马达驱动的微纳机器人可在微小、封闭的环境内（如生物体、集成电路等）特定目标位置执行任务，在生物医学、物联网、芯片制造等行业具有重要的应用前景。

Micro/nano-robots, driven by external fields and capable of performing tasks at target locations, represent the cutting edge of robotics and embody the concept of "Beyond Moore" in the field of intelligent microsystems. To efficiently drive micro/nano-robots in low Reynolds number environments, our team was the first in the world to employ integrated circuit technology-based self-rolling assembly of noble metal nanomembrane to fabricate micro/nano-tubular motors. These motors convert chemical energy into mechanical energy via catalytic reactions. Our team has theoretically and experimentally elucidated the dynamic behavior of micro/nano-tubular motors, establishing universal principles of deformation and multistable motion. Based on these findings, we introduced fine structures to improve energy conversion efficiency, motion speed, and directional movement ability, while also explaining the underlying mechanism. Micro/nano-robots driven by these motors can perform tasks in small and confined environments (e.g., within living organisms or integrated circuits), with significant potential applications in biomedicine, IoT, chip manufacturing, etc.



◉建立体变形模型分析催化运动机制，并基于此分析微纳管状马达动力学行为。

◉A body deformation model was established to analyze the mechanism of catalytic locomotion, and the dynamic behavior of the micro/nano-tubular motor was revealed.



◉ 利用微纳结构提升微纳管状马达运动稳定裕度。

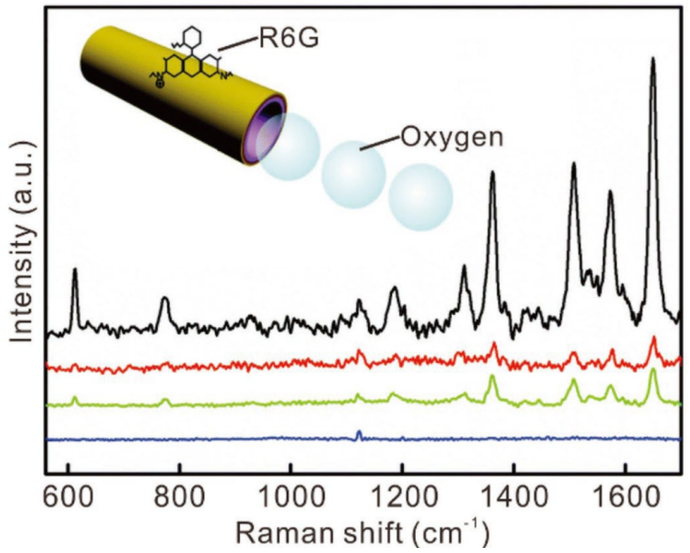
◉ Enhance the stability margin of micro/nano-tubular motor by using micro-/nano fine structure.

阐释了催化运动机制，为微纳机器提供了动力

Illuminating the Catalytic Locomotion Mechanism that Powers Micro-/nano-machines

如何构建微纳机器，被《科学》杂志列为当今 125 个重点科学问题之一，受到全球研究人员的广泛关注。然而微纳尺度下，来自布朗运动和介质粘滞力的影响变大。因此，如何在微纳尺度突破布朗运动和粘滞力的限制，实现低雷诺数条件下的可控运动，是当前微纳机器人领域的重要研究方向之一。本团队利用催化反应实现微纳马达的能量转换，并建立相应的动力学模型，阐释其运动准则，实现驱动性能提升。微纳管状马达的制备基于成熟的集成电路制程工艺，为功能化的微纳机器人的大规模批量制备创造了条件。本项目成果促进了微纳机器、生物医学等相关学科高速发展，解决了微纳机器人的动力来源，在智慧医疗、物联网、芯片制造、污染治理等一系列领域具有重要的应用前景。

How to construct micro-/nano-robots is listed as one of the top 125 key scientific questions by Science magazine, attracting extensive attention from researchers worldwide. However, in micro-/nano-scale, the effects of Brownian motion and surface viscosity become predominant. Therefore, how to surmount the limitations of Brownian motion and surface viscosity at the micro-/nano-scale and achieve controllable locomotion under low Reynolds number condition is one of the critical research directions in the current field of micro-/nano-robot. Our team realized energy conversion via catalytic reaction, and established kinetic model to elucidate the locomotion mechanism as well as energy conversion principle to enhance the performance. The fabrication of micro-/nano-motors is based on mature integrated circuit technology, which creates conditions for the large-scale fabrication of functional micro-/nano-motors. The achievement of this project has promoted the fast development of micro-/nano-machines, biomedicine, and other related disciplines, provides a solution for the power source of micro-/nano-robots, and has important application potentials in a series of fields such as smart medical treatment, Internet of things, chip manufacturing, and pollution control.



◉ 利用微纳管状马达靶向收集待测分子，可实现高灵敏度分子探测。

◉ Collection of targeted molecules by using micro/nano-tubular motor enables high sensitive detection of molecules.

发表了高水平论文，显著提升了国际影响力

High Quality Publications Significantly Promoted International Academic Impact

研究团队与德国、美国、韩国的高水平研究团队在微纳管状马达的制备和应用上开展了广泛而深入的合作。主要成果发表在 Chem. Soc. Rev.、Adv. Mater.、J. Mater. Chem.、NPG Asia Mater.、Environ. Sci.: Nano、Nanoscale 等高水平期刊上。团队还在 1st Asia Advanced Materials Summit 等重要国际会议上报告了研究进展，并有多项中国发明专利获授权。本成果研究工作被德国科学院院士、美国加州大学圣地亚哥分校纳米工程系系主任、美国宾夕法尼亚州立大学教授、芬兰约恩苏大学教授、法国巴黎综合理工大学教授等多个国际著名学者正面引用，总引用次数超过 1000 次，具有显著的国际学术影响力。梅永丰教授被认为开创了微纳管状马达研究方向。

Our team has made comprehensive and in-depth collaborations with high level teams from Germany, USA, and Korea in the area of fabrication and application of micro-/nano-motors. Major output was published in top journals such as Chem. Soc. Rev., Adv. Mater., J. Mater. Chem., NPG Asia Mater., Environ. Sci.: Nano, Nanoscale. The team also presented the research progress at significant international conferences like the 1st Asia Advanced Materials Summit. Multiple Chinese invention patents have been authorized. The research work has been positively cited by e.g., member of German Academy of Science and Engineering, head of the Department of Nanotechnology Engineering at the University of California, San Diego, professor at the Pennsylvania State University, professor at the University of Joensuu, Finland, professor at the Ecole Polytechnique, Paris, and many other internationally renowned scholars, with a total citation count exceeding 1000 times, exhibiting substantial global academic impact. Prof. Yongfeng Mei is recognized as pioneering the research direction of micro/nano-tubular motors.

◉ 团队成果被多个国际著名学者正面引用及评价。梅永丰教授被认为开创了微纳管状马达研究方向。

◉ Output has been positively cited and commented by many renowned scholars. Prof. Yongfeng Mei is recognized as pioneering the research direction of micro/nano-tubular motors.

世界互联网大会
领先科技奖收录成果集

Collection of World Internet Conference
Awards for Pioneering Science
and Technology

02

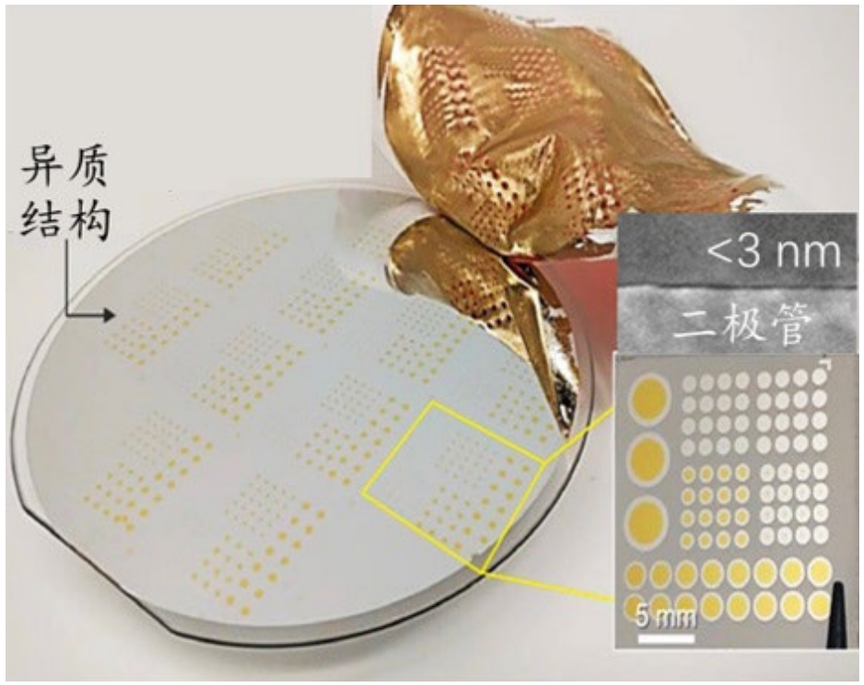
世界互联网大会
领先科技奖收录成果

Collection of Shortlisted Achievements of
World Internet Conference Awards for
Pioneering Science and Technology

关键技术组
Key Technology Group

下一代亚 10 纳米光刻技术：粘附光刻技术

Next Generation Sub-10nm Lithography: Adhesion Lithography



◉粘附光刻制造的异质集成亚 3 纳米芯片

◉Heterogeneous Integrated Sub-3 nm Chips Fabricated by Adhesive Lithography

挪威科技大学
Norwegian University of Science and Technology

西安交通大学
Xi'an Jiaotong University

引言

当前，高分辨纳米制造技术的版图主要由深紫外光刻、极紫外光刻等构成。为跨越高端芯片制造的鸿沟，台积电、华为等企业先后将结构尺度推向了 7 纳米乃至更小的节点，从而满足高端芯片制造的极致需求。

Introduction

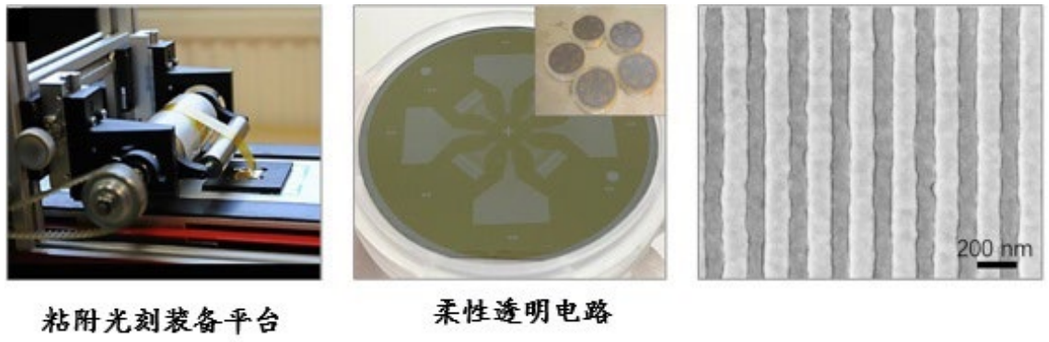
Currently, the layout of high-resolution nanomanufacturing technology mainly consists of key technologies such as deep ultraviolet lithography, extreme ultraviolet lithography. To bridge this technological gap, chip companies such as TSMC and Huawei have successfully pushed the structural scale to nodes of 7 nanometers or even smaller, thus meeting the ultimate demands of high-end chip manufacturing.

突破传统光刻衍射极限，实现亚 3 纳米分辨率

Breaking Through the Diffraction Limit of Conventional Lithography to Achieve Sub-3 Nanometer Resolution

现有高分辨纳米制造技术主要包括浸没式光刻、深紫外光刻、极紫外光刻等，ASML 公司量产的深紫外光刻和极紫外光刻技术分辨率分别为 38 和 13 纳米，制造分辨率还难以满足 10 纳米以下高端芯片的制造需求。为了解决这一难题，台积电等芯片制造企业采用多重曝光或刻蚀技术，通过多次曝光或刻蚀的方法缩小结构尺度，采用 38/13 纳米光刻机，实现了 7 纳米以下节点高端芯片的制造，华为公司近期也公布了多重曝光提升纳米结构分辨率的专利技术。我们团队在传统多重曝光技术之外，提出一种采用分子自组装单层和薄膜剥离实现亚 3nm 结构规模制造的创新技术 - 粘附光刻技术。该技术的加工分辨率取决于结构侧壁的分子长度，因此有望实现纳米、甚至分子尺度的结构制造。相关技术被国际同行评价为：有潜力的纳米级光刻方法，是器件进入分子和原子尺度的关键技术，得到美国、英国、韩国和日本等国际同行跟踪研究。

Existing high-resolution nanofabrication technology mainly includes immersion lithography, deep ultraviolet lithography, extreme ultraviolet lithography, etc., ASML mass production of deep ultraviolet lithography and extreme ultraviolet lithography resolution of 38 and 13 nanometers, respectively, the manufacturing resolution is still difficult to meet the manufacturing needs of high-end chips below 10 nanometers. In order to solve this problem, TSMC and other chip manufacturing companies use multiple exposure or etching technology to reduce the structure scale, using 38/13 nm lithography, to achieve the node below 7 nm high-end chip manufacturing, Huawei has also recently announced a multiple exposure to enhance the nanostructure resolution of the patented technology. To further reduce the scale of nanostructures, our team proposes an innovative technique-adhesion lithography-adopted in addition to the conventional multiple-exposure technique that uses molecular self-assembled monolayers and thin-film exfoliation to realize the fabrication of sub-3 nm structure scale. The processing resolution of this technique depends on the molecular length of the structure's sidewalls, and thus it is expected to realize the fabrication of structures at the nanometer, or even molecular, scale. Related is evaluated by international peers as: a potential nanoscale lithography method, a key technology for devices to enter the molecular and atomic scales, and has been tracked by international peers in the United States, the United Kingdom, South Korea and Japan.



◉粘附光刻装备平台及代表性亚 3 纳米间隙线阵结构

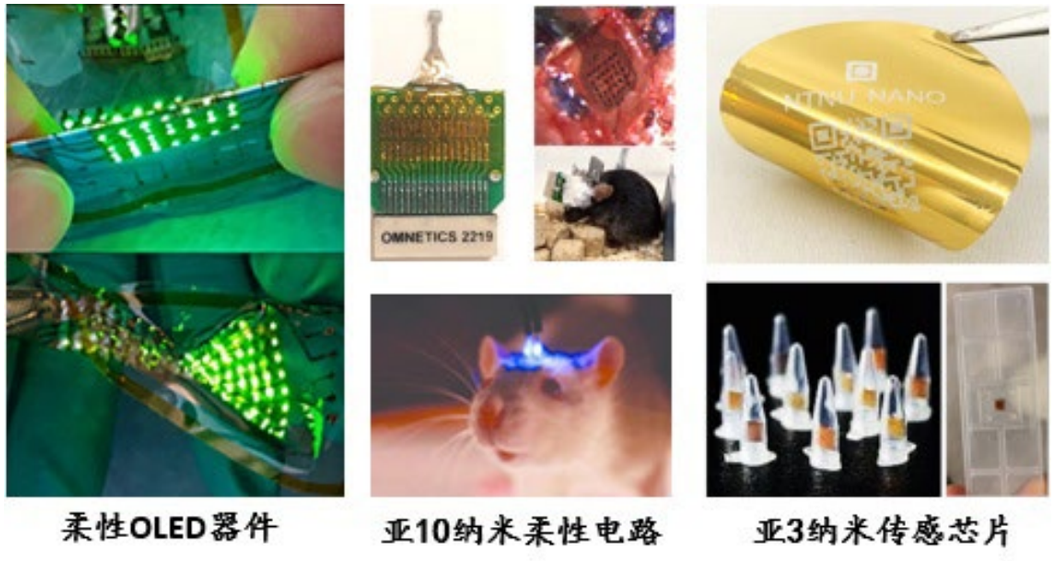
◉Adhesion Photolithography Equipment Platform and Representative Sub-3-nanometer Gap Linear Array Structure

亚 3 纳米粘附光刻为多种高性能器件提供解决方案

Sub-3nm Adhesion Lithography Provides Solutions for Multiple High Performance Devices

粘附光刻技术在极端纳米结构制造方面的能力，为低成本、批量化制造多种高性能器件提供了创新途径，比如，我们所开发的超高灵敏度亚 3 纳米传感芯片，已成功应用于环境监测、医疗诊断及高性能光电探测器件等领域。其中，可晶圆级制造的传感芯片，同传统制造技术相比，成本低、检测精度高，已供应国际多家生物检测公司、医院及高校等科研单位。

Adhesion lithography's ability to fabricate extreme nanostructures provides an innovative way for low-cost, batch fabrication of a wide range of high-performance devices. For example, the ultra-high-sensitivity sub-3nm sensing chips we have developed have been successfully applied to environmental monitoring, medical diagnostics, and high-performance optoelectronic detector devices, among other fields. Among them, the sensing chips that can be manufactured at wafer level have low cost and high detection accuracy compared with traditional manufacturing technology, and have been supplied to a number of international bio-detection companies, hospitals, universities and other scientific research units.



◉粘附光刻技术应用于制造多种器件实例

◉Examples of Adhesion Photolithography Technology Applied in the Manufacture of Various Devices

引领光刻技术革新，驱动产业合作

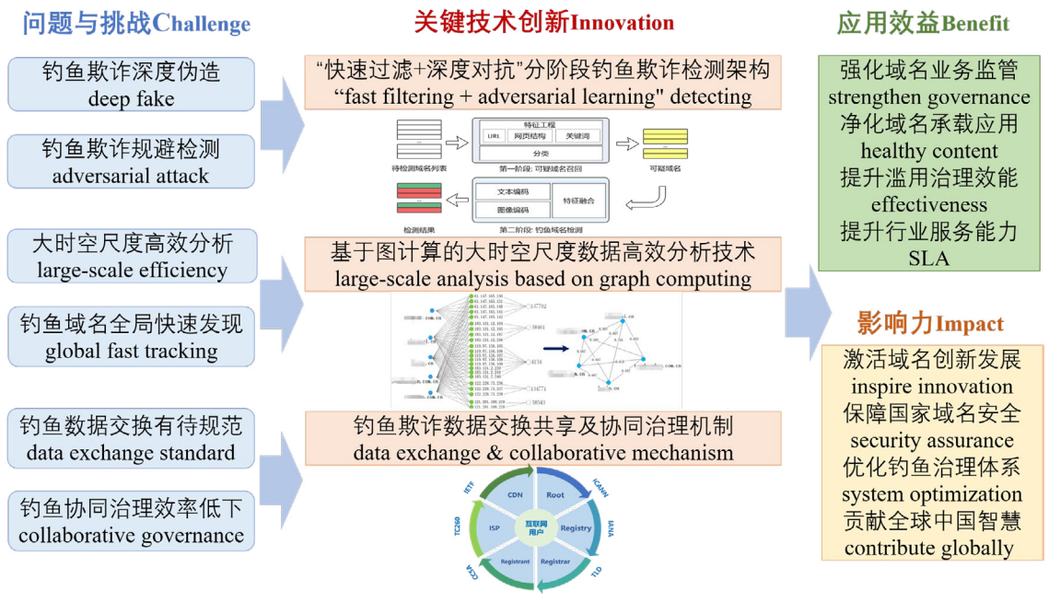
Leading Lithography Innovation and Driving International Cooperation in the Industry

该技术的影响力深远，涵盖了技术推动、产业带动和国际合作与交流等多个方面。首先，该技术推动了微纳制造领域的技术进步和创新。其高分辨率和低成本特点，为制造更小、更复杂的集成电路提供了可能，推动了集成电路产业的发展。其次，该技术的应用将带动相关产业的发展，如传感器制造、电子器件制造、医疗设备制造等，形成完整的产业链。随着技术的不断成熟和普及，该技术将逐渐渗透到更多领域，推动相关产业的转型升级和高质量发展。最后，该技术的成功研发和应用将吸引更多国际同行和企业的关注和合作，促进国际之间在微纳加工领域的合作与交流。

The influence of this technology is far-reaching, covering many aspects such as technology promotion, industry promotion and international cooperation and exchange. First of all, the technology promotes the technological progress and innovation in the field of micro-nano manufacturing. Its high-resolution and low-cost features provide the possibility of manufacturing smaller and more complex integrated circuits, promoting the development of the integrated circuit industry. Secondly, the application of this technology will lead to the development of related industries, such as sensor manufacturing, electronic device manufacturing, medical equipment manufacturing, etc., forming a complete industrial chain. With the continuous maturity and popularization of the technology, the technology will gradually penetrate into more fields, promoting the transformation and upgrading of related industries and high-quality development. Finally, the successful development and application of this technology will attract the attention and cooperation of more international counterparts and enterprises, and promote international cooperation and exchanges in the field of micro-nano processing.

针对 AI 网络钓鱼欺诈的深度对抗关键技术及应用

Critical Technologies for Deep Countermeasures and Their Application Against AI-Based Phishing Attacks



◉ 成果概览

◉ Overview

中国互联网络信息中心
China Internet Network Information Center

暨南大学
Jinan University

引言

AI 网络钓鱼欺诈是当前全球互联网面临的重大威胁，严重影响各国网络安全和社会稳定。针对 AI 网络钓鱼欺诈防范对抗能力不足等挑战，项目聚焦 AI 网络钓鱼欺诈深度对抗关键技术，推动提升 AI 网络钓鱼欺诈协同治理能力。

Introduction

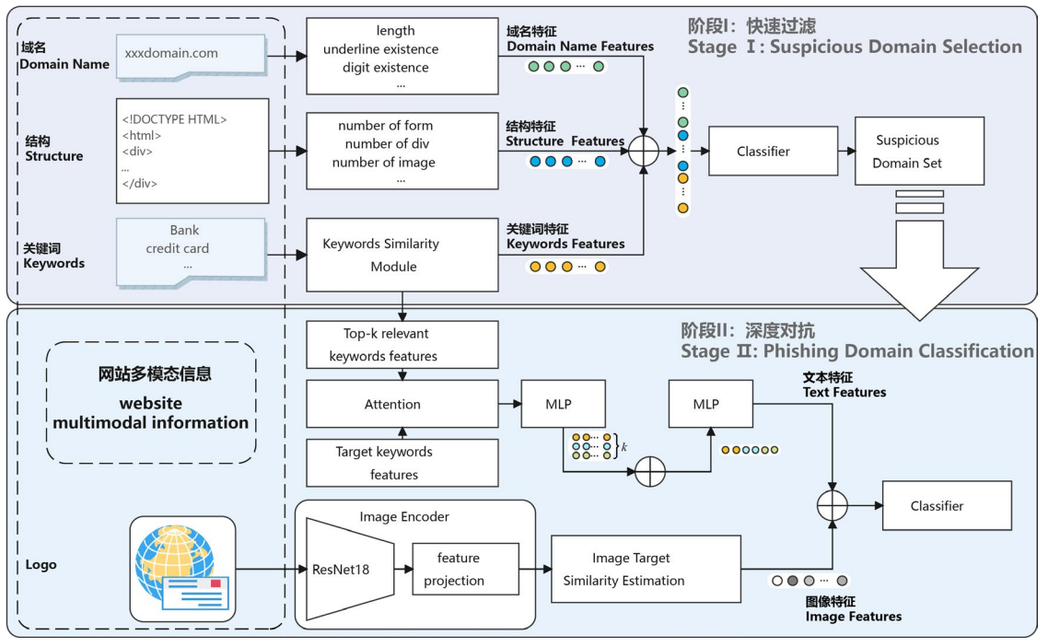
AI-based Internet phishing has become a major threat to the Internet, affecting the network security and social stability of all countries. In response to challenges such as the lack of AI phishing fraud prevention and confrontation capabilities, the project focuses on key technologies for AI phishing deep confrontation, and promotes the improvement of AI phishing fraud collaborative governance capabilities.

突破 AI 网络钓鱼欺诈的快速检测、高效分析和协同治理能力

Breakthrough in the Rapid Detection, Efficient Analysis, and Collaborative Governance Capabilities of AI Phishing Fraud

针对大规模复杂现实场景下的 AI 钓鱼欺诈深度伪造及规避检测等技术挑战，研制基于“快速过滤 + 深度对抗”的分阶段钓鱼欺诈检测架构机制，每日可完成亿级活跃主机的钓鱼欺诈检测，钓鱼欺诈网站平均存活时间由 12 天缩短至 4 天内。针对钓鱼域名检测中需高效分析大时空网状尺度数据的难题，提出一种基于图数据路径分析的钓鱼域名快速发现方法，实现覆盖千万级域名、百万量级 IP 地址及相关 AS 之间网状关联图的疑似钓鱼域名快速发现，在相同数量种子的条件下，疑似钓鱼域名发现能力提升 15 倍。针对中国乃至全球网络钓鱼等域名滥用数据不统一、不规范的问题，以及网络钓鱼跨地域实时性、多机构联动、多环节协作治理等需求，研究并提出一系列钓鱼数据格式和共享的技术标准，实现钓鱼数据举报、审核认定、处置防御等跨地域、跨行业一体化多方协作治理技术。

In view of the technical challenges such as AI phishing fraud deepfake and evasion detection in large-scale and complex real-world scenarios, a phased phishing fraud detection architecture mechanism based on “Fast Filtering + Adversarial Learning” was developed, which can complete the phishing fraud detection of hundreds of millions of active hosts every day, and shorten the average survival time of phishing websites from 12 days to 4 days. Regarding the difficulty of efficient data analysis at large space and time scales in phishing domain name detection, a rapid discovery method of phishing domain names based on graph data path analysis was proposed, which realized the rapid discovery of suspected phishing domain names covering tens of millions of domain names, millions of IP addresses and related ASs, and improved the detection ability of suspected phishing domain names by 15 times under the condition of the same number of seeds. In view of the problem of inconsistent and non-standard domain name abuse data such as phishing in China and even the world, as well as the needs of real-time phishing across regions, multi-agency collaborative governance, a series of technical standards for phishing data formats and sharing are proposed, so as to realize cross-regional and cross-industry integrated multi-party collaborative governance technologies such as phishing data reporting, identification, disposal, and defense.



◉ 基于“快速过滤 + 深度对抗”的分阶段钓鱼欺诈检测架构机制

◉ Two-stages Phishing Detecting Scheme: “Fast Filtering + Adversarial Learning”

推动中国域名审核和滥用治理服务的高质量发展

Promote the High-quality Development of Domain Name Audit and Abuse Governance Services in China

成果应用于国家域名滥用治理服务，极大提升滥用审核效率和治理水平，近五年累计发现并处置钓鱼网站超 12 万例，并大幅缩短钓鱼网站的平均存活时间（从 12 天缩短至 4 天内），为广大网民避免了高达数百亿元的潜在经济损失。成果应用于中国域名服务行业治理，全面支撑中国域名合规相关管理要求，近五年累计完成 3400 余万个域名命名核验，1700 余万个用户实名核验，成为中国域名服务行业审核标杆工程。成果应用于多个国家部委重要平台及国际合作项目，通过中国反钓鱼网站联盟为上百家成员单位提供持续高效的反钓鱼探测发现服务，并积极为国际社区贡献网络钓鱼关键数据，进一步保障全球互联网安全稳定发展。

The results of the project have been applied to the national domain name abuse governance, and have greatly improved the efficiency of the services. Over the past five years, more than 120,000 phishing websites have been detected and removed, and the average survival time of phishing websites has been significantly shortened (from 12 days to 4 days), tens of billions of yuan in potential economic losses have been avoided for Internet users. The results of the project have been applied to the management of China's domain name service industry, and have comprehensively supported the management requirements of China's domain name compliance. Over the past five years, with the cumulative verification of more than 34 million domain names and more than 17 million user names, this project has become the benchmark of China's domain name service industry. The results of the project have been applied to many important platforms of ministries and commissions. Through the China Anti-Phishing Alliance, we provide continuous and efficient anti-phishing detection services for hundreds of member, and actively contribute key phishing data to the international community to further ensure the safe and stable development of the global Internet.

◉ 成果应用于国家互联网基础资源大数据平台

◉ Application in the National Internet Basic Resources Big Data Platform

引领中国域名行业反钓技术创新并为全球贡献中国智慧

Leading the Innovation of Anti-phishing Technology in China's Domain Name Industry and Contributing Chinese Wisdom to the World

形成了一批具有行业影响力的成果，引领中国域名行业网络反钓技术进步。在中国乃至国际申请并获授权专利 12 项，发表 15 篇代表性论文，发布 10 项网络反钓和滥用标准，相关标准应用荣获“2023 年网络安全国家标准优秀实践案例”，入选中国工业和信息化部“电信和互联网行业网络安全”试点示范项目，荣获由中国互联网协会颁发的“中国互联网公益奖”，先后在世界互联网大会乌镇峰会、国家网络安全宣传周等国际或国家大型会议上举办数场反钓鱼欺诈科普活动，累计受众达数十万。项目面向全球发布数份钓鱼欺诈分析报告，并应用于全球反钓鱼欺诈工作组（APWG）钓鱼欺诈趋势报告，成为全球打击网络钓鱼欺诈犯罪的重要抓手。项目专家担任互联网域名领域全球最大的区域性国际组织 APTLD 董事会副主席、ICANN 互联网根服务器咨询委员会专家组成员、ICANN 国家和地区域名滥用治理委员会委员等职位，为全球互联网技术革新和域名滥用治理工作，积极贡献中国智慧。

The project has made a number of achievements with industrial influence, leading the progress of anti-phishing technologies in China's domain name industry. The project has applied for and obtained 12 patents internationally, published 15 representative papers, released 10 anti-phishing and domain abuse standards, which of them won the Excellent Practice Case of National Standards for Cybersecurity in 2023 and has been selected as a pilot demonstration project of “Cyber Security in the Telecommunications and Internet Industry” by the Ministry of Industry and Information Technology of China, and won the “China Internet Public Benefit Award” issued by the Internet Society of China. Several anti-phishing science popularization activities have been held at international or national conferences such as the World Internet Conference Wuzhen Summit andNational Cyber Security Publicity Week, with a cumulative audience of hundreds of thousands. The project has published several phishing analysis reports around the world, and applied them to the Global Anti-Phishing Working Group (APWG) Phishing Fraud Trend Report, which has become an important starting point for the global fight against phishing crimes. The project experts serve as the vice chairman of the board of directors of APTLD, member of the expert group of ICANN's Internet Root Server Advisory Committee, and member of ICANN ccNSO DNS Abuse Governance Committee.

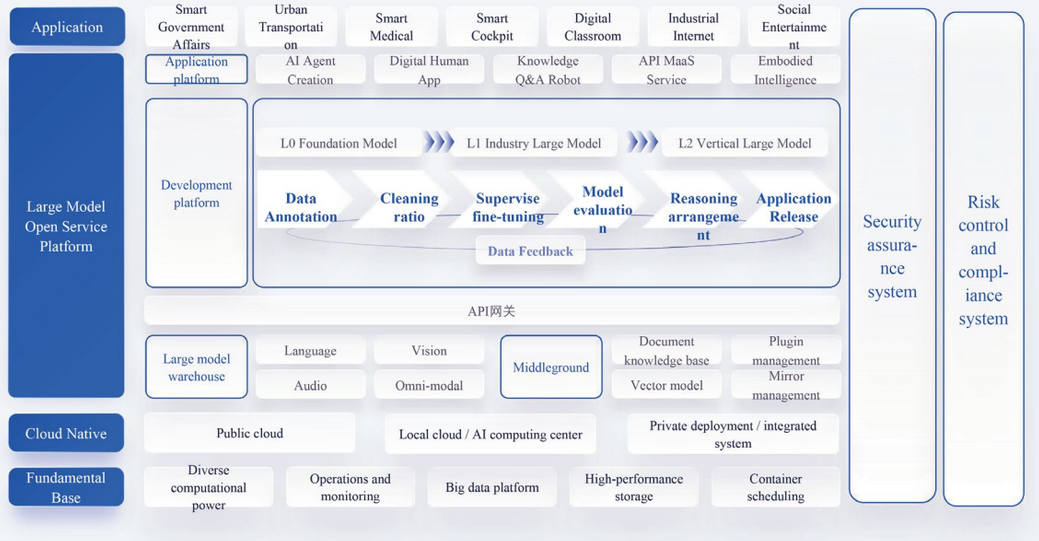
◉ 部分代表性成果及获奖情况

◉ Representative Achievements and Awards (in part)

紫东太初多模态大模型 3.0

ZiDongTaiChu Multimodal Large Model 3.0

◉ 紫东太初多模态大模型 3.0



◉ ZiDongTaiChu Multimodal Large Model 3.0

中国科学院自动化研究所
Institute of Automation, Chinese Academy of Sciences

中国科学院自动化研究所
INSTITUTE OF AUTOMATION CHINESE ACADEMY OF SCIENCES

引言

为了实现更接近人类自然交互方式，团队开发了面向文本、图像、音频、视频等数据的紫东太初多模态大模型，提出了跨模态多任务统一自监督学习等关键技术，实现了多模态共情对话，迈出人工智能通用化的重要一步。

Introduction

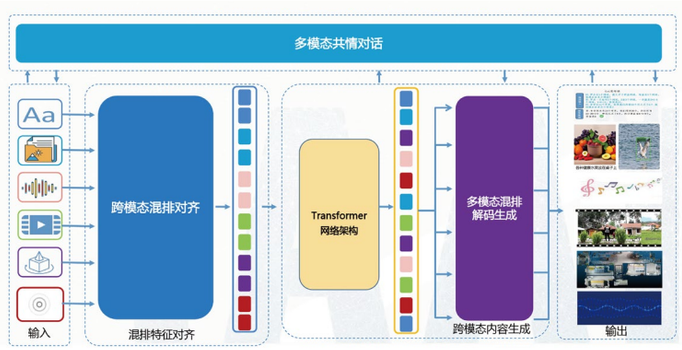
To achieve a more natural human interaction experience, the team developed ZiDongTaiChu Multimodal Large Model capable of handling text, images, audio, and video data. They proposed cross-modal multitask unified self-supervised learning as key technologies, enabling multimodal empathetic conversations, marking an important step towards the generalization of artificial intelligence.

面向数字物联时代的泛模态认知大模型

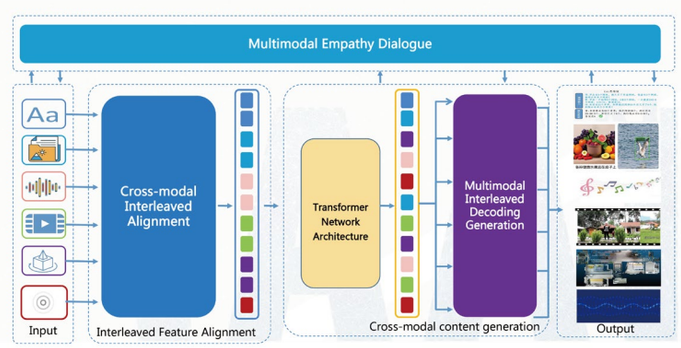
Omni-modal Cognitive Large Model Towards the Digital Internet of Things Era

针对多模态信息表征与交错融合难、理解与生成统一难、拟人难等挑战，研发了支持图像、文本、语音和视频的千亿参数紫东太初多模态大模型，开拓性提出跨模态多任务自监督学习等关键技术，实现了多种弱关联模态数据间的统一表示与相互生成。进而建立了紫东太初 2.0 版本 - 泛模态认知大模型，实现对文本、图像、视频、传感信号、3D 点云等模态的关联分析理解。紫东太初 3.0 则提出了基于行为对齐的共情原生多模态理解与生成统一架构，增强了不同模态原生混排能力，具备了更强大的视觉理解定位和生成能力，支持多模态检索增强处理包含图片图表类多种模态形式的文档，实现了多模态共情对话，更接近人类自然交互方式，迈出人工智能通用化的重要一步。

To handle with challenges such as difficulty in representing and fusing multimodal information, difficulty in unifying understanding and generation, and difficulty in personification, a hundred billion parameter ZiDongTaiChu multimodal large model supporting images, text, speech, and video has been developed. Key technologies such as cross-modal multi-task self-supervised learning have been proposed, achieving unified representation and mutual generation of multiple weakly correlated modal data. Furthermore, the ZiDongTaiChu 2.0 version - Omni-Modal Cognitive Large Model was established to achieve correlation analysis and understanding of modalities such as text, images, videos, sensor signals, and 3D point clouds. ZiDongTaiChu 3.0 proposed a unified architecture for empathy native multimodal understanding and generation based on behavior alignment, enhancing the native mixing ability of different modalities, possessing stronger visual understanding positioning and generation capabilities, supporting multimodal retrieval and enhanced processing of documents containing multiple modal forms such as images and charts, realizing multimodal empathy dialogue, closer to natural human interaction, and taking an important step towards the generalization of artificial intelligence.



◉ 泛模态认知增强：面向物联世界多源输入的认知，具有泛模态能力涌现，认知效率更高



◉ Omni-modal Cognitive Enhancement: Cognitive Processing for Multiple Sources of Input in the Internet of Things World, with Emergence of Omni-modal Capabilities and Higher Cognitive Efficiency

人工智能开放服务平台释放大模型能力，赋能千行百业

Artificial Intelligence Open Service Platform Releases the Capabilities of Large Models, Empowering Industries Across the Board

在开源共享方面，2022 年开源了 Mindspore 版本的紫东太初 1.0 图文音大模型代码，开源了 50 倍加速的快速通用分割模型 (FastSAM) 且 Github 星超过 7.3K。2022 年开放了亿级大规模中文多模态预训练数据集 TaiSu，为大模型研发提供了有力支持。

In terms of open source sharing, in 2022, the Mindspore version of the ZiDongTaiChu 1.0

image-text-audio large model code was open source, and the Fast Universal Segmentation Model (FastSAM) with 50 times acceleration was open source, with over 7.3K Github stars. In 2022, the hundred billion level large-scale Chinese multimodal pre-training dataset TaiSu was open source, providing strong support for the development of large models.

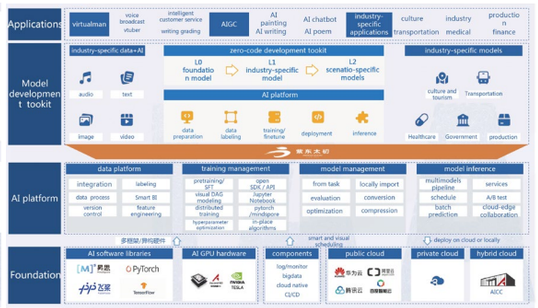
在模式复制方面，研发了大模型训推一体机，建立了全栈多模态大模型开放服务平台，在中国 6 家智能计算中心进行部署，大幅降低了普通开发人员开发大模型的门槛，全面赋能千行百业。

In terms of pattern replication, we have developed a large model training and promotion integrated machine, established a full stack multimodal large model open service platform, and deployed it in six intelligent computing centers in China, greatly reducing the threshold for ordinary developers to develop large models and fully empowering various industries.

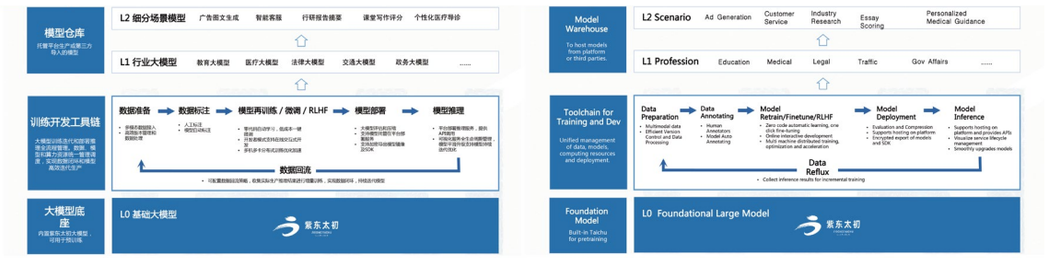
在行业应用方面，紫东太初大模型已成功应用于手语教育、智能制造、医疗诊断等领域，如手语教考一体机在特殊教育学校的部署、与沙特国家博物馆合作的虚拟人项目、多模态工业质检大模型提升精度 30%，显著提升了行业性能和效率，助力产业发展。

In terms of industry applications, the ZiDongTaiChu large model has been successfully applied in sign language education, intelligent manufacturing, medical diagnosis and other fields. For example, the deployment of sign language teaching and examination integrated machines in special education schools, the virtual human project in cooperation with the Saudi National Museum, and the multimodal industrial quality inspection large model have improved accuracy by 30%, significantly enhancing industry performance and efficiency and helping industrial development.

◉ 紫东太初大模型开放服务平台架构



◉ ZiDongTaiChu Large Model Open Service Platform Architecture



◉ 微调开发工具链释放大模型能力赋能千行百业

◉ Finetuning and Development Toolchain to Release and Amplify Model Capabilities, Empowering Thousands of Industries

◉ 超融合训推一体机

◉ All-in-one Machine

打造中国通用 AI 智能底座，助推认知智能时代加速到来

Omni-modal Cognitive Large Mod- Building a Generic AI Intelligent Foundation in China, Accelerating the Advent of the Era of Cognitive Intelligence

紫东太初多模态大模型探索了科研创新到产业落地的新模式，推动了中国人工智能研发范式和产业应用模式发生重要变革。

ZiDongTaiChu's multimodal large model has explored a new model from scientific research innovation to industrial implementation, which has promoted important changes in China's AI research and development paradigm and industrial application model.

紫东太初多模态对话虚拟人赋能沙特国家博物馆，实现沙特文化实时智能化交互，获得了高度评价。

ZiDongTaiChu's multimodal dialogue virtual human empowers the Saudi National Museum, achieving real-time intelligent interaction of Saudi culture and receiving high praise.

基于紫东太初大模型的 MicroNeuro 颅内微创手术机器人受到香港特首称赞。

The MicroNeuro intracranial minimally invasive surgical robot based on the ZiDongTaiChu large model has been praised by the Hong Kong Chief Executive.

紫东太初与马栏山计算媒体研究院合作打造的多模态手语教考一体机，已推广到中国湖南省内三十多家特校，开创了智能化聋哑教育新范式。

The multimodal sign language teaching and examination integrated machine jointly developed by ZiDongTaiChu and Malanshan Computing Media Research Institute has been promoted to more than 30 special schools in Hunan Province, China, creating a new paradigm of intelligent deaf mute education.

紫东太初与九州通联合研发医疗器械大模型将手术器械识别准确率 99%，加速了行业数字化转型。

ZiDongTaiChu and Jiuzhou Tong jointly developed a large-scale medical device model, which achieved a surgical instrument recognition accuracy of 99%, accelerating the digital transformation of the industry.

紫东太初与华为存储器厂商合作，将服务器运维效率提高 60%。

ZiDongTaiChu has partnered with Huawei memory manufacturers to increase server operation and maintenance efficiency by 60%.

紫东太初已成为共性平台技术，推动了人工智能生态发展，加速 AI 应用规模化落地。

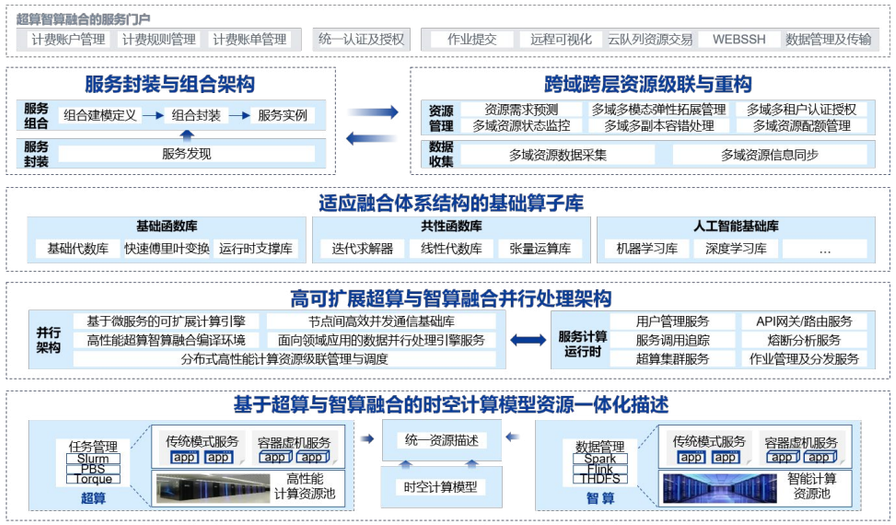
ZiDongTaiChu has become a common platform technology, promoting the development of the artificial intelligence ecosystem and accelerating the large-scale implementation of AI applications.

◉ 深入融合行业场景，赋能千行百业

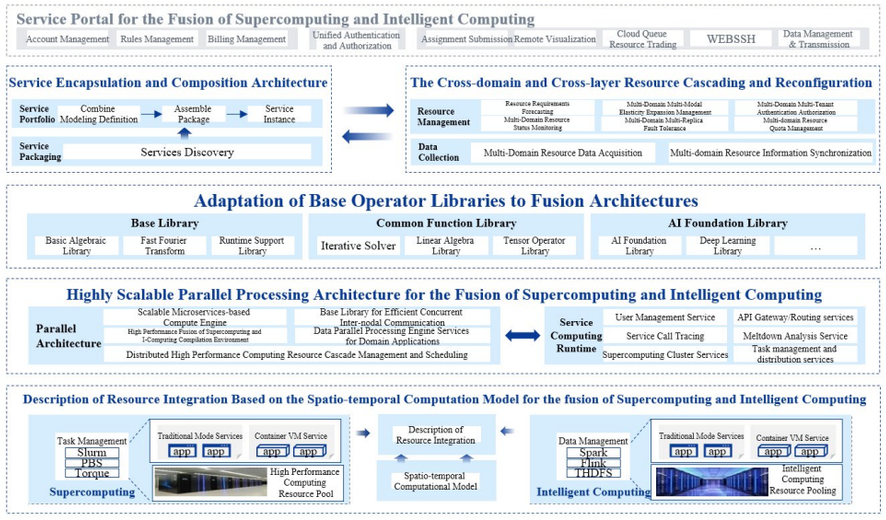
◉ Deeply integrate industry scenarios and empower thousands of industries

超算与智算融合计算调度技术

Scheduling Technology for the Fusion of Supercomputing and Intelligent Computing



◉ 超算与智算融合计算服务化平台



◉ Computing Servitization Platforms for the Fusion of Supercomputing and Intelligent Computing

湖南大学
Hunan University

湖南大学 HUNAN UNIVERSITY

引言

面向超算与智算高效融合面临的计算模型、系统架构、算法设计等重大挑战，从融合计算模型与并行处理架构、计算服务化到特定领域高效并行算法展开研究，提出时空计算模型，耦合超智计算体系架构，形成具有自主知识产权的技术体系。

Introduction

Facing the major challenges of computing model, system architecture and algorithm design in the highly effective fusion of supercomputing and intelligent computing, we have conducted research on the fusion computing model, parallel processing architecture, computing servitization and domain-specific efficient parallel algorithms. We have proposed the spatio-temporal computation model, coupled with the architecture of supercomputing and intelligent computing, and formed the technological system with independent intellectual property.

超算与智算高效融合面临的计算模型、系统架构、算法设计等重大挑战的突破

Breakthrough in Major Challenges Faced by the Efficient Fusion of Supercomputing and Intelligent Computing, Including Computational models, System Architecture, and Algorithm Design

提出时空计算模型，耦合超智计算体系架构。

This work proposes a spatio-temporal computation model coupled with a super intelligent computing architecture.

提出超算与智算融合的时空计算模型，发现并证明了数据时空熵下界，基于给出的数据特征空间分布函数，解决了融合计算难以适应数据时空非均匀动态分布难题；设计实现了基于代价模型的混合内存访问机制以及节点间运行时可扩展计算引擎，相较于 SLURM 等主流架构，通信和计算效率分别提升 25.2% 和 18.6%。

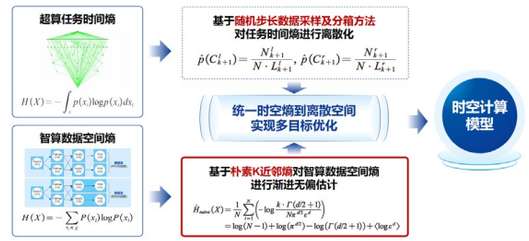
We first propose a spatio-temporal computation model for the fusion of supercomputing and intelligent computing, discover and prove the lower bound of spatio-temporal entropy of data, and solve the problem of spatio-temporal non-uniform dynamic distribution of data based on the given spatial distribution function of data features. We design and realize a hybrid memory access mechanism based on the cost model as well as an inter-node runtime scalable compute engine. Compared with the mainstream architectures such as SLURM, our architecture can improve the communication and computation efficiency by 25.2% and 18.6% respectively.

设计超算与智算融合的高效基础算子库，矩阵与张量运算效率相比于 Intel MKL 等主流算子库提升 12%-30%；提出跨域跨层资源级联与重构机制，突破了 OpenStack 原生架构 20 倍部署规模。

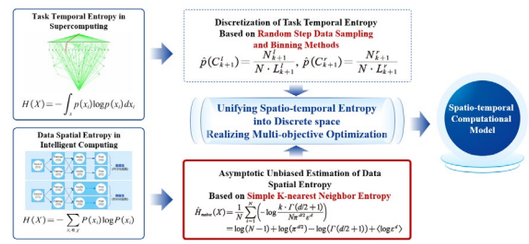
We also design an efficient base operator library which integrate supercomputing and intelligent computing. Compared with mainstream arithmetic libraries such as Intel MKL, the efficiency of matrix and tensor operations is improved by up to 30%. The cross-domain resource cascading and reconfiguration mechanisms we propose break through the deployment scale of the native OpenStack architecture by 20 times.

设计领域高效融合并行算法，解决了特定融合计算领域应用中的计算精度与效率平衡困难。在地球动力学模拟领域，实现了 5 亿年跨度的印度 - 欧亚碰撞带几何形态模拟；在智慧城市方面实现大规模多尺度应急场景的精准策略制定和快速响应。

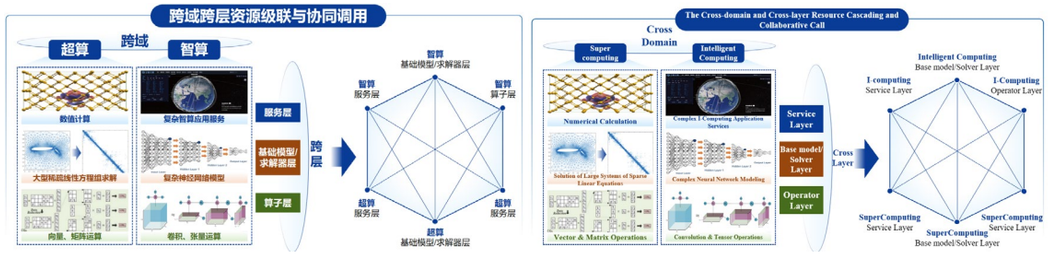
To solve the difficulty of balancing precision and efficiency, we design efficient fusion parallel algorithms in the application of specific areas. In the field of geodynamic simulation, we have realized the simulation of the geometry of the Indo-Eurasian collision zone with a span of 500 million years. And for the smart cities, we have realized the precise strategy formulation and rapid response to large-and-multi-scale emergency scenarios.



◉ 针对超算任务时序关系与智算数据空间关系的统一描述模型，从理论上解决了以时间熵为主因的超算和以空间熵为主因的智算间融合难题



◉ Focusing on the universal description model for the temporal task relationship of supercomputing and the data spatial relationship of intelligent computing, we solve the problem of fusion between supercomputing mainly with temporal entropy and intelligent computing mainly with spatial entropy theoretically.



◉ 跨大型稀疏线性方程组求解、向量矩阵运算等超算域与复杂神经网络卷积、张量计算等智算域，及跨基础模型求解器层、算子层和服务层的资源级联与协同调用技术。

◉ Resource cascading and collaborative call techniques across supercomputing domains, e.g. large-scale sparse linear equations solving and vector matrix operations, and intelligent computing domains, e.g. complex neural network convolution and tensor computation, as well as across the base model solver layer, operator layer and service layer.

大幅提升超算与智算在行业领域的应用水平

Significantly Improve the Application Level of Supercomputing and Intelligent Computing in the Industry Fields

项目成果大幅提升超算与智算在重大工程和行业领域的服务能力和应用水平，近 3 年实现经济效益 86.3 亿。

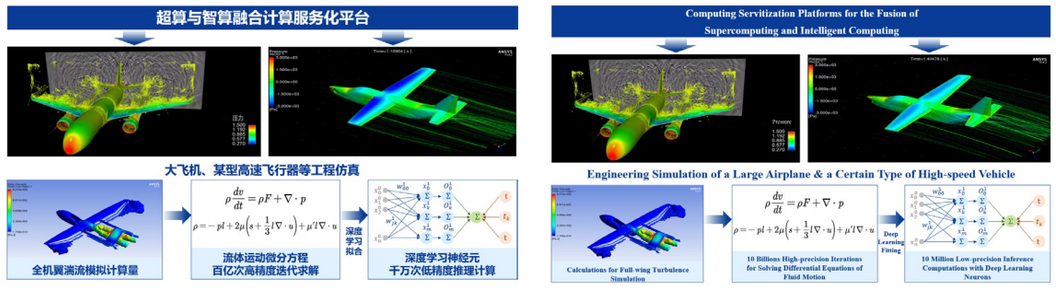
The results of our project have significantly enhanced the service capacity and application level of supercomputing and intelligent computing in major engineering projects and industrial fields, and realized economic benefits of 8.63 billion yuan in the past three years.

在经济效益方面，项目技术应用于互联网头部企业、研究院所等，产生经济效益 86.3 亿元。

In terms of economic benefits, the technology of our project is applied to Internet head enterprises, research institutes, etc., generating economic benefits of 8.63 billion yuan.

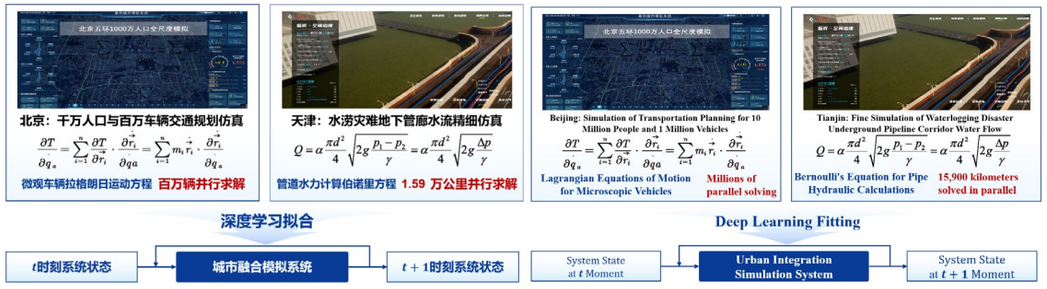
在社会效益及生态环境效益方面：项目成果应用于天津、长沙等九大国家超算中心，推动了超算和智算的计算技术进步和算力建设。支撑了材料计算、石油地震勘探等典型超算与智算融合计算应用。应用于地球科学、抗疫防灾等领域，推动了社会发展。在地球科学领域，实现了 5 亿年跨度的印度 - 欧亚碰撞带几何形态与青藏高原生长方式动力学模拟，模拟精度由 8km^3 细化到 0.125km^3，运行时间缩短 14.3 倍。项目成果支撑国家超级计算中心、智慧城市数据中心异构超算智算融合计算资源池，产生了巨大的生态环境效益。

In terms of social and ecological benefits, results of our project are applied to 9 national supercomputing centers in Tianjin, Changsha, etc., which promote the progress of computing technology and construction of computing power for both supercomputing and intelligent computing. It has supported typical applications of the fusion of supercomputing and intelligent computing, e.g. material computation and petroleum and seismic exploration. It also has been applied in the fields of geoscience, anti-epidemic and disaster prevention, etc., and has promoted social development. In the field of earth science, the simulation of the geometry of the India-Eurasia collision zone with a span of 500 million years and growth mode dynamics simulation of the Tibetan Plateau has been realized, and the simulation accuracy has been refined from 8 km^3 to 0.125 km^3, and the running time has been shortened by 14.3 times. The results of project support the National Supercomputing Centers and Smart City Data Centers to construct heterogeneous computing resource pool under the fusion of supercomputing and intelligent computing, which has produced great ecological and environmental benefits.



◉ 中国空气动力研究与发展中心大飞机工程仿真，100 亿网格三维全机翼湍流模拟计算时间由 106 天缩短至 21.3 小时。

◉ In China Aerodynamic Research and Development Center large aircraft engineering simulation, calculation time of 10 billion grid 3D full wing turbulence simulation has been shortened from 106 days to 21.3 hours.



◉ 超算与智算融合的特大城市仿真计算中实现了分钟级的城市动力学数字孪生和秒级的灾难响应能力。

◉ By fusion of supercomputing and intelligent computing, minute-level digital twinning of urban dynamics and second-level disaster response capabilities are realized in megacity simulation computation.

项目成果被九位院士认可，支撑了智慧城市等智能计算的应用深化，提升了数字社会的发展水平

The Achievements Have Been Recognized by Nine Academicians, Supporting the Deepening of Intelligent Computing Applications Including Smart Cities and Enhancing the Development Level of the Digital Society

项目成果被九位院士在中国各项成果鉴定会上认可，同时国际同行也给予项目成果积极认可。

The results of our project were recognized by 9 academicians at various China review conferences, while international counterparts also gave positive recognition to our project results.

项目成果在中国人工智能学会组织的“高效能数据并行处理与智能分析系统”和“基于异构计算加速的医学超声影像 AI 判读技术及应用”等科技成果鉴定会中，分别以张尧学院士、何友院士等专家组成的鉴定委员会认为：项目成果整体技术达到国际先进水平。其中面向数据时空非均匀性的调度及图迭代算法的分布式并行优化方法达到国际领先水平，胎儿质控医学超声影像深度学习模型和并行算法达到国际先进水平。

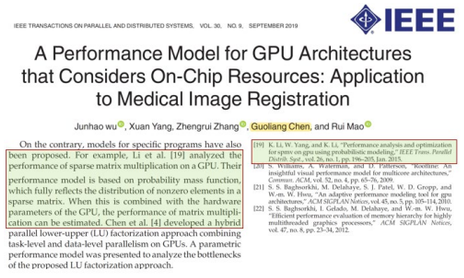
In the Technology Achievement Appraisal Meetings organized by Chinese Association for Artificial Intelligence, named “High-performance Data Parallel Processing and Intelligent Analysis System” and “Heterogeneous Computing Acceleration-Based Medical Ultrasound Imaging AI Interpretation Technology and Application”, the experts (led by Academician Yaoxue Zhang and Academician You He respectively) in the Appraisal Committee concluded that the overall technology of our project results has reached the international advanced level. In detail, the distributed parallel optimization approach for scheduling and graph iteration algorithms for data spatio-temporal non-uniformity has reached the international leading level, and the deep learning model and parallel algorithm of fetal quality control medical sonography has reached the international advanced level.

国际同行给予项目成果的认可：中国科学院院士陈国良教授团队在 IEEE TPDS 论文中肯定了项目提出的概率模型能很好地揭示稀疏矩阵中非零元素的分布；IEEE Fellow、纽约州立大学石溪分校 Yuanyuan Yang 教授团队在 IEEE TCC 论文中肯定了基于非合作博弈的计算卸载方法的作用。

International peers have given recognition to our project results. Prof. Chen’s team, academician of Chinese Academy of Sciences, affirmed that the probability model proposed by our project can well reveal the distribution of non-zero elements in sparse matrices in the paper published in IEEE TPDS. IEEE Fellow Prof. Yang’s team of the State University of New York at Stony Brook, affirmed the role of the computational offloading methods based on non-cooperative games in the paper published in IEEE TCC.

◉ 张尧学院士、何友院士等专家评价项目成果整体技术达到国际先进水平。

◉ Academician Yaoxue Zhang, Academician You He and other experts considered that the overall technology level of our project results has reached the international advanced level.

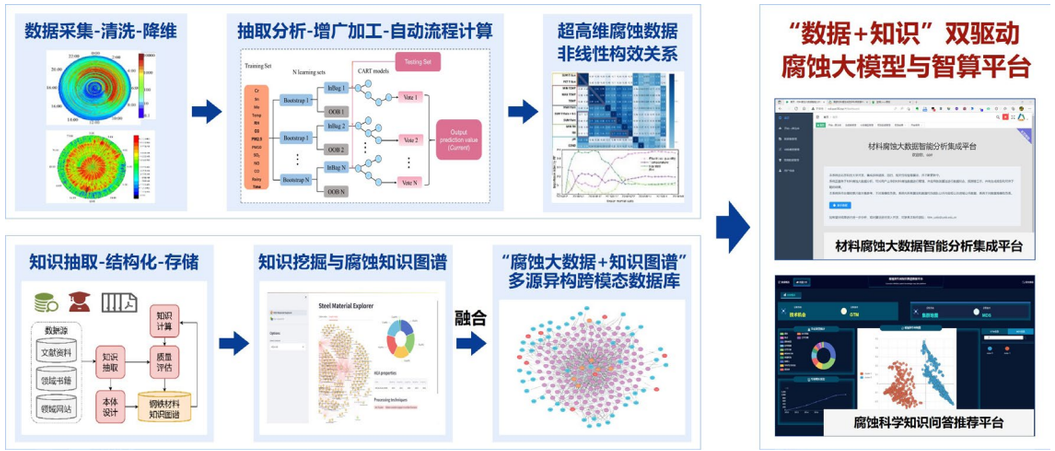


◉ 陈国良院士在 IEEE TPDS 论文指出项目提出的概率模型能很好揭示稀疏矩阵中非零元素的分布，对矩阵乘法的性能进行了准确预测

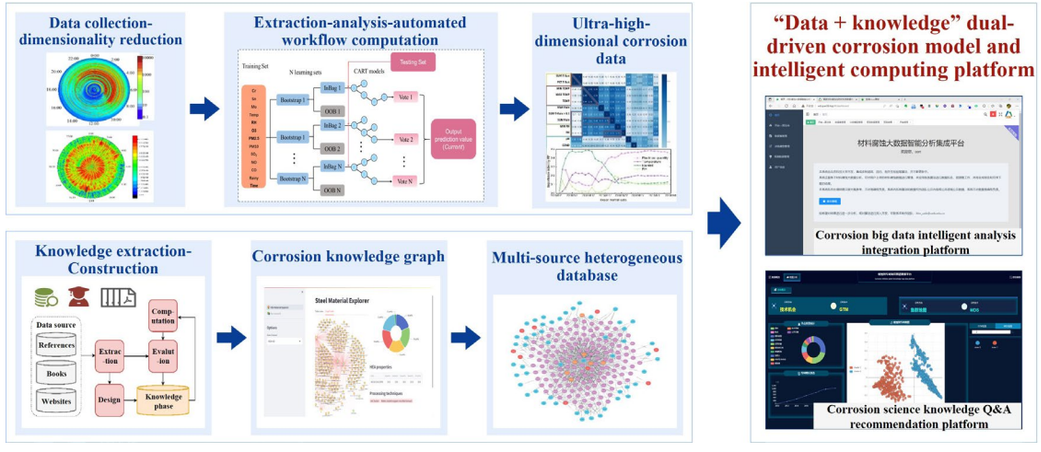
◉ Academician Guoliang Chen pointed out that the probability model proposed by our project can well reveal the distribution of non-zero elements in sparse matrices and predict the performance of matrix multiplication accurately in the paper published in IEEE TPDS.

钢铁材料耐蚀性控制数智化关键技术与应用

Key Technologies and Applications of Intelligent Control for Corrosion Resistance of Steel Materials



◉ 钢铁材料“数据 + 知识”双驱动腐蚀大模型与智算平台



◉ Data and Knowledge Dual-driven Steels Corrosion Model and Intelligent Computing Platform

北京科技大学
University of Science and Technology Beijing

广州天韵达新材料科技有限公司
Guangzhou Tianyunda Advanced Material Technology Co., Ltd.

引言

利用全球首创的腐蚀大数据理论，将钢铁结构设计、制造、服役、试验和计算产生的“腐蚀大数据流”贯穿钢铁材料生产全过程进行耐蚀性调控，实现了钢铁结构全寿命周期耐蚀性的整体协同调控，开创了耐蚀性全寿命数智化调控的新模式。

Introduction

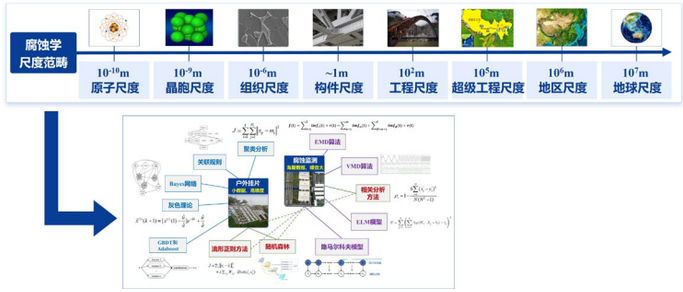
Based on the world's first corrosion big data theory, the "corrosion big data streams" generated by steel structure design, manufacturing, service, testing, and calculation run through the entire process of steels production for corrosion-resistance control, the overall collaborative control of structural steels life-cycle corrosion resistance is realized, which creates a new model of intelligent control of life-cycle corrosion resistance.

材料腐蚀大数据是人工智能与腐蚀科学的成功结合

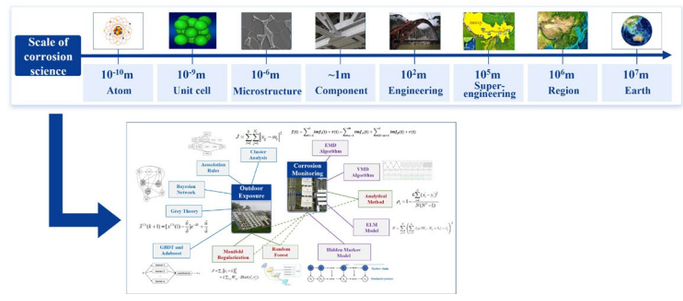
Materials Corrosion Big Data Is a Successful Integration of Artificial Intelligence and Corrosion Science

项目实现了 128 种腐蚀探测器分布于全球 1000 多个地点，年采集腐蚀数据超 10 亿条；构建了数据 - 知识双驱的材料腐蚀模型，建立了 7342 种钢、66849 个元数据实体和 247784 条关系的全球最大的结构钢腐蚀数据库。发明的耐蚀性调控数智化新技术打破了国际传统耐蚀钢的经验试错法；研发的服役结构钢腐蚀数字孪生与智慧化评估系统，实现了 6 种以上极端严酷环境包含高铁、电网、桥梁、新能源等 13 个行业重要装备和设施钢铁材料的多时空全要素腐蚀寿命预测，准确率超 90%。这一理论体系成为材料腐蚀领域为数不多的得到全世界同行公认的由中国学者提出的原创性理论。相关技术应用于全球重大工程和智慧化社会建设中起到“安全眼”的作用，有着巨大的经济价值和市场。

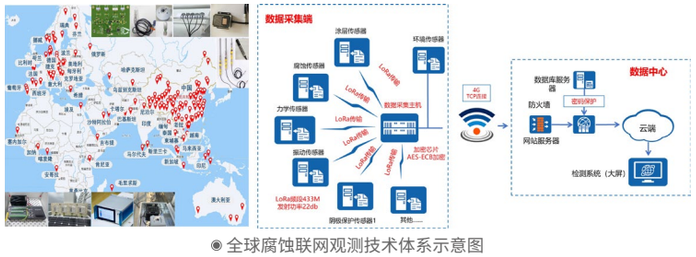
The project has achieved the installation of 128 types of corrosion detectors distributed in more than 1,000 locations worldwide, collecting more than 1 billion corrosion data annually. The project built a data-knowledge dual-driven materials corrosion model and established the world's largest structural steel corrosion database with 7,342 kinds of steel, 66,849 metadata entities, and 247,784 relationships. The digital intelligent design method is transformative compared with the traditional empirical trial-and-error approach of corrosion-resistant steels. Evaluation technologies for structural steels corrosion in extreme environments and digital twin and intelligent evaluation systems for in-service structural steels corrosion have been developed. These innovations enable multi-temporal, full-element corrosion life prediction for critical equipment and facilities made of steels in over 13 industries facing extremely harsh environments, such as high-speed railways, power grids, bridges, pipelines, marine equipment, and new energy, with an accuracy exceeding 90%. This theoretical system has received extensive international citations and positive reviews, becoming one of the few original theories with worldwide recognition proposed by Chinese scholars. This series of high-tech innovations has been applied to major national projects and the construction of an intelligent society, playing a crucial role akin to a "safety eye" with immense economic value and market potential.



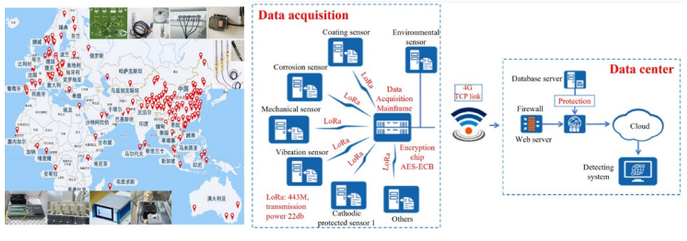
◉ 建立了钢铁材料从原子到工程尺寸的跨尺度腐蚀大模型



◉ A Cross-scale Corrosion Model of Steels from Atomic to Engineering Size



◉ 全球腐蚀联网观测技术体系示意图



◉ Diagram of Global Corrosion Network Observation Technology System

联合研制的耐蚀钢产品全球市场占有率第一

Jointly Developed Corrosion-resistant Steel Products with Leading Positions in the Global Market Share

项目成果广泛应用于海洋工程、石油、交通运输、航空航天、核电、新能源和电网等极端严酷环境中，解决了极端严酷环境下无材可用的难题，是驱动装备设施高质量发展的标志性成果。发表 SCI 论文 128 篇，引用 13893 次，先后 4 次获得美国和欧洲行业协会专题报道，多项技术被国际腐蚀领域同行公认为首创。2016 年获国际腐蚀工程师协会最高技术贡献奖。发明的系列腐蚀大数据技术产品，已推广至捷克、荷兰、比利时、泰国、新加坡等 20 个国家。团队与中国首钢、鞍钢、南钢、新兴铸管等大型钢企共同研制高性能耐蚀钢新品种，产量超 3800 万吨，总收入 759.98 亿元。颠覆性技术彻底突破了极端环境设施装备寿命短甚至无材可用的“服役禁区”，为全球高品质耐蚀钢制造、高质量发展做出了重要贡献，具有重大的社会和经济效益。

The project achievements are widely used in extremely harsh environments such as marine engineering, petroleum, transportation, aerospace, nuclear power, new energy, and power grids, solving the materials design and selection problem for extremely harsh environments, which is a breakthrough achievement to drive the high-quality development of China's equipment and facilities. The research team has published 128 SCI papers, with 13,893 citations, and has been reported four times by the United States and European industry associations. A number of technologies are recognized as the "first" by peers in the international corrosion field. In 2016, the project leader won the W. R. Whitney Award from the National Association of Corrosion Engineers (NACE International). The series of corrosion technology products combined with big data have been promoted to 20 countries such as the Czech Republic, the Netherlands, Belgium, Thailand, Singapore, etc. The team jointly developed new varieties of high-performance corrosion-resistant steels with large steel enterprises such as Shougang Group, Ansteel Group, Nanjing Iron and Steel Group, and Xinxing Pipes, with an output of more than 38 million tons and a total revenue of 75.998 billion yuan. The disruptive technology has completely broken through the "restricted area for materials service" of extreme environment facilities and equipment with short lifespans or even no material available. It has made significant contributions to the global high-quality corrosion-resistant steel manufacturing and high-quality development, with remarkable social and economic benefits.

◉ 技术推广全球 65 个重点工程，用量超 3800 万吨，产品全球市场占有率第一

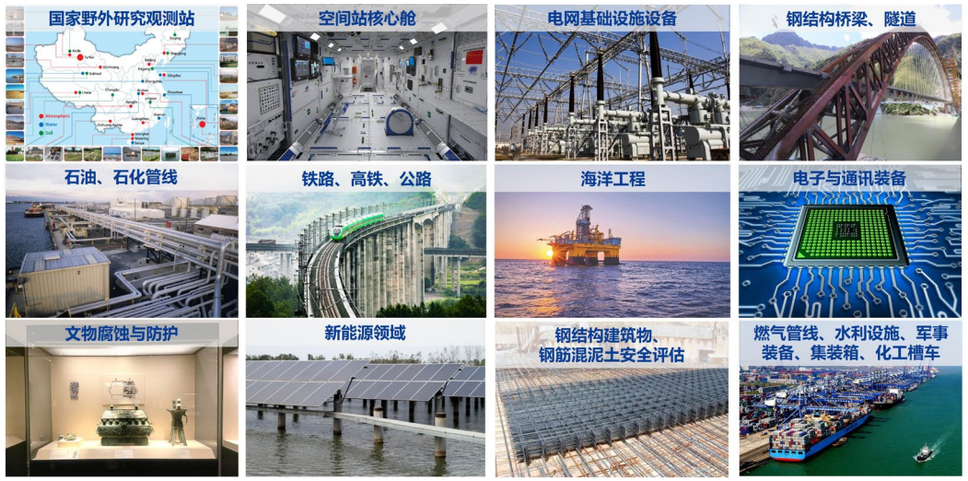
◉ The technology has been promoted to 65 key global projects, with a consumption of more than 38 million tons and the first global market share

建立的全新数智模式实现了耐蚀结构钢品质跨越式发展

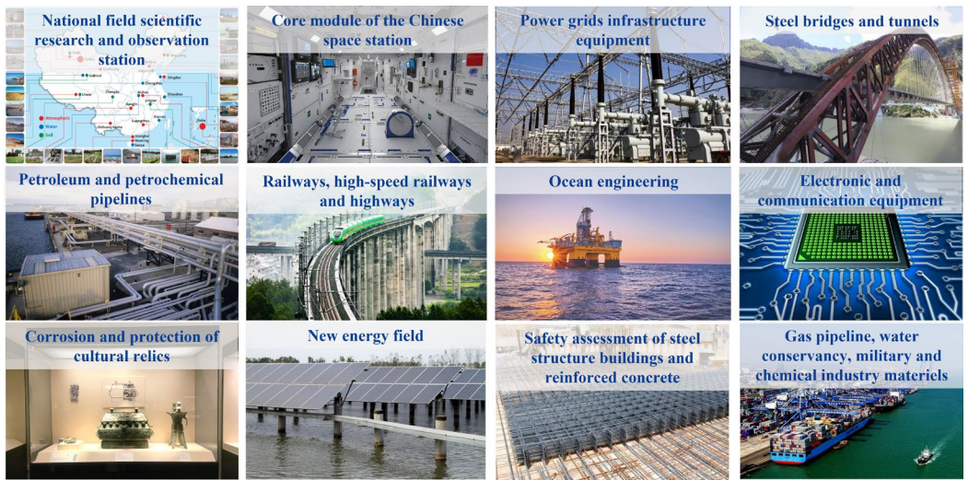
The Newly Established Digital Intelligent Model Achieves Breakthrough Development in Corrosion-Resistant Structural Steel Quality

首先，项目提出的原创理论带来了颠覆性技术，突破了极端环境结构钢“服役禁区”。依据本技术建立的全新数智模式，实现了全球耐蚀结构钢品质跨越式发展。其次，项目大大提升了全球材料产业中第一大类重要传统钢铁材料的综合性能，有力提升了全球重大装备和基础设施制造水平，为绿色节能经济发展做出了重要贡献，例如，通过本项目实施，中国的首钢、南钢和鞍钢成为全球高品质耐蚀钢主要生产基地，为世界钢铁工业转型、提升经济效益提供了有效途径。再者，面对轨道交通、公路桥梁全球化的重大战略需求和“一带一路”沿线国家复杂严苛的服役环境，以马尔代夫中马友谊大桥防腐蚀工程为标志，表明钢铁行业已经具备为世界最严酷自然环境的重大工程提供高品质耐蚀钢的能力。

First of all, the original theory proposed by the project brings revolutionized technologies, breaking through the "restricted area for materials service" of structural steel in extreme environments. Based on the new digital intelligent model established by this technology, the quality of corrosion-resistant structural steel has achieved leapfrog development. Second, the project has significantly enhanced the performance of the traditional steel materials in the global materials industry, substantially upgrading the manufacturing level of the world's major equipment and infrastructure and contributing significantly to the development of a green and energy-saving economy. For example, through the implementation of this project, China's Shougang Group, Nanjing Iron & Steel Group, and Ansteel Group have become the main production bases for high-quality corrosion-resistant steels in the world, providing an effective path for accelerating the transformation and enhancing the economic benefits of the world's steel industry. In addition, facing the significant strategic need for rail and road transportation abroad and the complex harsh service environments along the Belt and Road countries, the anti-corrosion project of the China–Maldives Friendship Bridge signifies that the steel industry has the capability to supply high-quality corrosion-resistant steels for major projects in the world's harshest natural environments.



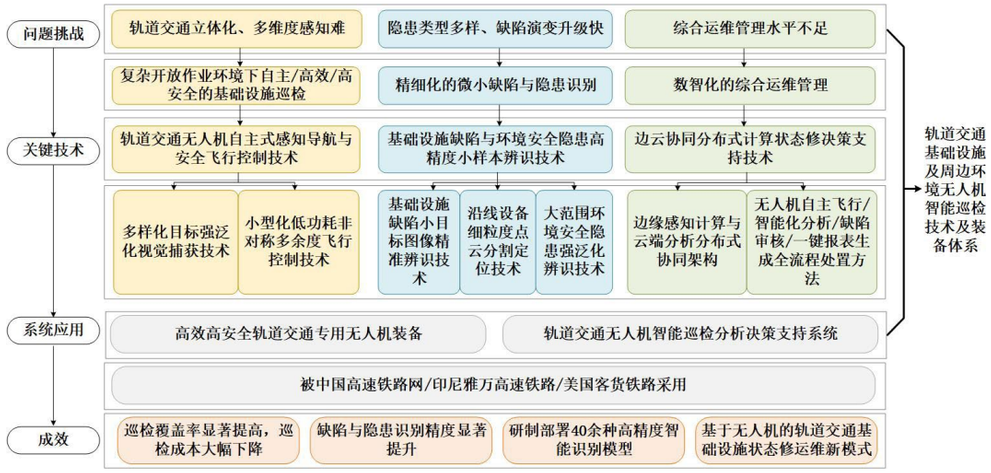
◉ 成功应用于高铁、风电、电网、管道、桥隧等 13 个行业重大工程



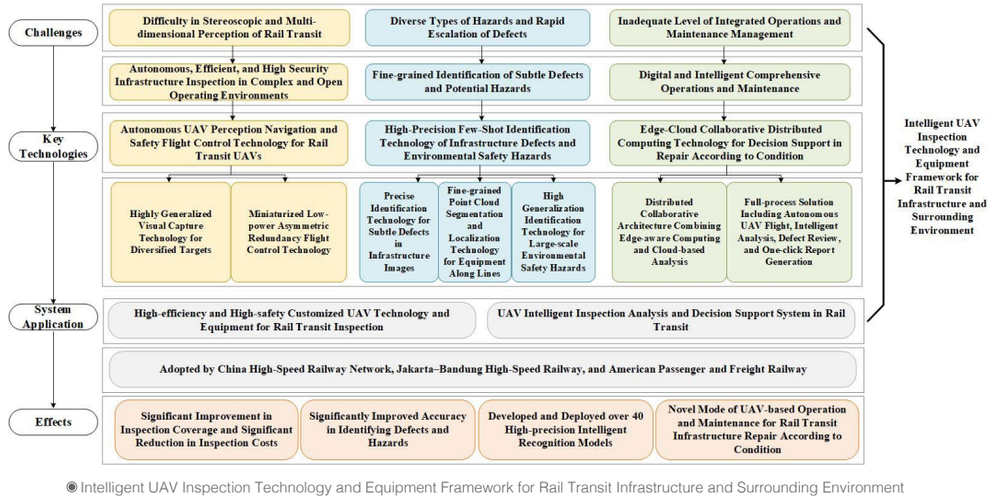
◉ The project has been successfully applied to 13 major projects in the industry, such as high-speed railways, wind power, power grids, pipelines, bridges and tunnels, etc.

轨道交通全自主无人机智能巡检技术及应用

Intelligent Autonomous UAV Inspection Technology and Applications for Rail Transit



◉ 轨道交通基础设施及周边环境无人机智能巡检技术及装备体系框架



◉ Intelligent UAV Inspection Technology and Equipment Framework for Rail Transit Infrastructure and Surrounding Environment

北京交通大学
Beijing Jiaotong University

南卡罗来纳大学
University of South Carolina

京沪高速铁路股份有限公司
Beijing-Shanghai High Speed Railway Co., Ltd.

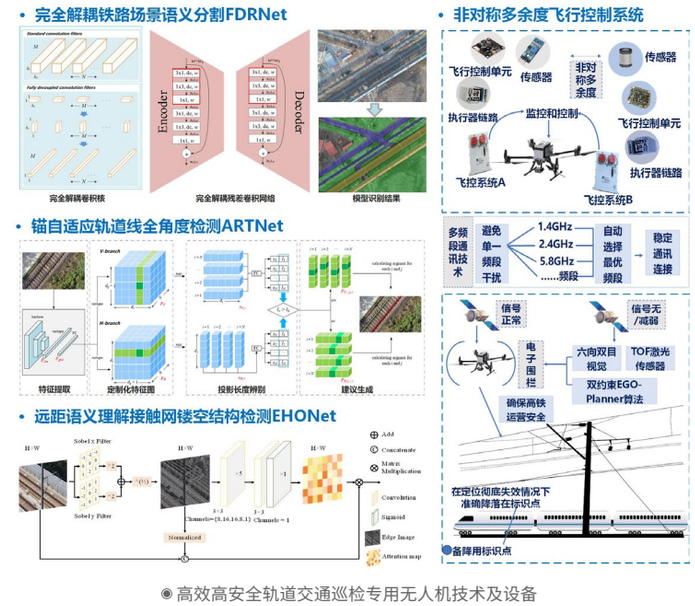
中国铁路设计集团有限公司
China Railway Design Corporation

引言

项目突破了轨道交通基础设施高效高安全无人机多专业综合巡检、高精准微小缺陷与潜在隐患识别、数智化状态修运维决策支持等关键技术，形成了轨道交通基础设施及环境安全状态无人机自主巡检与智能分析技术装备体系。

Introduction

The project has made breakthroughs in key technologies, including efficient and highly secure multi-disciplinary UAV inspections for rail transit infrastructure, high-precision detection of subtle defects and potential hazards, and digital-intelligent decision support for repair according to condition. It has developed an integrated system of autonomous UAV inspection and intelligent analysis technology and equipment for monitoring the safety status of rail transit infrastructure and its environment.



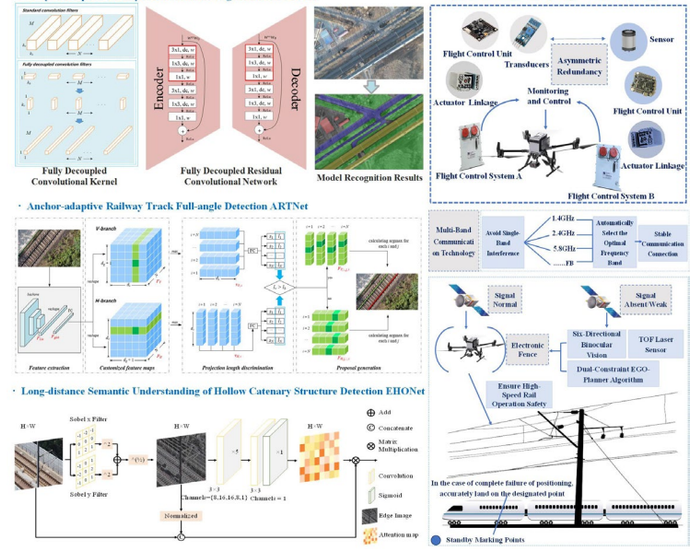
◉ 高效高安全轨道交通巡检专用无人机技术及设备

轨道交通无人机自主导航控制、缺陷识别及边云协同决策

Autonomous Navigation Control, Defect Detection, and Edge-Cloud Collaborative Decision Support for UAV in Rail Transit

针对复杂开放作业环境下的轨道交通无人机自主、高效、高安全的导航飞行难题，项目发明了多样化目标强泛化视觉捕获技术、小型化低功耗非对称多余度飞行控制技术，研发了高效高安全轨道交通巡检专用无人机装备。

To tackle the difficulties of autonomous, efficient, and highly secure navigation and flight of UAV in complex and open operational environments for rail transit, the project has developed a highly generalized visual capture technology for diversified targets, a miniaturized low-power asymmetric redundancy flight control technology, and has developed customized UAV equipment for efficient and secure rail transit inspections.

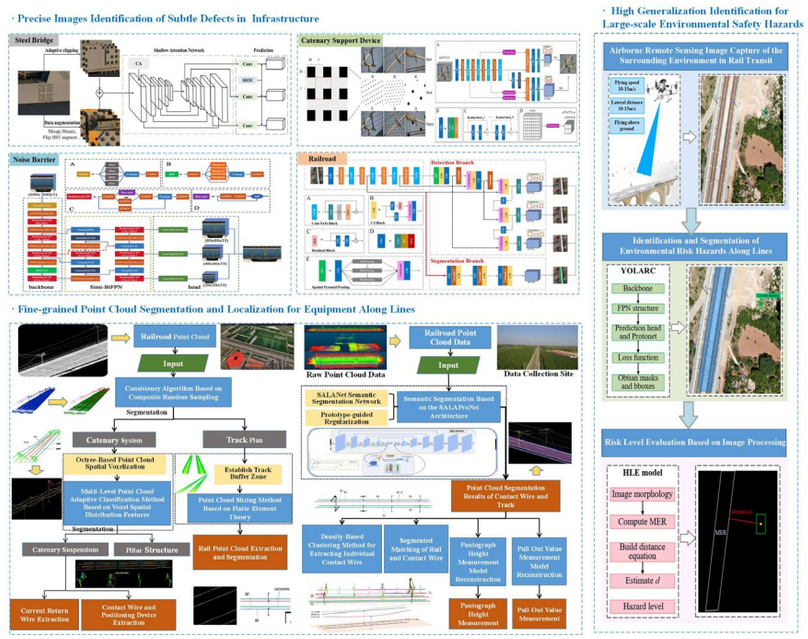


◉ High-efficiency and High-safety Customized UAV Technology and Equipment for Rail Transit Inspection

针对精细化微小缺陷与隐患识别难题，项目发明了基础设施缺陷小目标图像精准辨识技术、沿线设备细粒度点云分割定位技术、大范围环境安全隐患强泛化辨识技术，研制部署 40 余种高精度智能识别模型。

To tackle the difficulties of identifying subtle defects and potential hazards, the project has developed precise identification technology for subtle defects in infrastructure images, fine-grained point cloud segmentation and localization technology for equipment along lines, and high generalization identification technology for large-scale environmental safety hazards. Additionally, over 40 high-precision intelligent recognition models have been developed and deployed.

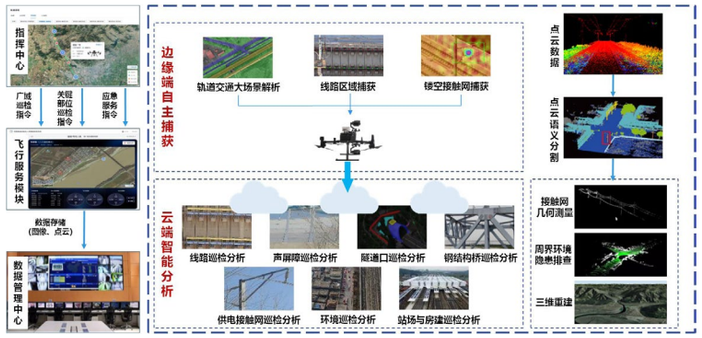
◉ 轨道交通基础设施缺陷及环境安全隐患精准辨识模型与技术



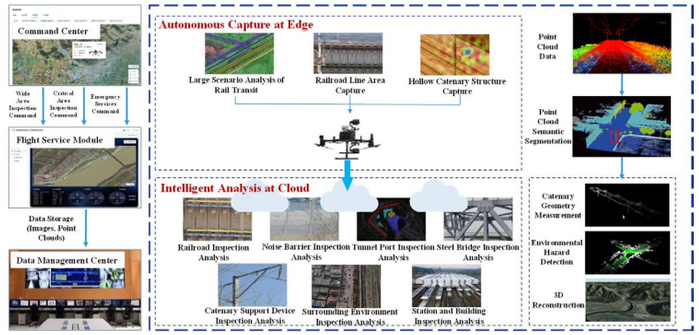
◉ High-precision Models and Technology for Identifying Rail Transit Infrastructure Defects and Environmental Safety Hazards

针对数智化综合运维难题，项目提出了边缘感知计算与云端分析分布式协同架构，构造了包括无人机自主飞行、智能化分析、缺陷审核、一键报表生成等全流程处置方法，形成了基于无人机的轨道交通基础设施状态修运维新模式。

To tackle the difficulties of digital and intelligent comprehensive operations and maintenance, the project has proposed a distributed collaborative architecture combining edge-aware computing and cloud-based analysis. It has developed a full-process solution including autonomous UAV flight, intelligent analysis, defect review, and one-click report generation, which forms a novel mode of UAV-based operation and maintenance for rail transit infrastructure repair according to condition.



◉ 轨道交通无人机智能巡检分析决策支持系统架构



◉ UAV Intelligent Inspection Analysis and Decision Support System Architecture in Rail Transit

轨道交通全自主无人机智能巡检技术引领全球应用

Intelligent Autonomous UAV Inspection Technology of Rail Transit Leads the Worldwide Application

项目成果在近三年来在铁路运营现场应用已产生了年均 2000 万元的直接经济效益；比常规人工巡检效率高 10 倍，每年平均节约 4000 余人次，节约人力成本 2800 余万元；累计减少高铁供电设备停电次数 32.7 次，减少设备停电时长 915.6 分钟，节省人力成本 1300 余万元，减少影响旅客运行列车 730 余辆。项目成果已广泛应用于中国京沪高铁、印尼雅万高铁、美国国家铁路客运公司 Amtrak（宾夕法尼亚州费城附近）等，同时为弗罗里达东海岸铁路、铁路资产管理公司 VisioStack 提供技术支撑与服务，正持续扩大应用规模并推广至重载铁路、市域铁路、城市轨道交通乃至高速公路等其他交通方式。通过该成果在轨道交通工程的勘探、建设与运维全周期中展现出的卓越应用价值，创新性的建立了天地一体化的轨道交通主动安全保障模式，形成了基于空基的轨道交通关键基础设施状态修运维新制式。

In terms of economic and social benefits, the Autonomous UAV intelligent inspection system for rail transit is 10 times more efficient than conventional manual inspections, resulting in an annual direct economic benefit of 20 million yuan over the past three years in railroad operations. It has also saved an average of over 4,000 laborers annually, reducing labor costs by more than 28 million yuan each year. Additionally, the research results have led to a cumulative reduction of 32.7 power outages for high-speed rail power supply equipment and shortened equipment downtime by 915.6 minutes. This has saved over 13 million yuan in labor costs for power maintenance and reduced the impact on more than 730 passenger trains. In terms of practical application, the results have been widely adopted by China's Beijing-Shanghai High Speed Railway, Indonesia's Jakarta-Bandung High Speed Railway, and Amtrak near Philadelphia, Pennsylvania, USA. Meanwhile, we have provided technical support and services to Florida East Coast Railway and VisioStack, a railway asset management company. The application scope is continuously expanding and is being promoted for use in heavy-haul railways, urban railways, suburban railway systems, and even expressways. Overall, the research has innovatively established an integrated space-ground active safety assurance mode for rail transit, creating a new air-based system for repair according to condition of critical rail infrastructure. It has demonstrated exceptional value throughout the entire lifecycle of rail transit projects, from exploration and construction to operations and maintenance.

中国高速铁路 | 中国市域铁路 | 印尼雅万高铁 | 美国客货铁路

◉轨道交通无人机智能巡检，打造全球轨道交通安全运维新高度。

China Railway Highspeed | China Suburban Railway | Jakarta–Bandung High-Speed Railway | American Passenger and Freight Railway

◉Intelligent UAV inspection for rail transit is setting a new global standard for safety and operations management in the rail industry.

国际产学研用融合助推轨道交通全自主无人机智能巡检发展

International Integration of Industry-academla-research-application Efforts is Accelerating the Development of Intelligent Autonomous UAV Inspection in Rail Transit

项目出版专著 1 部，发表 24 篇 SCI 论文（含 16 篇 Top 期刊），申请授权 5 项美国发明专利，授权 24 项中国发明专利，编制企业标准 2 项，获得国际学术界高度评价，引领了轨道交通无人机巡检技术的学术前沿。成果荣获 2 项国际发明金奖荣誉及 12 项行业内荣誉，展现了其在轨道交通智能巡检领域的卓越技术创新。已累计采集超 200 万张无人机巡检图像，构建了首套最大规模的轨道交通巡检领域无人机遥感图像数据集，为行业新装备研制提供了坚实基础。此外，作为大疆官方铁路行业唯一生态伙伴，轨道交通智能巡检系统方案成功入选大疆行业生态方案目录，进一步推动了产业合作与升级。项目成果荣获中国科技创新成就展重点展项殊荣，受到 China Daily、中国中央电视台等权威媒体关注报道，彰显其行业影响力。项目成果触发了无人机在轨道交通勘探设计、工程建设、运营管理与应急救援等广泛应用场景，初步构建了包括铁路专用无人机、机巢、集成载荷、飞行管理、人工智能模型、大数据云计算中心等上下游产业链，将为近万亿级低空经济发展增加动能。

In terms of intellectual property, the research team has published one monograph, authored 24 SCI papers (including 16 in top journals), applied for 5 U.S. invention patents, and authorized 24 Chinese invention patents, as well as developed 2 corporate standards. The research results have been highly praised by the international academic community, positioning the team at the forefront of UAV inspection technology of rail transit. In terms of honors and awards, the results have won 2 international invention gold awards and 12 industry honors, showcasing exceptional technological innovation in the field of intelligent inspection for rail transit. In terms of industry contribution, over 2 million UAV inspection images have been collected, forming the largest remote sensing image dataset in the rail transit inspection field. This provides a solid foundation for the development of new equipment in the industry. Additionally, in terms of industry impact, the research team, as DJI's sole official partner in the railway sector, developed an intelligent rail transit inspection system that has been successfully included in DJI's industry solutions catalog, further driving industrial collaboration and advancement. Also, the project's achievements were featured as a key exhibit at China Science and Technology Innovation Achievement Exhibition and received attention from prominent media outlets like China Daily and China Central Television, highlighting its influence within the industry. Overall, the project's results have initiated a wide range of UAV applications in rail transit, including exploration and design, engineering construction, operations management, and emergency response. It has laid the foundation for an upstream and downstream industrial chain, including customized railroad UAV, airports of UAV, integrated payloads, flight management systems, AI models, and big data cloud computing centers, providing new momentum for the development of the trillion-level low-altitude economy.

◉国际产学研用融合，加速轨道交通无人机产业成熟与发展。

◉International integration of industry, academia, research, and application is accelerating the maturity and development of the rail transit UAV industry.

太赫兹超构芯片技术及系统应用

Terahertz Hyper-Structured Chip Technology and System Applications

◉ 本团队研发的多款太赫兹超构芯片，器件及系统矩阵

◉ The Terahertz Hyper-structured Chips, Devices, and Diverse Systems Developed by Our Team

电子科技大学
University of Electronic Science and Technology of China

东南大学
Southeast University

中国电子科技集团公司第 13 研究所
The 13th Research Institute of China Electronics Technology Group Corporation

引言

为推动太赫兹技术在 6G 场景中的应用落地，本团队开发了太赫兹超构芯片、射频器件和高速无线通信系统，为成都电视台等企业提供关键器件、系统及超高清视频无线传输解决方案，验证太赫兹技术在多场景下应用的能力。

Introduction

In order to promote the application of terahertz technology in 6G scenarios, our team has developed terahertz hyper-structured chips, RF devices and high-speed wireless communication systems. We have provided key devices, systems, and ultra-high-definition video wireless transmission solutions to enterprises such as Chengdu Television Station, verifying the capability of terahertz technology in various application scenarios.

从底层二极管芯片到顶层多维复用系统的突破

Achieving a Comprehensive Technological Breakthrough from Bottom-up Diode Chip Innovation to Top-level Multi-dimensional

建立了截止频率 12.5THz，功率容量 1.5W 的多管芯功率增强的太赫兹高精度二极管模型，结合场分析与路分析方法，解决传统二极管与太赫兹波相互作用弱、功率容量低的问题，使通信系统“传得更远”。

A high-precision terahertz diode model with multi-core power enhancement has been developed, featuring a cutoff frequency of 12.5 THz and a power capacity of 1.5W. By combining field analysis and circuit analysis methods, this model addresses the issues of weak interaction between traditional diodes and terahertz waves, as well as low power capacity. As a result, it enables communication systems to “transmit over longer distances.”

攻克了基于人工表面等离激元的数字调制技术，将数字编码超构材料的概念延伸至表面波调控，解决数字域与模拟域结合不紧密的问题，使通信系统“延时更低”。

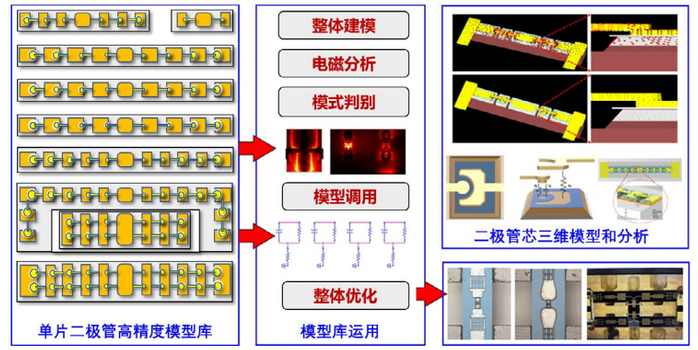
We have successfully developed digital modulation technology based on artificial surface plasmons, extending the concept of digitally-coded Meta-surfaces to surface wave manipulation. This breakthrough addresses the issue of insufficient integration between digital and analog domains, enabling communication systems to achieve “lower latency.”

研制了双层近场耦合增强的太赫兹高性能射频器件，通过多路数字编码与电磁谐振的非线性耦合，将变频损耗降低到 -9.3dB，调制速率提高到 175Gbps，使通信系统“传得更快”。

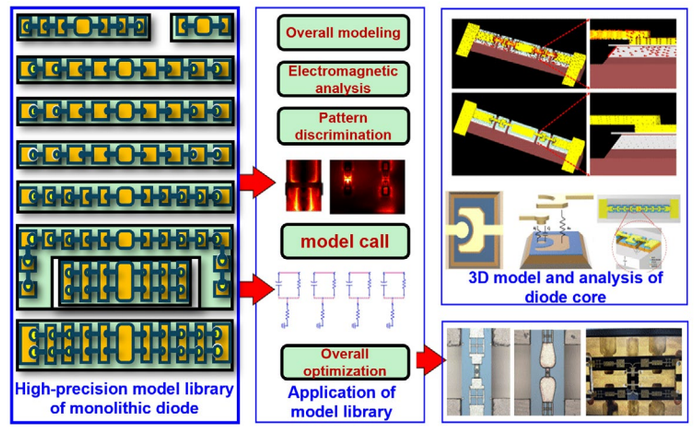
A high-performance terahertz RF device with dual-layer near-field coupling enhancement has been developed. Through multi-channel digital coding and nonlinear coupling of electromagnetic resonance, the frequency conversion loss has been reduced to -9.3 dB, while the modulation rate has been increased to 175 Gbps. This advancement allows communication systems to “transmit faster.”

提出太赫兹多维复用架构，结合极化与频分复用技术，提升射频通道数量 4 倍，解决频谱资源利用不足的问题，使通信系统“效率更高”。

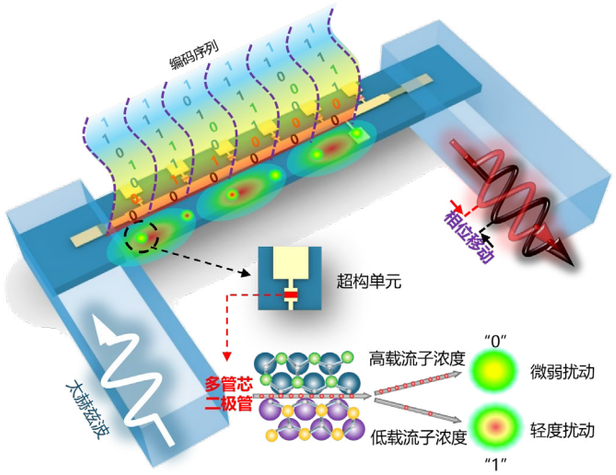
A multi-dimensional multiplexing architecture for terahertz communications has been proposed. By combining polarization and frequency division multiplexing technologies, the number of RF channels has been increased fourfold. This innovation addresses the problem of underutilized spectrum resources, making communication systems “more efficient.”



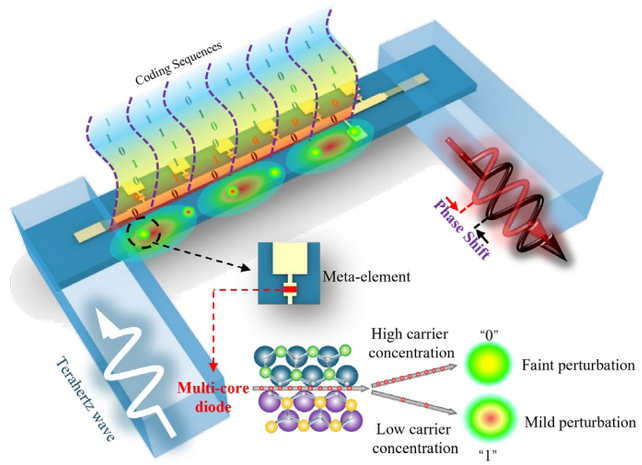
◉ 建立的太赫兹高精度二极管模型库



◉ Terahertz High-precision Diode Model Library



◉ 多路数字编码结合电磁谐振的太赫兹高性能射频器件



◉ Terahertz High-performance RF Device Combining Multi-channel Digital Encoding and Electromagnetic Resonance

本成果已在大运会进行超高清赛事转播示范

The System Has Been Used for Ultra-hIgh-definitIon Event Broadcasting at the UnIverslade

在创新研究方面，围绕太赫兹芯片，器件和系统，总共发表 SCI 论文 200 余篇，其中 38 篇为 TOP 论文，授权专利 30 余项，出版著作 3 部，获得太赫兹方向中国省部级奖项 3 项。

In terms of innovative research, we have published more than 200 SCI papers on terahertz chips, devices, and systems, including 38 TOP papers, over 30 authorized patents, 3 software copyrights obtained, and 3 provincial and ministerial level awards in the terahertz field in China.

在应用示范方面，研制出三款用于无压缩 4K 及 8K 赛事无线转播的太赫兹通信系统，转播距离最远 1.5km，重量最轻 3kg，已在成都大运会双流体育场进行应用示范。

In terms of application demonstration, we have developed three terahertz communication systems for wireless broadcasting of uncompressed 4K and 8K events, with a maximum distance of 1.5km and a minimum weight of 3kg. These systems have been applied and demonstrated at the Shuang Liu Stadium of the Chengdu Universiade.

在经济效益方面，到 2030 年，全球 6G 通信产业规模将突破万亿。提前布局从芯片，器件到系统的全产业链太赫兹技术，已为中电科思仪、华为等企业提供太赫兹二极管芯片和关键射频器件。

In terms of economic benefits, the global 6G communication industry is expected to exceed one trillion yuan by 2030. We have laid out the entire industry chain of terahertz technology from chips, devices to systems in advance, and have provided terahertz diode chips and key RF devices for enterprises such as CETC, Huawei, etc.

在社会效益方面，支撑了电子科技大学电子科学与技术和通信工程两个 A+ 学科的发展；建立了四川省先进光电集成射频超构芯片技术工程研究中心。

In terms of social benefits, we have supported the development of two A+ disciplines, Electronic Science and Technology and Communication Engineering, at the University of Electronic Science and Technology of China; and established the Sichuan Advanced Optoelectronic Integrated RF Meta-structure Chip Technology Engineering Research Center.

◉ 成都大运会双流体育场赛事转播应用示范

◉ Demonstration of Broadcast Application for Chengdu Universiade Shuang Liu Sports Stadium Events

◉ 建立的四川省先进光电集成射频超构芯片技术工程研究中心

◉ Sichuan Advanced Optoelectronic Integrated RF Meta-structure Chip Technology Engineering Research Center

完善太赫兹工艺线，支撑太赫兹通信系统发展

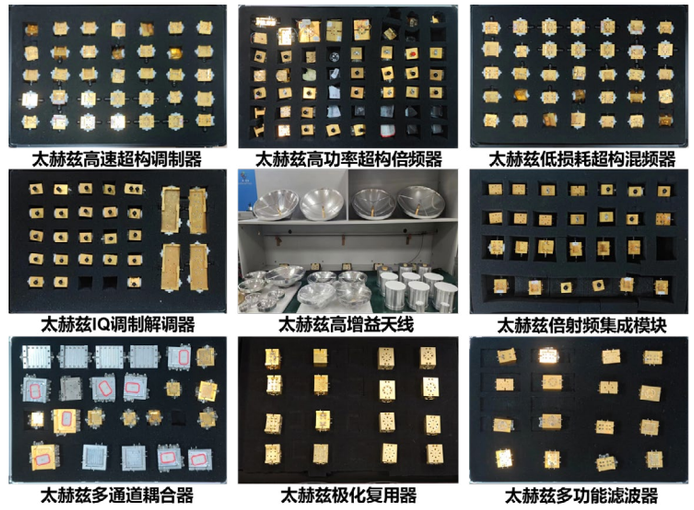
Improve Terahertz Process Lines to Support the Development of Terahertz Communication Systems

在技术进步方面，通过攻克 4 项与太赫兹超构芯片 - 器件 - 系统紧密相关的技术，提高了无线通信的数据传输速率和质量，完善了太赫兹工艺线，推动了全球太赫兹产业的进步。并牵头制定了 1 项 IEC 国际标准：TC 47 半导体器件 47/2476/NP；以及形成了 3 项二极管芯片企业标准。

Significant technological advancements have been made by overcoming four key challenges in terahertz metamaterial chip-device-system integration. These improvements have enhanced wireless communication performance, refined terahertz fabrication processes, and driven global progress in the terahertz industry. Furthermore, we have spearheaded the development of one IEC international standard: TC 47 Semiconductor Devices 47/2476/NP. Additionally, three enterprise standards for diode chips have been formulated.

在产业结构调整、优化、升级方面，突破了集成单片制造工艺，形成太赫兹射频单片整晶圆的中国制造能力。通过太赫兹高速无线通信系统的研制，促进了太赫兹通信、超高清视频传输等产业的发展，对传统产业结构进行了有效的补充。同时，推动了包括高性能材料制造、精密加工和软件开发在内的太赫兹相关产业链的延伸，为产业链的升级提供了新的增长点。

In terms of industrial structure adjustment, optimization, and upgrading, we have broken through the integrated single-chip manufacturing process and formed China's manufacturing capability for terahertz RF single-chip wafers. The development of terahertz high-speed wireless communication systems has promoted the development of industries such as terahertz communication and ultra-high-definition video transmission, effectively supplementing the traditional industrial structure. At the same time, it has promoted the extension of the terahertz related industry chain, including high-performance material manufacturing, precision machining, and software development, providing new growth points for the upgrading of the industry chain.



◉ 基于中国制造工艺线批量生产的太赫兹器件

◉ Terahertz Devices Produced in Bulk Using Chinese Manufacturing Process Lines

立足教育，培养新一代太赫兹领域领军人才

Based on Education, Cultivate a New Generation of Leading Talents in the Terahertz Field

相关成果入选 2023 年度“四川十大技术创新成果”榜单，团队毕业生 1 人入选了 2022 年度中国电子学会优博，1 人入选中国科协青年托举人才计划。还孵化出“第一届全国博士后创新创业大赛”国家级银奖，及中国国际大学生创新大赛（2023）国家级金奖“太视界——太赫兹远距离 8K 视频传输领跑者”。

The relevant achievements have been selected for the “Top Ten Technological Innovation Achievements in Sichuan” list in 2023. One team graduate has been selected for the 2022 China Electronics Society Excellent PhD, and one has been selected for the China Association for Science and Technology Youth Talent Program. It has also incubated the national silver award of the “First National Postdoctoral Innovation and Entrepreneurship Competition” and the national gold award of the China International College Student Innovation Competition (2023) “Tera sight - Terahertz Long Distance 8K Video Transmission Leader”.

IBM 开放式 AI 技术栈 —— 加速商业领域大规模部署负责任的 AI

IBM Open AI Stack —— Accelerating Deployment of Responsible AI for Business at Scale

◉ IBM 开放式 AI 技术栈加速大规模部署负责任的 AI

◉ IBM Open AI Stack Accelerates Deployment of Responsible AI for Business at Scale

国际商业机器（中国）有限公司
IBM

引言

人工智能的大规模部署时代已经到来，人工智能的未来应该是开放的。为此，IBM 推出了一套开源开放的 AI 技术栈，助力企业大规模部署负责任的 AI，将 AI 潜力转化为实际生产力，加速千行百业的可持续高质量发展。

Introduction

The era of large-scale deployment of AI has arrived, and the future of AI should be open. Therefore, IBM launched a series of open-source and open AI stack to help enterprises deploy responsible AI at large scale, turn AI potential into actual productivity, and accelerate sustainable and high-quality development across various industries.

IBM 开放式 AI 技术栈提供可信、可靠、负责任的企业级 AI

IBM Open AI Stack Provides Trust-worthy, Reliable, and Responsible enterprise AI

IBM 秉承开源开放、混合云与 AI 发展战略，与合作伙伴及开源社区共创，推动企业级人工智能技术与方案的负责任发展，加速千行百业实现可持续的数智化转型。IBM 开放式 AI 技术栈从全层级解决企业级 AI 的关键挑战，核心模块包括：

IBM adheres to its open source, hybrid cloud and AI development strategy, co-creating with partners and the open-source community to promote the responsible development of enterprise-grade AI technologies and solutions, accelerating sustainable digital transformation across industries. IBM's open AI technology stack addresses key enterprise AI challenges at all levels, with core modules including:

•Granite 系列开源基础模型，提供可信、安全的 AI 基座；

· Granite series of open-source foundation models: These provide a trustworthy and secure AI foundation.

• 实现大规模对齐的革命性开源技术 InstructLab，通过增量式方法将企业数据有效微调至模型中；

· InstructLab: A revolutionary open-source technology that enables large-scale alignment by effectively fine-tuning enterprise data into models through an incremental approach.

• 人工智能与数据平台 watsonx，涵盖 watsonx.ai、watsonx.data、watsonx.governance，支持全生命周期的 AI 开发和治理；

· Watsonx AI and Data Platform: It include watsonx.ai, watsonx.data, and watsonx.governance, supporting the full lifecycle of AI development and governance.

• 混合云平台 Red Hat Openshift AI，提供企业级 AI 运行环境；

· Red Hat OpenShift AI: A hybrid cloud platform providing an enterprise-grade AI runtime environment.

• 企业级 AI 就绪操作系统 RHEL AI，简化 AI 部署和管理；

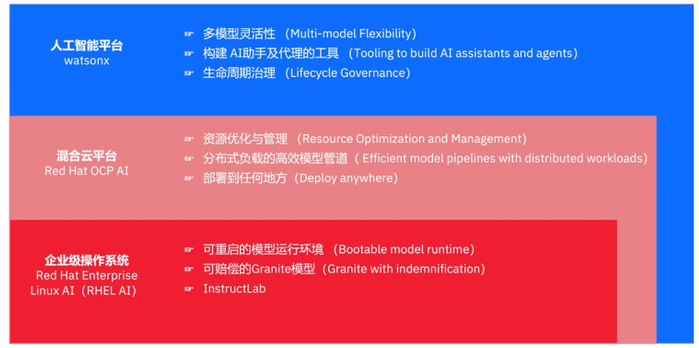
· Red Hat Enterprise Linux AI: An enterprise-grade AI-ready operating system that simplifies AI deployment and management.

• 透明异构的 AI 基础设施，全面兼容企业的混合云环境。

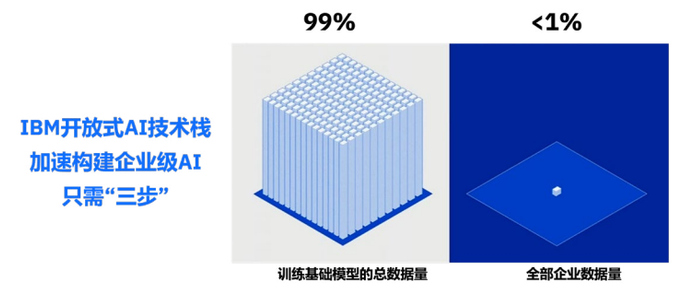
· Transparent Heterogeneous AI Infrastructure: Fully compatible with enterprises' hybrid cloud environments.

此外，IBM 在人工智能领域拥有超过 15,000 件授权国际专利，发表了近 7,000 篇国际论文。

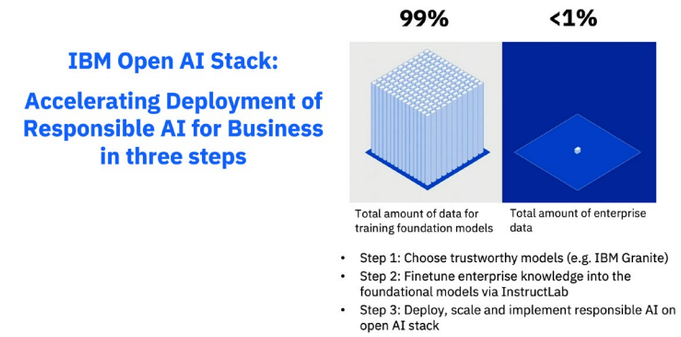
Additionally, IBM holds over 15,000 granted international patents and has published nearly 7,000 international papers in the AI field.



◉ IBM 开放式 AI 技术栈概览 ◉ Overview of IBM Open AI Stack



◉ IBM 开放 AI 技术栈加速构建企业级 AI



◉ IBM Open AI Stack accelerates development of Enterprise-grade AI

IBM 开放式 AI 技术栈加速将 AI 转化为生产力

IBM Open AI Stack Accelerates Turning AI into Real Production

IBM 开放式 AI 技术栈不仅为企业提供了强大的 AI 能力，也为整个社会的数字化转型和智能化升级带来了显著的市场价值与社会效益。

IBM Open AI Stack not only provides enterprises with powerful AI capabilities but also delivers significant market value and social benefits to the broader digital transformation and intelligent upgrading of society.

在经济效益方面，IBM 开放式 AI 技术栈显著降低了企业运营成本。IBM watsonx 平台将数据仓库的成本降低高达 50%，AI 部署周期快 70%，这使得企业能够更快地获得 AI 价值。

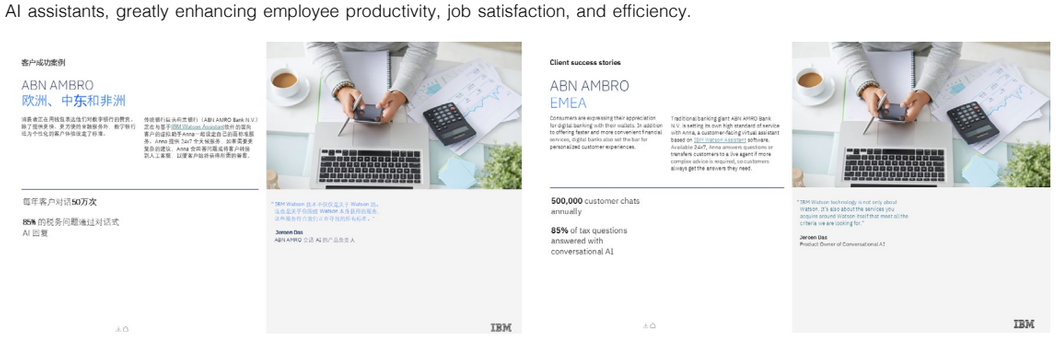
From the economic perspective, IBM Open AI Stack significantly reduces enterprise operational costs. The IBM watsonx platform lowers data warehouse costs by up to 50% and accelerates AI deployment cycles by 70%, enabling companies to realize AI value more quickly.

在社会效益方面，IBM 开放式 AI 技术栈通过 AI 助手自动化业务流程，极大提升了员工的生产力及工作满意度和效率。在 IBM，95% 的人力资源查询需求已由 AI 和自动化技术驱动的 " 数字劳动力 " 解决。

From the social perspective, IBM Open AI Stack automates business processes through AI assistants, greatly enhancing employee productivity, job satisfaction, and efficiency. At IBM, 95% of HR queries are now handled by AI and automation-driven “digital labors”.

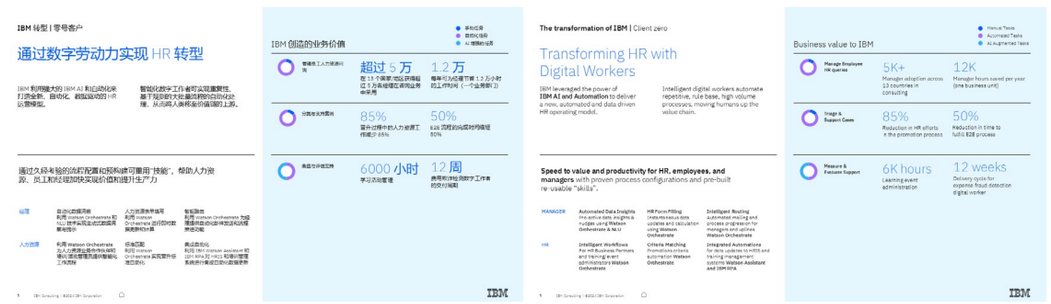
在环境可持续性方面，IBM 环境智能应用套件，帮助企业发现、预警及消除环境带来的运营风险。IBM 通过 AI 驱动的碳排放管理与报告系统帮助企业测量、跟踪和管理碳排放，助力企业实现环境目标，推动绿色可持续发展。

From the environmental sustainability perspective, IBM Environmental Intelligence Suite(EIS) helps enterprises identify, alert, and mitigate environmental risks in their operations. IBM AI-powered carbon management and reporting system enables businesses to measure, track, and manage carbon emissions, supporting them in achieving environmental goals and promoting green, sustainable development.



◉ 荷兰银行采用 IBM AI 解决方案实现智能客服

◉ ABN AMBRO adopts IBM AI Solution to implement Intelligent Customer Care



◉ IBM 作为零号客户通过 AI 实现人力资源智能转型

◉ IBM, as the Client Zero, implements the intelligent transformation for its Human Resources via AI

IBM 积极推动负责任的企业级 AI 的发展与大规模部署

IBM Actively Promotes the Development and Large-scale Deployment of Responsible Enterprise-grade AI

IBM 开放式 AI 技术栈的快速适应性和高度定制化能力，为企业提供了全栈解决方案，满足了不断变化的业务需求。IBM 通过开源开放、与社区共创的方式，为企业从底层操作系统、到混合云平台、再到 AI 与数据平台提供了企业就绪的解决方案，推动了企业级 AI 的大规模部署与行业应用。

The rapid adaptability and high customization capabilities of IBM Open AI stack provide enterprises with a full-stack solution, meeting the ever-changing business demands. Through an open-source, co-creation approach with the community, IBM offers enterprise-ready solutions from the underlying operating system to the hybrid cloud platform, and up to the AI and data platform, driving the large-scale deployment and industry application of enterprise-grade AI.

同时，IBM 的 AI 技术栈还通过提高 AI 应用的透明度和可解释性，增强了公众对 AI 技术的信任，推动了整个社会对 AI 技术接受度的提高。IBM 开源了 18 个 Granite 基础模型以及实现模型大规模对齐的 InstructLab 技术，为企业提供了可信的 AI 底座，并有效通过自己的数据构建及微调模型，加速 AI 落地与实施。

At the same time, IBM Open AI stack enhances public trust in AI by improving the transparency and explainability of AI applications, fostering greater societal acceptance of AI technology. IBM has open-sourced 18 Granite series of foundation models and the InstructLab technology, which enables large-scale model alignment, offering enterprises a trustworthy AI foundation. This allows them to effectively build and fine-tune models with their own data, accelerating the implementation of AI solutions.

另外，IBM 联合 70 多家国际机构，发起了 AI 联盟，致力于 AI 技术的合作创新。IBM 还与中国开源软件推进联盟联合发布《可信赖的企业级生成式 AI 白皮书》，推动负责任 AI 技术的发展和大规模部署，为行业提供了宝贵的指导和参考。

Moreover, IBM has collaborated with over 70 international organizations to launch the AI Alliance, dedicated to innovation and cooperation in AI technology. IBM, together with the China Open Source Software Promotion Alliance, has also released the “Trusted Enterprise Generative AI White Paper”, promoting the responsible development and large-scale deployment of AI technologies, providing valuable guidance and reference for the industry.

◉ IBM 开源 Granite 系列模型

◉ IBM Open Sourced Granite Series of Foundation Models

◉ IBM 与中国开源软件推进联盟联合发布《可信赖的企业级生成式 AI 白皮书》

◉ IBM and China Open Source Software Promotion Alliance jointly released the “Trusted Enterprise Generative AI White Paper”

IBM 开放式 AI 技术栈在全球范围内引领着企业级 AI 的发展

IBM is Leading the Development of Enterprise-Grade AI Globally

IBM 开放式 AI 技术栈在多个维度上展现出了先进性。首先， Granite 系列开源模型能够处理包括语言、代码、时序数据、地理空间、天气气候等多种数据，可以有效解决企业真实业务场景的需求。其次，IBM 开放 AI 技术栈使得企业能够以较低的基础设施要求实现更高的准确性，从而获得更高的性价比。此外，IBM 提供的知识产权保护和合同保障，确保了投资的安全性和可靠性。IBM 开放 AI 技术栈还解决了将 AI 集成到企业核心业务流程中的难点，确保了 AI 应用的准确性和可靠性，同时在保护数据安全和合规性的基础上实现快速部署。

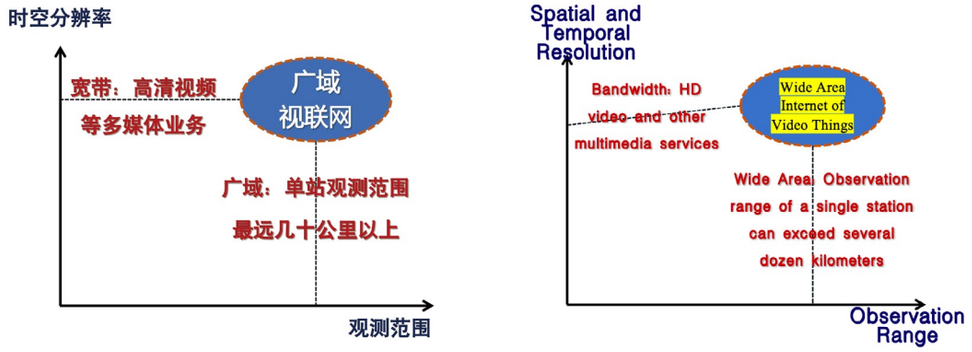
The IBM Open AI Stack demonstrates advanced capabilities across multiple dimensions. Firstly, the Granite series of open-source models can handle various types of data, including language, code, time-series data, geospatial data, and weather and climate data, effectively addressing the needs of real business scenarios. Secondly, the IBM Open AI Stack allows enterprises to achieve higher accuracy with lower infrastructure requirements, providing a better cost-performance ratio. Additionally, IBM Intellectual Property protection and contractual guarantees ensure the security and reliability of investments. The IBM Open AI Stack also addresses the challenges of integrating AI into core business processes, ensuring the accuracy and reliability of AI applications, and enabling rapid deployment while maintaining data security and compliance.

◉ IBM 助力意大利 Groupama Assicurazioni 实施 AI 解决方案，将 AI 集成到其核心业务流程中

◉ IBM assists Groupama Assicurazioni implement AI solutions to integrated AI into its core business processes

广域视联网通信技术及装备

Wide Area Internet of Video Things' Communications and Equipment



◉ 广域视联网是指利用铁塔等高点位优势，提供国土及边境高清视频监控服务。

◉ The wide area internet of video things refers to utilizing high vantage points, such as towers, to provide high-definition video surveillance services for national territories and border areas.

清华大学
Tsinghua University

中国铁塔股份有限公司
China Tower Corporation Limited

南京邮电大学
Nanjing University of Posts and Telecommunications

中移（杭州）信息技术有限公司
China Mobile (Hangzhou) Information Technology Co., Ltd.

北京旷视科技有限公司
Beijing Megvii Technology Co., Ltd.

北京科技大学
University of Science and Technology Beijing

引言

广域视联网利用铁塔等设施高点位优势， 将现有视联网广域拓展， 提供单站观测范围几十公里以上的国土及边境地区高清视频监控服务， 已经发展成为社会领域数字化治理和能力提升的重要基础。

Introduction

The wide area internet of video things leverages high vantage points from facilities such as towers to expand the existing video network over a broader area, providing high-definition video surveillance services for national territories and border regions with a single station observation range of tens of kilometers or more. It has developed into an important foundation for digital governance and capacity enhancement in various social sectors.

域视联网计算通信与信息服务

Video Network Computing, Communication, and Information Services

1. 提出云 - 网 - 端计算通信协同的广域视联网架构，突破脑启发的监控视觉满意度（QoE） 实时评测、 基于 QoE 评价准则的云原生分布式计算和时空素描图结构化高效编解码等关键技术， 与现有视联网计算与通信分离模式相比， 将带宽利用率提升 1-2 个数量级，为解决视联网广域拓展时带宽瓶颈问题提供新路径。

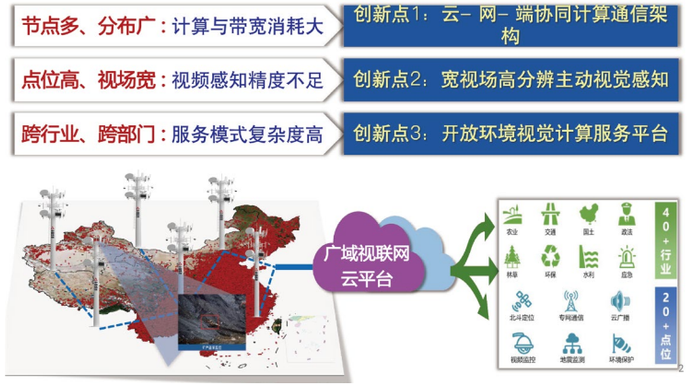
1. Proposing a wide-area video network architecture with cloud-network-edge collaborative computing and communication. This architecture breaks through key technologies, including real-time evaluation of surveillance visual Quality of Experience (QoE) inspired by brain cognition, cloud-native distributed computing based on QoE evaluation criteria, and efficient spatiotemporal sketch-based encoding/decoding. Compared to the existing separation of computing and communication in video networks, this new architecture increases bandwidth utilization by 1-2 orders of magnitude, offering a new solution to the bandwidth bottleneck in wide-area video network expansion.

2. 提出宽视场高分辨主动视觉感知方法，突破时 / 空 / 频多分辨融合的主动视觉传感、 RGB+IR 混合像素阵列和基于主动目标识别与跟踪的时空超分辨重建等关键技术， 将单摄像头光谱覆盖范围提升两倍，时空分辨率提升至 4 倍，有效克服视联网广域拓展时视频感知精度不足的问题。

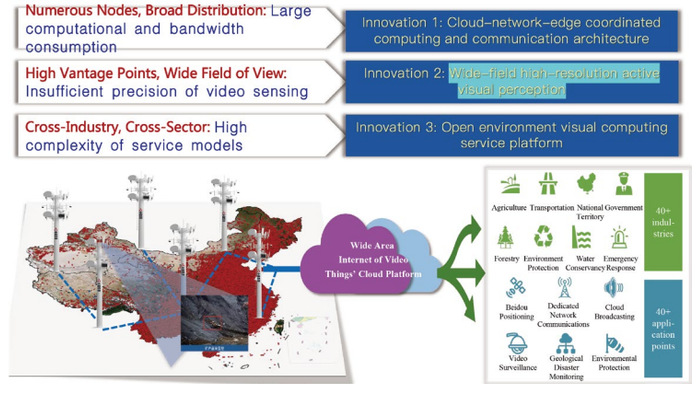
2. Proposing a wide-field, high-resolution active visual sensing method. This approach overcomes key technologies such as multi-resolution fusion in time/space/frequency, RGB+IR hybrid pixel arrays, and spatiotemporal super-resolution reconstruction based on active object recognition and tracking. It doubles the spectral coverage of a single camera and increases the spatiotemporal resolution by up to 4 times, effectively addressing the issue of insufficient video sensing precision during the wide-area expansion of video networks.

3. 提出基于目标 - 属性 - 关系模型的开放环境视觉计算服务平台方案，突破基于结构化表征的媒体中间件构建和面向任务驱动的粗粒度指令集编译等关键技术，与现有国际主流方案相比， 将系统设计效率提升 1-3 个数量级，为构建支撑多行业应用的通用数字底座奠定关键基础。

3. Proposing an open-environment visual computing service platform based on the Object-Attribute-Relation (OAR) model. This platform breaks through key technologies, including media middleware construction based on structured representation and coarse-grained task-driven instruction set compilation. Compared to current international mainstream solutions, this platform improves system design efficiency by 1-3 orders of magnitude, laying the critical foundation for building a universal digital base that supports multi-industry applications.



◉ 广域视联网技术挑战与科技创新



◉ Technological Challenges and Innovations in Wide Area Internet of Video Things

为国家社会治理和国防安全提供有力的基础设施保障

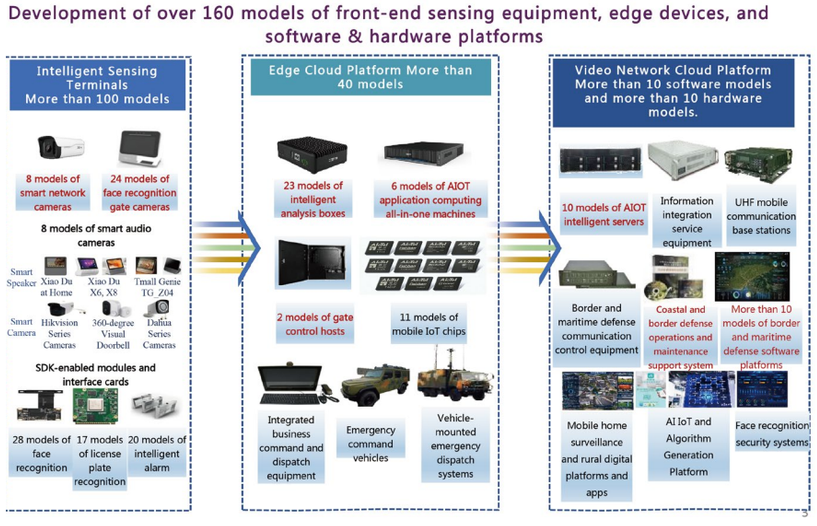
Providing Strong Infrastructure Support for National Social Governance and Defense Security

项目研制广域视联网通信系列装备和平台系统， 具备高精度感知、高效传输和快速响应能力， 已在中国 160 余座城市、 40 余万个行政村、

16 个省份国土边防部门部署应用，近三年新增经济效益逾 200 亿元。 服务灾害预警、 应急突发事件监测，任务响应时间提升 1 个数量级； 突破农村弱网环境监测难题， 带宽需求降低 1-2 个数量级。此外，该系统还应用于“蓝鲸二号”海上钻井平台监控系统、“西新工程”广播电视发射台站系统、“智慧长江”水上应急搜救系统、北京冬奥会和武汉世界军运会等重大活动保障， 社会、军事和经济效益十分显著， 推广前景广阔。

The project developed a series of wide area internet of video things' communication equipment and platform systems with high-precision sensing, efficient transmission, and rapid response capabilities. These systems have been deployed and applied across over 160 cities, more than 400,000 administrative villages, and in national border defense departments in 16 provinces in China, generating an additional economic benefit of over 20 billion RMB in the past three years. The system supports disaster warning and emergency incident monitoring, improving task response times by an order of magnitude. It also overcomes challenges of monitoring in rural weak network environments, reducing bandwidth requirements by 1-2 orders of magnitude. In addition, the system has been applied in the “Blue Whale II” offshore drilling platform monitoring system, the “Western New Project” broadcasting transmission station system, the “Smart Yangtze” waterway emergency search and rescue system, as well as in major events such as the Beijing Winter Olympics and the Wuhan Military World Games. The social, military, and economic benefits are highly significant, and the system has broad prospects for further expansion.

◉ 面向广域视联网通信的前端感知设备、边设备以及软硬件平台



◉ Front-End Sensing Devices, Edge Devices, and Software/Hardware Platforms for Wide Area Internet of Video Things' Communication

核心技术填补行业空白，国际影响显著

Core Technologies Fill Industry Gaps with Significant International Impact

获主要发明专利 200 余项， 制定国际标准 18 项、国家标准 20 项；出版学术专著 15 部，发表 Nature、 IEEE TPAMI 等国际期刊论文 52 篇，百余位知名院士和 IEEE Fellow 对项目成果给予高度评价。 培养中国杰青项目获得者、长江学者等 7 人。中国电子学会组织鉴定认为：“项目技术难度大、 创新性强，整体达到国际先进水平， 其中视联网带宽利用率、视频时空分辨率指标达到国际领先水平”。 部分成果获 2021 北京市科技进步一等奖、2018 教育部科技进步一等奖、 2017 中国人工智能学会技术发明一等奖等。

The project has secured over 200 major invention patents and established 18 international standards and 20 national standards. It has published 15 academic monographs and 52 papers in international journals, including Nature and IEEE TPAMI. The project outcomes have been highly praised by more than 100 renowned academicians and IEEE Fellows. Seven experts, including recipients of the National Science Fund for Distinguished Young Scholars and Changjiang Scholars, have been trained as part of this initiative. The China Institute of Electronics organized an evaluation, concluding: “The project is technically difficult and innovative, achieving an overall international advanced level. Notably, the bandwidth utilization of the video network and the video spatiotemporal resolution metrics have reached world-leading standards.” Portions of the project's outcomes have won the First Prize for Beijing Science and Technology Progress Award in 2021, the First Prize for the Ministry of Education Science and Technology Progress Award in 2018, and the First Prize for the China Association for Artificial Intelligence Technical Invention Award in 2017.

项目组制定基于脑电响应的视觉满意度评测国际标准，填补了主观质量衡量指标的空白。制定面向多形态终端的智能多媒体通信系统国际标准，服务用户数超过 7300 万，为 5G 时代从 70 亿人与人话音连接，向 200 亿人与人、人与物实时音视频连接的演进夯实基础。制定家庭安防监控国际标准，为 5800 余万用户提供可靠的视频监控服务。

The project team developed the international standard for visual satisfaction assessment based on EEG responses, filling a gap in subjective quality measurement metrics. Additionally, they established an international standard for intelligent multimedia communication systems targeting multi-format terminals, serving over 73 million users, laying the groundwork for the evolution from 7 billion person-to-person voice connections to 20 billion real-time audio and video connections between person-to-person and person-to-object in the 5G era. Furthermore, the team created an international standard for home security monitoring, providing reliable video surveillance services for over 58 million users.

面向全光组网智慧家庭的端网云边一体协同操作系统

Device-Network-Cloud-Edge CuOS for All-Optical Smart Home

◉ 面向全光组网终端，打造中国联通智慧家庭操作系统，助力端网云边融合创新，使能智慧家庭全新升级。

◉ Smart Home Operating System Built by China Unicom for FTTR Terminals to Realize Device-Network-Cloud-Edge Convergence, Innovation, and Smart Home Upgrade

中国联合网络通信有限公司
China United Network Communications Co., Ltd.

华为技术有限公司
Huawei Technologies Co., Ltd.

中兴通讯股份有限公司
ZTE Corporation

京东科技信息技术有限公司
JDT Technology Co., Ltd.

深圳市中兴微电子技术有限公司
Shenzhen ZTE Microelectronics Technology Co., Ltd.

引言

针对智慧家庭新需求，中国联通秉持技术向新理念，面向全光组网终端打造端网云边一体协同操作系统，构建“智能联接 + 智能应用”新模式，为用户提供智能化新服务，引领智慧家庭新风尚，共创智慧家庭新生活。

Introduction

To meet the new requirements of smart homes, China Unicom adheres to the concept of using latest technologies to build a device-network-cloud-edge synergy operating system for FTTR networking terminals, and builds a new mode of “smart connection + smart application” to provide users with innovative smart home services.

四大关键技术创新，打造智慧家庭核心底座

Four Key Technological Innovations, Building the Foundation for Smart Homes

针对智慧家庭业务中面临的硬件生态壁垒、用户体验不佳、互联互通困难、存算资源受限等难题，中国联通研发智慧家庭操作系统，实现四大关键技术创新，打造核心底座。

China Unicom has developed a smart home operating system to address the challenges faced by smart home services, such as hardware ecosystem barriers, poor user experience, difficult interconnection, and limited storage and compute resources. As a smart home foundation, the operating system has achieved four key technological innovations:

一是采用开放兼容系统架构，统一定义内核能力，抽象封装系统服务，实现跨平台差异化硬件的标准化原子能力封装，实现软硬件解耦分离，打通硬件生态壁垒。

First, an open and compatible system architecture is used to define kernel capabilities in a unified manner, abstract and encapsulate system services, encapsulate standard atomic capabilities of cross-platform differentiated hardware, decouple software from hardware, and eliminate hardware ecosystem barriers.

二是打造网络感知调度能力，自研智能算法，实现网络动态调优，分析网络流量，实现网络灵活调度，发挥千兆光网高速传输和 Wi-Fi 全屋覆盖能力优势，保障用户体验。

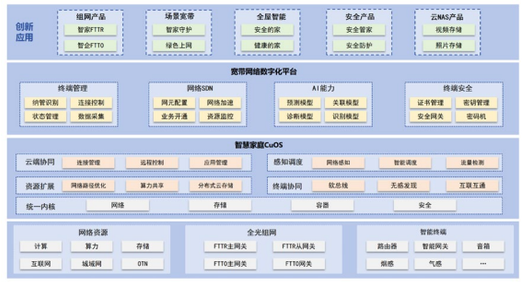
Second, innovative smart algorithms are developed to build network awareness and scheduling capabilities, realizing dynamic network optimization, network traffic analysis, and flexible network scheduling. In this way, the advantages of high-speed transmission and whole-house gigabit Wi-Fi coverage of optical networks are fully utilized to ensure user experience.

三是定义场景化交互协议，构建家庭终端统一调度协同能力，提供轻量安全、简洁高效的协议对接方案，支持场景化协同编排，实现智能终端互联互通。

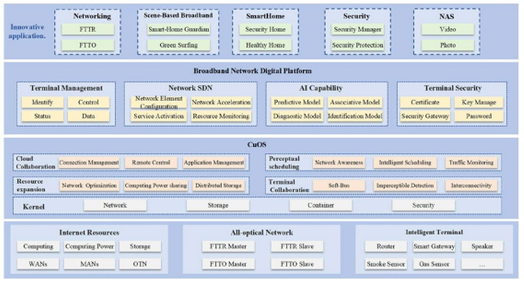
Third, scenario-specific interaction protocols are defined to build unified scheduling and collaboration capabilities for home terminals; provide lightweight, secure, simple, and efficient protocol interconnection solutions; support scenario-specific collaborative orchestration to implement interconnection between smart terminals.

四是构建资源扩展体系，依托专属网络通道，实现家庭内网和边缘算网的互通互访，按需提供分布式云存储能力和云计算能力，实现家庭网络、算力、存储资源的动态高效扩展。

Fourth, a resource expansion system is built. Based on dedicated network channels, the home intranet and edge computing network can communicate with each other. Distributed cloud storage and cloud computing capabilities are provided on demand to implement dynamic and efficient expansion of home networks, computing power, and storage resources.



◉ 端网云边一体协同操作系统业务架构



◉ Service Architecture of the Device-Network-Cloud-Edge CuOS

系统应用助力业务发展，经济和社会效益显著

System Applications Facilitate Business Development and Bring Significant Economic and Social Benefits

系统面向中国广泛部署应用，助力中国联通全屋光宽带业务发展，经济和社会效益显著。

The system has been widely deployed and applied in Chinese mainland, helping China Unicom develop FTTR services and bringing significant economic and social benefits.

经济效益方面，系统广泛部署，覆盖 2000 万全光组网终端，服务超 1000 万全屋光宽带家庭用户，结合 Wi-Fi7 和千兆光网等关键技术，为用户提供全屋千兆网络覆盖及无缝漫游体验，助力中国联通全屋光宽带业务发展在市场上保持持续领先，拉动宽带及智慧家庭收入增长近百亿。

In terms of economic benefits, the system is widely deployed, covering 20 million FTTR terminals and serving more than 10 million FTTR home broadband users. With key technologies such as Wi-Fi7 and gigabit optical networks, the system provides users with gigabit network coverage and seamless roaming experience, helps China Unicom maintain a leading position in the FTTR market, and increases the revenue of broadband and smart home services by nearly CNY10 billion.

社会效益方面，基于操作系统底座能力，构建智慧家庭创新体系，赋能算网数智业务创新，孵化 FTTR 全屋光宽带、FTTO 全光组网等新形态组网产品，并助力家庭视频、家庭云、全屋智能等应用创新，提供了丰富的用户随选增值服务，满足用户差异需求，改善用户生活品质，增强用户体验感知，切实提升人民群众在家庭生活中的获得感和幸福感。

In terms of social benefits, based on the operating system base capabilities, a smart home innovation system is built to enable the innovation of digital and intelligent services of the computing network, incubate new networking products such as FTTR whole-house optical broadband and FTTO all-optical networking, and facilitate the innovation of applications such as home video, home cloud, and whole-house intelligence. The system also provides various value-added services to meet users' differentiated requirements and improve user experience.

◉ 操作系统助力业务创新

◉ CuOS Facilitating Service Innovation

助力产业链协同发展，共建智慧家庭繁荣新生态

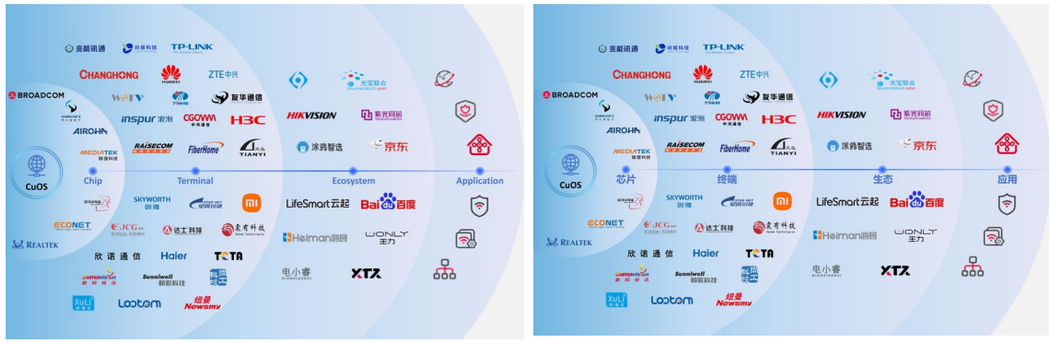
Facilitating Collaborative Development of the Industry Chain and Building a Prosperous Smart Home Ecosystem

端网云边一体协同操作系统以全局视角协同上下游芯片厂商、终端厂商、生态厂商和应用厂商，推进全产业链的深度合作。兼容 7 大主流芯片平台，面向全光组网终端完成 30 余家终端厂商系统适配，对接各品类百余款泛智能终端实现 cuLink 协议延伸，促进智能应用向家庭渗透，赋能业务不断取得新突破，为相关产业的发展提供了新的机遇和空间。

The device-network-cloud-edge synergy operating system collaborates with upstream and downstream chip vendors, terminal vendors, ecosystem vendors, and application vendors from a global perspective to promote in-depth cooperation across the entire industry chain. It is compatible with seven mainstream chip platforms, adapts to systems of more than 30 terminal vendors for FTTR terminals, and connects to more than 100 types of pan-smart terminals of various categories to extend the cuLink protocol, promoting the penetration of smart applications into homes, enabling new breakthroughs in services, and providing new opportunities and space for the development of related industries.

本成果形成超20项专利软著，并将成熟经验向行业和国际输出，促进产业技术创新和升级，推动行业数字化转型。同时助力中国联通先后获得 2022 年世界宽带论坛“年度最佳数字家庭运营商奖”、2023 年世界移动通信大会“智慧家庭最佳实践奖”，具有较高的国际影响力和认可度。

This achievement has generated more than 20 patents and software copyrights, and has shared mature experience to the industry and the world, promoting industry technology innovation and upgrade as well as industry digital transformation. In addition, China Unicom has won the “Leading Connected Smart Home Operator” award at the Broadband World Forum 2022 and the “Smart Home Best Practice” award at the Mobile World Congress 2023, obtaining high international influence and recognition.



◉ 助力产业链结构升级，赋能生态聚合

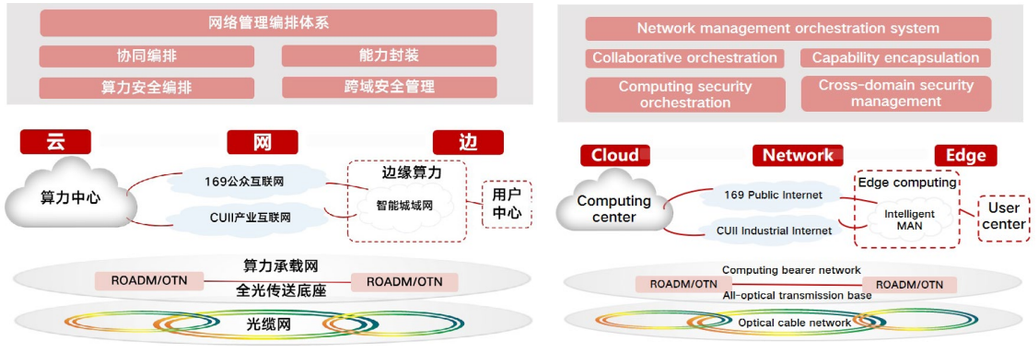
◉ Facilitating the Upgrade of the Industry Chain Structure and Enabling Ecosystem Aggregation

◉ 部分获奖、专利及软著情况

◉ A Selection of Awards, Patents, and Software Copyright Statuses

算网融合技术体系构建与应用创新实践

Computing and Network Convergence Technology System Construction and Application Practice Innovation



◉ 中国联通算网融合技术体系总体架构

◉ Architecture diagram of China Unicom's computing and network convergence technology system

中国联合网络通信有限公司
China United Network Communications Co., Ltd.

中国联通 China unicom

引言

中国联通开展“算网融合技术体系构建与应用创新实践”，构建可调配多级算力资源、实现算网协同的新型网络架构，赋能大规模智算、协同数训等场景，为上层业务提供强有力的底层通信能力支持。

Introduction

China Unicom carries out the “computing and network convergence technology system construction and application practice innovation” to build a new network architecture that can deploy multilevel computing resources and realize synergy between computing and network. This innovation measure empowers scenarios such as large-scale intelligent computing and collaborative digital training, and provides strong support of underlying communication capability for the upper layer business.

构建 SID as a Service（SIDaaS）网络服务架构及技术体系

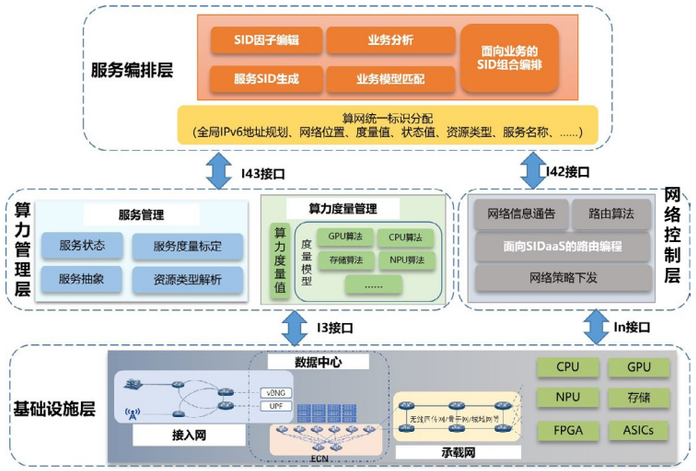
Architecture Diagram of China Unicom's Computing and Network Convergence Technology System

面向算网协同发展趋势，构建了算网协同 SIDaaS 可编程服务架构及技术体系，研发算网融合业务编排管理平台，实现云网边一体的可编程服务能力开放，面向用户提供差异化、端到端、灵活高效的融合服务能力。

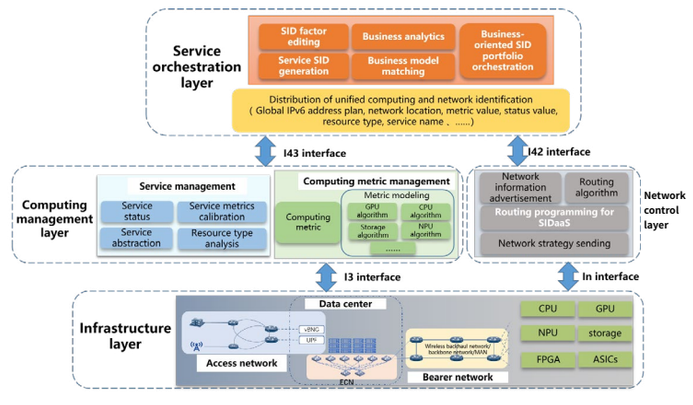
In response to the development trend of computing and network convergence, China Unicom has constructed the computing and network convergence SIDaaS programmable service architecture and technology system. And the orchestration platform for the computing and network convergence service has been developed. In this way, the opening of cloud-network-edge integrated programmable service capability can be realized, and differentiated, end-to-end, flexible and efficient convergence service capability can be provided for users.

面向智算中心、云网互联、算力服务三个方面，实现多项技术与实践创新。面向智算中心，联合开展信创无损交换机产品研发。研制智算中心网络流量管理调度平台，解决复杂组网下，多任务并行及相应网络流量规划、拥塞控制和负载均衡等问题；面向云网协同场景，研制虚拟业务网关，作为云侧检测锚点，结合随流检测，解决云网性能检测相对割裂、故障定界定位困难等问题；面向智算中心的算力服务化，形成算力服务原生研究体系，解决异构模型框架下差异化运行环境的代码不兼容问题，为运营商数字化转型提供异构计算资源的统一输出能力。

Targeting three areas of intelligent computing center (ICC), cloud-network interconnection and computing service, China Unicom has realized a number of technology and practice innovations. For the ICC, the information and innovation lossless switch products has been jointly researched. A network traffic management and scheduling platform for ICC has been developed to solve the problems of multi-tasking, corresponding network traffic planning, congestion control, and load balancing under complex networks. For cloud-network synergy scenario, virtual routing gateway has been developed as a cloud-side detection anchor, combined with the flow detection, to solve problems such as the relative fragmentation of cloud network performance detection and the difficulty of fault location. As for the computing service of ICC, a native research system for computing service has been established, which solves the problem of code incompatibility of differentiated operating environments under the framework of heterogeneous models, and provides unified output capability of heterogeneous computing resources for operators' digital transformation.



◉ SIDaaS 可编程服务架构



◉ SIDaaS Programmable Service Architecture

算网融合技术体系成果广泛应用，经济和社会效益显著

The Achievements of Computing and Network Convergence Technology System Have Been Widely Applied, Which Has Significant Economic and Social Benefits

中国联通算网融合技术体系成果为全国联通云数据中心建设提供了技术支撑和难点解决方案。

The achievements of China Unicom's computing and network convergence technology system have provided technical support and difficult solutions for the construction of China Unicom's cloud data centers nationwide.

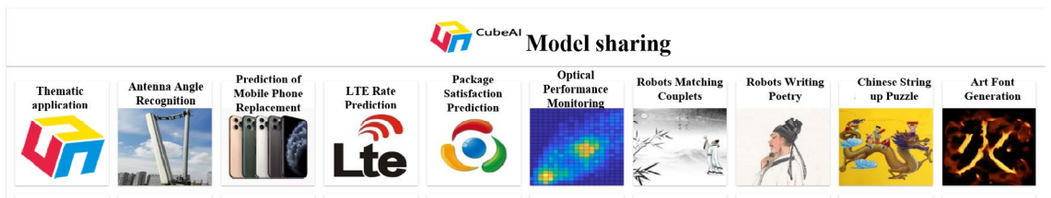
在智算中心网络管控及运维方面，研发智算中心流量自动化管理调度平台，提供数据驱动的全方位、一体化的智算中心网络的运营、维护和监控。实现智算中心内计算节点、存储节点及网络的端到端自动化部署和配置调优、超可视化监控、结合高性能通信库实现流量控制与流量均衡等能力，为智算中心网络的管控运维技术的验证和应用示范起到了先行先试的作用。

In terms of control, operation and maintenance for ICC network, an automated ICC traffic management and scheduling platform has been developed to provide data-driven, comprehensive, integrated operation, maintenance and monitoring for ICC network. It realizes end-to-end automated deployment, configuration and optimization, and ultra-visualized monitoring of computing nodes, storage nodes and networks in the ICC. Capabilities such as traffic control and traffic balancing have been achieved by combining high-performance communication libraries. It plays a pioneering role in the verification and application demonstration of network control, operation and maintenance technologies for ICC network.

研发的“CubeAI 智立方”工具集作为算力服务原生技术的一套具体实现案例，在 AI 模型从开发、发布、共享到部署、能力开放等全生命周期范围内实现了提升开发人员工作效率、降低运营成本的能力。通过模板化编程，开发者无需掌握复杂的网络编程、异步处理等技术，显著降低了开发门槛。全套代码贡献至中国有影响力的 AI 开源社区 OpenI 启智社区进行开源孵化，促进了业界开源开放和共建共享。

The “CubeAI” toolset developed as a set of implementation cases of computing service native technology, has achieved the ability to improve developers’ work efficiency and reduce operating costs throughout the entire lifecycle of AI models, from development, release, sharing, deployment, and capability opening. Through templated programming, developers do not need to master technologies such as complex network programming and asynchronous processing, significantly reducing the development threshold. The entire set of codes has been contributed to OpenAI, the most influential AI open source community in China, for open source incubation, which promotes open access, co-construction and sharing of resource in the industry.

◉ CubeAI AI 服务原生模型示例



◉ Examples of CubeAI AI Service Native Models

算网融合技术的研究助力了中国算力网络快速发展，也为国际研究热点提供了新思路

Research on Computing Network Convergence Technology Has Helped the Rapid Development of Chinese Computing Network and Provided New Ideas for International Research Hotspots

中国联通算网融合技术构建了算力资源灵活调度、算网协同承载的新型网络架构，突破相关技术瓶颈，有效的赋能大规模智算、协同数训等场景，助力中国基础设施的建设与发展。

China Unicom’s computing network convergence technology has built a new network architecture with flexible scheduling of computing resources and collaborative bearer computing and network. It has broken through the related technical bottlenecks, effectively empowers large-scale intelligent computing, collaborative digital training and other scenarios, and assisted the construction and development of China’s infrastructure.

基于算网协同的 SIDaaS 创新性网络架构的“大湾区算力网络联合解决方案”获评 2021 年度通信产业金紫竹奖。基于 CubeAI 技术建设的 AI 服务原生模型示范库中现有服务化模型数已达 1000+，累计下载量超十余万次。名开源平台魔搭（ModelScope）社区专门开辟了 CubeAI 模型示范专区，已有超过一百个开源模型服务在此上线发布，累计吸引数万人次访问互动。

The “Joint Solution of Greater Bay Area Computing Network” based on the innovative network architecture of SIDaaS with computing-network synergy was honored with the Golden Bamboo Award of Communications Industry in 2021. The number of existing serviced models in the AI service native model demonstration library built based on CubeAI technology has reached 1,000+, with a cumulative download volume of more than 100,000 times. The community of ModelScope, a famous open source platform, has opened a special area for CubeAI model demonstration. More than 100 open source model services have been released online here, attracting tens of thousands of visits and interactions.

中国联通联合产业界合作伙伴积极推进算力网络国际标准体系建设，基于相关研究工作，在 ITU 牵头制定了服务感知网络和智算管控等国际标准。

China Unicom, together with its industrial partners, has actively promoted the construction of an international standardization system for computing networks. Based on relevant research work, it has led the formulation of international standards such as service-aware network and intelligent computing control in ITU.

CubeAI 智立方

About CubeAI ★

CubeAI is an open source AI platform completely independently developed by the China Unicom Research Institute. It currently includes sub-platforms and functional modules such as AI online training, automated model release and deployment, and visualization of AI capabilities.

Its core role is to break through the barriers between AI model development and actual production applications, accelerate the process of AI innovation and application, and promote the rapid iteration and evolution of the entire life cycle of AI applications from design and development to deployment and operation.

■ **Network intelligence capability evaluation:** Network intelligence capability is evaluated by the test bed from various dimensions: demand mapping, data collection, analysis, decision-making and action implementation. Each application is evaluated according to the ITU-T Y.3173 standard and is divided into L0~L5 levels. The test process includes five steps: 1) determining the evaluation object; 2) dividing the evaluation dimension; 3) analysing the evaluation object; 4) scoring the evaluation dimension; and 5) obtaining the evaluation result. At the same time, the test results of stability, ease of use, accuracy, and throughput of each application are given.

Machine learning marketplace integration in future networks

Another important exploration is ML marketplace integration in future networks, including IMT-2020 (commonly known as 5G), which refers to network ML capability accumulation. Nowadays, ML models may be hosted in varied types of ML marketplaces e.g. The Linux Foundation’s Acumos AI, China Unicom’s CubeAI, AWS Marketplace, and Huawei’s Network AI Engine.

Sometimes, the latest advances in predictive analysis or algorithms have no dependency on network architecture evolution in ML underlay networks. Cloud-hosted ML marketplaces may attract developers of innovative ML mechanisms and algorithms to host their solutions.

Telecommunication operators integrate their own or third-party ML marketplace into the future network and push the application of AI on the telco network and promote the level of network intelligence.

While designing the ML application, network operators need interoperable mechanisms for identification of the ML marketplace which may be used as a source for ML models. Lack of standard mechanisms to exchange ML models and related metadata between ML marketplaces and the network operator’s ML deployment environments limits interoperability.

The ITU-T Y.3176 Recommendation: Machine learning marketplace integration in future networks including IMT-2020, which was edited by China Unicom, China Mobile and ZTE, provides the architecture and reference points for integrating ML marketplaces in future networks. Also, the interaction process of model search, model selection and push, model discovery, model training and model deployment are provided. ■

◉ CubeAI 在《ITU news Magazine》杂志中高亮宣传

◉ CubeAI Highlighted in ITU News Magazine

基于时空 AI 的智慧计算物流关键技术创新与应用

Innovation and Application of Key Technologies for Intelligent Computing Logistics Based on Spatiotemporal AI

◉ 智慧计算物流系统操作界面

◉ Real Time Operation Diagram of Intelligent Computing Logistics System

浙江菜鸟供应链管理有限公司
Zhejiang Cainiao Supply Chain Management Co., Ltd.

引言

成果创新提出 AI 在物流场景应用的系统架构，开创了计算物流发展方向与路线，研发出多层次多元知识的地理表征、物流时空预测与决策体系、数据推断与治理等关键技术并落地应用，突破数据及 AI 驱动在物流效率的瓶颈。

Introduction

Innovatively proposing a system architecture for the deep application of AI in logistics, we pioneer the direction and route of computing logistics, independently developing key technologies such as multi-level and diverse geographic knowledge representation, logistics spatiotemporal prediction and decision-making system, data inference and management governance. Furthermore, we implement these technologies, thereby breaking through the bottleneck of data and AI driven logistics efficiency.

计算物流技术取得突破，加速产业创新与升级

Breakthrough in Computing Logistics Technology Accelerates Industrial Innovation and Upgrading

针对物流场景海量异构数据表征不足、预测与决策有效性不足、数智化管理与治理效率不足等挑战，提出计算物流方向，在如下三方面取得成果创新突破：

In response to the challenges of insufficient representation of massive heterogeneous data in logistics scenarios, insufficient effectiveness of prediction and decision-making, and insufficient efficiency of intelligent management and governance, the direction of computing logistics is proposed, and innovative breakthroughs have been achieved in the following three aspects:

一是突破多层次多元知识融通的地理表征技术，提出层次化网格解决地理刻画与计算，并基于预训练技术实现地理领域大模型，将大数据转化成时空大知识。

One is to break through the multi-level and diverse knowledge integration of geographic representation technology, propose a hierarchical grid to solve geographic characterization and computation, and based on pre-training technology, implement a large-scale model in the geographic field to transform big data into spatiotemporal knowledge.

二是时空预测与决策技术，提出 DeepETA、DeepRoute、Graph2Route 等模型，从深度时序模型升级到深度时空图模型，显著提升预测准度。在深度强化学习、多目标预测决策一体化上取得突破，解决大规模、高精度、高时效决策挑战。

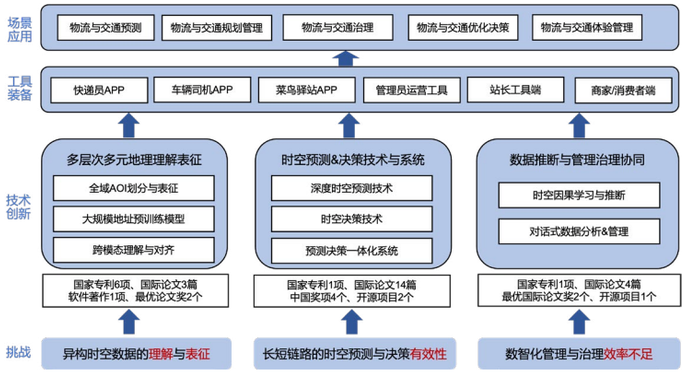
The second is spatiotemporal prediction and decision-making technology, proposing models such as DeepETA, DeepRoute, Graph2Route, etc., upgrading from deep temporal models to deep spatiotemporal graph models, significantly improving prediction accuracy. Breakthroughs have been made in the integration of deep reinforcement learning and multi-objective prediction decision-making, solving the challenges of large-scale, high-precision, and high timeliness decision-making.

三是数据推断与管理治理协同，推出物流场景下首款对话式数据洞察大模型 DataGPT，并和业务管理治理协同，形成大量优秀决策案例。

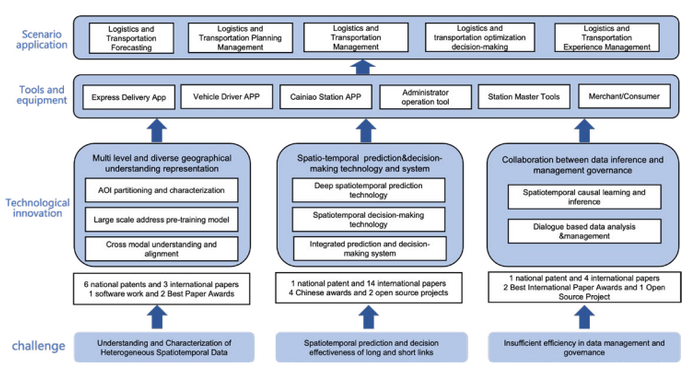
The third is the collaboration between data inference and management governance, launching the first conversational data insight big model DataGPT in logistics scenarios, and collaborating with business management governance to form a large number of excellent decision-making cases.

在计算物流方向的上述三个关键技术点持续攻坚，相应成果案例为实体产业 AI 升级提供了范本。

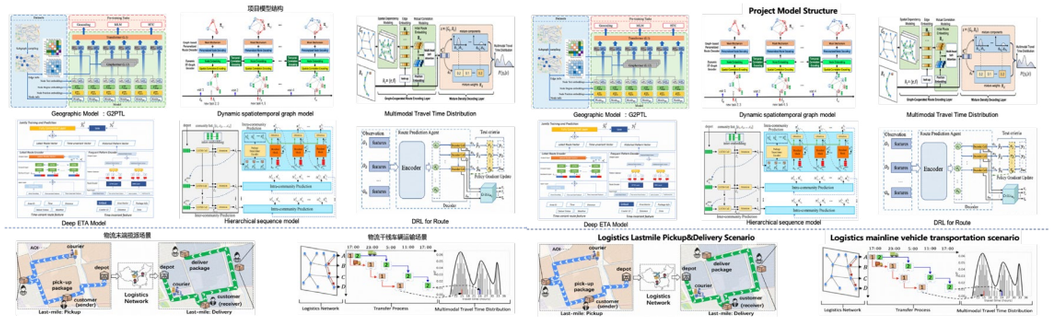
The above three key technological points in the field of logistics continue to be tackled, and the corresponding achievement cases provide a model for the AI upgrade of physical industries.



◉ 基于时空 AI 的智慧计算物流体系图



◉ Smart Computing Logistics System Diagram Based on Spatiotemporal AI



◉ 计算物流路线关键技术点模型结构图

◉Structural Diagram of Key Technical Points Model for Calculating Logistics Routes

深入全球物流实践，重点行业广泛应用

In Depth Global Logistics Practice, Widely Applied in Key Industries

凭借在计算物流方向上地理表征能力强、预测准度高、决策速度快、数据推断效率高等优势，成果已实现在中国、跨境、国际各领域物流场景的广泛应用，取得显著经济与社会价值，近三年直接收益超 17 亿元，并面向智能制造等实体行业推广，助力制造业实现数智化转型。

With the advantages of strong geographical representation ability, high prediction accuracy, fast decision-making speed, and high data inference efficiency in the field of computing logistics, the results have been widely applied in logistics scenarios in China, cross-border, and international fields, achieving significant economic and social value. In the past three years, the direct income has exceeded 1.7 billion yuan, and it has been promoted to physical industries such as intelligent manufacturing, helping the manufacturing industry achieve digital transformation.

其中，菜鸟跨境物流业务在资源分配环节应用该成果，覆盖欧洲、北美、东南亚等全球 120 国。在中国及全球行业领先的数字化快递末端服务网络中应用该成果，实现日 8 千万包裹的高效低成本运转。全球头部在线寄件平台 - 菜鸟裹裹，依托精准预测与调度技术，实现即时揽 1 小时的即时物流能力。基于此成果形成的智能装箱、智能合单等功能实现物流成本显著下降的经济价值。此外，在飞鹤、源氏木语等众多实体行业客户应用，展示出计算物流技术在实体行业产生的重要价值。

Among them, Cainiao's cross-border logistics business applies this achievement in resource allocation, covering 120 countries around the world such as Europe, North America, and Southeast Asia. By applying this achievement in the leading digital express delivery end service network in China and globally, efficient and low-cost operation of 80 million packages per day can be achieved. Cainiao Waibao, a leading global online shipping platform, relies on precise prediction and scheduling technology to achieve real-time logistics capabilities within one hour. Based on this achievement, the economic value of significantly reducing logistics costs is achieved through functions such as intelligent packing and intelligent order consolidation. In addition, the application of computing logistics technology in many physical industry clients such as Feihe and Genji Muyu demonstrates the significant value it brings to the physical industry.

◉ 成果面向各行业广泛应用

◉Wide Range of Applications for Various Industries

◉ 计算物流在物流多元场景的深入应用

◉ In Depth Application of Computing Logistics in Diverse Logistics Scenarios

技术引领产业升级，与实体经济共享成果

Technology Leads Industrial Upgrading and Shares Achievements with the Real Economy

基于时空 AI 的计算物流关键技术凭借其领域知识理解深、预测与决策高可靠等优势，为物流与交通物流产业数智化转型提出了有效路径，开放共享赋能制造等实体行业。一是在技术进步方面，通过信息流连接在仓 - 干（多式联运）- 配全链路基础能力之上，构建可计算的全链路数据能力，以提供成本更优、精度更高的全链路多元化智能解决方案，并催生类即时揽即时配需求下的新平台发展模式。二是在产业生态方面，计算物流聚焦在基础层地理表征、及上层大数据范式的预测、决策、推断关键技术突破，实现稳健的物流 AI 能力。三是实现产业稀缺模块开源，涉及时空数据集、地理预训练模型、强化学习决策等（https://huggingface.co/Cainiao-AI），助力计算物流技术生态与应用繁荣发展。

The key technology of computing logistics based on spatiotemporal AI, with its advantages of deep understanding of domain knowledge, high reliability of prediction and decision-making, has proposed an effective path for the digital transformation of logistics and transportation logistics industries, empowering physical industries such as manufacturing through open sharing. One is in terms of technological progress, by connecting information flow on top of the basic capabilities of the warehouse- trunk transport (multimodal transport)- distribution chain, a computable full chain data capability is built to provide more cost-effective and high-precision diversified intelligent solutions for the entire chain, and to stimulate the development of new platform models under the demand for instant collection and distribution. Secondly, in terms of industrial ecology, computing logistics focuses on breakthroughs in key technologies such as basic level geographic representation and upper level big data paradigms for prediction, decision-making, and inference, achieving robust logistics AI capabilities. The third is to achieve the open-sourcing of the industry's scarce modules, involving spatiotemporal datasets, geographic pre-training models, reinforcement learning decision-making, etc (https://huggingface.co/Cainiao-AI), to promote the prosperous development of the computing logistics technology ecosystem and its applications.

产学研结合，推动技术持续创新

Combining Industry, Academia and Research to Promote Continuous Technological Innovation

成果描绘了计算物流发展路线图，已发表 CCF- A&B 及运筹学顶刊学术论文 30 多篇，其中四篇获得最佳会议论文，并获多项中国与国际学会协会科技奖项。

The achievement depicts the development roadmap of computing logistics, and has published over 30 academic papers in the top journals of CCF-A&B and operations research. Among them, four papers have won the best conference papers and received multiple technology awards from the China and International Association of Societies.

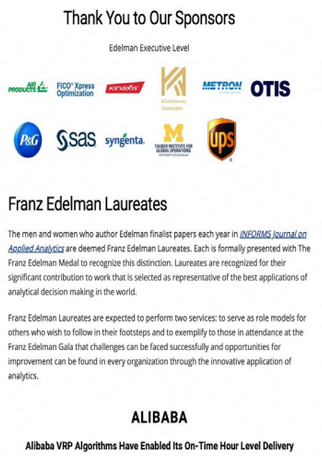
在关键技术点鉴定会上，清华大学戴琼海院士对其评价：“项目成果在菜鸟跨境与中国业务及第三方业务中开展了应用，项目整体技术达到国际先进水平”。

At the key technology point appraisal meeting, Academician Dai Qionghai of Tsinghua University evaluated the project: “The project achievements have been applied in Cainiao's cross-border and Chinese business as well as third-party business, and the overall technology of the project has reached the international advanced level.”

在产学研融合方面，联合全球顶尖高校与科研机构持续投入计算

物流技术生态建设及关键难点攻克，通过共同发表学术论文、制定标准、构建研究数据集及评估体系等合作方式，与全球科研工作者携手推进计算物流的长期发展与应用。

In terms of the integration of industry, academia, and research, we will continue to invest in the construction of a computing logistics technology ecosystem and tackle key challenges in collaboration with top universities and research institutions around the world. Through joint publication of academic papers, formulation of standards, construction of research datasets and evaluation systems, and other cooperative methods, we will work together with global researchers to promote the long-term development and application of computing logistics.



◉ 具有国际影响力的技术成果

◉ Technological Achievements with International Influence

◉ CSAMSE2022 授予最佳论文奖

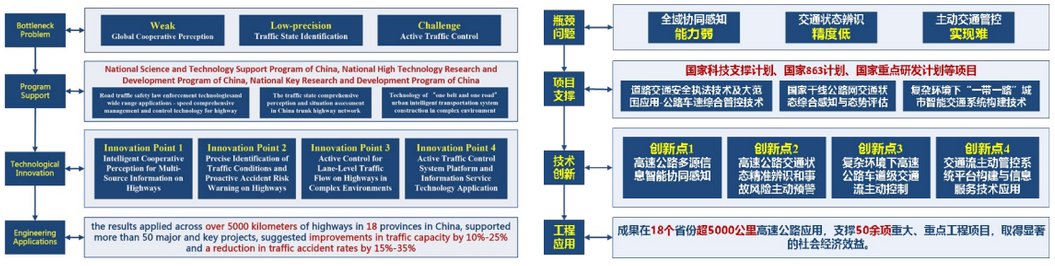
◉ Third Price

◉ CSAMSE2022 最佳实践奖

◉ Second Place

快速道路交通状态智能感知与主动管控关键技术

Highway Traffic State Sensing and Active Traffic Management Technologies



◉ 快速道路交通状态智能感知与主动管控关键技术总体框架

◉ Overall Framework of Highway Traffic State Sensing and Active Traffic Management Technologies

东南大学
Southeast University

交通运输部公路科学研究所
Highway Research Institute of the Ministry of Transportation and Communications

公安部交通管理科学研究所
Traffic Management Research Institute of the Ministry of Public Security

蜀道投资集团有限责任公司
Shudao Investment Group Limited

河北交通投资集团有限公司
Hebei Province Transportation Planning and Design Institute Co.

引言

高速公路承担了超过 1/3 的客运量和 1/4 的货运量，是经济社会发展的大动脉。本成果通过数字化智能化手段提升既有高速公路基础设施整体效能，实现高速公路“智慧扩容”，体现了高速公路行业发展的主要方向。

Introduction

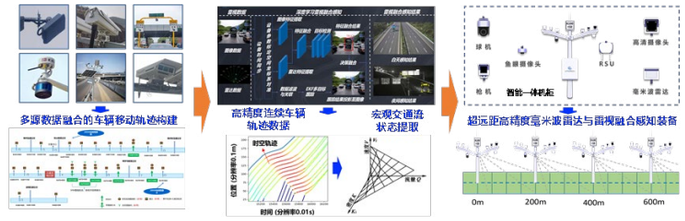
The highway carries more than one-third of the passenger traffic and one-fourth of the freight traffic, and is the artery of economic and social development. The achievements enhance the overall effectiveness of existing highway infrastructure and achieve highway “wisdom expansion” through digital intelligent means, reflecting the main direction of the development of the highway industry.

突破高速公路智能感知与主动管控等技术

Breakthroughs in Intelligent Perception and Proactive Control of Highway Traffic

本成果针对高速公路交通状态智能感知与主动管控技术开展了系统深入研究，突破了多源信息协同下全天候交通运行精准感知、复杂环境下交通状态精准辨识与事故风险预警、多瓶颈耦合作用下车道级交通流协同控制等技术难题，形成了高速公路多源信息智能协同感知技术、支撑高速公路智能化运行管控的成套技术及系统装备并大规模推广应用，实现了高速公路交通状态智能感知、精准辨识、主动管控等技术突破，大幅提升了高速公路交通运行效率与安全水平，取得了显著的社会经济效益。

The project has carried out systematic and in-depth research on the intelligent perception of highway traffic state and active control technology, broken through the technical problems of accurate perception of all-weather traffic operation under the synergy of multi-source information, accurate recognition of traffic state and early warning of accident risk under the complex environment, and cooperative control of highway traffic flow under the coupling effect of multi-bottlenecks, and formed complete sets of technology and system equipment to support the intelligent operation and control of highways, and promoted its application on a large scale. It has formed a complete set of technology and system equipment to support the intelligent operation and control of highways and promoted its application on a large scale, realizing technological breakthroughs such as intelligent perception of highway traffic status, accurate identification, active control and so on. The efficiency and safety level of highway traffic operation has been greatly improved, with significant social and economic benefits.



◉ 高速公路多源信息智能协同感知技术及装备

◉ Intelligent Collaborative Perception Technology and Equipment for Multi-source Information on Highways

成果在中国 18 个省超过 5000 公里高速公路应用

Application of the Results Across over 5000 Kilometers of Highways in 18 Provinces in China

本成果在北京、河北、江苏、浙江、四川、广东、山东等 18 个省份，超过 5000 公里高速公路推广应用，支撑了京雄智慧高速、延崇智慧高速、荣乌智慧高速、京德智慧高速、成宜智慧高速等 50 余项重大、重点工程项目，以及交通强国建设试点、新一代国家交通控制网和智慧公路示范、道路交通事故预防“减量控大”等中国国家重大示范工程。应用路段通行能力提升一成以上、突发事件导致的阻断时间下降三成以上。本成果研发的高速公路交通状态智能感知与主动管控成套技术及系列装备实现产业化，并推广应用于实际工程，取得了显著的社会经济效益。

The achievements have been extensively applied across over 5000 kilometers of highways in 18 provinces including Beijing, Hebei, Jiangsu, Zhejiang, Sichuan, Guangdong, and Shandong. This deployment supports more than 50 major and key projects such as JingXiong Smart Highway, YanChong Smart Highway, RongWu Smart Highway, JingDe Smart Highway, and ChengYi Smart Highway. Additionally, it underpins national major demonstration projects like the pilot construction for a strong transportation country, a new generation of national traffic control networks, smart highway demonstrations, and the “ Reducing the total number of traffic accidents and controlling the occurrence of major traffic accidents” China national initiative for road traffic accident prevention. The evaluation results indicate that the application of these technologies has increased the traffic capacity of the applicable sections by more than 10% and reduced the duration of blockages caused by sudden events by more than 30%. The intelligent perception and active control technologies for highway traffic states, along with the series of equipment developed by the project, have been implemented in practical engineering projects, generating significant social and economic benefits.

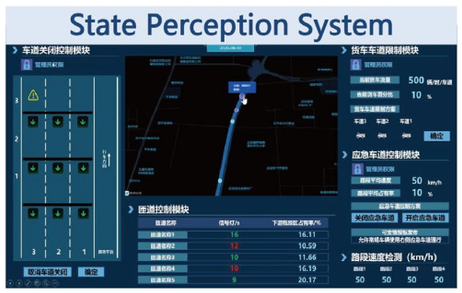
建立智慧公路运营标准体系、赋能企业智慧化转型

Establish a Smart Highway Operational Standards System and Empower Enterprises for Smart Transformation

本成果支撑近 10 年中国交通运输行业智慧公路相关技术政策文件制定，在本成果基础上，编制各类技术标准 33 项，包括智能交通系统实时数字孪生技术国际标准 1 部、国家 / 行业标准 25 部，以及地方标准 7 部，建立高速公路智慧化运营管理行业标准体系，有力支撑《公路工程标准体系》构建，为推动高速公路行业数字化、智能化转型发展，引领行业科技进步与创新做出了贡献。本成果形成的具有完整自主知识产权的高速公路交通状态智能感知与主动管控系统平台与系列装备，部分实现产业化。通过科技攻关合作、技术成果转让、产品联合研发、人才联合培养等方式为企业赋能，推动智慧公路产业发展。

The project's results have supported the development of nearly a decade's worth of technological policy documents related to intelligent highways within the China transportation industry. Based on the results, 33 various technical standards have been compiled, including 1 international standard for real-time digital twin technology for intelligent transportation systems, 25 China national/industry standards, and 7 local standards. A standards system for smart highway operational management has been established, significantly supporting the construction of the "Highway Engineering Standards System" and contributing to the digital and intelligent transformation of the highway industry, leading technological progress and innovation. The achievements have formed a complete system platform and series of equipment for intelligent perception and active control of highway traffic states with full independent intellectual property rights, partially achieving industrialization. Through scientific and technological collaboration, technology transfer, joint product development, and joint talent training, the project has empowered enterprises and promoted the development of the intelligent highway industry.

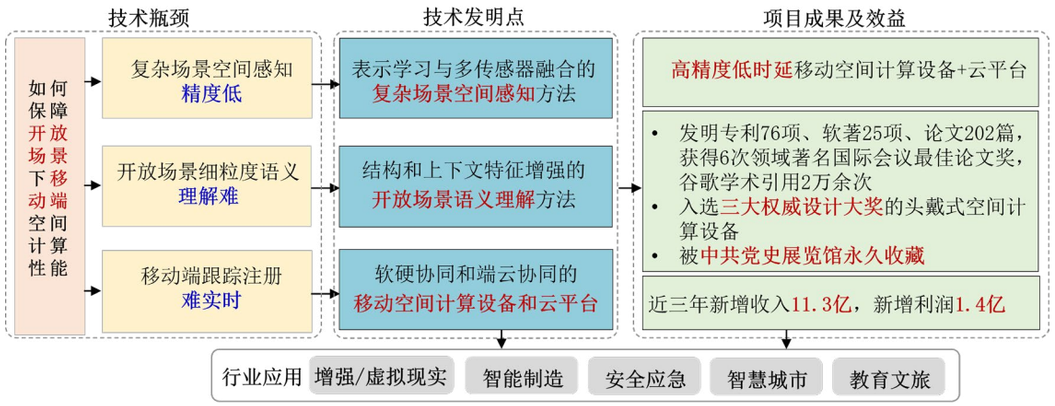
◉ 具有完整自主知识产权的高速公路交通状态智能感知与主动管控系统平台具备状态感知 - 主动管控 - 信息服务 - 决策支持全链条功能



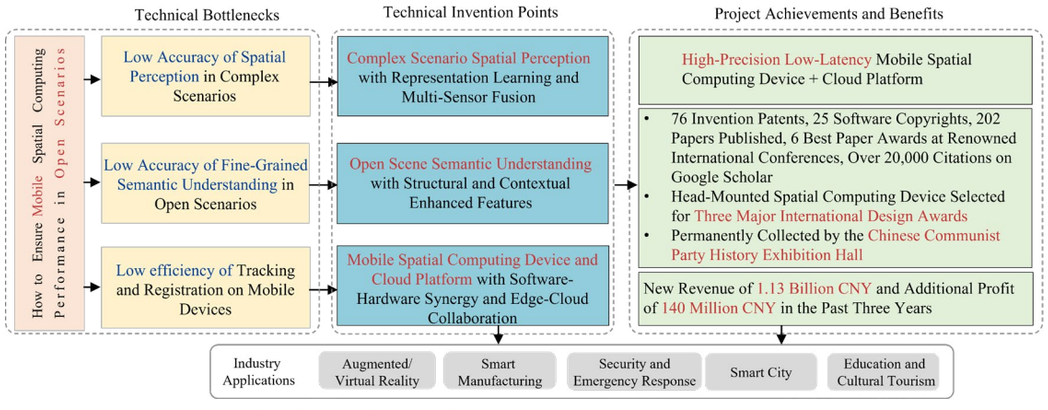
◉ a complete system platform and series of equipment for intelligent perception and active control of highway traffic states with full independent intellectual property rights featuring full-chain functionality of status perception, active control, information service, and decision-making support

开放场景中移动空间计算关键技术和应用

Key Technologies and Applications of Mobile Spatial Computing in Open Environments



◉关键技术挑战、技术发明点和行业应用



◉Key Technical Challenges, Technological Innovations, and Industry Applications.

华中科技大学
Huazhong University of Science and Technology

亮风台（上海）信息科技有限公司
HIAR Information Technology Co.Ltd.

南京理工大学
Nanjing University of Science and Technology

引言

项目研制了高精度低时延移动空间计算设备和云平台，研发了面向开放复杂场景的空间感知和语义理解技术体系和系统，提升了移动空间计算软硬件技术，推动了工业制造和军事安全智能化转型升级。

Introduction

The project developed high-precision, low-latency mobile spatial computing devices and a cloud platform, along with a technology framework and system for spatial perception and semantic understanding in complex, open environments. This advancement improves mobile spatial computing software and hardware, driving the intelligent transformation and upgrade of industrial manufacturing and military security.

开放场景下高精实时空间感知理解与虚实融合

High-Precision Real-Time Spatial Perception and Virtual-Real Fusion in Open Environments

在复杂场景视觉空间感知方面，项目提出了区域自适应与几何编码体的视觉深度感知方法，显著提升了场景中精细结构与大面积病态区域的三维重建精度；提出了点云分割重组技术，建立多传感器融合位姿测量系统，实现复杂场景下毫米级实时位姿测量。

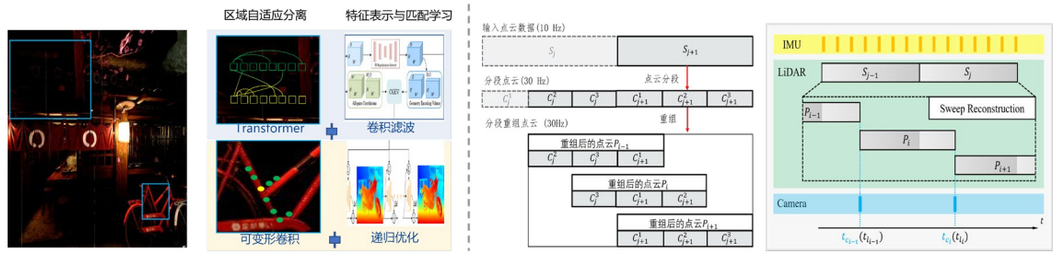
In the area of visual spatial perception in complex environments, the project introduced a region-adaptive and geometric encoding volume-based visual depth perception method, significantly improving the accuracy of 3D reconstruction for fine structures and extensive ill-regions (e.g., textureless/transparent/reflective regions). Additionally, a point cloud segmentation and reorganization technique was developed, along with a multi-sensor fusion-based pose estimation system, enabling millimeter-level real-time pose estimation in complex scenarios.

在开放场景细粒度语义理解方面，项目提出了结构和上下文特征增强的开放场景语义理解方法，显著提升开放场景下语义特征区分性，突破了大规模开放场景下细粒度目标识别难题。

For fine-grained semantic understanding in open environments, the project proposed a semantic understanding method enhanced by structural and contextual features, greatly improving the discriminability of semantic features in open environments and addressing the challenge of fine-grained object recognition in large-scale open scenes.

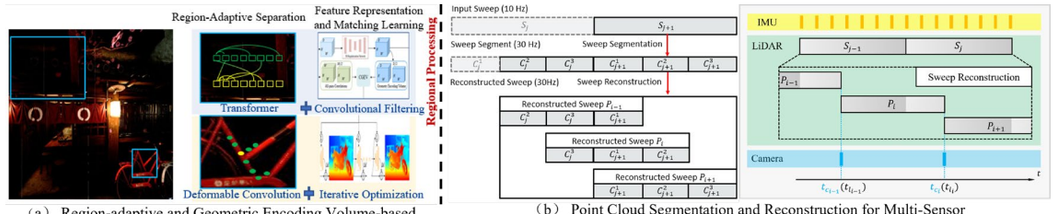
在移动端虚实融合方面，项目发明了硬件感知的跟踪注册模型轻量化方法，提出了“运动到光子”全链路优化技术，突破了移动端算力受限导致的移动端难实时瓶颈；搭建“A+B+C”空间计算云平台，研制高性能头戴式空间计算设备。

In the area of mobile device virtual-real fusion, the project invented a hardware-aware lightweight model for tracking and registration, and introduced a full-chain “motion-to-photon” optimization technique, overcoming the real-time performance bottlenecks caused by limited mobile device computing power. Furthermore, an “A+B+C” spatial computing cloud platform was established, and high-performance head-mounted spatial computing devices were developed.



(a) 区域自适应与几何编码体的视觉深度感知　(b) 点云分割重组实现多传感器融合位姿估计“提频+同步”

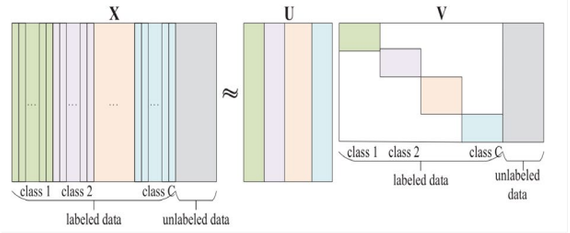
◉技术发明点 1 复杂场景空间结构与运动感知



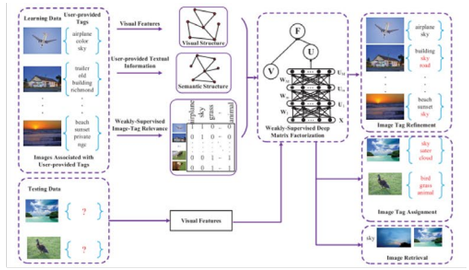
（a） Region-adaptive and Geometric Encoding Volume-based Visual Depth Perception Method

（b） Point Cloud Segmentation and Reconstruction for Multi-Sensor Fusion Pose Estimation: Enhanced Frequency and Synchronization

◉Technical Innovation 1: Spatial Structure and Motion Perception in Complex Scenes

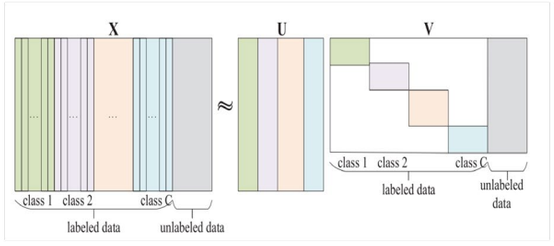


（a）基于块对角结构的图像特征学习

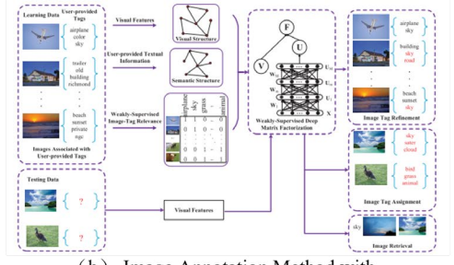


（b）多元结构约束的细粒度图像理解

◉ 技术发明点 2 开放场景细粒度语义理解

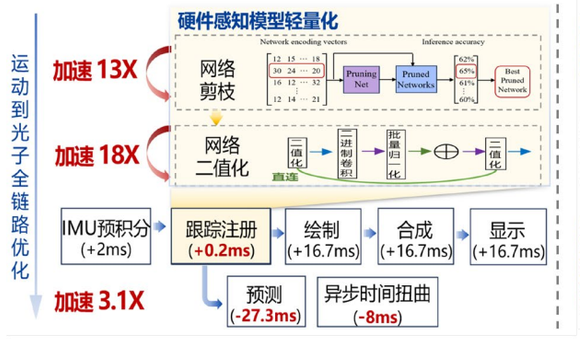


（a） Block Diagonal Structure-Based Image Feature Learning Method

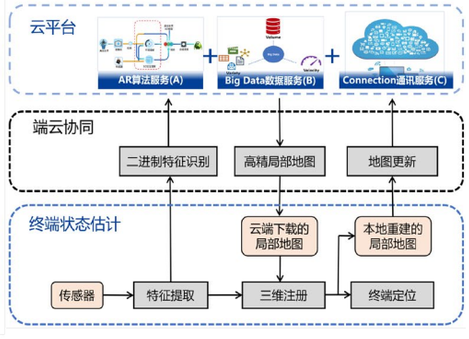


（b） Image Annotation Method with Multivariate Structural Constraints

◉ Technical Innovation 2: Fine-Grained Semantic Understanding in Open Scenes

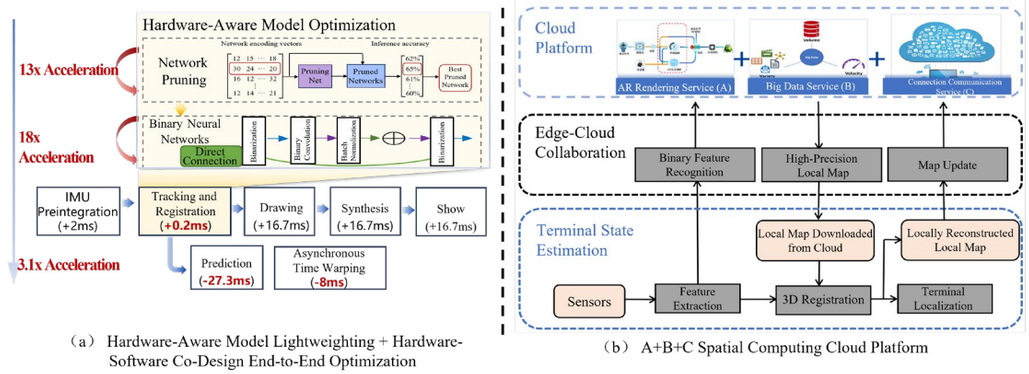


(a) 硬件感知模型轻量化+软硬协同全链路优化



(b) “A+B+C”空间计算云平台

◉ 技术发明点 3 软硬协同优化的移动端低时延跟踪注册



（a） Hardware-Aware Model Lightweighting + Hardware-Software Co-Design End-to-End Optimization

（b） A+B+C Spatial Computing Cloud Platform

◉ Technical Innovation 3: Low-Latency Tracking and Registration

广泛应用于混合现实、智能制造等多个领域

Widely Applied in Multiple Fields such as Mixed Reality and Intelligent Manufacturing

本项目技术指标与同类型先进设备微软 Hololens 和苹果 Vision Pro 相比，精度和时延达到同等性能，功耗更低目近三年实现新增销售额超过 11.34 亿元，新增利润超过 1.41 亿元，技术成果累计应用于中国宝钢、湘钢、中国商飞等多家单位，涵盖增强现实、智能制造、安全应急和智慧文旅等多个领域，社会经济效益显著。

The technical specifications of this project are on par with advanced devices such as Microsoft HoloLens and Apple Vision Pro in terms of precision and latency, while offering significantly lower power consumption. In the past three years, it has achieved additional sales exceeding 1.134 billion RMB and additional profits of over 141 million RMB. The technological outcomes have already been applied across multiple organizations, including Baowu and Xiangtan Iron and Steel Group Co., Ltd., covering fields such as augmented reality, intelligent manufacturing, safety and emergency response, and smart cultural tourism. The project has demonstrated significant socio-economic benefits.

Key Performance Indicators

Compared to similar devices, this project achieves **the same accuracy and latency** but with **lower power consumption.**

Function		Similar Products		Our Products
		Microsoft Hololens	Apple Vision Pro	G300
Optical See-Through		Supported	Not Supported	**Supported**
Speech Recognition Rate		>95%, NR<60db	>95%, NR<60db	>95%, NR<**90db**
6DOF Pose Measurement	Positioning Error(cm)	<0.9(Small Scene 100 m²)) <4.0(Large Scene (10,000 m²))	<0.9(Small Scene (100 m²)) <4.0(Large Scene (10,000 m²))	<0.9(Small Scene (100 m²)) <4.0(Large Scene (10,000 m²))
	Angular Error	0.8° (Real-time)	0.8° (Real-time)	0.8° (Real-time)
	Latency(ms)	20	12	17
	Power Consumption(w)	10	20	**4.31**
Price (CNY, 10,000s)		4.9	2.5	**1.7**
Product Image				

本项目设备与同类型设备相比，精度和时延达到同等性能，功耗更低

功能		同类型产品		本项目空间计算设备
		微软Hololens	苹果Vision Pro	G300
光学透视		支持	不支持	**支持**
语音识别率		>95%, 抗噪<60db	>95%,抗噪<60db	>95%，抗噪<**90db**
6DOF位姿测量	定位误差(cm)	<0.9(百平米小场景) <4.0(万平米大场景)	<0.9(百平米小场景) <4.0(万平米大场景)	<0.9(百平米小场景) <4.0(万平米大场景)
	角度误差	0.8°（实时）	0.8°（实时）	0.8°（实时）
	时延(ms)	20	12	17
	功耗(瓦)	10	20	**4.31**
价格(人民币，万元)		4.9	2.5	**1.7**
产品图				

◉ 同类先进移动空间计算设备功能与性能对比

◉ Comparison of Features and Performance of Advanced Mobile Spatial Computing Devices

为 XR、制造等行业数智化转型提供关键技术支持

Providing Key Technological Support for the Digital-Intelligent Transformation of XR and Manufacturing Industries

在增强现实领域，项目将设备在移动端芯片上空间定位速度提升 5.8 倍，同时显著提高了开放场景下空间感知鲁棒性，达到与苹果 Vision Pro 和微软 Hololens 相近的速度和精度。为研制高端空间计算设备和核心器件做出贡献。

In the field of augmented reality, the project increased spatial positioning speed on mobile device chips by 5.8 times while significantly improving spatial perception robustness in open environments, achieving speed and accuracy comparable to Apple Vision Pro and Microsoft HoloLens. This contributed to the development of high-end spatial computing devices and core components.

在工业制造领域，成果应用于增强现实远程巡检、运维等系统，服务宝钢、湘钢等多家大型企业，有效解决了传统工业制造中成本高、效率低等问题，特别在疫情期间实现了跨国远程指导，刷新工程建设周期纪录。

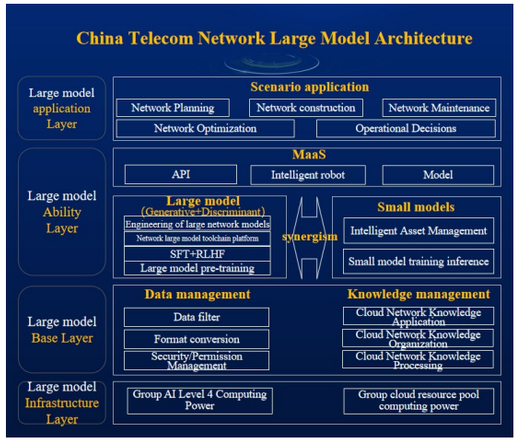
In the area of industrial manufacturing, the technology has been applied to augmented reality-based remote inspection and maintenance systems, serving large enterprises such as Baowu and Xiangtan Iron and Steel Group Co., Ltd. It effectively addressed challenges like high costs and low efficiency in traditional manufacturing, and during the pandemic, it enabled cross-border remote guidance, setting new records for project construction timelines.

在安全应急领域，项目成果提升了警务数据融合与指挥调度能力，应用于多个公安系统，打造了 3D 立体防控系统，增强了城市安全与应急响应能力。

In the field of safety and emergency response, the project's outcomes enhanced police data integration and command dispatch capabilities. It has been applied to multiple public security systems, creating a 3D stereoscopic defense system that strengthens urban safety and emergency response capabilities.

网络大模型关键技术研发及规模应用

Research and Development of Key Technologies of Network Large Model and Large-Scale Applications



◉ 网络大模型架构

◉ China Telecom Network Large Model Architecture

中国电信集团有限公司
China Telecom Corp Ltd.

华为技术有限公司
Huawei Technologies Co., Ltd.

引言

中国电信网络大模型贯穿云网运营全流程，激活海量云网资产与系统能力，大小模型协同，大幅提升运维效率，推进网络大模型产品化，与云网操作系统一体化，助力企业加速发展新质生产力，赋能信息通信基础设施运营。

Introduction

China Telecom network large model runs through the entire process of cloud-network operation, activates massive cloud-network assets and system capabilities, synergizes large and small models, greatly improves O&M efficiency, promotes the productization of network large model, and integrates with cloud-network operating systems, helping enterprises accelerate the development of new quality productivity and empower information and communication infrastructure operations.

技术创新是网络大模型的核心竞争力

Technological Innovation is the Core Competitiveness of the Network Large Model

中国电信网络大模型突破攻坚八项关键技术，实现核心竞争力提升，技术领先。

China Telecom network large model has made breakthroughs in eight key technologies to improve its core competitiveness and lead technology.

1. 打造网络领域大模型增量预训练能力。通过设计并行训练方案，实现大模型高效训练；构建能够正确理解电信业务能力的领域大模型。

1.The project has created incremental pre-training capabilities for large models in the network domain. By designing a parallel training scheme, the efficient training of large models can be realized. Build a large domain model that can correctly understand telecom business capabilities.

2. 提出面向任务的多轮对话管理机制。精准识别意图，实现场景任务的智能处理。

2.The project proposes a task-oriented multi-round dialogue management mechanism. Accurately identify intentions and realize intelligent processing of scene tasks.

3. 高质量语料自动生成能力。构建全域云网知识体系，研发基于图谱和文档批量生成问答对能力。

3.The project has developed a high-quality automatic corpus generation technology. It has innovatively built a global cloud-network knowledge system, and developed the ability to generate Q&A pairs in batches based on graphs and documents.

4. 多路检索增强生成。提出联合检索、多路复合切片重排序算法，解决大模型专业领域认知不足。

4.The project develops multi-channel search enhancement generation technology. By using joint retrieval and multi-channel composite slice reordering algorithms, the problem of insufficient cognition in the professional domain of large models is solved.

5. 大模型高效推理框架。结合高效推理框架，采用多机多卡并行推理。

5.The project builds an efficient inference framework for large models. Combined with the efficient inference framework, the multi-machine and multi-card parallel mechanism is used for large model inference.

6. 基于知识图谱的模型质量评估。提出基于知识图谱生成审查测试链、主客观分离自动评估闭环技术，解决大模型质量评估缺乏自动手段，迭代优化效率低问题。

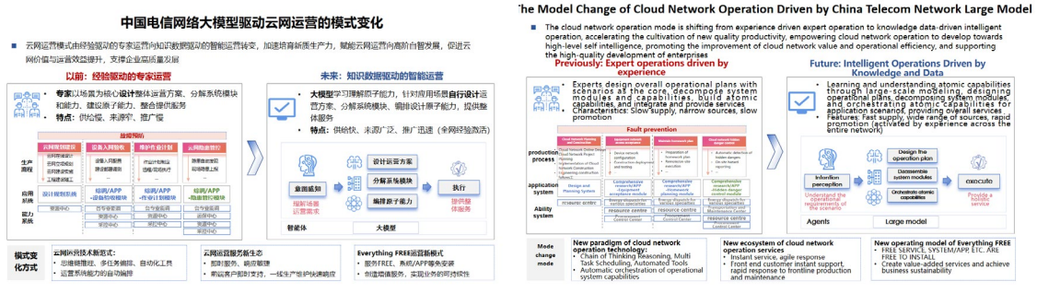
6.The project developed a knowledge graph-based model quality assessment technology. This paper proposes a closed-loop technology based on knowledge graph generation review test chain and subjective and objective separation automatic evaluation to solve the problems of lack of automatic means and low iterative optimization efficiency of large model quality evaluation.

7. 智能体多任务分解引擎。通过 API 能力实例化、并行串行逻辑控制，实现网运营复杂任务的高效管理和执行。

7.The project has developed the agent multi-task decomposition engine technology. Through API capability instantiation and parallel serial logic control, the efficient management and execution of complex tasks in network operation are realized.

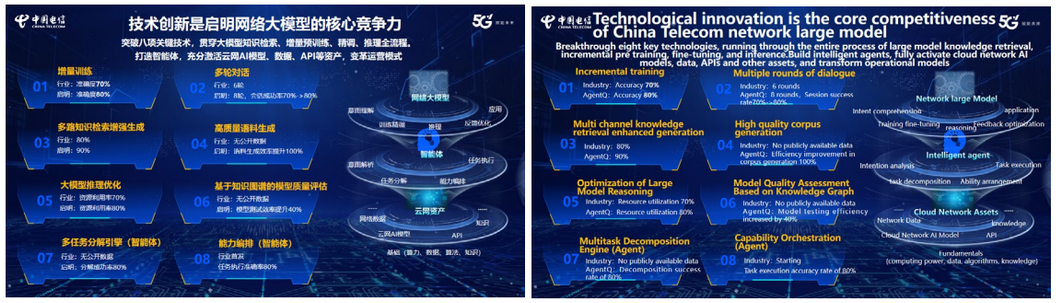
8. 智能体智能编排。设计云网融合智能体编排架构，实现任务的理解与快速处理。

8.The project realizes the intelligent orchestration capability of the agent. Design a cloud-network converged agent orchestration architecture to achieve task understanding and rapid processing.



◉ 网络大模型驱动云网运营模式变化

◉ The network large model drives changes in the cloud-network operation model



◉ 网络大模型核心关键技术及创新应用模式

◉ The Core Key Technologies and Innovative Application Modes of the Network Large Model

网络大模型赋能云网运营全流程

The Network Large Model Empowers the Entire Process of Cloud-Network Operation

网络大模型以其深厚的学习能力和广泛的适用性，推动 AI 技术赋能云网场景，全面提升运营效率。2023 年实现通信领域首发，持续迭代更新，引领行业发展。

The network large model, with its profound learning ability and wide applicability, promotes AI technology to empower cloud network scenarios and comprehensively improve operational efficiency. In 2023, the network model has been launched for the first time in the communication field, and it will continue to be iteratively updated to lead the development of the industry.

经济效益显著：网络大模型面向云网工程师，打造知识问答、运维辅助两类 12 个 AI 助手和智能体，实现故障处置效率提升 30%、硬件类故障装维上门次数减少 50%。深度嵌入中国电信现网系统，全网部署应用。

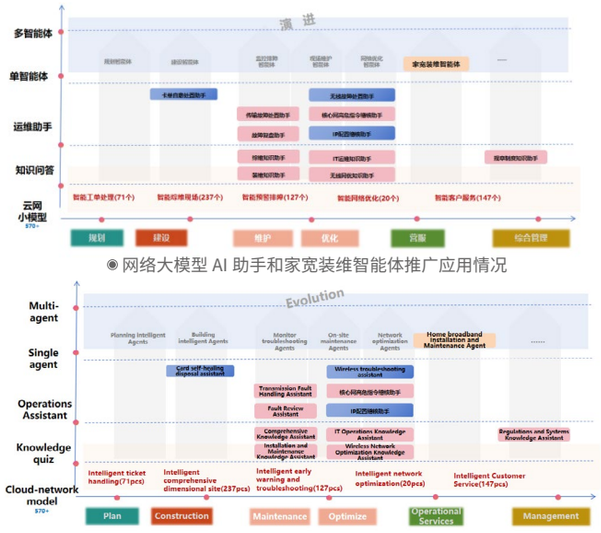
Significant economic benefits: Targeting cloud network engineers, we have created 12 AI assistants and intelligent agents in two categories: knowledge Q&A and operation and maintenance assistance. The efficiency of fault handling has been improved by 30%, and the number of hardware fault installation and maintenance visits has been reduced by 50%. The overall capability is deeply embedded in China Telecom's live network system, and the whole network deployment and application has been completed.

社会效益卓越：落地态势感知、知识检索与交互、故障处置方案、工单质量稽核等场景，解决一线生产问题。同步打造工具链平台，加速 AI 落地。

Excellent social benefits: Implementing situational awareness, knowledge retrieval and interaction, troubleshooting solutions, work order quality audits, and other scenarios to solve frontline production problems. Synchronize the creation of a toolchain platform to accelerate the landing of AI.

生态效益斐然：通过网络大模型的算力、数据、模型、场景大模型能力，构建专属大模型及智能应用，注智生产和决策，推动云网运营效率提升，使能产数发展。

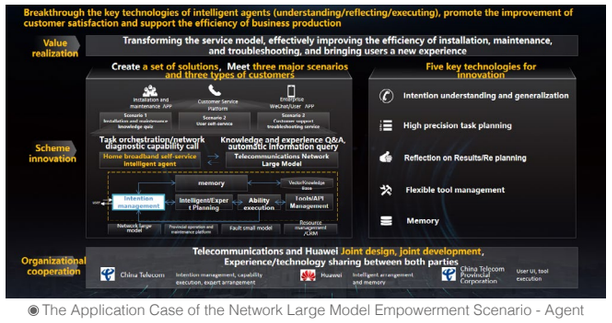
Outstanding ecological benefits: Through the computing power, data, model, and scenario model capabilities of the network model, exclusive large models and intelligent applications can be built, intelligent production and decision-making can be injected, and cloud-network operation efficiency can be improved, enabling the development of data production.



◉网络大模型 AI 助手和家宽装维智能体推广应用情况

◉The Application and Promotion of Network Large Models in AI Assistants and Home Broadband Installation and Maintenance Agents

◉网络大模型赋能场景应用案例——智能体



◉The Application Case of the Network Large Model Empowerment Scenario - Agent

网络大模型，开启云网运营自智新篇章

The Network Large Model Opens a New Chapter in the Self-Intelligence of Cloud-Network Operation

网络大模型的落地应用，被人民日报、人民邮电报等主流媒体报道。“网络大模型 - 知识管理平台”通过中国信通院知识构建与管理模块全能力域评估，成为电信行业率先通过评估并获得 4+ 级认证的单位。

The implementation and application of the large-scale network model have been reported by mainstream media such as People's Daily and People's Posts and Telecommunications Daily. The "The knowledge management platform for large network models" has passed the full capability domain evaluation of the knowledge construction and management module of the China Academy of Information and Communications Technology, becoming the first unit in the telecommunications industry to pass the evaluation and obtain a 4+level certification.

面向内部，嵌入核心系统，重点打造 12 个 AI 助手。为运营效率提升和智能化转型提供了有力支撑。面向外部，探索大模型商用方式，构建工具链平台，打造 MaaS 模式，实现网络大模型高可用性、易用性，促进产业融合，创造更大价值。

The network model is internal-oriented, and by embedding the core system, it focuses on building 12 AI assistants.It provides strong support for the improvement of operational efficiency and intelligent transformation. Externally, we explored the commercial mode of large models, and built a tool chain platform to create a MaaS model to achieve high availability and ease of use of large network models, promote industrial integration, and create greater value.

研发网络大模型智能体技术，实现从方案生成到任务分解、逻辑编排、感知分析、自动执行到自学习优化的全流程驱动。

We have developed the network large model agent technology to realize the whole process driving from solution generation to task decomposition, logical orchestration, perception analysis, automatic execution to self-learning optimization.

通过 MaaS 服务新模式，赋能生产，助力提质增效创收；面向行业赋能，促进与产业融合。

Through the new model of MaaS service, the network model empowers production and use, helps improve quality, increase effectiveness and create revenue, empowers the industry, and promotes integration with the industry.

◉网络大模型 MaaS 服务模式

◉MaaS Service Model for the Network Large Model

◉网络大模型生态共建

◉Collaborative Construction of Network Large Model Ecosystem

自智引领，推动云网运营全面 AI 化

Self-intelligence Leads to Promote the Comprehensive AI of Cloud-Network Operations

媒体报道方面，人民邮电报报道：中国电信重磅发布网络大模型，是中国信息通信领域首个发布的网络大模型。人民日报客户端报道：《网络大模型白皮书》发布。

In terms of media reports, the People's Post and Telegraph reported: China Telecom released a large network model, which is the first network model released in the field of information and communication in China. The People's Daily client reported an article entitled "The White Paper on the Network Large Model".

产业影响力方面，在行业系列标准获 CCSA 科技奖二等奖，相关案例获中国云网智联大会 2022 年度中国 SDN、NFV、网络 AI 优创新实践案，《云网 AI 自智关键技术创新与实践》入选“2023 自智网络优秀解决方案”。2024 年，在 ITU-T 的人工智能向善（AI for Good ）创新案例评选中，中国电信申报的“网络大模型赋能云网运营的创新实践”入选优秀案例集，并荣获“最佳行业影响力奖”。

In terms of industrial influence, it won the second prize of CCSA Technology Award in the industry series standards, and related cases won the 2022 China SDN, NFV, and Network AI Innovation Practice Case at the China Cloud Network Intelligent Connection Conference. The "Key Technology Innovation and Practice of Cloud Network AI Self-intelligence Network" was selected as the "2023 Excellent Solution for Self intelligence Network". In 2024, in the ITU-T's AI for Good innovation case selection, China Telecom's "Innovative Practice of Empowering Cloud Network Operations with Network Large Models" was selected as an excellent case set and won the "Best Industry Influence Award".

技术创新方面，发布《云网自智白皮书 3.0》，完成国际标准 ITU-T 立项 3 个、ETSI 立项 3 个，中国 CCSA 立项 3 个。

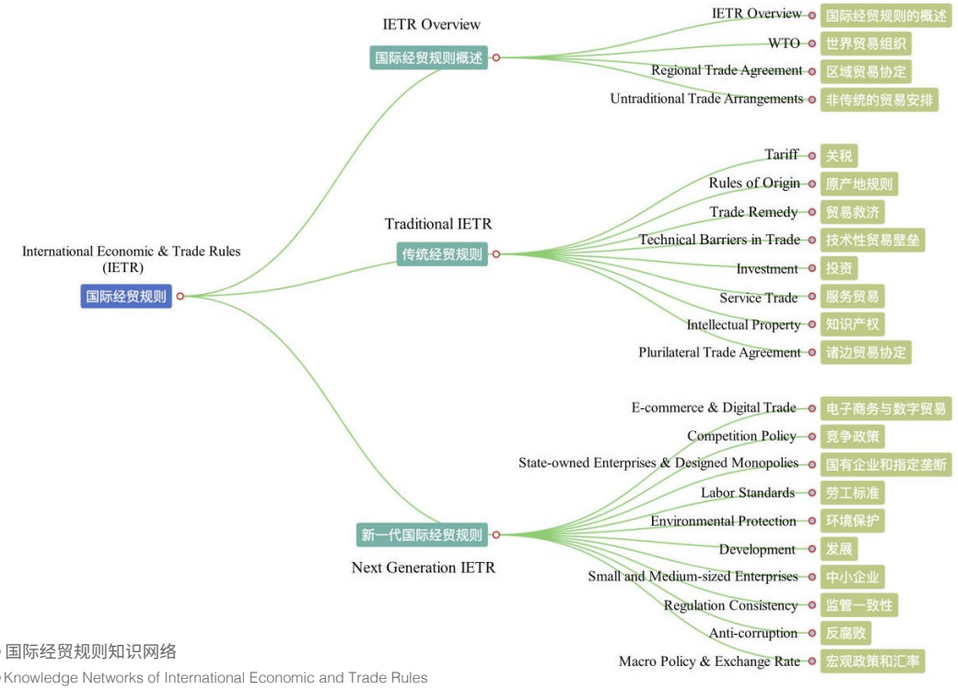
In terms of technological innovation, China released the "Cloud-Network Self-Intelligence White Paper 3.0", and completed 3 international standard ITU-T projects, 3 ETSI projects, and 3 CCSA projects in China.

◉ “网络大模型赋能云网运营的创新实践”荣获 ITU-T（AI for Good ） “最佳行业影响力奖”

◉ “Innovative Practice of Network Large Model Empowering Cloud-Network Operation" won the ITU-T (AI for Good) "Best Industry Influence Award"

国际经贸规则虚拟实验室

Virtual Laboratory of International Economic & Trade Rules



◉ 国际经贸规则知识网络

◉ Knowledge Networks of International Economic and Trade Rules

对外经济贸易大学

University of International Business and Economics (UIBE)

引言

本实验室构建了全球经贸规则数据库，围绕国际经贸规则条款解读、影响效应分析与签订走势预测展开研究。数据库涵盖 WTO 文本、区域贸易协定文本和投资贸易数据，提供量化分析报告、WTO/FTA 动态指数及 FTA 签订概率预测。通过先进的文本分析、数据可视化、企业数据检索及机器学习预测，推动对国际经贸规则的深度解析与前瞻性预测。

Introduction

The laboratory has built a database of global economic and trade rules to focus on the interpretation of the International Economic and Trade Rules, impact analysis and signing trend prediction. The database covers WTO texts, regional trade agreement texts and investment trade data, providing quantitative analysis reports, and WTO/ FTA dynamic index and FTA signing probability prediction. Through advanced text analysis, data visualization, enterprise data retrieval and machine learning prediction, we can promote in-depth analysis and forward-looking prediction of the International Economic and Trade Rules.

以智能技术构建文本数据量化分析系统

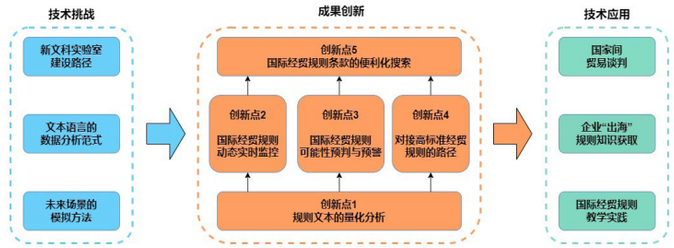
Build the Text Data Quantitative Analysis System with Intellectual Technologies

本实验室在全球经贸规则数据库的建设中突破了多个技术难点。首先，面对国际经贸规则文本的多语言、多格式和大数据量挑战，我们成功构建了一个全面的文本数据整合系统，确保了数据的一致性和完整性，并实现了高效的实时更新，以应对不断变化的国际经贸环境。与WTO和OECD提供的数据相比，我们的数据库不仅提供了更丰富的数据资源，还具备智能化的自主查询与分析功能，推动了政策研究和学术研究的智能化和多样化发展。

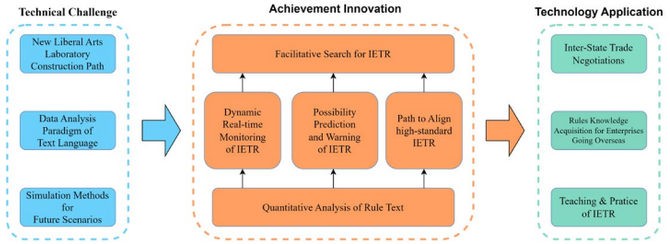
The laboratory has broken through many technical difficulties in the construction of the global economic and trade rules database. First of all, in the face of the challenges of the text of international economic and trade rules in terms of multiple languages, diverse formats and large data volume, we have successfully built a comprehensive text data integration system to ensure the consistency and integrity of data, and achieve efficient and real-time update for coping with the changing international economic and trade environment. Compared with the data provided by WTO and OECD, our database not only provides richer data resources, but also has intelligent self-inquiry and analysis functions, which promotes the intelligent and diversified development of policy research and academic research.

其次，在 FTA 生效概率预测方面，开发了优化的机器学习算法，克服了大数据量和高算力需求的瓶颈，显著提高了预测准确性和计算效率。“一键式”平台将区域、产品、时间序列及微观企业层面的贸易数据整合，提供了便捷的网络接口，用于快速分析和导出进出口数据，大幅度减少了时间成本，提升了分析效率。

Secondly, we have developed an optimized machine learning algorithm for FTA entry-into-effect probability prediction; such an algorithm overcomes the bottleneck of large data volume and high computability requirements, and significantly improves the prediction accuracy and computing efficiency. The “One-click” platform integrates regional, product, time series and micro-enterprise level trade data, providing a convenient network interface for rapid analysis and deriving import and export data, thus reducing time costs and improving analysis efficiency greatly.



◉ 国际经贸规则虚拟实验室架构图



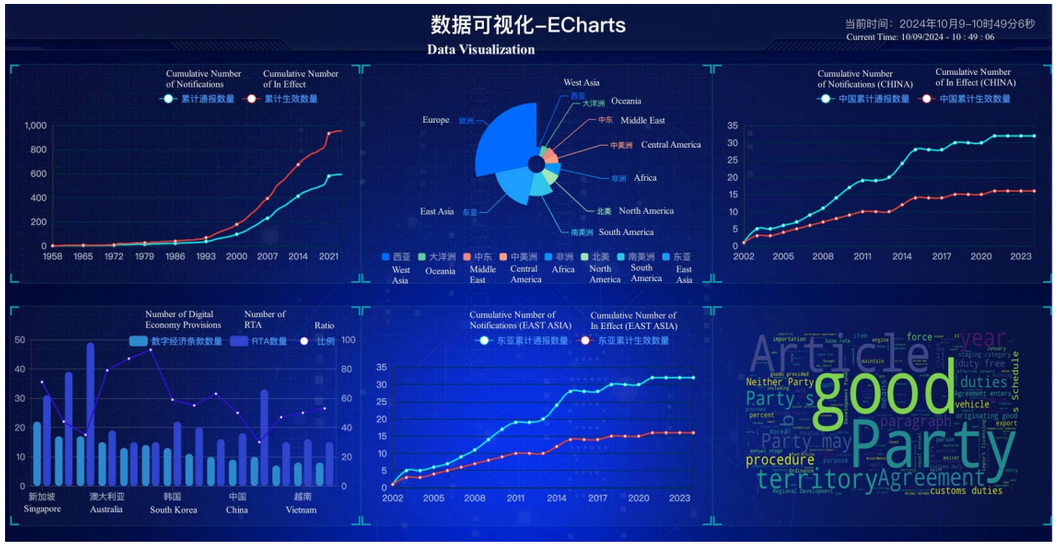
◉ Architecture Diagram on Virtual Laboratory of International Economic and Trade Rules

以数据量化模拟赋能国际组织人才培养

Enable Talent Cultivation of International Organizations Through Data Quantitative Simulation

该成果创新性地将国际经贸规则搬上了大数据平台，实现了研究理论与实践深度融合：一是打造集成式的经贸规则海量文本数据平台，推动国际经济学、国际法学、信息技术等多学科的跨学科交叉融合；二是创建智能仿真模拟谈判平台，基于 AI 技术打造国际经贸规则模拟谈判场景，培养国际组织人才；三是发布国际经贸规则动态指数，实时追踪全球经贸规则演变动向，提升中国经贸规则的国际话语权；四是基于 AI 大语言模型的经贸规则舆情监测，及时把握全球经贸规则热点趋势；五是成果转化应用到“一带一路”留学生课堂，讲好“中国发展故事”。

This achievement has innovatively put the International Economic and Trade Rules on the big data platform and realized the deep integration of research theories and practices: Firstly, we have built an integrated massive text data platform of the International Economic and Trade Rules to promote the interdisciplinary integration of international economics, international law, information technology and other disciplines; secondly, we have created an intelligent simulation negotiation platform to build a negotiation simulation scenario of the International Economic and Trade Rules based on AI technologies for developing the talents for international organizations; thirdly, we have released dynamic indexes of the International Economic and Trade Rules and track the evolution trend in real time to enhance the international power of discourse of the China’s Economic and Trade Rules; fourthly, we have carried out the monitoring of the public opinions on the International Economic and Trade Rules based on the AI large language model to timely grasp the hotspot trends; fifthly, the achievements are transformed and applied to the international students’ classrooms of “Belt and Road “ and tell the “Stories of China’s Development”.



◉ 全球经贸规则动态分析大屏

◉ Dynamic Analysis Big Screen of International Economic and Trade Rules

以智能分析提供决策咨询服务

Provide Decision-Making Consultation Services Through Intelligent Analysis

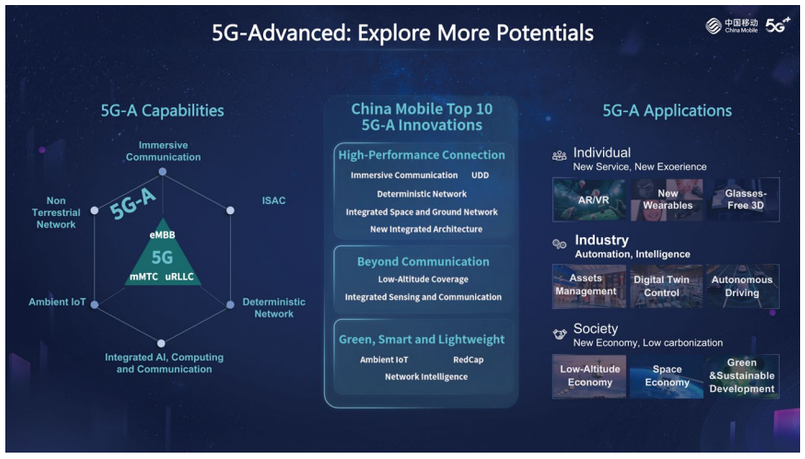
智库资政方面，实验室的量化分析报告、FTA 活跃度指数等成果为相关国家部委提供重要决策参考。产学研方面，实验室与许多行业组织建立起深度合作关系，已与世界互联网大会、阿里巴巴 e-WTP（世界电子贸易平台）、中国贸促会建立常态化合作关系，在国际经贸规则、跨境电商政策等领域开展课题合作研究。国际合作方面，该虚拟实验室是与 WTO 教席项目（中国仅有两家）标志性成果，也是“丝绸之路”中国政府奖学金项目的重要教学平台。项目主要负责人受邀参加 WTO 第 13 届部长级会议，与国际知名专家讨论平台建设。该项目多名成员推荐至 WTO 日内瓦总部实习，成为国际人才联合培养的成功案例。荣誉奖项方面，实验室的核心成果获教育部高等学校科学研究优秀成果奖 (人文社科最高奖)、安子介国际贸易研究奖（国际贸易研究最高奖）、北京市哲学社会科学优秀成果二等奖、中国大学生计算机设计大赛二等奖等多项国家级和省部级奖项，并获多项国家版权局颁发的计算机软件著作权。

In terms of Think Tank for the Government’s Governance, the quantitative analysis reports, FTA activity index and other achievements of the laboratory provide important decision-making references for relevant national ministries and commissions. In terms of industry, university and research cooperations, the laboratory has established in-depth cooperative relations with many industry organizations, and has established regular cooperative relations with the World Internet Conference, Alibaba e-WTP (Electronic World Trade Platform), and China Council for the Promotion of International Trade to carry out the cooperative research on the International Economic and Trade Rules, cross-border e-commerce policies and other fields. In terms of international cooperation, the virtual laboratory is a landmark achievement of the WTO Chairs Programme (there are only two in China), and it is also an important teaching platform for the Chinese Government Scholarship Program of the “Belt and Road”. The main leaders of the project were invited to attend the 13th WTO’s Ministerial Conference and discussed the construction of the platform with internationally renowned experts. Many members of the program were recommended to intern at the WTO headquarters in Geneva, which became a successful case of international talent joint training. In terms of honors and awards, the laboratory’s core achievements won a number of national and provincial awards, such as the Scientific Research Outstanding Achievement Award (Science and Technology) of Institutions of Higher Learning under the Ministry of Education (the highest award for Humanities and Social Sciences), the Anzijie International Trade Research Award (the highest award for International Trade Research), the Second Prize of the Beijing Philosophy and Social Science Outstanding Achievement Award, and the Second Prize of the Chinese Collegiate Computing Competition. Besides, the laboratory also obtained many computer software copyrights issued by the National Copyright Administration.

5G-A 技术创新、标准化及规模应用

5G-A Technology Innovation, Standardization and Large-Scaled Applications

◉5G-Advanced 拓展能力边界，探索无限可能



◉5G-Advanced: Extend Capability Boundaries, Explore More Potentials

中国移动有限公司
China Mobile Communications Group Co., Ltd.

华为技术有限公司
Huawei Technologies Co., Ltd.

中兴通讯股份有限公司
ZTE Corporation

引言

信息通信在全球数字化发展过程中发挥着基础性和先导性作用。5G-Advanced 首次实现从单一通信能力到通感算智多重能力融合、从地面覆盖到空天地立体泛在覆盖的新跨越，赋能个人视听新体验、经济发展新业态、行业数智新升级。

Introduction

Telecommunication industry plays a fundamental and pioneering role in the process of global digital development. For the first time, 5G-Advanced technologies realize a new leap from a single communication capability to the integration of multiple capabilities of communication, sensing, computing and intelligence, from ground-only coverage to three-dimensional coverage of the space and ground. 5G-A will empower new audio-visual experiences for individuals, new modes of economic development, and new upgrading of the industry digital intelligence.

引领 5G-A 技术创新与标准制定，领跑 5G-A 网络建设与应用示范

Leading 5G-A Technology Innovation and Standardization, and Spearheading 5G-A Network Construction and Application Demonstrations

本成果基于通信、感知、智能化等跨领域技术创新，打造低空智联网、通感一体、蜂窝无源物联、双工演进等 5G-A 关键技术，申请专利 700 余项，发表 SCI/EI 等论文近 30 篇，实现连接能力 10 倍提升、网络能力多维拓展。

Based on cross-domain technological innovations in communication, sensing, intelligence, etc., this achievement creates 5G-A key technologies such as low-altitude intelligent network, integrated communication and sensing, ambient IoT, duplex mode evolution, etc., applies for more than 700 patents and publishes nearly 30 papers including high quality SCI/EI papers. With this achievement, the connectivity capability can be enhanced 10-fold and network capabilities are extended in multi-demension.

引领 5G-A 标准制定，主导 3GPP 5G-A 标准项目数全球领先，累计担任 3GPP 全会副主席等主席职位 13 个，成功发布全球首个 5G-A 技术标准。

Leading the 5G-A standardization, we have possessed the leading number of 3GPP 5G-A work items globally, served as vice-chairman of the 3GPP Plenary and other chairmanships for a total number of 13, and promoted the successfully release of the world's first 5G-A standard.

探索 5G-A 产品创新无人区，创新提出中低频通感一体 AAU、通感算智一体化新架构、NTN 透明转发基站等产品解决方案，全球首发通感一体基站、智算基站、工业基站等十余款 5G-A 创新产品，带动产业跨越式发展。

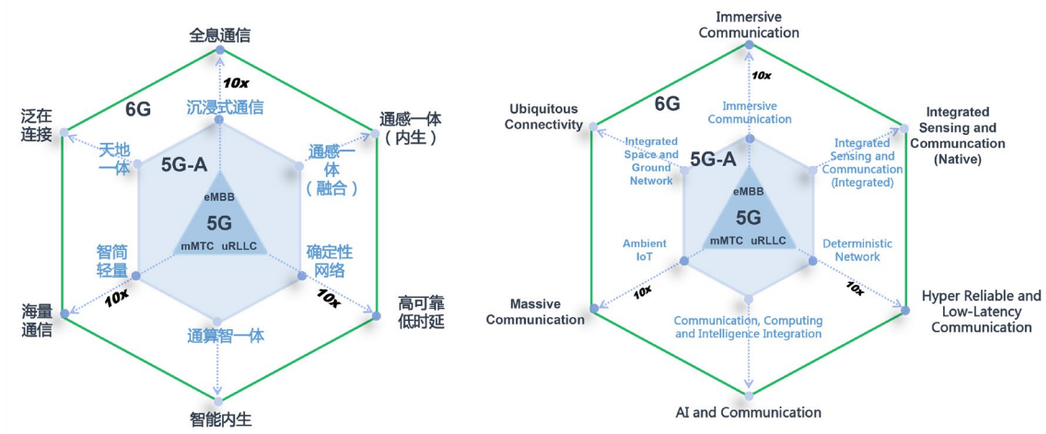
Exploring the 5G-A product innovation, we have innovatively put forward product solutions such as integrated sensing and communication AAU for medium and low frequency, integrated architecture of communication, sensing, computing and intelligent, NTN transparent forwarding base station, etc., and globally premiered 5G-A innovative products such as ISAC base station, intelligent computing base station, industrial base station, etc., leading the industrial development by leaps and bounds.

领跑 5G-A 网络建设，全球首发 5G-A 100 个商用城市，开启 5G-A 商用元年，2024 年完成 300 城市部署，建成全球规模最大的 5G-A 商用网络，反哺全球 5G-A 规模发展。

Leading 5G-A network construction, we have started the world's first 5G-A commercialization in 100 cities, opening the first year of 5G-A commercialization. We plan to complete the 5G-A network deployment of 300 cities in 2024, building the world's largest 5G-A commercial network, and feeding the global 5G-A scale development.

◉发布 5G-A 关键技术系列白皮书

◉5G-A Key Technology White Paper Series Released



◉ 5G-A 是对 5G 能力的增强和拓展，也是面向 6G 的前期探索和验证

◉ 5G-A is an enhancement and extension of 5G, as well as a pre-exploration and validation for 6G

5G-A 助力生产生活方式数智升级，为经济高质量发展注入强劲动力

5G-A Promotes the Digital and Intelligent Upgrade of Production and Life Style, and Facilitate the High-quality Development of the Economy

丰富个人通信业务体验，促进视听体验升级。沉浸实时技术助力首钢 SoReal 科幻乐园 XR 业务无线化，50 位玩家“轻装上阵”，无需背包即可流畅体验 XR 游戏；天地一体技术为自然灾害等场景、沙漠森林等地区提供通信服务，实现无处不达、无时不在的泛在连接。

5G-A enriches personal communication service experience and promotes audio-visual experience upgrading. Immersive real-time communication technology helps XR service go wireless in Shougang SoReal Park, with 50 players experiencing XR games smoothly without backpacks. Integrated space and ground network technology provides communication services for natural disasters and other scenarios, desert forests and other areas, realizing ubiquitous connectivity, reaching everywhere and at all times.

拓展移动通信能力边界，促进行业数智发展。Redcap 轻量化技术降低电力 / 工业、视频监控终端成本，打造亚运会安防视联、华兴源智慧工厂、李惠利医院园区等标杆应用，让数智化更普惠；5G 内生确定技术及产品大幅减少工控机、PLC 等现场物理设备和线缆损耗，以汽车制造企业为例，依托高确定性工业基站，产线交付周期缩短 15%、设备减少 60%、成本降低 50%，已在荆州美的、广州京信等工厂落地应用。

5G-A extends the boundaries of mobile communication capabilities and promotes the development of digital intelligence in the industry. Redcap lightweight technology reduces the device costs in the industry of utilities, video surveillance, etc., and creates benchmark applications such as video surveillance for security in Hangzhou Asian Games, Huaxingyuan Smart Factory, and Lihuili Hospital Campus to make digital intelligence more universal. 5G deterministic technology and products significantly reduce the loss of industrial controllers, PLCs, and other on-site equipment and wires. Taking automobile manufacturing as an example, relying on high deterministic industrial base station, production line delivery cycle has been shortened by 15%, equipment has been reduced by 60%, and cost has been reduced by 50%. Jingzhou Midea and Guangzhou Jingxin have deployed deterministic network and applications.

构建高效安全的智慧社会，促进社会民生发展。5G-A 通感一体应用于水陆空全场景，打造深圳人才公园低空经济样板示范区、上海 - 舟山跨海航线“低空海鲜”极速达等标杆应用，预期市场规模超万亿。

5G-A builds an efficient and secure intelligent society, and promotes the development of society and people's livelihoods. 5G-A integrated sensing and communication technology is applied to the land, water and air scenes, and creates benchmark applications such as the talent park in Shenzhen, low-altitude logistic route for Shanghai - Zhoushan cross-sea delivery of seafood. The expected market size will reach more than a trillion dollars.

◉ 室内超密集沉浸式场景下的 XR 应用试点现场

◉ XR Application Trials for Indoor Ultra-dense Immersive Scenes

◉ 无人机在浙江舟山至上海跨海低空航线飞行

◉ The drone flies on the cross-sea low altitude route from Zhoushan to Shanghai

创新引领与融合，共赢数智新未来

Innovation Leadership and Integration, Reaching Win-Win for a New Digital Intelligence Future

标准引领，提升科技创新影响力。本成果关键技术方案写入 3GPP 标准，为推动全球 5G-A 标准发展贡献中国力量；在 2024 年全球移动通信大会首次体系化定义并发布 5G-A 关键技术成果，获得全球媒体广泛报导。

Leading in standardization to enhance the influence of science and technology innovation. The key technological solutions of this achievement are written into 3GPP standards, contributing China's power to the development of global 5G-A standards. The 5G-A key technologies were systematically defined for the first time and the related achievements were released at the Mobile World Congress 2024, widely reported by global media.

跨界创新，激发数字经济新业态。作为数字经济发展的信息通信底座，5G-A 激发数字经济创新活力，为各行业提供精准、高效、优质、便捷的信息服务。例如，5G-A 创新的空地协同立体组网助力美团无人机外卖配送和顺丰无人机物流配送等产业升级，助力低空经济腾飞。

Promoting cross-area innovations to stimulate new business in digital economy. As an information and communication base for the development of digital economy, 5G-A stimulates the innovation and vitality of digital economy and provides accurate, efficient, high-quality and convenient information services for industries. For example, 5G-A innovative three-dimensional air-ground collaborative networking has helped upgrade industries such as Meituan drone takeaway delivery and Shunfeng drone logistics distribution, helping the low-altitude economy develop.

融合应用，加速行业数智化转型。本成果内生确定、无源物联等创新技术开辟移动通信应用新赛道，助力千行百业数智转型。在制造业领域，5G-A 确定性网络能力使得 5G 深入至工业控制等核心生产环节；在物流业领域，5G-A 蜂窝无源物联能力将无源通信与蜂窝网络相结合，提升覆盖范围，赋能供应链全生命周期智能管理升级。

Converging applications to accelerate the digital transformation of the industry. The innovative technologies such as deterministic and ambient IoT of this achievement open up a new track of mobile communication applications and help the digital intelligent transformation in industries. In the manufacturing industry, 5G-A deterministic network enables 5G to penetrate into core production links such as industrial control. In the logistics industry, 5G-A ambient IoT combines passive IoT with cellular network to improve coverage and empower the upgrade of intelligent management for the whole life cycle of the supply chain.

开放合作，打造合作共赢产业链。依托 GTI 等国际组织，积极开展 5G-A 技术创新与应用探索，凝聚全球产业共识，搭建全球产业的沟通桥梁，合力打造开放繁荣的全球产业链。

Opening cooperation to build a win-win industry chain. Relying on GTI and other international organizations, we actively carry out 5G-A technology innovation and application exploration to reach global industrial consensus, build a communication bridge for the global industry, and build an open and prosperous global industry chain together.

◉ 中国移动在 2024 MWC 发布 5G-A 十大创新成果

◉ China Mobile released 5G-A Top 10 Innovations in 2024 MWC

新一代移动高清技术创新与应用

Technological Innovation and Application of New-Generation YDGQ TV

◉移动高清落地中国 31 个省份，实现超 200 亿价值创收，为 2 亿 + 用户提供高品质互动视听娱乐体验

◉YDGQ TV has landed in 31 provinces in China, generating over 20 billion yuan in revenue and providing high-quality interactive audio-visual entertainment experiences for over 200 million users

中移（杭州）信息技术有限公司
China Mobile (Hangzhou) Information Technology Co., Ltd.

中国移动 China Mobile | 智慧家庭运营中心

引言

“移动高清”是中国移动推出的提供高清影音、互动娱乐、智慧控制等内容及应用的电视产品。新一代移动高清围绕“AI+ 运营 + 内容 + 安全”技术创新和应用展开攻关并取得重要突破，推动中国广电事业大步向前发展。

Introduction

“YDGQ TV” is a television product launched by China Mobile, offering high-definition audio and video, interactive entertainment, intelligent control, and other related content and applications. The new generation of YDGQ TV focuses on technological innovation and application centered around “AI + operation + content + security”, achieving significant breakthroughs and driving the rapid development of China’s broadcasting and television industry.

突破核心难题，实现技术创新

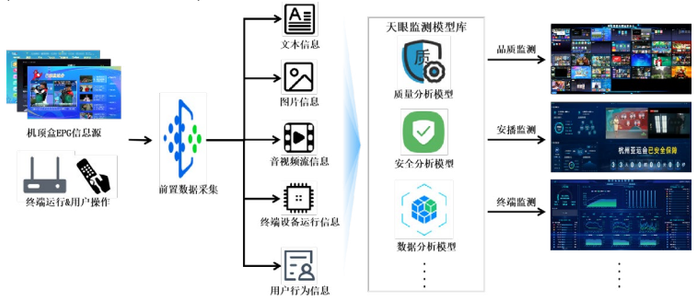
Breaking Through Core Challenges and Achieve Technological Innovation

中国移动围绕“AI+ 运营 + 内容 + 安全”，打造新一代移动高清全链路创新技术体系：（1）智能遥控，以数字人“灵犀”为载体，打造家庭领域 AI 对话系统；（2）内容智创，创新“AI 内容生成 +AI 内容互动”的内容生成方式；（3）跨屏互动，将小屏算力与大屏应用相结合，实现在大小屏场景下的互联互通；（4）超高清视频，攻关内容存储与格式支持能力、高码率视频传输能力和内容版权保护能力等超高清视频相关底层能力；（5）安播监测，研发音视频质量分析、内容源智能拨测、内容风险 AI 识别与终端质差识别等监测功能，全面覆盖“直播 + 点播 +EPG+ 终端应用”等业务场景；（6）媒资管理，构建数字媒资资产库，实现媒资数据的统一采集、细粒度理解、能力输出与集中管理。

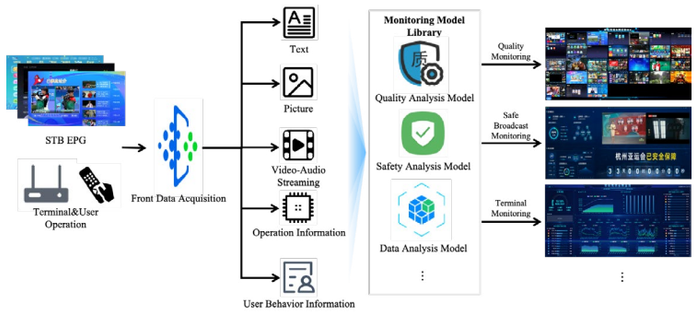
Around “AI+operation+content+security”, China Mobile has achieved full-chain technological innovation for the new generation of YDGQ TV: (1) intelligent remote control, using the “Lingxi”, a digital human on television, to create an AI dialogue system in home; (2) content intelligent creation, innovating the method of “AI content generation+AI content interaction”; (3) cross screen interaction, combining small screen computing power with large screen applications to achieve connectivity of multiple screens; (4) ultra high definition video, tackling related underlying abilities, including content storage and format support, high bitrate video transmission, and digital rights management; (5) safe broadcast monitoring, developing monitoring functions, including audio and video quality analysis, intelligent content source dialing testing, AI-based content risk recognition, and terminal quality identification, fully covering business scenarios of “live streaming+on-demand streaming+EPG+terminal applications”; (6) media asset management, building a digital media asset library to achieve unified collection, fine-grained understanding, capability output, and centralized management.

本成果近三年累计授权发明专利 66 项，发表论文近 10 篇，荣获 2022 年、2023 年广播电视和网络视听人工智能应用创新大赛三等奖。

66 patents have been granted and nearly 10 papers have been published in the past three years. Technological innovation and application have won the third prize in the 2022 and 2023 Radio and Television and Network Audiovisual Artificial Intelligence Application Innovation Competition.



◉全量内容安播监测，异常监测识别准确率达到 98% 以上



◉Full-content Safe Broadcast Monitoring with an Accuracy Rate of over 98% in Identiying Anomalies

◉近三年累计授权发明专利 66 项

◉A total of 66 patents have been granted in the past three years

推广技术应用，造福亿万大众

Promoting the Application of Technology to Benefit Millions of People

本成果落地中国 31 个省份，2023 年实现超 200 亿价值创收，为 2 亿 + 用户提供高品质互动视听娱乐体验。新一代移动高清积极提升适老化服务质量，打造智慧康养，让“银发人群”共享数字经济发展红利。此外，带动乡村医疗、文化多领域数智化发展，为超 6500 万乡村家庭提供文化、治理、帮扶全方面支撑，支撑中国 31 省圆满完成元旦、春节、“两会”（中华人民共和国全国人民代表大会和中国人民政治协商会议）、大运会、亚运会、“一带一路”国际合作高峰论坛等重保任务，有效杜绝家庭场景中内容传播的低俗之境和文化荒漠。

The new generation of YDGQ TV has been implemented in 31 provinces in China, achieving a revenue of over 20 billion yuan by 2023 and providing high-quality interactive audio-visual entertainment experiences for over 200 million users. It actively improves the quality of aging friendly services, creates intelligent health care, and allows the elderly to benefit from the development of digital economy. In addition, it drives the digital and intellectual development of rural medical and cultural, providing cultural, governance and assistance support for more than 65 million rural families. Moreover, it has successfully provided 31 provinces in China with security services in major festivals and events such as the New Year’s Day, the Spring Festival, the “two sessions” (the National People’s Congress and the Chinese Political Consultative Conference), the National University Games, the Asian Games, the Belt and Road Forum for International Cooperation, effectively prevented the spread of vulgar content in the family.

本成果应用推广案例曾荣获第三届“全球减贫案例征集活动”最佳减贫案例，AIIA 人工智能十大先锋应用案例，第二届高新视频创新

应用大赛二等奖，第五届世界声博会 2022 年度人工智能创新产品金奖。

The application and promotion cases have won the Best Poverty Reduction Case in the 3rd “Global Poverty Reduction Case Collection Activity”, the AIIA Top Ten Pioneer Application Cases of Artificial Intelligence, the Second Prize in the 2nd High tech Video Innovation Application Competition, and the Gold Award for Artificial Intelligence Innovation Products in the 5th World Sound Expo 2022.

◉ 助力乡村教育，荣获第三届“全球减贫案例征集活动”最佳减贫案例

◉ Assisting Rural Education and Winning the Best Poverty Reduction Case in the 3rd “Global Poverty Reduction Case Collection Activity”

突出标准引领，带动产业发展

Focusing on Standard Formulation and Driving Industrial Development

中国移动智慧家庭运营中心积极参与中国广播电影电视标准化技术委员会、中国通信标准化协会、世界超高清视频产业联盟等组织的标准编制工作，包括《信息技术全双工语音交互系统 通用技术要求》等国家标准 8 项，《网络视听节目音频响度技术要求和测量方法》等行业标准 20 项，《生成式人工智能技术及产品评估方法》等团体标准 8 项。

The smart home operational center of China Mobile actively participate in the formulation of standards organized by the China Technical Committee for Standardization of Radio, Film and Television, China Communications Standards Association, and UHD World Association. It has participated in the development of 8 national standards such as “Information technology—General technical requirements of full duplex speech interaction system”, 20 industry standards such as “Technical Requirements and Measurement Methods for Audio Loudness of Network Audiovisual Programs”, and 8 group standards such as “Generative Artificial Intelligence Technology and Product Evaluation Methods”.

中移智家打造开放共赢的良性生态，联合科大讯飞共建“智慧家庭智能交互实验室”，着力攻关空间感知唤醒、低算力自主识别能力、虚拟人交互呈现、智适应编解码技术等技术难题，推动智能交互技术与音视频技术的融合，协同内容提供方、播控牌照方、平台建设方、传输建设方、运营支撑方，提供满足用户多场景需求的泛屏产品，实现了产业链的广泛拓展及结构优化升级。

The smart home operational center of China Mobile is building benign ecosystem of open and win-win. It has collaborated with iFLYTEK to jointly establish the “Smart Home Intelligent Interaction Laboratory”, focusing on tackling technical challenges such as spatial perception awakening, low computing power autonomous recognition ability, virtual human interaction presentation, and intelligent adaptation encoding and decoding technology, promoting the integration of intelligent interaction technology with audio and video technology. It collaborates with content providers, broadcast control license holders, platform builders, transmission builders, and operation support providers to provide pan-screen products to meet users’ multi-scenario needs, achieving extensive expansion and structural optimization and upgrading of the industry chain.

◉ 中移智家联合科大讯飞共建“智慧家庭智能交互实验室”

◉ The smart home operational center of China Mobile and iFLYTEK jointly build the “Smart Home Intelligent Interaction Laboratory”

品牌高频曝光，行业瞩目聚焦

High Frequency Brand Exposure, Attracting Industry Focus

近两年来，移动高清品牌曝光超 6 亿次，累计发布移动高清相关稿件 123 篇。其中，被人民邮电报纸质报纸刊登 1 次。参与“4K/8K 超高清产品发布会、数字中国建设峰会 |AI+ 大屏、2024 千兆智家生态大会 | 生态赋能”等重要会议，在中国小康网、新华网、中国青年网、中国日报网、中华网、光明网、人民网、中国网、北青网等央媒渠道曝光 41 次，在流媒体网、C114 通信网、环球网、科技世界网等行业媒体曝光 22 次。

In the past two years, the YDGQ TV has been exposed more than 600 million times. A total of 123 reports related to YDGQ TV have been published. Specifically, it has been published in the People’s Post and Telecommunications News. It has showed in many important conferences such as the 4K/8K Ultra HD Product Release Conference, Digital China Construction Summit | AI+Large Screen, 2024 Gigabit Smart Home Ecological Conference | Ecological Empowerment. It has been exposed 41 times on central media channels such as cnxk.com, xinhuanet.com, youth.cn, chinadaily.com.cn, china.com, guangming.com, people.cn, china.com.cn, and ynet.com. It has been exposed 22 times on industry media such as lmtw.com, c114.com.cn, huanqiu.com, and twwtn.com.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一线动态

数字惠农，乡村电视架起为民服务“连心桥”

信息集锦

由西将全面推动
中部城市群信息通信基础设施建设

中移云能云存储团队入选
中国移动首批“专精特新”团队

贵州移动
护航春日“云赏樱”

石家庄电信开展春季景区网络专项优化行动

宿迁移动
助力传统工厂制造变“智造”

鹤壁联通
广泛调查提升宽带感知

吴忠铁塔“快控省”三步走满足客户需求

◉《人民邮电报》报纸报道

◉ The Report in the “People’s Posts and Telecommunications News”

世界互联网大会
领先科技奖收录成果集

Collection of World Internet Conference
Awards for Pioneering Science
and Technology

02

世界互联网大会
领先科技奖收录成果

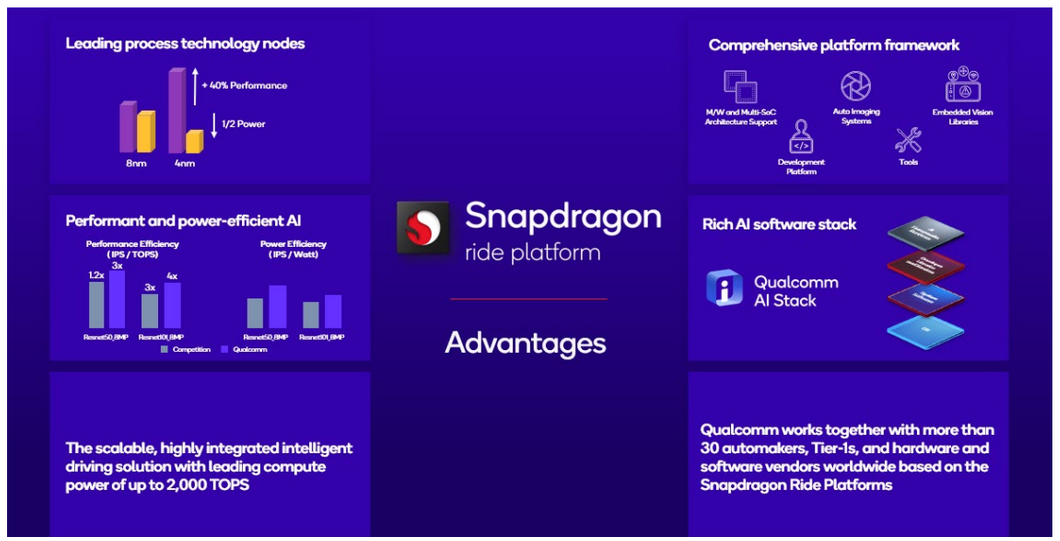
Collection of Shortlisted Achievements of
World Internet Conference Awards for
Pioneering Science and Technology

工程研发组
Engineering Research and
Development Group

拥有高达 2000TOPS 领先算力的可扩展高集成性智能驾驶解决方案 Snapdragon Ride 平台

The Scalable, Highly Integrated Intelligent Driving Solution with Leading Compute Power of Up To 2,000 TOPS -- Snapdragon Ride Platforms

◉ 拥有高达 2000TOPS 领先算力的可扩展高集成性智能驾驶解决方案——Snapdragon Ride 平台



◉ The Scalable, Highly Integrated Intelligent Driving Solution with Leading Compute Power of Up To 2,000 TOPS -- Snapdragon Ride Platforms

高通无线通信技术（中国）有限公司
Qualcomm Wireless Communication Technologies (China) Limited

Qualcomm 高通

引言

作为高通汽车解决方案的关键支柱，Snapdragon Ride 平台由先进、可扩展和可定制的智能驾驶 SoC 系列组成，助力全球汽车制造商和一级供应商打造安全、高能效的 ADAS/AD 解决方案，不仅推动舱驾融合创新，还助力加速智驾普及。

Introduction

As a key pillar of the Qualcomm Automotive Solution, the Snapdragon Ride Platforms are comprised of advanced, scalable and customizable automated driving system-on-chip (SoC) family, and help global automakers and Tier-1s produce safe, power-efficient ADAS/AD solutions to drive cockpit-driving integration innovation and to accelerate penetration of intelligent driving.

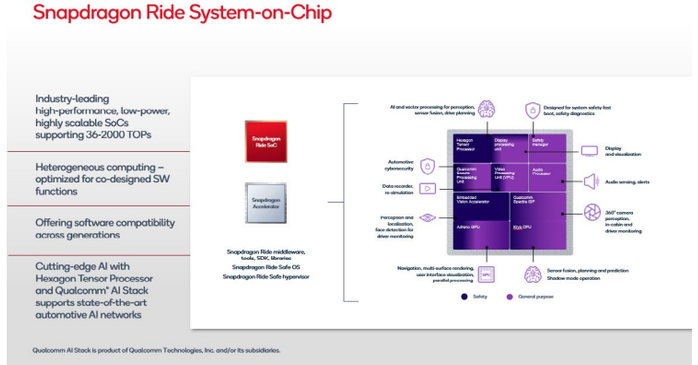
2000TOPS 算力支持，兼具高能效、可扩展、高集成多项优势

2000 TOPS Compute Power Support, Combined with Multiple Advantages Like Power-efficiency, Scalability and High-level Integration

Snapdragon Ride 平台具备高算力高能效、可扩展、高集成、软硬件结合的独特优势，并能支持汽车行业面向未来打造不断进化的智能驾驶系统。该平台包括底层系列 SoC，中间层工具链，以及顶层车辆控制、数据与云服务；其中，Snapdragon Ride Flex SoC 同时支持数字座舱和 ADAS，且具备可扩展的优势，可助力加速舱驾融合。Snapdragon Ride 平台提供高达 2000TOPS 的算力支持，还能实现领先的散热效率、提升续航。与友商同类产品相比，最新一代 Snapdragon Ride SoC 每秒推理次数高至 30%，DDR 带宽占用低至 1/7，能效提升高达 2 倍。Snapdragon Ride 平台通过不同 SoC 和加速器的组合，降低开发复杂性，灵活满足全球汽车厂商需求。同时，该平台的高集成度特性可在系统层面显著降低成本，并采用多款行业领先软件栈提供软硬件结合的方案。

The Snapdragon Ride Platforms have unique advantages including high compute power, high power-efficiency, high-level scalability and integration, as well as hardware and software combination. At the bottom layer of the platforms are a series of SoCs, in the middle are tools, and on the top are vehicle control, data and cloud services. The Snapdragon Ride Flex SoCs simultaneously support digital cockpit and ADAS with advantage in scalability, help accelerate cockpit-driving integration. The Snapdragon Ride Platforms provide compute power of up to 2000 TOPS, support leading cooling efficiency and improved battery life. Compared to competitors, the latest generation of Snapdragon Ride SoCs offer up to 30% higher inferences per second, up to 7x lower DDR bandwidth consumption and up to 2x better power efficiency. Based on different combinations of SoCs and accelerators, the Snapdragon Ride Platforms can help reduce development complexity and flexibly meet the needs of global auto OEMs. Meanwhile, the platforms significantly reduce costs at the system level, and adopt various industry-leading stacks to provide hardware and software-combined solutions.

◉ Snapdragon Ride 平台具备高算力高能效、可扩展、高集成、软硬件结合的独特优势



◉ The Snapdragon Ride Platforms have unique advantages including high compute power, high power-efficiency, high-level scalability and integration, as well as hardware and software combination

◉ Snapdragon Ride Flex SoC 同时支持数字座舱和 ADAS

◉ The Snapdragon Ride Flex SoCs Simultaneously Support Digital Cockpit and ADAS

携手生态伙伴提升交通安全、驾乘体验、出行效率，赋能万亿市场

Join Hands with Eco-partners to Improve Traffic Safety, Driving Experience, Mobility Efficiency and Bring Enablement to Trillion-worth Market

自动驾驶作为汽车智能化的核心之一，将显著提升交通安全、驾乘体验、出行效率和生态效益。麦肯锡预测，到 2035 年 ADAS 和自动驾驶在全球乘用车市场将产生 2.2-2.9 万亿人民币的收入。Snapdragon Ride 平台助力合作伙伴打造创新产品，为汽车产业迈向自动驾驶未来提供底层支持。基于 Snapdragon Ride 平台，高通与全球超过 30 家汽车厂商、一级供应商、软硬件厂商合作，比如宝马集团、哪吒汽车、德赛西威、Momenta、卓驭科技等众多产业链合作伙伴。

在乘用车领域，众多全球合作伙伴基于 Snapdragon Ride 平台打造的解决方案正在落地，助力行业探索前沿汽车科技，为消费者带来智能便捷的驾乘体验。在商用车领域，Snapdragon Ride 平台赋能的限定场景自动驾驶产品也已率先商用，助力物流场景显著降本增效。

Intelligent driving, as one of the cores of smart vehicles, will significantly improve traffic safety, driving experience, mobility efficiency and ecological benefits. ADAS and AD could generate between CNY 2.2 trillion to 2.9 trillion in the global passenger car market by 2035, according to McKinsey analysis. The Snapdragon Ride Platforms help partners build innovative products and provide underpinnings for the automotive industry to move towards the future of autonomous driving. Qualcomm works with more than 30 automakers, Tier-1s, hardware and software vendors across the globe by leveraging the Snapdragon Ride Platforms, including BMW Group, Neta Auto, Desay SV, Momenta, ZYT and more partners from the industry chain.

In terms of passenger cars, Snapdragon Ride Platforms-based solutions built by many global partners are coming to fruition, leading the industry to explore cutting-edge automotive technology, and delivering smart and convenient mobility experience to consumers. In terms of commercial vehicles, the autonomous driving products empowered by the Snapdragon Ride Platforms in limited scenarios first come to commercialization, helping vehicles in logistics scenarios gain significant advantages in cost reduction and efficiency enhancement.

◉ Snapdragon Ride 平台支持全球生态迈向自动驾驶未来

◉ The Snapdragon Ride Platforms support global automotive ecosystem to move towards the future of autonomous driving

加速融合创新和架构演进，助力行业迈入“高阶智驾标配时代”

Expedite Integration Innovation and Architectural Evolution and Help the Automotive Industry Embrace an “Era of Advanced Intelligent Driving as a Standard Feature”

在支持汽车行业抓住智能化机遇过程中，高通汽车解决方案创新合作成果显著：已应用于全球超过 3.5 亿辆汽车，全球几乎所有主要汽车制造商都是高通的合作伙伴。

技术侧，Snapdragon Ride 平台凭借支持舱驾融合功能的 Flex SoC 和其高集成性技术优势，加速融合创新和架构演进——不仅解决成本和硬件支持程度的行业难点，还凭借高集成性智驾平台的底层中央计算架构，

使得不同域之间无缝迁移各种功能变得更为灵活。预计到 2030 年，智驾与座舱跨域集成平台的市场规模将达到近 2500 亿元。

产业侧，Snapdragon Ride 平台助力汽车行业迈入“高阶智驾标配时代”——凭借高性能和成本优势，支持汽车制造进行智能驾驶技术的迭代，推动高阶智驾规模化，让创新惠及更多消费者。

Qualcomm automotive solutions have made notable innovation-driven cooperation achievements in supporting the automotive industry to seize the opportunity of intelligent vehicles: The solutions have been used on more than 350 million vehicles in the world, and nearly all major automakers worldwide are partners of Qualcomm.

From the perspective of technology, the Snapdragon Ride Platforms utilize the cockpit-driving integration-supported Flex SoC and highly integrated technology advantages to expedite integration innovation and architectural evolution – not only solve the industry pain point of cost and level of hardware support, but also utilize the fundamental central compute architecture for highly integrated intelligent driving platforms to create great flexibility to seamlessly move functions across different domains. It is expected that a market volume of approximately CNY250 billion could be achieved by 2030 for intelligent driving and cockpit cross-domain integrated platform.

From the perspective of industrial deployment, the Snapdragon Ride Platforms help the automotive industry embrace an “era of advanced intelligent driving as a standard feature”. The Snapdragon Ride Platforms combine high-performance and low-cost advantages, support automakers to iterate intelligent driving technologies, promote advanced intelligent driving at scale, and allow more consumers to benefit from innovation.

◉ Snapdragon Ride 平台加速融合创新和架构演进，助力行业迈入“高阶智驾标配时代”

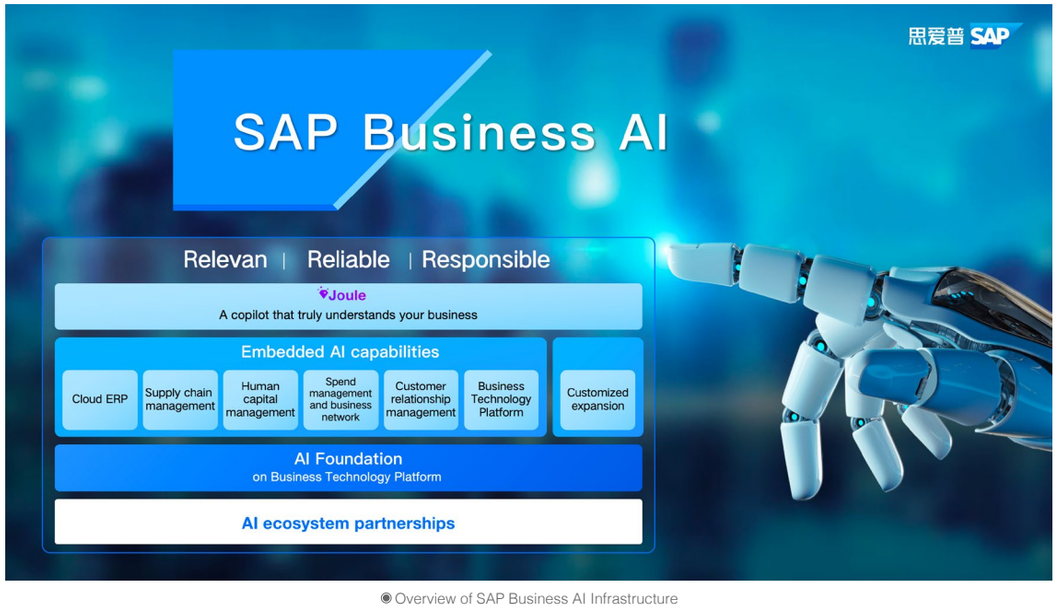
◉ The Snapdragon Ride Platforms expedite integration innovation and architectural evolution, help the automotive industry embrace an “era of advanced intelligent driving as a standard feature”

SAP 商业 AI- 重构企业运营模式、释放创新潜能

SAP Business AI: Reinventing Business Operationis to Unlock Innovative Potential

思爱普（中国）有限公司
SAP (China) Co., Ltd.

◉ SAP 商业 AI 架构总览



◉ Overview of SAP Business AI Infrastructure

引言

SAP 商业 AI 是全球领先的企业级 AI 应用和平台。它全面嵌入企业核心业务流程，处理真实、实时、准确的业务数据并确保结果的可靠性，同时在安全、隐私、合规和伦理方面有着最高标准的要求，将重新定义企业运营方式并引领创新浪潮。

Introduction

SAP Business AI is a world-leading enterprise AI application and platform. Seamlessly integrated into core business processes, SAP Business AI solutions handle true, accurate and real-time data to ensure reliable results, while committing to the highest standards in security, privacy, compliance and ethics to redefine business operations and lead new waves of innovation.

通过强化企业、行业属性和嵌入业务流程，SAP 商业 AI 塑造适合企业级市场的 AI 应用和平台

By enhancing enterprise and industry capabilities and integrating business processes, SAP Business AI solutions create enterprise-grade AI applications and platforms

SAP 商业 AI 是全球企业级 AI 的领导者，其成果创新主要体现在以下四个方面：

1. 汇集上百个细分行业的最佳实践和数据，构建商业 AI 基础模型，优化生成式 AI 在企业应用的专业性和准确性。同时，SAP 开发了基于 SAP HANA 的向量数据库，使生成式 AI 在企业级数据平台内的使用更加便捷。

2. 打造嵌入业务流程的智能商业应用，涵盖了从云 ERP 到供应链管理、人力资源管理、商业网络、客户关系管理、业务技术云平台等主要业务流程。

3. 研发企业级生成式 AI 智能助手 Joule，革新了用户体验，并提供更深刻的业务洞察。

4. 基于 SAP 业务技术云平台，形成全球领先的多模型开放生态体系。通过结合商业 AI 基础模型，以及微软、谷歌、亚马逊等通用模型的多重优势，不仅为客户提供了多样化的选择，更确保了在不同行业和场景下实现最优的 AI 应用效果。

SAP Business AI is the global leader of enterprise AI, with major innovations in the following four fields:

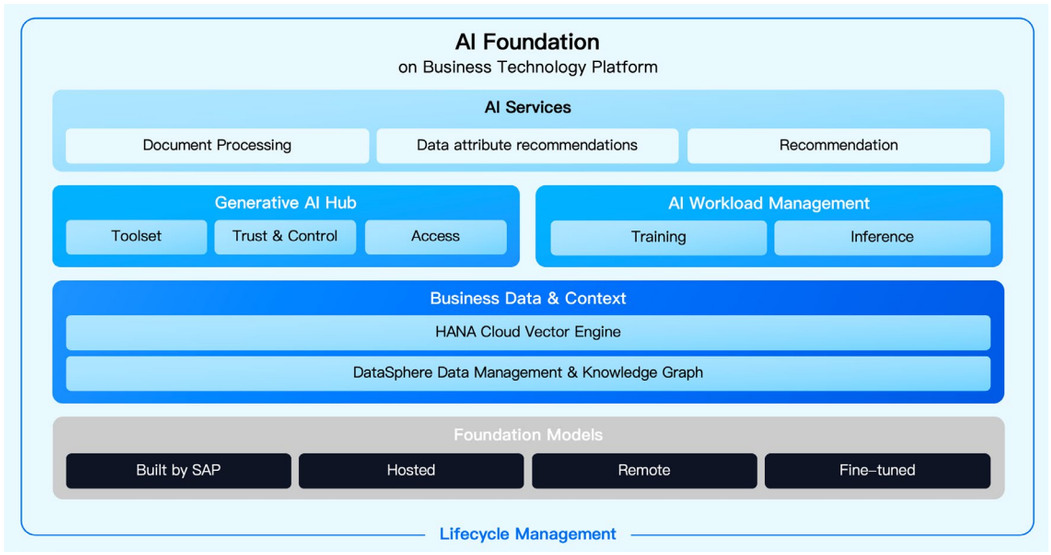
1. Aggregating best practices and data from hundreds of industry segments to enable the foundation model for business AI and enhance the expertise and accuracy of generative AI in enterprise application. SAP also introduced a vector store for SAP HANA Cloud, making it easier to utilize generative AI across enterprise-wide data platforms.

2. Creating intelligent business applications embedded into key business processes including cloud ERP, supply chain management, HR management, business network, CRM, and business technology platforms.

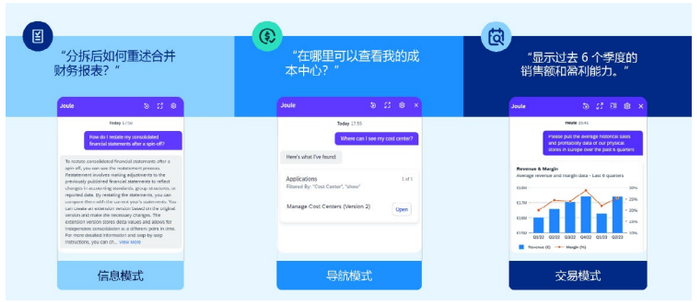
3. Launching enterprise-grade generative AI copilot Joule to revolutionize user experience and enable deeper business insights.

4. Building world-leading multi-model open ecosystem based on SAP Business Technology Platform (SAP BTP). By combining various advantages of business AI foundation models and the general-purpose models from Microsoft, Google, Amazon and others, SAP Business AI not only provides customers with diversified options, but also ensures optimal AI application outcomes across different sectors and scenarios.

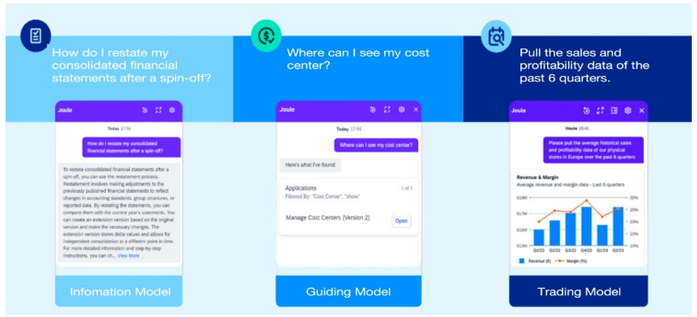
◉ AI 基座：通过 SAP 业务技术云平台为开发者提供全面的 AI 服务



◉ AI foundation: Offering Developers with Comprehensive AI Services Based on SAP BTP



◉ SAP Joule： 提供丰富的内容模式构建 AI 用例



◉ SAP Joule: Numerous Content Models for Creating AI Use Cases

SAP 商业 AI 全面重塑企业运营模式，释放企业创新潜力，提升业务效率和韧性

SAP Business AI is Revolutionizing How Business Operates to Unleash Innovation while Enhancing Efficiency and Resilience

SAP 商业 AI 为企业量身定制，全面嵌入核心业务流程，带来卓有成效的业务价值。部分示例如下：

1. 全面提高传统财务和 ERP 效率，例如实现高达 99% 的自动化入账付款分配、为财务控制人员提供个性化的视频数据报告、预测延迟付款的可能性等。

2. 深度挖掘制造和物流效能潜力，例如制造业销售环节，可以快速准确地生成产品和配置建议；收货环节，可以解决纸质交货单验证等行业痛点，准确、自动处理各种语言文档，降低运营成本多达 55%。

3. 助力企业释放人才潜能，例如 AI 驱动的 SAP SuccessFactors 可以自动整合组织和个人的技能、成长、属性等数据，打造个性化人才发展路径。

4. 显著加强全球供应链韧性与效率，例如通过市场数据、销售数量和供应链数据等，提升需求供应计划的预测准确性。

SAP Business AI is tailored for enterprises and seamlessly embedded into core business processes to deliver significant business value. Here are some examples:

1. Comprehensively improving traditional finance and ERP efficiency, including up to 99% automation of incoming payment allocation, personalized video data reports for financial controllers and prediction for chances of delayed payments.

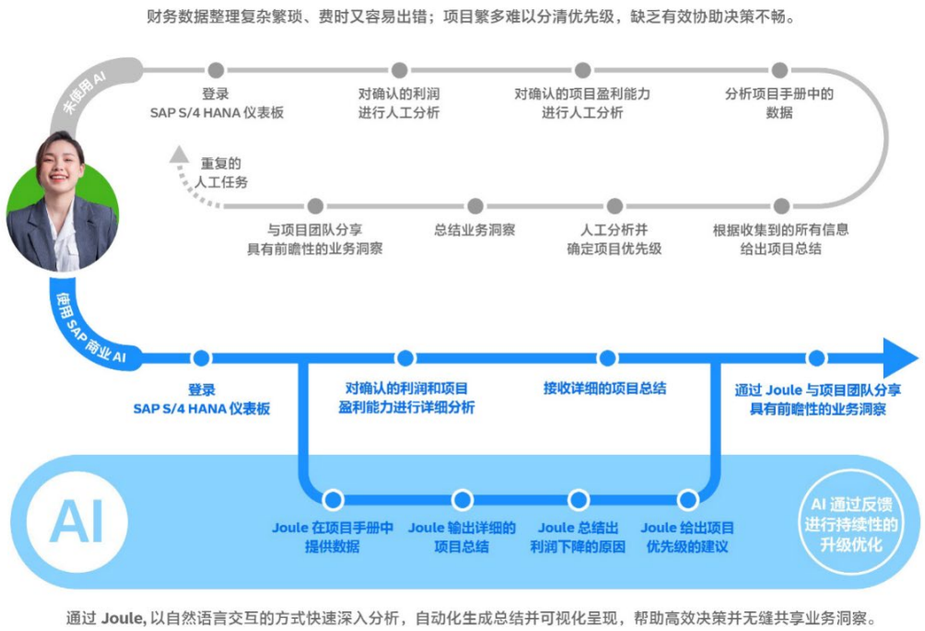
2. Tapping into the potential of manufacturing and logistical performance, such as fast generation of accurate product and configuration recommendation for manufacturing sales; elimination of industry pain points including paper-based delivery validation for receiving process; automated accurate processing of multi-lingual documents; up to 55% reduction in operational cost.

3. Helping enterprises unlock talent potential. For example, AI-driven SAP SuccessFactors solutions automate integration of organizational and personal data of skills, growth, attributes and others, to facilitate personalized talent development path.

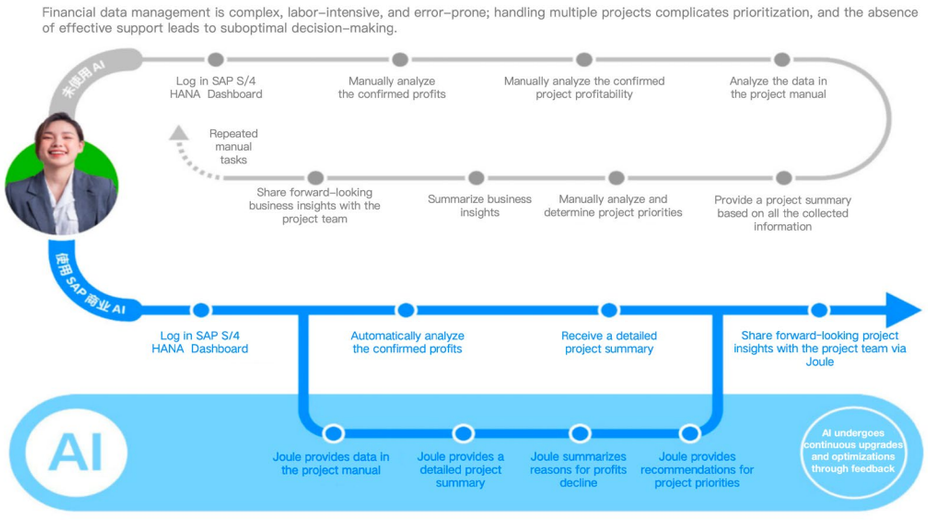
4. Maximizing global supply chain resilience and efficiency, including more accurate forecast of demand & supply planning through market, sale and supply chain data.

◉ 助力行业提升全价值链、端到端的业务效率（以消费品行业为例）

◉ Boosting End-to-End Business Efficiency Across the Entire Value Chain (CPG sector as an example)



◉ 助力企业核心业务流程实现智慧运营（以财务为例）



◉ Facilitating Intelligent Operation of Core Business Processes (Finance as an example)

SAP 商业 AI 获得广泛的市场认可，为企业级 AI 应用树立新标杆

SAP Business AI is Widely Recognized in the Market, Setting a New Benchmark for Enterprise AI Applications

SAP 解决方案在产业升级与效率革新方面具有强大的全球影响力。SAP 拥有超过五十年的企业信息化、数字化和智能化经验，支持超过 190 个国家的法规。SAP 的客户创造了全球 87% 的贸易额，覆盖 25 个不同行业。

SAP solutions have significant global influence in industrial modernization and efficiency innovation. With over 50 years of experience in enterprise informatization, digitization, and intelligent transformation, SAP fully understands the legal regulations of over 190 countries and regions, supporting enterprises in maintaining compliance around the globe. SAP's customers account for 87% of global trade across 25 industries.

SAP 商业 AI 不仅能优化业务流程，还能显著提升运营效率和决策质量，最大化数据资产的价值，为财务、供应链、客户体验等关键业务领域注入新动力。

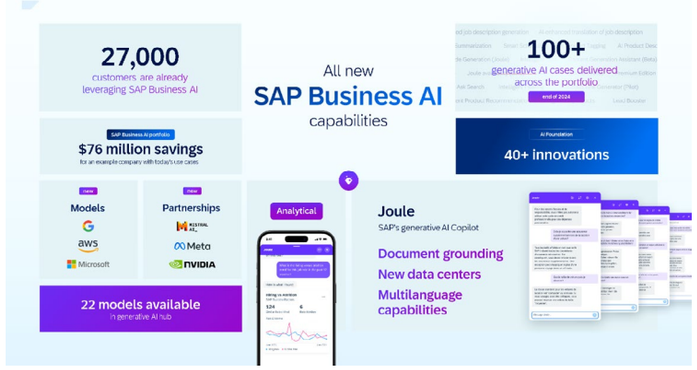
SAP Business AI not only improve business processes, but also enhance operational efficiency and decision-making, maximizing data asset value and invigorating key business areas such as finance, supply chain, and customer experience.

SAP 引领行业塑造 AI 伦理，提供 AI 伦理、隐私和安全的实践最高标准，保障了技术应用的负责任性。SAP 积极探索利用企业私有数据，结合知识图谱技术，挖掘商业价值，推动产业实现突破性进展。

SAP leads in industry AI ethics, setting highest standards for AI ethics, privacy and security practices to ensure responsible tech applications. SAP is actively exploring the utilization of enterprise proprietary data, integrating knowledge graphs to unlock business value and drive industry breakthroughs.

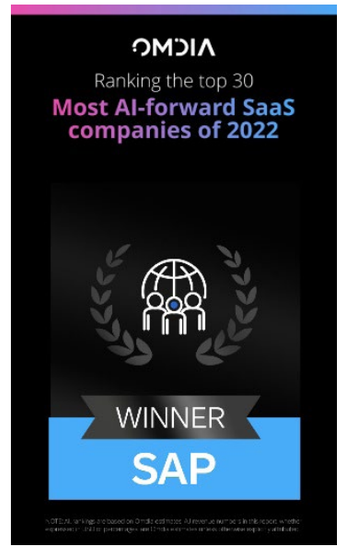
SAP 商业 AI 获得了广泛的市场认可，被认为是全球企业级 AI 应用领导者和履行社会责任的典范。 SAP 在 2022 年被 Omdia 评为全球人工智能 SaaS 公司的领导者。

SAP Business AI is widely recognized as global leader in enterprise AI application and exemplar of social responsibility and commitment. SAP is recognized as 2022 Leader in global AI SaaS by Omdia.



◉ SAP 商业 AI 被 27000 客户认可，显著提升企业运营效率

◉ SAP Business AI recognized by 27,000 customers as maximizing efficiency



◉ SAP 被评为全球人工智能 SaaS 公司 30 强中的第三名

◉ SAP rated third in Top 30 Global AI SaaS Companies

基于 5G 和 AI 融合的车路网云协同服务系统研发与应用

R&D and Application of Vehicle-Infrastructure-Network-Cloud Cooperative Service System Based on 5G and AI Integration

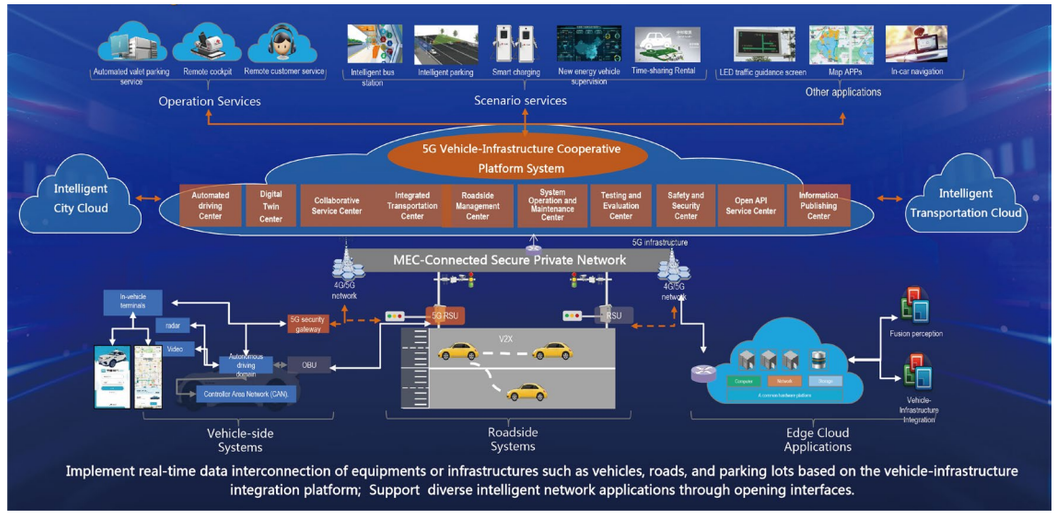
联通智网科技股份有限公司
China Unicom Smart Connection Technology Co., Ltd.

中国联合网络通信集团有限公司
China United Network Communications Group Co., Ltd.

天津大学
Tianjin University

北京交通大学
Beijing Jiaotong University

◉ 5G 车路协同服务平台系统



◉5G Vehicle-Infrastructure Cooperative Platform System

引言

近年来，智能网联汽车已成为全球汽车产业技术变革和转型升级的战略制高点，总体而言，面向规模化应用的“车路云一体化”建设，尚处于初级阶段，行业未形成完备系统架构，网络基础设施建设“碎片化”且能力不足。

Introduction

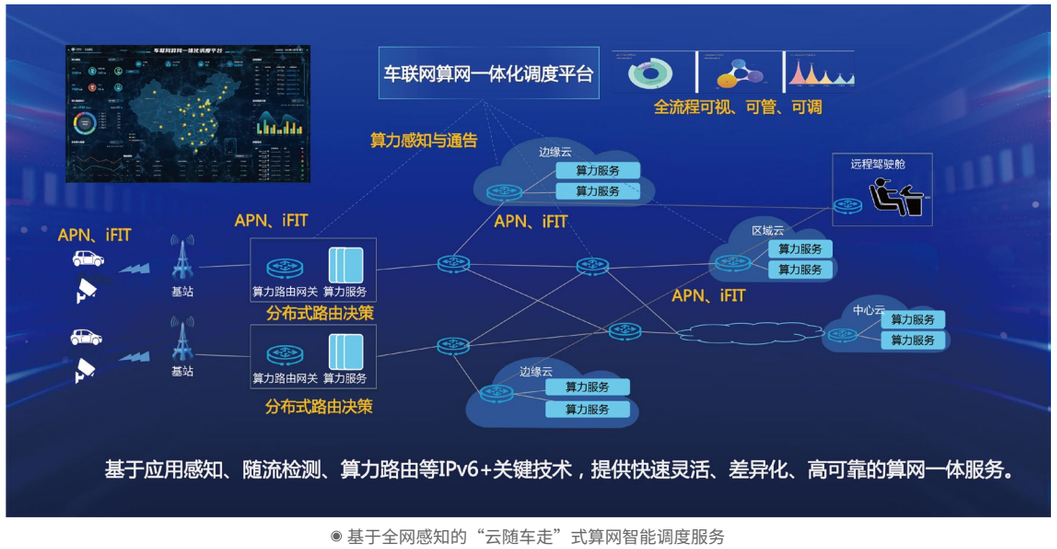
In recent years, intelligent and connected vehicles have become the strategic high ground of technological transformation and upgrading of the global automotive industry. In general, the construction of “vehicle-infrastructure-cloud integration” for large-scale applications is still in its infancy. The industry has not formed a complete system architecture, and the construction of network infrastructure is “fragmented” and insufficient in capacity.

智能分发、协同感知、协同计算等实现落地

Intelligent Distribution, Cooperative Perception, and Cooperative Computing Have Been Implemented

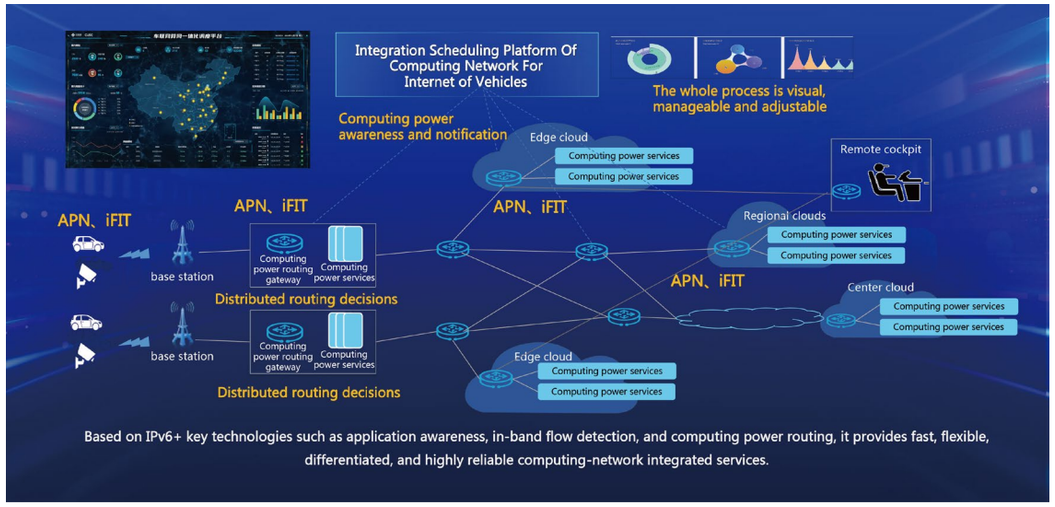
率先提出基于 5G 的“人车路、网边云”协同系统架构，具备端到端协同的资源调度能力，低时延、强算力边缘计算环境，支持一点复制全网部署；5G 车路协同平台，集成了网络能力、业务能力 2 大引擎，6 大服务子系统，310 余 API 接口，领先的分布式计算、分布式存储底座及融合感知、AI 事件检测等组件；开发业内首个车联网无线场景数据库；打造行业先进的车联网算网一体调度底座，依托联通集团算力布局，纳管车、路、边缘云、云池等算力单元，打通业务需求认知、算网资源实时感知、算力编排调度业务流程；建设了行业领先的基于 5G 边缘云的分布式融合感知系统，云端搭建跨设备、跨驱动、跨 AI 库的标准化、可视化、模块化感知框架，成本降低 50%；自主泊车、远程驾驶、5G 消息预警、云控低速驾驶、露天矿区感知等 5 套场景方案、产品规模落地。

China Unicom Smart Connection Technology Limited is the first to propose a



◉ 基于全网感知的“云随车走”式算网智能调度服务

5G-based “people-vehicle-infrastructure, network-edge-cloud” cooperative system architecture, which has end-to-end cooperative resource scheduling capabilities, low-latency, edge computing environment with strong-computing-power, and Single-click Copy and Full Network Deployment supporting capabilities. The 5G vehicle-infrastructure cooperative platform integrates two major engines of network capability and service capability, with six major service subsystems, more than 310 API interfaces, leading distributed computing, distributed storage base, fusion perception, AI event detection and other components. China Unicom Smart Connection Technology Limited has developed the industry’s first wireless scenario database and integration scheduling platform of Computing Network for the Internet of Vehicles. Relying on the computing power layout of China Unicom Group, China Unicom Smart Connection Technology Limited manages computing power units such as vehicles, roads, edge clouds, and cloud pools, meanwhile, it connects business demand cognition, real-time perception of computing network resources, and computing power orchestration and scheduling business processes. It has built an industry-leading distributed fusion perception system based on 5G edge cloud, and built a standardized, visualized, and modular perception framework across devices, drivers, and AI libraries in the cloud, reducing costs by 50%. 5 sets of scenario solutions and products have been implemented in a large scale, including Autonomous Valet Parking, Remote Driving, 5G Message Alert, Cloud-controlled Low-speed Driving, and Opencast Mining Area Perception.



◉Cloud-based Intelligent Scheduling Service Based on Network-Wide Sensing

成果契合行业趋势，超 30 城市多场景示范

The Results are in Line with Industry Trends, with Multi-Scenario Demonstrations in over 30 Cities

项目已呈现出良好的经济、社会及生态效益，概述如下：

（1）经济效益可观。应用推广直接经济效益超 4 亿元，带动联通集团交通领域累计收入超过 100 亿元，2022 年后呈加速趋势；拳头产品“5G 车路协同服务平台”支撑 30 多重点示范项目，拓展 92 家车厂客户近 7000 万车主的服务。

（2）社会效益显著。2022 年北京冬奥会和冬残奥会、海南博鳌亚洲论坛、天津世界智能大会等国际重大活动场合展示，获广泛关注、好评；支撑成都、三亚等城市设施升级，提供交通控制、智慧泊车等服务。

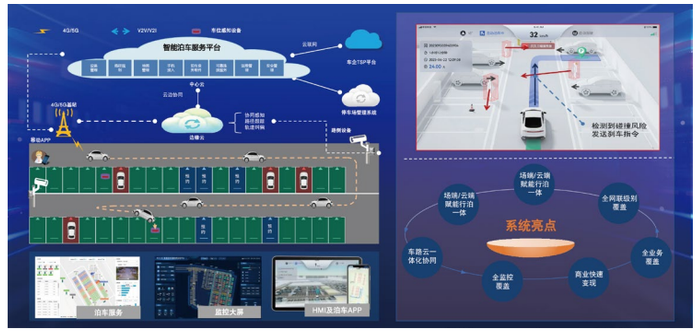
（3）生态效益突出。三种方式为行业生态赋能：中国联通 5G 车联网 Openlab 开放实验室，面向行业提供体系化、标准化测试服务；中国联通车联网创新联合体，已汇合 61 家优势车厂、解决方案商伙伴，为车主提供最佳“移动空间”服务；向 OpenV2X 开源项目贡献核心代码，向智能网联路侧单元操作系统开放环境提供路侧边缘计算单元及运营商 MEC 平台。

The project has demonstrated good economic, social, and ecological benefits, which are summarized below:

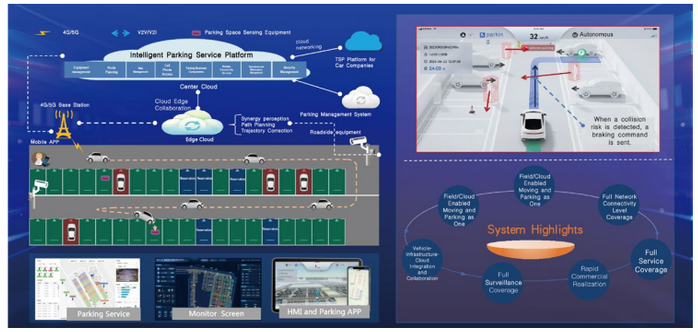
(1) This platform has brought considerable economic benefits. The direct economic benefit of its application exceeded 400 million RMB, contributing to the cumulative revenue of China Unicom Group’s transportation field which exceeded 10 billion RMB and continued to accelerate after 2022. The flagship product “5G Vehicle-Infrastructure Cooperative Platform” has supported more than 30 key demonstration projects and expanded the services to 92 vehicle OEMs, reaching nearly 70 million car owners.

(2) This platform has brought significant social benefits. It has been displayed at major international events such as the 2022 Beijing Winter Olympics and Winter Paralympics, the Boao Forum for Asia in Hainan, the World Intelligence Congress in Tianjin, receiving widespread attention and positive feedback. Also, it has supported the upgrading of urban facilities in Chengdu, Sanya, and other cities, and provided services such as traffic control and Autonomous Valet Parking.

(3) This platform has brought outstanding ecological benefits. We have empowered the industry ecosystem mainly through three approaches: Firstly, China Unicom’s 5G OpenLab for the Internet of Vehicles provides systematic and standardized testing services for the industry. Secondly, China Unicom’s Innovation Consortium for the Internet of Vehicles brings together 61 leading car manufacturers and solution provider partners to deliver the best “mobile space” service for car owners. Thirdly, China Unicom’s Innovation Consortium for the Internet of Vehicles contributes the core code to the OpenV2X open-source project, and provides roadside edge computing units and operator MEC platforms to the open-source organizations of the intelligent networked roadside unit operating system.



◉ 基于车路云协同的自主泊车（AVP）



◉Autonomous Valet Parking (AVP) Based on Vehicle-Infrastructure-Cloud Collaboration

发挥运营商优势，全面赋能应用、服务部署

Leveraging Operator Strengths to Fully Empower Applications and Services Deployment

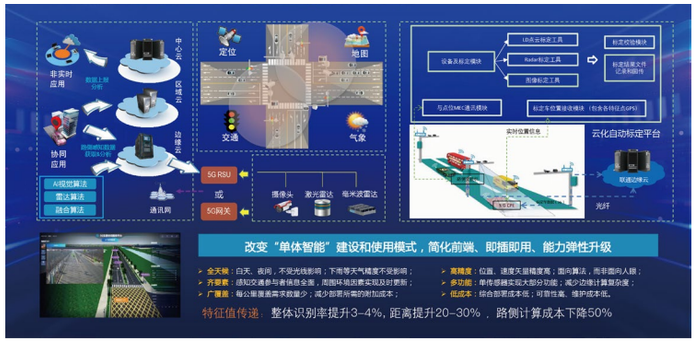
首次实现车端、路侧计算能力上移至 5G 边缘云，自主研发感知算法实现了雷达和视频等多源异构感知数据在边缘云的融合计算，准确度超 99.5%，定位精度 0.5m 以下，单路口计算成本节省 50%；同时，面对融合感知评估系统、感知算法准确性难以评估的重大问题，建立超 20 万用例评测库及 3D CAD 感知设计体系，性能行业领先；建设业内首个车联网 5G/C-V2X 无线

◉ 典型落地案例：海南博鳌东屿岛项目

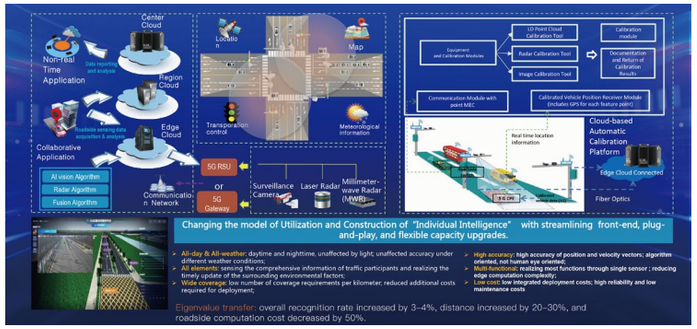
◉Autonomous Valet Parking (AVP) Based on Vehicle-Infrastructure-Cloud Collaboration

场景库系统，涉及高速直道 / 弯道、隧道直道 / 弯道、城区路口 / 直道、地上 / 地下停车场等 10 余场景，路径损耗、多径、多普勒等 5 类信道性能参数，及 RSRP、RSRQ、时延、丢包率、CBR 等 5 类网络性能参数，填补了车联网行业信道及网络性能研究、能力空白；5G 车路协同服务平台，基于业务时间敏感性特征率先部署 5G 与 C-V2X 网络多路径消息智能分发、协同感知及协同计算等关键功能。

For the first time, the computing capacity of the vehicle end and roadside has moved up to the 5G edge cloud. The self-developed perception algorithm has realized the fusion computing of multi-source heterogeneous perception data such as radar and video in the edge cloud, with an accuracy of over 99.5%, and positioning the accuracy of less than 0.5m, also a 50% reduction in the computing cost of a single intersection. At the same time, to solve the major problem that it is difficult to evaluate the accuracy of the integrated perception evaluation system and perception algorithm, we have established an evaluation library of more than 200,000 use cases and a 3D CAD perception design system, with industry-leading performance. The construction of the industry's first Internet of Vehicles 5G/C-V2X wireless scenario library system, involving more than 10 scenarios such as high-speed straights/curves, tunnel straights/curves, urban intersections/straights, above-ground/underground parking lots, 5 types of channel performance parameters such as path loss, multipath and Doppler, and 5 types of network performance parameters such as RSRP, RSRQ, delay, packet loss rate and CBR, filling the gap in channel and network performance research and capability in the Internet of Vehicles industry. The 5G vehicle-infrastructure cooperative platform takes the lead in deploying key functions such as intelligent multi-path message distribution, cooperative perception, and cooperative computing on 5G and C-V2X networks based on service time sensitivity characteristics.

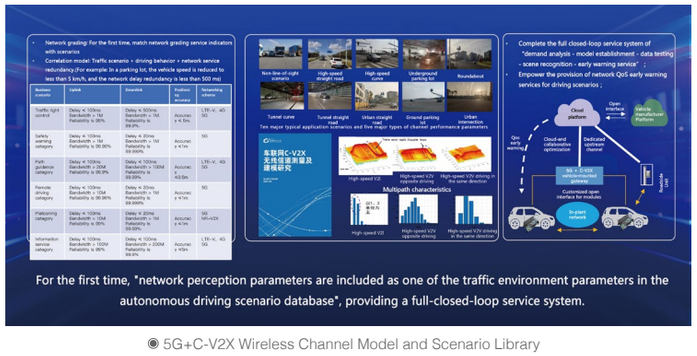


◉ 边端协同的一体化智能感知系统



◉ An Integrated Intelligent Sensing System with Edge-Terminal Collaboration

◉ 5G+C-V2X 无线信道模型和场景库



◉ 5G+C-V2X Wireless Channel Model and Scenario Library

优化新布局，突出大数据、网络能力、本地生态

Optimize the New Layout, and Highlight Big Data, Network Capabilities, and Local Ecology

面对新形势下智能网联规模发展新需求，多方优化布局：以数据要素为重要驱动，建设基于区块链的数据交易平台，支持数据要素资产化、可信化、交易化，已初步实现路侧感知、车辆位置、轨迹数据上传；以定制化网络为核心支撑，持续融入 5G-A、ipv6+ 及 6G 相关技术，夯实网络底座能力，且衔接低空经济；以重要区域创新生态打造为布局牵引，例如近期牵头成立“长三角生态绿色一体化发展示范区智能网联汽车产业创新共同体”，汇聚 33 家理事单位，共建多场景、跨省域、可持续、有创新、有培育、聚产业的区域智能网联产业新局面。

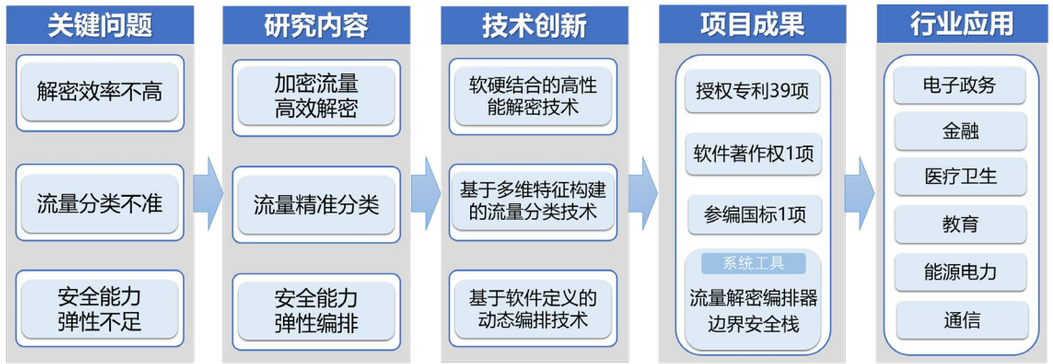
In response to the large-scale development of intelligent networking under the new situation, the layout has been optimized in various ways: with data elements as an important driver, a blockchain-based data trading platform has been built to support the commercialization, credibility and transaction of data elements, and the upload of roadside perception, vehicle location and trajectory data has been initially realized; With customized networks as the core pillar, we continue to integrate 5G-A, IPv6+ and 6G-related technologies to strengthen the foundation of network capabilities and connect with low-altitude economies. For example, China Unicom Smart Connection Technology Limited recently took the lead in establishing the “Intelligent Connected Vehicle Industry Innovation Community in Yangtze River Delta Ecological Green Integrated Development Demonstration Zone “, bringing together 33 member units, jointly initiating a new stage in regional intelligent connected industries that are multi-scenario, cross-provincial, sustainable, innovative, nurturing, and industry clustered.

◉ 长三角智能网联汽车产业创新共同体揭牌

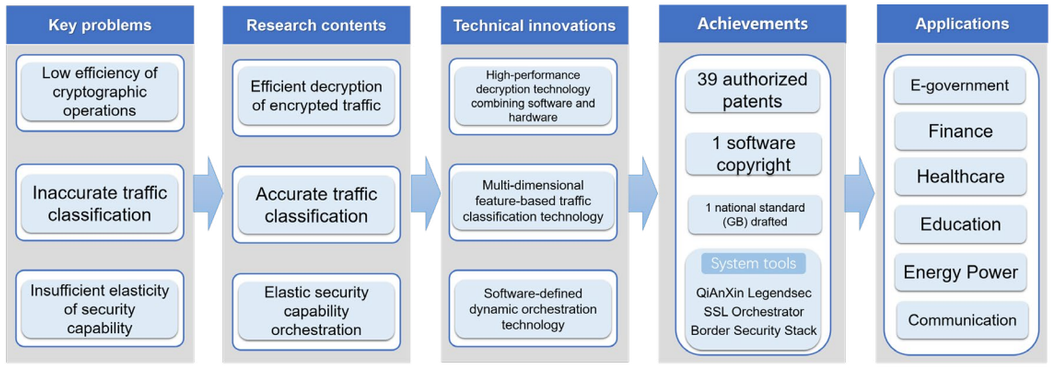
◉ The Yangtze River Delta Intelligent Connected Vehicle Industry Innovation Community was unveiled

加密流量高效检测与动态弹性编排关键技术及应用

Key Technologies and Applications of Efficient Detection and Dynamic Elastic Orchestration of Encrypted Traffic



◉ 项目总体架构



◉ Overall Architecture of the Project

奇安信科技集团股份有限公司
Qi An Xin Technology Group Inc.

奇安信 新一代网络安全领军者

引言

本项目面向加密流量攻击检测，针对解密效率不高、流量分类不准、安全能力弹性不足等技术难题，在加密流量高效解密、流量精准分类和安全能力弹性编排三方面开展技术攻关并取得创新性突破，在满足隐私合规要求的同时，有效提升了针对加密流量攻击的威胁检测和安全防护能力。

Introduction

This project, targeted for the detection of attacks in encrypted traffic, has made technical breakthroughs in efficient decryption of encrypted traffic, accurate traffic classification, and elastic security capability orchestration, to address technical challenges such as low efficiency of decryption, inaccurate traffic classification, and insufficient security capability elasticity, thereby effectively enhancing threat detection and security defense capabilities while complying with privacy regulations.

破局加密流量检测，提高网络安全防护能力

Make Breakthrough in Detection of Encrypted Traffic to Enhance Cybersecurity Protection Abilities

本项目针对加密流量攻击检测取得了进展，一是突破 SSL 加密流量解密耗时长的问题，提出软硬结合的高性能解密技术，基于多维特征的加密流量识别和基于协程异步机制的一体化解密等关键技术，以软硬件结合的形式，实现对 SSL 加密流量高效解密，解密性能相比传统方法提升 10 倍。二是突破传统的基于协议的分类方法无法精准分类流量的问题，提出基于多维特征构建的流量分类技术，能够识别 4000 多种应用类型，从而实现流量的精细化分类。三是突破业务流量多样、安全能力难以弹性调配的问题，提出基于软件定义的动态编排技术，突破服务链智能编排、服务链链路保障等关键技术，实现不同安全需求的安全能力编排。

This project has made progress in the detection of attacks in encrypted traffic. Firstly, to address the long decryption time of SSL encrypted traffic, a high-performance decryption technology combining software and hardware is proposed, relying on key technologies such as multi-dimensional feature-based encrypted traffic recognition and the integrated decryption technology based on coroutine asynchronous mechanisms, to realize efficient SSL encrypted traffic decryption, enhancing decryption performance by a factor of ten compared to traditional methods. Secondly, to deal with the challenge of inaccurate traffic classification with traditional protocol-based methods, a multi-dimensional feature-based traffic classification technology is proposed, capable of identifying more than 4,000 applications, thereby enabling refined traffic classification. Thirdly, to cope with the diverse business traffic and the difficulty in elastically allocating security capabilities, a software-defined dynamic orchestration technology is proposed, which overcomes key challenges in intelligent service chain orchestration and service chain link assurance, thereby enabling security capability orchestration for different security needs.

完成规模化应用，提升国际竞争力

Scale Application Empowers Elevation in International Competitiveness

项目成果已广泛应用于中国多个领域，包括但不限于中国电信、广州无线电等公共通信和信息服务；中国石油、中国石化等能源领域；中国农业银行、招商银行等金融行业；中国中药控股等医疗卫生领域；工业和信息化部、水利部、国家市场监督总局等电子政务领域；以及中国烟草、中国电子等央国企和京东科技集团等大型互联网企业。

The project achievements have fruited in many applications in China, including but not limited to China Telecom and Guangzhou Radio in the public communication and information service sector; PetroChina and Sinopec in the energy sector; Agricultural Bank of China and China Merchants Bank in the financial sector; China Traditional Chinese Medicine Holdings in the healthcare sector; Ministry of Industry and Information Technology (MIIT), the Ministry of Water Resources, the State Information Center, and the State Administration for Market Regulation in the e-government sector; and the National Center for Educational Technology in the and central and state-owned enterprises and large internet companies such as China Tobacco, China Electronics, and JD Technology Group.

同时，在国际市场的拓展方面取得了显著成就。产品成功进入中东、北非等地区，实现了市场多元化布局，并加深了与”一带一路”沿线国家的合作。项目采用一次解密、多次检测的方法，实现了高性能的流量解密和多种安全能力的动态编排，提升了网络安全产品的国际竞争力。

More than that, it has achieved significant success in expanding into international markets, having made presence in regions such as the Middle East and North Africa, realizing a diversified market layout, and deepening cooperation with countries related to the “Belt and Road”. Additionally, it employs a one-time decryption, multiple detection method, achieving high-performance traffic decryption and dynamic orchestration of various security capabilities and strengthening the international competitiveness of cybersecurity products.

项目成果获得认可，助力构建网络空间命运共同体

Highly-ratified Project Achievements Support the Construction of a Community of Shared Future in Cyberspace

项目成果在中国重大活动的网络安全保障中发挥了关键作用，为加强网络安全屏障做出了显著贡献。项目成果已广泛应用于电子政务、金融、能源、电力、教育、通信等多个行业，形成了 8 个行业一体化解决方案，为客户提供了定制化的网络安全产品和服务。项目成果在中东、北非等关键国际市场的成功布局，不仅展示了奇安信产品和技术的国际竞争力，也获得了国际市场的高度认可。通过与当地政府、企业、机构建立合作，构建了广泛的国际合作伙伴网络，为公司在全球范围内的多元化市场布局奠定了坚实的基础，而且通过在”一带一路”沿线国家的成功实施，不仅促进了网络空间命运共同体的构建，也为当地经济的发展和数字化

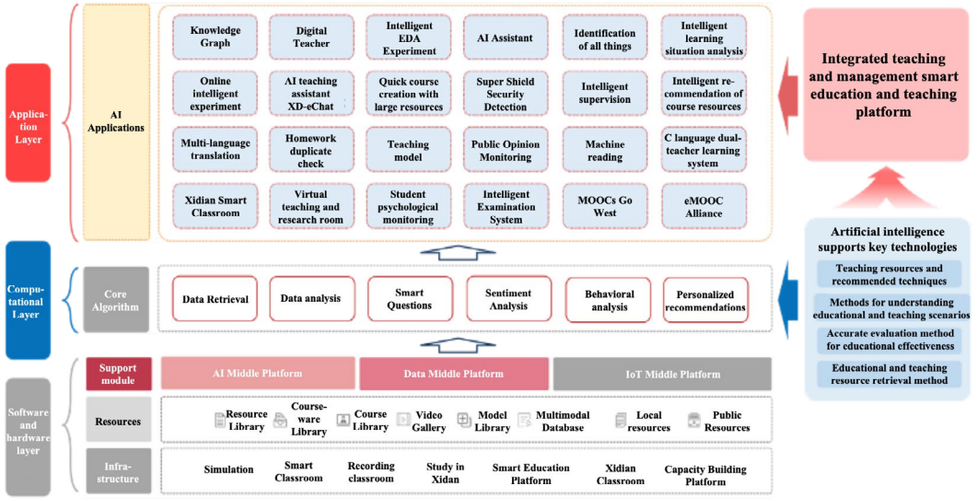
转型注入了积极动力。

This project has played a vital role in ensuring cybersecurity for national events and significantly strengthening cybersecurity barriers. Its achievements have been widely applied across various industries such as e-government, finance, energy, electricity, education, and telecommunications, forming eight integrated industry solutions and providing customized cybersecurity products and services to customers. Its presence in key international markets such as the Middle East and North Africa signifies that our products and technologies have gained international competitiveness and widely applauded worldwide. By establishing cooperative relationships with governments, enterprises, and institutions locally, we have built a broad international cooperation network, which has laid a solid foundation for our diversified market layout in the globe. Its success achieved in countries related to “the Belt and Road” has not only boosted the construction of a community of shared future in cyberspace, but also injected dynamics into the economic development and digital transformation locally.

教育教学中 AI 关键技术及一体化平台建设

Key Technology of AI and Construction of Integrated Platform in Education and Teaching

◉ 教管学一体化智慧教育教学平台



◉ Integrated Smart Education and Teaching Platform for Education Management and Learning

西安电子科技大学
Xidian University

北京世纪超星信息技术发展有限责任公司
Beijing Century Superstar Information Technology Development Co., Ltd.

引言

本成果通过人工智能技术与教育教学的深入融合，致力于破解教育数字化转型难题，突破了课堂教学质量客观评价与个性化教学两项关键技术，在国际教育领域具有显著的创新性与领先性，研究成果在学术界产生了重要影响。

Introduction

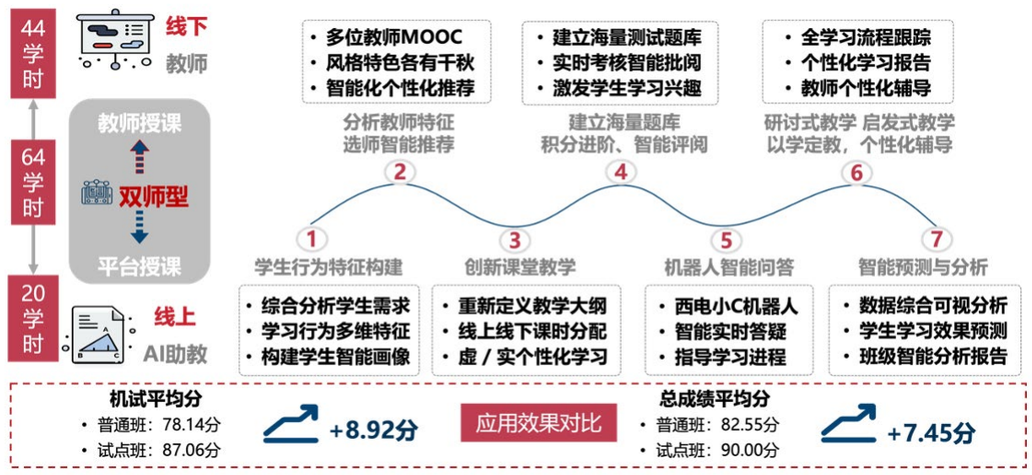
This achievement is committed to solving the problem of digital transformation in education through the deep integration of artificial intelligence technology and education teaching. It breaks through the two key technologies of objective evaluation of classroom teaching quality and personalized teaching, and has significant innovation and leadership in the international education field. The research results have had an important impact on the academic community.

AI+ 教育融合，破解教学评价与个性化教学难题

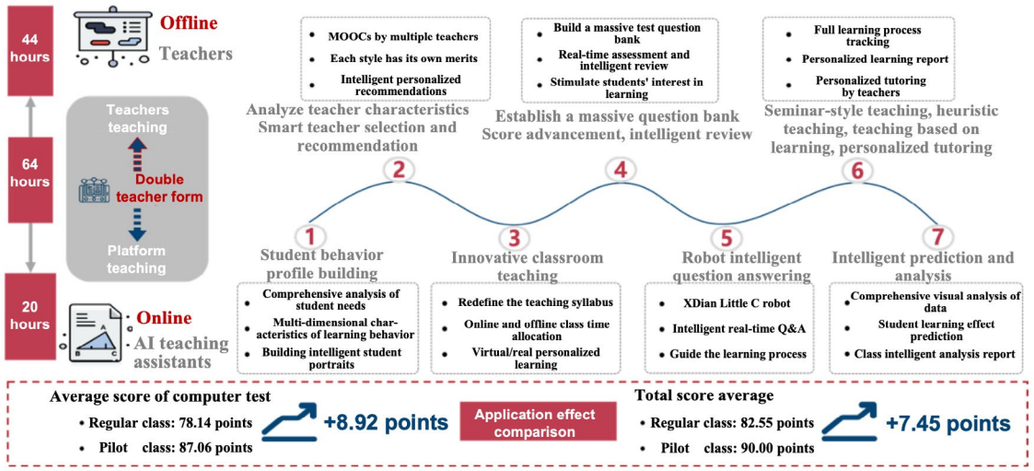
AI+ Education Integration, Solving the Problem of Teaching Evaluation and Personalized Teaching

本成果在攻克教育领域的技术难题方面取得了显著突破，实现了多项技术创新。具体而言，我们成功解决了课堂教学质量的客观评价问题，通过细粒度的行为分析技术，为提升教学质量提供了有力支持，这一技术突破在国际处于领先地位。同时，我们还满足了学生的个性化教学需求，通过个性化的辅导与教学策略，有效提升了学生的学习效果和兴趣，这一创新点同样具有国际领先性。此外，我们的 AI+ 教育应用及平台在技术上展现了明显的先进性，围绕相关成果，我们已在 CVPR、AAAI、IJCV 等高水平国际会议及期刊上发表论文 50 余篇，并申请相关专利及软件著作权 20 余项，充分证明了其在国际学术界的领先地位和影响力。综上所述，本成果在技术上实现了多项创新突破，具有显著的国际领先性。

This achievement has made significant breakthroughs in tackling technical challenges in the field of education and achieved multiple technological innovations. Specifically, we have successfully addressed the issue of objective evaluation of classroom teaching quality, providing strong support for improving teaching quality through fine-grained behavior analysis techniques. This technological breakthrough is at the forefront internationally. At the same time, we also meet the personalized teaching needs of students, effectively enhancing their learning outcomes and interests through personalized tutoring and teaching strategies, which is also internationally leading in innovation. In addition, our AI+educational applications and platforms have demonstrated obvious progressiveness in technology. Centered around these achievements, we have published over 50 papers in high-level international conferences and journals such as CVPR, AAAI, and IJCV, and have applied for more than 20 related patents and software copyrights, fully attesting to our leading position and influence in the international academic community. In summary, this achievement has achieved multiple innovative breakthroughs in technology and has significant international leadership.



◉ 教师 + 平台双师教学模式



◉ Teacher+Platform Dual Teacher Teaching Model

◉ 著名学者引用并认可本成果发表的算法

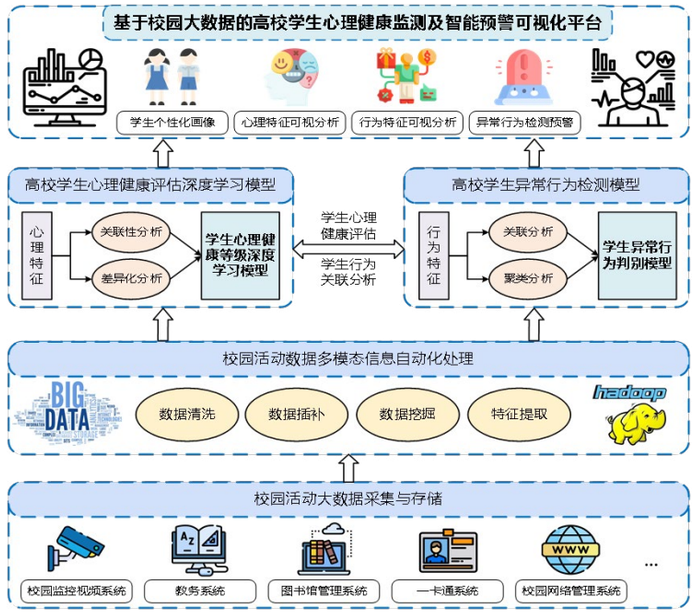
◉ Famous Scholars Cite and Acknowledge the Algorithms Published in This Work

推动教育数字化转型，创造巨大经济效益

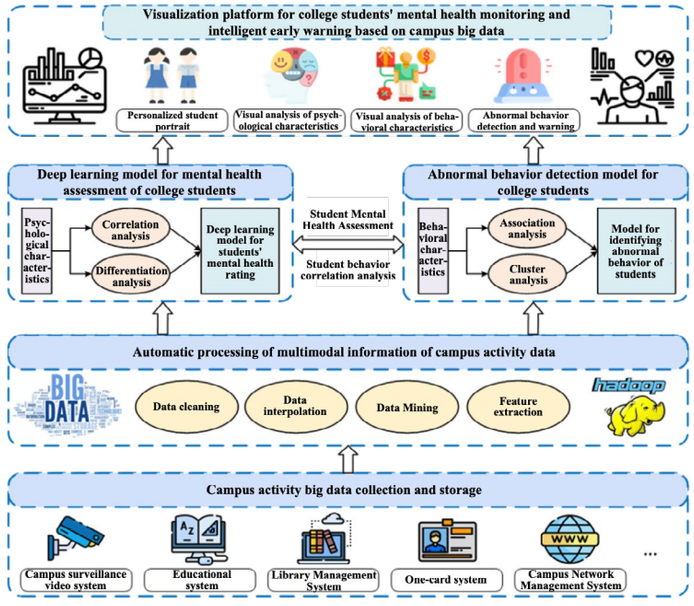
Promote the Digital Transformation of Education and Create Huge Economic Benefits

本成果在应用实施方面已经较为成熟，通过与多家企业的深度合作，成功将 AI 技术融入教育教学平台，并在中国进行了广泛的推广和应用，覆盖了各类型教育机构，证明了其在实际操作中的成熟度和稳定性。在应用效益方面，本成果带来了显著的经济、社会及生态环境效益。经济效益方面，合作企业新增销售额和利润分别达到了 2.2 亿元和 1.02 亿元，展现了巨大的市场潜力。社会效益方面，通过提供个性化的学习资源和教学策略，有效提高了教学质量和学习效率，促进了教育公平，同时对学生的心理健康问题进行了及时预警和干预，有助于社会的和谐发展。生态环境效益方面，数字化、智能化的教学方式减少了对纸质教材等实体资源的依赖，降低了对环境的破坏。技术创新的市场价值和社会价值得到了充分体现。

This achievement has been relatively mature in terms of application and implementation. Through deep cooperation with multiple enterprises, AI technology has been successfully integrated into education and teaching platforms, and has been widely promoted and applied in China, covering various types of educational institutions, proving its maturity and stability in practical operation. In terms of application benefits, this achievement has brought significant economic, social, and ecological benefits. In terms of economic benefits, the cooperative enterprises have added sales and profits of 220 million yuan and 102 million yuan respectively, demonstrating enormous market potential. In terms of social benefits, by providing personalized learning resources and teaching strategies, the quality and efficiency of teaching have been effectively improved, educational equity has been promoted, and timely warning and intervention for students' mental health problems have been carried out, which is conducive to the harmonious development of society. In terms of ecological and environmental benefits, digital and intelligent teaching methods have reduced reliance on physical resources such as paper textbooks and reduced environmental damage. The market value and social value of technological innovation have been fully reflected.



◉ 构建学生心理健康检测及智能预警可视化平台



◉ Building a visualized platform for student mental health testing and intelligent warning

引领 AI+ 教育创新潮流，推进 AI+ 教育行动

Leading the Trend of AI+Education Innovation and Promoting AI+Education Action

本成果在教育领域的应用产生了深远影响，不仅加速了教育数字化转型，还创造了广泛的社会与经济价值。提供个性化学习资源和教学策略，有效提升了教学质量和学习效率，促进了教育公平，使更多学生受益于优质教育资源。同时，构建的学生心理健康检测及智能预警可视化平台，有助于提升学生心理健康水平，减少心理问题，进一步推动了社会和谐发展。成果支撑西安电子科技大学 AI+ 教育中心建设，并取得了显著成效，截至 2024 年 8 月，该中心已接待包括教育部、中央网信办、地方政府、国家留学基金委、北京邮电大学、厦门大学等数百家单位，共计 965 批次 9788 人次参观交流。在经济层面，本成果与合作企业深度融合，实现了显著经济效益，为合作企业创造了新增销售额和利润。

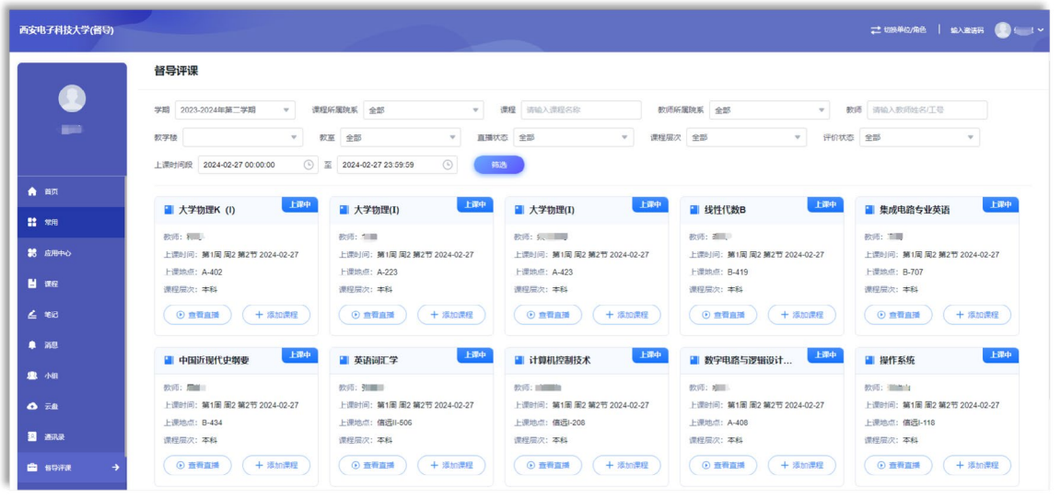
The application of this achievement in the field of education has had a profound impact, not only accelerating the digital transformation of education, but also creating extensive social and economic value. Providing personalized learning resources and teaching strategies effectively improves teaching quality and efficiency, promotes educational equity, and enables more students to benefit from high-quality educational resources. At the same time, the construction of a student mental health detection and intelligent warning visualization platform helps to improve students' mental health level, reduce psychological problems, and further promote social harmony and development. The achievements have supported the construction of the AI+Education Center at Xi'an University of Electronic Science and Technology, and have achieved significant results. As of August 2024, the center has received hundreds of units including the Ministry of Education, the Cyberspace Administration of China, local governments, the China Scholarship Council, Beijing University of Posts and Telecommunications, Xiamen University, etc., with a total of 965 batches and 9788 visitors for exchange. At the economic level, this achievement has been deeply integrated with the cooperative enterprises, achieving significant economic benefits and creating new sales and profits for the cooperative enterprises.

AI 赋能课堂教学与督导，技术引领教育变革

AI Empowers Classroom Teaching and Supervision, Technology Leads Education Transformation

依托本平台构建的“两端一体化”的课堂教学智能督导应用入选教育部首批 18 个“人工智能 + 高等教育”应用场景典型案例；团队在 AI+ 教育领域的突出成绩，教育部特发函委托团队王泉、苗启广等同志参与《世界高等教育数字化发展报告（2023）》的研究、撰写工作；团队成果近 3 年获国家级教学成果奖二等奖 1 项、中国电子学会科学技术奖科技进步二等奖 1 项、陕西省科学技术奖科技进步奖二等奖 1 项、陕西省高等学校科学技术研究优秀成果特等奖 1 项。

The classroom teaching intelligent supervision application built on this platform has been selected as one of the first 18 typical cases of “artificial intelligence+higher education” application scenarios by the Ministry of Education of the People's Republic of China; The outstanding achievements of the team in the field of AI+education have been entrusted by the Ministry of Education to Wang Quan, Miao Qiguang and other comrades to participate in the research and writing of the “World Higher Education Digital Development Report (2023)”; The team's achievements have won one second prize in the National Teaching Achievement Award, one second prize in the Science and Technology Progress Award of the China Electronics Society, one second prize in the Science and Technology Progress Award of the Shaanxi Provincial Science and Technology Award, and one special prize for excellent scientific and technological research achievements in higher education institutions in Shaanxi Province in the past three years.



◉ “两端一体化”的课堂教学智能督导

◉ Intelligent Supervision of Classroom Teaching

面向市域零碳的多要素融合智慧能源互联平台

Multi-Element Integration Smart Energy Interconnection Platform for Urban Carbon Neutrality

◉ 多要素融合智慧能源互联平台

◉ Multi-element Integration Smart Energy Interconnection Platform

国网浙江省电力有限公司丽水供电公司
State Grid Zhejiang Electric Power Co., Ltd. Lishui Power Supply Company.

国家电网 STATE GRID
国网丽水供电公司 STATE GRID LISHUI POWER SUPPLY COMPANY

引言

面向市域零碳的多要素融合智慧能源互联平台是市域零碳能源转型的创新实践。平台整合31个系统、251万条数据等，实现了多维生态数据融合，显著提升了可再生能源消纳和电网调节能力，实现技术、市场、政策和商业模式的协同创新突破。

Introduction

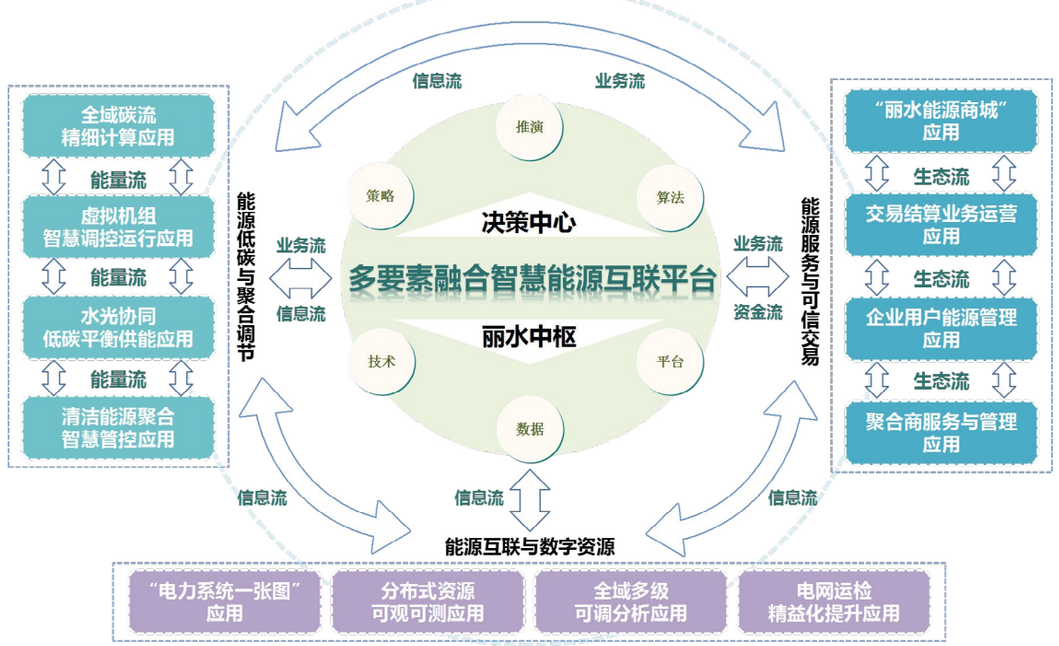
The Multi-element Integration Smart Energy Interconnection Platform for Urban Carbon Neutrality is an innovative practice for urban carbon-neutral energy transformation. The platform integrates 31 systems and 2.51 million data entries, achieving multi-dimensional ecological data integration, significantly enhancing the absorption of renewable energy and grid regulation capabilities, and achieving breakthroughs in the collaborative innovation of technology, market, policy, and business models.

技术、市场、政策和商业模式的协同创新

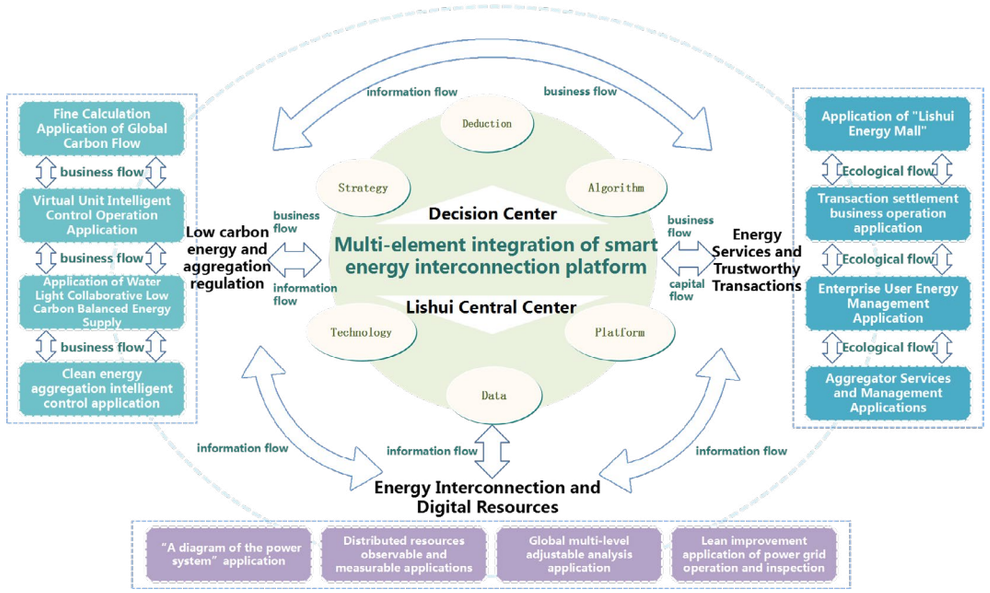
Collaborative Innovation in Technology, Market, Policy, and Business Models

本成果研究并应用了基于IPT技术的轻型控制终端、基于电网CIM拓扑模型与GIS矢量切片的“电网社会要素”贯通融合等技术，建成了面向市域零碳的多要素融合智慧能源互联平台，整合了电网内外31个系统与平台，实现多维数据一图融合，主配网遥测遥信数据同步频度小于30ms，数字高程模型分辨率达30m，有效支撑了可再生能源和负荷预测精度达到96%以上、用户对激励响应的建模、碳排放监测与核算以及电网各类业务。构建了服务电网安全稳定运行的智慧虚拟机组，激活和挖掘社会闲散资源，精准匹配了多样化的电网调节需求和多种类的社会资源调节能力，聚合50万千瓦资源池，参与第三方独立主体辅服务等调峰响应，实现电网与用户的双赢。建设了能源商城，打造市场主体聚合交易平台，上线应用15项，平均结算周期压降89%，入驻用户近7000户，月均活跃度达72.7%，实现技术、市场、政策和商业模式的协同创新突破。

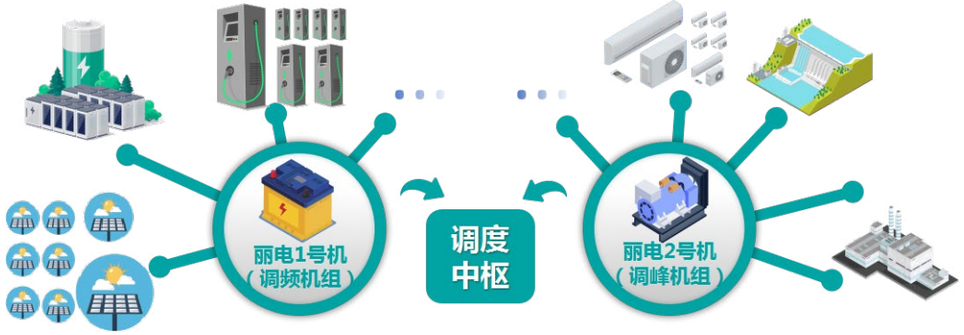
This achievement has researched and applied technologies such as lightweight control terminals based on IPT technology and "grid social elements" integration based on the CIM topology model and GIS vector slicing. A Multi-element Integration Smart Energy Interconnection Platform for Urban Carbon Neutrality has been constructed, integrating 31 internal and external systems and platforms, achieving multi-dimensional data integration in one map. The synchronization frequency of remote measurement and remote signaling data for primary and secondary networks is less than 30ms, and the resolution of the digital elevation model reaches 30m, effectively supporting the prediction accuracy of renewable energy and load to over 96%, modeling of user response to incentives, carbon emission monitoring and accounting, and various grid operations. A smart virtual power unit has been constructed to support the safe and stable operation of the grid, activating and mining idle social resources, and accurately matching diverse grid regulation needs with various social resource regulation capabilities. A 500,000 kW resource pool has been aggregated, participating in third-party independent auxiliary services and peak response, achieving a win-win for the grid and users. An energy mall has been established, creating a market aggregation trading platform, with 15 applications launched, an average settlement cycle reduced by 89%, nearly 7,000 users settled, and a monthly activity rate of 72.7%, achieving breakthroughs in the collaborative innovation of technology, market, policy, and business models.



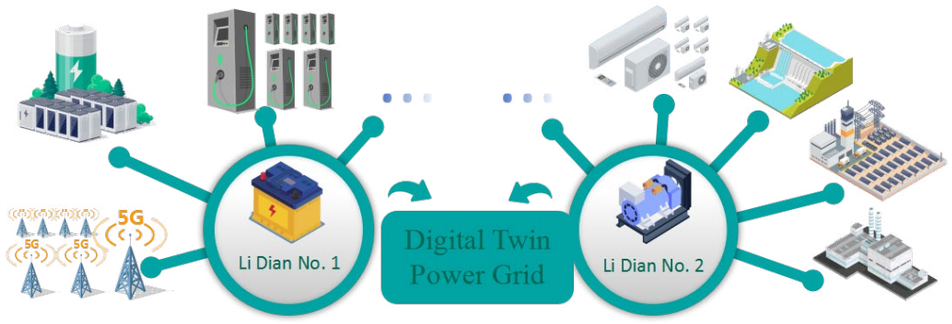
◉ 多要素融合智慧能源互联平台跨业务协同应用总览



◉ Overview of Cross-business Collaborative Applications of the Multi-element Integration Smart Energy Interconnection Platform



◉ 丽电 #1、#2 虚拟机组



◉ Lishui #1, #2 Virtual Power Units

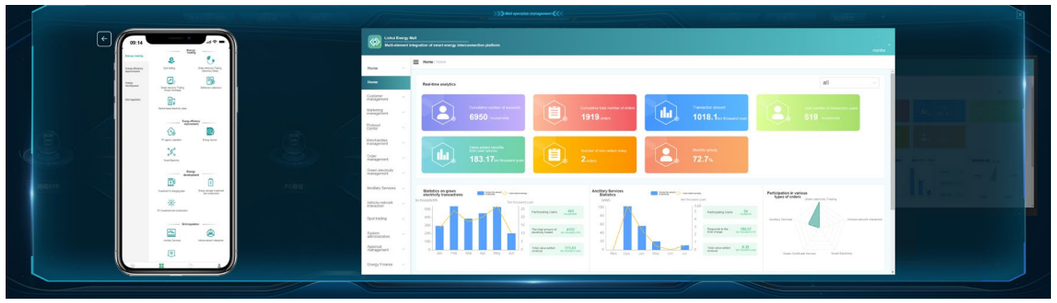
经济效益与环境价值双重提升

Dual Enhancement of Economic Benefits and Environmental Value

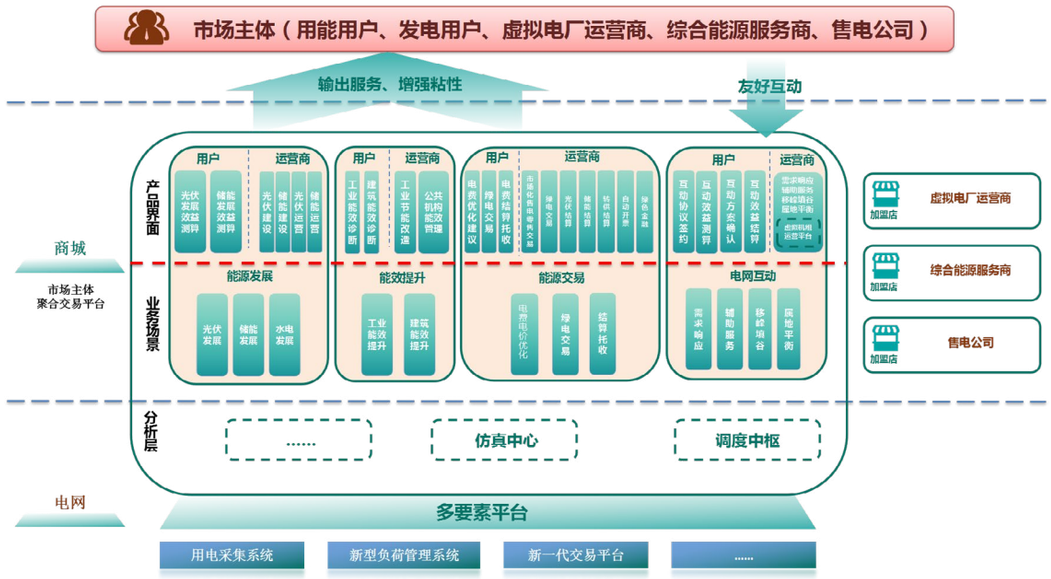
本成果的应用在丽水市域范围内取得了显著成效。平台通过整合 31 个系统和 251 万条数据，实现了能源互联的全景可视化，显著提升了源荷预测精度至 96% 以上，有效支撑了新能源的高效消纳和电网稳定。平台在过去三年中助力丽水 125 万千瓦的可再生能源实现全面消纳，同时通过智能调峰技术释放了 60 万千瓦消纳空间，降低并网成本约 20%。通过丽水绿色能源“虚拟电厂”的调节，增加了 108 万千瓦时新能源消纳量，减少 94 吨发电耗煤，相当于减排 253 吨二氧化碳。丽水能源商城上线的 15 项应用服务了近 7000 户用户，累计结算额突破 1.7 亿元，绿电交易和调峰响应为市场用户带来 183.17 万元收益。近三年累计减少碳排放量 126.28 万吨，2022 年丽水电力碳排放因子降至中国平均水平的 32.6%，较 2020 年降低 25%，为丽水市创建“中国碳中和先行区”提供了有力支撑，展现了该平台在推动能源行业可持续发展方面的显著成效。

The application of this achievement has achieved significant results in the Lishui urban area. The platform, by integrating 31 systems and 2.51 million data entries, has realized the panoramic visualization of energy interconnection, significantly enhancing the prediction accuracy of source and load to over 96%, effectively supporting the efficient absorption of new energy and grid stability. Over the past three years, the platform has helped Lishui to fully absorb 1.25 million kW of renewable energy, while smart peak regulation technology has released 600,000 kW of absorption space, reducing grid connection costs by about 20%. Through the regulation of Lishui's green energy "virtual power plant," an additional 1.08 million kWh of new energy has been absorbed, reducing coal consumption for power generation by 94 tons, equivalent to a reduction of 253 tons of carbon dioxide emissions. The 15 applications launched on the Lishui Energy Mall have served nearly 7,000 users, with a cumulative settlement amount exceeding 170 million yuan, and green electricity transactions and peak regulation responses have brought 1.8317 million yuan in benefits to market users. Over the past three years, a total of 1.2628 million tons of carbon emissions have been reduced, and in 2022, the carbon emission factor of Lishui's electricity has dropped to 32.6% of the China's average level, a decrease of 25% from 2020, providing strong support for Lishui City to create a "Chinese Carbon Neutrality Pioneer Zone," demonstrating the platform's significant effectiveness in promoting sustainable development in the energy industry.

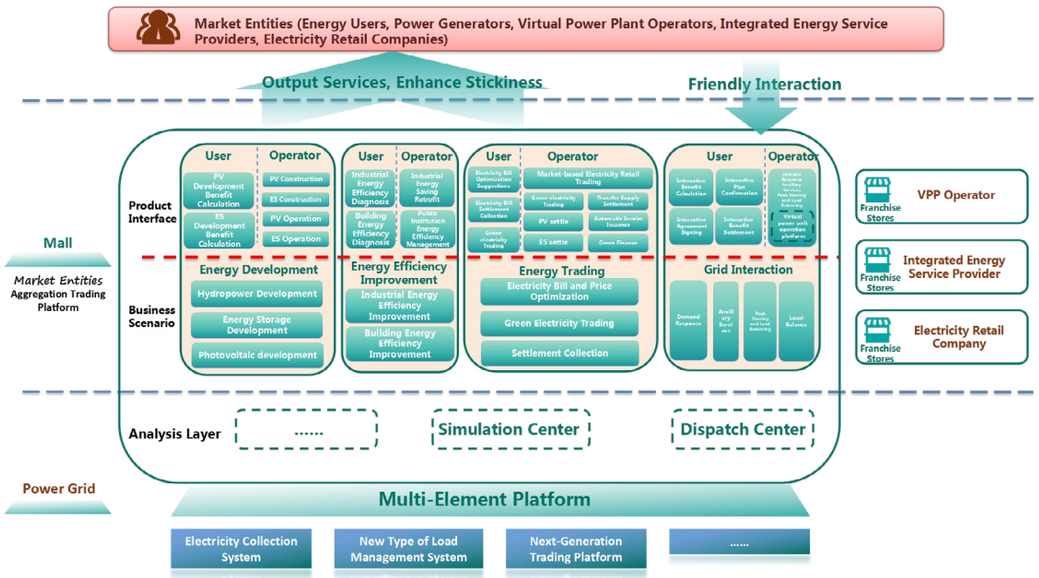
◉ 丽水能源商城运营管理界面



◉ Lishui Energy Mall Operation and Management Interface



◉ 平台功能和服务体系



◉ Platform Functions and Service System

推动能源行业的可持续发展

Promote the Sustainable Development of the Energy Industry

本成果不仅在技术层面取得突破，更在推动能源行业向更加可持续的方向发展方面发挥了重要作用。平台打造了国网首个地市级零碳能源互联网示范工程，包括中国首个主配微三级协同电网和风光水储清洁能源汇集站等创新应用，近三年累计收益达 14.23 亿元，减排 126.28 万吨碳。技术成果获得中国电机工程学会鉴定为国际领先，荣获多项科技进步奖项，包括 2024 年数字中国创新大赛全国一等奖。项目还被评为联合国工业发展组织“全球零碳城市创新典范铂金奖”，并受到时任浙江省省长的高度评价，2021-2023 年得到包括央视在内的 50 余家媒体的广泛报道。

This achievement has not only made technological breakthroughs but also played an important role in promoting the development of the energy industry towards a more sustainable direction. The platform has created the first municipal-level zero-carbon energy internet demonstration project of the State Grid, including China's first primary, secondary, and micro-level coordinated grid and wind, light, water, and storage clean energy collection stations, and other innovative applications. Over the past three years, the cumulative revenue has reached 1.423 billion yuan, and carbon emissions have been reduced by 1.2628 million tons. The technical achievements have been identified as internationally leading by the China Electrical Engineering Society and have won several science and technology progress awards, including the first prize of the 2024 Digital China Innovation Competition. The project was also rated as the "Global Zero-Carbon City Innovation Model Platinum Award" by the United Nations Industrial Development Organization and was highly praised by the then-Governor of Zhejiang Province. It has been widely reported by more than 50 media outlets, including CCTV, from 2021 to 2023.

◉ 项目获“全球零碳城市创新典范铂金奖”

◉ Project Awarded "Global Zero-Carbon City Innovation Model Platinum Award"

◉ 项目获 2024 年数字中国创新大赛一等奖

◉ Project Awarded the First Prize of the 2024 Digital China Innovation Competition

“交管 12123”APP 轻微交通事故视频快处系统

“Traffic Management 12123” App Video Quick Handling System for Minor Traffic Accident

◉ “交管 12123”事故视频快处

◉ Video Quick Handling System

公安部交通管理科学研究所
Traffic Management Research Institute of the Ministry of Public Security

中国电信股份有限公司
China Telecom Corp Ltd

引言

“交管 12123”APP 轻微交通事故视频快处系统，应用视频云技术改进轻微事故处理模式，将“线下出警”转为“线上视频”，视频远程在线快速完成事故处理并组织撤离，便捷了群众事故处理，缓解了城市交通“小事故大拥堵”现象。

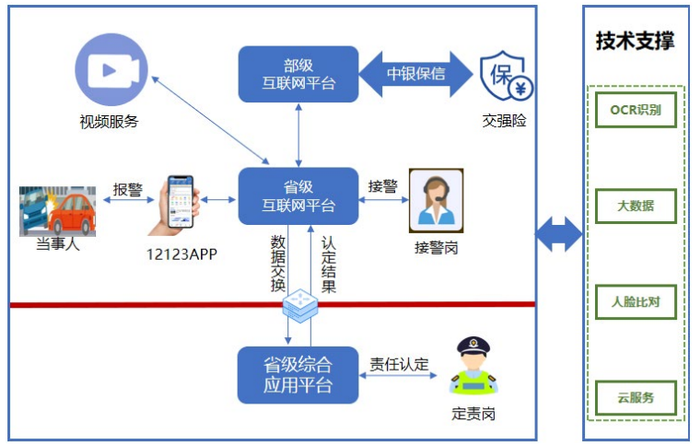
Introduction

The “Traffic Management 12123” App video quick handling system for minor traffic accident uses video cloud technology to improve the minor traffic accident handling mode from “offline police dispatching” to “online video handling”. The system uses online video quickly complete minor traffic accident handling and evacuation organization remotely, providing convenience for the public in minor traffic accidents handling and solving the problem of “minor traffic accident resulting in major traffic congestion” in urban areas.

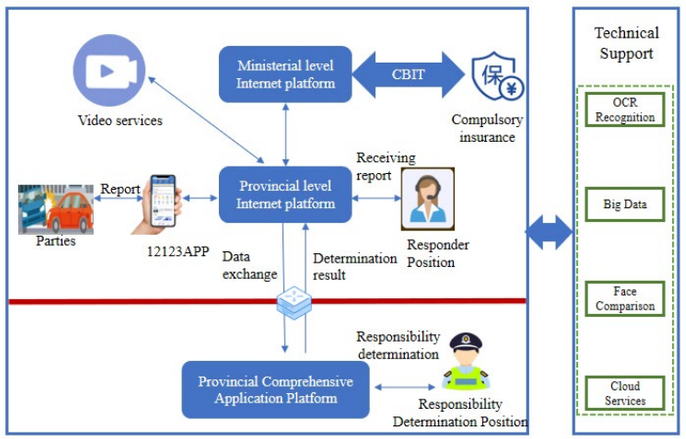
基于“视频云 + 公安交管大数据”，打造轻微交通事故处理新模式

1.Based on “Video Cloud + Public Security Traffic Management Big Data”, A New Mode for Minor Traffic Accidents Handling Has Been Created

公安机关交管部门利用视频通话远程处理轻微事故，解决了传统轻微事故处理不便捷、往返跑、矛盾多和撤离慢等问题，提高事故处理效率和缓解交通拥堵，实现轻微事故的快处快撤。一是视频服务采用“SFU+MCU”融合方式部署，支持云资源弹性扩展，视频过程智能降噪和自动外音播放处理，以保障低失真、低时延和高可靠性的视频服务。二是应用公安交管大数据资源，根据报警人手机号码自动确认身份，利用 OCR 识别车牌自动核验机动车有效性和保险信息，并自动关联获取驾驶人。三是通过视频远程核对当事人人脸图片和身份证据信息进行实时比对验证，以防范当事人冒名顶替。“交管 12123”事故视频快处系统通过线上全流程信息采集核验，无需当事人提供任何纸质材料。



◉ “交管 12123”APP 事故视频快处技术路线



◉ The Technical Route of Video Quick Handling System

简化轻微事故处理流程，全面提升轻微事故处理效能

Simplifying the Minor Traffic Accident Handling Process and Comprehensively Improving the Efficiency of Minor Traffic Accident Handling

“交管 12123”轻微交通事故视频快处系统已经在中国 330 个城市推广应用。发生交通事故后，当事人通过视频报警 5 分钟即可远程在线完成处理，平均节约处理时间

近 30 分钟，避免了现场长时间滞留等候和事后多次往返跑腿。当前，“交管 12123”APP 事故视频快处系统日均处理轻微事故达 2.7 万起，以每起事故节约 20 元成本估算，一年可以节约近 2 亿元。同时，通过与保险机构共享对接，将轻微事故在线处理和保险在线理赔无缝衔接，实现轻微交通事故快处、快撤和快赔全流程线上闭环管理，为群众提供一站式保险理赔服务。对于一线公安交警，通过视频远程处理可以大大减轻工作压力，将释放的警力资源投入到疑难复杂的重伤和死亡事故中，从而实现警力资源效能最大化利用。

The “Traffic Management 12123” App video quick handling system for minor traffic accidents has been promoted and applied in 330 cities in China. After a traffic accident occurs, the parties involved can report the accident through online video; then the traffic accident can be handled online through video remotely in about 5 minutes, saving an average of nearly 30 minutes per accident, avoiding long time waiting on-site and multiple round-trips afterwards. Currently, this system can handle an average of 27,000 minor traffic accidents per day. It is estimated that nearly 200 million yuan can be saved a year based on a cost saving of about 20 yuan per accident. At the same time, by sharing and docking with insurance institutions, the online handling of minor traffic accidents and online insurance claims are seamlessly connected, achieving a closed-loop management of the entire process of minor traffic accident quick handling, quick evacuation and quick compensation, Thus, one-stop insurance claim services for the public is provided. For the front-line traffic police officers, the remote video traffic accident handling mode can greatly relieve their work pressures, and the released police resources can be input into more complex and serious injury and death traffic accidents, thus maximizing the efficiency of police resources.

◉ 事故视频快处系统应用方式和推广成效

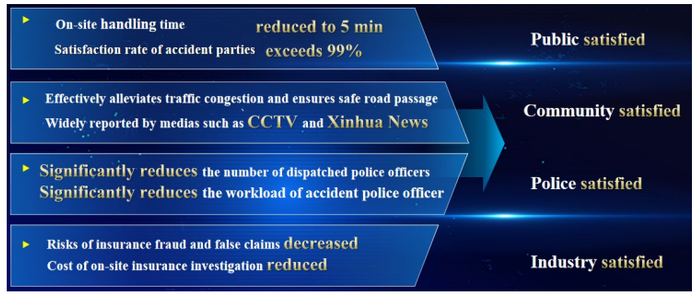
◉ The Application Method and Promotion Effectiveness of the Video Quick Handling System for Minor Traffic Accident

破解轻微交通事故处理难点和痛点，让事故处理变得简单、高效、透明和公正

Solving the Difficulties and Pain points in Handling Minor Traffic Accidents and Making the Traffic Accident Handling simple, Efficient, Transparent and Fair

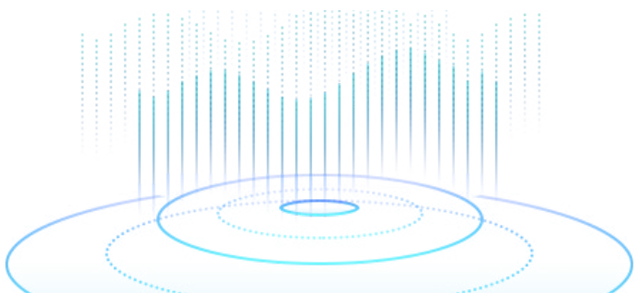
截止 2024 年 8 月，“交管 12123”APP 注册用户达 5.5 亿。发生轻微事故后，当事人仅需通过“交管 12123”APP 发起视频报警在线处理，不需要等候民警出警处理或者撤离至交警队进行处理，尤其早晚高峰期通过视频远程处理，可以快速恢复道路交通秩序避免拥堵。通过视频远程处理时，由接警人员通过视频远程完成现场勘查和证据采集，明确事故发生原因和损伤后果，当事人和机动车的信息通过公安交管大数据资源在线实时核验比对，不需要提供任何纸质证明材料，以简化处理程序让其省心省力。同时，视频通话过程全流程云端录像存储，保证交通事故处理的公开、公平和公正，打消当事人顾虑和快速化解矛盾纠纷，将当事人的“烦心事、堵心事”办成“暖心事、顺心事”。

As of August 2024, the number of registered users of the “Traffic Management 12123” App has reached 550 million. After a minor traffic accident occurs, the parties involved only need to initiate an online video reporting through the “Traffic Management 12123” App for online handling, and do not need to wait for the police to respond and handle on-site or evacuate to the traffic police department for handling, especially during the morning and evening peak hours, can quickly restore traffic order to avoid congestion. When handling a traffic accident through the online video handling system, the responder will remotely complete the scene investigation and evidence collection through video, determine the cause of the accident and the consequences of the damage, then the information of the parties and motor vehicles involved are verified and compared online in real-time through public security traffic management big data resources, without the need to provide any paper proof materials, thus simplifying the traffic accident handling procedures, save the parties' worries and efforts. Meanwhile, the whole video talk process is fully recorded and stored in the cloud, ensuring the openness, fairness and impartiality of the traffic accident handling, dispelling the concerns of the parties involved and quickly resolve contradictions and disputes, turning their “troubles and blockages” into “warm and smooth things”.



◉ 轻微事故视频快处获得广泛好评

◉ The Video Quick Handling System for Minor Traffic Accident Has Received Widespread Praise



阿里巴巴达摩院（杭州）科技有限公司
Alibaba Damo (Hangzhou) Technology Co., Ltd.

面向多类肿瘤和慢病的 AI影像早筛平台

AI Imaging Early Screening Platform for Multiple Tumors and Chronic Diseases

8种重大肿瘤 + 5种高发慢病

8 Major Tumors + 5 Prevalent Chronic Diseases

引言

全球范围内肿瘤和慢病是两大主要的公共卫生挑战，它们的发病率随着人口老龄化和生活方式变化而持续攀升。因此开发面向多类肿瘤和慢病的 AI 影像早筛平台，对提升患者的生存质量有重要帮助。

Introduction

Globally, cancer and chronic diseases are two major public health challenges that continue to rise in prevalence with aging populations and changes in lifestyles. Therefore, developing an AI imaging early screening platform for various types of cancers and chronic diseases can be of great help in improving patients' quality of life.

国际率先提出基于平扫 CT 的肿瘤早期筛查方法

The International Initiative to Propose a Tumor Early Screening Method Based on Non-contrast CT Scans

团队构建的面向多类肿瘤和慢病的 AI 影像早筛平台，在全球率先提出了使用最常见的平扫 CT 来“一扫多筛”，使患者在不增加辐射量的前提下临床获益最大化。

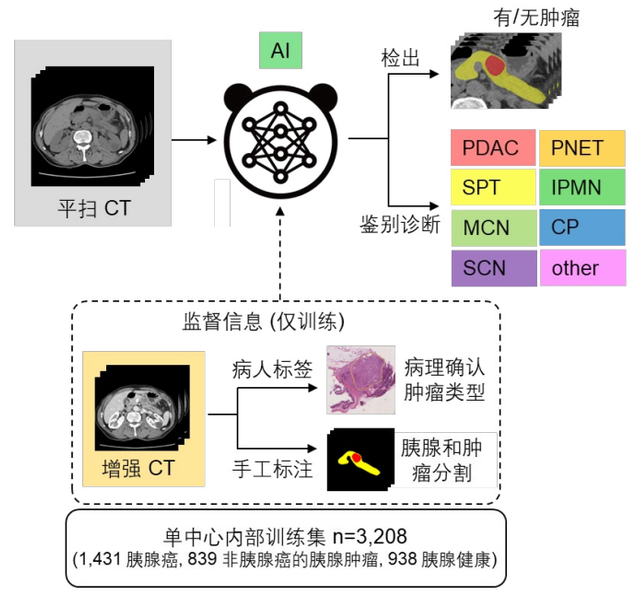
国际上率先提出基于平扫 CT 的多类肿瘤早期筛查，覆盖如胰腺癌、食管癌、结肠癌、胃癌、肝癌、肺癌、乳腺癌和肾癌等 8 种重大肿瘤疾病。以胰腺癌为例，该平台在 3 万余人多中心数据上检测敏感性 92.9%，特异性 99.9%，检测能力远超放射科医生平均水平。

基于平扫 CT 在慢病筛查领域也实现较多突破，首先利用算法优化主动脉综合征诊疗路径，在 8 个多中心的 2 万多例数据上 AUC 达到了 0.95，其次脂肪肝筛查技术获得国际竞赛第一名，再次为心血管疾病设计了一种可提供 18 种影像学标志物的风险预测模型等。

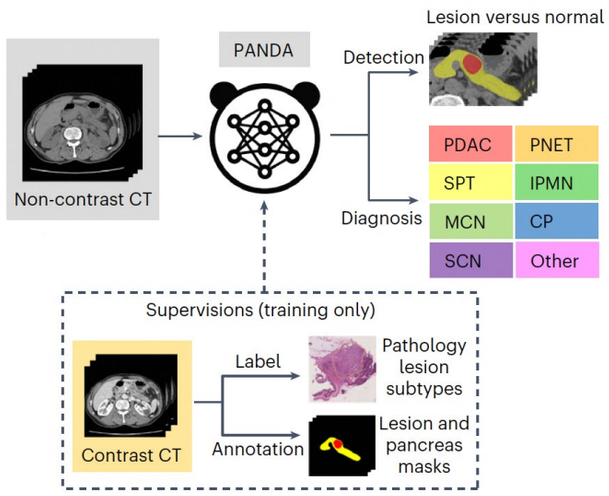
Our team has built an AI-based imaging early screening platform for multiple types of tumors and chronic diseases, which is the world's first to propose the use of non-contrast CT scans for 'one scan, multiple screenings', maximizing clinical benefits for patients without increasing radiation exposure.

We are international pioneers in proposing the use of non-contrast CT scans for early screening of multiple tumors, covering eight major tumors, including pancreatic cancer, esophageal cancer, colorectal cancer, stomach cancer, liver cancer, lung cancer, breast cancer, and kidney cancer. For example, our platform has achieved a detection sensitivity of 92.9% and specificity of 99.9% for pancreatic cancer in a multi-center dataset of over 30,000 people, far surpassing the average level of radiologists.

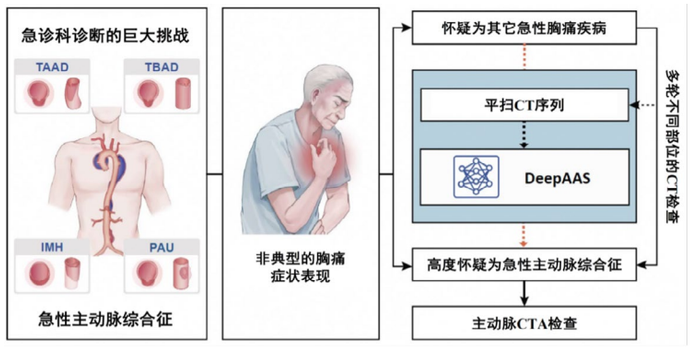
Our non-contrast CT screening technology has also made significant breakthroughs in the field of chronic diseases. We have optimized the diagnosis and treatment pathway for aortic syndrome, achieving an AUC of 0.95 in a multi-center dataset of over 20,000 cases. Additionally, our fatty liver screening technology has won first place in an international competition, and we have developed a risk prediction model for cardiovascular disease that provides 18 imaging biomarkers.



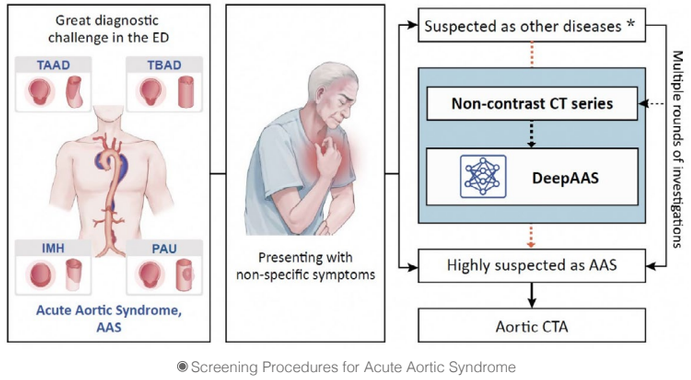
◉ 胰腺癌早筛模型



◉ Pancreatic Cancer Early Screening Model



◉ 急性主动脉综合征筛查流程



◉ Screening Procedures for Acute Aortic Syndrome

低成本早筛技术助力全球科技普惠

Low-Cost Early Screening Technology Empowers Global Health Equity

目前该平台已与 200 余家医院、体检机构、医共体等医疗机构开展科研合作，平台检测能力累计调用量超过 4 千万余次。

依托该平台能力，在浙江丽水开展了多癌早筛公益项目，5 个月时间内筛查超过 10 万人次，发现的 158 例癌症病变已被临床证实，充分验证了该技术在县域医疗环境中部署的可行性，未来有望向更多医疗资源不均衡地区推广。

该平台基于“平扫 CT+AI+ 云计算”的癌症早筛技术有望从根本上提高早诊早治率，从而一举解决医疗命题的“不可能三角”(cost, quality, accessibility)，降低癌症死亡率、改善病人生存质量，减轻社会负担。平扫 CT 是全球普通人，特别是发展中国家体检的常规选项，价格低廉，接受度高，可规模化推广，这也与全球癌症防治行动的思路紧密契合。

The platform has currently collaborated with over 200 hospitals, physical examination institutions, and medical groups to conduct scientific research, with a cumulative detection volume of over 40 million times.

Relying on the platform's capabilities, we have launched a multi-cancer early screening public welfare project in Lishui, Zhejiang, which has screened over 100,000 people within 5 months, and identified 158 cases of cancerous lesions that have been clinically confirmed. This fully verifies the feasibility of deploying this technology in county-level medical environments, and it is expected to be promoted to more areas with uneven medical resources in the future.

This platform's cancer early screening technology based on 'non-contrast CT + AI + cloud computing' is expected to fundamentally improve early diagnosis and treatment rates, thereby solving the 'impossible triangle' of healthcare (cost, quality, accessibility) in one stroke. This will reduce cancer mortality rates, improve patient survival quality, and alleviate social burdens. Non-contrast CT scans are a routine option for regular health check-ups globally, especially in developing countries, with low costs and high acceptance, making it possible for large-scale promotion, which is closely aligned with the global strategy for cancer prevention and control.

◉ 多癌早筛公益项目落地丽水

◉ Multi-Cancer Early Screening Public Welfare Project Lands in Lishui

AI 早筛技术踏上国际舞台备受各方关注

AI Early Screening Technology Steps onto the International Stage, Attracting Widespread Attention

2023 年 11 月 21 日，胰腺癌平扫 AI 筛查成果在医学期刊《自然·医学》中刊发，首次证实了在平扫 CT 上使用 AI 进行大规模胰腺癌筛查的可行性，也是中国放射影像领域的科研成果首次刊登在《自然·医学》上。2024 年 4 月，本工作中提出的胰腺癌筛查模型被斯坦福大学 AI Report Index 2024 年度报告，评选为 2024 年医学方面的五个亮点突破之一（唯一入选来自中国的成果）。

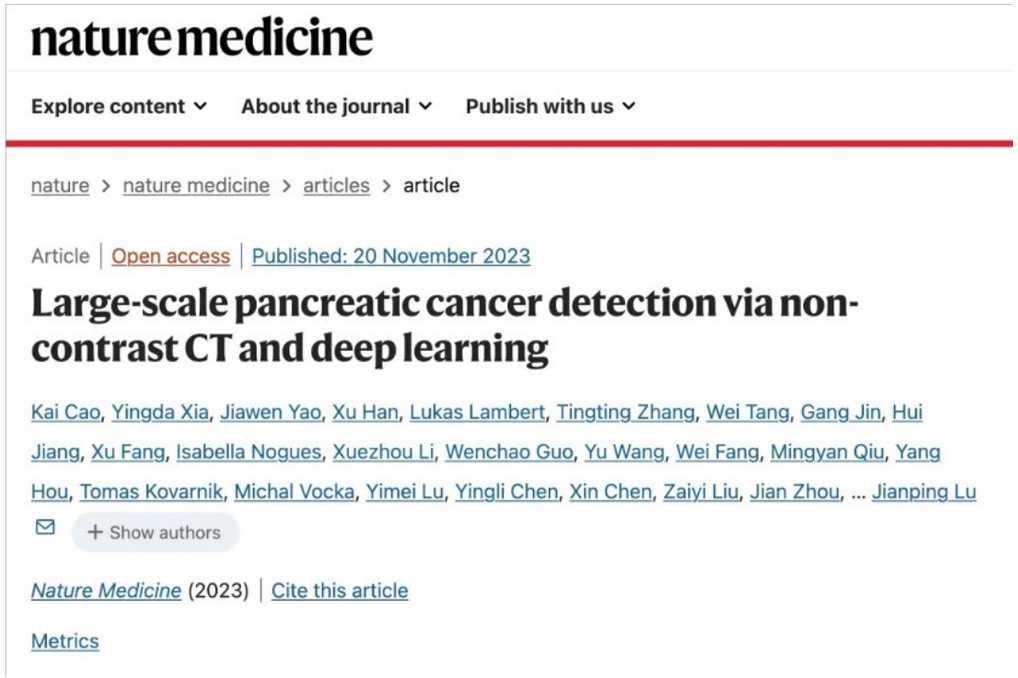
2024 年 1 月，安提瓜和巴布达与阿里达摩院达成合作。5 月，在联合国 AI for Good 峰会上，世卫组织（WHO）数字健康合作中心宣布向全球推广这项 AI 技术，助力更多发展中国家抗击癌症。

同时，本项目团队成员创建了业界最大规模的 CT 多病种数据集 DeepLesion，被 NIH、美国肿瘤研究协会等国际多家权威医学媒体报导，促进了通用病灶检测、分类和跟踪技术的发展和前沿算法的应用，显著提升了癌症诊疗效果的评估与复发监测水平，获得 2018 年美国放射学年会 RSNA Trainee Research Prize。

On November 21, 2023, the results of AI-assisted pancreatic cancer screening using non-contrast CT scans were published in the medical journal Nature Medicine, marking the first time that the feasibility of large-scale pancreatic cancer screening using AI on non-contrast CT scans was confirmed, and also the first time that research from China's radiology field was published in Nature Medicine. In April 2024, the pancreatic cancer screening model was selected as one of the five breakthroughs in the medical field in the Stanford University AI Report Index 2024, and was the only achievement from China to be included.

In January 2024, Antigua and Barbuda partnered with Alibaba Damo Academy. In May, at the UN AI for Good Summit, the World Health Organization's (WHO) Digital Health Cooperation Center announced that it would promote this AI technology globally, helping more developing countries combat cancer.

Meanwhile, the project team members created the largest CT multi-disease dataset, DeepLesion, which was reported by multiple international authoritative medical media outlets, including NIH and the American Cancer Research Association. This promoted the development of universal lesion detection, classification, and tracking technologies, and drove the application of cutting-edge algorithms. This significantly improved the assessment and monitoring of cancer treatment outcomes, and won the 2018 RSNA Trainee Research Prize at the American Radiology Annual Meeting.



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Article | Open access | Published: 20 November 2023

Large-scale pancreatic cancer detection via non-contrast CT and deep learning

Kai Cao, Yingda Xia, Jiawen Yao, Xu Han, Lukas Lambert, Tingting Zhang, Wei Tang, Gang Jin, Hui Jiang, Xu Fang, Isabella Nogues, Xuezhou Li, Wenchao Guo, Yu Wang, Wei Fang, Mingyan Qiu, Yang Hou, Tomas Kovarnik, Michal Vocka, Yimei Lu, Yingli Chen, Xin Chen, Zaiyi Liu, Jian Zhou, ... Jianping Lu

+ Show authors

Nature Medicine (2023) | Cite this article

Metrics

◉ 《自然·医学》正式刊发胰腺癌平扫筛查成果成果

◉ Nature Medicine Officially Publishes Pancreatic Cancer Non-contrast CT Screening Results

◉ WHO 数字健康合作中心与达摩院签约现场

◉ Ceremony for Signing of Agreement between WHO Digital Health Cooperation Center and Alibaba Damo Academy

网络安全 AI Agent 平台

Cybersecurity AI Agent Platform

◉ 网络安全 AI Agent 平台（产品名称：安恒恒脑安全垂域大模型系统）

◉ Cybersecurity AI Agent Platform(Product Name:HengNao Security Domain Large Model System)

杭州安恒信息技术股份有限公司
DBAPP Security Co., Ltd.

中兴通讯股份有限公司
ZTE Corporation

国家能源集团
China Energy Investment Corporation Limited

中国工业互联网研究院
China Academy of Industrial Internet

引言

网络安全 AI Agent 平台是在恒脑安全垂域大模型驱动下自主执行任务拆解、工具调用、知识融合辅助安全运营闭环，对化解行业困境有重要意义，先后在 2023 年成都大运会、杭州亚运会投入使用，保障两大国际赛事网络安全零事故。

Introduction

The Cybersecurity AI Agent Platform, powered by the HengNao Security Domain Large Language Model, autonomously performs task decomposition, tool invocation, and knowledge integration to assist end to end security operations. It holds significant importance in resolving industry challenges and has been deployed in major international events such as Chengdu 2021 FISU World University Games and the Hangzhou Asian Games, ensuring zero cybersecurity incidents.

引导生成智能体，功能效能并行优化成果显著

Guided Generation of Agents, Achieving Great Results with Optimization on Both Accuracy and Efficiency

网络安全 AI Agent 平台可有效缓解当前面临的威胁隐蔽难发现，防护技术应对乏力，数据泄露风险高等问题，与境外知名大语言模型 llama3 和 GPT4o 相比，创建的数据分类分级 Agent 准确率提升 4 倍，敏感数据识别准确率提升 2 倍，还具有 llama3 和 GPT4o 暂不具备的 API 风险识别能力。

The Cybersecurity AI Agent platform can effectively mitigate current challenges such as the concealment and difficulty in detecting threats, the inadequacy of defensive technologies, and the high risk of data breaches. Compared to well-known foreign large language models like llama3 and GPT4o, the platform's data classification and grading Agent has achieved a 4-fold increase in accuracy, and the accuracy of sensitive data identification has doubled. Additionally, it possesses API risk identification capabilities that llama3 and GPT4o currently lack.

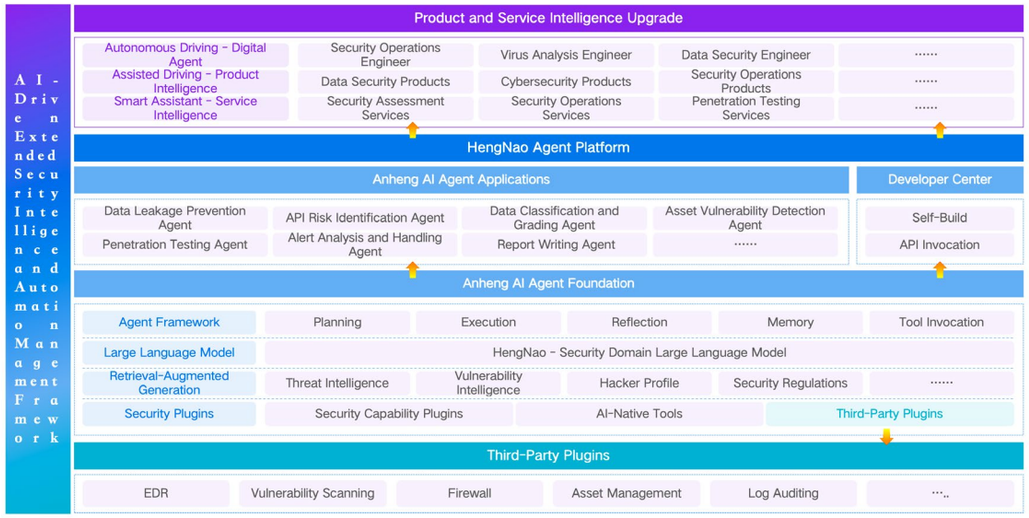
功能上，提出一种基于多专家系统（MOE）的黑灰盒攻防一体算法，通过集成深度强化学习（DRL）和对抗性训练，实现动态适应和自我防御。利用元学习和引导生成技术，实现自学习、自适应智能体，有效应对未知威胁。

Functionally, the platform introduces a black and gray box attack and defense algorithm based on a Mix of Expert System (MOE), integrating Deep Reinforcement Learning (DRL) and adversarial training to achieve dynamic adaptation and self-defense. Utilizing meta-learning and guided generation techniques, it enables self-learning and self-adaptive agents to effectively counter unknown threats.

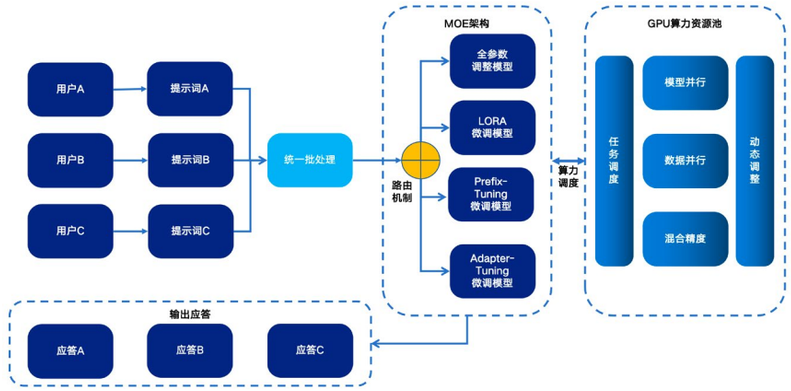
性能上，设计一种集成多种优化策略的推理引擎，包括 PagedAttention、连续批处理、CUDA 算子融合，提高模型推理效率。特别是，业界首创多 LoRA 并行加载和前缀树缓存技术，减少模型切换和数据处理延迟，显著提升吞吐量。

In terms of performance, the platform features an inference engine integrated with various optimization strategies, including PagedAttention, continuous batch processing, and CUDA operator fusion, to enhance model inference efficiency. Notably, it pioneers the industry with multi-LoRA parallel loading and prefix tree caching technologies, reducing model switching and data processing latency, and significantly increasing throughput.

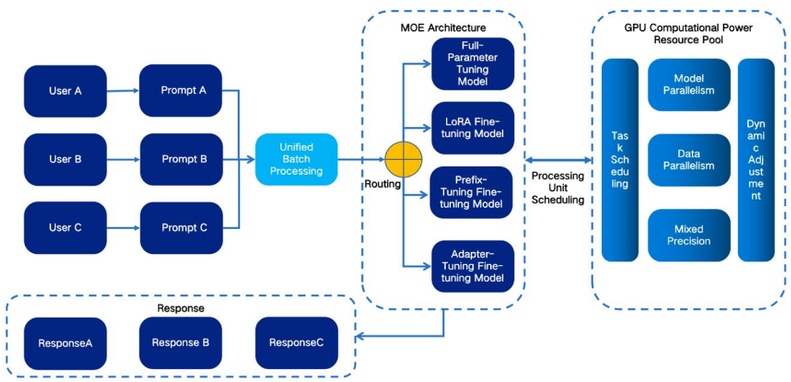
◉ 平台功能架构



◉ Platform Functional Architecture



◉ 多策略优化引擎



◉ Multi-strategy Optimization Engine

应用范围广泛、覆盖场景齐全为行业发展提供借鉴

The Application Scope is Extensive, Covering a Complete Range of Scenarios, Providing a Reference for Industry Development

经济效益方面

网络安全 AI Agent 在应用实施方面已经成熟。从范围上看，已由 IT 领域拓展到物联网、车联网和工业互联网领域；从数量上看，各类 Agent 超 100 个，激活状态超 80 个；从覆盖场景上看，重保场景覆盖超 80%，日常安全运营超 90%。创建 Agent 执行自动化告警研判、事件调查和处置响应，可降低企业安全人力成本 50% 以上，实现 7*24 小时值守，事件响应由数小时提升到秒级。

Economic Benefits:

The Cybersecurity AI Agent has reached maturity in its application and implementation. In terms of scope, it has expanded from the IT sector to the Internet of Things (IoT), vehicular networks, and industrial internet sectors. Quantitatively, there are over 100 types of Agents, with more than 80 actively running. In terms of coverage, critical protection scenarios are covered by over 80%, and daily security operations are covered by over 90%. The Agent performs automated alert analysis, incident investigation and response, which can reduce corporate security operating costs by more than 50%, achieve 24/7 monitoring, and improve incident response time from hours to seconds.

社会效益方面

Agent 也能够根据实时数据和历史经验，优化安全资源的分配，目前已可 100% 接入等保、关基投入的全部安全软硬件，有效保护安全投资。

Social Benefits:

The Agent can also optimize the allocation of security resources based on real-time data and historical experience. It can currently integrate 100% of all security software and hardware invested in Information Security Degree Protection and critical infrastructure, effectively safeguarding security investments.

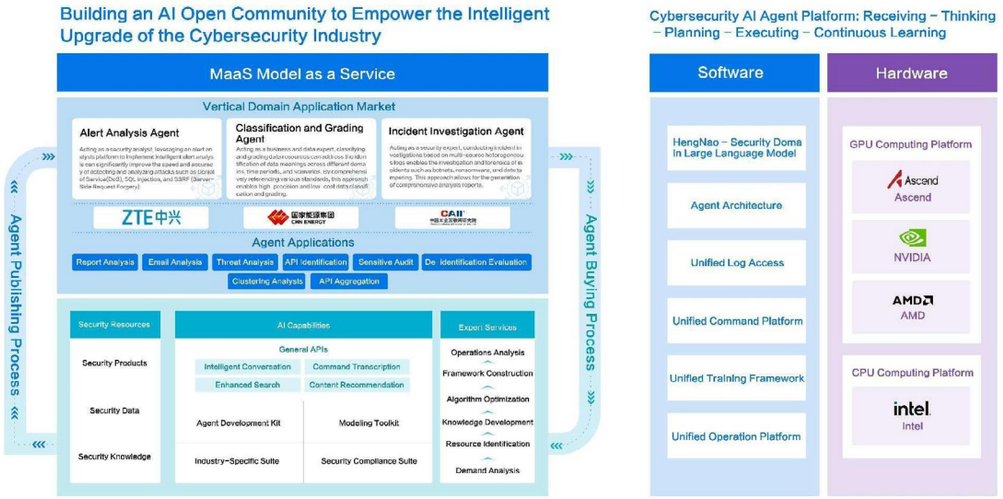
环境效益方面

网络安全 AI Agent 的发展和普及，可以有效降低 MSS 运营托管的成本，促使企业从采购安全产品转向购买安全服务，减少硬件资源投入和使用，推动绿色安全和可持续发展。

Environmental Benefits:

The development and popularization of Cybersecurity AI Agents can effectively reduce the costs of MSS (Managed Security Services) operations and hosting, encouraging enterprises to shift from purchasing security products to buying security services. This reduces investment and use of hardware resources and promotes green security and sustainable development.

◉ 智能体开放社区实现模型即服务



◉ Agent Open Community Achieves Model-as-a-Service (MaaS)

◉ 重大活动保障出色

革新交付模式、推动原始创新实现降本增效

Innovating Delivery Models and Promoting Innovation to Achieve Cost Reduction and Efficiency Enhancement

安全 AI Agent 平台成功应用于 2023 年成都大运会和杭州亚运会重保，亚运会赛事期间响应各类系统调用 34864 次，辅助处理安全事件 287 起，综合提升指挥中心 57% 的工作效率。

The Cybersecurity AI Agent platform has been successfully applied to the 2023 Chengdu 2021 FISU World University Games and the Hangzhou Asian Games, with 34,864 system calls responded to and 287 security incidents assisted during the Asian Games. The platform has comprehensively increased the control center's work efficiency by 57%.

Agent 模式革新安全行业交付，由交付产品演进到交付服务，促使安全企业弱化工程研发重技术创新，将更多资源投入到核心能力做深做强，需求落地也由之前的最低 3 个月压缩到现在的 3-5 周，运营成本相较传统模式降低 50%。

The Agent paradigm has revolutionized the delivery of the security industry, evolving from delivering products to delivering services. This has encouraged security companies to de-emphasize engineering R&D and focus on technological innovation, investing more resources into strengthening their core capabilities. The time required from requirement to implementation has been reduced from a minimum of three months to 3-5 weeks, and operational costs have been reduced by 50% compared to previous ways.

平台获 2023 年中国人工智能协会举行的《全国人工智能应用场景创新挑战赛》全国总决赛中获特等奖，华为《昇腾 AI 创新大赛》2023 全国总决赛中获金奖。作为最佳实践，参与编撰的《AI 安全白皮书》在 2023 年第七届云安全联盟大中华区大会发布。同时，辅助立项 1 个国家标准、5 个行业标准和 2 个团体标准。

The platform won the Special Prize in the "National Artificial Intelligence Application Scenario Innovation Challenge" held by the China Artificial Intelligence Association in 2023, and the Gold Prize in the "Huawei Ascend AI Innovation Competition" 2023 National Finals. As a best practice, it has been compiled in the "AI Security White Paper," which was released at the 7th Cloud Security Alliance Greater China Conference in 2023. Additionally, it was included in 1 national standard, 5 industry standards, and 2 group standards.

◉ Outstanding Security for Major Events

◉ 全国人工智能应用场景创新挑战赛（最高奖）
◉National Artificial Intelligence Application Scenario Innovation Challenge (Top Award)

多元算力适配，加速产业落地引领业界探索

Adapting to Diverse Computing Architectures, Accelerating Industrial Deployment and Leading Industry Exploration

当前，大模型海量的安全知识以及巨大的事务处理需求，带来了较高的算力开销，基于 GPU 的模型推理方案在性能上表现突出，但是成本和部署难度都较大，安全 AI Agent 平台持续探索多元算力适配方案，除支持英伟达、AMD、华为昇腾 GPU 外，还在 Intel MAX 系列 CPU 上成功完成适配，实现了更高的投资收益，与 Intel 联合发布白皮书《安恒信息采用英特尔 ® 至强 ® 可扩展处理器加速恒脑大模型推理 助力实现智能安全运营》，为业界提供参考。

Currently, the vast security knowledge of LLM and the huge processing demand lead to significant computational costs. Model inference solutions based on GPUs stand out in terms of performance, but they are costly and difficult to deploy. The Cybersecurity AI Agent platform continuously explores diverse computational architecture adaptation solutions. In addition to supporting NVIDIA, AMD, and Huawei Ascend GPUs, it has also successfully adapted on Intel MAX series CPUs, achieving a higher return on investment. In collaboration with Intel, a white paper titled “DBAPPSecurity Adopts Intel® Xeon® Scalable Processors to Accelerate DBAPPSecurity Brain Large Language Model Inference, Facilitating Intelligent Security Operations” has been released, providing a reference for the industry.

◉ 基于英特尔 CPU 实现恒脑大模型推理
◉Achieving DBAPPSecurity Brain Large Model Inference Based on Intel CPUs.

一款基于工业物联网 (IIoT) 的微型智能无线传感器

A Smart Wireless Solution for the IIoT

Sushi Sensor®

◉ 无线振动、压力、温度传感器

◉ Wireless Vibration, Pressure, Temperature Sensor

横河电机（中国）有限公司
Yokogawa China Co., Ltd.

YOKOGAWA

引言

Sushi Sensor 是一种基于工业物联网（IIoT）的无线解决方案。通过传感层测量设备的振动、温度和压力值，数据上传云端或本地处理器，用户通过云或本地趋势监控识别设备状态，从而高效地计划和执行设备维护。

Introduction

Sushi Sensor is a wireless solution based on the industrial IoT which can help plan and execute equipment maintenance more efficient. It acquires data of vibration, pressure and temperatures of equipment, processes data on cloud or on premise. The user can identify the status of equipment through a local dashboard or a cloud account.

集成精密测量、无线通讯与物联网属性的工业级解决方案

Industrial-Grade Solution That Integrates Precision Measurement, Wireless Communication and IoT Attributes

与过程监控和安全用途的传感器不同，引入传感技术来改善工厂的维护、环境和能源管理时，需要百级至千级的测量点。小型无线传感器对于这些应用场景，是非常有吸引力和实际意义的解决方案，因为不需要布线。然而，为使其广泛使用，需要降低成本并确保工业用途的耐环境性。此外，还需要显著减少安装传感器、采集数据以及维护功能和性能所涉及的工作量。

Unlike sensors for process monitoring and safety purposes, the introduction of sensing technology to improve maintenance, environmental and energy management in plants requires hundreds to thousands of measuring points. A Small wireless sensor is an attractive and practical solution for these applications, as no wiring is required. However, in order for it to be widely used, it is necessary to reduce costs and ensure environmental resistance for industrial use. In addition, the effort involved in installing sensors, collecting data, and maintaining functionality and performance needs to be significantly reduced.

Sushi Sensor 是一种无线传感器，集成了与智能手机和云等通用 IT 基础设施连接的功能，可轻松执行安装和操作工业无线传感器所需的各种操作。同时，传感器主体设计紧凑小巧，没有显示部分和操作部分。其主要技术特点如下：

Sushi Sensor is a wireless sensor that integrates the functionality of connecting with common IT infrastructure such as smartphones and the cloud, making it easy to perform various operations required to install and operate industrial wireless sensors. At the same time, the sensor body has a compact design and does not have a display and operation parts. Its main technical characteristics are as follows:

在硬件配置层面：

传感器本体小巧轻便，可通过磁吸方式实现非介入式样安装；

通过内置电池供电，最长工作续航 10 年；

适用于各种恶劣工作环境，可安装在包括危险区域在内的环境中（防水、防尘、防爆）；

数据传输采取 LoRaWAN 通讯方式，最大可实现 7 公里远距离无线通信，增加了传感器安装位置的灵活性。

In terms of hardware configuration:

The sensor body is small and lightweight and can be installed in a non-intrusive way by magnetic suction.

Powered by a built-in battery which has a maximum operating range of 10 years.

It is suitable for all kinds of harsh working environments and can be installed in environments including hazardous areas (waterproof, dustproof, explosion-proof).

The data transmission adopts LoRaWAN communication mode, which can achieve long-distance wireless communication of up to 7 kilometers, which increases the flexibility of the sensor installation location.

在软件与功能设计方面，

通过 NFC（近场通信）进行传感器设置，具体通过智能手机应用程序进行操作；

数据可上传云端，可通过云环境应用程序访问相关数据；

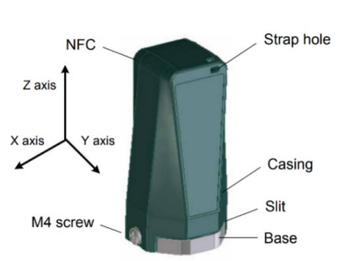
通过人工智能 / 机器学习算法，进行设备各种采集数据的分析。

In terms of software and functional design:

Sensor setup via NFC (Near Field Communication), which can be operated via a smartphone app.

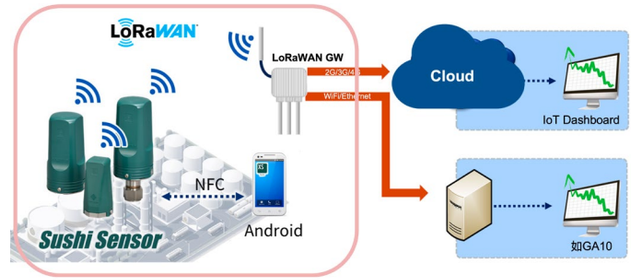
Data can be uploaded to the cloud and relevant data can be accessed through cloud environment applications.

Through artificial intelligence/machine learning algorithms, various collected data of the equipment is analyzed.



◉ Sushi Sensor 主体主要构成

◉ Major Composition of Sushi Sensor Body



◉ 系统构成

◉ System Composition

通过精准数据采集与分析，提高生产效率，实现降本增效

Through Accurate Data Collection and Analysis, Improve Production Efficiency, Reduce Costs and Increase efficiency

基于 Sushi Sensor 的解决方案的所有模块均可实现产业化水平，技术水平、工艺水平均居于世界一流水平，其主要效益如下：

All modules of Sushi Sensor-based solutions can be industrialized, and the technology and process level are at the world-class level, and its main benefits are as follows:

提高生产效率：通过实时监测和控制生产过程中的关键参数，提高生产线的稳定性和效率。通过收集并分析生产数据，企业能够更好地了解生产过程中的缺陷和瓶颈，从而采取相应措施提高生产力，减少浪费，降低生产成本。

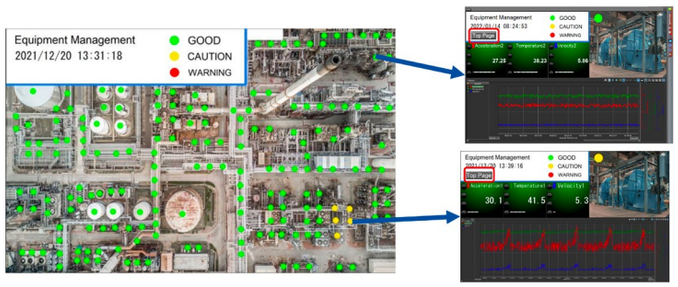
Improve production efficiency: Improve the stability and efficiency of the production line by monitoring and controlling key parameters in the production process in real time. By collecting and analyzing production data, users can better understand defects and bottlenecks in the production process, so they can take steps to improve productivity, reduce waste, and reduce production costs.

节约能源资源：实时监测和控制能源设备的运行状态和能源消耗情况，通过精确调节设备和系统的运行状态，最大限度地节约能源和资源的使用，降低企业的运营成本。

Energy and resource saving: real-time monitoring and control of the operation status and energy consumption of energy equipment, by accurately adjusting the operation status of equipment and systems, to maximize the use of energy and resources, and reduce the operating costs of enterprises.

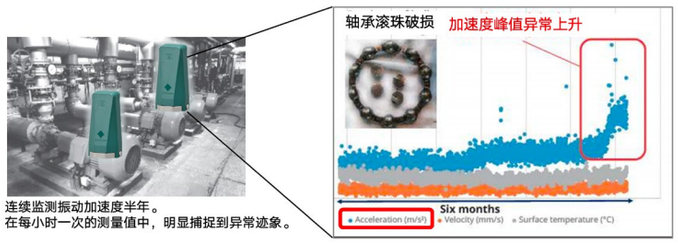
预测性维护：传感器收集的数据可以用于设备的预测性维护，从而避免设备意外故障导致的生产中断和昂贵的维修成本。减少停机时间，提高设备的使用效率和生产效益。

Predictive maintenance: The data collected by the sensors can be used for predictive maintenance of equipment, thus avoiding production interruptions and costly repairs due to unexpected equipment failures. Reduce downtime and improve equipment efficiency and productivity.



◉ 通过可视化实现预测性维护与生产效率提升

◉ Predictive Maintenance and Productivity Gains Through Visualization



◉ 通过异常振动发现轴承破损

◉ Bearing Breakage Detected by Abnormal Vibrations

降低设备运营成本，通过新质生产力为制造业数字化赋能

Reduce Equipment Operating Costs and Empower the Digitalization of the Manufacturing Industry Through New Quality Productivity

基于 Sushi Sensor 的解决方案所有模块均可实现产业化水平，技术水平、工艺水平在日本历经 6 年打磨，在日本市场投入使用 3 年以上，近 30 个商业应用业绩。研发团队长期与各行业资深团队深入合作的同时，近期也与中国各行业团队开始探索开放性合作，技术生命周期非常可观。该解决方案已在日本市场销售使用约 3 年，具备一定数量的应用场景和应用业绩。目前研发、生产在日本国内完成。该解决方案于 2023 年正式在中国市场发布。

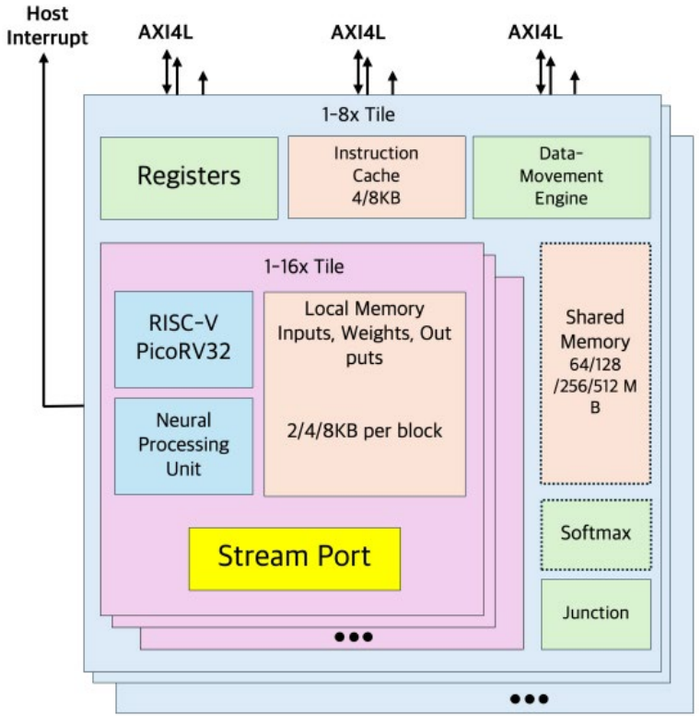
All modules of the Sushi Sensor-based solution can achieve the industrialization level, and the technical level and process level have been polished in Japan for 6 years and have been put into use in the Japan market for more than 3 years, with nearly 30 commercial application achievements. While the R&D team has been cooperating with senior teams in various industries for a long time, it has also recently begun to explore open co-operation with teams in various industries in China, and the technology life cycle is very considerable. The solution has been sold and used in the Japan market for about 3 years and has a certain number of application scenarios and application performance. Currently, R&D and production are completed in Japan. The solution has been officially released in the Chinese market in 2023.

Sushi Sensor 的核心技术已经拥有完整的专利布局。同时在中国有优秀的本土化技术团队。同时，横河电机在中国乃至全球有大量的优秀资源，能够实现助力产品化和应用推广的功能。

The core technology of Sushi Sensor already has a complete patent layout. At the same time, it has an excellent localized technical team in China. At the same time, Yokogawa has a large number of excellent resources in China and around the world, and is able to realize functions that contribute to productization and application promotion.

NeuroMosAIc 处理器硬件（NMP）和 Studio 软件开发工具包（SDK）

NeuroMosAIc Processor Hardware (NMP) and Studio SDK (Software Development Kit)



◉ AiM Future 基于 RISC-V 处理器面向边缘应用的 NeuroMosAIc 架构

◉ AiM Future's RISC-V Processor Based NeuroMosAIc Architecture Targeting the Edge Applications

AiM Future, Inc

AIM FUTURE

引言

AiM Future 研发的 NeuroMosAIc 处理器是（NMP）一款专为边缘计算市场设计的多模态推理引擎，其强大的并行处理能力使得人工智能算法在实时性要求极高的场景中得以高效运行。NMP 作为 AiM Future 的旗舰产品，不仅具备高效的推理能力，更在数据融合与实时处理方面有着卓越的表现。它能够同时处理来自不同传感器的多种数据，为智能家居、智能制造等领域提供精准、实时的智能识别服务。

Introduction

NeuroMosAIc processor (NMP) developed by AiM Future is a multi-modal inference engine designed for the edge computing market, w-ith powerful parallel processing capabilities that enable AI algorith-ms to to run efficiently in scenarios where real-time is critical. As AiM Future's flagship product, NMP not only has efficient inference capabilities, but also has excellent performance in data fusion and real-time processing. It is capable of processing multiple data from different sensors at the same time, providing accurate and real-time intelligent identification services for smart home, smart manufacturing and other fields.

与此同时，AiM Future 还提供了 Studio SDK 软件开发工具包，它简化了人工智能算法在 NMP 上的开发、优化和部署过程。通过 Studio SDK，开发者能够轻松实现人工智能算法与 NMP 的深度融合，进一步提升系统的智能化水平。

Meanwhile, AiM Future also provides Studio SDK, a software development kit that simplifies the development, optimisation and deployment of AI algorithms on NMP. With Studio SDK, developers can easily implement the deep integration of AI algorithms with NMP to further enhance the intelligence of the system.

支持边缘应用中的多模态能效优化

Support Energy-Efficient Multi-modality in Edge Applications

神经网络技术的演进速度往往超越了硬件发展的步伐。鉴于这一现状，未来的神经网络应用可能会涵盖当前硬件尚未支持的功能、层级结构以及操作指令。为了应对这一潜在挑战，我们采取了前瞻性的设计策略，即集成 RISC-V 处理器，以执行那些神经处理单元（NPU）暂时无法直接处理的运算任务。这一创新举措，我们称之为“面向未来的设计”，旨在确保我们的硬件平台能够灵活适应并支撑未来神经网络技术的不断发展。

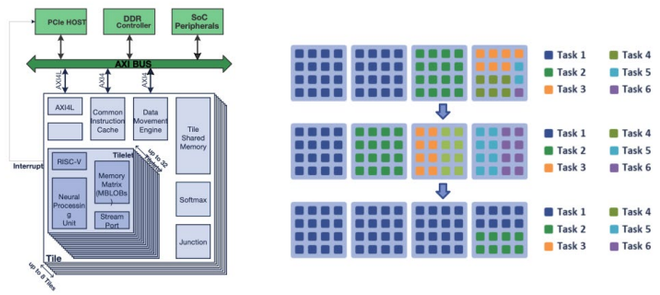
Typically, neural networks are evolving faster than hardware. So future applications (neural networks) may have features, layers, and operations that are not supported by the hardware which was developed in the past. We tried to resolve this problem by integrating RISC-V processor to execute operations that are not supported by neural processing unit. This is called future-proof.

我们面临的另一项重大挑战在于，需要构建一个能够广泛满足多种不同应用需求的通用架构。举例来说，物联网设备所需的硬件性能远不及信息娱乐系统或自动驾驶等高端汽车应用。为了应对这一广泛的适用性挑战，我们创造性地开发了一种基于多核的架构方案。该方案仅需通过简单的配置调整，便能轻松适配于各种应用场景。随着使用内核数量的增加，系统所能支持的性能水平也随之显著提升。

Another challenge we solved is to create generic architecture to support many different application needs. For example, IoT does not use much hardware horsepower than automotive applications such as infotainment system and self-driving. To address this wide range of applications, we invented multi-core-based architecture that can easily be applicable to various cases with simple changes. The more cores used, the higher performances it supports.

边缘计算领域要求系统能够同时高效地处理具有不同特征、多样化的数据类型，如图像、语音以及时序数据等，这即为多模态处理的挑战。为了有效支持多模态数据处理，我们创新性地设计了一种高度灵活的架构，该架构能够根据具体任务的工作负载动态地分配不同数量的内核资源。具体而言，鉴于视觉相关网络的处理需求通常高于语音应用，我们的架构能够自动分配更多的内核给视觉网络，而仅分配较少数量的内核给语音应用。这一过程完全由软件动态控制，无需对硬件配置进行任何调整。

Edge computing requires processing different characteristics, various data such as image, speech, and time-series data simultaneously. This is a so-called multi-modality. To support multi-modality, we invented flexible architecture to allocate different numbers of cores to the tasks depending on their workloads. For example, vision related networks are typically heavier than voice applications. So many cores are allocated to vision networks while smaller number of cores are allocated to voice applications. And this can be done by software dynamically without changing hardware configurations.



◉ 工作原理图

◉ Operating Schematic

NeuroMosAIc 架构带来可扩展的特性，以满足市场的不同要求和需求

NeuroMosAIc Architecture Brings Scalable Feature to Meet Market's Different Requirements and Needs

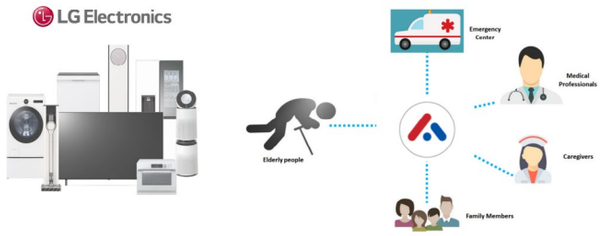
NeuroMosAIc 处理器（NMP）多模态融合的技术特点，使得 NMP 在智能家居、智能工厂、智能农业等多个领域展现出巨大的应用潜力。

The NeuroMosAIc Processor (NMP)'s multi-modal fusion technology feature allows NMP to show great application potential in a variety of fields such as smart home, smart factory, and smart agriculture.

在智能家居领域，通过集成在智能家居设备中，NMP 能够实时分析用户的生活习惯和喜好，为用户提供更加个性化的服务。例如，当老人在家中突遇意外时，NMP 能够迅速识别并触发警报系统，为老人的安全保驾护航。此外，NMP 还能够根据室内环境自动调节家居设备的运行状态，如智能空调、智能照明等，为用户提供更加舒适的生活环境。

In the field of smart home, by integrating into smart home devices, NMP can analyse users' habits and preferences in real time and provide more personalised services to users. For example, when an elderly person encounters an accident at home, NMP is able to quickly identify and trigger an alarm system to protect the safety of the elderly. In addition, NMP can also automatically adjust the operating status of home equipment, such as smart air conditioning and smart lighting, according to the indoor environment, providing users with a more comfortable living environment.

而 Studio SDK 作为与 NMP 配套的软件开发工具包，则为开发者提供了强大的支持。通过 Studio SDK，开发者可以轻松地构建基于 NMP 的人工智能应用程序，实现各种复杂的 AI 功能。无论是图像识别、语音识别还是自然语言处理，Studio SDK 都能为开发者提供一站式的解决方案，降低开发难度，提高开发效率。



◉ 场景应用图

◉ Scenario Application Diagram

Studio SDK, the software development kit that comes with NMP, provides strong support for developers. With Studio SDK, developers can easily build NMP-based AI applications and implement various complex AI functions. Whether it is image recognition, speech recognition or natural language processing, Studio SDK provides developers with a one-stop solution to reduce development difficulty and improve development efficiency.

此外，Studio SDK 还提供了丰富的 API 接口和文档支持，使得开发者能够更加灵活地定制和优化自己的应用程序。这种灵活性和可扩展性，使得基于 NMP 和 Studio SDK 构建的人工智能解决方案能够更好地适应不同场景的需求，实现更加智能化的应用。

In addition, Studio SDK provides rich API interfaces and documentation support, enabling developers to customise and optimise their applications more flexibly. This flexibility and scalability enables AI solutions built based on NMP and Studio SDK to better adapt to the needs of different scenarios and achieve more intelligent applications.

技术提高了能源效率，广泛应用于各个领域

The Technology Drives Enhanced Energy Efficiency and is Applied Across Diverse Fields

NMP 和 Studio SDK 的技术广泛应用于多个领域，如人工智能、机器学习、图像处理等。特别是在人工智能领域，NMP 凭借其强大的神经拟态计算能力，能够支持复杂的人工智能任务，如自然语言处理、语音识别等。同时，Studio SDK 提供了丰富的 API 和工具，使得开发人员能够轻松地构建和优化基于 NMP 的人工智能应用。这些应用在全球范围内得到了广泛的应用，进一步证明了 NMP 和 Studio SDK 在市场上的重要地位。AiM Future 的 NPU IP 已被广泛应用于 LG 的众多消费级产品中，包括但不限于洗衣机、冰箱及智能电视等，并且依托 LG 硅谷实验室多年积累的深厚研发经验，实现了卓越的能效表现。

The technologies of NMP and Studio SDK are widely used in a variety of fields, such as artificial intelligence, machine learning, and image processing. Especially in the field of artificial intelligence, NMP, with its powerful neuromimetic computing capability, is able to support complex artificial intelligence tasks, such as natural language processing and speech recognition. Meanwhile, Studio SDK provides rich APIs and tools that enable developers to easily build and optimize NMP-based AI applications. These applications are widely used worldwide, further proving the importance of NMP and Studio SDK in the market. AiM Future's NPU IP is silicon-proven, market-proven and has been used in many LG consumer products such as Washer machine, Refrigerator, and smart TVs. Its energy-efficient advantages are the results of accumulated experiences and expertise of many years of extensive research and development from the LG advanced lab in Silicon Valley, USA.

此外，Studio SDK 推动了人工智能应用落地。Studio SDK 的易用性和可扩展性使得更多的国际开发者能够参与到人工智能应用的开发中来。这不仅降低了人工智能技术的门槛，还推动了人工智能技术在全球范围内的应用落地，进一步提升了项目的国际影响力。

Additionally, it promotes the landing of AI applications. The ease of use and scalability of Studio SDK enables more international developers to participate in the development of AI applications. This not only lowers the threshold of AI technology, but also promotes the landing of AI technology applications globally, further enhancing the international influence of the project.

◉ 积极参与国际展会

◉ Active Participation in International Exhibitions

AiM Future 推动人工智能发展，助力负责任且可持续的创新

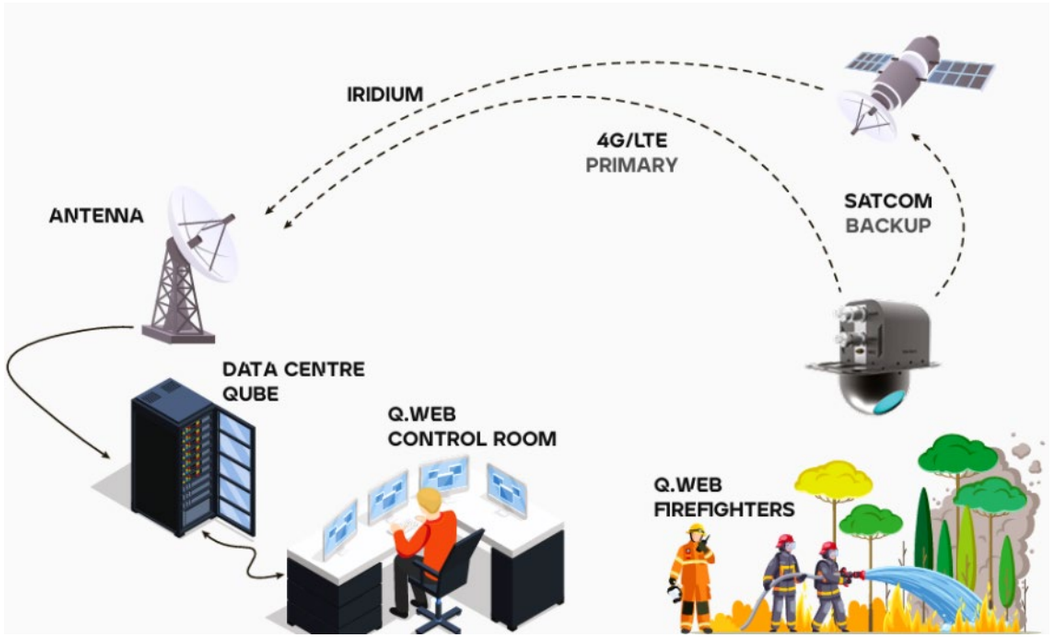
AiM Future Advances AI and Ensures Responsible and Sustainable Innovation

除了 NPU 技术，AiM Future 还开发了一个全面的人工智能软件生态系统，支持人工智能模型优化、部署和管理，使人工智能集成更容易为企业所用。该公司还参与了与学术机构和行业领袖的合作研发，从而推动了人工智能算法和安全性的进步。此外，AiM Future 为全球人工智能标准做出了贡献，确保他们的创新符合道德和监管最佳实践。这些努力强调了 AIM Future 以负责任和可持续的方式推进人工智能技术的承诺。

In addition to its NPU technology, AiM Future has developed a comprehensive AI software ecosystem that supports AI model optimization, deployment, and management, making AI integration more accessible for businesses. The company is also involved in collaborative R&D with academic institutions and industry leaders, resulting in advancements in AI algorithms and security. Additionally, AiM Future contributes to global AI standards, ensuring that their innovations align with ethical and regulatory best practices. These efforts underscore AIM Future's commitment to advancing AI technology responsibly and sustainably.

Q.System 航空电子系统

Q.System Avionic System



◉ 工作原理图

◉ Operating Schematic

HIGHTEK SRL

引言

Hightek 是一家专注于硬件设计和软件开发的初创公司。公司业务涵盖航天传感器、利用摄像头技术为飞行任务提供支持的航空电子设备等。此外，Hightek 还从事物联网系统开发，应用于物流、环境监测和基础设施诊断。由 Hightek 开发的 Q.System 是一项创新的航空电子系统，能够获取、处理和提供关键的实时信息，用于山火、洪水和地震的灾害预防、监测和干预。该技术的核心是创新的航空电子传感器 Q.Fly, 可无缝部署在直升机、飞机和无人机上 , 此传感器配备了多光谱传感器、地理定位系统和 4G/ 卫星通信系统。

Introduction

Hightek is a startup specialised in hardware design and software development of aerospace sensors, camera-based mission support avionics, and IoT systems development for logistics, environmental monitoring, and infrastructure diagnostics. Q.System developed by Hightek is an innovative avionic system, which can obtain, process and provide key real-time information for disaster prevention, monitoring and intervention of mountain fires, floods and earthquakes. The core of this technology is that the innovative avionics sensor Q.Fly can be seamlessly deployed on helicopters, planes and drones. Q.Fly is equipped with multi-spectral sensors, geographic positioning system and 4G/ satellite communication system.

Q.System: 消防和应急响应的创新性系统

Q.System Revolutionises Firefighting and Emergency Response

该系统实现了消防和应急响应系统的创新，为飞行员和现场人员提供了关于火线位置和最佳投放点的即时、可操作信息。这提高了运营效率，降低了与飞行相关的成本。

Q.System revolutionises firefighting and emergency response, providing pilots and field personnel with immediate, actionable information on fire front locations and optimal drop points. This enhances operational efficiency and reduces flight-related costs.

对于现场人员和控制室，直升机采集的数据被实时传输到服务器，进行处理并在地图上进行地理参考。无需用户端处理即可访问，这在紧急情况下节省了重要的时间和资源。

For on-site personnel and control rooms, helicopter-acquired data is transmitted in real-time to servers, processed and georeferenced on maps. Accessible without user-end processing, this saves crucial time and resources during emergencies.

该系统不仅限于飞机，还包括地面人员和卡车地理定位。作为一个开放系统，Q.System 集成了第三方设备、软件和天气数据，提供了统一的访问点、共享数据库和聚合数据处理。设备数据轻松集成到数据驱动的火灾模拟器中，无需手动提取坐标即可完善模拟。

Q.System extends beyond aircraft, including ground personnel and trucks geolocation. As an open system, Q.System integrates third-party devices, software, and weather data, offering a unified access point, shared database, and aggregated data processing.

Q.Fly 设备的可重构特性使其能够根据客户需求添加新的软件功能和传感器。与需要终端用户管理技术和数据的系统不同，Hightek 负责整个 Q.System 基础设施的运维，将用户从复杂的任务和软件开发中解放出来，该系统通过优化空中灭火和降低运营成本，产生经济效益。

The reconfigurable nature of Q.Fly devices enables the addition of new software features and sensors based on customer needs. Unlike systems requiring end-users to manage the technology and data, Hightek takes care of the entire Q.System infrastructure, alleviating users from complex tasks and software development. Q.System positively impacts the economy by optimising aerial firefighting and reducing operational costs.

◉ 系统传感器

◉ Q.fly Sensor

Q.System: 结合第三方的集合数据处理系统

Q.System Integrates Third-party and Provides an Aggregate Data Processing

Q.System 的目标市场涵盖私营企业和政府机构，服务领域广泛，适用于多个行业和部门。

The target market for Q.System encompasses both private companies and government entities, catering to a broad spectrum of industries and agencies.

在空中消防和应急响应领域，Q.System 先进的基于摄像机的解决方案有助于关键任务的自动化。其功能包括对火线、洪水、石油泄漏和山体滑坡的自动绘图，以及对与紧急情况相关的照片和视频进行精确的地理定位。该技术有助于来自直升机和无人机的实时视频流，实现对行动的实时监控。此外，Q.System 确保消防液体释放点的准确地理定位，创建热成像地图以优化补救工作，以及 GNSS 卫星跟踪以增强应急响应期间的车辆协调。该系统在自然灾害后自动检测和绘制受损建筑物方面表现出色，为搜索、救援和恢复工作提供了宝贵的支持。

In the realm of aerial firefighting and emergency response, Q.System's advanced camera-based solutions are instrumental in automating critical tasks. This includes the automatic mapping of fire fronts, floods, oil spills, and landslides, along with precise geolocation of photos and videos related to emergency situations. The technology facilitates live video streaming from helicopters and drones, enabling real-time monitoring of operations. Additionally, Q.System ensures accurate geolocation of release points for

firefighting liquids, creation of thermographic maps for optimized remediation efforts, and GNSS satellite tracking for enhanced vehicle coordination during emergency responses. The system excels in automatically detecting and mapping damaged buildings in the aftermath of natural disasters, providing valuable support for search, rescue, and recovery efforts.

该系统的能力扩展到空中监视和情报，为边境控制、搜索和救援行动、船只识别以及打击贩毒等非法活动提供多光谱成像解决方案。该技术的多功能性使其能够探测保护区内的个体，监测海洋环境，并有助于各种情报、监视和侦察活动。

Q.System's capabilities extend to aerial surveillance and intelligence, offering multispectral imaging solutions for border control, search and rescue operations, vessel identification, and countering illegal activities such as drug trafficking. The technology's versatility allows it to detect individuals in protected areas, monitor marine environments, and contribute to various intelligence, surveillance, and reconnaissance activities.

此外，Q.System 是航空检查和测绘领域的宝贵资产，适合广泛的应用。它擅长检查基础设施、桥梁、大坝和河岸，提供对电力线和太阳能电池板的光学和热成像检查。事实证明，这项技术在检查天然气和水管道、检测泄漏以及确保铁路、能源和工业基础设施的完整性方面是不可或缺的。该系统的能力延伸到绘制海上石油泄漏图，通过热成像监测作物，对植被和土地利用进行分类，以及进行全面的制图调查和三维制图。

Furthermore, Q.System is a valuable asset in the domain of aerial inspection and mapping, catering to a wide range of applications. It excels in the inspection of infrastructures, bridges, dams, and riverbanks, providing optical and thermographic inspections of power lines and solar panels. The technology proves indispensable in inspecting gas and water pipelines, detecting leaks, and ensuring the integrity of railway, energy, and industrial infrastructures. Q.System's capabilities extend to mapping oil spillage in the sea, monitoring crops via thermal imaging, classifying vegetation and land use, and conducting comprehensive cartographic surveys and 3D mapping.

这些多样化的应用使 Q.System 成为应急响应机构、边境管制机构、环境保护机构、农业企业和管理关键基础设施的组织等部门不可或缺的通用工具。

◉ 实际应用演示图

◉ Demonstration of practical application

These diverse applications position Q.System as a versatile and indispensable tool for sectors such as emergency response agencies, border control authorities, environmental protection agencies, agricultural enterprises, and organizations involved in managing critical infrastructure.

Q.System: 提供全方面服务的创新型解决方案

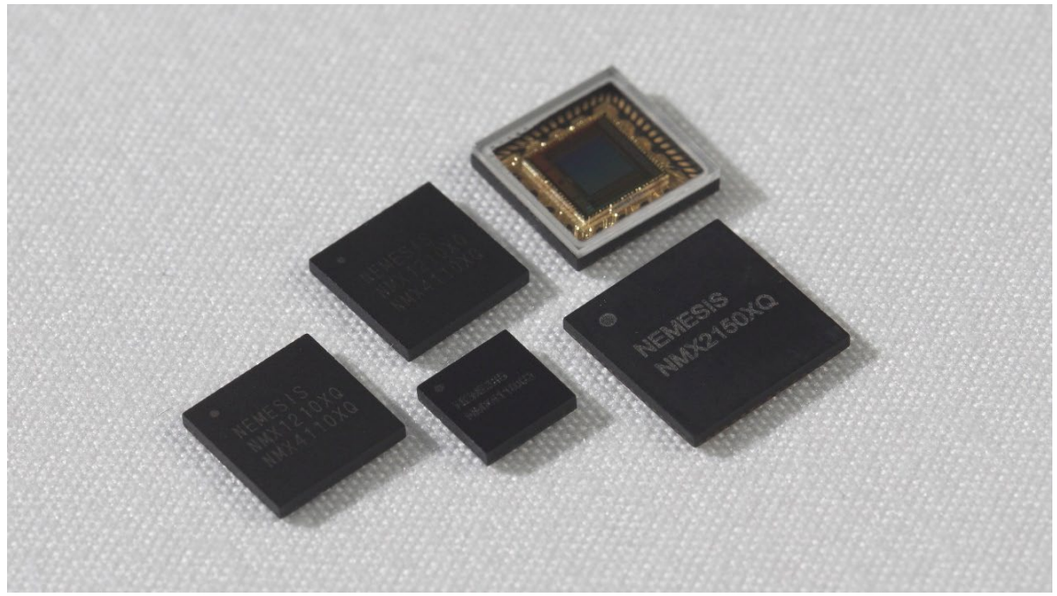
Q.System Provides Innovative Solutions Offering Comprehensive Services

R.System 技术成本低，可为客户提供全方面服务。该系统的目标市场主要定位于提供公共安全、环境保护和应急响应服务的私营运营商。Q.System 在成本（比竞争对手低 5 到 10 倍）和为目标行业定制化服务方面具有竞争优势。Q.System 遵循平台即服务（PaaS）模式，为客户提供全方位的服务，涵盖数据管理、数据中心管理、传感器维护和更新、新功能实施、认证流程和人员培训。面对市场中服务方案不全面的情况，Q.System 的全面性服务为其创造了战略优势。

S.One of the main advantages of Q.System technology is its market positioning. Q.System targets a market segment consisting of private operators offering public safety, environmental protection, and emergency response services. Q.System has a competitive advantage in terms of costs (5x to 10x lower than competitors) and services specifically tailored to the target sector. This creates a strategic advantage by addressing a market segment currently underserved by existing solutions. Q.System follows a Platform as a Service (PaaS) model. Unlike competing solutions, a comprehensive 360-degree service is provided to the customer, covering data management, data center management, sensor maintenance and updates, implementation of new features, certification processes, and personnel training. This creates a strategic advantage by addressing a market segment currently underserved by existing solutions. Q.System follows a Platform as a Service (PaaS) model.

智能生物信号处理系统芯片

Intelligent Bio Signal Processing SoC



◉ 生物信号处理芯片

◉ NEMESIS Bio Signal Processing Chips

NEMESIS.CO.LTD

NEMESIS

引言

针对生物信号中的噪声大、预测困难，以及医疗设备体积大、电池寿命短、价格高等挑战，NEMESIS 对模拟电路进行了优化配置，使其能够根据需求进行灵活调整，并利用机器学习生成参数值以进行控制，从而研发出一款具备通用传感能力的系统级芯片（SoC），以高效处理各种生物信号。此外，我们还将基于 Tiny ML 的轻量化人工智能算法应用于生物信号处理的系统芯片（SoC），从而开发出一种实现个性化和低功耗的解决方案。

Introduction

Bio signals generally have big noise and variations, it could be hard to make signal amplification and calculation. In addition, the health care device size is big, the battery life is short, and the price is high. NEMESIS made a SoC (System on Chip) which can be universal sensing that can process various bio signals by configuring analog circuit to be reconfigurable and generating parameter values to control it through machine learning. And by applying TinyML-based Light AI algorithm to bio signal processing SoC, we have developed a solution that enables personalization and low power consumption.

基于生物信号和数据优化的智能生物信号处理系统芯片技术

Bio Signal Processing SoC with Analog-based Customized Bio Signal Processing Technology and Tiny ML Algorithm Technology for Data Optimization

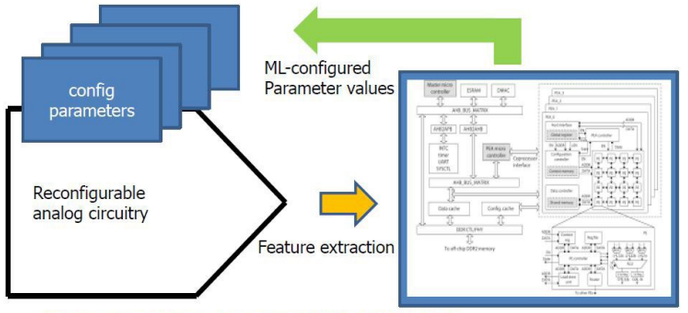
Nemesis 基于对生物信息和生物信号特点的研究和理解，以及多年的半导体设计经验，利用生物信号和半导体融合技术开发了一款智能生物信号处理系统芯片 (SoC)。该生物信号处理系统芯片 (SoC) 应用了输入阻抗改善技术、多模态技术、干扰消除技术、长电池寿命实现技术和用于生物信号优化的 TinyML 算法，将具有较大噪声和信号变化的生物信号转换为有用的生物信息。此外，Nemesis 独特的通用传感器接口技术显著提高了信噪比，使生物信号处理更容易，并有助于开发低成本、低功耗和小型化的生物诊断设备。

Nemesis developed an intelligent bio signal processing SoC by bio-signal and semiconductor convergence technology based on research and understanding of the characteristics of bio information and bio signals and many years of semiconductor design experience. Nemesis' bio signal processing SoC, which applies input impedance improvement technology, multi-modal technology, interference removal technology, long battery life implementation technology, and TinyML algorithm for bio signal optimization, converts bio signals which have large noise and signal variations into useful bio information. In addition, Nemesis' unique universal sensor interface technology significantly improves the signal-to-noise ratio, making bio-signal processing easier and enabling the development of low-cost, low-power, and miniaturized bio-diagnostic devices.

生物信号，包括生物电势或生物标志物，受到各种噪声的影响，并且在个体之间存在显著差异。因此，NEMESIS 结合生物传感器技术的发展成果、能够处理宽动态信号的模拟技术以及机器学习技术，以提高生物信号的可靠性。基于对生物信号的深刻理解，NEMESIS 为数字医疗设备制造商的客户提供精确、高效和可靠的生物信号处理芯片。

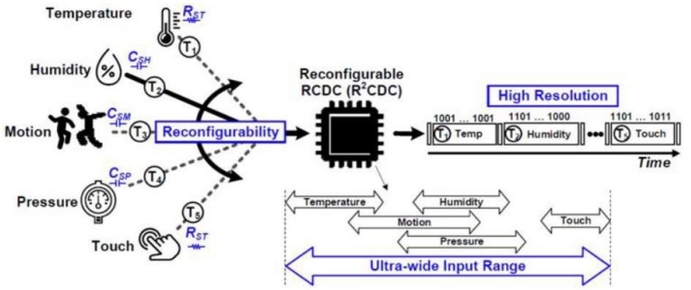
Biological signals consisting of biopotentials, or biomarkers are affected by various noises and have significant differences between individuals. Accordingly,

NEMESIS is implementing technology to increase the reliability of bio-signals by combining technology derived from the development of biosensor technology, analog technology that can receive wide dynamic signals, and machine learning techniques.Based on a deep understanding of bio signals, NEMESIS provides accurate, efficient and reliable bio signal processing SoC (System on Chip) to customers who are digital health care device manufacturers.



◉ 生物医学应用生物信号处理模拟电路设计技术

◉ Bio-Medical Application Analog Circuit Design Technology for Bio-Signal Processing.



◉ 通用传感器接口解决方案

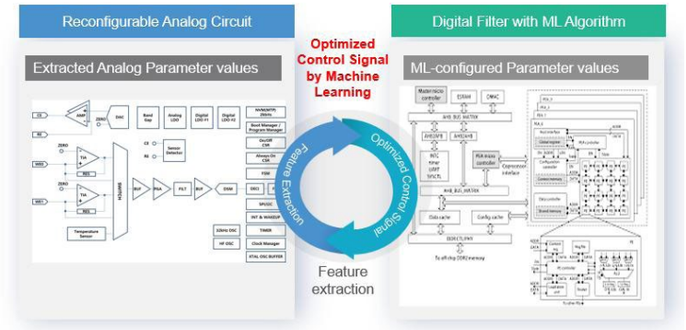
◉ Universal sensor interface solution

NEMESIS 为客户提供了一种生物信号处理系统芯片 (SoC) 解决方案，通过实施轻量化人工智能算法，实现个性化、提供最优数据，并达成低功耗目标。

NEMESIS offers our clients a bio-signal processing SoC solution that enables personalization, provides optimal data, and achieves low power consumption by implementing Light AI algorithms.

NEMESIS 的技术通过在单芯片上集成多种传感器，充分利用多模态能力，采用宽动态范围以扩展输入范围，并运用时序电路将模拟信号转换为数字形式，从而有效应对当前信号处理解决方案所面临的挑战，提升了整体性能。

NEMESIS' technology addresses the issues of existing signal processing solutions by using multi-mode to receive multiple sensors on a single chip, wide dynamic range to expand the input range, and time-based circuits that convert analog circuits to digital, enhancing performance.



通过高性能、低功耗芯片解决方案，帮助人类延长健康寿命

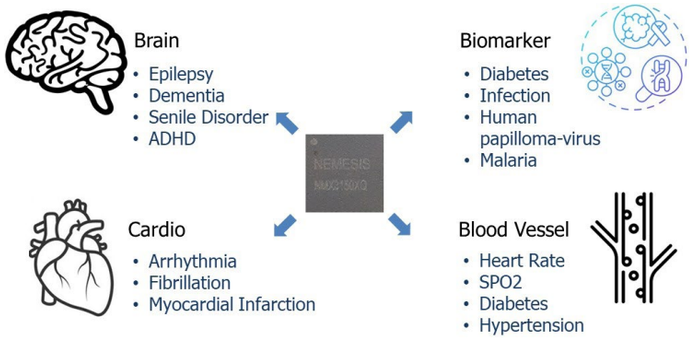
Contribute to Extending Healthy Lifespan by Securing High-performance, Low-power Solutions of Intelligent Bio-signal Processing SoC

生物半导体的高需求和高附加值

High Volume and High Value-Added in Bio-Semiconductors

数字医疗应用已成为半导体行业中快速发展的领域。尽管生物半导体的需求较为有限，随着一次性设备（如连续血糖监测仪（CGM）和心电图仪（ECG））需求的增长，以及智能手表生命体征监测功能的普及，医疗领域对半导体的需求正显著提升。一旦某款芯片被选用于生物应用，通常不会轻易更换，因为更换芯片需要重新进行临床测试。此外，生物半导体具备较高的利润率。因此，数字医疗和生物应用市场对于半导体公司而言，已成为不可忽视的机遇。

Digital healthcare applications represent a rapidly growing field for semiconductors. Although biosemiconductors have played a minimal role due to low volumes, the increase in disposable devices like CGM and ECG, along with the rise in vital sign monitoring through smartwatches, is significantly boosting the demand for semiconductors in healthcare. Once selected for a bio-application, a chip is rarely replaced due to the need for re-clinical testing. Moreover, biosemiconductors boast a high-profit margin. Therefore, digital healthcare and bio applications are markets that semiconductor companies cannot afford to miss.



◉ 可以通过 NEMESIS 技术处理的生物信号

◉ Bio signals that can be processed by NEMESIS technology

提升数字医疗行业的竞争力

Enhancing the Competitiveness of the Digital Healthcare Industry

NEMESIS 借助系统级芯片（SoC）技术，令设备变得更小，电池寿命更长，且更具成本效益。根据客户需求定制提供服务，NEMESIS 实现了产品的独特性及差异性，提供竞争对手无法提供的专属服务，增强竞争优势。

With the help of SoC technology, the devices are becoming significantly smaller, have longer battery life, and are more affordable. NEMESIS provides a customization service tailored to customer requirements. This method enables the implementation of unique, differentiated features and offers a service exclusive to NEMESIS that none of our global competitor's support. Through this, we will be able to gain a competitive edge over international companies.

满足社会的数字医疗需求

Meeting the Digital Medical Needs of Society

从社会角度来看，医疗保险支出明显偏高。解决这个问题最有效的方法是推广数字医疗。生物半导体技术的应用可以促进远程医疗和个性化医疗的发展，减少医院就诊次数和住院率，从而降低医疗保险和个人医疗支出。

From a social perspective, healthcare insurance expenditures are significantly high. The most effective way to address this issue is by promoting digital healthcare. The application of bio-semiconductor technology can promote the development of telemedicine and personalized healthcare, reducing hospital visits and hospitalization rates, thereby lowering both insurance and individual healthcare expenses.

NEMESIS 的产品可通过分析个人健康数据，提供个性化治疗和预防措施，从而实现更为个性化的医疗服务。这种智能生物信号处理解决方案在数字医疗中起着关键作用，为延长人类健康寿命作出贡献。

It also enables more personalized healthcare by analyzing personal health data to provide customized treatments and preventive measures. NEMESIS' intelligent biosignal processing solution plays a key role in digital healthcare and contributes to extending healthy lifespan.

通过智能生物信号处理解决方案开发具有颠覆性技术创新的健康监测设备

Development of Innovative Health Monitoring Devices Through Intelligent Bio Signal Processing Solutions

就经济效益而言，该创新有可能通过实现更高效、更具成本效益和更个性化的护理，颠覆式改变医疗保健和医疗设备。例如，通过降低功耗，这些技术可以延长可穿戴设备的电池寿命，使其更加实用和人性化。实时准确处理生物信号的能力还可以通过改善早期检测和病情监测来降低医疗成本。

In terms of economic benefits, the innovation holds the potential to revolutionize healthcare and medical devices by enabling more efficient, cost-effective, and personalized care. For example, by reducing power consumption, these technologies can extend the battery life of wearable devices, making them more practical and user-friendly. The ability to process biosignals accurately in real-time could also lower healthcare costs by improving early detection and monitoring of conditions, reducing the need for more expensive interventions.

从社会角度来看，这项技术可以通过实现对健康状况的持续性监测，显著提高人类的生活质量，特别是对老年人或慢性病患者效果显著。个性化的设计意味着医疗服务可以根据个人需求量身定制。这可以给患者带来更好的健康管理效果，提高患者的满意度。

Socially, the technology could significantly enhance the quality of life by enabling continuous, unobtrusive monitoring of health conditions, particularly for the elderly or those with chronic illnesses. The personalization aspect ensures that healthcare can be tailored to individual needs, leading to better health outcomes and increased patient satisfaction.

总体而言，这项技术的创新市场价值和社会价值都非常巨大。这项技术展望了未来，使医疗服务变得更加便捷、高效和可持续。

Overall, the market and social value of this technological innovation are substantial, offering a future where healthcare is more accessible, efficient, and sustainable

◉ 目标应用：生物标记和生命体征监测设备

◉ Target application: Bio marker and Vital sign Monitoring Device

◉ 目标应用：诊断设备

◉ Target application: Diagnostic Device

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