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Build Platforms, Drive Cooperation, Respect Boundaries, and Develop Ecosystems

Huawei is committed to empowering Smart Cities to build 'nervous systems' able to provide holistic solutions that support complex technical integrations and the development of partner ecosystems to deliver an intelligent, fully connected society.

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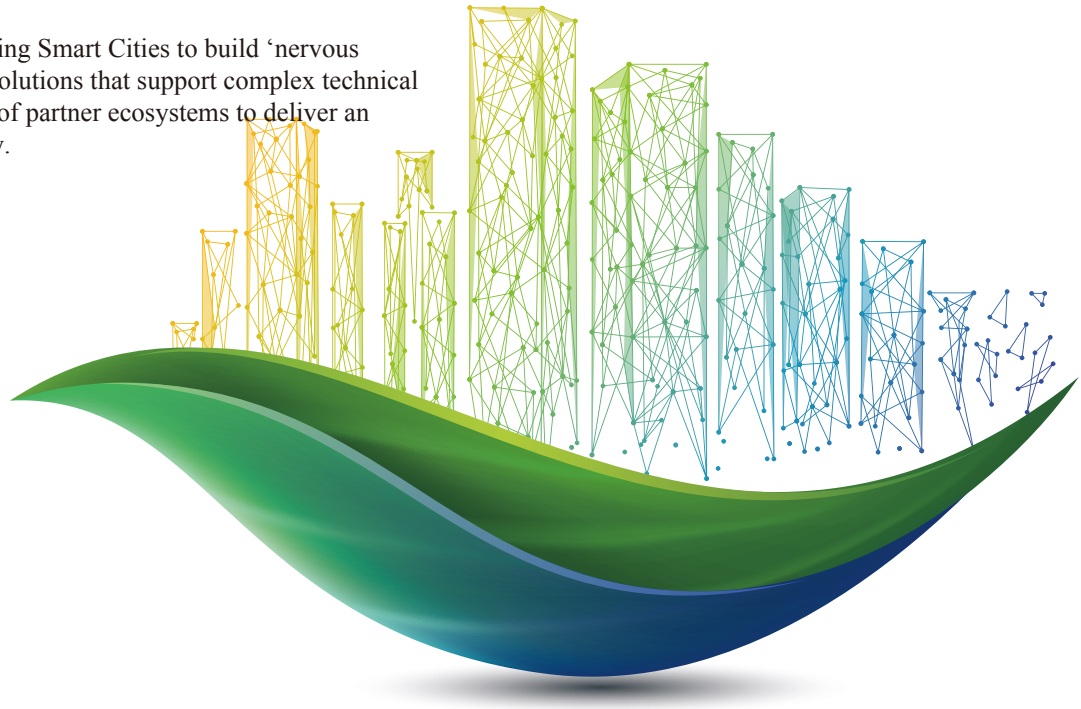

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Leading New ICT: **Creating a Smart City 'Nervous System'**

By *Yan Lida, President, Enterprise Business Group, Huawei Technologies Co., Ltd.*

The first Agricultural Revolution transformed human societies from hunting and gathering to farming animals and crops. From agriculture, civilizations grew and centuries later the Industrial Revolution introduced industrialization that changed social, cultural, and economic conditions and enabled rural societies to become industrial and urban. More recently the emergence of the Information Age, which is defined by digital technologies, is driving social and economic evolution.

During these waves of change, cities have benefited from urban growth. They have enriched and extended their functionality to become a prominent force for social and economic development. Today's cities increasingly combine the physical and digital worlds to transform services and improve the lives of citizens.

There is no doubt, cities are being shaped by the innovative power of Information and Communications Technology (ICT). Digital technologies are being integrated into government management, citizen services, public safety, industry development, and other urban activities.

Smart Cities are rapidly emerging from the implementation of these digital technologies. And, as a new development stage following industrialization, urbanization, and informatization — Smart Cities will bring new ideas and create opportunities to improve citizen lives.

The development of Smart Cities is characterized by an evolution not a revolution, it has a starting point and no end. To date there have been three distinct phases and advanced cities have now entered phase 3.0.

In phase 1.0, eGovernment services enabled residents and organizations to access information and services online. In phase 2.0, citizens embraced mobile Internet applications to manage their government affairs and social activities. This phase empowered governments/municipalities to interact with citizens more frequently.

Now in phase 3.0, the Internet of Things (IoT) is the foundation of Smart Cities, and digital technologies are integrated with city governance to improve management capabilities through mass data mining. This phase will enable sustainable city development.

In phases 1.0 and 2.0, Smart Cities moved service processes from the physical world into the digital world, which helped improve efficiency and enabled paperless services. However, in phase 3.0, digital technologies are used to mirror the physical world, creating a completely new world as a 'digital twin.' There is a vast difference in the potential value of data between these phases: If the management

Smart Cities will become a future reality around the world, and Huawei is dedicated to providing a fertile ecosystem for their development. Through our continuous efforts, we hope more and more cities aim to become smart. >>

data of phase 1.0 is like a river, and the Internet data in phase 2.0 is an ocean, then the IoT data in phase 3.0 is more like an entire planet.

In phase 3.0, Huawei is helping governments and municipalities streamline and converge management data, Internet data, and, more importantly, IoT data. This enables customers to fully analyze and process crucial data to explore innovative services and realize new value for citizens.

Human intelligence comes from a complex nervous system that collects, transfers, and analyzes internal and external information, and then ultimately provides feedback. Similarly, a Smart City also needs a robust 'nervous system.'

Huawei believes that cities are like living beings. The data of physical city activities is collected by sensors, cameras, and other front-end devices in real time, and then transmitted to cloud data centers through ubiquitous networks. The data centers then perform calculations and analysis using technologies such as Big Data analytics and Artificial Intelligence — and respond quickly by collaborating across functional areas.

These are the city nervous systems that Huawei hopes to build to power Smart Cities.

Huawei is committed to building world-leading Smart City nervous systems and providing a fertile ecosystem to enable massive data convergence through the Smart City Platform.

The Smart City platform features service innovation based on the coordination of key city resources. Huawei is leading this concept by building a digital platform that integrates the IoT, Big Data, Geographical Information System (GIS) maps, video clouds, and converged communication resources to enable a Smart City. The platform allows governments/municipalities to share and utilize basic resources, and opens these resources to ecosystem partners to support city governance innovation, for example in smart parking, water and utilities metering, lighting, traffic management, and more.

Based on the Smart City Platform, Huawei has brought together and enabled a large number of partners to deliver top-level design, integration, operations, and service application capabilities and create sustainable Smart Cities.

Smart Cities will become a future reality around the world, and Huawei is dedicated to providing a fertile ecosystem for their development. Through our continuous efforts, we hope more and more cities aim to become smart, and that we can bring digital to every person, home and organization for a fully connected, intelligent world. ▲

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Smart City Builders **Integrate Geospatial Big Data**

By *Prof. Li Deren, Academician at the Chinese Academy of Sciences and the Chinese Academy of Engineering, and Scientist in Photogrammetry and Remote Sensing*

More than half of the world's population now lives in urban areas, and further urbanization is one of the most important social and economic phenomena around the world. The trend of urbanization continues to intensify and is causing the emergence of massively large metropolises and urban agglomerations, particularly in densely populated Asia. As the world's most populous nation, China is in the process of developing at least 15 mega-cities with more than 10 million inhabitants due to urbanization. It is natural to expect that projects operating at such scales will face many challenges.

'Smart City' Infrastructures Solve an Array of Issues

We've seen a variety of issues over the course of the urbanization process:

- The problem of land subsidence in ultra-large cities has become increasingly common. The gradual settling or sudden sinking of Earth's surface due to subsurface movement is a serious natural disaster that has compromised the safety of the urban infrastructure in more than 50 Chinese cities.

Smart City infrastructures connect cities by fusing physical and virtual spaces through the use of Internet technologies. Cloud computing centers use spatio-temporal data mining technologies to process real-time Big Data and achieve smart, sustainable city development.

• We are acutely aware that mega-cities have changed the nature of land use, and that urban disasters frequently occur in environments that have been extremely compromised by such large-scale developments. The impact of one such example is the fact that roadways and buildings create impermeable surfaces that fundamentally change the absorption of precipitation. When impermeable surfaces account for over 75 percent of a city's land mass, we understand that only 55 percent of rainfall will drain away as surface runoff. Frequent and extraordinary rainstorms in recent years have caused severe hazards, inconveniences, and huge economic losses.

• Urban traffic development poses challenges to safety and efficiency. Congestion and other pressing issues like limited parking, public transportation delays, and traffic management difficulties are especially troublesome in the mega-cities of China and other rapidly urbanizing countries.

• The existing power grids in mega-cities face challenges in terms of unsustainably high energy consumption and low efficiency.

The above-listed urban issues can all be resolved by following the operating precedents programmed into today's Smart City solutions — which have the potential to promote economic transformation, efficient city management, and high-availability public services for the purpose of supporting the harmonious development of people and nature.

Digital City + IoT + Cloud Computing = Smart City

Smart Cities are simple combinations of digital city, the Internet of Things (IoT), and cloud computing. A digital city, as a virtual space on the network, contains all the data about a physical infrastructure so we can view its information and dynamic characteristics on the Internet. However, this is not the whole story. A digital city needs the IoT to remain connected with the city's physical assets to receive traffic and transportation status and other logistics information in real time. The data collected by hundreds of millions of IoT sensors must be calculated, analyzed, and managed — which is where cloud computing comes in to complete the picture. Think of the IoT and cloud computing as 'twin brothers.'

In the construction and operation of smart cities, sensor networks will generate trillions of megabytes (or exabytes) of data about natural and human activities. We are truly operating in the Big Data era. Digital cities are the basis for civic organization, and Internet technologies are the means to facilitate connectivity. Smart cities require a new generation of information technologies — including the IoT, cloud computing, and the integration of spatio-temporal Big Data — to implement new concepts and models of smart city planning, construction, management, and service. The realization of seamless global intelligence is paramount to solving the problems of data collection and transmission, real-time processing, timely feedback, and so on.

We must make full use of spatio-temporal data to fully unleash the intelligence of a city, and spatio-temporal Big Data, once stored, processed, queried, and analyzed can be used by various applications to provide smart services.

On December 27, 2012, the BeiDou navigation-satellite cloud service platform started to officially provide services to China and its neighboring regions. The high-precision positioning and speed-test services can be used for vehicle control and

Smart City constructions are systematic projects. After the completion of the top-layer design, each city needs to plan their Smart City construction in a unified manner based on local characteristics. >>

intelligent driving in smart transportation. In the future, networks consisting of nearly eighty satellites will be deployed above China to enable multi-network convergence and real-time services, improve the precision of remote sensing and navigation, collect spatio-temporal Big Data, and form data models.

We are making breakthroughs to solve diverse city challenges with remote sensing and cloud-based Big Data technologies. For example, we can analyze the range of a city's flood submergence, continuously locate indoor and outdoor mobile phones with precision, perform real-time navigation, and provide various location-based services and solutions.

Smart cities require the efficient management of spatio-temporal Big Data — processing, storing, and analyzing the data based on site requirements; and providing services to deliver various outdoor or indoor applications into space, or on the ground — by wire, fiber optics, or wirelessly.

Fully Explore the Value of Spatio-temporal Big Data

Multi-layer methods such as data expression, information organization, and knowledge discovery can be used to mine spatio-temporal Big Data. For example, Geographic Information System (GIS) data mining is used to form an ecological and intelligent management system as a modern control method to accelerate the resolution of flood prevention and comprehensive power generation.

For example, data from low-light city images at night, population density, and land coverage all indicate changes in urban population activities. Based on the data, we can establish models and analyze citizen behavior to solve urban construction problems. In addition, through video data mining and time-lapse sequence analysis, we can evaluate the impact of armed conflicts on different regions and maintain security.

Remote sensory data mining allows us to perform agricultural monitoring, extract crop information or yield estimations, and perform statistical analysis that provide references for economic development.

Construct Smart City Operation Centers

Smart City constructions are systematic projects. After the completion of the top-layer design, each city needs to plan their Smart City construction in a unified manner based on local characteristics.

Based on site requirements, Smart City operations centers become the command and dispatch hubs, and the smart service core for high-level monitoring. These centers are developed in a visualized, controllable, and intelligent manner for continuous optimization. In this way, enterprises can reorganize production resources and improve business models to gain greater benefits; and citizens can enjoy better social services that improve their well-being.

Smart City construction is a top leadership project.

We need to focus on the core of Smart City construction, promote development, and form technology, data, and value chains. The Big Data challenges that highlight many Smart City deployments reflect the cutting-edge concerns for scientific research, and a key driving force behind the continuing developments in the Smart City sector.

We need to accelerate the levels of Big Data research and technical innovation to promote the development of the smart service industries to make city operations more scientific, efficient, and secure — all with a lower carbon footprint. ▲

Tianjin Smart City Creates Economic Prosperity and Better Lives

By *Zhang Guosheng, Deputy Head of the People's Government, Tianjin Binhai New Area, China*

The Tianjin Economic-Technological Development Area (TEDA), established in 1984, is located in the eastern coastal region of Tianjin, at the center of the Bohai Economic Rim. TEDA is one of the earliest coastal economic and technology development areas in China.

Over its 34-year history, TEDA has focused exclusively on investment promotion and the development of enterprise services. In terms of today's industrial footprint, the area now hosts more than 37,000 international corporations, including more than 200 members of the *Fortune Global 500*, such as Motorola and Samsung. Each of these companies is an active contributor to the economic health of the TEDA region.

One example of the type of innovation emerging from Tianjin region is Motorola's concept for total customer satisfaction: Simple customer satisfaction occurs when basic expectations are met. Total satisfaction is achieved when customer expectations are exceeded. However clear the premise, absent the availability of Big Data or Artificial Intelligence (AI) at the time, it was impossible for the program to succeed.

One Center: AI Performs Deep Analysis, 'City Brain' Generates Value

Today, Tianjin's Binhai New Area Smart City solution provides an accurate macro and micro understanding of the needs of its industrial and residential constituents. The Smart City solution uses cloud computing, Big Data, and AI to offer services that were not possible before. The '1 + 4' solution, with an AI platform at the core, was designed by TEDA and implemented with Huawei's support for processing, communication, and in-depth mining with the goal to maximally integrate information about people and things via the 'City Brain' Intelligent Operations Center (IOC). In this way, TEDA provides enterprises and residents with full-lifecycle, point-to-point smart services through the 'Serving Enterprises' and the 'Caring for Residents' platforms. TEDA's platform integration enables the

As one of China's first comprehensive reform and innovation districts, the Tianjin Binhai New Area has taken the lead for in-depth integration of Artificial Intelligence and Smart City technologies to set a new benchmark for Smart City solutions.

analysis and prediction of the needs of each enterprise and the ability to communicate with residents and households for the delivery of services targeted to meet their specific needs.

The '1 + 4' solution refers to one center, the IOC, and four AI platforms. The IOC is the central point for recommendations and fulfillment. Data sourced from government, industry, and individual citizens through the Internet and the Internet of Things (IoT) is aggregated for processing by the TEDA AI.

The analysis performed by the IOC delivers the following three benefits. First, a real-time dashboard visualizes the moment-to-moment status of the local area for city managers. Second, decision-making tools analyze and offer optimization solutions to high- and low-level decision makers. For example, heat maps illustrate residential activity to help officials precisely site new commercial or industrial construction. Third, the IOC hosts a suite of technical monitoring, warning, and event-linkage responses based on scientific protocols, which are especially important for complex accidents or emergencies. One such example is when the public security agencies are able to easily manage a festival or other type of celebratory activity based on input from the heat map. In the past the agencies may have been nervous or uncertain about crowd control for a daytime marathon or evening light show. With the video surveillance and cloud computing technologies available today, the agencies are far better equipped to relay dynamically changing information about all sites to the IOC.

The IOC command and control screen displays the operating status of six distinct domains in real time: A TEDA overview, economic flow, safety, transportation, public utilities, and macro quality-of-life (happiness) indices that are extracted from the data. By presenting the information visually the IOC operators are able to gain a comprehensive understanding of TEDA's overall operating status.

Four AI Platforms Support the 'City Brain'

The TEDA solution currently involves four AI platforms that interact closely with the IOC to provide smart services: Resident Voices, Resident Care, Sensing the City, and Enterprise Services.

- **Resident Voices:** Voice recognition and semantic parsing technologies enable city managers to understand the voice of each resident to gain insight into their needs. Resident voices are captured through a hotline, online messages, and in-person visits. The information and data are then analyzed in text and audio data formats. The platform provides voice navigation for residents to improve their service experience. The smart monitoring of sensitive details enhances the quality of management by government agencies. Key information is communicated to leaders at all levels for further action.
- **Resident Care:** Deep learning and correlation analysis are used throughout the service lifecycle to generate personalized resources for residents. Beginning in utero, individual profiles are created for each person in the TEDA system, and additional information is added as residents progress through their lives. Pre-natal care and post-partum training is provided to expectant parents. Infant-nursing information is integrated with social support resources to manage the healthiest possible outcomes. As children begin school the smart education system will recognize each person's learning pattern and serve as a tutor. When the time comes for college entrance examinations, the system will recommend the most appropriate universities

to best enhance each person's personality and learning style. Post-graduation the system will help with individual career planning. In summary, the platform intelligently enables a comprehensive range of services throughout the life of each resident.

• **Sensing the City:** Image recognition and correlation analysis are used to explore the relationships between people, places, and things for the purpose of fostering a harmonious order for all. Sensors collect the data required for city management, including air and water quality, street lighting, available parking spaces, and other information. The video system collects information from transportation hubs, schools, community centers, hospitals, and other locations that, when combined with sensor data, is used to build a unified view for regional health and progress. The visualization platform is used to help city managers comprehensively understand the city's status. For example, residential community surveillance can intelligently analyze the risk level posed by unknown visitors to ensure community safety. Smart surveillance throughout the transportation network is used to monitor vehicles carrying dangerous chemicals or unlicensed vehicles to ensure road and railway safety. The sensor network is also used to monitor water tanks in households and high-rise buildings to alert for water quality changes to ensure the safety of the local water supply.

• **Enterprise Services:** Multi-dimensional correlation analysis helps to clarify the internal relationships of industries in the TEDA district for the purpose of accurately matching the availability of service resources throughout the enterprise lifecycle. A primary task for the TEDA administrators is the promotion of investments directed to local industry. The investment promotion phase relies on Big Data technologies to analyze the available information from government and Internet sources to better understand the market landscape in which the target enterprise is operating and evaluate its forward-looking risk. The Tianjin Binhai New Area district government pushes both targeted and general local investment information to regional enterprises in real time. Local governments follow their investments by providing targeted services during the construction and operation process. For example, if changes in the consumption data of water, electricity, gas, or heat of an enterprise are detected, this may indicate production or operational challenges that may require immediate intervention from a supervising agency.

The goal of the TEDA 'AI + Smart City' construction is to continually improve and maintain a happy, comfortable living environment for all residents. >>

Additional Innovations: Residential Happiness Index

Evaluation standards complement the AI platforms to help ensure that residents enjoy a better life through access to high-quality services. The success of the 'AI + Smart City' solution is measured by a 'happiness index' that has been established to build a safe living environment for all local residents. First, data is collected through sensors or surveys. Then Big Data analytics are performed and the grid-based city management system is used to identify risks in all regions. One example of proactive discovery is TEDA's ability to track, capture, and analyze data on water consumption patterns for each household. Every service or utility is a candidate for this type of closed-loop management. Trends and projected outcomes are subject to further supervision by city managers who are charged with responsibility to assess and intervene with the relevant stakeholders, whether they are on the supply or consumption side of the equation. The TEDA data management tools allow public services to be provided in neighborhood convenience stores so that residents can apply for licenses, pay bills, and engage with other public services while they are close to their homes.

The goal of the TEDA 'AI + Smart City' construction is to continually improve and maintain a happy, comfortable living environment for all residents. Based on the information gathered from the distribution and collection of large numbers of questionnaires we learned the issues that bring inconvenience and unhappiness to urban residents. By using the TEDA AI platform we summarized the leading factors that bring happiness to our neighbors, including peace, beauty, convenience, harmony, social order, and vitality.

In the future, we hope to develop smarter platforms using AI technologies. Our goals include building more personalized Smart City applications to continually improve the happiness indices for the residents of Tianjin Binhai New Area. We expect that the next phase of our Smart City platform will better understand the needs of people and businesses to enable a prosperous and happy modern city, and a better way of life.▲

Increasing Smart City Governance

By *Fen Kui, Secretary General, Academic Committee of the Urban and Small Town Reform and Development Center, the National Development and Reform Commission of China (NDRC)*

Smart City governance is a current hot topic, both as research and in practice. From a general perspective, research on Smart City governance stems from the implementation of Smart City solutions around the globe. Fueled by multi-subject collaborative innovations, Smart City governance uses information technology to make cities more livable, government services more streamlined, economies more dynamic, ecosystems more accessible, and societies more harmonious.

Reasons for Smart City Governance: Four Demands

Smart City governance has drawn more and more attention in recent years due to these 'Four Demands:'

- **At the national level,** modern China not only maintains one of the world's top Gross Domestic Products (GDP) per capita, but also holds strong soft power, which is mainly reflected in the modernization of the national system of governance, which guarantees sustainable economic development.
- **At the city level,** the prevention and settlement of urban issues requires smarter city governance. Recent years have witnessed the proliferation of a variety of urban challenges in Chinese cities, especially in the transportation and environmental sectors, which can be remedied using information technologies.
- **The public** should participate in city governance while enjoying developmental achievements.
- **Livelihood requirements:** Smart governance is required to deliver increasingly personalized and diversified services for living and working.

Deploying technologies to better serve people is the essence of Smart City governance. Starting with information technologies, we need to mobilize all stakeholders to improve our cities and our lives so we can create a brighter future, and usher in the policy of 'Putting People First.' Therefore, information technologies are a fundamental and paramount prerequisite for Smart City governance.

The benefits of Smart City governance include low social costs, efficient and precise government services, and modern urban development. In short, it aims to unleash the full potential of city development in the most sustainable way, at the lowest cost. Intelligence, good governance, innovation, and environmental friendliness are the core concepts behind Smart City governance.

Basic Conditions of Smart City Governance: Development in Four Aspects

The basic conditions of Smart City governance can be summarized as 'Development in Four Aspects.'

Smart City governance, fueled by cross-domain collaborative innovation, uses information technologies to make cities livable, government services streamlined, economies dynamic, ecosystems favorable, and societies harmonious.

• **Development of Information Technologies:** In recent years, a new generation of technologies, such as Artificial Intelligence (AI), intelligent hardware, new display modes, mobile intelligent terminals, fifth-generation mobile communications, virtual and augmented reality, advanced sensors, and wearable devices are driving the rapid development of information technologies.

• **Smart City Development:** China embarked on Smart City implementation in 2010, and in recent years has been a successful advocate for the development of new Smart Cities — making substantial progress transforming government services and 'Putting People First.'

• **Deep Integration of Information Technologies and Urban Governance:** Information technologies are becoming deeply integrated with urban planning, construction, and operations.

• **Government Reform:** Streamlining administration, delegating and regulating power, and optimizing services are not only paving the way for smarter city governance, but also creating new requirements.

Model Framework of Smart City Governance

At present, the main research topics of Smart City governance include ownership, policy objectives, content, and implementation. To build the framework for Smart City governance, we can construct a basic model consisting of the ownership, infrastructure, platform resources, and content layers to better analyze its developmental status and issues.

• **Ownership:** Governance owners include government, enterprises, social organizations, the public, and the media. Through continuous innovation of governance concepts, we need to further clarify the positioning and responsibilities of each subject, accelerate the construction of multi-level governance channels, promote new applications and reward mechanisms, fully mobilize governance owners, and form new multi-owner governance models.

• **Infrastructure:** City governance requires intelligent infrastructures, which include broadband networks, the Internet of Things (IoT), cloud computing centers, and intelligent facilities. The comprehensive deployment of intelligent infrastructures supports resource integration, data sharing, and interconnection — laying a solid foundation for smart management.

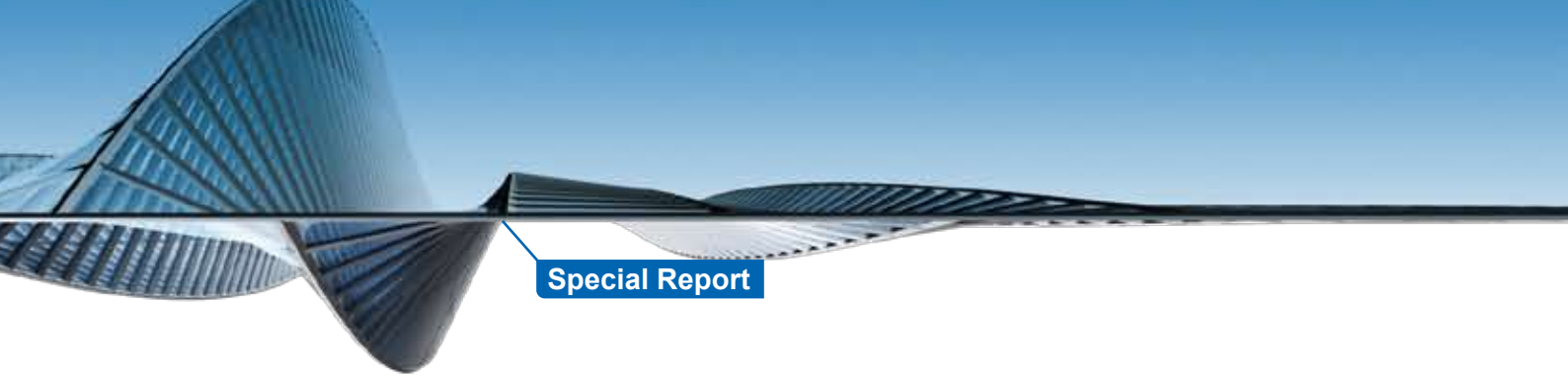
The wide application of information technologies is significantly changing city governance, which will feature intelligent awareness, refined management, convenient services, regulated cyberspace, and diversified participants. >>

- **Platform Resources:** Platform resources support and make up the core elements of city governance. Based on city governance requirements, we need to establish unified and shared databases, build integrated service management platforms, and deliver integrated and intelligent city management services through technology convergence and innovation — providing comprehensive support for every aspect of smart governance.
- **Content:** City governance is an inevitable choice for promoting multi-dimensional city management, improving government efficiency, and efficiently solving social problems. We need to take comprehensive measures — including mechanism innovation, intelligent control, and collaborative management — in city operations, social security, ecological systems, and environmental and economic development to enable smarter governance.

The City Governance Trend in the Internet Era

The wide application of information technologies, in the Internet era and the continuous innovation of business models are significantly changing city governance, which will feature intelligent awareness, refined management, convenient services, regulated cyberspace, and diversified participants.

- **Intelligent City Perception:** The Internet, the IoT, and various intelligent terminals will enable the interconnection between individuals, individuals and things, and between things to ensure constant updates and awareness of city operations, which supports the precise public management, personalized services, and general functions that are an important basis for realizing Smart City governance.
- **Precise Public Management:** Information technology applications and legislation-based city governance promotes information sharing and city organization collaboration, changes the government's management and service modes, and breaks the boundaries between departments and regions for integrated and precise city governance, which is the key feature of Smart City governance.
- **Convenient Livelihood Services:** Through 'Internet +' modes and platform-based sharing strategies, integrated service resources (and channels) build people-oriented, intelligent city governance services and public service systems; promote social co-governance and sharing; provide favorable environments for citizens; and continuously increase citizen welfare, which is the core objective of Smart City governance.
- **Regulated Cyberspace:** Through continuously improving the laws and regulations of cyberspace management, regulated cyberspace establishes cyber-security management mechanisms, public opinion monitoring, and cyber-market management systems to promote regulated cyberspace development. This is not only an important feature of Smart City governance, but also an important indicator of a modern city's management level.
- **Diversified Participants:** Through institutional and mechanical innovations, including the implementation of legally mandated city governance measures; governments and their citizens are making full use of the Internet to facilitate public participation. This encourages multiple parties to participate in city governance and strengthens the interaction between the government, enterprises, and other stakeholders. The result is an improved sense of achievement for social subjects in urban governance. ▲



Build Platforms, Drive Cooperation, **Respect Boundaries, and Develop Ecosystems**

By *Yu Dong, President, Industry Marketing and Solutions Department, Enterprise Business Group, Huawei Technologies Co., Ltd.*

When discussing hazardous chemical supervision, the topic of video surveillance systems like Closed-Circuit Television (CCTV) will often be raised. Traditional supervision systems that use closed IT architectures are not capable of sharing data between enterprises and government departments. The sharing restriction raises the information barrier to the point that cross-department communication within an organization is a costly challenge. Public participation is rare because releasing supervisory information is almost impossible.

Information about hazardous chemicals is squirreled away in closed systems, concealing critical information such as project approval, site selection, production, storage, and transportation details. Consequently, first responders and on-site personnel are forced to make time-sensitive decisions based on incomplete or inaccurate information — and a single misjudgment can have catastrophic consequences. Local residents may have no idea they are living next to a 'time bomb' until it explodes.

With this in mind, Huawei has designed a Smart City platform that can intelligently control hazardous chemical production, storage, loading, unloading, transportation, and delivery activities.

Hazardous Chemical Management in Smart Gaoqing

Technology once again transforms what was once impossible into a reality. Gaoqing County in the Shandong Province has a cloud platform that monitors the county-wide production, transportation, and handling process for hazardous chemicals.

In the Smart Gaoqing project, the cloud platform coordinates Big Data, Geographic Information Systems (GIS), video, command and dispatch, and computing resources. Using new Information and Communications Technology (ICT), the Gaoqing government can better calculate accident probabilities, detect risks, and issue warnings, thereby improving the effective quality of hazardous chemical management.

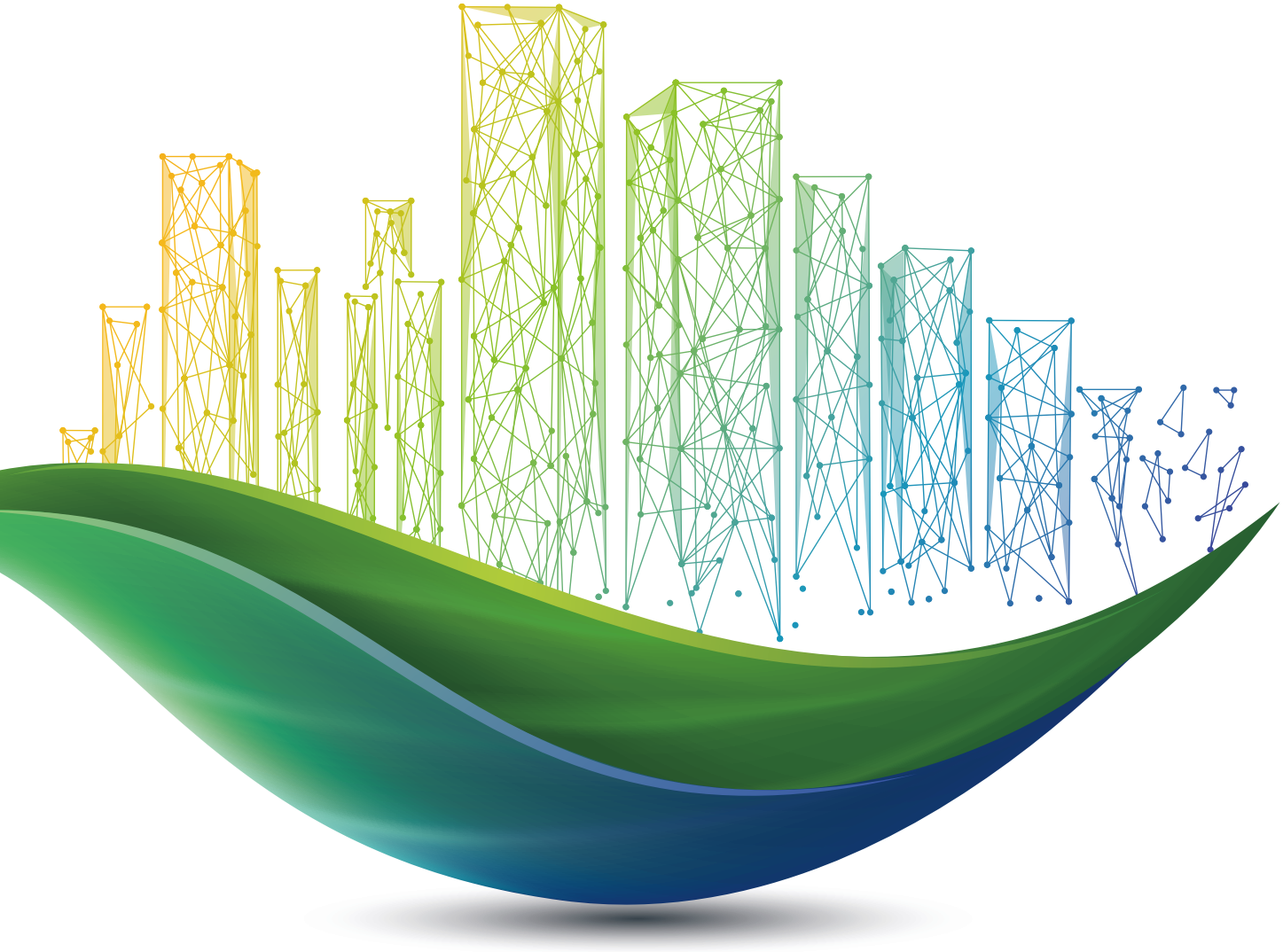
The Big Data platform breaks down inter-departmental barriers, which makes project approval easier and more efficient. The 3D GIS and video surveillance systems dynamically monitor inherently hazardous chemical production operations, and the private eLTE wireless network allows visual dispatching and command.

The solution uses algorithms and Big Data resources to analyze people, vehicles, and objects — and the five systems bring qualitative changes to hazardous chemical management. Through continuous research and practice, Huawei has given 'Smart Gaoqing' a new connotation.

The Huawei Smart City solution supports more than just hazardous chemical management in Gaoqing. With Huawei's latest intelligent technologies, the local government has built a brand-new digital platform that houses the administrative data for 54 departments, and smart applications for 20 ecosystem partners. Information silos and barriers to sharing have been eliminated; and service data across departments can now be closely integrated.

The Huawei Smart City Platform is a digital technology solution. With the assistance of ecosystem partners, the platform coordinates five types of resources: Cloud computing, Big Data, video, command and dispatch, and GIS — to help Gaoqing mine and fully leverage the value of service data. Hundreds of smart applications are flourishing on this 'fertile land,' where they converge.

Huawei is committed to empowering Smart Cities to build 'nervous systems' able to provide holistic solutions that support complex technical integrations and the development of partner ecosystems to deliver an intelligent, fully connected society.



In complex urban scenarios, Huawei's Smart City Platform serves more than a dozen fields, including government administration, policing, city management, healthcare, and agriculture. The platform has significantly improved Gaoqing's administrative efficiency.

Digital Platforms Support Smart City Digitization

Huawei has participated in building more than 120 Smart Cities around the world.

Experience shows that successful Smart City projects share a common point: They link all smart applications in one smart platform. These applications cover education, healthcare, security supervision, and city management. There are hundreds of these applications, and the number is quickly growing.

Huawei specializes in ICT infrastructure construction within Smart City projects, and many application and end-point partners participate in the development of joint solutions.

All participants agree to build digital platforms that link systems and modules, which is why Huawei built its Smart City Platform.

The Von Neumann architecture used in computing is a useful reference point to understand how this platform horizontally integrates applications.

Huawei has participated in building more than 120 Smart Cities around the world. Huawei specializes in ICT infrastructure construction, and many application and end-point partners participate in the development of joint solutions.
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In Dr. Von Neumann's model, the core architecture of computers consists of the input/output unit, the Central Processing Unit (CPU), and memory. Openness is the greatest advantage of this architecture, where the modules are decoupled from each other, but can be integrated together when needed. This enables global collaboration and labor division. And thanks to Dr. Von Neumann's efforts, the computer industry — following Moore's Law — continues to grow exponentially each year. And though many years have passed since its origination, the Von Neumann architecture remains the standard for the computer industry.

Huawei has been enlightened by this classic architecture, and offers two types of key abilities for industry transformation:

First, in critical service scenarios, Huawei uses the Enterprise Operating System (EOS) to help customers quickly gain business benefits and complete their digital transformation.

Second, Huawei gives full play to the advantages of the platform, provides differentiated value models for ecosystem partners, and enables growth. This is similar to the relationship between mobile phones and the App store — mobile phones are pure hardware (like ICT infrastructure), Huawei's digital platform is like the phone's operating system, and the Apps in the App store are like partner applications.

The Huawei Smart City Platform is built on a backbone of ICT infrastructure; including adaptation to key Smart City scenarios; support for various terminals and applications; and the ability to coordinate Big Data, the Internet of Things (IoT), video, GIS, and converged communication resources.

Huawei works with partners to build industry solutions, and our platform has been used in a number of success cases around the globe. In complex city scenarios, the platform provides powerful functions — such as smart government, smart policing, smart city management, smart healthcare, and smart agriculture — that support Smart City digitalization.

Build a Neural Network and Give Life to Smart Cities

Smart Cities are an important enabler for Digital China and a key catalyst for future breakthroughs. Smart City platforms can effectively converge data and theoretically connect everything.

Like a living organism, a Smart City is not just a simple superposition of functions — it is not an overnight task, but an ongoing project.

In a Smart City, systems such as transportation, education, healthcare, energy, environmental protection, government management, and public security are well connected and constantly support each other. Smart Cities are built to evolve and eventually upgrade. Smart City developments are not just a single project or series of projects, but systematic undertakings with an iterative schedule for evolution.

When building a Smart City, one must ask: If a Smart City has only a brain and nothing else, will this city still be smart?

Human intelligence is based on a nervous system that collects and processes information, and then gives feedback — and similarly, a Smart City also needs a 'nervous system.'

Data collection, analysis, and usage are impossible without the 'nervous system' and intelligent operations are nothing but an empty promise. Smart City needs such a 'nervous system' to link service systems and coordinate resources. The human nervous system facilitates reflexes, just as the Smart City nervous system enables automatic judgment and linkages between systems.

A strong 'nervous system' consists of a healthy 'brain' and a well-connected network. The network transmits data from peripheral units to the brain and, once the brain makes a decision, the network sends the data to the muscular tissue and prompts action.

With comprehensive Smart City ecosystems in place, Huawei will continue to meet increasingly complex requirements, and we hope these unremitting efforts will help more cities in China become smarter. >>

Living organisms and Smart Cities use a similar mechanism consisting of two parts. The peripheral component connects the city communications network with the IoT to enable automatic, all-scenario, city-wide data collection and transmission; and the central component connects Big Data and Intelligent Operation Centers (IOC) to display city operations, conduct linked emergency responses, and provide decision support.

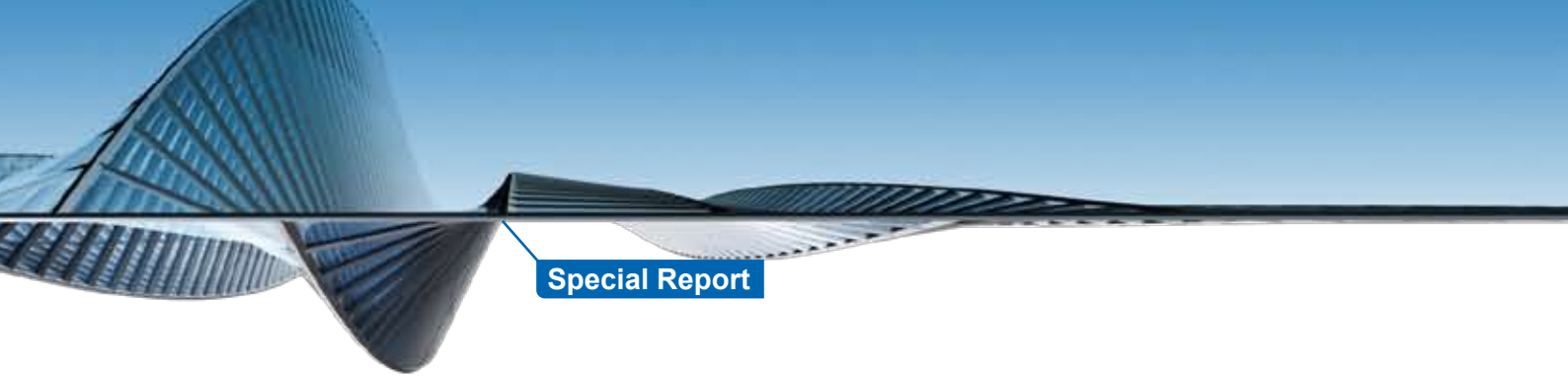
With continuous efforts, Huawei has originated a number of best practices. In Longgang, Shenzhen, Huawei built an urban IoT platform, wired and wireless networks, and cloud data and city operation centers. These practices now connect more than 50 government departments and have streamlined more than 210 service systems into a single, unified platform.

Huawei has deployed 11 service applications on these infrastructures such as smart government, smart healthcare, and smart transportation — that have served to eliminate legacy information silos.

Huawei adheres to the objective of 'benefiting people through smart administration,' which proved successful in improving public safety and resident happiness following the deployment of Longgang's Smart City.

Huawei is committed to building an intelligent and connected world. We will work with partners to build holistic Smart City solutions, and help cities around the world develop the necessary nervous systems.

With comprehensive Smart City ecosystems in place, Huawei will continue to meet increasingly complex requirements, and we hope these unremitting efforts will help more cities in China become smarter. ▲



Embracing the Digital Economy and **Moving Toward a Smart Society**

By *Zheng Zhibin, the President of Global Smart City Business, Huawei Technologies Co., Ltd.*

ICT Technological Transformation Drives the Digital Economy

Due to changes to international economic structures, China is facing developmental bottlenecks in the 'new normal' of the current macro-environment, resulting in the economy slowing from 'high-rate growth' to 'mid- to high-rate growth.'

This 'new normal' has four defining characteristics: 1) Abandonment of traditional development modes; 2) internal economic risks, huge downward pressure, and requirements for growth-pattern transformation; 3) internal conflict between steady growth and structural adjustment; and 4) greater 'middle-income trap' risk.

Facing complicated economic situations and severe challenges at home and abroad, China must shift from 'low- and mid-level development' to 'mid- and high-level development' and promote structural reform. The government is very concerned about the development of the digital economy and has drafted many policies in recent years to better define its role in the digital economy: Digital economy was mentioned in the *Report on the Work of the Government* for the first time in 2017. In this report, Premier Li Keqiang called for more efforts to deepen the development of 'Internet Plus,' accelerate the growth of the digital economy, and bring more benefits to enterprises and the public. The digital economy has become an important part of China's national development strategy.

At present, the world is undergoing a profound technological revolution. New technologies that once seemed inaccessible are now widely deployed, and technological advances are promoting industrial, social, and national development in various domains.

The latest cutting-edge technologies are rapidly integrating into people's daily lives, and play an increasingly important role in the operations of enterprises. More and more enterprises are integrating connectivity, cloud, Big Data, the Internet of Things (IoT), and Artificial Intelligence (AI) into core production processes and management systems to improve efficiency and competitiveness. We are embracing a fully connected and super-intelligent world that will benefit all aspects of human life and drive economic prosperity.

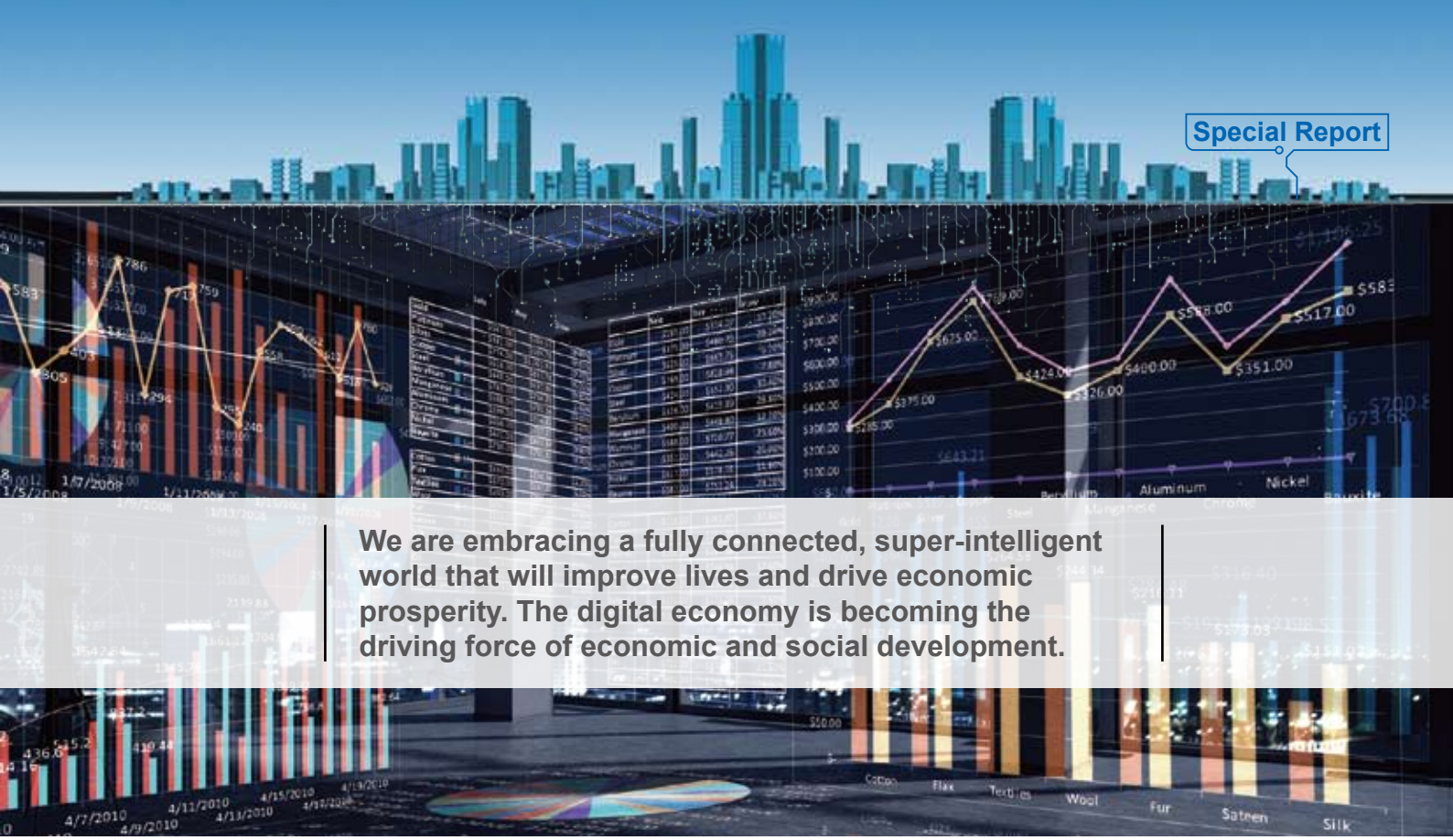
• Technological Revolution Promotes Development Process Evolution

Carlota Perez, a Venezuelan-British evolutionary economist, believes every big technological revolution forms a techno-economic paradigm that adapts to it in two stages: The first stage is marked by the rise of emerging industries and the widespread installation and application of new infrastructure; the second stage is marked by prosperous development and profits from the first stage's emergent industries (each phase spans nearly 30 years).

With the emergence and application of new Information Technologies (IT), the production factors and production relations affecting contemporary economic activity have changed. The IoT, Internet, cloud computing, Big Data, and AI have become the new production factors.

Production changes, such as the rise of a sharing economy, crowdsourcing, and network collaboration, have reconstructed production relationships and led to the birth of the digital economy. U.S. magazine *Bloomberg Businessweek* defines the digital economy as: Against the backdrop of economic globalization, the IT revolution has driven economic growth and the high-tech industry has become the leading business sector. The digital economy is the economic and cultural culmination of informatization and characterized by low unemployment, low inflation, low budget deficits, and high growth.

Currently, the world is in a new era of Big Data transformation. Mobile Internet, smart terminals, and new sensors are rapidly spreading to every corner of the globe. Accenture expects that global data usage will reach about 44 ZB (1 ZB = 1,000,000,000,000,000,000,000 bytes, or 1 billion terabytes) by 2020, covering all areas of economic and social development. The



We are embracing a fully connected, super-intelligent world that will improve lives and drive economic prosperity. The digital economy is becoming the driving force of economic and social development.

impact of this will reshape the productivity development model; restructure production relations; improve industry efficiency and management; and improve the precision, efficiency, and predictability of governance. There is no doubt the technology system represented by the new generation of IT will create the next generation of Internet ecology, trade form, and manufacturing form.

- **Digital Economy Drives Economic and Social Development**

In December 2016, General Secretary Xi Jinping pointed out in the 36th collective study of the CPC Central Committee Political Bureau that the world's economy is transforming toward one where the network IT industry plays a significant role. We must seize this historic opportunity, use informatization to gain momentum, and leverage that momentum to achieve new development.

In the past, the Information and Communications Technology (ICT) sector has accounted for a small proportion of the entire economy, but its role is becoming increasingly prominent.

ICT sectors from constituent countries of the Organization for Economic Co-operation and Development (OECD) account for 6 percent of the Gross Domestic Product (GDP) of the organization, and the figure is much lower in developing countries.

However, in recent years, the emergence of technologies such as cloud computing, Big Data, the IoT, and ICT has increased the Total Factor Productivity (TFP) and made remarkable indirect contributions to economic growth. The rapid application of digital technologies in the economy has produced wide-ranging benefits, and it is evident the digital economy is becoming a highlight of the overall economy for many nations. The digital economy is becoming society's new driving force of economic development and its growth rate in each country is higher than that of the overall (traditional) economy.

The value of the digital economy in promoting the development of a society is embodied in 5 aspects: Reconstructing business models, improving labor productivity, driving industry upgrades, promoting mass entrepreneurship, and creating more jobs.

China Should Pursue the Digital Economy Dividends

In the current macro-environment, the digital economy is a strategic necessity for China's transformation from an economic giant to an economic power. The digital economy is a major driver of innovation and efficiency, as well as an effective way to achieve economic optimization, economic transformation, and robust development.

The construction of a digital economy is a systematic project, which will promote economic and social development in five aspects:

- **Reconstructing Business Models**

First, with the advent of the digital economy, traditional industries are facing transformation and labor re-division challenges — and traditional business models are being reconstructed.

The freedom brought on by the Internet has subverted traditional industries, ushered in disruptive innovation, removed information barriers, and changed the intermediate phases of transactions. The shift from large-scale production to customization is reshaping the division of labor and making data a core enterprise asset. In addition, new transaction models (such as the shared economy) in the digital economy redefine user consumption models. Leasing, as a service

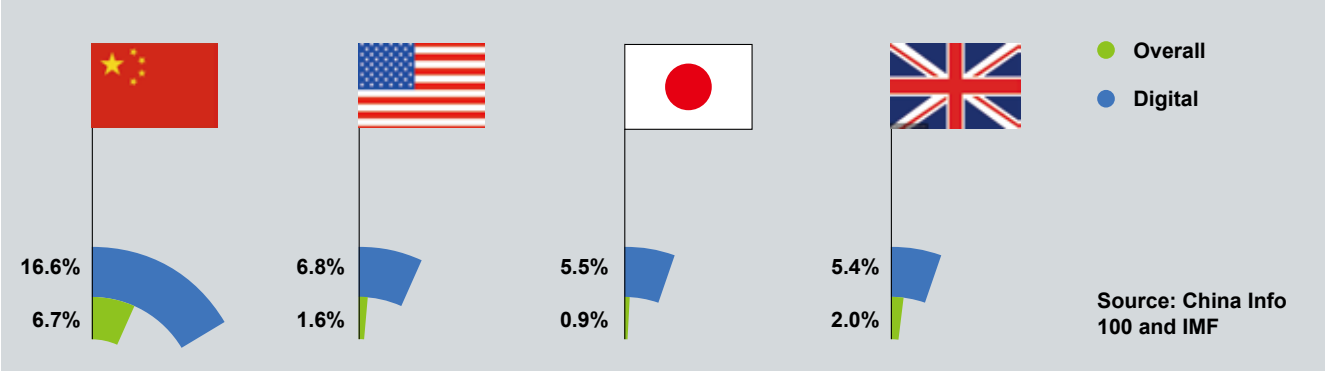


Figure 1. Comparison of national digital economic growth and overall economic growth in four countries

model, is replacing purchasing. Blockchain emergence and the prevalence of mobile payments will encourage additional economic development models, and the digital economy will afford low unemployment, low inflation, low fiscal deficits, and high growth.

- **Improving Labor Productivity**

According to the World Bank's report in 2013, while China enjoyed the largest manufacturing output in the world, the country's overall labor productivity was USD 15.5 thousand (CNY 103.3 thousand) per worker (GDP per capita), which was seven times lower than that of the U.S. — USD 107.2 thousand (CNY 714.8 thousand) per worker — and even lower than that of developing countries like Brazil.

China's labor productivity was only one-twelfth, one-tenth, one-ninth, and one-sixth of that of the U.S. in the information communications, manufacturing, finance, real estate, and commerce industries respectively. China's labor productivity for the wholesale retail industry was among the top in the world, but only a quarter of that of the United States.

Against this backdrop, the effective utilization and vigorous development of the data economy can promote the improvement of labor productivity. Research from U.S. consulting firms showed that in all enterprises, labor productivity with a high informatization usage rate was 60 percent to 90 percent higher than that of enterprises with a low informatization usage rate. In the service industry, the contribution rate of the digital economy was two-to-three times higher than that of traditional models. Informatization drives process reconstruction and optimization while Big Data and IoT improve production automation capabilities.

- **Driving Industry Upgrades**

China is facing demographic dividend losses and greater manufacturing costs. According to data from the National Bureau of Statistics, regarding population distribution by age, China will soon become an 'aging society.' By 2050, the largest percentage of the population will be between the ages of 60 and 69, and the demographic dividend of the manufacturing industry will gradually disappear.

At the same time, China faces the pressure of increasing manufacturing costs. Boston Consulting Group (BCG) reported that China's manufacturing costs are basically the same as those of the U.S. when natural gas and electricity manufacturing costs are taken into consideration, indicating a gradual cost-advantage loss for China's manufacturing industry.

The gradual adoption of the digital economy throughout the manufacturing industry can promote the convergence and transformation of the traditional industry's ecosystem chain and gradually improve the competitiveness of Chinese manufacturing.

In industry chain sectors such as marketing, service, R&D, and manufacturing, the more open the sector is, the deeper the integration between the industry chain and informatization. In this way, the sectors can provide personalized products, manufacturing as a service, process virtualization, organization decentralization, and manufacturing resource cloudification.

China is vigorously promoting 'China Manufacturing 2025' to encourage industry development through the in-depth integration of industrialization and informatization.

The comprehensive adoption of the digital economy will promote the application of China Manufacturing 2025, drive service industry development, and promote industry upgrades. Through the digital economy, China's manufacturing industry can evolve toward both ends of the 'smiling curve.'

- **Promoting Mass Entrepreneurship**

China is vigorously promoting mass entrepreneurship and innovation. In developed countries, Small- and Medium-sized Enterprises (SMEs) act as important engines in social and economic development. For example, SME GDP contributions reached 67 percent in Italy, while in China the figure was only 37 percent — far lower than in many developed and even developing countries.

The digital economy innovates traditional social services, and caters to a large number of start-up SMEs. In a digital economy, long-tail demands will drive the birth of numerous SMEs and create abundant innovation opportunities. On top of this, the digital economy provides fertile ground for development, which can lower the barrier for innovation and greatly improve labor productivity for SMEs.

- **Creating More Jobs**

The digital economy can create more jobs attracting middle- and high-end talent. The World Bank tracked this trend in the workforce employment ratio among developing countries from 1993 to 2010. According to its report, the demand for low-skill jobs in China was declining, reducing the number of many traditional positions, especially physical labor-intensive positions.

However, China was distinct in that the demand for middle-skill jobs was growing rapidly, which was in stark contrast to situations in all other countries. This phenomenon demonstrated the rapid rise of China's middle class and the continuous upgrade of China's manufacturing industry.

According to statistics, China had more than 7.3 million college students in 2014. By comparison, the number of college students was 2.7 million in the U.S. and 400,000 in Germany. After more than 10 years of collegiate development, the number of obtained higher education degrees in China has exceeded 120 million.

Cities that more deeply adopt the digital economy become more attractive to middle- and high-end talent, and can provide more jobs for those individuals.

The digital economy will create more jobs and facilitate population migration during urbanization, which is an important aspect of China's future economic development.

In 2030, China's urban population proportion is expected to reach 70 percent. This means more than 300 million people will migrate from rural areas to cities over the next 10 years. Providing job opportunities for those people will become an important challenge.

IT innovation can meet urbanization service requirements, refine the industrial division of labor, and create new positions for employing urban residents. According to the World Bank, the disappearance of one position from the traditional industry will bring 2.4 new positions in the digital economy.

Embrace the Digital Economy and Move toward a Smart Society

The 19th National Congress of the Communist Party of China proposed that China should promote the in-depth integration of the Internet, Big Data, and AI with the real economy, and build network power, digital China, and a smart society. This is the guiding principle of digital economy construction in the new era. China urgently needs to ride the wave of the digital economy to inject vitality into overall economic development.

- **Digital Economy Requires Full Connectivity**

As digital technologies play a more important role in the total reconstruction of business logic, information infrastructure construction becomes a source of momentum for the digital economy, and even the real economy, to achieve quality growth.

In 2030, China's urban population proportion is expected to reach 70 percent. The digital economy will create more jobs and facilitate population migration during urbanization, which is an important aspect of China's future economic development. >>

As the saying goes, "if you want to get rich, build roads first."

ICT infrastructure paves the way for the information connectivity that serves as the foundation of digital economy development. According to Huawei's *Global Connectivity Index (GCI)* 2017, the multiplier effect brought by ICT infrastructure investment is becoming apparent.

In 2016, a USD 1.00 (CNY 6.67) investment in ICT infrastructure led to a USD 3.00 (CNY 20.00) rise in GDP; and by 2025, for every USD 1.00 (CNY 6.67) investment, the average return to GDP will be USD 5.00 (CNY 33.34).

Governments need to enact more positive policies to encourage and lead increased information infrastructure investments. In other words, a determined and far-sighted government should adopt active and effective policies to help industries better achieve digital transformation.

• Government Is the Most Important Driver of Digital Economy Development

With its huge scale and influence, government plays a key role in improving the productivity, participation, and creativity of an entire society; and is thus uniquely well suited to dictate the application of digital economy strategies.

In the pursuit of digital economy development, government bears the following responsibilities: It should not only realize its own digital transformation, but also drive the digital transformation of enterprises and social departments to exert a far-reaching influence.

According to the management consulting company McKinsey & Company, with existing ICT technologies, the digital transformation of governments and all industries can generate over USD 1 trillion (CNY 6.67 trillion) a year.

• Leading National Digitization and Improving Competitiveness

In promoting digital economy development, government should provide guidance and support through capital, talent, tax policy, and other programs to create an environment that helps industries better apply information technologies and Big Data.

In the progression toward an intelligent society, the government should make full use of the latest ICT and platform construction to realize new governance models, and transform toward a people-centric digital government through data sharing and analysis. >>

In the next 10 years, information technologies with Big Data as the core element will become new core competitors. More and more countries have developed national strategies to evolve into digital countries. Some examples include Germany's Industry 4.0, Singapore's Smart Country, Kenya's National ICT Development Plan, the E.U.'s Horizon 2020 and Digital Agenda, the United States' Smart Earth, and Japan's Resurgence Strategy.

In the progression toward an intelligent society, the government should make full use of the latest ICT and platform construction to realize new governance models, and transform toward a people-centric digital government through data sharing and analysis. In addition, through collaborative operations and policy guidance, the government needs to promote the digitization of industries and social departments, and enable evolution toward Smart Cities and a digital country.

Two successful examples of governments playing an active role in the move toward Smart Cities (and ultimately Digital Countries) are Yanbu Industrial City in Saudi Arabia (see pg. 58) and Guilin in China. Yanbu Industrial City seized the opportunity offered by the Saudi Arabian government's transformation strategy *Vision 2030*, and initiated Smart City construction to meet modern industrial city construction requirements. And Guilin cooperated with Huawei to develop three major functional sectors: Lijiang, Guilin Old City, and New Industrial City — achieving converged development of the city and its industries.

These two typical cases illustrate how governmentally-guided digital economy development can bring new value to cities. ▲

Actions Speak Louder Than Words: **Huawei Consolidates the Foundation of Smart Cities**

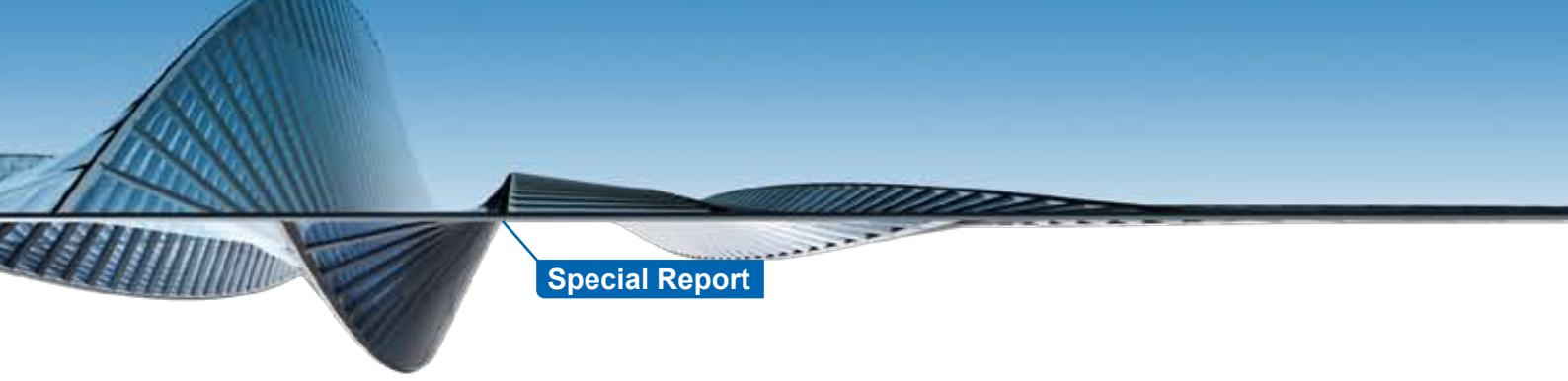
By *Zhang Zhiwei, TechECR Reporter*

'A lack of blood within the brain affects a Smart City's thinking and judgment.' Huawei has expanded its understanding of Smart City as well as its interpretation of the Smart City 'nervous system.'

A 'Smart Brain' Is Not the Only Value of a Smart City's 'Neural System'

During the *Big Data Expo* in May 2018 at Guiyang, China, Huawei's Smart City exhibition area hosted dozens of local and regional mayors. Zheng Zhibin, Vice President of Huawei's Strategy Department and General Manager of Huawei Global Smart City Solution said, "City managers were first attracted by the more than 4,000 indicators of the seven modules running in the 'smart brain.'"

The indicators signify that application scenarios from each domain are reflected in the 'smart brain,' and ecosystem partners can customize the 'smart brain' based on each city's different development requirements. However, Zheng Zhibin added, "The



A Smart City is not born with the ability to think. The sharing and coordination of software and hardware platforms and integrated data perception, transmission, and analysis capabilities are a Smart City's driving forces for self-evolution and self-development.

'smart brain' is just one part of the 'nervous system' of Huawei's Smart City solution. Based on the city's all-scenario data being perceived, transmitted, and analyzed by the 'nervous system,' Huawei has deployed various functions such as situational awareness, operations monitoring, convergent command, and decision analysis to achieve multi-scenario smart management."

Reinterpreting the 'Nervous System'

Zheng Zhibin's words served as the new interpretation of the Smart City 'nervous system.' A Smart City is a combination of 'city + town + production.' Therefore, each functional module of a Smart City should collaborate with each other.

In November 2017, Huawei proposed the concept of a 'nervous system' for Smart Cities. The purpose was to deeply integrate cloud computing, Big Data, the Internet of Things (IoT), mobile Internet, and Artificial Intelligence (AI) into city application scenarios to build Smart City technical systems and a collaborative ecosystem. These systems and ecosystems would then enable ubiquitous perception, connectivity, data, computing, and intelligence.

In this concept, the 'central nerve' (aka, 'smart brain') of the Smart City is the city's Intelligent Operation Center (IOC) and Big Data center. The 'central nerve' not only monitors the operation indices of the city, but also supports emergency linkage, analysis, and decision-making. The 'peripheral nervous systems' (city awareness network systems) correspond to the city IoT wired and wireless communications network, and automatically collect and transmit all-scenario data.

During the Expo, Huawei updated its interpretation of the 'nervous system.' Smart Cities detect resident activities in real time through sensors and video systems; the perception data is transmitted to the city center through ubiquitous networks; and technologies such as cloud computing, Big Data, and AI calculate and analyze the data to support innovative Smart City application systems.

Smart City Neutral System 2.0

What are the differences between the old and the new interpretations?

Huawei is gaining insight into the construction mode of Smart City infrastructure from the perspective of top-level design. Huawei is currently emphasizing that the 'nervous system' is a collection of hardware and software capabilities for various ICT infrastructures in cities.

In 2016, Huawei proposed the 'One Cloud, Two Networks, and Three Platforms' solution architecture for Smart City. In 2017, Huawei proposed the Smart City Neural System 1.0 and reconstructed the previous solution architecture into the 'central' and 'peripheral' nervous systems based on application value.

The current reinterpretation shapes the 'Nervous System 2.0.' Under it, Huawei further emphasizes the association between different nervous systems and the integrity and coordination of the Smart City solutions. The 'peripheral nervous system' is the eyes, ears, hands, and feet of the Smart City. An insufficient blood supply to the 'brain' ('central nervous system') will affect a Smart City's judgment. A Smart City is a living being. If the 'brain' lacks data perception and data transmission capabilities, it will gradually lose its ability to evolve, and will be unable to continuously iterate or generate wisdom.

Smart City Foundation

From an ecosystem and application perspective, the 'nervous system' demonstrates the significance of Huawei's 'platform + ecosystem' architecture. An open platform serves as the Smart City's foundation for the ecosystem to create wisdom. Currently, Huawei has signed

contracts with 30 Smart City strategic partners and established stable cooperation with more than 1,100 solution partners and more than 5,600 channel service partners.

Based on the 'platform + ecosystem' architecture, Yao Jiankui, Chief Engineer of the Smart City Sector for Huawei Enterprise Business Group, believes the 'neural system' of the Smart City is not a simple functional overlay. In fact, the 'neural system' not only implements the support and linkage between the 'brain' and 'organs' of the city, but also supports the smart innovation of ecosystem partners. Furthermore, the 'neural system' achieves universal association and collaboration among various subsystems such as transportation, education, medical care, energy, environmental protection, government management, and public safety.

This is Huawei's reinterpretation of a Smart City's nervous system. Just as human wisdom is derived from a complex nervous system that collects, transmits, considers, and responds to the body and its environment, Smart Cities also need a robust 'nervous system' to enable the complete neural reaction process from front-end perception to decision-making and action.

Coordinated Smart City

How can a complete neural reaction process be achieved?

Huawei's answer is by building Smart Cities with ICT resource coordination. In fact, the 'nervous system' concept embodies Huawei's Smart City construction experience and reflects its capabilities for integrating words with actions. In early instances of Smart City construction, the focus of the projects was not smart innovation. Instead, resources were primarily invested in the interconnection and interworking of ICT infrastructure with the goal of service system and data convergence.

We often complained that more than 10 cameras were installed on a wire pole, yet ignored the hundreds of IoT sensors from different departments; we criticized the repeated construction of urban pipelines, and yet we ignored isolated Geographical Information Systems (GISs).

These double standards are due to a lack of overall thinking. All underlying Smart City ICT resources need to be coordinated. Take Smart Gaoqing as an example. The government conducted Smart City construction based on the 'One Private Network, Five Coordinations, and N-applications' concept, and achieved Big Data, GIS-mapping, video-cloud, converged-communication, and IoT resource coordination.

The Gaoqing model is the rudiment of Huawei's Smart City Digital operating system and the embodiment of coordinated Smart City design. In this model, Huawei integrated Big Data, GIS, video, communication, and the application understanding capabilities of its partners. Through ICT resource coordination, city data convergence and multi-service collaboration were applied to improve city operational efficiency and service capabilities. The automatic data collection and 'nervous system' analysis enabled the city's self-management, self-operation, and self-optimization.

No One Is Born Smart

In Smart City construction, actions speak louder than words. Smart Cities are not born with the ability to think, just as no one is born smart. The sharing and coordination of the underlying ICT software and hardware platforms, and the integrated data perception, transmission, and analysis capabilities are the driving force of Smart City self-evolution and self-development — and fundamental to continuous iteration and wisdom.▲

Just as human wisdom is derived from a complex nervous system, Smart Cities also need a robust 'nervous system' to enable the complete neural reaction process from front-end perception to decision-making and action. >>

Special Report

Standards Safeguard Smart City Constructions

By *Cui Hao, Industry Marketing & Solutions, Enterprise Business Group, Huawei Technologies Co., Ltd.*

In recent years, China has attached great importance to Smart City construction. According to a report delivered at the 19th National Congress of the Communist Party of China (CPC), President Xi Jinping has made significant headway toward establishing 'network power, digital China, and smart society.' Smart City construction will help cities implement diversified public services with universal benefits, achieve efficient and Smart City management, build intensive and coordinated infrastructure, develop a converged and innovative industry economy, establish secure and controllable protection systems, and further fulfill the strategic goals of a smart society.

Standards are important for the healthy development of Smart Cities in China, and serve as the basis for promoting the convergence, sharing, and development of information resources. In addition, standards are necessary conditions for promoting large-scale applications of intelligent technologies such as cloud computing, the Internet of Things (IoT), and Big Data. In fact, standards are an important guarantee for the quality of China's new city constructions.

Huawei has been seeking out and joining international industry standards organizations. By adhering to the 'platform + ecosystem' strategy, Huawei has cooperated with partners to initiate and promote the development of standards for Smart City architectures with the Institute of Electrical and Electronics Engineers (IEEE), and have built a Smart City ecosystem based on the specifications of the Industrial Internet Consortium (IIC). Based on its evaluation of new types of Smart Cities in China and participation in global standards organizations, Huawei has built a Smart City industry ecosystem that effectively supports the healthy development of Smart Cities around the world.

Proposing Smart City Architecture Standards to IEEE

Huawei has actively participated in the formulation of IEEE P2413 (the architectural framework standard of the IoT). Huawei has hosted IEEE P2413 international conferences multiple times, and was elected as an IEEE P2413 editor.

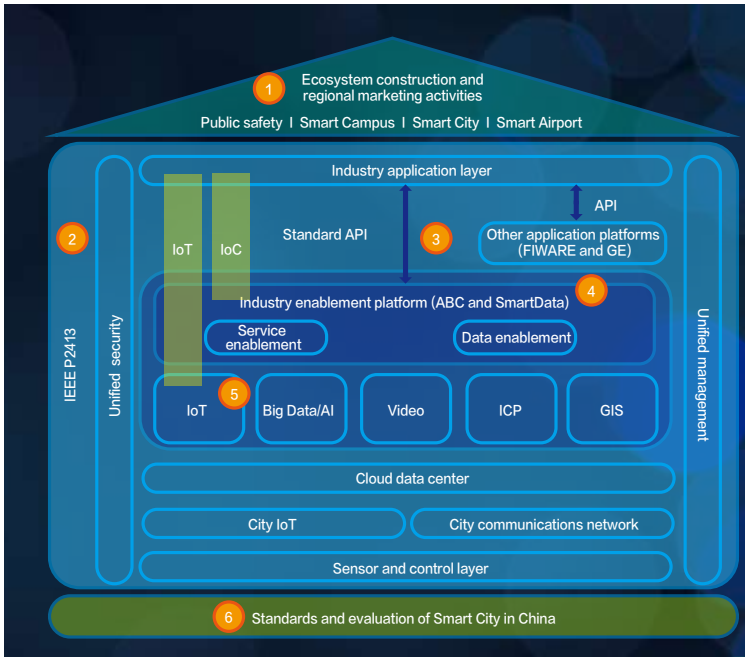
In November 2017, Huawei held the IEEE P2413 working group meeting in Shenzhen, where we introduced the 'one cloud, two networks, three platforms' solution architecture and an abstract architecture of four layers (equipment, communications network, IoT platform, and applications) for the Smart City IoT domain. Huawei also defined the IoT platform and specified modules such as device management, connection management, applications, and Big Data

Standards are a prerequisite for Smart City development, and Huawei has been an active member of industry standards organizations for years. By adhering to the 'platform + ecosystem' strategy, Huawei, its partners, and standards organizations form a Smart City ecosystem that supports the healthy development of Smart Cities.

analytics. In addition, Huawei successfully added the city Intelligent Operation Center (IOC) solution to the IoT architectural framework standard of IEEE P2413. At the IEEE-Standards Association (IEEE-SA) Corporate Advisory Group (CAG) 2018 meeting in Shenzhen, all CAG members unanimously approved the Huawei-proposed Smart City reference architecture standard project P2413.1, which was a huge milestone for IEEE standards in the Smart City area.

The P2413.1 standard for smart city reference architecture will include Smart City IOC, IoT, descriptions of different vertical applications, and the commonality among them. The architecture will describe the Smart City cloud infrastructure, the edge computing and Big Data analytics technologies, and unified security and management. Smart City applications are rich — including smart water management, smart waste management, smart street lamps, smart parking, smart environmental protection, smart campuses, smart buildings, smart healthcare, and smart government — and the P2413.1 standard will provide a blueprint for cross-domain interworking in Smart Cities.

"Promoting standards and building an ecosystem are the best proof of the importance of P2413 standards," IEEE P2413 Working Group Chair Oleg Logvinov said. "Development of Smart Cities, as well as edge computing and its relevant enabling technologies,



1) Huawei built a Smart City ecosystem out of the IIC to promote industry development, and through participation in standards development in China, Huawei has formed a Smart City industry ecosystem.
2) Huawei added its Smart City architecture standards to IEEE's P2413 standard.
3) Interfaces for the Huawei standardized industry enablement platform simplify application development, unify interfaces, enable quick integration, and attract more ecosystem organizations and application partners to develop applications based on platform capabilities.
4) Huawei-selected industry enablement platform to promote standards development and production.
5) Huawei-guided standardization of functional module definitions, which include a connection and device management system (oneM2M), and a Big Data platform (FusionInsight).
6) Huawei participated in China's national standard formulation and pilot site evaluation, which was based on solution planning and sought to promote industry solution adaptations. Huawei's participation reflects its strength in planning, consulting, and solution implementation, and will help to ensure the consistency of standards everywhere.

More than a core member of IIC, Huawei is a member of the organization's steering committee, and plays an active role in promoting network technology applications and collaboration between international standards organizations. >>

is not possible without the IoT. Huawei is one of the founding members of the IEEE P2413, and Huawei's Smart City proposal has significantly promoted the current standard development process. It is worth mentioning that Huawei has been the chief editor of the P2413 standard, and Huawei's leadership in P2413 has continued to improve."

Building Huawei's Smart City Industry Ecosystem with IIC

IIC is an important industry ecosystem. Its mission is to collaborate with all parties in the ecosystem and use common frameworks, inter-operation, and open standards to connect and integrate devices, processes, and data. It aims to accelerate the development of the industrial Internet through pioneering business results. The alliance has gathered organizations in related industries to identify, integrate, and promote the best technologies and solutions; advance the development of the industrial Internet industry; and accelerate digital transformation.

In the Smart City field, IIC members have established a series of testbeds to explore new technologies and applications that include smart water affairs, intelligent construction, energy conservation, traffic optimization, and emergency response. They have adopted the IoT, networks, and Big Data, as well as cloud platform technologies for agile transportation, energy conservation, environmental protection, water management, and efficient and safe operations. In addition, a Smart City test bed project has been launched to promote the research and deployment of new technologies and applications in the Smart City field.

More than a core member of IIC, Huawei is a member of the organization's steering committee, and plays an active role in promoting network technology applications and collaboration between international standards organizations.

For example, Huawei actively promotes LTE-based application solutions in metro and urban rail. Huawei and its partners have created a testbed in IIC to replace the existing Wi-Fi-based train-to-ground communication network with one that can handle multiple services. This network solution, based on the open standard LTE protocol, can greatly improve security and reliability, which reduces O&M workload and costs.

Teaming Up with China's Smart City Standards

To comply with State Council policy and Smart City construction and city management authority requirements, the Standardization Management Committee of China has established the general team, coordination and promotion team, and expert consultation team for national Smart City standards development. The purpose is to specify the overall framework of China's Smart City standards and evaluation indicator systems, determine the overall layout and key areas, and assign tasks for key standards development. The teams are attempting to promote the adaptation of China's standards to meet international standards, and even guide the formulation of new global Smart City standards.

As a key member of both the general and expert consulting teams, Huawei has participated in the organization's activities and has initiated the formulation of Smart City standards for multiple projects. Huawei has supported the general team in standards interpretation, verification, training, and promotion — and most importantly, promoted the implementation of standards in Smart City construction projects.

Through those efforts, Huawei has established itself as an important contributor to and practitioner

of Smart City standards. During its deep engagement in the drafting of China's *Smart Cities Standard System and Evaluation Indicators for New-type Smart Cities*, Huawei analyzed Smart City construction requirements, visualized Smart City solution panoramas, and provided references for Smart City construction. Huawei gained in-depth insights into customer business requirements using Smart City panorama and indicator systems, and combined standard implementation with Smart City planning to guarantee the healthy development of Smart City construction.

The *Smart City Top-Level Design Guide* is one of the most important standards in the system. Smart City requires cross-system interaction, so Huawei needs to consider cross-domain coordination before project initiation. This requires an overall design (covering objectives, key points, and implementation approaches) from a strategic height and a global perspective of city development. As the primary editor of the national *Smart City Top-Level Design Guide*, Huawei has vigorously orchestrated the top-level design of Smart Cities, proactively assisted in formulating national standards based on practices, and provided top-level design for Smart City construction in more than 60 cities, including Beijing, Shanghai, Shenzhen, Nanchang, Lanzhou, and Sanya.

Additionally, Huawei has actively participated in the verification of China's new-type Smart City evaluation indicators, which will help guide pilot site construction and future development. In this process, Huawei has integrated its Smart City construction experience and specific project achievements to form an evaluation indicator system that will verify feasibility and promote indicators throughout the entire country.

For example, at the beginning of Smart City construction in Longgang, Shenzhen, Huawei developed a portrait of the city based on the *Evaluation Indicators for New-type Smart Cities*, and determined the city's three major pain points: 1) A weak data-sharing foundation caused by information silos; 2) City-governance risks due to large floating populations; and 3) A low sense of personal gain due to unbalanced education, medical care, and government services.

To address those pain points, Huawei formulated a top-level design with the '5+6+11' architecture; built the 'one cloud, one network, one map, and one device' unified IT infrastructure; and streamlined more than 50 departments and more than 200 information systems for data aggregation and sharing. In addition, Huawei conducted the development of 11 beneficial services — including government services, smart healthcare, smart education, safe city, and comprehensive governance that improved lives and streamlined city management.

Safeguarding Smart City Construction

Smart City construction has a long way to go, and standards are an important guarantee and theoretical basis to prevent detours in the process. Authorities, cities, research institutes, and enterprises must make concerted efforts and learn from international standards through international exchanges and cooperation. Huawei advocates openness, cooperation, and a win-win philosophy. It aims to provide basic capabilities for the ICT ecosystem of the future smart society, and promote the continuous progression of the industry and society through alliances.

At present, Huawei has built a large-scale, worldwide industry ecosystem. By attracting more partners and cooperating with industry standards organizations, Huawei strives to guide the development of the entire industry. Huawei believes its global industrial layout and project practices will effectively accelerate the promotion and application of China's Smart City standards worldwide.▲

Huawei has built a large-scale, worldwide industry ecosystem. Huawei believes its global industrial layout and project practices will effectively accelerate the promotion and application of China's Smart City standards worldwide. >>

Huawei's New ICT Builds **Key Technological Capabilities for Smart Cities**

- City IoT: The Central Nerve of a Fully Connected City
- Building an Inexhaustible Data Lake and Achieving City Intelligence
- Blockchain: Building Trust in Smart Cities and Accelerating Digitization
- AI Plus 'Cloud-Pipe-Device Collaboration' Promotes Smart Society Development

With the global digital economy entering the fast lane toward full development, the mission of Smart Cities has changed. Smart Cities have become an important basis for the development of local digital economies and a catalyst for sustainable development in general. To contribute to this transformation, Huawei is leveraging its technological capabilities to accelerate the intelligent evolution, deepen sustainable development, and help propel the digital economies of cities that are committed to ushering in a smarter world where all things will be sensed, connected, and intelligent.

City IoT: The Central Nerve of a Fully Connected City

By *Li Jinhui, Director, Smart City IoT Business Department, Enterprise Business Group, Huawei Technologies Co., Ltd.*

IoT Enhances City's Service Capabilities

As one of the strategic emerging industries that is emphatically promoted around the world, the Internet of Things (IoT) not only facilitates the transformation and upgrade of industrial structures, but also functions as an important basis for implementing refined governance and smart services in cities.

In recent years, reduced IoT construction costs (over the past 10 years, the price of IoT processors, sensors, and network bandwidth have decreased by 98 percent, 54 percent, and 97 percent, respectively) and continuous improvements to new technologies and products (such as the IoT, Low Power Wide Area Network (LPWAN), edge computing, and the convergence of broadband and narrowband) have drastically changed the construction and application means of the IoT. New IoT construction and applications feature 'network infrastructures with broadband and narrowband convergence' and 'an ecosystem with various technologies, diversified entities, and multiple-layer applications.'

The IoT has spread to various fields in cities. It not only increases the intelligence of urban facilities such as buildings, bridges, roads, pipeline networks, lamp poles, and parking areas, but also automatically detects their running status, and further integrates with traditional industries to develop new Smart City business strategies, such as smart tourism and smart business communities. This improves the transmission, management, and service capabilities of all spatiotemporal domains in cities.

Three Core Issues Challenging City IoT

To improve and enrich a city's 'nervous system network' and construct an overall sensing system, the following three core issues need to be resolved:

Huawei is a Smart City IoT solution and intelligent platform developer. It provides an 'OS/chip + connection + platform + ecosystem' solution for city IoT expansion.

• Smart City scenarios are diversified, with different connection requirements, such as low power consumption, wide coverage, the coexistence of both broadband and narrowband, and the coexistence of both high density and high speed. Connection capabilities are a major challenge for Smart Cities.

• Large amounts of data need to be analyzed and processed near the data sources of fully connected cities in order to maintain timeliness and efficiency. This complicates Smart City construction.

• The integration of various IoT vertical application scenarios and service innovations is a major bottleneck for Smart City development.

'OS/Chip + Connection + Platform + Ecosystem' Safeguards Smart City Evolution

With the evolution of Smart City IoT, Huawei is positioned as an intelligent platform builder, an innovator of multiple connection modes, and an enabler of the IoT ecosystem. Huawei provides a complete solution featuring 'OS/chip + connection + platform + ecosystem' to address the challenges facing city IoT expansion, ensuring the sustainable evolution of Smart Cities.

• **Huawei LiteOS: Accelerates the rise of IoT terminal intelligence.** With a minimum kernel of 6 KB, LiteOS supports the lightweight secure transmission protocol, DTLS+, and LiteOS is an optimal solution for weak terminals with limited resources (such as memory, storage, and CPU) and that are sensitive to costs and power consumption, such as water meters, gas meters, and vehicle detectors in Low-Power Wide-Area (LPWA) scenarios. The LiteOS supports multiple network access protocols, such as Wi-Fi, Bluetooth, Zigbee, Ethernet, and Narrowband IoT (NB-IoT), to meet the requirements for different types of terminals. The interconnection framework includes a complete device-cloud interoperability protocol stack and supports default connection to the OceanConnect IoT platform. In addition, Huawei LiteOS can be embedded in the Huawei Boudica chip. Terminal vendors can seamlessly connect to the OceanConnect IoT platform through open Application Programming Interfaces (APIs) and NB-IoT networks to quickly put intelligent products into commercial use.

• **Integrated wireless access: Narrowband and broadband convergence for both licensed and unlicensed spectra.** Huawei's eLTE wireless private network integrates broadband and narrowband technologies into licensed and unlicensed spectra. eLTE-IoT is a narrowband IoT technology that complies with 3GPP standards. The technology operates on the Industrial Scientific and Medical (ISM) spectrum and features low power consumption and numerous connections. Both eLTE-Licensed and eLTE-U are broadband IoT technologies. The eLTE-Licensed solution is developed based on 4.5G, and the eLTE-U solution is developed based on 2.4G and 5.8G. The wide coverage and high bandwidth features of both solutions ensure bandwidth for video surveillance, mobile office, and other services. In addition, Huawei is the only NB-IoT supplier that can provide chips, access network devices, and IoT cloud platforms. Huawei is capable of developing protocols independently. Huawei has drafted and contributed to the creation of numerous industry standards. The company has submitted more than 1,000 proposals and over 200 of them have been approved, ranking first in the world.

• **Edge computing: Real-time and fast data processing.** Huawei's Edge Computing IoT (EC-IoT) Solution innovatively introduces edge computing and cloud management into the IoT field. Edge computing gateways provide smart services for surrounding areas, and the Agile Controller can be connected to different partner application systems through open APIs or the enterprise Software Development Kit (eSDK). The solution uses cloud management

architecture to implement smart interconnection and efficient management of a large number of unattended terminals in various industries. EC-IoT supports more than 17 types of interfaces and protocols, meeting the converged access requirements of different industries and scenarios for Smart City construction. This effectively resolves issues caused by the coexistence of new and old equipment, various interfaces and protocols, and connection difficulties at production sites. EC-IoT supports local real-time data analysis to achieve service implementation within 10 milliseconds in Smart City construction. This solution also supports local data aggregation, optimization, and filtering. The collected data is pre-analyzed locally, and only results and high-value data are uploaded to the cloud. In this way, a large amount of status data for Smart City construction is filtered and optimized locally, reducing the network pressure when mass data is uploaded.

- **OceanConnect IoT platform: Enabling rapid industry innovation.** The OceanConnect IoT platform disrupts the traditional terminal-application vertical design concept by adopting the terminal-platform-application architecture to decouple applications from terminals. In this way, the innovation, vitality, and rich scenarios of the IoT are integrated. Open APIs and unique agents can integrate various applications and connect to various sensors, terminals, and gateways to reduce service integration difficulties and help cities quickly enrich IoT scenarios. Big Data analytics help applications quickly determine the value of IoT data and reduce the difficulty of technological innovation. Cloud service suites such as public utilities and the Internet of Vehicles (IoV) can improve and accelerate the application development, and shorten the rollout time of new services. The OceanConnect IoT platform is highly recognized by the industry for its business agility, flexible operations, open ecosystem, and business achievements. OceanConnect was listed as a leader on the IHS Market's *IoT CMP Platforms Scorecard* and won the Best IoT Platform award at *IoT World Europe 2017*.
- **Ecosystem construction: Service integration and application innovation.** Huawei has fostered more than 500 partnerships in the IoT field. The LiteOS open-source community aggregates the developer ecosystem. At the same time, Huawei, as one of the six founding members, initiated the establishment of the Edge Computing Industry Alliance, which has grown to more than 170 members. In addition, Huawei-Weifang Smart City IoT Industry Alliance has aggregated 52 high-quality partners from across the IoT field, both in and outside of China.

Build a Fully Connected, Intelligent World Together

The Huawei Smart City IoT is building benchmark projects around the world. Scenario-specific solutions have been widely used, including a city-level unified IoT platform, NB-IoT, eLTE broadband and narrowband convergence network, EC-IoT, smart street lamps, smart parking, smart water management, and smart sanitation. In this way, enterprises, governments, and residents around the world can enjoy more convenient and efficient work and life experiences.

In Weifang, Shandong, the IoT platform and the NB-IoT network were connected to the city's municipal infrastructure to support 12 industrial-scale applications, such as water management, agriculture, and environmental protection, and upgrade 41 sub-domains to a smarter level. The crisis response efficiency of the city improved by 30 percent, and the labor costs for second-level fault locating were reduced by 90 percent. With approximately three-to-five years of effort, Weifang will invest approximately USD 1.5 billion (CNY 10 billion) into the development of an IoT-enabled industrial park to support the continuing innovation of applications in related industries and social fields. At the *2017 World Economic Forum in Davos*, Weifang's IoT project was featured as an example of an IoT-based Smart City that supports sustainable development that can easily be duplicated. In addition, this Smart City stood out from more than 600 participating cities in the world and was nominated for the 2017 Smart City Award at the Smart City Expo in Barcelona, the world's largest and most influential Smart City exhibition.

In the future, Huawei will continue to embrace the concepts of customer-centric and business-driven focuses; firmly and deeply participate in the construction of Smart Cities; join hands with governments and ecosystem partners to achieve the goals of realizing smarter city administration, providing more benefits to citizens, fulfilling economic revitalization; and continue to build a fully connected, intelligent world. ▲

Building an Inexhaustible Data Lake and Achieving **City Intelligence**

By *Ren Dongmin, Solution Director, Smart City Solution Department, Enterprise Business Group, Huawei Technologies Co., Ltd.*

A Smart City is a Big Data ecosystem centered on and driven by data. Big Data forms only when a large amount of data is fully converged, and, according to Big Data experts, data aggregation is difficult to achieve during governmental Big Data development.

No Data Aggregation, No Big Data

When constructing a city's Big Data center, challenges stemming from data aggregation will arise, like growing data sources, expanding data types, and exploding data volume. Big Data is useful only when it is technologically manageable.

In addition to the typically limited traditional application system data, the Big Data center will aggregate new types of Big Data such as electronic documents and multimedia files generated

China currently leads Big Data development and is driving the emergence of Smart City data lakes. By replicating China's data lake construction, Huawei improves data lake solutions, strives for breakthroughs in governmental Big Data aggregation, and sets sail toward Smart Cities.

by daily work; streaming data generated by city-wide video surveillance and Internet of Things (IoT) sensors; and even the social data resources of enterprises, institutions, and the Internet. How to collect, store, and manage such data becomes a problem for the Big Data center. Enterprises must obtain, store, manage, and understand data before they can achieve 'one-time aggregation and multiple sharing times.'

Simply aggregating massive disordered data will turn a Big Data center into a data marsh, as the data is unstructured. However, a government's information resource directory and information exchange systems process only structured data. With the evolution of government informatization over the past 10 years, technology and management limitations are becoming increasingly prominent.

Governmental Big Data Developments Need to Go Their Own Way

Big Data technologies come from Internet enterprises. However, governmental Big Data is distinct from Internet Big Data in that it is heterogeneous, scattered, and disordered — and data storage is not highly centralized or completely homogeneous. Manual cataloging cannot handle the pressure of metadata annotation for mass data, and the system architecture must be upgraded to that of Big Data. Governmental Big Data is an attribute of public ownership where external value is greater than internal value, and external use occurs prior to internal use. Therefore, the focus is on public data-set development and resource-based services. Data aggregation problems cannot be solved by simply replicating the experience of Internet enterprises and ignoring the scattered distribution, diversity, and value of governmental Big Data.

Generally, Big Data development adopts type-A application modes that focus on data analysis results (application object: Analytical application). For Big Data development, there is also type-D application modes that focus on data content (application object: Public data sets). If data resources are not fully concentrated in scale, most governments should use type-D modes, instead of pursuing rapid development with type-A.

What Is a Data Lake?

James Dixon, CTO of Pentaho, proposed the concept of the data lake in 2010. A data lake differs from a data warehouse in regards to two major limitations: 1) A warehouses can only be used to answer pre-determined questions; and 2) The data stored in a warehouse has been filtered and packaged, obscuring the initial state.

"If you think of a datamart as a store of bottled water — cleansed and packaged and structured for easy consumption — the data lake is a large body of water in a more natural state," said Dixon in his original blog post. "The contents of the data lake stream in from a source to fill the lake, and various users of the lake can come to examine, dive in, or take samples."

The core principle of the data lake is to centrally store original and unchanged data, and then process it only after extraction. Data lakes store various types of data, primarily unstructured and semi-structured, and then allow access to the data through a unified view. The data lake must have powerful metadata management capabilities to ensure the semantic consistency of stored data resources, which is the prerequisite for Big Data analytics.

Data Lakes and Governmental Big Data Value Chains

Governmental Big Data value chains include convergence,

aggregation, management, calculation, and use. The data lake is an upstream part of the chain related to data collection, aggregation, and storage — and functions as the source of Data-as-a-Service (DaaS) and analytical applications. In a narrow sense, the data lake corresponds to the aggregation phase. In a broad sense, the data lake corresponds to convergence, aggregation, and management.

- **For data aggregation,** enterprises aim to build a unified data collection system and a unified Big Data resource pool to optimize data processing on the Big Data supply side.
- **For data analysis,** enterprises aim to establish a channel between Big Data analytics and the Big Data lake so that data can be extracted for immediate analysis.
- **For data management,** enterprises aim to establish a unified metadata management system and a unified raw data warehouse for Big Data analytics to fully meet Big Data demands.

Huawei's 'One Cloud, One Lake, One Platform' Solution

Huawei has proposed the 'One Cloud, One Lake, One Platform' Solution, which leverages the company's extensive experience in Smart City construction, data asset management transformation, and the technical accumulation of Big Data and Artificial Intelligence (AI). 'One Cloud' refers to an eGovernment cloud, 'One Lake' to a data lake, and 'One Platform' to a Big Data platform. The data lake consists of a metadata management platform, data lake warehouse, and data lake service. The metadata management platform registers, counts, evaluates, and disposes of data assets; the data lake warehouse stores native data in a manageable and scalable manner; and the data lake service provides data discovery, preparation, and extraction for external systems.

Huawei launched the Smart City Data Lake Solution to provide an inexhaustible source for the Big Data ecosystem. Huawei's Big Data solution, with a data lake as its core, has the following three capabilities:

- **Early practice and pilot exploration:** With 180,000 employees, Huawei has accumulated extremely complex information systems with massive data resources. Cross-domain data acquisitions can be difficult, or even impossible, due to a lack of permissions or the loss of large amounts of intermediate data which, in turn, prevent legacy systems from meeting digital operations and Big Data analytics application requirements. In 2017, Huawei launched the data asset management transformation project, initiated data lake construction in the product field, successfully applied the Image Process Design (IPD) data lake solution, and constructed a unified database to store theme data for centralized data asset management. In this way, Huawei removed data barriers, connected data, and enabled proactive services.
- **Targeting the future with leading architecture:** In the future, all data will be migrated to the unified eGovernment cloud. In the early stages of advanced and practical systems, organizations can adopt the small data architecture of traditional databases and new Big Data architecture from data lakes and apply unified metadata management. When conditions mature, those same companies can then integrate traditional data architecture with the new Big Data architecture.
- **Automation and high efficiency:** AI technologies enable metadata to be automatically annotated. The existing directory system applies only to structured data and primarily relies on manual cataloging, which has disadvantages like a heavy workload, high complexity, and low quality. After the system stores unstructured and semi-structured data, the manual cataloging method becomes useless because of the large scale — and mature AI technologies such as image recognition, voice recognition, and natural language processing must be introduced to handle video, voice, and electronic documents. Robots understand unstructured data and automatically extract subject words, keywords, and labels. Therefore, the adoption of machine learning technologies continuously improves quality.

Setting Sail toward City Intelligence

China has taken the lead in Big Data development by driving the emergence of Smart City data lakes. In Big Data engineering projects such as Smart Gaoqing; Beijing's secondary municipal center; and Lanzhou's new district — Huawei replicated China's approach to IPD data lake construction and accelerated solution implementation to make breakthroughs in governmental Big Data aggregation, which is helping local governments to set sail toward the new horizons that are Smart Cities.▲

Blockchain: Building Trust in **Smart Cities and Accelerating Digitization**

Source: Huawei Blockchain White Paper

Blockchain has been a hot topic in recent years. Benefiting from its integration with technologies such as distributed data storage, point-to-point transmission, consensus mechanisms, and encryption algorithms, blockchain can effectively identify fraud when data is transferred. Blockchain has expanded from the financial industry to the Internet of Things (IoT), supply chain management, data storage, and transaction fields — and is increasingly accepted as the transaction platform that enables cities to build trusted digital environments.

Development Phase	Typical Event	Function
2009 to 2014 (Blockchain 1.0)	Launch of the bitcoin system	Origin of blockchain technology
2014 to 2017 (Blockchain 2.0)	Release of open-source blockchain projects such as Ethereum and Hyperledger	Optimization of blockchain protocol and framework layers, support for smart contracts, and emergence of public and consortium blockchains
2017 to 2018 (Blockchain 3.0)	Explosive emergence of commercial applications, which have yet to reach any large scale audience	Application of blockchain in different industries

The Rise of Blockchain

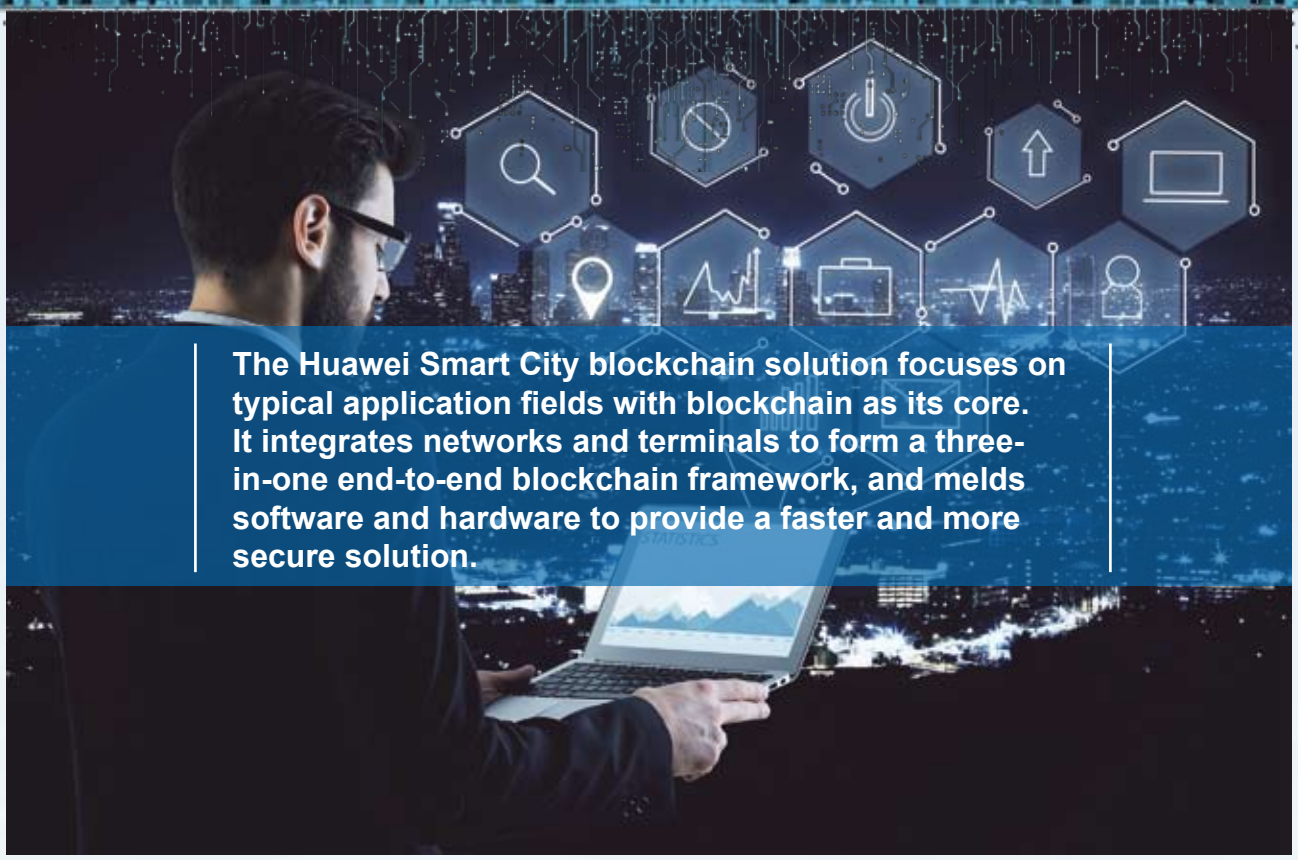
As an independent technology, the history of blockchain dates back to the birth of bitcoin in 2008. By 2018, blockchain ledgers had entered a third phase of utility.

Typical Smart City Scenarios

- **City Data Transactions: Shaping Transparent and Auditable Processes**

Data is the foundation of Smart Cities. The effective exchange and convergence of data are prerequisites for promoting Smart City development. The anti-tampering and traceability features of blockchain foster trust between participating entities, and achieve sustainable and remarkable growth through data transactions for all parties.

The scope of data ownership, including transaction and authorization histories, is recorded in blockchains so ownership can be confirmed. Further, refinements in the authorization process standardize data usage. At the same time, data collection and distribution can be recorded in blockchains to ensure transparency and trace points of origin. In this way, data sources are restricted and quality is enhanced. The decentralized data transaction network can support IoT networks that are distributed citywide, including real-time transaction tracking. Decentralized, blockchain-based data platforms can form large-scale global transaction scenarios so



The Huawei Smart City blockchain solution focuses on typical application fields with blockchain as its core. It integrates networks and terminals to form a three-in-one end-to-end blockchain framework, and melds software and hardware to provide a faster and more secure solution.

that all parties obtain the data required for transparency.

- **Smart Assets: Broadening Smart City Digitization**

The acceleration of city digitization is leading to the increasingly wide use of identity authentication for Internet, IoT, and social and economic scenarios. However, identity services are faced with problems such as private data breaches, identity fraud, and fragmentation, which pose great challenges to users, devices, and systems.

Blockchain has the potential to become a foundational technology in the identity and access management fields due to its high reliability, transaction traceability, and collaboration features. Applying blockchain to identity and access management services may shape a collaborative and transparent identity management solution — and thereby form a digital asset management environment for cities. The liquidity of digital asset proofs far exceeds those of traditional substantial proofs, which help reduce transaction costs and shorten investment cycles, making it possible to raise funds quickly. Digital asset proofs can register substantial products such as real estate, billboards, and cars.

- **Smart Energy: Promoting Sustainable City Development**

Sustainable city development requires the widespread use of new types of energy. To realize the development of the Internet from digitization to informatization, and finally to intelligence, blockchain is transforming existing industries through three high-value capabilities:

- **Precise measurement:** Blockchain-based data ensures trust, access control, and privacy using both public and private keys.
- **Ubiquitous interaction:** Trust is transferred between Internet interaction bodies through blockchain based on trusted measurements, enabling trust-based interoperation.
- **Optimized decision-making:** Blockchain-based Internet devices interact with each other in point-to-point mode, forming a regional consensus. This prevents complex areas and deadloop consensus caused by a large number of distributed devices from forming, thereby effectively improving efficiency.

Huawei recently applied blockchain technology to a smart new energy project. Huawei's blockchain technology allows users to clearly view each transaction record and understand the source of each kilowatt-hour of electricity, that is, from the source point — for instance, a power station's photovoltaic inverter circuit. In addition, users can select the power source based on price and available energy yield. Power generation enterprises can dynamically calculate a power station's supply and demand, and then adjust generation strategies and prices according to consumption.

- **Smart Healthcare: Building a Health Protection System**

From cradle to grave, healthcare has the following characteristics: A large amount of data (including image data, diagnosis data, disposal data, and drug-use data generated by various medical devices); multi-party participation (including hospitals, disease control centers, community health service institutions, maternal and child healthcare institutions, and insurers); lack of a trusted party because of inconsistent interests (for example, competition among the patients, insurers, and hospitals); objective evidence collection (for example, facts such as accident records, can be used by multiple parties); and a large number of process interactions (for example, medical treatment often involves multi-party process interactions). A unified data interaction mechanism will greatly improve efficiency.

Blockchain's advantages coincide with the above characteristics. When using blockchain, a unified, secure, and traceable account book records healthcare service information throughout a patient's entire lifecycle, and can be shared to facilitate a decentralized information exchange.

In addition, based on cutting-edge technologies such as smart contracts and on- and off-chain data interoperation, various processes can be automatically applied to further improve efficiency. For example, a smart contract can simplify insurance reimbursement and ensure pharmaceutical safety and authenticity by monitoring the entire supply-chain process.

Huawei's Smart City Blockchain Solution and Technological Innovation

Huawei's Smart City blockchain solution focuses on typical application fields with blockchain as its core; integrates networks and terminals (including chips) to form a three-in-one end-to-end blockchain framework; and melds software and hardware to provide a faster and more secure end-to-end blockchain solution.

- **Chip:** The software infrastructure, including a consensus algorithm, is incorporated into the chip architecture to improve security and operational efficiency, and solve blockchain's 'last mile' problem.
- **Network:** To safeguard blockchain's large-scale commercial use, the network needs to be involved in blockchain processes. In addition, network architectures need to be upgraded from the original Peer-to-Peer (P2P) topology to a tree structure.
- **Huawei's Blockchain Service (BCS):** A cloud service product based on open-source blockchain technology and Huawei's extensive experience with distributed parallel computing, Platform-as-a-Service (PaaS), data management, and security encryption.

The Huawei Cloud blockchain service is an open, easy-to-use, flexible, and efficient technology. It focuses on a platform built using blockchain cloud technology for the purpose of helping ecosystem partners quickly and efficiently build Smart City blockchain solutions and applications on the HUAWEI CLOUD. Huawei has innovated key technologies based on the difficulties and pain points in blockchain applications.

• Consensus Algorithms

Consensus efficiency is blockchain's core ability to provide external services. The Practical Byzantine Fault Tolerance (PBFT) algorithm uses complex full point-to-point communications to monitor various abnormal behaviors. The communication complexity reaches $O(n^2)$ and requires a large number of signature verifications, which increases system overhead. In addition, the PBFT cannot reach a consensus during primary node selection. Although primary node selection may be continuously performed, if the newly selected primary node cheats or becomes faulty, then blockchain's service capability will be greatly reduced or even invalidated.

Huawei's blockchain uses an efficient consensus algorithm that supports PBFT with independent intellectual property rights to rectify algorithm defects. Unnecessary signature verifications decrease, and communication complexity is reduced from $O(n^2)$ to $O(n)$, which improves consensus efficiency and scalability. At the same time, the consensus process is improved to ensure blockchain service stability during node failure and primary selection.

• Security and Privacy Protection

- **OSCCA-approved encryption algorithm:** Huawei's blockchain supports SM2/3/4, which meets compliance requirements and provides multiple encryption algorithms per the requirements of the Office of the State Commercial Cryptography

Administration (OSCCA), a Chinese certification program for information security products.

• **Homomorphic transaction encryption:** 1) Provides a homomorphic encryption library. User transaction data is encrypted using the public key, and transaction data is encrypted for calculation and storage in the account book. Even if a node is attacked and the account book is obtained, records cannot be decrypted. 2) Provides scope proof verification. The endorsement node endorses the ciphertext and verifies transaction accuracy without decryption. In this way, malicious transaction risks can be identified and smart contracts can be correctly executed. Huawei uses an improved algorithm that yields a performance boost that is 10 times greater than traditional addition-supported homomorphic encryption and zero-knowledge proof based on loop-signatures.

• **Zero-knowledge proof:** Huawei's blockchain provides zero-knowledge proof capabilities to protect user privacy and reduce data breach risks.

• **Smart contract security:** Huawei's blockchain provides a smart contract detection tool to prevent malicious vulnerabilities from invading user data through smart contracts. Users can continuously monitor the provided container's running status and effectively isolate vulnerabilities, and they can ensure contract-running security by controlling its access permissions.

• **Consensus security:** Huawei's blockchain provides hardware-based consensus algorithms with formal verifications that ensure consensus mechanism security, increase efficiency, and upgrade network stability.

• **Account book security:** Huawei's blockchain provides a hardware-based protection mechanism to protect local account book confidentiality and integrity, and prevent tampering.

• **Off-chain Channels**

Transaction processing in unit time is still one of the main bottlenecks in large-scale blockchain applications. Due to the distributed architecture of blockchain, unequal node computing capabilities and different network conditions make an entire network consensus difficult to achieve, which hinders transaction processing.

The blockchain community has long been debating and developing transaction capacity expansion solutions. The existing solutions include block expansion, consensus algorithm improvement, security hardware assistance, Segregated Witness (SW), lightning networks, transaction/status fragments, and multi-layer chains. None of the preceding solutions meet the three key requirements of decentralization, scalability, and security at the same time. However, balance points are expected to be found for specific scenarios.

In large-scale Decentralized Applications (DApps), small payments account for the majority of transaction requests. Small transactions do not require confirmation in a timely manner, so when massive amounts of small transactions are processed through off-chain channels, they do not interact with the main chain. The main chain records the final transaction status only when the channel is closed or when the transaction party exits, which greatly relieves the processing demand. This is the design idea behind off-chain micro-payment channels. Huawei adopts an innovative mode of 'on-chain/off-chain execution' based on efficient and secure handshake transaction party protocols in order to realize more than 2,000 Transactions Per Second (TPS) over a single channel between users.

The Future Development of Smart City Blockchain

In 2017, blockchain and related industries developed rapidly, and China took the lead in the digital economy with its trusted blockchain technology. Rapidly developing Smart City solutions will synergize with blockchain technology, and usher in new opportunities.

• **Application:** 2018 is the first year to see the proliferation of blockchain applications. Before standards are finalized, it is critical to perform trial runs in different Smart City fields, among which government data transactions, proof storage, and IoT fields will be the first. In essence, these fields need to leverage blockchain to build a fair and trusted business environment.

• **Technology:** Security is an important consideration when building blockchains, and the OSCCA-approved encryption algorithms will become the main blockchain application standards in major markets in China. ▲

AI Plus 'Cloud-Pipe-Device Collaboration' Promotes **Smart Society Development**

By *Yao Jiankui, Director, Smart City Department, Enterprise Business Group, Huawei Technologies Co., Ltd.*

From AlphaGo and driverless cars to smart speakers and smart households, Artificial Intelligence (AI) technologies are gradually integrating with physical economies and industries. Smart products are constantly improving people's lives and accelerating the construction of a smart society.

Our society will evolve to be 'smart' over the coming 20 to 30 years. Huawei envisions 'bringing digital to every person, home, and organization for a fully connected, intelligent world.' However, both challenges and opportunities will present themselves during this social transformation.

AI Growth Pains

As part of this AI trend, a full range of enterprises are rigorously researching this field; however, technology improvement comes with its own challenges, and we are facing AI development pain points that need to be quickly resolved.

First, AI needs to simulate human intelligence. We still do not fully understand how human intelligence is generated, and brain science research is still in the exploration stage.

The second pain point is computing capability. As evidenced by the use of large numbers of Central Processing Units (CPUs) and Graphics Processing Units (GPUs) to realize AlphaGo's victory over 9-dan ranked Lee Sedol, large-scale computing platforms are often required to complete single, complex tasks, such as a game of Go. In light of this, what is the future of AI development?

The third pain point is data. We need to integrate AI with each industry, make systems generate a significant amount of data, and transmit the data to AI systems to make them smarter through continuous machine learning. However, the current industry environment cannot satisfy such conditions. Therefore, the data necessary to fully support AI development is currently insufficient.

Huawei's Three Strategies for AI Development

To address these pain points, Huawei has adopted the following strategies for AI development: Technical innovation, collaborative business practices, and open cooperation.

- **Technical Innovation: Building Full-stack Technical Capabilities**

We conduct technical innovation in two aspects. First, we continue to increase our investment in R&D. Currently, Huawei invests in the R&D of real-time analysis and mining, in-depth user modeling and analysis, natural language processing, and analysis theory evolution technologies. The purpose is to gradually become familiar with basic theories and computing capabilities for further AI developments.

Second, we build full-stack technical capabilities using a 'cloud-pipe-device collaboration' architecture, where 'cloud' is enterprise intelligence, 'pipe' is the variety of equipment that connect clouds and devices, and 'device' is for the intelligent terminals. Huawei has formulated a strategy to support the development of AI technology that coordinates the interactions between next-generation platforms, applications, large-capacity information pipes, and a wide spectrum of intelligent devices. To be specific:

- **Cloud:** Huawei released the cloud Enterprise Intelligence (EI) solution in 2017 to provide one-stop platform services for business, industry, and government. The solution includes a heterogeneous computing platform and three types of enterprise-level intelligent cloud services — basic platform services, general services, and scenario-based solutions.

In the last two years, the information technologies that underpin Artificial Intelligence, the Internet of Things, Big Data, and cloud computing have matured. Industries, governments, and people are now clearly recognizing the power of AI.

- **Pipe:** Based on AI analytics, Huawei builds an Intent-Driven Network (IDN) for customers to implement network self-adaptation, self-optimization, and automatic configuration.
- **Device:** In 2017, Huawei released Kirin 970, the world's first smartphone chip with a dedicated Neural-network Processing Unit (NPU). The most significant highlight of the NPU module is the built-in Cambrian Period-1A GPU-based AI unit. The AI breakthroughs included with the Kirin 970 indicate an important watershed moment in the transition from traditional smartphones to all future phones that will include AI capabilities.

• Collaborative Business Practice: Huawei Provides Solutions Based on Customer Requirements

For business practices, we take two approaches. First, Huawei has added AI to our internal production, logistics, and after-sales services to improve operations management and support a sales volume of over USD 100 billion. For example, Huawei requires a large number of customs declaration orders every year to support global logistics operations. Previously, each manifest was processed manually with great inefficiency. AI technology has been applied in the form of optimization measures for the entire process: As intelligent documents are now automatically identified, entered, classified, and archived. This has increased the accuracy of shipment forecasts by 30 percent, decreased logistics expenses by 30 percent, and significantly improved efficiency by shortening the time to import customs declaration documents from 24 hours to one hour.

Second, Huawei joins hands with industry partners to provide customers with AI-based industry solutions. For example, Huawei and the Shenzhen Traffic Police Bureau have jointly innovated to build a 'smart brain' for Shenzhen's roadway infrastructure. The system can detect the traffic information of each lane in real time through video, embedded magnetic coil, and microwave connected sources that provide traffic police with a complete picture in a timely manner. The result is an increase in status detection and reporting accuracy to 95 percent or higher. By applying AI technology, the efficiency needed to identify traffic violation snapshots has improved by 10 times; and a precise traffic-signal-control mode has been developed that, when combined with spatio-temporal analysis of traffic volume and roadway incidents in multiple dimensions, has improved road capacity by more than 8 percent.

• Open Cooperation: Building a Global AI Ecosystem

In the AI field, Huawei has adopted an open cooperation strategy that focuses on the collaboration with ecosystem partners to build a global ecosystem. For the implementation of this strategy, Huawei adheres to a policy of maintaining clear business boundaries for the purpose of developing a platform that supports other platforms and operates as the foundation of the larger ecosystem. Additionally, Huawei has created many joint innovation labs. Together, through joint solution development with partners, Huawei will continue to achieve business successes made greater by the combined strength of many parties. At present, Huawei runs 20 OpenLabs around the world and is working with more than 500 partners to incubate more than 200 joint AI solutions.

We believe that our heavy R&D investment and open cooperation strategy will strengthen our core competitiveness in the AI field and promote further AI development. ▲

Platform Coordination: The Core of **Building County-level Smart Cities**

By *Sang Wei, Global Smart City Director, Enterprise Business Group, Huawei Technologies Co., Ltd.*

Since Emperor Qin Shi Huang united China as one country in 221 B.C., China has operated under the commandery-county system of administrative divisions. In ancient China, the emperor appointed magistrates to govern the counties with the understanding that good governance ensures the stability of the nation as a whole. In the modern age of Digital China and smart society, the county-level administrative regions are facing unprecedented opportunities and challenges. Looking ahead, county-level coordination will become the defining feature of building county-level Smart Cities — and will unleash the potential of digital resources that play a significant role in the county's transformation to a digital economy.

County-level Smart Cities: Stepping Stones to Rural Revitalization and Digital China

Huawei regards the construction of county-level Smart Cities as an important business strategy for two reasons:

- **County-level Administrative Regions Occupy a Unique Position in the State Power Structure**

A county-level government is a grass-roots government with complete organizational design and functional configuration. A county is the connecting point between urban and rural areas and serves important roles for economic development, safeguarding people's livelihoods, and maintaining stability. County-level administrative regions are key to revitalizing rural development, implementing coordinated development of urban and rural areas, and building a Digital China.

- **Social Governance Refinements are Needed Urgently to Replace Outdated Sources of Economic Development in Urban and Rural Areas**

At present, the importance of a digital economy is self-evident.

County-level jurisdictions are the best unit size for building Smart Cities. During county-level Smart City construction, Huawei focuses on business and customer needs.

More county-level administrative regions are eager to leverage new factors of production, such as cloud computing, Big Data, the Internet, the Internet of Things (IoT), and Artificial Intelligence (AI) to accelerate the replacement of old developmental agendas, innovate governmental systems and mechanisms, and address challenges in governance, livelihood services, industry growth, talent loss, and rural revitalization.

However, the overall informatization level of county-level administrative regions is still low. Some vertical industries rely heavily on upper-level departments and are isolated from other branches, resulting in data silos. In addition, many government agencies do not have their own information systems. Against this backdrop, building Smart Cities based on new Information and Communications Technology (ICT) will help the county-level administrative regions upgrade their governance level and capabilities, improve the quality and efficiency of public services, speed up the replacement of outdated developmental agendas, and activate the digital economy, thereby continuously enhancing public satisfaction.

In short, county-level administrative regions are the best units for building coordinated and integrated Smart Cities. They can be the stepping stones for revitalizing rural development to realize a Digital China. How will Huawei build a county-level Smart City?

County-level Smart City Construction: Platform Coordination Is an Inevitable Trend

Currently, Smart Cities in China are sectionalized by government agencies that build separate service systems resulting in repeated investment and resource waste. These systems operate independent of each other, causing information silos and lowering governmental service quality and efficiency. The companies that recognize this problem are taking intensive measures to build new infrastructures; however, the platforms and applications are still not deeply integrated.

During the construction of a county-level Smart City, Huawei focuses on businesses and sets addressing customer challenges as the starting and end points for each engagement. Through top-level design and coordinated construction, Huawei implements in-depth integration of infrastructures, platforms, and applications.

- **County-level Administrative Regions are the Best Units for Building Coordinated Smart Cities**

County-level administrative regions are equipped with relatively comprehensive sets of government agencies, which make them the smallest unit sizes on which coordinated and integrated Smart Cities can be built. In addition, county-level administrative regions have fewer layers of management and relatively simple decision-making processes. Local decision makers attach great importance to business plan implementation, which makes it easier for each jurisdiction to build its own, coordinated Smart City.

- **Platform Coordination is the Optimal Construction Mode for County-level Smart Cities**

• Compared with traditional distributed construction, coordinated construction maximizes resource utilization, saving at least 35 percent of the investment costs and 45 percent of the Operations and Maintenance (O&M) costs. The more applications that are deployed, the greater the benefits.

• Centralized operation and O&M reduce the requirements and dependency on ICT professionals.

• Data sharing, application streamlining, and efficient collaboration across government agencies are implemented.

For example, in Gaoqing, Shandong, data from 54 government agencies is now integrated, and the application systems of more than 10 government commissions, offices, and bureaus have been streamlined. Rainstorm warning data from the meteorological

bureau can now be pushed to the urban management bureau's flood warning system in real time, in order for the staff to better implement the flood emergency response plan before disaster strikes — and equip county leaders to make coordinated decisions for the emergency management departments, including traffic management, water affairs, environmental protection, and emergency handling.

County-level Smart City Solution: A Digital Platform Based on Five Coordinations

Based on successful practices in the county-level Smart City field, Huawei proposes a county-level Smart City solution featuring '1 network + 1 platform + N applications.' Standard terminals, terminal data, communication protocols, and data platforms enable differentiated smart applications to meet different requirements.

- **Smart City Cornerstone: eLTE Wireless Private Network, a Smart City Nervous System**

eLTE is a world-leading 4.5G mobile private network technology developed by Huawei. eLTE solutions have already been deployed in a number of locations, including Shanghai's Yangshan Port, one of the largest and most automated ports in the world. It can also be deployed in a county-level administrative region to build a Smart City nervous system that connects sensors scattered across urban and rural areas and to implement real-time data upload and command delivery, ensuring smooth communication in the region.

- **Smart City Core: Building a Digital Platform Based on Five Coordinations**

Through Five Coordinations, Huawei has built an integrated digital platform for county-level Smart Cities. The platform integrates cloud computing, storage, Big Data, Geographical Information System (GIS) maps, video clouds, and command and dispatch resources in counties.

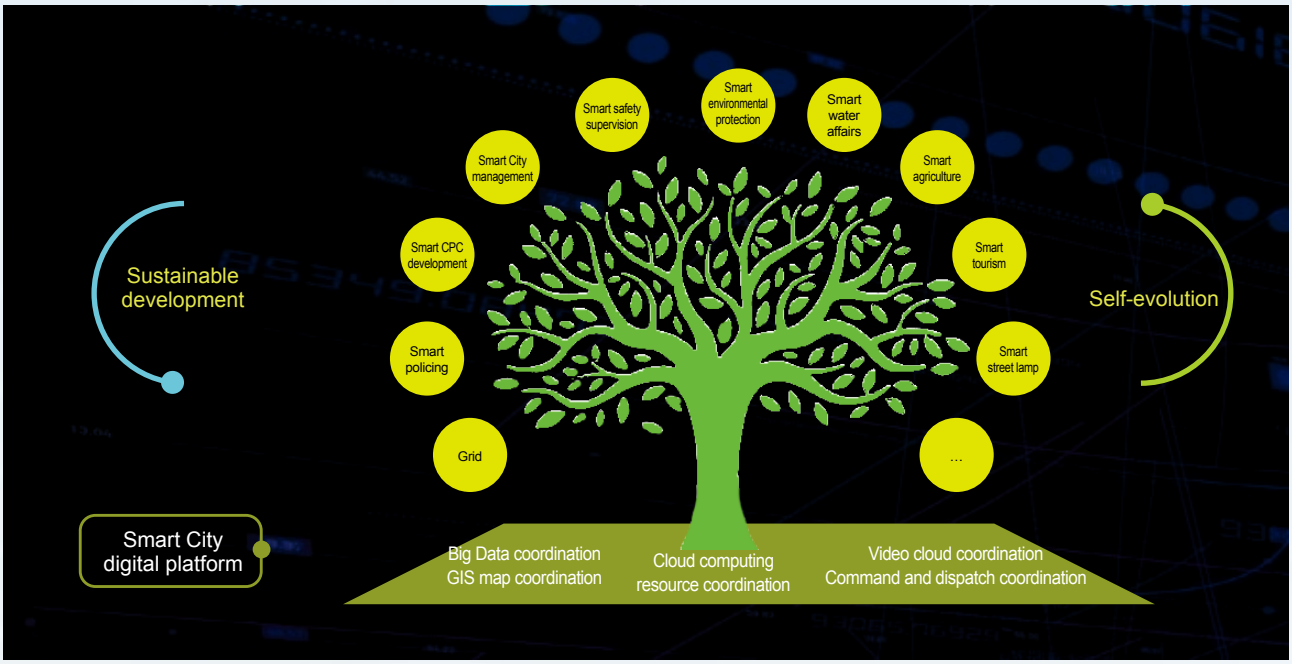
- **Coordination of cloud computing and storage resources:** Provides unified computing and storage resources for all platforms and service application systems in Smart Cities. Government commissions, offices, and bureaus need only to apply for cloud resources based on service requirements. They have no need to purchase ICT hardware devices independently, which reduces hardware procurement and maintenance costs.
- **Coordination of Big Data resources:** Aggregates various data from governments, the Internet, and the IoT; supports data cleansing, analysis, application, and visualization; and provides Big Data support for city managers to improve decision-making.
- **Coordination of GIS map resources:** Displays all county resources on a map, including the population, legal citizens, and city component (cameras, vehicles, law enforcement personnel, hospitals, schools, fire hydrants, well covers, and kiosks) information, and supports cross-department resource scheduling based on the resource map.
- **Coordination of video cloud resources:** Accesses and manages video resources from different departments and industries within the county, including fixed cameras, handheld terminals, and Unmanned Aerial Vehicles (UAVs). The user-rights control function allows these video resources to be shared within authorized departments, which significantly improves the utilization of existing cameras and reduces the need for new cameras.
- **Coordination of command and dispatch resources:** Performs the unified command and dispatch of personnel, vehicles, and cameras managed by the county government, which greatly improves the efficiency of daily law enforcement and emergency handling. For example, when a traffic accident occurs, a police patrol officer uses a handheld terminal to send the on-site video to the city command center. The command center forwards the video to nearby hospitals, as well as traffic management and fire departments, and delivers an emergency command. In this way, related personnel can quickly understand the on-site situation and take appropriate measures.

- **Smart City Vitality: N Applications**

The Five Coordinations have shaped the Smart City digital platform, which provides continuous sustenance for smart applications. A wide variety of applications have been developed, forming a Smart City life that continues to evolve by itself.

Construction Practices of Coordinated County-level Smart Cities

The Five Coordinations have endowed smart applications in Gaoqing with unique value.



Take emergency management as an example. In the past, if a rainstorm occurred during the flood season, more than 20 people would be dispatched to patrol the flood-prone areas in the county, and dedicated personnel would be dispatched to the river gates to stand watch. Even so, flooding frequently occurred. Now, Gaoqing's flood emergency management system, which was developed based on the Five Coordinations, enables multiple departments to jointly combat urban flooding. The eLTE broadband IoT dedicated network can be used to transmit the IoT monitoring information from the flood-prone areas, water gates, and all related video sources (including video from fixed cameras, smartphones, and UAVs), coordinate the information through the video cloud, and deliver it to the command center, achieving all-round awareness of the on-site situation. There is no need to dispatch a large number of human resources for patrol and attendance. Based on data shared by government commissions, offices, and bureaus, all flood-related information and resources in the county are centrally managed on a GIS map, including city components, such as well covers, cameras, water levels, emergency personnel, emergency vehicles, schools, and hospitals. In this way, resources can be quickly allocated. A gate-lifting report is automatically generated based on Big Data analytics and AI-based video analysis to help county leaders make decisions. In addition, the flood emergency management department can cooperate with the traffic management, water affairs, environmental protection, and emergency handling departments in real-time. The coordination of command and dispatch resources allows the flood emergency management department to view the emergency resources of related departments on a map to improve emergency response efficiency.

Another example is smart agriculture. It streamlines the entire industry chain; allows farmers to understand soil and water quality, what crops to plant, quantity of crops to plant, planting method, and management; and helps farmers sell fast, sell well, and earn high income during harvest. In addition, it allows consumers to know who plants and sells the crops and how the crops grow, making shopping more convenient and food healthier.

The preceding two cases are only part of the story. In 2017, Huawei transformed Gaoqing into the first coordinated county-level Smart City featuring full-area, full-domain, full-coverage, full-application, full-system, full-collaboration, and full-connectivity.

Huawei's county-level Smart City solution is dedicated to bringing digital to every person, family, and organization in the more than 2,800 counties of China. This solution greatly improves city governance, increases citizen satisfaction, and promotes industry transformation and upgrades to truly realize the concept of "one Smart City for tens of millions of happy families."▲

GLDM: Digital China's 'Five-Cross' Data Governance Methodology

By *Jia Xibei, Distinguished Expert, National Thousand Talents Plan and CEO, Shenzhen Audaque Data Technology Co., Ltd.*

In the collective studies published by the Communist Party of China (CPC) Central Committee Political Bureau in October 2016 and December 2017, President Xi Jinping emphasized that China must promote technology, service, and data convergence ('three-convergence') to enable cross-layer, cross-region, cross-system, cross-department, and cross-service ('five-cross') collaboration management and service. This has become the guiding principle of government informatization in China. During the construction of Digital China, Audaque needs to comply with this principle and build a 'five-cross' data governance system. Such a system is the key to realizing the value of government Big Data. With the development of the national Big Data strategy and the establishment of the National Network Information Committee and Big Data bureaus in different regions, 'five-cross' converged data governance system construction has commenced in many places.

Although cities have 'three-convergence' and 'five-cross' as guiding principles, they still need a 'five-cross' data governance methodology to establish data governance systems and construct converged data governance platforms. Based on their experience with Huawei's ecosystem and practices, Audaque has summarized the Government Logical Data Model (GLDM) methodology to standardize the establishment of data governance systems and the construction of data governance integration platforms.

Avoiding 'Columbus's Dilemma?'

The government's data sources are like islands (most of them are information silos) that are 'discovered' when built. The era of 'three-convergence' and 'five-cross' is similar to the Age of Discovery in the 15th century when small islands were discovered and connected to the rest of the world, and global trade was made possible. In fact, this current trend is making this moment a data discovery era. In the Age of Discovery, early navigators, such as Christopher Columbus, were often confronted with a dilemma: When they embarked on an expedition, they had no known destination; when they made landfall, they did not know where they were; when they returned home, they had no name for the places they had been. The GLDM is a modern data navigation strategy to help avoid a new 'Columbus's Dilemma.' During the construction of the 'five-cross' data governance system, we do not know what we can do (at the beginning), what needs to be done (during the process), and what we have done (in the end).

To be specific, the GLDM data navigation strategy for data governance system construction addresses 'Columbus's Dilemma' with four elements:

- **Map:** The streamlining of government information resource catalogs is similar to developing a map in the Age of Discovery;

Building a data governance system is the key to realizing the value of Digital China and governmental Big Data. Based on their collaboration with Huawei, Audaque has standardized the GLDM methodology to realize data governance systems and integration platforms.

the finished product can identify the locations of continents (large data users), small islands (data resources), reefs (sensitive data), and glaciers (data that is difficult to coordinate). 'Five-cross' is an essential feature of governmental data, and it distinguishes governmental data from enterprise data. With a hierarchical structure, the government cannot adopt an enterprise informatization construction mode in any place where a unified national IT department builds and operates information systems. Instead, each department or business team at each level must independently conduct informatization construction and operate their own information systems. This makes the streamlining of government information resource catalogs a top priority. The streamlining of these catalogs is a general survey of data and businesses, with the focus on maintaining the status quo and meeting requirements. The contents include the following: 1) Responsibilities and services of bureaus and offices; 2) Processes and systems of each business; 3) Data that is generated and used by each service and system; 4) Databases; 5) Data organization methods; 6) Systems that are being built or planned; and 7) Types of data.

During the streamlining process, the following is collected and recorded: 1) Data and database generation systems and processes; 2) Data source departments; 3) Data storage locations; 4) Metadata (such as database types, data formats, data models, data standards, data update frequency, and data interfaces); and 5) Pain points and bottlenecks (such as business risks and information siloes).

Finally, a panorama of city/regional governmental administration data is formed. Due to the standardization of government responsibilities by regulations such as the 'Three Determinations' (determination of the position, organization, and headcount) and administrative authorization, the streamlining of government information resource catalogs is often similar among provincial, municipal, and county-level governments. Based on such similarities, the GLDM simplifies the streamlining of the catalogs of each government department that adopts the GLDM. The review result of the catalogs is recorded in a metadata management system. In the governmental data governance system, the basic functions of the metadata management system form the government information resource catalogs.

- **Route:** The data sharing and exchange platform charts the course for data navigation. At present, there are many data sharing and exchange platform products, and many articles on data sharing/exchange theory and practice exploration, which will not be elaborated on in this document.
- **Compass:** The data standard, data supervision, and data compliance platforms are similar to compasses in that they prevent data governance system construction from going in the wrong direction. The construction of a data governance system is like building a data factory. The input of the factory is the as-is data (source data). The output includes the data resource (basic library and theme library), as well as the quality feedback and security supervision of the as-is data.
- **Ship:** The data quality governance platform and 'five-cross' data convergence platform are key devices in the data factory. They are the ships of data navigation, and the real navigation depends on the two platforms. The data quality governance platform is like a rudder, which controls the ship's direction. The 'five-cross' data convergence platform is like an engine, which pushes the ship forward.

A data governance system that contains these four elements can be used to manage and monitor the metadata (information directories), standardization process, quality, and security. This system can also support the 'three-convergence' and 'five-cross' concept and visualize this model as 'five-cross' data standardization,

consistency, timeliness, integrity, and entity consistency. In this way, a comprehensive data governance system can be established, which facilitates the implementation and mutual guarantee of data catalogs, data standards, data quality, and data security governance.

Data Standard Platform: Ensure 'Five-Cross' Standardization to Better Control Data Processing

A map is not enough for data navigation because the map can only inform us of the current data and data requirements. If we do not know the data processing goals and target data we can still get trapped in Columbus's Dilemma. We are more concerned that data processing is unpredictable and uncontrollable, and the results vary according to each person, time, and thing; therefore, we need to develop standards for our target data. The more refined these standards are, the more controllable the data processing procedure.

The as-is data is often business-oriented, and its modeling is driven by applications. This means that the as-is data presents us with information such as social security payment and compensation records, test reports, clinical cases, birth certificates, residence registration, rental contracts, and household registration records. On the other hand, the target data is resource-oriented, and its modeling is driven by general data. In essence, the target data is mapped to the physical world and integrates the data description of the city management service entities in the data space. The target data represents every person, certificate, enterprise, social organization, house, component, car, road, and event in the city.

The data standard platform should first implement the modeling of target data, including data encoding, data model, data storage, data exchange format, and data sharing interface standards, as well as data meta-standards.

Second, the data standard platform must enable gradual standardization from the source data to target data. As the as-is data systems and databases have been constructed, abandoning the model, code, type, dictionary, format, and interface of inventory data and starting all over again is costly. In addition, a large number of new smart applications will be deployed during Smart City construction and a large amount of incremental data will be generated. If we adopt the source business data standards that are compatible with the target data during new system construction, data waste will be greatly reduced and a significant number of data cleansing costs can be saved; therefore, the data standard platform requires general business data standards and key dedicated business data standards, and we must adopt these standards in the initiation and acceptance of informatization projects.

Third, the data standard platform needs to implement standardization in the data processing procedure. Both the as-is data and target data are standardized, making it easy to standardize the process of transforming as-is data into target data. In this way, we can construct the data factory in a standard manner and make the data factory a systematic, standardized, and intelligent data refinery. Data processing standards include data cleansing rules, data fusion process standards, and data quality assessment standards. The standardization of the target data, source data, and processes prevents detours, wrong directions, and other mistakes. The data standardization platform has the following functions:

- Assists in formulating standards (through standard induction, discovery, and analysis).
- Manages existing standards.
- Ensures standard application in system design and development (through standard registration, release, subscription, and adoption registration).
- Performs standards compliance tests on inventory and incremental data, detects data problems using standards (through data error check), implements intelligent standardization on problem data, and solves the problems (through error correction).

Data Supervision and Data Compliance Platforms: Ensure Data Security and Prevent Risks

The data standard platform can solve the most difficult issue in data governance system construction: Standardization. However, data governance system construction has another important issue: Security. Information resource catalog streamlining reveals the data in each bureau and business system. How can Data Protection Authorities (DPAs) prevent security problems in the processing and application of source data and target data? How can they seal all data leakage points to prevent data loss, data breaches, malicious tampering, and illegal commercial use? DPAs must utilize data supervision platforms to ensure information security.

In fact, data transactions, operations, openness, and sharing should be under effective data supervision to ensure healthy and orderly processes; otherwise, risks will accumulate in transactions, operations, openness, and sharing. >>

In fact, data transactions, operations, openness, and sharing should be under effective data supervision to ensure healthy and orderly processes; otherwise, risks will accumulate in transactions, operations, openness, and sharing, and with the implementation of data legislation and data policy formulation in the future, flare-ups can occur at any time. DPA departments must supervise data exchanges and data operation companies to avoid data disorder. This is similar to the scenario where Securities and Futures Commissions regulate stock exchanges to avoid problems, such as an Internet financial crisis. "Render to Caesar the things that are Caesar's; and to God the things that are God's." The market can develop and use data. However, data supervision is the bottom-line responsibility of the government in data transactions and operations, as is similar to the finance bureau having responsibility for supervising the financial industry, land resource supervision responsibility by the land bureau, and the content creation and public opinion survey responsibilities of the cyberspace administration.

The General Data Protection Regulation (GDPR) for data supervision and protection in the EU took effect on May 25, 2018. Some regulations, such as "right to be forgotten," "right to data portability," "right to be informed," and general record keeping requirements are exerting significant influence on Internet and Big Data enterprises in China. At the same time, the "owner principle" (long-arm jurisdiction principle) and "personal information exit principle" will affect China's data sovereignty and data legislation. Data protection legislation, establishment of a DPA, and the specification of the DPA's supervisory responsibilities must be implemented as soon as possible. The data supervision platform prevents data governance system construction from taking detours or the wrong paths.

In addition to the data supervision platform constructed by the DPA, enterprises and government bureaus that process personal information need to build a data compliance platform that will be managed by the DPA. The purpose is to ensure the implementation of data management measures and eliminate risks in data collection, processing, sharing, exchange, and openness.

Data Quality Governance and Data Convergence Platforms: Ensure Data Quality and Prevent GIGO

After creating the map, route, and compass of the data navigation process, we need a vessel to ship the data to the destination. The ship's core components are the rudder (data quality governance platform) and engine ('five-cross' data convergence platform). Garbage In, Garbage Out (GIGO) can occur in 'five-cross' data processing via governmental administration applications in complex scenarios. In this case, data application makes the situation worse. The two platforms can prevent this from happening. During the transformation of the source data to target data, problems such as data duplication, data conflicts, data errors, and format disorder can emerge. There are two kinds of errors: Format errors and substantial errors. Format errors can be rectified by current technical measures such as automatic data cleansing. By contrast, substantial errors cannot be rectified in a fully automated manner. In addition, government departments often do not allow automatic data cleansing. To deal with substantial errors, source business systems or data responsible departments must manually modify data while complying with laws. However, large-scale manual intervention takes a long time, hindering data resource library construction. Therefore, we need both a data quality governance platform and a 'five-cross' data convergence platform. The data quality governance platform automatically detects data errors, introduces manual intervention to rectify substantial errors (the system provides recommended

Information resource catalog streamlining, the data sharing and exchange platform, the data standard and data supervision platforms, and the data quality governance and 'five-cross' data convergence platforms constitute the GLDM 'five-cross' data governance methodology for data navigation.
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values), and controls the quality of source data. The 'five-cross' data convergence platform does not require manual intervention. It can ensure and improve data quality to the greatest extent and enable precise decision analysis applications. While ensuring correct statistical significance, the 'five-cross' data convergence platform can continuously deal with all data problems in the background and build a data resource library in the shortest time.

The data quality governance platform comprehensively uses technical measures and management mechanisms to control source data quality, and scientifically appraise the data sharing performance of commissions, bureaus, and offices. The 'five-cross' data convergence platform is like a factory with round-the-clock data production lines that extract source as-is data to target data resources. In the GLDM methodology, the data quality governance platform is a data 'Skynet' system consisting of three data governance network layers (exploration network, standard network, and quality network). The 'five-cross' data convergence platform is a data factory with a production line-based structure of six layers (history, standard, atom, integration, data mart, and application).

GLDM: Building Blocks for the China Data Governance Solution

Information resource catalog streamlining (map), the data sharing and exchange platform (route), the data standard and data supervision platforms (compass), and the data quality governance and 'five-cross' data convergence platforms (ship) constitute the GLDM 'five-cross' data governance methodology for data navigation. The cooperation between Audaque and Huawei has made this methodology the best form of knowledge accumulation, and it now provides guidance for best practices. It enables Big Data center construction to avoid the detours and mistakes of early exploration. As a practical exploration of the 'three-convergence' and 'five-cross' principle, data center construction using the GLDM methodology is highly successful.

Over the past 30 years, Logical Data Models (LDMs) have played a vital role in many fields, such as finance, telecommunications, energy, and transportation. Teradata, the data warehouse leader, has become one of the most important data companies in the world with its insights into LDMs in many industries. Worldwide, there is a lack of large-scale 'three-convergence and five-cross' practices and logical models for cross-department and cross-service governmental data. This means that 'five-cross' LDM is currently unavailable. The development of the GLDM methodology fills this gap. By continuously summarizing the data center and data governance system construction experience of each province, city, district, and county, the GLDM helps gradually improve data center and data governance system construction at all levels.

At the *Big Data Expo* in May 2017, the GLDM methodology received extensive attention and was reported heavily by the *People's Daily Online*, *China News Service*, *Phoenix Financial Daily Report*, and Guizhou local media. Audaque is working with more provincial-, municipal-, district-, and county-level Big Data centers, Big Data bureaus, economic informatization commissions, cyberspace administrations, and digitization offices to summarize and share more experience in data governance system construction and enrich the GLDM methodology.

At the *Huawei Partner Conference 2017*, Audaque and Huawei jointly released the governmental data governance and convergence solution with GLDM as the methodology. This solution has been demonstrated several times and won wide recognition. Audaque is willing to work with governmental data authorities to explore, practice, and create building blocks for China's Data Governance Solution. ▲

NB-IoT Apps Enable **Agricultural Digitalization**

By *Zhang Dandan, President, Shenzhou Agricultural Group of Digital China Agriculture, Beijing, China*

Trending and Potential Developments for Agricultural Digitalization

Compared with the level of IT application development in other industries, China's agricultural sector has lagged behind the times and remains quite traditional. Faced with a generation of retiring farmers, the agricultural labor force is shrinking which, in turn, is causing a past demographic dividend to subside. Simultaneously, a new land and property rights system is being established — the result of which is to move agricultural production toward centralization, industrialization, and moderate economic growth. Science-driven agricultural industrialization is transforming farming practices from traditional and experiential to digital.

Based on generations of experience and first published in 104 B.C., the Taichu Calendar included '24 solar terms' to guide China's seasons for planting and harvest. Agricultural production depends on an understanding of the natural environment and weather patterns. In the modern world of advanced information technologies, it is essential that our agricultural production practices be guided by the

With years of experience in the agriculture industry, the Shenzhou Agricultural Group uses Huawei's Internet of Things and cloud ecosystems to develop IoT products and cloud service applications that enable agricultural digitalization.

powers of data collection and scientific analysis. The adoption of smart agriculture practices is enabling a fundamental transformation from 'living at the mercy of the elements' to 'living with an understanding of the environment.'

Agricultural production contains a variety of meteorological, environmental, soil moisture and fertility, water quality, animal and plant ontology, parcel, circulation, and pricing data. The collection and analysis of this data will greatly improve the quality of agricultural and pastoral products, reduce production costs, minimize pollution, and increase benefits. Therefore, agricultural digitization offers great potential for farming applications.

NB-IoT Enables Agricultural Digitization

Agricultural data collection has the following features:

- A single farm requires the collection of many types of data, but agricultural data is scattered. For a single type of data, collection locations are limited and farms are scattered throughout suburban and remote areas.
- Data collection comes at a high cost, but yields only a minor increase in agricultural production value. Therefore, to be widely implemented, collection sites must have low construction and O&M costs.
- It is difficult to deploy cables and power supplies in the field. Therefore, solar panels or batteries are recommended as power sources, and wireless transmissions are recommended for data collection.

The NB-IoT has the following advantages in terms of data transmission:

- Low power consumption: The power consumption during normal operation is less than 20 mA so that batteries can last for several years.
- Low cost: Both the module and operational costs are significantly lower than those of the cellular network. Moreover, a battery power supply is adopted, which greatly reduces deployment and hardware costs.
- Compared with non-4G transmission, gateway deployment is unnecessary, making devices easy to install.
- With wide coverage and a large number of connections, the Huawei NB-IoT solution can resolve issues related to scattered agricultural data collection.

The NB-IoT technology facilitates production and circulation data collection. And comprehensive and large-scale data collection lays a solid foundation for agricultural digitization.

NB-IoT Application Scenarios in Agricultural Digitalization

Soil temperature, humidity, Electrical Conductivity (EC), and Potential of Hydrogen (PH) values affect crop nutrient absorption, growth, and photosynthesis. Through the use of low-cost, dynamic, real-time data collection with timely adjustments, crops can thrive in suitable soil to ensure high yield and quality.

In agricultural production, if the temperature and humidity are not suitable for plant and animal growth, diseases and pests will frequently materialize, necessitating excessive use of pesticides and antibiotics, which affects the quality and safety of agricultural products. Real-time collection of accurate temperature and humidity data can help predict and prevent diseases, and control pests through preventative environmental measures.

Northern China suffers from chronic water shortage and agricultural irrigation consumes the largest amount of water (65 percent). To promote the scientific usage and conservation of agricultural irrigation, the government is conducting comprehensive

water pricing reform with accurate water measurements as the basis. Devices such as water meters and sensors need to be installed in channels and wells with motorized pumps, impeding power supplies and signal transmissions. And the large amount of manpower required for meter reading prevents timely data collection and scientific guidance for irrigation usage.

Utilizing NB-IoT applications, irrigation data can be obtained in a timely, comprehensive, and convenient manner — enabling accurate water scheduling for the entire irrigated area, and guiding data-driven water use. Digital and scientific water use improves the efficiency of agricultural irrigation and helps conserve water.

In the animal husbandry industry, it is difficult to stay informed on the health status of grazing livestock. If no measures are taken to deal with disease, treatment can become complex, and more importantly, the disease may infect more animals and cause great losses. By using NB-IoT-based intelligent collars, you can record the location, behavior, and vital signs of farm animals in real time; track their location; obtain early warnings of disease; and monitor their emotional state to improve production — thereby promoting refined breeding management and reducing risk.

Farmers can also forward the data collected to insurance institutions and banks, which promotes the development of agricultural insurance and loans. In addition, the data can be shared on eCommerce platforms to promote the reservation and pre-sale of livestock, and increase the added value of animal husbandry products.

A large amount of data needs to be collected and transmitted in the modern agricultural industry. As one of the many data transmission approaches, NB-IoT is not applicable to all scenarios. Data collection should be application-oriented, that is, data collection and transmission modes must be selected based on site requirements. The core value of the NB-IoT is enabling more convenient IoT network construction and more efficient data collection.

The application of NB-IoT will continuously promote the connectivity of everything in agricultural and rural areas, and the large amount of generated data will continuously promote the digital development and achievement of intelligent agriculture with algorithms and computing advances. >>

Shenzhou Agricultural Group Application Practices

The R&D team within the Shenzhou Agricultural Group has upgraded the company's soil and environmental information collectors based on Huawei's NB-IoT modules, and has further implemented data collection and transmission in the agricultural park of Weifang, in the Shandong province. At the same time, the R&D team has built an agricultural service platform on HUAWEI CLOUD, which has achieved fruitful results in irrigation and fertilization guidance, and in early warning and analysis of disease and pests with comprehensive data analytics.

In addition, the R&D team has upgraded their water meters with the NB-IoT-based transmission technology, and developed NB-IoT-based intelligent collars for farm animals (currently being tested). With the large-scale deployment of NB-IoT base stations and comprehensive network coverage, these smart devices will be widely used in the future.

The application of NB-IoT will continuously promote the connectivity of everything in agricultural and rural areas, and the large amount of data generated will continuously promote the digital development and achievement of intelligent agriculture with algorithms and computing advances. With years of experience in the agricultural field and Huawei's Internet of Everything and cloud ecosystem, the Shenzhou Agricultural Group is continuously exploring and developing IoT products and cloud service applications for the modern agriculture industry, enabling agriculture digitization. ▲

‘Fertile Soil’ Grows a Robust Ecosystem

By *Zhao Jue, Zol.com.cn*

In the spring of 2018, the *Huawei China Eco-Partner Conference 2018* was held in Qingdao. A feast for guests interested in Smart City construction. Huawei exhibited smart solutions for a full range of domains, including education, healthcare, government, industry, and business — and invited more than 700 industry professionals to participate in a summit meeting: ‘Aggregating Ecosystem Partners to Build Living Smart Cities.’ Domain experts, contractors, government spokespeople, and enterprise representatives all shared their views on current development trends, recent construction experiences, and the Huawei Smart City development ecosystem.

Smart City Ecosystem Highlights

According to Zhang Yande — President, China Smart City Department, Huawei Enterprise Business Group (EBG) — smart cities must meet the following three standards:

- Implement Smart City requirements as established by national ministries and commissions to ensure citizen quality of life.
- Improve the efficiency and effectiveness of city management by using cloud computing, Big Data, the Internet of Things (IoT), and mobile Internet technologies.
- Accelerate local industries through digital transformation.

These three standards are also applicable to all phases of Smart City system development, from top-level design to infrastructure construction to operating services. Effective Smart City deployments require specialized ecosystem partners from each sector to base their solutions on Huawei’s platform specifications to meet customer requirements. The goal is to promote urban innovation, enable transformation, and improve quality of life.

TelChina Smart Industry Group Co., Ltd. (TelChina) is a core partner in Huawei’s Smart City ecosystem, and has cooperated with Huawei to deploy the Smart City platform in Weifang, Gao Qing, the high-technology district for Qingdao. Huawei and TelChina have jointly developed a comprehensive Smart City system and method covering technology, applications, and services.

Ma Shujie, Chairman of TelChina, said Huawei and their Smart City partners have a clear goal — improve everyone’s well-being through Smart City construction.

Ma is particularly impressed by two characteristics of the Huawei Smart City ecosystem. First is the value proposition. With Huawei’s assistance, cooperating enterprises are able to fully unleash the strength of their innovation. In the Huawei ecosystem, partners form differentiated products and services to provide cities with best-in-class Smart City services for sustainable development and operations efficiency. Second, both Huawei and their partners foresee a broad space where they can reliably grow together over the long term, which enables them to stay focused on key domains, and encourages a professional and dedicated atmosphere for cooperation.

In addition to instilling value and leadership, Huawei establishes clear boundaries between all stakeholders that contribute to the attraction of its Smart City ecosystem.

Huawei adheres to the core principle of not competing with its partners. Further, Huawei emphasizes partner cooperation in all phases of the Smart City life cycle to strengthen the advantages of Huawei’s Smart City platform. Huawei is committed to providing partners with opportunities for learning, communication, marketing, and market expansion.

‘Fertile Soil’ Nurtures Smart City Development

Huawei recently proposed the ‘fertile soil’ concept. By focusing on ICT infrastructure and smart terminals, Huawei provides an information-based, automated, and intelligent environment in which partners are encouraged to grow their businesses.

Jia Xibei, CEO of Shenzhen Audaque, has his own understanding of ‘fertile soil:’ Partners must be self-sufficient and prepared to push

Huawei provides the 'fertile soil' for cultivating a robust Smart City ecosystem through scientific data management and data operations services. Huawei's Smart City Ecosystem will be the new blueprint for Smart City development.

through inevitable challenges to grow in Huawei's new environment. Jia explained that Smart Cities are not constructed overnight, and require a determined effort. Indeed, building a Smart City ecosystem demands a devotion to delivering quality services that bring real happiness to city residents through hard work and innovation.

Shenzhen Audaque began working in the Big Data domain in 2011, and the company has processed billions of records using in-house technology. In China, this type of data management service is still regarded as the cutting edge for advanced applications. However, to Jia's team it is a direct extension of the established trends in large-scale urban data convergence, and the value is evident. Shenzhen Audaque focuses on reducing theories to practice through technologies to create data services that meet government regulations for financial industries. Shenzhen Audaque fully leverages the value of data to improve human welfare, revitalize local economies, improve governance, and optimize government operations.

To address problems with legacy Information Technology (IT) installations such as data silos, poor quality data, insufficient application demand, and more — Shenzhen Audaque and Huawei have jointly released the Audaque & Huawei City Big Data Solution.

The solution provides full-lifecycle management for new Smart City-oriented data collection, aggregation, sharing, mining, and services that establishes a scientifically based decision-making mechanism applying innovative data-driven presentations. The objective of this joint solution is to optimize the government's management philosophy and social governance mode.

To ultimately benefit people and industries, an integrated data platform is indispensable. Audaque and Huawei include the underlying technical infrastructure, a middle-layer for data exchange, and upper-layer applications supporting the interconnection of all systems.

Zhang emphasizes additional prerequisites for Smart City construction. First, data must be converged and streamlined to allow city departments to collaborate with each other by forming a unified 'neural data pipeline' for improved command efficiency. Second, Smart Cities need to collect IoT terminal data from across each city, analyze and process the data, and deliver results through a 'neural platform.'

Smart City construction relies on high-quality infrastructures, operations, and services; and must also deliver superior data management. A 'Do it Yourself' (DIY) spirit is reflected not only in the efforts of the builders, but more importantly, in the objectives of administrators following their own development path. The key is to identify the practices that promote each city's exceptional characteristics.

Four Aspects Improve the City Ecosystem

At the *Huawei China Eco-Partner Conference 2018*, Huawei's exhibition area, forum, and new cooperative relationships conveyed the unique value of the company's approach to Smart City.

- Adhere to the 'Platform + Ecosystem' strategy, aggregate ecosystem partners through open platforms, and jointly provide customers with the tools required for Smart City construction.
- Provide key technical capabilities for Smart City construction and become an important standards contributor and technical innovation leader in cloud computing, Big Data, IoT, 5G, Artificial Intelligence, and other domains.
- Set clear business boundaries (e.g. circumventing user applications or data).
- Play a leading role as a Smart City practitioner.

In short, the Huawei Smart City Ecosystem serves as 'fertile soil' for cultivating the wellness of the larger ecosystem through data science, data management, and operations services — as is reflected in every aspect of Huawei's new blueprint for Smart City design. ▲

Yanbu Industrial City: A Smart City Emerges in the Oil Kingdom

In recent years, falling global oil prices have created challenging opportunities for Saudi Arabia to move towards renewable energy and opening new investment projects that will support the economy since oil generates about 70 percent of the country's revenue. As such, Saudi Arabia announced its new transformation program called 'Vision 2030' in April 2016. This ambitious yet achievable blueprint has clarified the goals of developing cities, achieving environmental sustainability, improving digital infrastructures, and expanding the variety of digital services. In particular, this new initiative recognizes the significance of expanding industrial clusters and attracting more high value-added investments — as feasible ways to build up national competitiveness. In line with Saudi Arabia's vision, the Smart Yanbu Industrial City project has started to build upon the hopes of Saudi Arabian citizens for transformation.

Smart Yanbu Industrial City, a Transformative Engine for the Oil Kingdom

In 1975, Yanbu Industrial City was set up according to a royal decree and managed by a Royal Commission. After more than 40 years of fast growth, Yanbu industrial city has become the third largest oil refinery center in the world. It can produce more than 1.1 million barrels of oil every day, and its yearly industrial production capacity reaches 131 million tons. Yanbu has also set up the largest petroleum transportation port near the Red Sea and established key petroleum liquefying and processing locations.

Yanbu industrial city has become the beneficiary of high-speed industrialization. The efficient city layout, wide roads, sufficient public spaces, and green parks all indicate the vitality of this fast-growing city. However, Yanbu is also facing ever-increasing pressure. For example, limited network bandwidth cannot meet the requirements of governments, enterprises, and residents, affecting office efficiency and online entertainment experiences. The daily operations of large refining factories, ports, and warehouses, as well as large-scale city construction require a large number of heavy vehicles. Overloading and speeding by these heavy vehicles have caused costly maintenance for the roads. Public parking spaces are difficult to manage because there are too many private cars. Road lighting costs are high. Building rubble and waste are sometimes not handled in a timely manner. Security risks exist in densely populated areas. A large number of underground industrial facilities need security due to lack of monitoring.

In line with 'Vision 2030,' the Royal Commission for Yanbu (RCY) decided to take the lead in addressing the Yanbu industrial city challenges by constructing the Smart Yanbu Industrial City.

Dr. Alaa Nassif, Chief Executive Officer (CEO) of RCY, said, "Today's global competition is fierce. We hope to maintain the competitiveness of the city through our Smart City initiative. We have focused on industrial growth over the past 40 years. Now, we will gradually shift to more diversified sectors including

In line with 'Vision 2030,' the Royal Commission for Yanbu decided to construct the Smart Yanbu Industrial City, to create industrial clusters, expand business diversification.

entertainment, tourism, and science and technology. In doing so, we desire to create industrial clusters, enhance collaboration between industries, expand business diversification, improve investment environments, and enhance competitiveness."

"The vision of building a Smart Yanbu Industrial City is aligned with the 'Vision 2030' goal. It aims to improve the quality of life through a smart city. We have set a series of specific goals. For example, all national transformation projects that have been planned will be on the right track; the annual smart city revenue will exceed USD 66 million; the average incident response time will be less than 7 minutes; the annual traffic accidents will be fewer than 1,200; the optical fiber coverage rate will be greater than 59 percent; the free Wi-Fi coverage rate in public places will be higher than 70 percent; the public lighting costs will be reduced by 30 percent; the waste clearing efficiency will grow by 30 percent; and the road maintenance costs will be reduced by 20 percent." added by Dr. Nassif.

The Smart Yanbu Industrial City plan has three phases:

- **Phase 1 (Smart City 1.0):** Focuses on the construction of city infrastructure, such as city broadband and cloud computing, to build a connected city
- **Phase 2 (Smart City 2.0):** Revolves around city applications, including security, intelligent public services, and environmental protection, to build a sensor-enabled city
- **Phase 3 (Smart City 3.0):** Centers on the city platform, covering the city management platform and smart community portal, to ultimately build a fully intelligent city

The Smart City Initiative Pays Off After Two Rounds of Construction

It is impossible to conceive of smart cities without strong information infrastructures. For Phase 1 of the project, city broadband was the core, and RCY implemented Public-Private Partnerships (PPP). Specifically, RCY provided public infrastructures such as roads, buildings, power grids, and water services, city optical networks, while the telecom operator Mobily delivered telecom infrastructures and Huawei provided ICT solutions, including Smart City data centers, GSM/3G/LTE, as well as related service and operations support systems.

This PPP mode gave full play to complementary advantages and ensured mutual benefits. As a result, the wired and wireless broadband networks across the entire city were quickly constructed, providing high-speed network access services, and delivering improved network experiences for governments, industrial, and residential areas. In addition, open access networks were deployed to connect the transportation signal facilities to prepare for the construction of the next phase of the Smart City.

In 2016, for Phase 2 of the project, smart applications were launched. Aiming to enhance municipal administration, RCY focused on eight smart applications, including Heavy Vehicle Management, Smart Waste Management, Smart Streetlight, Smart Parking, Smart Energy Efficiency Monitoring, Crowd Density Analysis, Smart Manhole Cover, and Comprehensive Performance Assessment. These applications improve municipal administration efficiency, enhance public safety, and create a better living environment. Huawei provided a comprehensive portfolio of network and IT solutions (including wireless access points, routers, switches, servers, storage, and 2G/3G/4G base stations), devices such as surveillance cameras, the eSight + Network Management System (NMS) platform which uniformly manages network-wide devices, and software products provided by Huawei partners. All these help ensure that the data collected by front-end devices can be transmitted to the back-end system in a secure, stable, and real-time manner for management and analysis.

• **Heavy Vehicle Management:** Almost all industrial cities have these big headaches: Overloading and speeding of vehicles, which make the road easy to be damaged, and need a lot of maintenance costs. To prevent this, Yanbu has buried pressure and length sensors in important entrances and exits of the industrial areas. These sensors work with HD License Plate Recognition (LPR) cameras that are set up at the roadside to accurately record information about all vehicles passing by, such as the registration information, speed, and weight. Through the networks, routers, and switches, such information will be uploaded to the automatic management system that can assess penalties to vehicles for overloading and speeding. High efficiency of road transportation is crucial to a country that is undergoing transformation. The new dynamic weighing system does not require vehicle docking or manual guidance; therefore, the traffic is not affected. The dynamic weighing system also does not require fixed weighing sites or employees for on-site work, reducing construction and operations costs by 80 percent.

• **Smart Waste Management:** In Saudi Arabia, the hot weather accelerates garbage deterioration. However, almost all garbage bins are uncovered, give an unpleasant smell, and attract stray cats, dogs, and mice, which increases the risk of disease infection and adversely affects people's life comfort and health. The Smart Waste Management Solution provides capacity sensors powered by solar energy. With such capacity sensors installed, the fill-level of a garbage bin is reported in real time, so that the administrator can optimize the driving routes of garbage vehicles to improve garbage collection efficiency. In addition, the oil consumption of garbage vehicles is monitored. The administrator is notified of all exceptional changes in the oil volume to prevent oil theft.

• **Smart Streetlight:** The old streetlight system had limited management and control over streetlights. The system could simply turn on and off streetlights, and only notify the related management department of streetlight faults. Now, the energy-consuming and high-voltage sodium lamps that could not be remotely controlled have been replaced with new LED lighting modules, which feature low energy consumption, can be automatically turned on/off, and can have brightness adjusted according to the environmental conditions. The use of such modules reduces the lighting energy consumption by 70 percent. With the Smart Streetlight system, the lighting policy can be flexibly configured and modified on a per-streetlight basis, instead of the traditional power-on and power-off based on the power phase line. The management platform provides information about the working status and service life of every streetlight, which reduces the workload of traditional road device inspection. In addition, by integrating terminals such as digital signage, environment monitoring sensors, emergency alarming devices, speakers, and surveillance cameras, the streetlights can provide diverse information (such as emergency notification, business, and weather) and provide convenient services (such as emergency calls and video surveillance), building a better interactive platform for bridging the government and citizens.

• **Smart Parking:** The parking lots in Yanbu have long been free of charge for citizens, which objectively leads to unfair allocation of parking resources in popular places. While keeping most parking lots free of charge, the smart parking management system charges the residents who use the parking lots in popular places. Such a successful combination of technologies and economics ensures that resources are provided based upon citizens' needs. The usage of a parking space is reported in real time by the geomagnetic and infrared sensor installed on the parking space. The number of available parking spaces and the occupancy duration of each parking space are automatically and quickly determined. Citizens can pay parking fees in various ways, such as using mobile phones and parking fee machines.

• **Smart Energy Efficiency Monitoring:** The high incomes in Saudi Arabia allow citizens to enjoy cheap electricity services which inevitably increases resource consumption and creates a burden to the vulnerable ecosystem. RCY has decided to reduce power consumption in office areas and set a good example to encourage citizens to enhance their awareness of power conservation. The energy consumption sensors in office buildings can collect power consumption data on each area in real time. Then, diverse management approaches based on power consumption data comparison can be taken to improve government staff's awareness of energy savings and promote reasonable power consumption. The sensors can also remotely control the power supply. During non-working hours, the sensors can be remotely controlled to shut down the air conditioners and lighting devices for more energy savings.

• **Crowd Density Analysis:** With the popularity of smartphones, Wi-Fi is now everywhere. Consequently, monitoring Wi-Fi signals can accurately learn the distribution and flows of people, allowing city authorities to closely follow situations and take necessary measures in a timely manner in the case of any emergencies.

• **Smart Manhole Cover:** As an industrial city experiencing rapid growth, Yanbu has a large number of pipes, valves, and connectors installed underground. The manhole covers for accessing these facilities have become a focus for security measures to protect the underground facilities from becoming targets for attacks. The Smart Manhole Cover Solution provides remote control over manhole covers. The covers can be opened only when maintenance is required, preventing unauthorized access. Different types of sensors such as hazardous gas detection and water permeation detection sensors can be installed on the covers for different types of manholes, monitoring overflow accidents in real time and ensuring the safety of personnel inside the manholes.

• **Comprehensive Performance Assessment:** With this comprehensive assessment system, the key tasks of all related city departments can be planned and assigned in a unified manner, and the progress of each department's work indicators is monitored. This helps identify problems ahead of time and find the root causes. The unified performance indicators help promote collaboration between departments and hence improve government work efficiency.

Livable and Business-friendly City with Higher Attractiveness

After two phases of Smart City construction, Yanbu Industrial City is starting to enjoy many benefits. The road maintenance cost has been reduced by 20 percent; the garbage clearing efficiency has been improved by 50 percent; the overall cost of the public lighting system has been reduced by 30 percent; and the utilization of public parking spaces increased by 30 percent. In the third phase of Smart City construction, a Big Data analytics platform, IoT data platform, and communications integration platform will be built to support municipal services, investment trend analysis, smart public facilities, emergency response and smart police services, and build an integrated command center. RCY will continue to deepen its collaboration with Huawei and leverage new technologies to enable citizens to enjoy better public services and make Yanbu more attractive.

Thanks to bold exploration and practices, Dr. Alaa Nassif said happily, "The Smart City project has proven that our Royal Commission is visionary. We are on the right track and all will benefit from the Smart City project, including the government, enterprises, and individuals. Smart City construction not only greatly improves Yanbu's public service level, but also enhances its capability of attracting high value-added investments. Since the construction of Smart Yanbu Industrial City in 2014, the growth rate of external investments has reached 16 percent, much higher than the previous 2.5 percent; by June 30, 2017, RCY has 81 companies of Light/Support industry in operation, 36 under construction, and 33 in design; restaurants account for 16.7 percent in commercial establishments in operation, retail shops occupy 12.42 percent, and business offices take up 14.9 percent; the satisfaction rate of residents has reached 90 percent; and the revenue from the Smart City construction is continuously increasing and is expected to reach USD 100 million in the next year."

"With deeper development of the Smart City project," he added, "more and more young people choose to work and start a new life in Yanbu. Both the employment rate and the population are increasing in a healthy and orderly manner."▲

Customer Testimony

"The cooperation and achievements of the RCY and Huawei for Smart Yanbu Industrial City establishes a good model for other cities. Huawei leads a robust ecosystem. Through flexible application of new ICT innovations, we can now sense, analyze, and integrate more city operations, enrich key information required by the management system, and make smarter, faster responses to various requirements, such as city governance, public services, and business activities. I believe that such a data-driven city development path can inject new energy towards improving people's lives, optimizing city operations and management, and enhancing business with other cities around the world. It will definitely create a better city life for human beings."

— Dr. Alaa Nassif, Chief Executive Officer of RCY

Bringing the Digital World to Cape Verde Archipelago, North Atlantic

Pearls of the North Atlantic

At the westernmost edge of the world map, there is a small dot — Cape Verde (Portuguese: República de Cabo Verde) in the Atlantic between the edge of the African continent and the map frame. Cape Verde, a volcano archipelago located in the mid-Atlantic Ocean, is composed of 10 volcanic islands and has a coastline of 965 kilometers. Cape Verde suffers from poor industry and agriculture due to its unique geographical location; however, the service industry is extremely robust, accounting for more than 70 percent of the country's GDP and proposing strong demands for information technology development. With informatization as a national strategy, the Cape Verde government is committed to building a more people-oriented government, creating more business opportunities to improve the competitiveness of Cape Verde, developing an open economy to promote economic development, and alleviating poverty through information communication and network technologies.

In recent years, many West African countries have built national data centers for informatization technology advances. However, due to lack of application software development capabilities, ICT talent, and an ICT ecosystem, many data centers have no load. The government of Cape Verde expects to change this situation. Through the implementation of the eGovernment project, the government of Cape Verde is attempting to build a nationwide eGovernment office network and a national data center. The purpose is to greatly improve government office efficiency, promote the sharing of education, medical care, and other types of resources, improve Cape Verde's informatization level, and build the country into an information hub for West Africa's coastal countries, as well as a lighthouse in West Africa.

NOSi, Cape Verde's Operational Information Society Nucleus, initiated and implemented the eGovernment project and was responsible for service development and O&M after the eGovernment system was built. With 19 years of experience in eGovernment operations and development, NOSi has strong capabilities in eGovernment application software development and ICT technologies. The first phase of the eGovernment project was initiated in 2010 and delivered in 2014, which mainly included the construction of a national data center and an upgrade of the government communications network. This project phase completed the preliminary establishment of the national government network system platform and island interconnection network platform. Based on these achievements, NOSi initiated the deployment of the government informatization system.

The Cape Verde eGovernment network was dedicated to connecting 1,142 organizations across the country through the same network. It used 530 routers and 669 switches provided by Huawei to expand the network built in phase one and built data transmission pipelines for upper-layer applications.

With the gradual emergence of new eGovernment applications in Cape Verde and the rapid growth of service leasing to third parties, the national data center, with only 200 Virtual Machines (VMs) built in the first phase, was fully loaded, leaving no available space for new applications or services. Organizations in areas that were not connected to the network were still using a paper-based working mode, leading to poor archival management, low work efficiency, and great difficulties in statistics collection and management. The education and medical care resources of the 10 islands could not be effectively shared. Remote areas suffered from sub-par teachers, poor hardware, and a low overall education level, and the government could not effectively obtain the population's health and medical information in those areas. Due to difficult inter-island transportation, government agencies faced high travel expenses each year. The average travel cost per person was about USD 340 per trip. In this way, the travel expenses of 1,000 persons would reach USD 340,000 per month. An inefficient transportation network also hindered communication between government agencies.

The preceding factors drove the initiation of the second phase of Cape Verde's eGovernment project. Through smooth cooperation with the government of Cape Verde and NOSi, one-stop innovative ICT infrastructure platform enabling cloud-pipe-device synergy, and a large number of success stories in the eGovernment cloud field, Huawei was immediately selected by NOSi.

Constructor of Cloud-Pipe-Device Infrastructure in Cape Verde

In the first phase of the eGovernment project, Huawei completed the following:

- Delivered a national data center with 54 IT standard cabinets covering 200 square meters to the government of Cape Verde, providing information services for not only the government, enterprises, and institutions of Cape Verde, but also surrounding countries.
- Built intra- and inter-island backbone networks, metropolitan area networks, and wireless broadband access networks; constructed a fiber backbone ring using Dense Wavelength-Division Multiplexing (DWDM) technology on six major islands to upgrade Synchronous Digital Hierarchy (SDH) capacity from 622 MB to 20 GB; and provided broadband access service through the construction of Worldwide Interoperability for Microwave Access (WiMAX) to achieve the network coverage for some organizations throughout the country.
- Established 21 telepresence videoconferencing systems, giving the government the convenience of remote conferences. The phase-1 project construction effectively improved the national information and communication technology level of Cape Verde, which was a solid step towards eGovernment and social informatization.

Huawei's continuous innovation in the cloud data center domain also impressed NOSi. Huawei employed the "one cloud, one lake, and one platform" architecture to assist customers in various industries in accelerating information system integration and sharing, thereby creating business value:

- **'One cloud':** A converged cloud resource pool, which implements unified delivery, management, and services of the infrastructure through intensive construction.
- **'One lake':** A data lake, which aggregates a full range of data and provides the full-lifecycle processing capability of "collection, storage, calculation, management, and use" to help customers transform data resources into data assets.
- **'One platform':** An application-enabling platform, which

integrates basic data services, general middleware, and industry middleware to enable customers and industry Independent Software Vendors (ISVs) to quickly innovate services based on multiple types of middleware.

Currently, the Huawei cloud data center solution has served projects in more than 140 countries and regions, including more than 330 eGovernment cloud projects.

Bringing the Digital World to Ten Volcanic Islands

The second phase of the eGovernment project further upgraded the ICT infrastructure based on the achievements of the first phase. To be specific, Huawei performed the following:

- Deployed new IT devices and system software and transformed the old data center into the disaster recovery center, providing secure and reliable IT leasing services for government agencies and enterprises in Cape Verde through an active-active data center.
- Deployed internal office networks and videoconferencing systems for the government, schools, and hospitals in Cape Verde to expand the office informatization coverage in those places and improve the efficiency and quality of government administration, education, and medical services.
- Jointly developed the integrated ICT training system WebLab with the Cape Verde Ministry of Education to support ICT talent cultivation in Cape Verde and promote social information sharing and development.

In terms of cloud data center capacity expansion, Huawei built 1,000 VMs for customers and upgraded the system from 480-core CPUs with 400 TB of storage capacity to 1,656-core CPUs with 1,000 TB of storage capacity. If the national data center's demands for VMs continues to grow at the same annual rate (60 percent) as that from 2011 to 2015, the capacity expansion implemented this time could meet the business development requirements in the next five years.

Based on the 'one cloud, one lake, and one platform' architecture, the Huawei eGovernment Cloud solution provides the NOSi with shared basic resources, open data support platforms, rich smart government administration applications, comprehensive eGovernment services, strong security assurance, and efficient O&M service assurance. Those services helped remove data barriers between departments, build cloud platform-based and cross-department data sharing and exchange platforms, and deliver ICT infrastructure to enable the proactive and efficient one-stop work mode of government agencies and enterprises in Cape Verde.

Similar to many African countries, Cape Verde suffered from unevenly distributed public resources, with one third of the country's schools in three cities (the capital Praia, the port city of Mindelo, and Santa Catarina) and 58.6 percent of the hospitals on two islands (Santiago and Santo Antão). The Cape Verde eGovernment network was dedicated to connecting 1,142 organizations across the country through the same network. It used 530 routers and 669 switches provided by Huawei to expand the network built in phase one and allowed access from schools, medical institutions, government agencies, and enterprises in small and medium-sized cities and towns, and built data transmission pipelines for upper-layer applications. The network infrastructure broke geographical separation and brought network and eGovernment benefits to people in remote areas. For example, the telemedicine application system enabled emergency patients to obtain better professional services from the capital's medical teams in a timely manner.

Confronted with insufficient teachers and low education quality, schools outside the capital of Cape Verde were eager to access the national eEducation network and acquire quality education resources of other schools in time to improve the local education quality. Teachers also expected to exchange with each other in schools in and outside Cape Verde; however, the cost of traveling between volcanic islands was extremely high. In this case, videoconferencing systems could provide great convenience. Therefore, Huawei deployed 30 videoconferencing systems in high schools and municipal governments on Cape Verde islands.

Huawei also provided WebLab, an integrated ICT training system, to help Cape Verde build a talent cultivation mechanism for educating sufficiently qualified ICT talent for its ICT industry development. ICT communications equipment, programmable enlightening robot suites, electronic maintenance tools, and furniture were deployed in containers based on NOSi's current cloud national data center to provide basic ICT training for students on other islands. Those containers could not only provide ICT training for middle school students and local people, but also serve as multi-functional classrooms to deliver other skill training and certification services.

eGovernment Cloud: Shining in West Africa

Based on Huawei's eGovernment cloud, NOSi developed more than 150 websites and 77 types of eGovernment software, covering social security, electronic elections, budget management, distance education and healthcare, and Enterprise Resource Planning (ERP) for all government departments, schools, hospitals, and state-owned enterprises in Cape Verde. NOSi also provided eGovernment applications and data center hosting services for surrounding countries, including Equatorial Guinea, Mozambique, Burkina Faso, Guinea-Bissau, São Tome, and Principe.

Major NOSi eGovernment applications and websites included the following:

- Government Resource Integration and Planning Framework (Integrated Government Resource Planning, IGRP)
- Financial Information System (SIGOF)
- Free Network Access Service (Konekta)
- Social Welfare System (SIPS)
- Medical Information System (SIS)
- Geographic Information System (GIS)
- Portal (Porton dinos ilha)
- Online Certificate System (Online-Certification)
- National System of Identity and Civil Identification (SNIAC)
- Land Registration Special Management System
- Municipal Information System (MIS)
- Student Information Management System

Take the IGRP as an example. Developers can use a variety of pre-integrated application modules and components to quickly build upper-layer application software, improve the efficiency of the government's public departments, avoid duplicate resource investment, minimize public management costs, and maximize Return On Investment (ROI). With these capabilities, the IGRP earned the title "eGov Software Maker" from NOSi's President.

Another example is the Medical Information System (SIS). It is a connection module used to manage hospitals, monitor the population status, and improve institutions' functional capabilities. The SIS manages pharmaceuticals, clinical equipment, materials, laboratory diagnosis, and reservations (analyzing a hospital's appointment information through the Internet and making schedules for doctors based on the results), and collects statistics on hospitalizations, appointments, and deaths.

Antonio Joaquim Fernandes, NOSi's President, said, "Huawei provides valuable support for the national data center, data transmission network, and eGovernment construction in Cape Verde. It provides data, voice, and videoconferencing services for government departments and public institutions and delivers an innovative digital platform to help NOSi build an eGovernment platform. Based on the digital platform, we will develop the business center, enterprise incubation center, and training center to build a leading information service platform in Africa for Cape Verde."

According to the 2017 International Telecommunication Union (ITU) report, the ICT Development Index (IDI) of Cape Verde ranked No. 4 in Africa, far higher than that of coastal countries such as Nigeria, Angola, Gambia, and Mozambique. Under the regional ICT hub strategy of Cape Verde, NOSi has delivered eGovernment applications and services to neighboring countries in West Africa based on its ICT infrastructure and capabilities and attracted government delegations from more than 40 countries.

Currently, every organization, including each government, is in a critical period of digital transformation. Huawei is looking forward to bringing digital to every organization for a fully connected, intelligent world. It is evident that the construction of Cape Verde's eGovernment cloud is a necessary step for government, education, medical institutions, and enterprises in Cape Verde to enter a smart world. The eGovernment cloud also makes Cape Verde a pearl of digital transformation in the North Atlantic region.▲

Customer Testimony

"Huawei provides valuable support for the national data center, data transmission network, and eGovernment construction in Cape Verde. It provides data, voice, and videoconferencing services for government departments and public institutions and delivers an innovative digital platform to help NOSi build an eGovernment platform. Based on the digital platform, we will develop the business center, enterprise incubation center, and training center to build a leading information service platform in Africa for Cape Verde."

— Antonio Joaquim Fernandes, NOSi's President

Longgang, Shenzhen: Giving Birth to a Smart City

By *Kang Xiang, Power to Tech*

Information technologies such as Big Data, cloud computing, and Artificial Intelligence (AI) are causing great changes in our daily lives, as well as in the operational mechanisms for entire cities.

By properly mining and applying data analytics, cities are unlocking their potential for growth, improving their decision-making, promoting economic development, and upgrading regional industries as a result of digital transformation. First and foremost, cities are focused on improving the well-being of residents.

Five years ago, the Chinese Ministry of Housing and Urban-Rural Development released a list of Smart City developments to be built and commissioned, with the Longgang District in Shenzhen ranking among the first set of 46 pilot smart communities — and so far its residents are benefiting greatly from the project.

Building a Thriving Smart City

Today, Longgang residents no longer need to visit multiple agencies for government services.

Now residents simply download materials from the Internet, communicate with the corresponding agency through SMS or WeChat, and then queue in front of a 'single window' in the Administrative Service Hall for a final, expedited review.

In addition to interacting with the on-line Apps, residents can engage with other service channels such as an online service hall — integrating the online and offline approval steps.

Smart Longgang has entered a new stage of development. More than a century ago, people built the predecessor of digital Smart Cities with the deployment of telegraph and telephone cables, water pipes, and metro railways. Today, the innovative application of cloud computing, Big Data, AI, and other technologies has opened an entirely new era for the world's cities.

With a collaborative ecosystem and an interactive system featuring ubiquitous sensing, connectivity, computation, and digital intelligence — new Smart Cities are not simply racks of cold machines. Smart City platforms have now evolved into living entities that are constantly learning and adapting through the increasing use of cloud computing, Big Data, the Internet of Things (IoT), mobile Internet, and AI technologies.

During the 19th China Hi-Tech Fair, the 'Smart City Operation Management Center' (Smart Center) was opened on a 'trial run' basis for selected guests attending *Huawei's Smart City Summit 2017*. Over the course of the demonstration, company representatives, partners, and journalists in attendance witnessed a powerful performance of Longgang's new 'Smart City brain.'

Based on an investment of nearly USD 79 million (CNY 500 million), the Longgang Smart Center now covers a total floor area of 17,748 square meters. The project includes one command center, and three application platforms: One for basic information, a second for collaborative office activities, and the third, a public services

Huawei and its partners have created a unique Smart City that achieves sustainable city development and improves the well-being for Longgang District residents in Shenzhen, China.

environment.

With the support of Huawei and other enterprises, Longgang District administrators have planned to further develop the Smart Center Big Data platform to advance the comprehensive integration of technologies, services, and data within the next three-to-five years. Over this time, the district expects to meet its goals for the collaborative management of services across different data layers, regions, systems, agencies, and businesses to establish a high benchmark for all smart district projects across China.

Longgang is one of the most well-known smart districts in China, as every year large numbers of city representatives from China and around the world visit to better apply Longgang's experience to their own Smart City deployments.

Developing a Smart City Data Brain

The Smart Center is located in a low-rise building, and nearby roads are equipped with Huawei-supplied smart street lamps — each featuring a sunlight-based illumination controller, which reduces energy consumption by 80 percent.

A wall-sized video screen in the central control hall of the Smart Center displays the 'brain's' running status, the 'central nervous system,' and the 'nerve endings' of the city.

The objective is to view the overall situation with the ability to immediately investigate the smallest details of available information about Longgang's current status.

During both routine and emergency operations, the Smart Center, maintains active links with associated Big Data-based information to support decision-making, and the data of each street, community, and building can be visualized for screen display.

Currently, the Smart Center maintains 2,030 types of municipal data resources, more than 400 million municipal data records, and more than 20 billion data records covering the past, present, and future of Shenzhen's Longgang District.

This large quantity of data enables city managers to properly plan and construct essential service aspects for citizens, including education, medical, and transportation resources by understanding the causes and effects uncovered by the analysis of urban statistics processed by Longgang's new Big Data platform. In other words —

By investing around USD 79 million (CNY 500 million), using 17,748 square meters of floor area to build one command center, three platforms, and hosting multiple applications to form the Smart Center — How has Huawei helped Shenzhen's Longgang District build a new 'Smart City Brain'?

- Aggregating 2,030 types of municipal data sources, more than 400 million municipal records, and more than 20 billion district records to intuitively display the real-time status of the city and enable smart scheduling and decision-making.
- Displaying 2D and 3D real-world images with overlay maps that include 303 layers of data in 32 categories for intuitive, simple, and effective data-driven maps for use by public service and city managers.
- Decreasing the total number of criminal incidents in the Longgang district by 29 percent. Serious crimes have been drastically curtailed, which helps to create a secure and stable social environment for city development.

because of Smart Center technology — administrators can now solve difficult issues with unprecedented efficiency.

The Smart Center integrates the management of city operations through video conferencing, command and dispatch, and Smart City experiences. The system intuitively displays the city's status in real time which, in turn, enables decision-making and predictive scheduling based on data science.

The urban-safety example often attracts the most attention. We can track areas of concentration and peak incident periods within the city on the big screen. Based on these inputs, we receive updated warnings that prepare police personnel to respond instantly at critical moments.

Since the implementation of smart policing, the total number of criminal incidents in Longgang — the most populated district in Shenzhen — has decreased 29 percent. This is the largest such decrease in the history of the city, and serious crimes have been drastically curtailed.

Visual Connections for Instant Handling

The Smart Center enables decision-makers to see events developing in real-time by giving them a 'macro view' of the dynamic trends occurring throughout the city. In this way, all information pertaining to the government, the city, and its residents is closely integrated.

The central screen can visualize information in many formats, including 2D, 3D, and live video — and it can archive images with map overlays organized into 32 categories and further detailed into 303 digitalized layers. This provides live data and real-time maps for public services and city management that are intuitive, simple, and effective.

Through the efficient aggregation of data, cross-agency business processes can be connected and optimized. This approach enables rapid responses to events, the efficient delivery of government services, and more highly refined city services. Together, the results provide a happier life for residents and lay the foundation for ongoing, sustainable development.

With Smart Center support, all industry business systems in Longgang are fully linked, which contributes to a unified view over all city management aspects. This benefits an accelerated transformation of service-oriented government functions, and implements full-lifecycle protocols for the management of social events, avoidance of social conflicts, and a reduction in the occurrence of criminal incidents — with the objective of creating a secure and stable social environment for city development.

Smart City solutions supply the information that energizes the rate of expansion for evolving cities, and with more than 120 Safe City installations across 40 countries, Huawei helps enable scientific, agile, real-time, and efficient Smart City development. >>

The convergence of information about people, events, and 'things' makes quantified decision-making possible. The Longgang Smart Center can detect potential problems well before they reach crisis levels by mining and analyzing historical and real-time data, and then using Big Data analytics to track the associations. By using an analytics sandbox to simulate policy scenarios, the government is able to make smarter, more efficient decisions.

Based on the ubiquitous deployment of sensors throughout the city, Huawei and its partners have created a unique Smart Center that features instant emergency response capabilities for the Longgang District of Shenzhen.

Having adopted a 'Platform + Ecosystem' strategy, Huawei is focused on building ICT infrastructure platforms that cultivate productive urban environments in which a robust ecosystem will grow.

To build world leading Smart City solutions, Huawei is working with 30 core partners, such as China Development Bank, CETC, Aerospace Shenzhou Smart System Technology, iSoftStone, Digital China, and iFLYTEK.

When visiting the Longgang Smart Center, we can see and feel the full extent of Huawei's contribution to the evolution of Smart Cities by following the improvements realized for the well-being of residents and the regional economy at large.

Smart City solutions supply the information that energizes the rate of expansion for evolving cities, and with more than 120 Safe City installations across 40 countries, Huawei helps enable scientific, agile, real-time, and efficient Smart City development.

The future of tomorrow's Smart Cities has arrived today. ▲

New ICT Helps Build Smart Zambia

Scott and Ben's Work Worries

Scott is a senior staff member at the Zambian Ministry of Finance (MoF). As part of his job, he analyzes a wide range of economic data, including statistics on power generation, copper production and export, the use of mobile communication services, and numbers of tourists. Scott's information is sourced from government departments across Zambia.

Scott has often faced delays in receiving critical data. There has been a history of disagreements between departments over the specific data to be released, or when, or sometimes difficulties when needing to access old data stores. Challenges on the systems level have included the inability to deliver a reliable supply of electricity to the IT systems, which at times has caused the loss of important information. Scott relies on his colleague Ben, an IT engineer for the MoF, to resolve all such technical issues as they arise.

Among Scott's concerns is maintaining effective voice and mail communications between the Zambian ministries of finance, agriculture, transport, and customs.

As the national data infrastructure of Zambia has become more digitalized, the need to store and analyze large amounts of data has grown exponentially. However, because the IT resources of the Zambian government have been operated separately, the risk of data loss remained high. Scott, Ben, and their peers throughout the government have been unable to keep pace with the rapid change in the requirements for enterprise ICT leasing, and each of the problems described above were having an equal effect across other major agencies, including agriculture, transport, customs, and tourism.

To ensure the development of secure, efficient and interoperable systems between departments the Zambian government set out plans to build and promote a "Smart Zambia." The government determined that progress into the digital age would involve the use of innovative technology to advance a national informatization program for eGovernment, eCommerce, and IT talent.

The National Data Center Is the Foundation of a Smart Zambia

In March 2015, during his first official visit to China, Zambian President Edgar Lungu met with Chinese President Xi Jinping. Together they witnessed the signing of a Phase 1 joint framework and financing agreement for the Smart Zambia project. With Huawei as the primary project supplier, the goal of the "National ICT Development Project" would be to build a national cloud data center and launch an ICT talent training center.

Huawei provided the Zambian National Data Center with a reliable solution that included: A Three-Data-Centers-in-Two-Cities (3DC) solution that ensures the security and continuity of government services and data; a Huawei cloud solution with services such as government and enterprise cloud hosting; and Huawei energy solutions to guarantee safe operation of devices in data center equipment room.

Zambia's main national data center at the Information and Communication Technology Authority (ZICTA), is located in

The 'Smart Zambia' project ensures the development of interoperable systems between departments.

Lusaka, the capital city. The ZICTA center covers an area of about 450 square meters, with an equipment room containing 72 server cabinets, a power room, monitoring room, and two outdoor diesel-engine generators supported by underground fuel tanks. The ZICTA cloud platform was designed to provide processing, networking, and storage facilities for government and public institutions, and commercial enterprise services.

A 400-square-meter backup data center is co-located at the Roma switch office of Zamtel, the Zambian national telecommunications operator. A second backup data center — this one covering 600 square meters — is situated at the Zamtel Kitwe switch office. Each of the three centers is fully equipped with servers, power, monitoring, and communications equipment rooms.

The Zambia National Data Center project officially commenced in January 2016, and installation and delivery were completed by the end of December 2016. The center was handed over to the government on February 28, 2017. The ZICTA National Data Center is now officially in operation.

Huawei's cloudified 3DC solution has provided the physical infrastructure currently in use by the Zambian government. The result is the delivery of eGovernment services from a centralized facility that has greatly increased government efficiency and accelerated the process of creating a paperless environment. The solution is a powerful and reliable 'information nerve center' that ensures the efficiency and data security of government operations, including support for transportation and commercial applications.

The ICT Academy: Ben's Second University

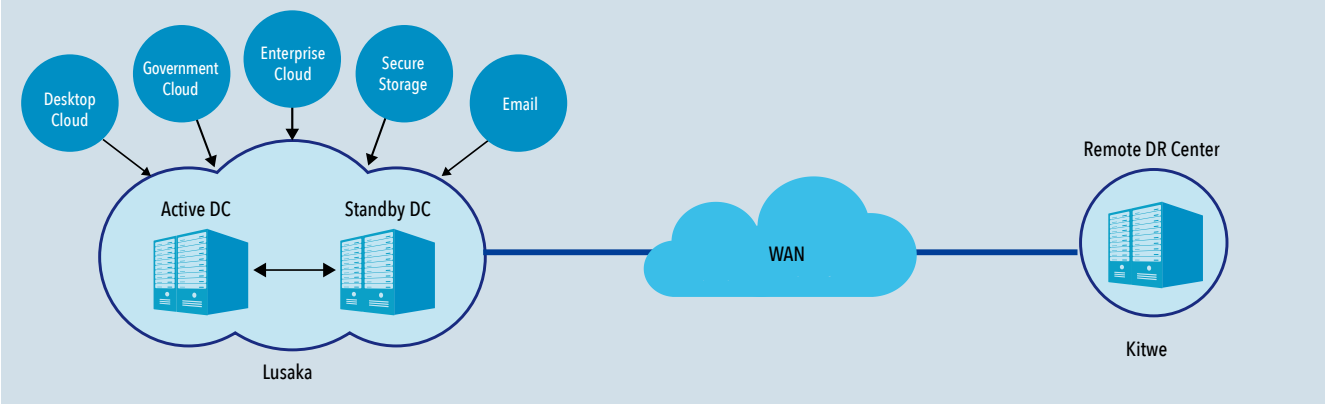
According to Zambia's 7th Five-Year Development Plan, ICT has been identified as an important catalyst for socio-economic development and a driving force for good governance. In order to fulfill this mandate, Zambia needed to create a national program to train ICT talent. The Zambia government expects that the expansion of educational opportunities for ICT managers and technicians will increase the employment rate nationally and lower the costs of operation for Zambian ICT enterprises.

In addition to supplying the technical infrastructure, Huawei has also provided an advanced ICT training solution that includes modern multimedia classrooms and labs, course materials, and on-site training. The resulting high standard for training and certification ensures that a qualified workforce is available for data center operations and business activities both inside and outside of Zambia.

Ben, this story's second protagonist, was assigned to take part in the Smart Zambia ICT training project. Using electronic whiteboards, teachers and trainees can engage in discussions using remote video through Huawei's smart teaching system. And, in the technical labs, trainees can practice IT operation and maintenance procedures for storage, networking, transmission, and telepresence activities.

In order to meet Zambia's national ICT industry and human resources development strategy, Huawei launched the ICT 'Star Instructors' certified vocational training course that gave trainees the opportunity to travel to China to receive high-quality guidance and hands-on experiments to assure that the teaching methods used in Zambia would meet Huawei's requirements. Following their return to Zambia, instructors are qualified to train more ICT instructors and students to an established international standard.

Ben's training ran from February to mid-September 2016. He attended a total of eight courses, obtained the related certificates, and became a Star Instructor at the Zambia ICT College (Zict College). He, and all other instructors who had received the necessary credentials began to teach at Zict College. At times, and depending on the topic, Huawei Authorized Information and Network Academy (HAINA) instructors may also join the discussions. The ICT online learning system includes courses on networks, IT, enterprise



communications, among others. At present, 156 students are enrolled in the program; and, in the future, Ben will both work at the National Data Center and also continue to train up-and-coming ICT talent for Zambia.

Immersive, Efficient Communication

Huawei has supplied a number of telepresence conferencing systems to the Zambian government, including five three-screen systems and 21 two-screen systems. According to the mandate, 26 ministries have access to the telepresence facilities, with coverage that includes the President's Office, Cabinet Offices, and the Ministries of Finance, Home Affairs, and Defense.

The video telepresence conferencing system gives participants an immersive, true-to-life experience that transforms the conventional model for convening meetings between separate offices. Communications and decision-making are improved, and many issues can be solved without the need to travel. By eliminating the need for routine face-to-face meetings, the frequency and costs for travel are reduced. The use of Huawei's telepresence system has significantly cut time and costs of government meetings and helped make the communication between Scott and other government officials simpler and more efficient. The Zambian Minister of Foreign Affairs has remarked that, "Things have been changed for the better!"

National Broadband Network: A Step Further toward 'Smart'

With the first phase complete, the Smart Zambia Institute (SZI) has launched Phase II of the Smart Zambia project to build a national broadband network and eGovernment platform to benefit 17 cities across the country. 9,050 kilometers of fiber-optic cable will be deployed across 10 provinces, with a plan to connect 10,000 businesses and public-sector organizations, and 200,000 urban households to the National Data Center built in Phase I. The country of Zambia is undergoing a large-scale boost in informatization based on the access and promotion of smart national government applications to the general public.

The Huawei-supplied eGovernment platform is also supporting an eCustoms system for 12 Zambian shipping ports that are connected to the existing Asycuda system. The new system will add logistics tracking, cargo testing, and ensure the collection of tax revenues for all goods passing through customs. The Zambia Customs Commission will use the system to combat tax evasion and increase total revenue.

In addition to providing Phase I and II of the Smart Zambia project, Huawei has acted as a lead planner to help the government implement the Smart Zambia ICT Master Development Plan over the next 50 years. The Master Plan is the guiding document for steering the transformation of the Zambian economy into a smart future. ▲

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