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Member of
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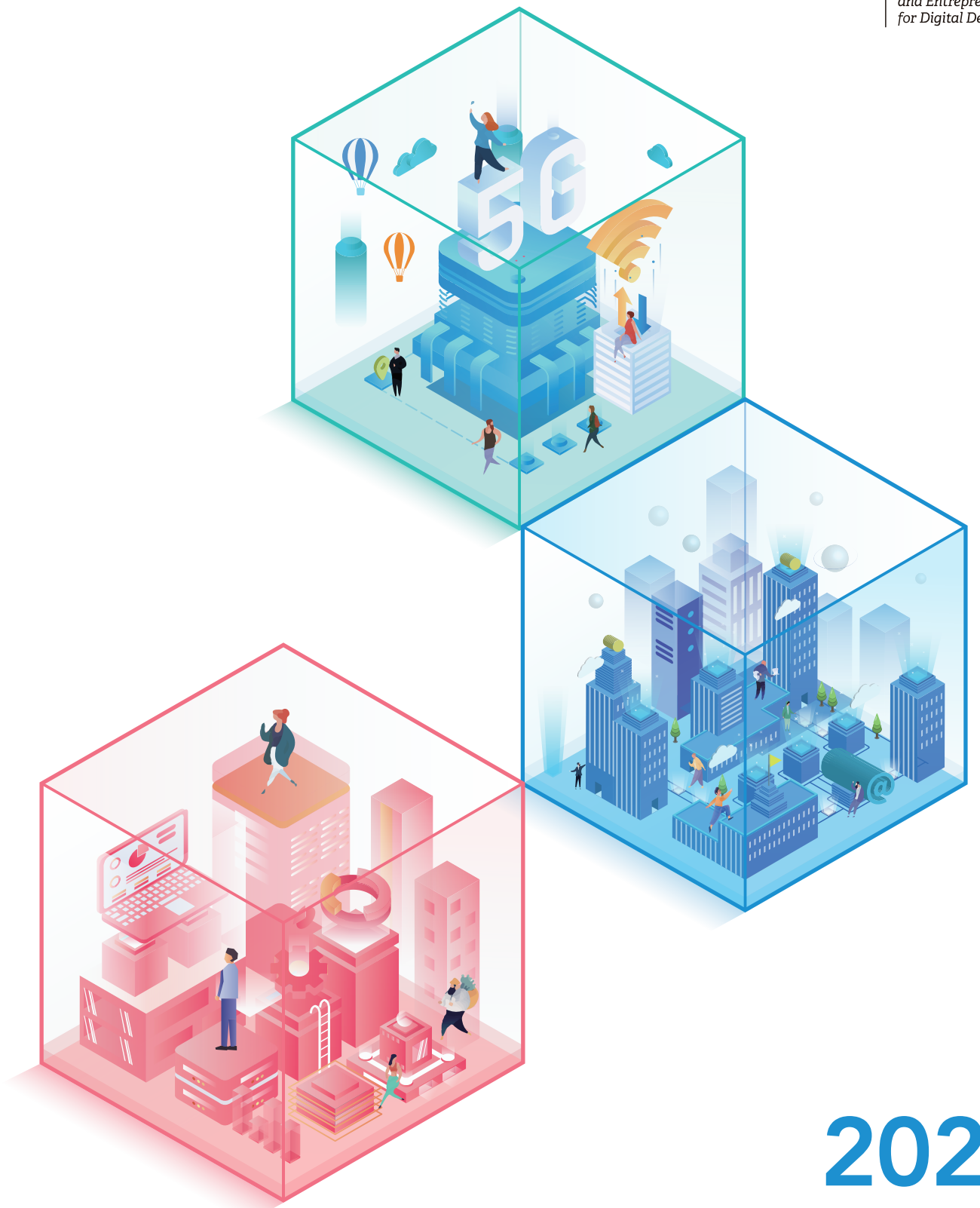
Vehicle of the Innovation and Entrepreneurship Alliance for Digital Development



2025

Digital Development Acceleration Toolkit for Developing Countries

Foreword

The Digital Development Acceleration Centre is a key component and vehicle for the International Telecommunication Union (ITU) to implement its strategic goal of "digital transformation". It aims to accelerate digital transformation by promoting research on innovative technologies, policies, and innovation ecosystems, alongside capacity building and project development globally. A total of 17 institutions from 16 countries were selected worldwide, with the China Academy of Information and Communications Technology (CAICT) being selected as a Global Acceleration Centre.

In recent years, the digital economy has swept across the globe, creating urgent demands for digital development and transformation in developing countries. Based on its research and case studies in areas like 5G and gigabit optical networks, the CAICT has developed this toolkit. It encompasses policies, practices, and application cases related to 5G, gigabit optical networks, and universal telecommunication service (UTS), providing references for developing countries to accelerate their digital development and transformation.

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01

Digital Development Acceleration Toolkit for Developing Countries

5G Innovation and Development

2025

5G Innovation and Development

The Chinese government's strategic deployment to build a cyberpower and a digital China serves as the foundational guideline for the development of the nation's information and communication industry. China has systematically planned and holistically deployed efforts to advance the coordinated development of 5G in construction, application, and R&D, adopting comprehensive measures across technology, industry, network infrastructure, and application domains to drive high-quality 5G development. The pivotal role of 5G in empowering industries, enhancing value, and embedding intelligence, along with its capacity to leverage one sector to catalyze growth across many others, is increasingly evident.

1.1 Optimizing Policy Support to Foster a Favorable Environment for 5G Development

Recognizing the strategic importance of 5G, the Chinese government has released numerous policy documents since 2020 to expedite the build-out of 5G and other new infrastructure and to broaden the range of 5G application scenarios.

Through coordinated national planning and strengthened top-level design, China has deepened the on-the-ground implementation of its 5G strategy. Under the 14th Five-Year Plan, the Ministry of Industry and Information Technology (MIIT) has implemented a systemic 5G development strategy, rolling out an integrated policy suite, comprising "Dual-Gigabit Synergy", "Broadband Frontier", "Signal Enhancement", and "5G Sets Sail", to drive 5G network construction, application adoption, technological advancement, and security assurance. This approach maximizes the scale effects and catalytic role of 5G as a new-type infrastructure to underpin high-quality economic development.

Cross-ministerial collaboration is enhanced, and sector-specific strategies are implemented to strengthen 5G's role as an enabling technology. MIIT, together with the National Health Commission, the Ministry of Education, and other stakeholders, has initiated the "5G+ Healthcare" and "5G+ Smart Education" pilot programs, which have fostered 987 and 109 demonstration projects, respectively, to accelerate innovative breakthroughs in 5G-enabled applications for public welfare sectors. Collaborating with the Ministry of Culture and Tourism, MIIT has selected 30 "5G+ Smart Tourism" pilot programs to nurture innovative smart tourism models and formats, supporting the quality upgrading of information consumption.

Policy implementation has yielded visible results through effective central-local coordination. Local governments across China, aligning with their respective stages of economic development and industrial strengths, have consistently implemented targeted measures, such as subsidies for base station construction and electricity costs, spearheaded 5G application pilots, and deepened industrial cooperation on 5G. Collectively, these efforts have generated more than 1,000 5G-related policy documents, creating a powerful synergy between central and local authorities in advancing 5G development.

1.2 Advancing Deployment and Adoption in Tandem for Nationwide 5G Coverage

During the initial and intermediate stages of 5G rollout, China followed the guiding principle that "let the road wait for the car, not the car for the road", adopting a virtuous cycle of driving adoption through infrastructure deployment while advancing both simultaneously. This approach, closely attuned to industrial and market needs, has enabled holistic planning and systematic nationwide 5G network deployment. **In spectrum utilization**, amid U.S. and South Korean emphasis on millimeter-wave bands, China implemented a decisive mid-band-first approach, based on a holistic evaluation of industrial capacity, sector-specific requirements, and spectral properties. It becomes the first country globally to issue a 5G mid-band spectrum roadmap, which designates the 6 GHz band for 5G/6G systems, refarms the 800 MHz and 900 MHz bands for 5G, and allocates more than 100 MHz of sufficient spectrum resources to each operator, thereby providing robust support for the nation's 5G innovation and development. **In network construction,** the

Chinese government has adhered to a dual-track approach driven by both supply and demand. Authorities have guided foundational telecom enterprises to sustain higher investment in 5G networks, expedite 5G standalone (SA) deployment, intensify infrastructure co-construction and sharing, and implement a range of cost-reduction measures to improve 5G coverage quality in priority use cases. A novel 5G industry virtual private network model has been introduced, capitalizing on the low-cost advantages of public networks to address sector-specific, differentiated requirements for network customization, data localization, and self-governed management, which thereby substantially boosts industrial service capacity. Meanwhile, adhering to the principle of "maximizing existing assets through intensive use and prioritizing sharing over new builds", the government has promoted basic telecom enterprises to jointly construct and share physical network infrastructure, yielding substantial reductions in construction and O&M costs, a higher utilization rate of network resources, and expedited rollout of 5G coverage.

Since the launch of 5G network deployment, China has built the world's first and largest 5G SA network, setting an example for global large-scale 5G deployment and green development. Over 90% of China's 5G base stations have been co-constructed and shared. China Telecom and China Unicom have co-constructed and shared over 1.22 million 5G base stations, while China Mobile and China Broadnet have co-constructed and shared over 1.91 million 5G base stations. This has formed a "2+2" industry structure, effectively enhancing network benefits and asset operational efficiency.

1.3 Advancing 5G Application Innovation Through Multifaceted Initiatives

In promoting 5G applications, China has cultivated a 5G integrated application ecosystem through various methods including policy guidance, alliance establishment, and hosting 5G application competitions. In 2021, MIIT rolled out a targeted action plan, clearly defining the goals and priority tasks for 5G application development in China over the subsequent three years. By employing a comprehensive and coordinated policy mix, relevant ministries have mobilized local governments and industry stakeholders to steadily

implement assigned tasks, achieving tangible phased milestones in 5G application innovation.In 2024, China released a follow-on policy document to its 5G application action plan, entering a new stage of large-scale 5G application. Anchored in the principle of "government guidance, enterprise leadership, goal orientation, and collaborative innovation", and building on extensive cross-sectoral 5G exploratory practices from the prior phase, the document refines common scenario-based requirements, comprehensively strengthens supporting capabilities in industry, network infrastructure, and ecosystem development, actively promotes the integrated innovation of digital technologies, enhances supply-demand alignment and the effectiveness of 5G-enabled empowerment, and vigorously advances the large-scale development of 5G applications to accelerate the emergence of new drivers for high-quality socio-economic development.

Under the strong support and guidance of MIIT, CAICT, together with operators, equipment manufacturers, internet companies, application developers, financial investment institutions, and research organizations, established the 5G Applications Industry Array (hereinafter referred to as the "5G AIA"). As of August 2025, the 5G AIA has 337 member entities, conducting research on key technologies and standards for 5G integrated applications, and promoting industrial development. To advance the large-scale adoption of 5G applications, the 5G AIA organizes various activities including 5G Terminal Bootcamps, 5G Inside brand events, star-rated supplier selection for 5G application solutions, maturity assessments of 5G application solutions, and selection of 5G application innovation centers. These initiatives address challenges such as supply-demand matching, innovation, and promotion, accelerating the cultivation of the 5G integrated application industrial ecosystem.

Guided by MIIT, CAICT has organized the "Blooming Cup" 5G Application Competition. Focusing on numerous sectors including information and communications, industry, energy, healthcare, culture and tourism, and agriculture, the Competition aims to accelerate the integration and innovation of 5G with various industries. Since 2018, the number of participating enterprises has increased significantly, growing from fewer than 200 in the first session to over 13,000 in the seventh edition, with a cumulative total of 138,000 application cases. The Competition has concurrently carried out supporting services such as promotional activities, supply-demand matching, and industry-finance collaboration, playing a significant

role in advancing 5G development, fostering 5G application innovation, accelerating supply-demand matching, and driving the digital transformation across economic and social sectors.



▲ Figure 1-1: Number of Participating Enterprises and Projects in Previous "Blooming Cup"5G Application Competitions

Since the implementation of these initiatives, China has made significant strides in 5G application deployment. First, 5G industry applications have evolved from pilot demonstrations to widespread adoption in priority scenarios. 5G applications now span 86 out of 97 major economic categories, achieving large-scale deployment in manufacturing, mining, power, ports, healthcare, culture and tourism, and agriculture, and are accelerating expansion into water conservancy, construction, textiles, and other sectors. Among China's 25 major coastal ports, 92% have adopted 5G applications; adoption rates stand at 95% among the top 20 coal producers and 85% among the top 20 steelmakers. Second, 5G industry applications are moving beyond surface-level use cases to penetrate critical business and production workflows. Within the industrial sector, 5G applications have steadily expanded from peripheral tasks such as video-based inspections to core activities spanning R&D, design, manufacturing, O&M management, and product services, yielding 20 representative scenarios including machine vision–based quality inspection and on-site assisted assembly. In healthcare, 5G applications have extended from remote diagnostics to remote precision treatment. Third, 5G industry applications have evolved from isolated single-point links to integrated end-to-end workflows. In the power sector, 5G applications have expanded from unmanned inspection in the transmission segment to cover all five stages of the power value chain—generation, transmission, transformation, distribution, and consumption. In agriculture, 5G use cases have evolved from single-point smart greenhouse deployments to diversified applications across crop production, livestock farming, and logistics, including unmanned pest control and intelligent agricultural machinery.

5G+ Industrial Internet



01 Pairdeer, Ningbo: 5G Empowers Transformation and Upgrade in Battery Manufacturing

Technical Features:

The project utilized 5G LAN and cloud-based PLC technologies to achieve uninterrupted, unmanned, and flexible fully automated production; employed 5G cloud machine vision for online intelligent product quality inspection; implemented 5G cloud AGVs and RGVs to establish a fully automated closed-loop logistics system within the facility; and leveraged 5G+ new passive IoT technology to enable extensive coverage and real-time inventory management in automated storage systems.

Application Results:

The project increased production efficiency by over 25%, with product inspection accuracy reaching 98%; improved logistics efficiency by 50%, and inventory counting efficiency by 90%; reduced overall energy consumption by 10%; and enhanced management efficiency by 30%.

Background

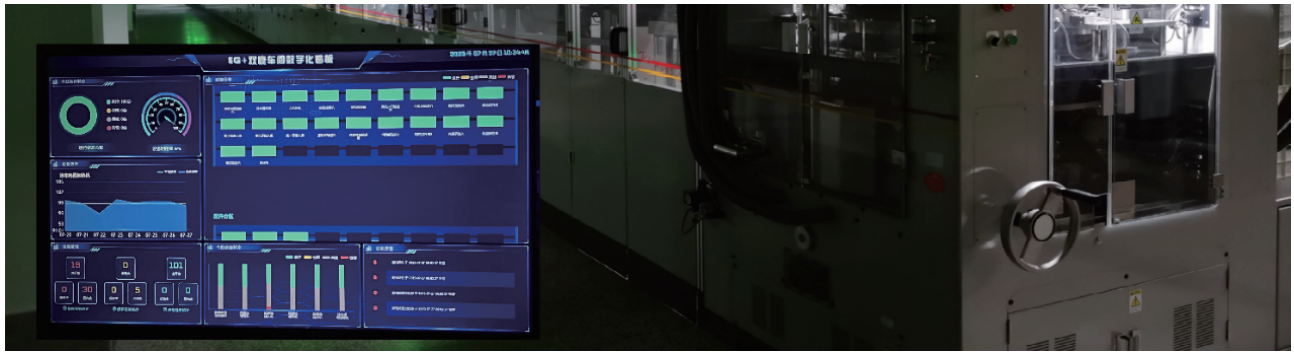
Ningbo GP & Sonluk Battery Co., Ltd. (hereinafter referred to as Pairdeer) encountered multiple challenges in its pursuit of higher product quality: manual material handling resulted in low operational efficiency and high costs; stacker cranes relied on Wi-Fi/infrared communication, which was prone to disconnection; and the legacy RFID system suffered from a limited coverage range and infrequent inventory counts. By leveraging 5G connectivity and an edge cloud platform, Pairdeer has built a next-generation 5G-enabled smart factory, achieving full-process intelligent automation across battery production, quality inspection, logistics transfer, and warehousing.

Typical Application Scenarios

The project leveraged 5G industry VPNs and platform capabilities to develop 5G application scenarios deeply integrated into core production processes, including dark factories, AI quality inspection, and intelligent logistics within the plant. These enabled integrated operation and management of end-to-end business processes.

◆ 5G+ Dark Factory: Uninterrupted, Unmanned Fully Automated Production

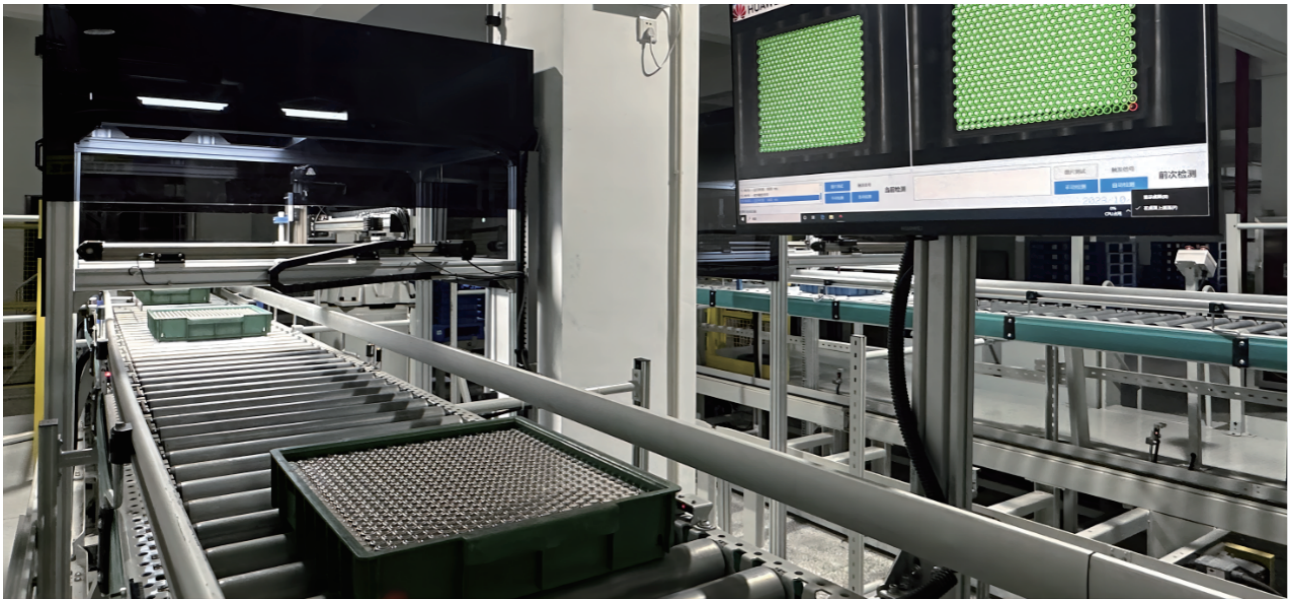
This scenario utilized 5G industry VPNs alongside technologies such as 5G LAN and cloud-based PLCs to upgrade traditional production lines into flexible lines. It enabled unmanned management of key data including equipment parameters, production processes, and material flow, achieving unified scheduling across all production stages from positive ring formation and electrolyte injection to sealing.



▲ Figure 1-2: 5G+ Dark Factory Application Site

◆ 5G+ AI Quality Inspection: Online Intelligent Battery Quality Detection

This scenario utilized the high uplink bandwidth of 5G networks to transmit battery appearance images captured by 4K HD industrial cameras to an AI machine vision technology platform on the MEC. It enabled online intelligent detection of 18 sub-types of battery defects across 6 major categories, such as contamination and leakage.



▲ Figure 1-3: 5G+ AI Quality Inspection Operation Site

◆ 5G+ AGV/RGV: Zero Stuttering, Zero Disconnections in Plant Intelligent Logistics Operations



This scenario leverages the high-reliability transmission capabilities of 5G networks to upgrade the connectivity and control methods of AGVs and RGV, while utilizing 5G high-precision integrated positioning to facilitate effective monitoring and supervision of AGV operational status.

▲ Figure 1-4: 5G+ AGV/RGV Operation Scenario

5G+ Smart Power



02 Shandong Electric Power: Large-Scale Application of 5G Scenarios Supports "Dual Carbon" Goals

Technical Features:

The project leveraged 5G+ distributed PV to enhance new energy consumption capacity; 5G+ Beidou + AI technologies to improve inspection efficiency in power transmission and transformation; and 5G+ differential protection to enhance grid security.

Application Results:

The project provided the optimal communication solution for integrating 600,000 distributed PV systems in Shandong; and reduced 5G base station electricity costs by 20%.

Background

Guided by China's "dual carbon" goals, the energy transition is accelerating. However, the inherent intermittency and high volatility of renewable energy—epitomized by phrases like "no wind on hot days" and "no sun when clouds gather"—are placing unprecedented stress on grid stability, making the power system's "dual-high" (high penetration of renewables and high power electronics) and "dual-peak" (morning and evening load peaks) characteristics especially pronounced. State Grid Shandong Electric Power Company has leveraged 5G technology to build a secure, reliable, and cost-effective IoT network, enabling renewable energy assets to be observable, measurable, and controllable, thereby enhancing the power system's flexibility and grid regulation capabilities.

Application Scenarios

State Grid Shandong Electric Power Company has empowered the new power system with 5G technology, successfully establishing "one network, one chip, 12 major scenarios, and 300,000 applications", overcoming bottlenecks in implementing 5G industry applications, and effectively enhancing the synergistic interaction of "generation, grid, load, and storage" as well as the integration capacity of new energy.

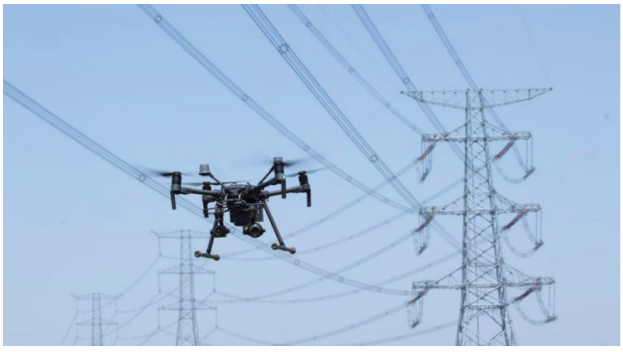
◆5G+ Distributed PV: Enhancing New Energy Integration on the Generation Side

Through 5G terminals, secure access and comprehensive perception of over 10,000 distributed PV devices were achieved. Terminal monitoring information was transmitted in real time via the 5G network, providing data support for precise grid regulation. This enabled visibility, measurability, and controllability of large-scale distributed energy resources, effectively improving the synergistic interaction of "generation, grid, load, and storage" and the integration level of new energy.



◀ Figure 1-5: 5G+ Distributed PV Power Equipment

◆ 5G+ Beidou + AI Smart Inspection: Enhancing Inspection Efficiency on the Transmission Side



UAVs equipped with HD cameras securely transmitted inspection footage in real time via 5G's high bandwidth. The control console used AI technology to automatically diagnose and analyze faults in the transmitted footage, eliminating manual transfer steps and significantly improving fault identification.

▲ Figure 1-6: "5G+ Beidou + AI" UAV Inspection

◆ 5G+ Smart Robot Inspection: Significantly Improving Inspection Efficiency on the Substation Side

In substation operations, robots equipped with 4K HD cameras transmitted collected information in real time via the 5G network to the power operation platform. This enabled real-time monitoring of substation equipment, intelligent fault analysis, and intelligent inspection.





▲ Figure 1-7: 5G+ Smart Robot Inspection(Left: 5G Robot, Right: 5G Power Operation Platform)

◆ 5G+ Differential Protection: Enhancing Grid Safety on the Distribution Side



5G+ Differential Protection fully leverages 5G's low latency to minimize the scope and duration of power outages. In distribution scenarios, the ultra-low latency of 5G networks is leveraged to monitor smart terminals, reducing the grid fault isolation time to seconds.

▲ Figure 1-8: 5G+ Differential Protection

5G+ Smart Oil & Gas



03 Shengli Oilfield, Shandong: Pioneering a New Cross-Region 5G Smart Oil Well Model

Technical Features:

The project utilized a cross-region 5G MEC VPN to enable data uplink, centralized management, centralized monitoring, and intelligent operations and maintenance; employed 5G+ remote control to ensure the stability of automatic interlocking control in key production processes; and leveraged 5G+ HD video for the rapid identification of various anomalies and violations.

Application Results:

The project reduced on-site manual operation workload for frontline staff by 95%; increased overall work efficiency by 98%; decreased the average daily energy consumption per unit of liquid extraction by 2.23 kWh/m³; achieved a 60% reduction in daily cumulative electricity consumption; and reduced routine tasks for frontline employees, such as patrol inspections and wellsite checks, by 80%.

Background

To advance toward the goal of progressively achieving "reduced staffing and unmanned operations" at production sites, depots, and central processing facilities in Shengli Oilfield, Dongsheng Company faced critical challenges, including fragmented remote control systems, harsh working conditions for on-site manual operations, and highly unstable wireless connectivity. To address these challenges, Dongsheng Company deployed a 5G virtual private network across Shengli Oilfield, implementing more than 10 distinct 5G application scenarios to support the transition of production sites toward "reduced staffing and unmanned operations".

Application Scenarios

The project leveraged a stable and reliable 5G network to promote the on-site deployment of various 5G applications, such as remote control and HD video surveillance, supporting the digital and informational transformation of the production site.

◆ 5G+ Remote Control: Reducing On-Site Operations and Optimizing Well Parameters



▲ Figure 1-9: 5G-based Remote Control of Pumping Units

This scenario utilized the low latency and high reliability of 5G to ensure the stability of automatic interlocking control in key production processes. Employees at the centralized monitoring center issued remote control commands via the 5G network to perform frequent, high-risk operations such as brake activation, chemical dosing, and well startup for pumping units. They also remotely adjusted equipment parameters, enabling the remote start and stop of oilfield pumping units. This reduced on-site operations, lowered workload intensity, and improved work efficiency.

◆ 5G+ HD Video Surveillance: Intelligent Inspection Requiring Less Legwork

This scenario transmitted HD video over the 5G network to the centralized monitoring center. Using a self-developed video intelligent identification "digital brain", it identifies various anomalies and violations, enhancing onsite safety. The system autonomously and promptly issues alerts to safety supervision personnel in cases such as loose components on pumping units, oil leaks at the wellhead, or improper wearing of safety helmets. Furthermore, with 5G-enabled UAV remote infrared patrols, issues like underground pipeline perforations and illegal tapping can be detected even at night.



▲ Figure 1-10: 5G-based HD Video Surveillance

5G+ Smart Ocean



04 China Unicom Shandong: 5G Sets Sail, Charting a New Blueprint for the Marine Digital Economy

Technical Features:

The project constructed a multi-dimensional ocean ultra-long-distance coverage network by integrating "5G+ Satellite + Submarine Cable" and underwater acoustic communication technologies; and developed multiple 5G digital ocean scenarios, including offshore wind power, remote maritime supervision, sailing events, and "sea granaries".

Application Results:

The project improved maritime safety supervision efficiency by approximately 30%; reduced supervisory personnel by approximately 10%; and enabled precise 5G-based feeding, reducing feed waste by approximately 80% and lowering labor costs by approximately 50%.

Background

Marine economic growth is currently hindered by weak maritime communication infrastructure, uncoordinated marine industrial development, poor inter-sectoral coordination in spatial planning, and insufficient intelligent capabilities. To address these challenges, China Unicom Shandong has built a multi-dimensional 5G ocean ultra-long-distance coverage network and established multiple new digital ocean scenarios, activating new momentum for the marine economy.

Application Scenarios

◆ 5G+ Offshore Wind Power: Strengthening Maritime Energy Construction and Supervision

This scenario integrated 5G+ intelligent video surveillance to allow real-time monitoring of construction vessels from shore via 5G-connected video feeds, with AI-powered analytics triggering instant alerts for non-compliant activities. Meanwhile, 5G+ BeiDou was implemented to enable high-precision crane operations during construction, replacing traditional visual estimation with centimeter-level accuracy.

Construction Compliance Detection	Maritime Visual Supervision	Wind Turbine Digital Monitoring	5G Beidou Positioning and Navigation



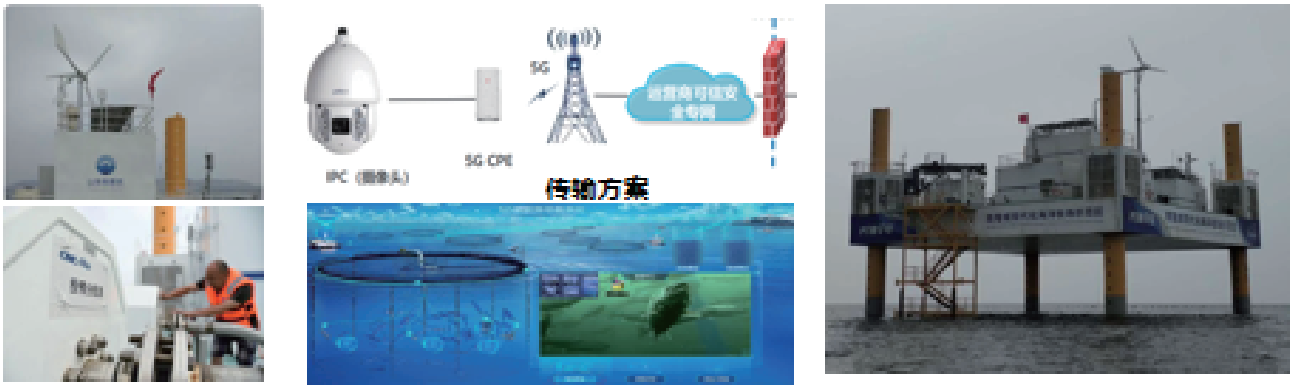
▲ Figure 1-11: 5G Offshore Wind Power Application

◆ 5G+ Cloud-Based Boarding: Enabling Remote Supervision and Law Enforcement

This scenario, relying on the high bandwidth and ultra-low latency of 5G networks, enabled crew members to wear smart visual terminals to comply with enforcement instructions in real time; 5G drones delivered cloud-based boarding kits to facilitate remote, contactless maritime supervision by enforcement personnel.

◆ 5G+ AI Ocean Ranch: Driving Intelligent Marine Aquaculture

Based on technologies like 5G, Digital Twin, and AI, this scenario developed the Yantai "Changyu No.1" smart ocean ranch project. Digital twin technology helped build a unified management platform, enabling streamlined ranch ecological monitoring, intelligent management of cage nets, automated bait feeding, and other smart operations. AI image recognition, by analyzing video footage of the fishery, enabled fish stock statistical analysis and intelligent identification of illegal intrusions for early warnings.



▲ Figure 1-12: 5G+ AI Ocean Ranch Construction

5G+ Vehicle-to-Everything (V2X)



05 Hanjiang Zhixing, Hubei: 5G Paves the Way for Smart Transport in Ancient Xiangyang

Technical Features:

The project established a national-level V2X pilot zone to enable smart transport in Xiangyang City; achieved a breakthrough in 5G V2X deployment, evolving from isolated pilot points to broader area coverage; enabled efficient information exchange and collaboration between vehicles and transportation infrastructure; and developed in-depth application city models to serve all traffic participants and enhance urban transportation informatization and intelligence.

Application Results:

The project reduced travel time by approximately 180 million hours annually; generated data monetization revenue of 30 million yuan per year; and achieved platform operation revenue of 40 million yuan per year.

Background

Xiangyang is fully advancing the development of ICVs. Leveraging its automotive industry foundation, the city is building an ICV industrial cluster centered on vehicle manufacturing, supported by component manufacturing, guaranteed by a C-V2X intelligent connected system and vehicle/component testing, and driven by independent innovation. By creating a pioneer application environment for V2X, industrial public service platforms, multi-dimensional V2X application scenarios, and an O&M management center, it is establishing a public service platform for industrial technological infrastructure. This platform serves the large-scale testing and verification of V2X, provides services and support for the smart transport and ICV industries, and aims to quickly form a highly influential V2X industrial ecosystem.

Application Scenarios

The Xiangyang V2X Pilot Zone focused on three deep applications—Smart Logistics, Smart Mobility, and Smart Traffic Management—to build a comprehensive collaborative environment and V2X application system integrating "human, vehicle, road, network, and cloud". It leveraged smart logistics applications to drive safe and efficient logistics operations in Xiangyang, used smart mobility applications to enhance the convenience of daily commutes for citizens, and employed smart traffic management applications to empower the city's transition towards smart traffic management.

◆ 5G+ Smart Logistics: Extending Smart Logistics Demonstration Routes to Public Roads

In this scenario, a three-tier urban logistics node system was established, comprising logistics parks, distribution centers, and last-mile service points, with unmanned last-mile delivery resources integrated to further enhance intelligent logistics solutions for autonomous delivery vehicles. The adoption of new energy delivery vehicles has been accelerated, model enterprises have been fostered, and an urban green freight distribution platform has been systematically developed, culminating in a "resource-efficient, high-efficiency, green, and intelligent" urban livelihood logistics service system.’



Logistics inbound and outbound are concentrated at logistics gates ⑨ and ⑧.

Chassis Route: 4 vehicles, 3 personnel, 9m flatbed trailer type

Route 1: Chassis Workshop ①/③/⑩ → ② Final Assembly 3 (26km)

Route 2: Chassis Workshop ①/③/⑩ → ⑧ → ⑨ → ④ Final Assembly 1 (83km)

Stamping Parts Route: 2+1 vehicles, 3 personnel, 9m van type

Route 1: Stamping 1 ⑦ → ⑨ → ⑧ → ⑤ Stamping 2

Route 2: Stamping 1 ⑦ → ⑨ → ⑧ → (u) Stamping 2

Route 3: Stamping 2 ⑤ → ⑧ → ⑨ → ⑦ Stamping 1 (93km)

Body Route: 5 vehicles, 5 personnel, 6m vehicle type

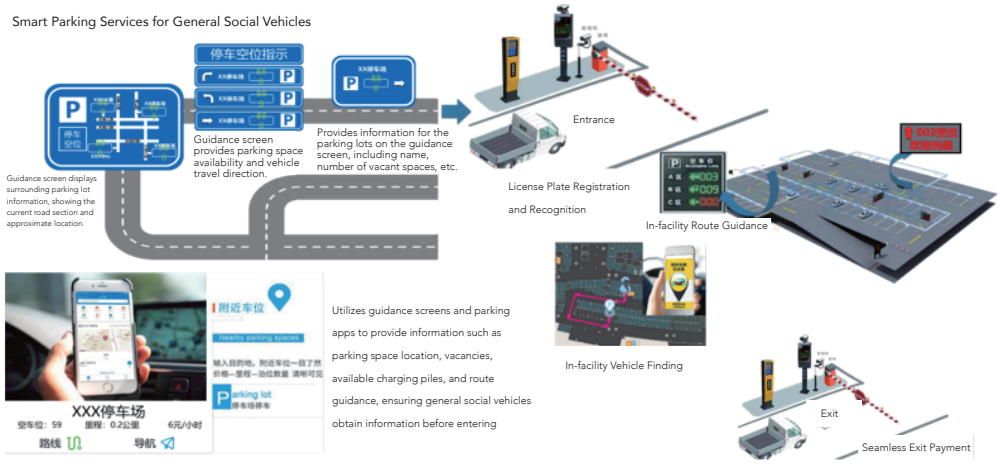
Route 1: Paint Shop 1 (12) → (13) → ⑨ → ⑧ → (14) Final Assembly 3 (105km)

Route 2: Final Assembly 3 (15) → ⑧ → ⑨ → ⑥ Final Assembly 2 (60km)

▲ Figure 1-13: Smart Logistics Application - Park Logistics

◆ 5G+ Smart Mobility: Promoting V2X Terminal Penetration and Deepened Operations

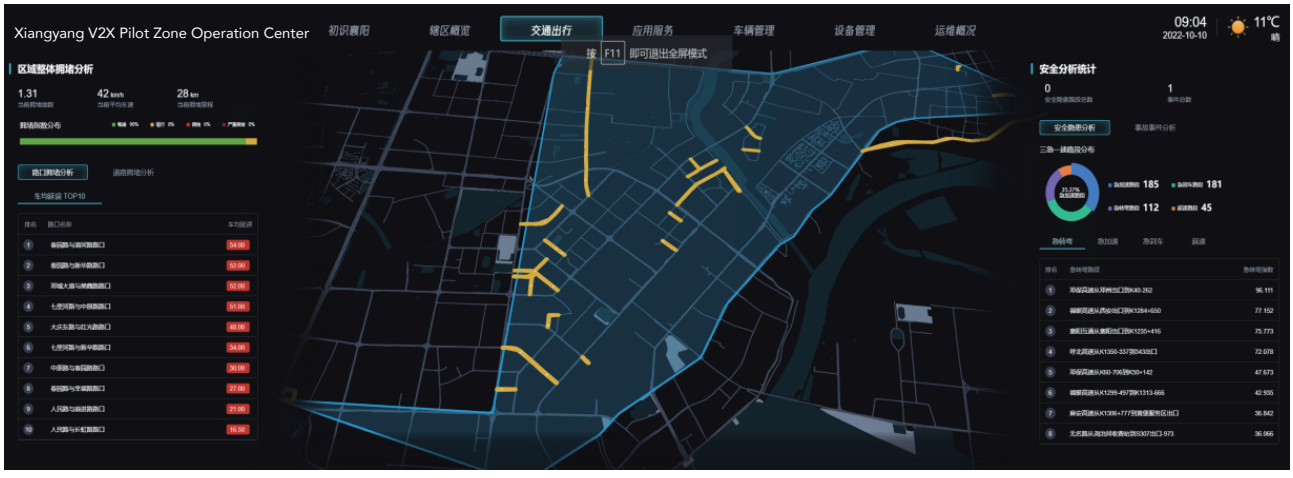
This scenario developed deep application demonstrations for smart mobility centered on four aspects: smart navigation, smart parking, smart public transport, and smart highways. While addressing the travel needs of local residents in Xiangyang, it also provided C-V2X smart mobility services to tourists through information mapping on digital maps, smart bus applications, smart parking, and smart highway features. This allowed more people to perceive and enjoy the convenience brought by intelligent connectivity to their journeys.



▲ Figure 1-14: Smart Mobility Application - Smart Parking

◆ 5G+ Smart Traffic Management: Unified Signal Control, Situation Awareness, and Adaptive Control

This scenario deployed traffic analysis tools and models to conduct a comprehensive analysis of Xiangyang's road network. Based on the analytical data and considering local traffic characteristics, ICV technologies, an urban traffic data foundation, and a "traffic brain" were employed to fuse perception data collected by traffic police and the V2X Pilot Zone. Through integrated fusion and deep mining of these multi-source data streams, the system enabled systematic evaluation and diagnostic analysis of urban traffic operational status.



▲ Figure 1-15: Smart Transport Application - Traffic Situation Analysis

5G+ Smart Agriculture



06 Nanjing Taihe Farm: Digitalization Facilitates Standardized Rice Production

Technical Features:

By combining 5G, cloud, and AI technologies and specifically integrating 5G connectivity with machine vision, this solution enables full-lifecycle monitoring of organic rice growth, effectively supporting pest and disease prevention, lower fertilizer application, and yield enhancement.

Application Results:

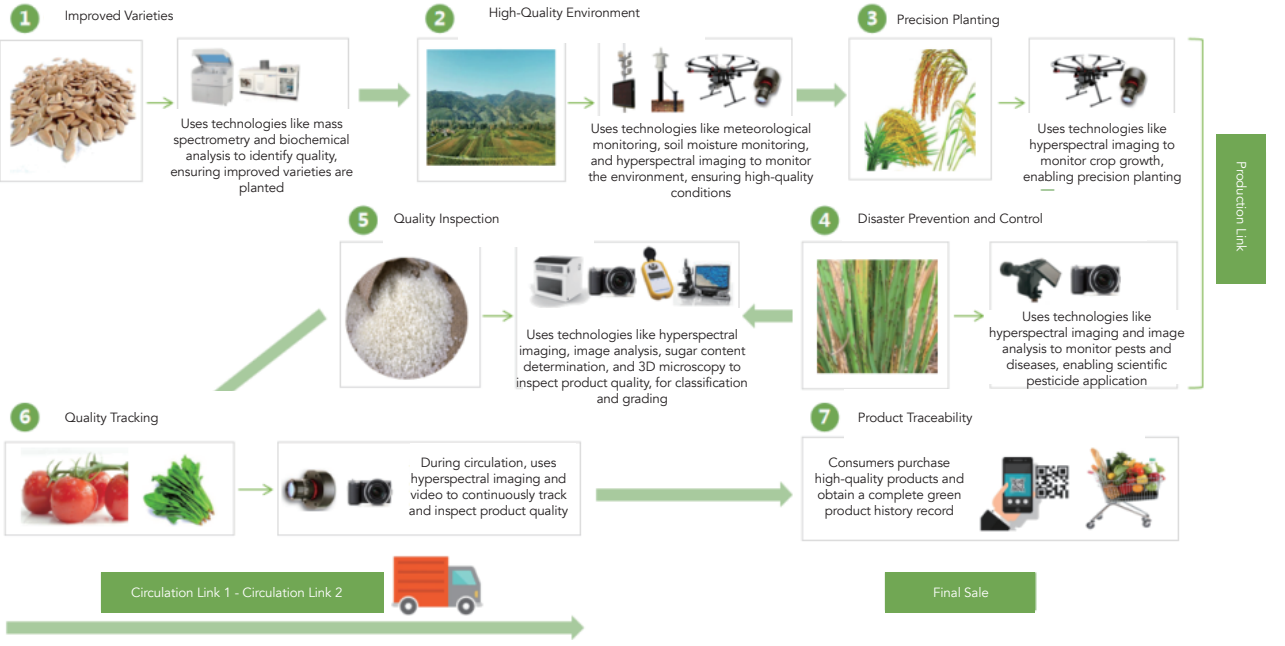
Organic rice yield increased by 40% per mu; precision management reduced water, fertilizer, and labor costs by approximately 50% during cultivation; high-quality Taihe organic rice, produced through green and eco-friendly practices, achieved a 50% increase in revenue per mu.

Background

Rice growth involves numerous factors, with variety, location, year, environmental conditions, and growth stages all significantly impacting quality and yield. Taihe Farm has deeply integrated biotechnology with information technologies represented by 5G, machine vision, AI, big data, and cloud computing to achieve scientific coordination of inputs in the pre-production phase, precise allocation of production factors during cultivation, and optimal alignment of supply and demand in the post-harvest phase. By fostering a virtuous cycle of material flows across the agricultural value chain, the farm has realized highly efficient resource utilization and sustained enhancement of ecological functions.

Application Scenarios

Based on 5G+ multiple types of front-end visual devices + AI technology, full-process control can be achieved across stages including production, circulation, and sales, providing quality assurance for premium ecological rice throughout the entire process.



▲ Figure 1-16: Full-Process Control Across Production, Circulation, and Sales Stages

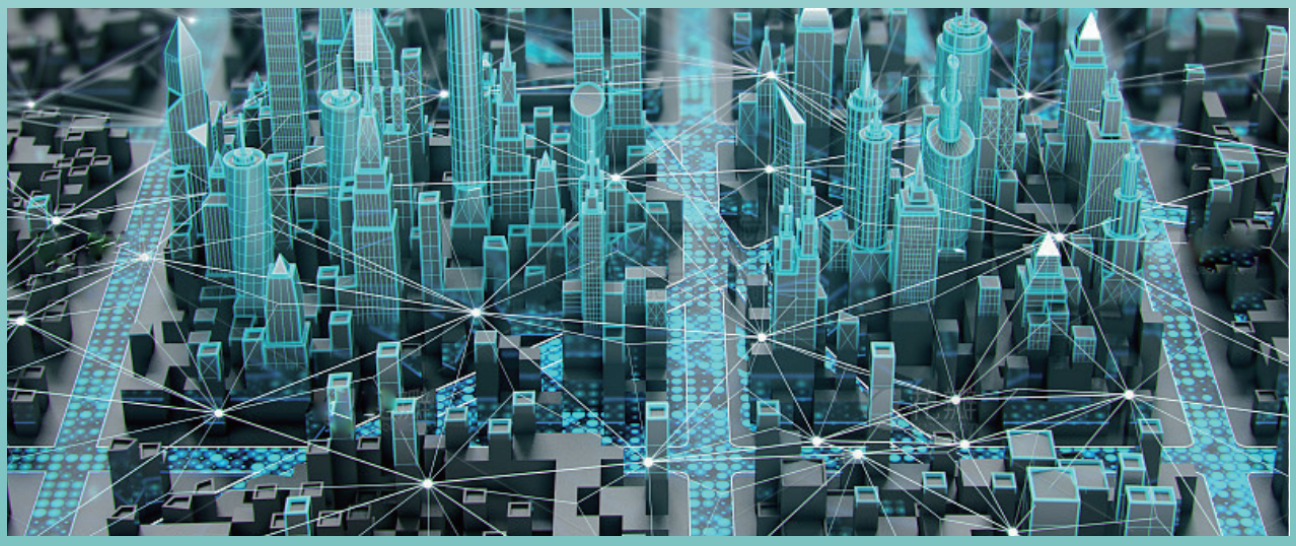
◆ 5G Fixed-Point Observation: Accurate and Efficient Modeling

By setting up observation devices such as hyperspectral cameras, HD cameras, and infrared cameras at fixed points, along with 5G energy gateways, information data on crop products was collected, modeled, and analyzed. HD cameras were employed to screen rice seeds, removing diseased and immature grains to reduce costs and increase yields, while simultaneously capturing morphological data on roots, stems, leaves, and panicles. Infrared cameras were used to develop leaf water content estimation models, enabling precision water management. Additionally, infrared HD cameras monitored plants and soil-water temperatures to optimize irrigation scheduling and detect nocturnal pest activity, facilitating early intervention and reducing pesticide application.

◆ 5G UAV Mobile Observation: Precision Water and Fertilizer Control

Equipped with devices such as hyperspectral cameras, 3D laser cameras, HD cameras, and infrared cameras, 5G UAVs conducted mobile scanning or detection across large areas of paddy fields. Multi-spectral drone imagery was utilized for periodic monitoring to optimize water and nitrogen management, thereby enhancing photosynthetic efficiency and promoting the characteristic leaf color transition of "three yellows and two blacks" in rice. High-altitude imaging enabled crop variety identification, weed detection, and soil moisture analysis to assess irrigation and drainage capacity. The system also supported early pest and disease detection to minimize losses, monitored rice growth dynamics for yield prediction, and holistically enhanced field management with wide-area coverage, high timeliness, and data accuracy.

5G+ Smart City



07 Shenzhen Nanshan District Government Services and Data Management Bureau: Pioneering Demonstration in Smart City Governance

Technical Features:

The project utilized 5G+ AI to intelligently analyze pedestrian flow and crowd characteristics; and employed a 5G government VPN, combined with 5G surveillance and AI analysis, to ensure safe construction at work sites and safe driving for hazardous goods transport vehicle drivers.

Application Results:

The project reduced electric bicycle violations by 56%, indirectly reducing electric bicycle accident casualties by 80%.

Background

Urban governance in Nanshan District currently faces three key challenges: Information systems across departments operate in silos; data accuracy is difficult to assess, and data acquisition suffers from significant delays; the urban environment is highly complex, with diverse and rapidly evolving citizen needs. To address these issues, the Nanshan District Smart Digital Twin City Platform has integrated 5G technology to develop a comprehensive 5G+ Smart City Governance solution. This platform supports government administration, public services, and industrial development, providing end-to-end scenario support for intelligent urban governance and advancing the city's digital transformation.

Application Scenarios

The project developed over 100 5G applications, including management of persistent electric bicycle violations, rapid digital governance of ancient towns, "X-ray vision" for underground spaces, construction site monitoring, and epidemic control. These applications have been promoted and implemented across subdistrict offices in Shenzhen, making urban operations smarter.

◆ 5G+ Smart Traffic Management: Reducing Electric Bicycle Violations and Accident Casualties

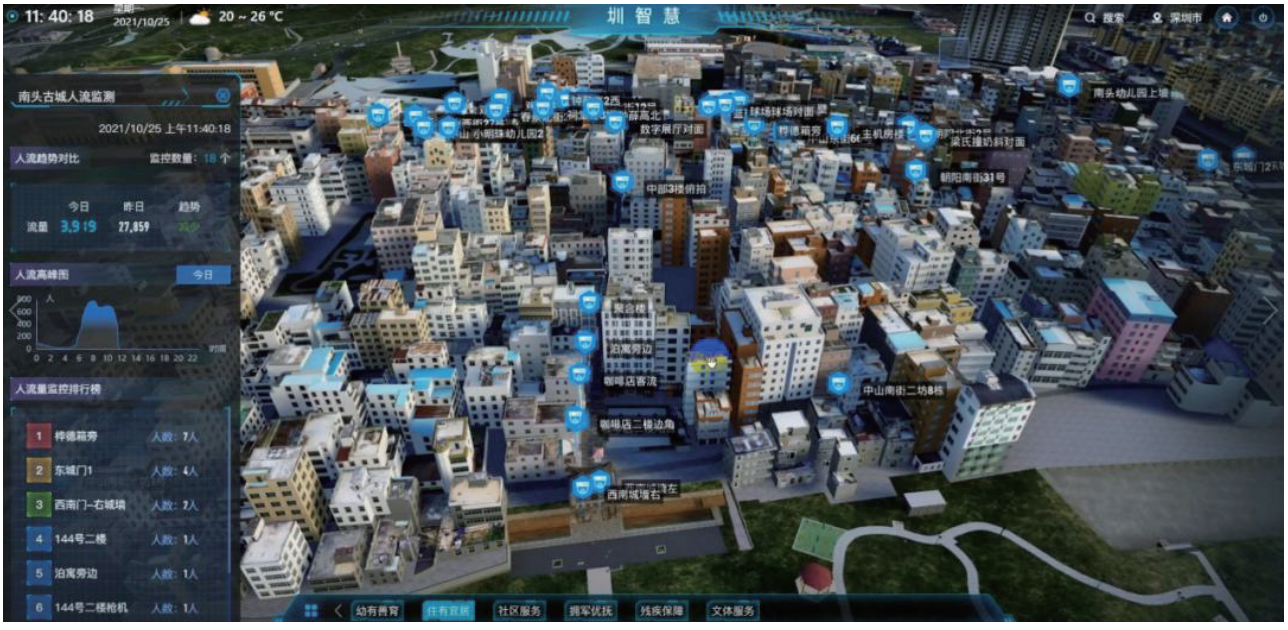
This scenario deployed 5G-enabled poles equipped with cameras to promptly detect electric bicycle violations. Violations were immediately reported to a platform for action, and 5G messages were simultaneously dispatched to the violators, their affiliated units, and the nearest traffic police officers, enabling real-time and efficient violation handling.



◀ Figure 1-17: 5G+ Smart Traffic Management: Early Warning and Handling of Electric Bicycle Violations

◆ 5G+ Digital Governance of Ancient Towns: Enhancing Public Service Capabilities

This scenario integrated 5G with the City Information Modeling (CIM) technology to improve urban governance. Taking the Nantou Ancient City as an example: The scenic area was deployed with 26 5G cameras, 3 5G patrol robots, and 2 5G patrol vehicles, achieving "zero development" and "deployment completed within 7 days". During the 2021 Spring Festival, the system served over 300,000 people, contributing to zero public security incidents, zero hygiene complaints, zero child losses, and zero property management errors.



▲ Figure 1-18: 5G+ Digital Governance of Ancient Towns: Crowd Flow Analysis in Nantou Ancient City

5G+ Smart Education



08 Fudan University: 5G-Enabled Smart Education Complex

Technical Features:

Leveraging edge computing and 5G network slicing technology, the project achieved deep integration of 5G networks with the campus network. It established a manageable, controllable, and perceivable campus VPN, meeting the university's needs for service connectivity, high-speed computing, and information security.

Application Results:

The 5G traffic offload ratio increased by 6.6%, and the proportion of 5G users grew by 8.7%. Compared to VPN, the 5G campus network provided approximately 20 times faster speeds, reduced latency by about 10–20 ms, and improved internal network download speeds by roughly 3 times. Additionally, IPv6 traffic within the university increased by 16%.

Background

Traditional campus networks face two main challenges. First, faculty and students can only access on-campus resources from external networks by connecting through a VPN; second, VPN connections are constrained by inherent limitations on concurrent user sessions. To address these issues, Fudan University developed a 5G campus VPN, establishing the foundation for a smart education ecosystem and implementing a smart campus network solution characterized by the "Internet of Everything, Multi-Network Convergence" framework.

Application Scenarios

Fudan University's 5G campus VPN covers multiple scenarios including personal user access for faculty and students, teaching and education applications, and campus management.

◆ 5G+ Mobile Access: Ensuring Secure Personal Access to Campus Network

Within Fudan University's 5G campus VPN, terminals of various forms can be connected to the campus network via the 5G sliced VPN. This was achieved through wireless base stations and bearer networks, utilizing dedicated UPFs for both To B and To C services, and connecting via edge computing nodes. With secondary authentication ensuring security control, direct access to the campus network was enabled from anywhere without the need for VPN dial-up.



▲ Figure 1-19: Direct Off-Campus Access to the University's OA System

◆ 5G+ Smart Education: Immersive Teaching and Simulation

Leveraging the 5G campus VPN, this scenario enabled rapid and realistic presentation of various teaching resources in the classroom through video, AR, VR, and MR formats. This allowed students to more authentically perceive and manipulate the external world, bringing profound changes to educational models.



▲ Figure 1-20: VR Simulation Teaching Project Based on 5G Virtual Campus Network

◆ 5G+ Campus Management: Enhancing Campus Security

Across campus spaces, device terminals are widely distributed in large numbers, with high density in certain areas. This scenario utilized the massive connectivity of 5G networks, combined with edge computing, to provide reliable connection resources for campus IoT terminal devices. This enabled all-scenario, comprehensive, and round-the-clock monitoring and management.



▲ Figure 1-21: Campus Logistics Management System Based on 5G Campus VPN

5G+ Smart Healthcare



09 Beijing Emergency Medical Center: 5G Emergency Response System Integration Project

Technical Features:

The project leveraged emerging technologies including 5G, AI, and cloud computing to achieve integration of command and dispatch, emergency coordination, and pre-hospital to in-hospital information transmission, creating a one-stop operational platform for the emergency center.

Application Results:

The project optimized the emergency command service system for public incidents through 5G technology, enabling rapid response to emergencies and improved treatment efficiency for critical cases. The average pre-hospital emergency response time was reduced to approximately 15 minutes, and the success rate of cardiopulmonary resuscitation increased from less than 1% to 2.2%.

Background

As its operations continued to expand, Beijing Emergency Medical Center faced several challenges in ambulance-based rescue missions, including a relative lack of digital capabilities—particularly real-time remote medical guidance—as well as the inability to rapidly track equipment status and patient diagnostic results, and reliance on limited communication channels during rescue operations. To address these challenges, the Center has adopted 5G as the core enabling technology, integrating its business, management, service, and 5G-enabled medical support information systems into a unified platform, thereby creating higher economic and social benefits.

Application Scenarios

◆ 5G+ Emergency Dispatch: Enabling Emergency Support for Incidents and Major Events

This scenario leveraged 5G technology, integrating AI, big data, and cloud computing to build an emergency command and decision-making platform. Using this platform, the command center can grasp the real-time situation on the ground and the vital signs of casualties, enabling timely emergency dispatch and relevant command decisions. This facilitated visual, dynamic management of emergency response and medical support for major events.



Figure 1-22: 2022 Beijing Marathon Emergency Support Application Scenario

◆ 5G+ Data Exchange: Enabling Full-Process Management of Emergency Care



▲ Figure 1-23:
Remote Guidance for Emergency Care

This scenario utilized 5G to achieve real-time exchange of pre-hospital emergency device data, vehicle location information, and electronic medical records. It involved the collection, transmission, storage, processing, and display of pre-hospital emergency information, enabling timely video consultations between the ambulance and the hospital. This comprehensively enhanced the treatment capacity per unit time of the pre-hospital emergency system.

◆ 5G+ Patient Transport: Creating Standardized 5G Ambulances

The standardized 5G ambulance leverages 5G technology to integrate data from multiple devices, including multi-parameter physiological monitors, ultrasound systems, and HD video consultation terminals, enabling seamless connectivity between prehospital and in-hospital systems. This allows real-time, HD video communication between hospital-based specialists and on-board emergency medical personnel, supporting continuous, real-time monitoring of the patient's condition.



▲ Figure 1-24: Standardized 5G Ambulance Refit

5G+ Cultural Tourism



10 Mount Tai Scenic Area: Smart Cultural Tourism with Multi-Dimensional Scenic Management

Technical Features:

The project utilized technologies such as 5G, AI, VR, and AR to build a digital management platform and innovative applications for scenic area management and tourist services. This enhanced data utilization, reduced operational management costs, and improved tourist satisfaction.

Application Results:

Data utilization increased by 50%. The number of personnel in the scenic area construction teams was reduced by 30%, saving over 1.5 million yuan in labor costs and operational expenses. Tourist satisfaction rose by 30%, driving an additional 30 million yuan in secondary consumption revenue.

Background

Nowadays, advances in digital technologies are driving the tourism industry toward more diversified business models. Traditional tourism operations face persistent challenges, including insufficient revenue generation and operational efficiency at scenic sites, as well as tourists' limited access to novel, engaging, and enjoyable travel experiences. Utilizing new technologies like 5G, VR, and AI, Mount Tai Scenic Area is building the "Mount Tai Model" for smart scenic area digitalization, making management more efficient, tourist trips more convenient, and travel experiences more meaningful.

Application Scenarios

The application scenarios of this project primarily include one digital management platform and seven 5G innovative applications: 5G+AI mobile law enforcement, 5G+UAV inspection, 5G+VR live streaming, 5G+panoramic photo booth, 5G+AR content cloud, 5G+AI travel notes, and 5G+self-service UAV aerial photography.

◆ 5G+AI Mobile Law Enforcement: Data Interconnectivity Enables Remote Dispatch

Scenic site staff used wearable devices such as AI-powered smart glasses to capture real-time information and transmit data via 5G networks. Through a dedicated mobile app, they leverage the backend system's analytics and dispatch capabilities to conduct mobile enforcement, significantly enhancing security personnel's ability to rapidly respond to and manage emergency incidents.



◀ Figure 1-25: Real-time Viewing by Security Personnel

◆ 5G+UAV Inspection: Integrated Air, Ground, and Personnel Security Network

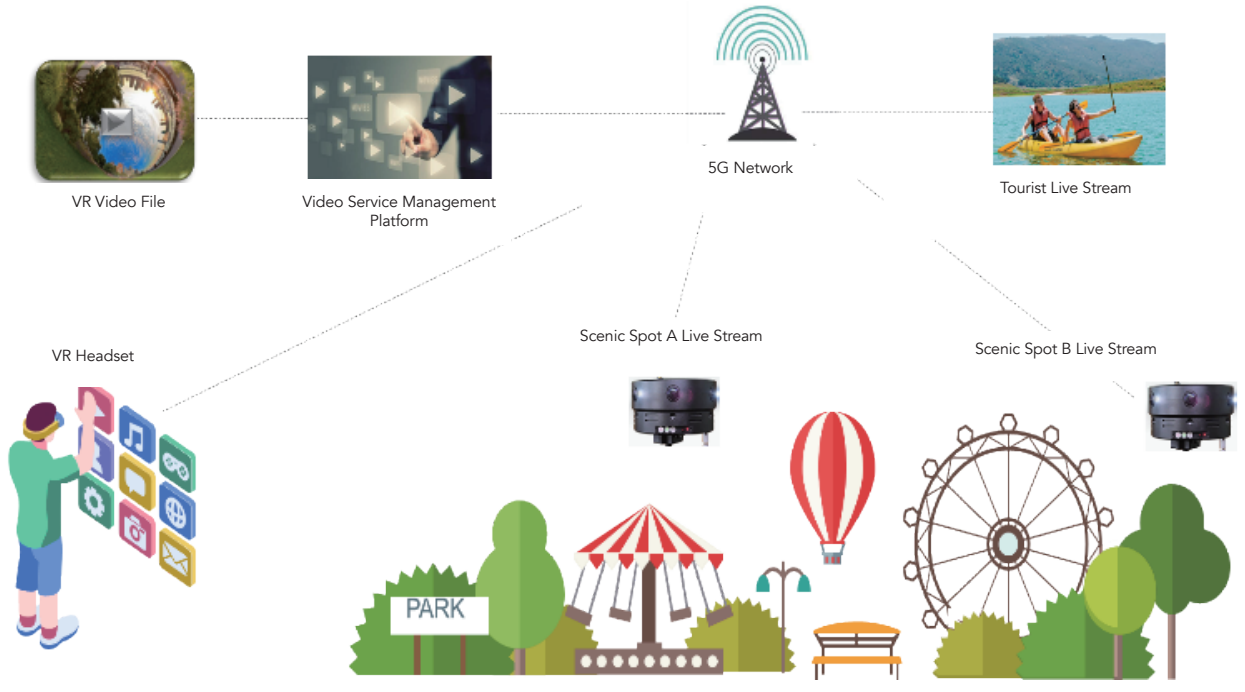


▲ Figure 1-26: Remote UAV Inspection Scenario

The 5G network ensured real-time transmission of video footage captured by UAVs, which was displayed in real-time on the large monitoring screen in the command center. This enabled 24-hour remote UAV patrols of the Dai Temple wall area within Mount Tai Scenic Area. During inspections, the command center can remotely adjust camera angles and use AI technology to intelligently analyze the UAV footage, providing real-time alerts for potential hazardous incidents.

◆ 5G+VR Live Streaming: A Novel Experience Throughout the Entire Tour

This scenario's architecture consists of a VR panoramic camera, 5G CPE, 5G service network, VR live streaming platform, and VR terminals. Tourists can experience Mount Tai's natural landscapes and cultural sights through VR equipment. This scenario offered tourists a novel experience that spans before, during, and after their tour.



▲ Figure 1-27: Mount Tai Scenic Area VR Live Streaming System



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02

Digital Development Acceleration Toolkit for Developing Countries

Gigabit Broadband Evolution



2025

Broadband Evolution Towards Gigabit Optical Networks

In 2013, the Chinese government established broadband development as a national strategy, facilitating the widespread adoption of networks as critical public infrastructure. This was notably achieved through the implementation of mandatory standards for fiber optic coverage in residential areas, which laid the groundwork for the joint construction and sharing of urban and rural network facilities. Subsequently, through multiple measures such as increasing network speeds, reducing fees, and establishing a universal service compensation mechanism, the Chinese government effectively enhanced the user experience and narrowed the urban-rural access divide.

In recent years, the focus of China's broadband network development has shifted towards advancing the coordinated development of gigabit optical networks and 5G. By implementing a coordinated development strategy, extensively building "Gigabit Cities", hosting innovation application competitions to stimulate cross-industry integration, and actively exploring application models in the industrial sector, China has achieved an overall leap in fixed and mobile broadband network capabilities. This has effectively supported the accelerated upgrade of information infrastructure and provided critical support for the digital transformation of the economy and society.

2.1 Implementing the National Broadband Strategy to Achieve Comprehensive Network Coverage

In the early stages of development, China faced challenges such as insufficient broadband network coverage, uneven regional development, and an urgent need to improve access performance, which

hindered its ability to meet the demands of rapid economic and social growth. To address these issues, the Chinese government designated broadband networks as critical strategic public infrastructure and formulated a national broadband development strategy. This strategy aimed to build consensus, define clear goals, and systematically advance construction efforts. It was closely aligned with national macro-level planning and incorporated international experience and industry practices, establishing clear short-term and long-term development targets across three dimensions: network coverage, access capability, and application scenarios.

To tackle regional development disparities, China adopted a differentiated approach, focusing on enhancing network capabilities in rural and underdeveloped areas and promoting coordinated development of urban and rural broadband networks. **To address the issue of overall low network performance,** policy initiatives were concentrated on key areas such as backbone network expansion, access network optimization, and website application acceleration, thereby achieving comprehensive improvements in end-to-end network performance. Meanwhile, **to resolve the insufficient adoption of broadband applications,** China vigorously promoted the deep integration and widespread use of broadband in economic production, public services, cultural education, and people' s livelihood services. Additionally, **to enhance industrial resilience,** China advanced and guided multi-stakeholder participation in technological innovation through measures such as key technology research and development, industrialization of major products, development of smart terminals, and construction of support platforms, thereby strengthening domestic industrial self-sufficiency. **To improve cybersecurity,** China implemented measures including refining security protection systems, building emergency communication systems, and establishing security management mechanisms, laying a solid foundation for the healthy and sustainable development of broadband networks.

However, broadband adoption, particularly the "last mile" connectivity in urban areas, often faced obstacles due to inconsistent construction standards for communication infrastructure in residential areas and access barriers among operators. To overcome this bottleneck and ensure the effective implementation of the national strategy, China introduced mandatory national technical standards for Fiber-to-the-Home (FTTH) in residential areas. These standards explicitly require that: new residential buildings must adopt FTTH

FTTH deployment, and communication facilities within new residential areas and buildings must be constructed and inspected simultaneously with the residential areas and buildings themselves. Additionally, the standards mandate equal access rights for multiple operators, thereby providing policy assurance for a fair market competition environment, and further promoting the collaborative development and resource sharing of communication infrastructure within residential areas.

The implementation of these mandatory standards not only provided clear technical guidelines for the standardized deployment of fiber-optic networks but also effectively resolved long-standing challenges in residential broadband deployment. This significantly accelerated the pace of fiber-optic network coverage and strongly supported the network upgrade process of "fiber-over-copper transition". Relevant authorities also actively promoted the enforcement of these standards through various measures, such as standardization promotion trainings and joint inspection campaigns.

2.2 Promoting Network Service Upgrades to Enhance User Access Experience

Following the achievement of basic broadband network coverage, China encountered three key challenges: persistent disparities in network quality between older urban residential areas and remote rural regions, relatively high service costs for SMEs and low-income groups, and a significantly widening gap in network experience between urban and rural areas. In response, China launched a comprehensive and systematic network service upgrade initiative, addressing bottlenecks simultaneously across three dimensions.

In terms of network quality optimization, the Chinese government prioritized increasing the penetration rates of fiber-optic and 4G networks, setting development targets of 80% penetration for 100Mbps broadband users and 80% penetration for 4G users. Through specialized projects such as standardized fiber-optic renovation in older urban residential areas and the "Fiber to the Village" initiative in rural areas, broadband network access capabilities were continuously enhanced. Concurrently, the government guided and urged network operators to consistently increase backbone network transmission capacity, optimize backbone network architecture, significantly expand internet exchange bandwidth, and accelerate the

deplo ment of application infrastructure like CDN and data centers. These efforts facilitated the distribution of content services closer to end-users, further improving the user network experience.

To eliminate access barriers in critical sectors, the government simultaneously strengthened the institutional support system. Cross-departmental joint initiatives addressed broadband monopolies in commercial buildings, and a legal guarantee mechanism for right-of-way in fiber-optic network construction was established. A targeted campaign was launched to ensure broadband access for educational and medical infrastructure, guaranteeing 100% internet broadband connectivity for all primary and secondary schools nationwide (including remote teaching sites) and achieving comprehensive telemedicine network coverage in county-level hospitals within impoverished counties. Furthermore, a national-level network quality monitoring platform was established, alongside the formulation of unified broadband speed measurement standards, providing technical support for the evaluation of network service quality.

To address service affordability, the Chinese government fostered market competition through the gradual opening of the telecom market, permitting mobile resale and broadband access services to drive widespread tariff reductions via market mechanisms. Simultaneously, the government established comprehensive inclusive mechanisms for key demographics, such as providing communication discounts of no less than 50% for low-income individuals or families, and continuing to advance broadband and dedicated line fee reductions for SMEs. While implementing supportive policies, the Chinese government also emphasized the supervision and guidance of the market environment to maintain fair and healthy market competition order.

To bridge the urban-rural digital divide, MIIT and the Ministry of Finance jointly established a UTS compensation mechanism. This aimed to provide financial subsidies for network construction in remote areas, enhance network operators' enthusiasm for participating in UTS, and promote the achievement of "Broadband Access in Every Village" across all administrative villages. Currently, the average rural fiber-optic download speed in China exceeds 100 Mb/s, significantly narrowing the urban-rural digital divide.

Since the implementation of network service upgrade initiatives, China's broadband network has achieved comprehensive urban-rural coverage, enabling an increasing number of regions and users to benefit from high-speed network services. As of June 2025, the number of fixed internet broadband access users in

China with access rates of 100 Mbps and above has amounted to 651 million, accounting for 95.1% of the total user base. The number of users with access rates of 1000 Mbps and above has reached 226 million, a net increase of 19.15 million since the beginning of the year, representing 33% of the total user base.

2.3 Facilitating the Coordinated Development of Optical and Mobile Networks to Lead Gigabit Network Upgrades

In response to the higher requirements for network capabilities posed by industrial digital transformation, the Chinese government planned and implemented an industrial upgrade roadmap for the coordinated development of optical and 5G networks in 2021. Centered on the construction of "Gigabit Cities", a three-year initiative stimulated 207 cities to complete generational network upgrades, forming a replicable policy toolkit in areas such as shared infrastructure development, streamlined approval processes, and cost control. Simultaneously, the Chinese government guided industry stakeholders to build an industrial application innovation ecosystem. Through the open innovation competition platform "Guanghua Cup", cross-disciplinary technology integration was stimulated, promoting the deep integration of gigabit optical networks into multiple core industrial production processes. Driven by both policy and industry efforts, China's fixed broadband gigabit users exceeded 226 million, and 5G connections accounted for over 40% of the global total, providing efficient and reliable network support for economic and social digitalization.

"Gigabit Cities" is a national-level urban gigabit network capability assessment project launched by MIIT in 2021. It comprehensively evaluates the development level of "Dual Gigabit" networks in various cities based on network coverage, user development, application innovation, and policy support.

Since its launch, the "Gigabit Cities" project has received enthusiastic responses and active participation from over 330 cities across China. As the three-year project progressed, a positive pattern emerged with key cities taking the lead and others striving to develop. Cities including Beijing, Shanghai, Shenzhen, Guangzhou, Nanjing, and Hangzhou—totaling 207—successfully built themselves into Gigabit Cities, accounting for approximately two-thirds of all prefecture-level cities in China. Guangxi, Jiangsu, Zhejiang,

and other provinces took the lead in having all their prefecture-level cities achieve Gigabit City status, setting an advanced benchmark for other regions. During the construction process, these cities explored and formed a series of typical practices and effective experiences for promoting network construction and application, serving as excellent demonstrations for driving regional network development..

In terms of network construction, some regions strengthened policy support for "Dual Gigabit" network development by incorporating fiber-optic network construction into their respective territorial spatial plans and integrating it into a "dashboard" system for territorial spatial planning, effectively promoting the build-out. Other areas enhanced the open sharing of public resources, actively advancing the co-construction and sharing of communication infrastructure with municipal and transportation infrastructure to achieve intensive development. Several regions integrated FTTH requirements into the construction project approval processes managed by housing and urban-rural development authorities, establishing integrated service windows for "electricity, water, gas, heating, and internet" approvals. This enabled joint review of multiple drawings and one-stop services for communication infrastructure alongside municipal utilities like water, electricity, and gas, standardizing the management of fiber-optic network construction projects.

Regarding cost reduction, some regions exempted or reduced rental fees for constructing communication infrastructure, including fiber-optic networks, in public spaces and facilities. This applied to government agencies, enterprises, public institutions, airports, railway stations, high-speed rail stations, tourist attractions, parks, and green spaces. Other areas streamlined electricity application procedures and regulated behavior in secondary power supply to ensure reliable electricity for communication infrastructure. Several regions provided financial subsidies for "Dual Gigabit" network construction and operational maintenance through special funds.

In organizational support, some regions established multi-department joint working mechanisms, where relevant industry authorities actively coordinated and promoted solutions to difficulties and high costs associated with accessing sites for fiber-optic network construction, effectively advancing network deployment. Other areas instituted performance evaluations for network construction and established oversight systems, providing strong institutional support and guarantees for the network build-out.

The "Guanghua Cup" Gigabit Optical Network Application Innovation Competition is organized by CAICT. It primarily solicits and selects Gigabit optical network business applications from across the industry that feature innovative business models, strong development prospects, and distinct demonstrative significance. Through the exemplary effect of these application cases, the Competition aims to drive industrial development and support economic and social digital transformation. The Competition is structured in multiple stages, including "themed competitions, regional competitions, and a national final", covering areas such as new information consumption (e.g., VR/AR, smart homes, cloud gaming, UHD video), integrated applications (e.g., manufacturing, mining, ports, industrial parks), and social and livelihood services (e.g., digital government, healthcare, education, environmental protection). This has sparked a wave of Gigabit optical network application innovation across various sectors of society.



▲ Figure 1-28: "Guanghua Cup" Gigabit Optical Network Application Innovation Competition

As of July 2025, the "Guanghua Cup" Competition has successfully held four editions, collecting over 30,000 Gigabit optical network industry application cases and selecting a total of 469 outstanding exemplary application cases. These cases demonstrate the significant role of Gigabit optical networks in enhancing production efficiency, improving quality of life, and promoting social progress, while also further fostering in-depth cooperation and exchange across industries and sectors.

During the Competition, statistics on submitted cases revealed that the industrial manufacturing sector accounted for the largest proportion of cases and featured the most application scenarios. Consequently, CAICT, in collaboration with China's three major operators, industrial manufacturing enterprises, telecom equipment suppliers, and other industry stakeholders, jointly launched the "Chasing Light Plan - Industrial Pioneering Initiative". The Initiative prioritized the industrial manufacturing sector to further promote the implementation of innovative Gigabit optical network applications. The Initiative primarily encompassed two key tasks:

In advancing optical network construction, the Initiative involved researching and publishing the White Paper on Gigabit Optical Network Construction Guidelines for Industrial Manufacturing Enterprises. This document, with focus on key sectors and typical scenarios, proposes construction targets and network architecture for Gigabit optical networks in industrial manufacturing enterprises to guide their deployment. Additionally, a directory for the Gigabit optical network industrial chain in manufacturing was established and released. This serves as a standardized reference document outlining Gigabit optical network products, solutions, and industry dimensions, assisting enterprises in better deploying Gigabit optical networks and promoting the development of critical links and key directions within the industrial chain.

Regarding industrial ecosystem expansion, the Initiative continuously recruited industry stakeholders from related fields such as AI and edge computing to strengthen and guide collaboration among all parties. Simultaneously, it continually refined the hierarchical evaluation index system for the service experience of Gigabit optical networks in manufacturing enterprises. The release of the White Paper on Service Experience Classification for Gigabit Optical Networks in Industrial Manufacturing Enterprises established a reference and provided support for the digital transformation of enterprises.

Gigabit Optical Network + Smart Manufacturing



01 Zhejiang Autowin Factory: Industrial PON All-Optical Network Lays Foundation for a "Future Factory"

Technical Features:

Guided by the transformation and upgrading of Autowin's "Future Factory", a dual-gigabit intelligent optical network was constructed using Industrial PON, 5G, and MEC, enabling intelligent applications across smart campus, office, and production scenarios.

Application Results:

The project increased production efficiency by 25%, reduced operating costs by 25%, shortened product production cycles by 35%, lowered product defect rates by 25%, and achieved automated production line operations.

Background

As an automotive parts supplier, Autowin faced growing demands for capacity expansion, product diversification, and volatile customer requirements, necessitating a comprehensive digital transformation of both new and old production lines to enable flexible manufacturing. By empowering Autowin's factory with Industrial PON, the solution has established a robust digital foundation and leveraged gigabit optical networking to drive intelligent transformation in manufacturing, thus enabling smart production, controllable quality, and visible delivery timelines, and positioning the facility as a "Future Factory" in the era of intelligent manufacturing.

Application Scenarios

Industrial PON has been deployed across production management, office collaboration, production control, and security monitoring scenarios, fulfilling requirements for machine-to-machine connectivity, integrated production and office operations, online acquisition of energy consumption data in real time, and data visualization and transparency. This addressed critical shortcomings of traditional networks, namely, complex hierarchical architecture, poor reliability, and high latency.

◆ Gigabit Optical Network + Industrial Data Collection: Enabling Efficient Management of Production Data.

PON served as the bearer network for factory workshops, with the OLT deployed in the enterprise data center. Different types of ONUs, such as MDUs and SBUs, were selected based on the specific access requirements of workshop equipment. Using the passive optical splitters for hierarchical networking, the system enabled real-time, online data acquisition from production machinery.

◆ Gigabit Optical Network + Network Slicing: Facilitating Coordination between Production and Office Operations.

The architecture, primarily enabled by OLT slicing technology, comprised a production management network and a collaborative office network. The production management network hosted industrial software for production process control, including ERP, MES, APS, PLM, and WMS, while the collaborative office network supported enterprise applications such as video conferencing, OA systems, SRM, and CRM.

◆ Gigabit Optical Network + Security Management: Implementing All-Optical Networking for Campus Security.

The video access network employed the PON as the access network for enterprise video surveillance, with ONUs deployed across the facility and interconnected via passive optical splitters. Each ONU aggregated video streams from single or multiple cameras as well as signals from access control, barrier gates, and attendance systems, enabling an all-optical network for security devices throughout the facility.

◆ Gigabit Optical Network + AI Inspection: Achieving Production Cost Reduction and Efficiency Improvement.

Leveraging gigabit optical networking, the facility employed AI technologies, including machine vision, posture recognition, and anomalous behavior analytics and alerting, to enable real-time monitoring, automated issue identification, and proactive alerts across four domains: security, regulatory implementation, quality inspection, and production process management.

Gigabit Optical Network + Smart Healthcare



02 Qilu Hospital of Shandong University: Gigabit Optical Network + Multi-Technology Integrated Innovation Empowers Smart Hospital Transformation

Technical Features:

The hospital has deployed an all-optical network to deliver high-bandwidth, highly reliable connectivity across all key areas, including clinical outpatient and inpatient wards, administrative areas, and the imaging center.

Application Results:

Both equipment failure rate and overall energy consumption were reduced by approximately 30%; O&M workload decreased by 50%; The DICOM image retrieval time was significantly shortened: loading more than 30 images now takes less than 5 seconds, down from over 15 seconds.

Background

Qilu Hospital of Shandong University has seen continuous growth in outpatient/emergency visits, surgical procedures, and advanced clinical applications. At the network layer, access port speeds were inadequate due to aging structured cabling. At the application layer, unmanaged deployment of numerous terminals (e.g., self-service kiosks and vital sign monitors) has led to ad hoc cabling, creating complex wiring that cannot support massive data flows. Following cloud migration of hospital systems, the high-volume north-south traffic (especially medical imaging data) demanded a high-bandwidth, low-latency network.

Application Scenarios

Different PON technologies were selected based on specific requirements: GPON was deployed in patient wards and administrative areas, while in the imaging center, where high bandwidth was required, the symmetric XGS-PON was adopted to deliver 10 Gbps symmetrical bandwidth, supporting real-time transmission of CT and other medical imaging data and ensuring low-latency, high-throughput north-south traffic.

◆ Gigabit Optical Network + Registration, Billing, and Pharmacy Windows

Data services (e.g., PCs, APs, and printers), voice services (e.g., IP phones and traditional phones), and multicast/broadcast services (e.g., IPTV, information release systems and queuing systems) were supported. The number of access information points typically averaged 4 to 8 points per window.



▲ Figure 1-29: Fiber to the Pharmacy Deployment Scenario

◆ Gigabit Optical Network + Ward Areas

Composite fiber-optic cables were deployed alongside 5G and WiFi6 into patient rooms, enabling remote centralized power supply with enhanced reliability and safety, with a power transmission distance exceeding 200 meters. WiFi6 ONUs were tailored for all application scenarios in wards.

◆ Gigabit Optical Network + Cutting-Edge Applications

In advanced domains such as imaging consortiums for remote teaching and research systems and tele-diagnostics, Gigabit Optical Network was deeply integrated with various innovative technologies at Qilu Hospital. This enhanced clinical efficiency, improved operational management, reduced IT infrastructure investment and maintenance costs, and elevated the patient care experience.

Gigabit Optical Network + Smart Education



03 Huaihua Education Network: Gigabit Optical Network Facilitates Upgrade of Digital Education Service System

Technical Features:

Based on an integrated architecture of "Cloud + Gigabit Optical Network + IoT Terminals + Specialized Applications", the project featured wired and wireless integration, and implemented a unified network management platform as well as a unified audio-video management platform.

Application Results:

The project effectively supported the operation of new digital education hardware on campuses, significantly improving the network experience for teachers and students. Attainable in-classroom network speeds reached 900 Mbps. The unified audio-video dispatch platform has integrated all cameras and broadcast systems from schools.

Background

Hongjiang District of Huaihua City comprises 14 primary and secondary schools. While all campuses are now fully connected, common issues include insufficient bandwidth due to the widespread adoption of smart education devices, aging campus cabling, and difficulties in maintaining network equipment. In response to these challenges and driven by the advancement of gigabit optical networking, a High-Quality Education Network has been developed. Leveraging the Gigabit Optical Network technology, it provided campuses with high-bandwidth, low-latency network services, advancing education informatization and digitalization in Hunan.

Application Scenarios

By incorporating the gigabit optical network with advanced technologies such as AI, IoT, and big data, the solution has addressed campus audiovisual and network management requirements, enabling comprehensive surveillance across all campus scenarios and ensuring that management has comprehensive reach into classrooms and offices, and allowed all campus network equipment to be managed through a single unified platform.

◆ Gigabit Optical Network + Smart Campus: Enabling High-Speed Education Network Access.

The underlying network of the High-Quality Education Network was built upon the high-quality OTN networks already deployed at the provincial, municipal, and county levels. Miniaturized OLTs were deployed at the school level, with optical splitters extending connectivity down to individual classrooms and 10 Gigabit Ethernet links interfacing with the campuses' existing aggregation switches, delivering high-speed all-optical network services to K-12 and preschool institutions. Classrooms adopted white-box ONT terminals for access.

◆ Gigabit Optical Network + Audio-Video Management: Integrated Control of Campus Surveillance and Audio Broadcasting.

The Unified Network and Audio-Video Management Platform provided schools with integrated control over campus surveillance and audio broadcasting, along with unified maintenance of network equipment. The audio-video platform allowed for real-time monitoring of visitor movement trajectories through campus surveillance feeds. When issues are detected on campus, the audio broadcast function can be used to trigger alarms via speakers in the specific location of the incident, facilitating timely warnings for the school. The Audio-Video Management Center supported both PC and mobile clients, enabling quick monitoring anytime, anywhere. Furthermore, the Unified Network and Audio-Video Management Platform fully leveraged existing campus surveillance cameras and the monitoring network, without compromising original surveillance effectiveness or usage patterns.



▲ Figure 1-30: Unified Network and Audio-Video Management Platform

Gigabit Optical Network + Digital Government



04 Shandong "Yellow River Private Network": Gigabit Optical Network and Cloud Integration Empowers Smart Water Management

Technical Features:

The "Yellow River Private Network" is an intelligent core for the Yellow River basin. It operates as a connectivity pipeline between the cloud and endpoints, delivering integrated services that combine "connectivity + computing + data + intelligence".

Application Results:

Focusing on water resources, the project fostered more intelligent project scheduling, more efficient water management, and a more harmonious relationship between people and water. This achieved systematic operations, intelligent applications, and socialized services.

Background

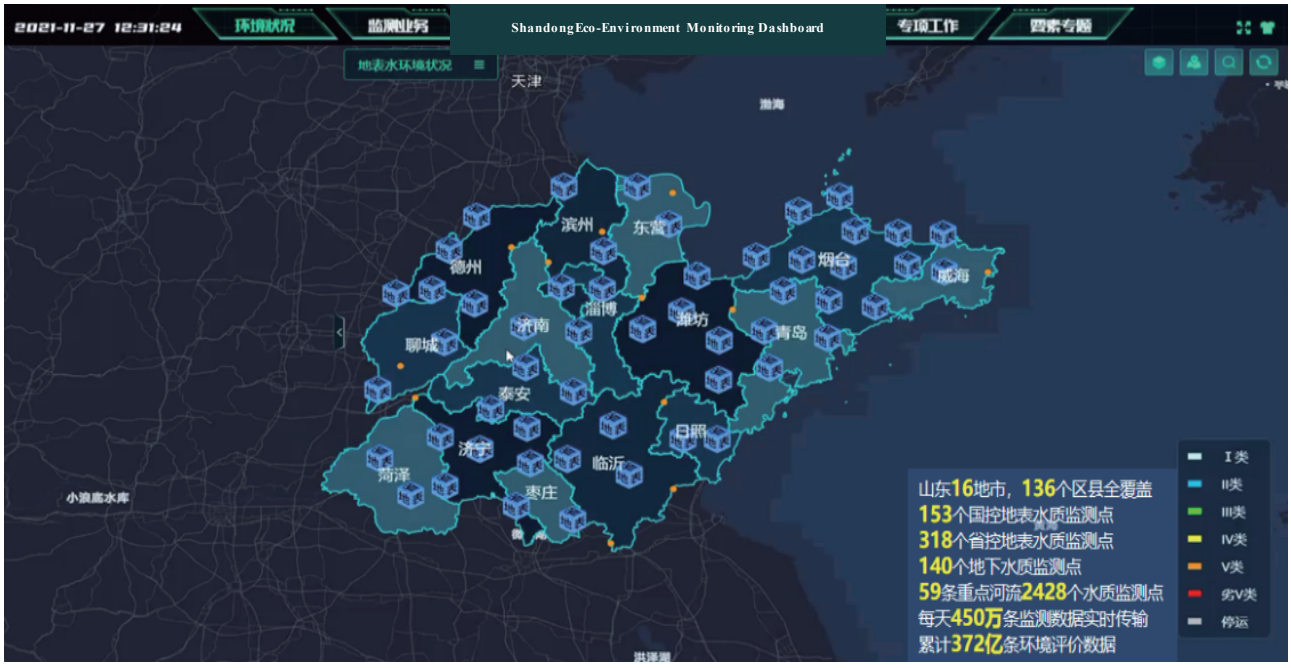
There exists a significant interdependence between water resources and energy, particularly in the Yellow River Basin where there is a severe mismatch between land and water resources. The basin's area accounts for 8.3% of the national territory, yet its total water resources represent only 2% of the country's total, while supporting 15% of its arable land, 12% of its population, and 14% of its economic output. Shandong Province has been advancing the construction of smart water management and has established the "Smart Yellow River" digital platform. It pioneered the establishment of a dedicated network for ecological conservation and high-quality development in the Yellow River Basin, which was initially deployed across 9 cities and 25 counties along the Yellow River.

Application Scenarios

Built upon an OTN network infrastructure, the "Yellow River Private Network" overcame the limitations of traditional communication technologies, which fail to support cross-jurisdictional water resource interconnection, reservoir-to-reservoir linkage, and river-to-river integration. This "1+N+X" dedicated network for ecological conservation and high-quality development in the Yellow River Basin delivered advanced capabilities including centralized management, network slicing, all-optical scheduling, and deep coverage.

◆ Gigabit Optical Network + Environmental Monitoring: Developing a Dashboard for Eco-Environment Monitoring.

The "Yellow River Private Network" emphasized "flexibility, intelligence, efficiency, rapid deployment responsiveness, and high reliability" in networking, with a focus on the integration capability of the entire network. It aimed to build interconnectivity for the Yellow River Private Network, enhance communication efficiency, and stimulate innovation among enterprises in the Yellow River Economic Belt. This interconnectivity was reflected in two aspects: first, the ability to interconnect with existing private networks, and second, the capability for cross-domain connectivity with various clouds. By empowering IoT and big data through the all-optical network, a unified eco-environment monitoring dashboard was developed, optimizing water quality monitoring and enabling unmanned supervision.



▲ Figure 1-31: Shandong Eco-Environment Monitoring Platform

◆ Gigabit Optical Network + Smart Environmental Protection: Enabling Precise Pollution Prevention and Control.

By utilizing satellite remote sensing data to obtain water transparency and leveraging the computational power of supercomputing centers, polluted water areas were identified, enabling rapid and accurate tracing of water pollution sources. This achieved the integration and visual management of fundamental environmental data based on GIS spatiotemporal dimensions; core foundational data for comprehensive eco-environment management and monitoring operations; an AI-powered video surveillance analysis application system; a remote sensing monitoring system for urban black and odorous water bodies; and applications such as the integrated monitoring system for VOCs pollution source and governance in Jining City.

Gigabit Optical Network + Digital Finance



05 Guosheng Securities: Gigabit Optical Network Facilitates Digital-Intelligent Transformation

Technical Features:

Guosheng Securities has leveraged OTN premium private lines to support the network upgrade of Guosheng Securities' disaster recovery center, enabling intelligent digital transformation of the interconnections among its "two-site, three-center" data facilities and all branch offices across Jiangxi Province.

Application Results:

Centralized transaction was completed within 5 minutes. Local data synchronization time was reduced from the original 11 hours to 5 hours, and remote synchronization time was shortened from 34 hours to 15 hours.

Background

High-quality development in the securities industry demands not only ultra-low network latency but also sub-second fault switchover to ensure uninterrupted business operations. Highly available, low-latency networking is therefore critical for real-time disaster recovery in securities trading environments. In recent years, Guosheng Securities has continuously increased its investment in information technology, fully leveraging fintech enablers, such as big data, artificial intelligence, and cloud computing, to drive business growth and enhance both customer experience and operational efficiency. Guosheng Securities' data centers faced mounting challenges, including high O&M difficulty, elevated operating costs, imbalanced resource utilization, and insufficient security management capabilities. These issues have significantly increased pressure on O&M teams, creating an urgent need for next-generation ICT infrastructure exemplified by gigabit optical networking to provide robust support.

Application Scenarios

◆ Gigabit Optical Network + Digital Finance: Enabling Digital and Intelligent Financial Management.

By deploying OTN premium private lines to upgrade Guosheng Securities' disaster recovery network, all connections with the client's two data centers and three computer rooms and between its branch offices across Jiangxi Province were enhanced with OTN premium private lines. This optimization reduced local data synchronization time from 11 hours to 5 hours, and remote synchronization from 34 hours to 15 hours. Hot standby data disaster recovery latency was maintained below 2.5 ms. Intelligent decision-making was upgraded with Nanchang as the central node and branches as endpoints, allowing swift responses to automated security commands and safeguarding core data integrity and confidentiality.

Compared to the previous MSTP lines, the new system eliminated the outdated practice of requiring eight personnel to manually complete switching operations in 30 minutes. Simultaneously, operations were upgraded to intelligent management, optimizing branch functions and gradually introducing digital services such as online account opening, trading strategy tools, and 24/7 online customer support. These

improve ments significantly enhanced customer experience and operational efficiency, reduced costs and workload, freed up human resources, and resolved issues of prolonged processing times and staff shortages at branches, driving their digital transformation. By deploying OTN private lines, the client's network architecture was continuously optimized, reducing overall latency by 30% and ensuring seamless high-frequency transaction. Customer monitoring capabilities were enhanced, enabling timely alerts for anomalies—for instance, reducing the delay for failed account opening notifications from 15 mins to 10 s.

Gigabit Optical Network + Smart City



06 Shanghai All-Optical Smart City: Gigabit Optical Network Empowers Urban Development

Technical Features:

The construction of an all-optical network was comprehensively advanced to create an all-optical city architecture characterized by ultra-large bandwidth, ultra-low latency, and advanced reliability. It supported Shanghai's urban digital transformation, aiming to build it into the world's premier all-optical smart city.

Application Results:

The project established the world's largest OXC all-optical cross-connect metropolitan area network, comprising 34 optical switching nodes. This saved 190 200G wavelength transitions and corresponding equipment room energy consumption, significantly reducing network construction investment and lowering energy consumption by 30%.

Background

Shanghai is comprehensively advancing urban digital transformation and continuously enhancing its "dual-gigabit" network capabilities. However, limited by challenges such as insufficient OTN network coverage and high comprehensive deployment costs, OTN all-optical networks are now primarily applied in digital scenarios for leading government and enterprise sectors, including public services and finance. Extending the quality experience of OTN to benefit all industries and achieving further prosperous development of the optical network industry has become a core issue actively explored by the upstream and downstream sectors.

Application Scenarios

The Shanghai Mobile All-Optical Smart City, built upon gigabit optical networking, has been widely adopted across sectors such as finance, government services, healthcare, and large enterprises, providing OTN premium private network services to support Shanghai's urban digital transformation.

◆ Gigabit Optical Network + Digital Governance: Enabling Smart Urban Management.

While developing initiatives like "One-stop Online Government Services", "One Net For All", intelligent security, and government cloud reform, the Shanghai government established a robust gigabit optical city network to support the external e-government network, addressing challenges such as enhancing network performance, increasing bandwidth, centralizing data, and integrating private networks. Utilizing OTN technology and a "Dual-Plane Single Network" architecture, it not only resolves issues like insufficient government fiber resources and inadequate network security but also endows the network with high reliability, simplified maintenance, and easy scalability, building an all-optical foundation for urban digital transformation.

◆ Gigabit Optical Network + Smart Media: Enabling Digital Media Upgrades.

As a global hub for mainstream media, Shanghai is accelerating the digital transformation of its media industry. UHD live broadcasting has become a key competitive differentiator for media coverage. However, UHD live streaming requires uncompressed real-time transmission of video data and code streams, posing high demands on the transmission network. Shanghai Qingpu Radio and Television Station, relying on gigabit optical networking, implemented its digital transformation by enabling unified, uncompressed uploads of video streams from outdoor broadcasts, OB vans, UAVs, and indoor studios to the cloud. This facilitated video production, rendering, cloud media asset storage, and multi-channel distribution, significantly enhancing UHD live streaming capabilities and delivering a superior viewing experience.

Gigabit Optical Network +Information Consumption



07 Beijing Winter Olympics Community: FTTR Broadband Network Deployment for the Winter Olympics Community

Technical Features:

By replacing traditional copper Ethernet cabling with fiber optics for WiFi networking, and deploying a master-slave ONT MESH topology, gigabit broadband and gigabit Wi-Fi were extended to every room, office, and even desktop.

Application Results:

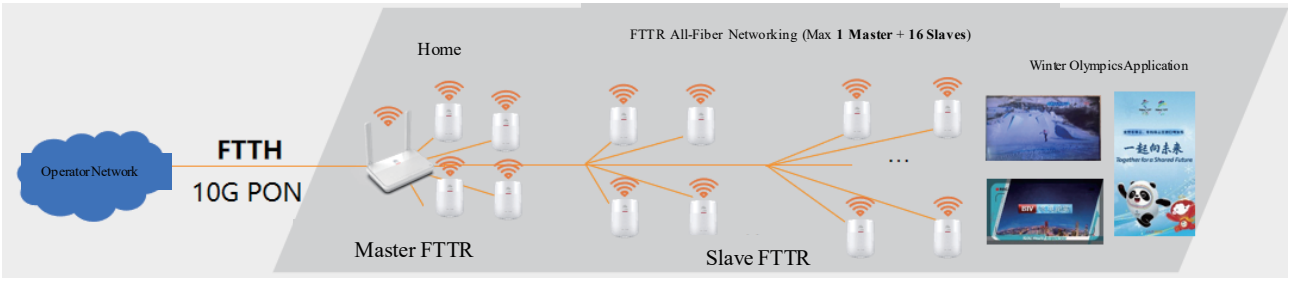
The failure rate for users of the FTTR networking solution decreased by nearly 65% compared to other terminal equipment, significantly improving the user experience.

Background

While broadband service speeds in Beijing have reached gigabit levels, the actual user experience varies significantly depending on household layout and the capabilities of the Wi-Fi extension equipment. Practical research identifies two core pain points for home broadband. First, achieving comprehensive Wi-Fi coverage is difficult due to significant interference; Wi-Fi often only covers limited areas with many dead zones. Second, traditional cabling is unreliable and difficult to upgrade. A new approach and set of products for home networking are required to fundamentally address the gap between users' actual experienced throughput and the network's provisioned access speed.

Application Scenarios

Beijing built an all-optical foundation that provided a high-bandwidth, highly reliable, zero-packet-loss, low-latency 8K UHD transport network for the Winter Olympics, perfectly meeting the bandwidth requirements of the video transmission network. Leveraging the fundamental advantage of a whole-home unified network and the network management capabilities and interfaces provided by FTTR equipment manufacturers, operator-grade intelligent operations were established. This enabled visibility, manageability, and maintainability of the home network, reducing failure rates and improving service quality.



▲ Figure 1-32: All-Optical Connectivity

◆ Gigabit Optical Network + Winter Olympics Community: Delivering an Ultimate Gigabit Network Experience.

The officially designated Winter Olympics Community serves as a model for Beijing's "Three-Gigabit" communities. Using this community as a pilot, an FTTR whole-home optical network was deployed, providing dedicated 1000 Mbps broadband access, 1000 Mbps 5G mobile access, and 1000 Mbps Wi-Fi wireless access via the FTTR all-optical network, enabling residents to enjoy the high-quality broadband services of the Winter Olympics.

◆ Gigabit Optical Network + Customized Networking: Enabling Tailored FTTR Services.

Beijing's basic telecom enterprises launched in-home network testing services. Customers can simply schedule an appointment with one click to receive professional inspection services from smart home engineers. These engineers communicate with customers to understand their needs, learn about household internet usage habits and network layout, and conduct on-site evaluations. They then create personalized FTTR networking solutions tailored to different home layouts and wiring requirements, delivering the optimal online experience.

Gigabit Optical Network + Transportation



08 Shandong Ocean Strategy Private Network: Facilitating Marine Sci-Tech Innovation

Technical Features:

The project adopted an integrated F5G + 5G solution, featuring ultra-high bandwidth, ultra-high reliability, ultra-low latency, and extreme simplicity & energy efficiency.

Application Results:

The integration of the gigabit optical network with technologies like 5G, machine vision, AI, and cloud platforms enabled the creation of a comprehensive, diversified intelligent system that can drive social services, reduce labor costs, and enhance management capabilities.

Background

Shandong Province is a major fisheries powerhouse with abundant marine resources and a rapidly growing marine economy, offering vast economic potential. The urgent advancement of marine informatization and digitalization now demands a robust, high-capacity network infrastructure as a foundational enabler.

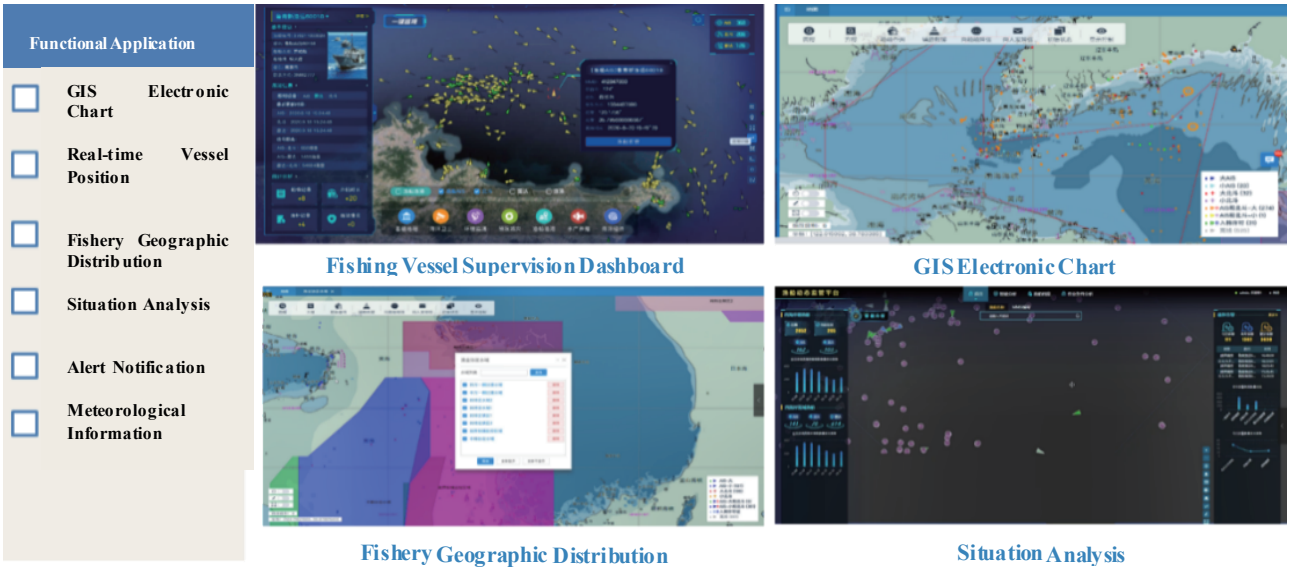
Application Scenarios

◆ Gigabit Optical Network + Marine Supercomputing: High-Quality Transport Network Supports Marine Supercomputing Network.

The National Laboratory of Marine Science and Technology's supercomputing network construction project established a high-quality, on-demand computing power network within the province featuring a 4ms low-latency circle, providing 99.999% network availability. It built a flexible and elastic supercomputing network with gigabit optical network bandwidth, offering more substantial computational support for scientific research applications such as earth simulation, ocean forecasting, and the "Blue Drug Bank".

◆ Gigabit Optical Network + Smart Fishing Port: Meeting Fishing Vessel Safety Supervision Needs.

Upon completion, the Smart Fishing Port platform developed a dashboard for monitoring all fishing vessels in the region. To address the comprehensive management needs of fishing vessel safety supervision, it consolidates multi-dimensional attributes such as vessels, crew, ports, and environment to build a multi-dimensional situational map for marine fishery law enforcement, supporting intelligent control and decision-making. It provides overall situational analysis of vessel registration port management (in-port status, port of registry, return rate, non-returning vessels), total vessel count, numbers of various vessel types, online equipment count, alarm numbers, and vessel traffic at various ports or anchorages. This enables rapid generation of management, dispatch, and emergency command recommendations to better ensure the safety of fishing vessel operations.

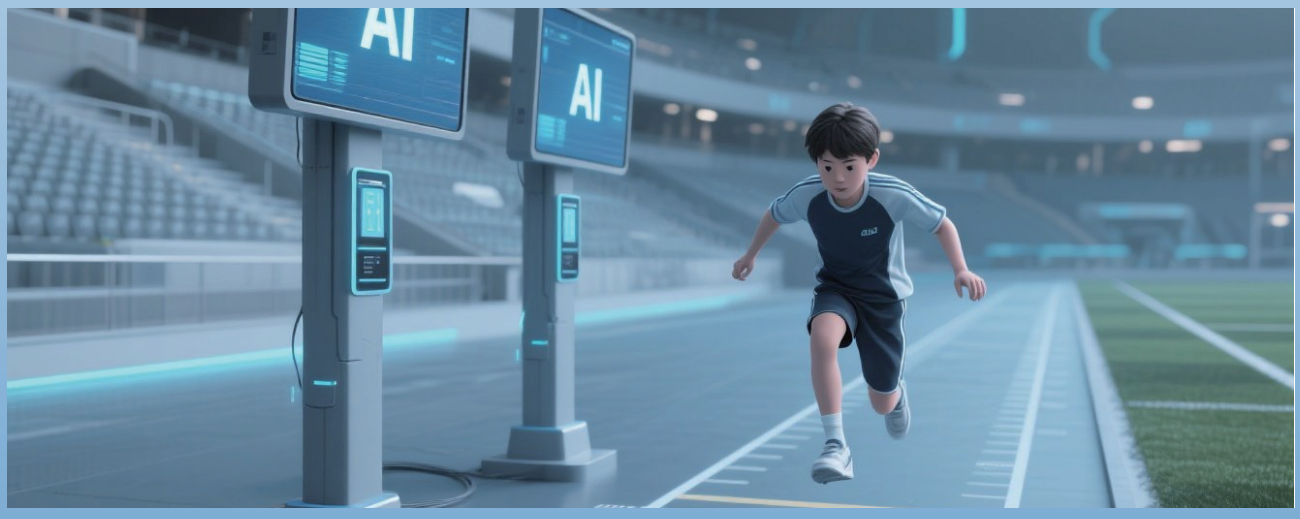


▲ Figure 1-33: Smart Fishing Port

◆ Gigabit Optical Network + Marine Ranching: Enabling Digital Management of Aquatic Product Growth.

The intelligent optical network backbone supports specialized functions including underwater vision, AI intelligent analysis, and feed dispensing. It contributes to the construction of the first national-level "Dual Gigabit" + Marine Ranching project—"Changyu No.1"—by directly collecting growth data of aquatic products. This enables more effective management of aquaculture quality in ranch waters, allows for scientific adjustment of feeding plans, and utilizes equipped wind-powered automatic feeders to improve feed utilization while meeting automated aquaculture requirements.

Gigabit Optical Network + Culture and Sports



09 Henan Museum: Gigabit Optical Network Brings Cultural Relics to Life

Technical Features:

A Gigabit Optical Network + Smart Cultural Tourism Cloud Platform was established to enable the intelligent allocation and information aggregation of resources related to the people (the public), objects (collections), operations (museum management), and industry (cultural and tourism ecosystems).

Application Results:

The diverse range of innovative cultural relic experience programs has cumulatively served over 1 million visitors, promoted the open sharing of digital cultural assets, and stimulated growth across upstream sectors (e.g., cultural equipment manufacturing and 3D printing) and downstream industries (e.g., education and internet services).

Background

Traditional museums face four main challenges: relatively singular forms of cultural relics presentation, poor interactive experiences for visitors, significant inadequacy in promoting the historical and cultural connotations of relics, and a lack of unified management integrating cultural relics and venues. By leveraging the technical advantages of high bandwidth and low latency of Gigabit Optical Networks, and incorporating technologies like cloud computing, big data, and VR/AR, the project achieved comprehensive information technology empowerment across all museum operations. It created a unified smart museum ecosystem featuring diverse cultural relics display, intelligent cultural innovation services, smart relic protection, and intelligent venue management, thereby enhancing the public visiting experience and interpretation service levels.

Application Scenarios

Leveraging a gigabit all-optical network and integrating ultra-precise modeling, holographic multi-user interaction, and AR/VR technologies, this solution brought cultural relics to life, moving beyond the traditional "viewing-through-glass" paradigm to an immersive, real-time holographic multi-user experience.

◆ Gigabit Optical Network + Cultural Relic Modeling: Enabling Holographic Display of Relics.

Using HD cameras, each relic is captured with 10 to 20 million polygons. The large-bandwidth uplink channel established by XGS symmetric 10G-PON enables rapid uploading of the captured material to the XR converged media platform for digital modeling and rendering. Audio and textual explanations are integrated, and the relic's image is projected into mid-air, bringing the holographic relic to life with dynamic, interactive presence.

◆ Gigabit Optical Network + Cultural Relic Modeling: Enabling Holographic Display of Relics.

When visitors scan a relic using an AR terminal (AR exploration lens), supported by Gigabit Wi-Fi, the relic model on the converged media platform is quickly loaded, allowing for real-time deconstruction and rotation of the digitized model, thus bringing a broader range of artifacts to life before their eyes.



▲ Figure 1-34: AR Exploration Lens + AR Guide

◆ Gigabit Optical Network + Immersive XR: Providing an Immersive Visitor Experience.

Based on the edge computing capabilities (blade computing power and on-demand computing) built into the OLT and immersive XR technology, visitors are transformed from "observers" into "participants". At the Henan Museum, Wang Ximeng's Northern Song Dynasty painting "A Thousand Li of Rivers and Mountains" was digitized and projected into a three-dimensional space the size of a medium meeting room.

Gigabit Optical Network + Digital Village



10 Jilin Agricultural Investment Group: Gigabit Optical Network Facilitates Smart Cattle Farming

Technical Features:

The project leveraged gigabit optical networking, cloud-network integration, and comprehensive digital service capabilities, as well as blockchain technology, to create a digital platform for biological asset management, achieving a novel integration of intelligent technology with the traditional breeding industry.

Application Results:

The platform currently covers 242 pasture farmers, managing 21,738 cattle in total. The project has achieved a total financing scale of 290 million yuan, with cumulative revenue reaching 60 million yuan.

Background

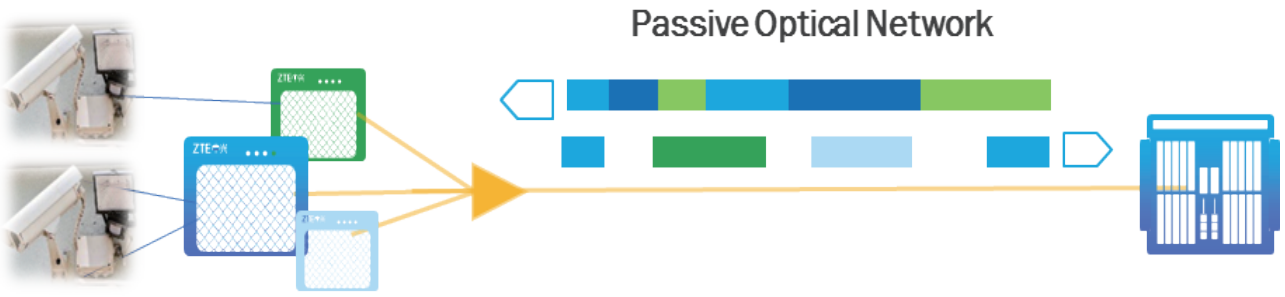
To support rural revitalization and industry-driven poverty alleviation, the solution addressed farmers' critical gaps in financing, technology, and market access by establishing a new "Digital Cattle Industry" chain. Built on the robust digital foundation of gigabit optical networking and integrating NB-IoT, Wi-Fi, and 5G for comprehensive connectivity, it leveraged AI, big data, and cloud computing to deploy two key platforms, implemented across three core scenarios and four targeted applications.

Application Scenarios

In professional farming scenarios, an integrated model has been established combining Industrial PON enterprise intranets, 5G industry private networks, Tianyi Cloud and digital-intelligent computing platforms, and cattle farming industry applications. Based on all-optical network Industrial PON technology and employing a symmetric XGS-PON solution, a streamlined, converged gigabit fiber network has been uniformly planned and built, extensively covering breeding areas, office zones, storage and transportation areas, and living quarters. This enables unified, integrated access for multiple services and new applications, including wired and wireless communications, video communications, digital security, industrial interconnection, and environmental sensing.

◆ Gigabit Optical Network + Video Surveillance: Enabling Multi-Channel HD AI Video Backhaul.

XGS-PON technology provides 10GE uplink bandwidth capacity, meeting the aggregated traffic demands of multiple HD cameras in this scenario and delivering low latency required for AI applications. The PON P2MP topology is currently the most suitable networking solution for multi-camera access at cattle barn endpoints. The high performance of the passive PON architecture ensures stable and reliable network communication in rural areas, even under harsh natural conditions such as wind, rain, extreme heat, cold, electromagnetic interference, and lightning strikes, thereby guaranteeing stable and reliable video backhaul and quality.



▲ Figure 1-35: Real-time Multi-channel HD AI Video Backhaul

◆ Gigabit Optical Network + Data Collection: Enabling Optical Network Backhaul from Cattle-mounted Devices.

Cattle-mounted devices connect wirelessly via Wi-Fi, Bluetooth, and NB to small IoT base stations installed near cattle barns. These base stations backhaul data through the PON access network and ultimately connect to the digital cattle farming platform via the Gigabit Optical Network, addressing the challenge of high-frequency big data collection from frequently moving live cattle.



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03

Digital Development Acceleration Toolkit for Developing Countries

Universal Service

2025

Universal Service

The Chinese government places a high priority on rural broadband network construction and steadfastly implements national strategic directives, continuously promoting the universal telecommunication service (UTS). From the early "Connecting Every Village" initiative, which brought the first glimmer of connectivity to remote areas and laid the groundwork for formal pilot programs, to large-scale fiber-based universal service that built national information highways, followed by mobile universal service that rapidly eliminated coverage gaps, and now to the current "Broadband Frontier" phase targeting border and special regions, this journey has not only witnessed China's dramatic leap in communications technology, but also demonstrated the nation's unwavering commitment to bridging the urban-rural digital divide, advancing social equity and balanced development, and fostering comprehensive socio-economic progress. It has laid a solid foundation for the telecommunications sector's transition to high-quality development and offered valuable insights and a Chinese approach to global UTS efforts.

With support from the UTS, fiber and mobile broadband networks have rapidly expanded across rural and remote China, fully achieving the goals of "gigabit connectivity in every county, 5G coverage in every township, and broadband access in every village". This has established a critical "information superhighway" linking rural communities to the digital economy, providing robust network infrastructure for the comprehensive advancement of rural revitalization and the acceleration of agricultural and rural modernization.

3.1 Phase of Basic Telephone Network Coverage: The "Connecting Every Village" Initiative

In 2003, nearly 75,000 of China's 694,000 administrative villages had no telecommunications access, representing 10.8% of all administrative villages. To address this situation,China's former Ministry of Information Industry (MII) launched the "Connecting Every Village" Initiative in early 2004. Following the establishment of the Ministry of Industry and Information Technology (MIIT) in 2008, the program was further deepened, with the entire telecommunications sector mobilized to accelerate rural communications and informatization.

Over the decade from 2004 to 2013, China's former MII and later MIIT adhered to the inherent development patterns of rural telecommunications, innovating approaches to ensure the "Connecting Every Village" Initiative was implemented effectively and pragmatically. First, the program adopted a "regional responsibility" model, later transitioning to a "quota-based responsibility" approach. The Chinese government designated basic telecom enterprises to finance, construct, operate, and maintain the "Connecting Every Village" infrastructure in assigned regions under the regional responsibility model. After achieving universal telephone access in all administrative villages, the initiative extended to natural villages, where unconnected settlements were scattered and non-contiguous. The approach thus shifted to a quota-based responsibility model, under which China's basic telecom enterprises committed to fulfilling their construction tasks under the initiative, based on their respective network capabilities and business development strategies. This dual-assignment mechanism effectively motivated enterprises' initiative and accountability, ensuring timely task completion. Second, implementation followed a phased, step-by-step approach: Geographic coverage expanded progressively from townships to administrative villages and then to natural villages; service levels advanced incrementally from basic telephone service to broadband internet access; informatization progressed hierarchically from infrastructure deployment to business platform development and finally to the promotion of agriculture-tailored digital services. Third, cost-effective and adaptable technologies were actively explored. Chinese enterprises were encouraged to flexibly deploy a mix of wired communication, mobile communication, satellite communication, and fixed wireless access

solutions, and to develop and promote affordable technologies and devices. This not only addressed challenges of high costs, long deployment cycles, and difficult construction and maintenance, but also spurred widespread adoption of independently developed, low-cost user terminals in rural areas.

Through a decade of sustained effort, the "Connecting Every Village" Initiative connected 204,000 administrative and natural villages to telephone services and provided broadband access to 111,000 townships and administrative villages. Telephone coverage reached 100% of administrative villages and 95.6% of natural villages, exceeding the national targets set for universal village telephone access and laying a solid foundation for rural ICT development and subsequent UTS efforts.

3.2 Phase of Fiber Broadband Penetration: Fiber-Based UTS

As society continued to advance, basic telephone service alone could no longer meet rural needs in areas such as public welfare and economic development, making broadband access a universal requirement for both urban and rural residents. By the end of 2014, 50,000 administrative villages in China lacked broadband access entirely, and 150,000 had network access speeds below 4 Mbps, underscoring the urgent need to bridge the urban-rural digital divide. However, the construction and O&M of optical networks in rural and remote areas entail high costs and low returns; without policy-level support and guidance, incumbent operators alone would struggle to achieve breakthrough progress.

In October 2015, the Chinese government launched a pilot program for the UTS, targeting administrative villages either without broadband or with access speeds below 12 Mbps, to accelerate fiber broadband deployment in rural and remote areas. Between 2015 and 2018, China implemented three rounds of USO pilots, supporting optical network construction in 130,000 administrative villages across 27 provinces (autonomous regions and centrally administered municipalities), spanning over 240 prefecture-level and more than 1,600 county-level administrative divisions. China Telecom, China Mobile, China Unicom, and China Broadcasting Network, the four basic telecom enterprises, actively undertook the pilot construction projects.

By the end of the 14th Five-Year Plan, fiber broadband coverage in administrative villages and poverty-stricken villages had risen from below 70% and 62% in 2015 to over 98%, with the Xizang Autonomous Region

surging from 4% to 99%. In deeply impoverished areas, coverage jumped from under 26% to 87% by 2018 and exceeded 98% by 2020. As a result, fiber optic connectivity has been essentially achieved in all of China's administrative villages, laying the groundwork for rural broadband speed upgrades.

3.3 Phase of Deep Mobile Network Coverage: Mobile UTS

Building on the nationwide rollout of fiber optic coverage, the Chinese government further deepened its UTS pilot program, commencing in 2018 with a focus on 4G base station construction in administrative villages, border regions, and island areas to provide robust support for the realization of a moderately prosperous society in all respects. As of the end of November 2021, all 510,000 village-level administrative units in China had broadband access, with coverage in both administrative villages and poverty-stricken villages reaching 100%, achieving dynamic zero clearance of villages without broadband. Additionally, 4G coverage in administrative villages exceeded 99%, and signal quality was significantly enhanced in densely populated village clusters, resettlement sites, state farms, and forest stations.

Against the backdrop of contiguous 5G coverage in urban areas, the construction of 5G networks in rural regions has become a key focus for all stakeholders. The Chinese government has continued to refine and strengthen the UTS compensation mechanism, launching a new round of UTS projects in 2022 with enhanced support for rural 5G network construction. Basic telecom enterprises were encouraged to build 5G networks in rural areas, progressively expanding coverage and improving network quality. As of the end of February 2025, 5G coverage has been extended to over 90% of administrative villages. Fiber, 4G, and 5G networks in rural and remote areas now deliver high-quality connectivity, effectively supporting critical services such as education, healthcare, and e-commerce, and contributing to socio-economic development.

3.4 Phase of Frontier Connectivity Advancement: The "Broadband Frontier" Initiative

Border and island areas have long faced challenges such as high construction and operational costs. Since 2018, China's UTS pilot programs have continuously supported network infrastructure development in these areas. To further enhance network supply capacity in border areas, fully leverage the enabling role of broadband infrastructure, improve living and working conditions for all ethnic groups, and support the national strategies of "prospering border areas and enriching residents" and "stabilizing and consolidating border areas", the Chinese government has issued dedicated policy documents to advance the "Broadband Frontier" initiative.

MIIT and the Ministry of Finance have jointly incorporated the construction needs under the "Broadband Frontier" initiative, intensifying support within the UTS framework for 140 land-border counties (cities, districts, and banners) across nine frontier provinces—including Inner Mongolia, Liaoning, Jilin, Heilongjiang, Guangxi, Yunnan, Xizang, Gansu, and Xinjiang—and 58 border regiments of the Xinjiang Production and Construction Corps, to actively address the urgent network coverage needs in these areas characterized by high construction costs and harsh natural conditions.

China Telecom: Rural Broadband Network Construction Project in Xizang

Background

Xizang is located in southwestern China, with an average altitude exceeding 4,000 m and a vast area of 1.2028 million km2. It is sparsely populated and is often referred to as the "Roof of the World". Due to natural conditions and historical reasons, Xizang was once the region in China with the highest poverty incidence, the most severe poverty depth, the highest poverty alleviation costs, and the greatest difficulty in lifting people out of poverty. By the end of 2015, the fiber broadband coverage rate in Xizang's administrative villages (communities) stood at only 4%, while 4G network coverage was virtually nonexistent.

Application Results

Since 2016, eleven batches of UTS pilot projects have been implemented in Xizang. To overcome severe natural constraints, Xizang' s basic telecom enterprises employed methods such as using bulldozers to clear and excavate paths for erecting communication poles. In areas where commercial grid power was unavailable, they utilized solar panels or alternative methods for power supply, and manually transported routine maintenance materials required for base stations. Ultimately, fiber-optic broadband was deployed to 5,433 administrative villages (settlements) across the Xizang Autonomous Region, and 4G networks were activated in 5,393 administrative villages (settlements), with access speeds averaging over 50 Mbps.



▲ Figure 1-36: Workers from the Chinese basic telecom enterprises Transporting Base Station Equipment and Other Supplies

With the support of UTS, the fiber optic coverage rate in administrative villages across Xizang has increased from 33% to 100%, while 4G network coverage has risen from zero to full availability, marking the highest nationwide increase. This represents a monumental leap from no connectivity to comprehensive, high-quality optical network coverage in Xizang's farming and pastoral areas, effectively linking the Qinghai-Xizang Plateau with the rest of the world.

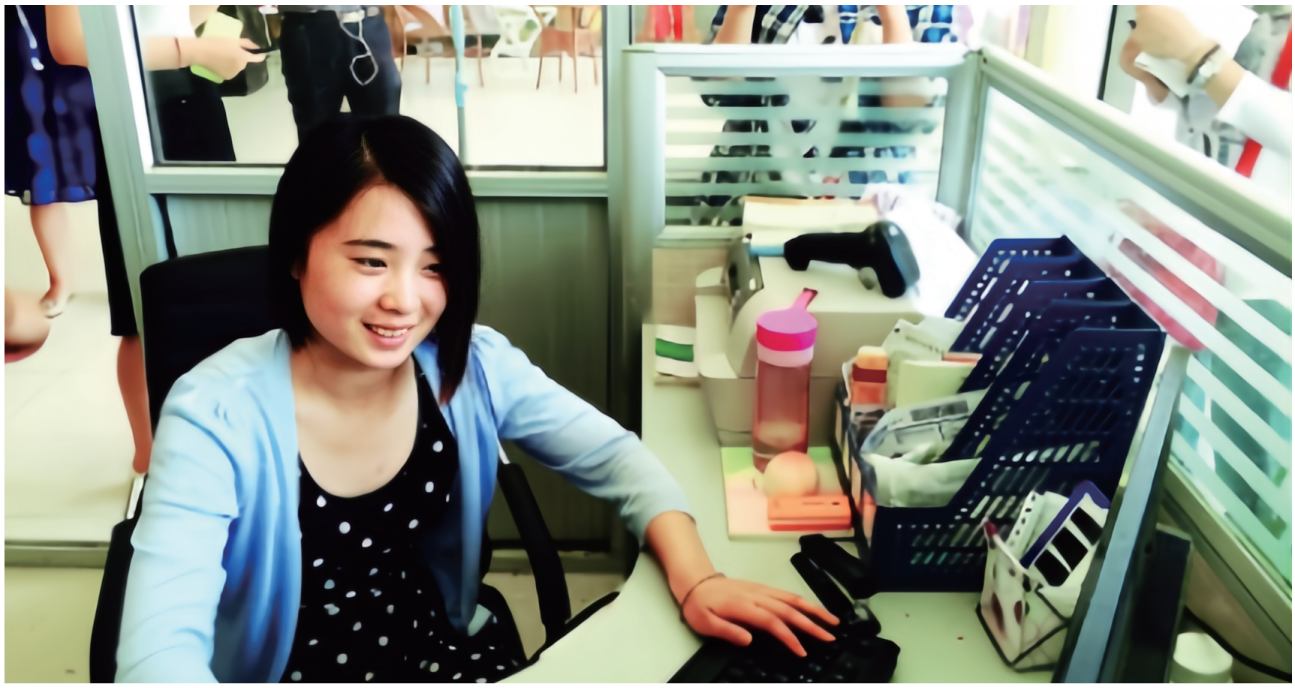
China Unicom: "Optical Network" Empowers Taobao Village Project

Background

Cao County, Heze City, Shandong Province, is located in the relatively underdeveloped southwestern region of Shandong Province. Daji Town, a traditional agricultural township situated 15 km southeast of Cao County's urban area, was connected to the outside world only by a single county-level road linking neighboring towns. Its remote location has resulted in extremely low network penetration. Before the rise of e-commerce, Daji Town in Cao County gradually developed a cluster of enterprises specializing in photo studio attire and dance performance costumes. However, due to highly dispersed customers and fragmented orders, industrial growth remained extremely slow.

Application Results

Through the implementation of UTS, high-speed optical fiber broadband provided robust support for villagers' innovation and entrepreneurship. The previously little-known Daji Town gained prominence in the e-commerce sector, with various e-commerce companies springing up. Currently, nearly all residents in the administrative villages of Daji Town, Cao County, are engaged in e-commerce, primarily involved in the production and manufacturing of performance costumes, theatrical attire, dancewear, etc. The town is now home to over ten thousand online shops. In the famous Dinglou Village, a "Taobao Village" with an annual turnover exceeding 100 million yuan, 35 costume processing households achieve annual sales revenues of over 1 million yuan each, with more than 10 households exceeding 5 million yuan. Over 160 processing households have established their own companies, fully embodying the wave of "mass entrepreneurship and innovation" unleashed by the optical network.



▲ Figure 1-37: Employees in the Taobao Village, Cao County

With a GDP of RMB 48.701 billion, Cao County in Heze City, Shandong Province, leads all districts and counties in Heze and ranks at the forefront of the city's economic development. It has not only accelerated its economic development through industrial upgrading, digital transformation, and cultural innovation, but has also further propelled its economic takeoff by implementing innovative government services and attracting talent back to the region.

China Mobile: Sansha Broadband Network Construction Project

Background

Sansha City is the southernmost prefecture-level city in China, with the largest total area (including sea area), the smallest land area, and the smallest population. It is the second prefecture-level administrative division in China, after Zhoushan City in Zhejiang Province, to be established on an archipelago. Sansha is situated on the golden waterway connecting China to the Indian Ocean, boasting a highly strategic location and serving as a crucial hub for the "Maritime Silk Road". The South China Sea area, where it is located, is a massive "treasure basin", abundant in plant, biological, and energy resources. However, Sansha City experiences year-round high temperatures, high humidity, and high corrosion. It faces complex sea conditions, frequent typhoons, and inconvenient transportation. These geographical conditions and natural environment pose severe challenges to all stages of network infrastructure development, including site surveys, equipment transportation, and construction.

Application Results

The Chinese government engaged in multiple discussions with basic telecom enterprises to find solutions. Ultimately, they overcame a series of construction difficulties by modifying the design plan, adjusting construction sites, and using temporary generator sets to address power supply issues. With the full support of the central government and related stationed island units, 4G base stations were finally activated on the pilot islands and reefs in September 2019, with some also deploying 5G base stations, effectively enhancing local network service quality. Simultaneously, China Mobile deployed shipborne mobile base stations, achieving mobile network coverage during navigation.



▲ Figure 1-38: China Mobile Employees Performing Network Line Maintenance in Sansha

The comprehensive activation of 4G/5G stations under the UTS in Sansha's island and reef areas has facilitated the deeper implementation of applications such as telemedicine and unmanned smart service halls. This provides residents on the islands and reefs, as well as passing vessels, with higher-quality mobile communication services and enhances their production and living experience.

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