Huawei Technologies *Think Tech* >>>>>>>>>>>>>>>>

communicate

02/2018
ISSUE
84

Weifang Smart City lights the way ahead for China

Making IoT good for business

DHL: Smart management is smart business

A new cash cow in the dairy field

Scan for mobile reading


HUAWEI
197 of the Fortune Global 500 companies
choose Huawei as
digital transformation partner.
Reshape your business with Leading New ICT
Explore e.huawei.com for more information
HUAWEI

Sponsor:
Corporate Communications Dept.
Huawei Technologies Co., Ltd.

Editor-in-Chief:
Sally Gao (sally@huawei.com)

Editors:
Gary Marcus Maidment, Kyra Mi
Cao Zhihui, Linda Xu, Xue Hua
Amanda He

Art Editor:
Zhou Shumin

Contributors:
Zhang Shunmao, Chi Zhentao
Jiang Wangcheng, Liu Jianfeng
Mao Yaqing, Liu Kan, Liu Chunyu
Li Shuo, Zhao Junfeng

E-mail: HWtech@huawei.com

Tel: +86 755 89241660
Fax: +86 755 89241674
Address: H1, Huawei Industrial Base, Bantian, Longgang, Shenzhen 518129, China

Publication Registration No.:
Yue B No. L015060003

Copyright © Huawei Technologies Co., Ltd. 2018.All rights reserved.
No part of this document may be reproduced or transmitted in any form or by any means without prior written consent of Huawei Technologies Co., Ltd.

NO WARRANTY
The contents of this document are for information purpose only, and provided “as is”. Except as required by applicable laws, no warranties of any kind, either express or implied, including but not limited to, the implied warranties of merchantability and fitness for a particular purpose, are made in relation to contents of this document. To the maximum extent permitted by applicable law, in no case shall Huawei Technologies Co., Ltd be liable for any special, incidental, indirect, or consequential damages, or lost profits, business, revenue, data, goodwill or anticipated savings arising out of or in connection with any use of this document.

The golden age of IoT is here

The Internet of Things (IoT) is entering a golden age of mass commercial deployment, with the market set to enjoy explosive growth. It's already been applied widely in 40 industries, including public utilities, smart manufacturing, and agriculture, profoundly changing the way we produce things and how we live.

Huawei is bringing digital technology to every individual, home, and organization to achieve a fully connected, intelligent world. In IoT, Huawei focuses on ICT infrastructure and on driving industry digitalization. We empower things with chips and Huawei LiteOS to make terminals smart. We build ubiquitous networks with network technologies like NB-IoT, eMTC, eLTE, 5G, edge computing IoT gateways, and smart home gateways. And we deliver IoT cloud services based on the OceanConnect IoT platform and our public cloud to make everything intelligent.

IoT projects – from planning and deployment to commercial adoption and promotion – require huge investment in financial and human capital. To achieve meaningful ROI, companies need clear business goals. We recommend a three-step process:

Step 1: Tailoring solutions to customer requirements. IoT is a large and complex system that involves many industries with vastly different needs. Huawei works with its partners to develop solutions centered on customers' unique problems and challenges, helping them to address specific problems.

Step 2: Building local ecosystems. The IoT ecosystem involves both small and medium local vendors as well as global multinationals. In fact, 90 percent of the ecosystem comprises SMEs, 70 percent of which focus solely on local markets. The key to success is partnering with local SMEs.

Step 3: Creating a value-sharing business model. Digitalization is creating a more open, less vertical commercial environment. Integration between and across digital and traditional industries and upstream and downstream players is on the rise, and new business models and applications are emerging. Enterprises need stable ecosystem partners with a long-term view to gain a successful foothold in the IoT sector.

Huawei's IoT Solution Partner Program is designed to drive industry development with support for IoT solution design, development, integration, certification, and sales. The Huawei Developer Zone enables developers and IoT partners to access open lab services through Huawei's OpenLabs around the globe.

Huawei will continue to invest in IoT and work with its partners to drive the development of the IoT industry.

Willam Xu,
Chief Strategy & Marketing Officer, Huawei

CONTENTS communicate ISSUE 84

Cover Story

A new cash cow in the dairy field

Collaboration is the key to success in the IoT domain. Find out how strong partnerships have created success in the agriculture vertical with connected cows.

P04

How to Operate

Weifang Smart City lights the way ahead for China

Find out how this ancient city is making smart IoT moves with a range of pioneering initiatives and shaping up to be a true smart city.

P10

How to Operate

DHL: Smart management is smart business

DHL has boosted yard management efficiency by 30% with an NB-IoT solution optimized for its requirements. Tailored solutions are the key.

P14

How to Operate

Gas goes digital with IoT

P18

Australia's SEW takes the smart approach to water

P23

Perspectives

Making IoT good for business

Enterprises cannot meet the software development demands of complex IoT ecosystems. Partnerships and the right solutions are the way forward.

P26

Perspectives

Closing the gaps in IoT security

IoT is a honeypot for hackers – 80% of devices have simple passwords and 27% of IoT control interfaces have been infected or compromised. What's the answer?

P30

Perspectives

NB-IoT is a blue ocean for operators

P34

Six IoT models: Which should telcos choose?

P39

Focus

How OpenLabs can boost global IoT success

With 22 OpenLabs around the globe, including 8 set up with telcos, Huawei is committed to open partnerships and success for all in the IoT domain.

P44

Focus

5G shifts Connected Vehicles up a gear

P49

Open IoT gets developers in the zone

P53

Solutions

OceanConnect: Cloud IoT for the future

OceanConnect funnels cloud and IoT into industry enablement suites that take business domains like IoV, Smart Homes, and public utilities to the next level.

P56

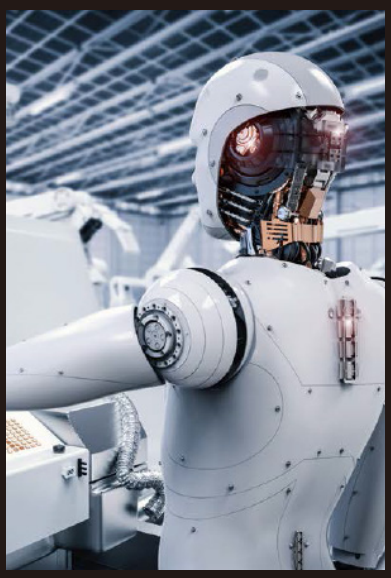
Solutions

Making manufacturing productive again with IoT

P61

Huawei LiteOS: A heavyweight in IoT connectivity

P66



A new cash cow in the dairy field

China's dairy farming industry is starting to adopt large-scale, intensive, tech-based production methods resulting in many opportunities that are too good to miss. In the case of connected cows, strong partnerships have created success based on NB-IoT technologies.

By Zhang Hai, Chen Hua & Liu Jianfeng

China's dairy industry today

China's dairy farming industry is marked by two characteristics: a significant lack of technological capabilities and huge growth potential.

Livestock numbers: After over ten years of expansion, growth has leveled out. In 2015, there were almost 15 million dairy cattle in China, putting the nation behind India, the EU, and Brazil in numbers. The industry's CAGR since 2012 has been 0.5 percent.

Per capita consumption of dairy products: In 2016, China's per capita consumption of fresh milk was equivalent of 36.1 liters, about one-third of the world average. This figure belies the nation's robust economic growth, clearly indicating huge room for growth in dairy consumption.

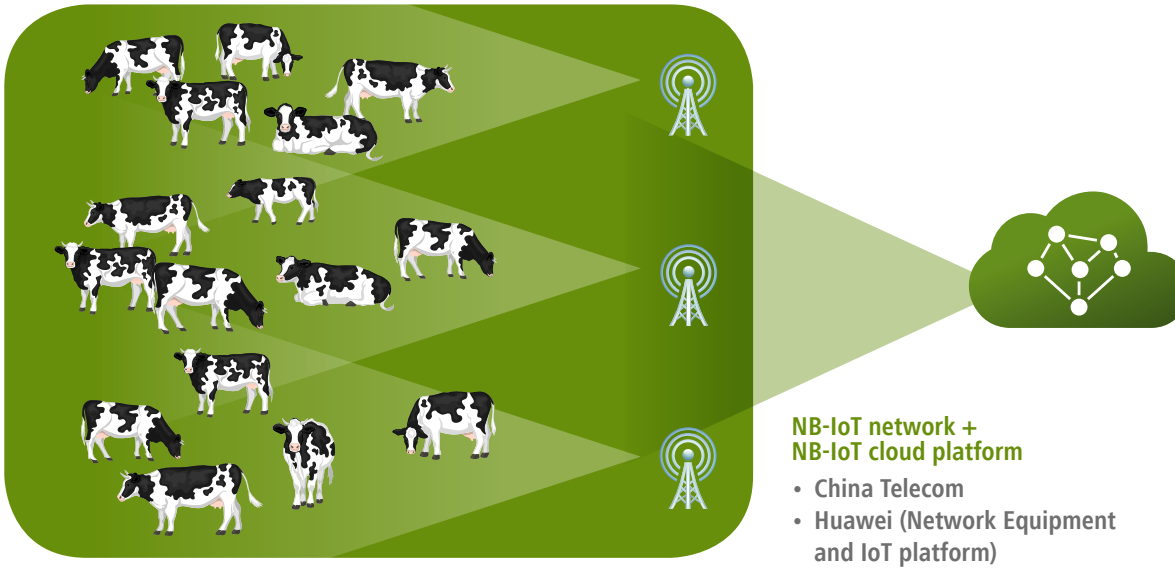
Average per-cow yield and dairy herd size: Annual per-cow yield in China is about 6 tons, which places China somewhere in the middle of the rankings table. By contrast, India, where free-range, extensive farming is prevalent, has one of the world's lowest annual per-cow yields at just 1.22 tons. In the US, Japan, and South Korea – countries that use factory farming techniques – per-cow yield exceeds 9 tons. In China, the percentage of dairy farms with more than 100 cows is 48 percent, whereas in the US it tops 80 percent.

China's dairy farming industry is marked by two characteristics: a significant lack of technological capabilities and huge growth potential.

Monitoring what's vital

Widely raised in China, Holstein cows enter physical and sexual maturity at 14 months. After a 280-day gestation period, the cows produce milk for 300 days. Cows can be bred again 55 days after calving, falling to 50 days after the second calf. On average, cows enter a two-day estrus period every 21 days, during which time they can be bred.

As physiological cycles vary for individual



cows, successful breeding and maximum profitability requires that dairy farms can identify the estrus period correctly. Missing a cow's estrus period can result in an about 2,000-yuan loss – assuming a milk yield of 30 kg per day and a value of 3.6 yuan (US$0.7) per kg of milk.

Currently, most dairy farms employ vets to monitor cows' estrus cycles using manual methods such as rectal examinations, behavioral observation, and tail base painting. However, it's easy to miss when a cow is in estrus. About 65 percent go into heat between 9 pm and 4 am, and individual cows behave differently when in estrus. High-yield cows have a shorter estrus period, and there's no set best breeding time after a cow goes into heat. Rates of successful detection using manual checks therefore sit at less than 75 percent. Furthermore, this method is very labor-intensive with high manpower costs, as it requires vets to carry out inspections in shifts.

Some dairy farms opt for estrus synchronization for cows that haven't been bred during their estrus period. This involves injecting them with hormones and breeding them all at the same time when they go into heat three days later. However, the breeding success rate of hormones is 9 percent lower than natural estrus. They also interfere with a cow's estrus cycle, resulting in lower quality milk and health problems for the animal. Repeated injections also compromise a cow's immunity to disease and shorten life expectancy.

To improve the efficiency of large-scale farming, dairy farms are applying tech like smart cow collars to monitor vital signs in real time. Data from cow collars is collected by small cells (readers) and uploaded to a data management platform via 3G or 4G, with data transmission achieved through short-range communication methods such as ZigBee. The cow data management platform carries out big data modeling on each cow's

AOTOSO Farmers

vital signs, producing a full health report that includes diagnosing illness and estrus cycle data. Farmers can then use this data to feed the animals more scientifically and carry out treatment and breeding at the right times.

Smart collar solutions produce higher estrus detection and fertilization rates than manual inspection methods. This can lower breeding costs and avoid the use of health-damaging hormones. However, this type of solution isn't problem-free.

Complex installation: Small cells are installed on-site and data backhaul is completed on the telecom operator's network, both of which require technical expertise to set up.

High fault rate: System reliability is low because of the tough farm environment, poor power supply conditions, and account arrears.

High costs: It's not viable to apply universally on small and mid-sized dairy farms and can represent a financial burden even for large farms.

Leading the herd with UCOWS

In February 2017, China Telecom partnered with Huawei and Yinchuan AOTOSO to create a new solution and business model targeting the livestock sector, resulting in the NB-IoT product, UCOWS, which is a vast improvement over traditional cow monitoring systems.

The tech

UCOWS harnesses NB-IoT instead of ZigBee for smart collar communications. Collar data is transmitted via China Telecom's NB-IoT network directly to its open IoT platform and transferred to a cow data management platform deployed on China Telecom's eCloud. Dairy farm managers, farmers, and

China Telecom partnered with Huawei and Yinchuan AOTOSO to create a new solution and business model targeting the livestock sector, resulting in the NB-IoT product UCOWS.

vets have real-time access to cows' vital signs on a mobile app or website.

As the product is one of China Telecom's own, the operator is responsible for sales and services and also E2E reliability, which is crucial for large-scale commercial adoption.

Power consumption: Because collars are worn for the cow's entire lifetime, they're fitted with low-power MCUs and sensors that give at least five years of battery life. The devices are also rated IP65 to meet the needs of the harsh dairy farm environment. The data for cows' vital signs must be reported once every three hours, much higher than smart meters' once-per-day reporting. Since adding batteries would increase the cost and weight of the collars, power consumption requirements for the collars were therefore extremely high.

The solution design uses conventional NB-IoT battery-saving features such as PSM, with CDRX and RA features applied to chips, base stations, and the core network. CDRX boosts collar battery life from five to six years, and RA extends it to seven years.

Congestion: Large dairy farms can easily contain 10,000 to 20,000 cows. With each IoT cow collar reporting eight times a day, multi-device access is a very common scenario. Lab testing shows that when multiple devices report data simultaneously, base station noise is raised, making them inaccessible.

Therefore, backoff and preamble parameters were included in the solution design to increase system robustness. Devices access the network and upload data in a staggered manner, better suiting NB-IoT networks.

UCOWS is connected to China Telecom's Open IoT platform, which supports chip firmware upgrades and device MCU software upgrades, E2E fast fault demarcation, and

million-level concurrent connections – all of which are conducive to large-scale adoption of the solution.

Business design

If operators want to increase profits in the IoT sector, they have to offer more than just connectivity. They also need to provide connection management platforms (CMP) and application enablement platforms (AEP) and enterprise solutions, including upper-layer applications and devices, from partners. Then, they can offer end-to-end solutions to enterprise customers, extract additional value on top of connections, and boost customer loyalty.

Partners can collaborate with operators by using their AEPs to develop industry applications and harnessing national networks to quickly attract users and a share of the profits. Enterprise customers can in turn benefit from the increased efficiency IoT brings without needing any IT capabilities.

The business model of the UCOWS solution was designed based on the SaaS model, which lets China Telecom leverage its NB-IoT networks, sales channels, and customer service capabilities to the fullest extent. The operator has been able to bypass the pipes and platforms stage and move straight to selling services, shifting from an industry bystander to an industry leader that can pull in four to five times more revenue than is yielded by the dumb pipe model.

This model also lets the telco also build its own ecosystem, providing a foundation for future applications such as food traceability.

Market outlook

Thanks to its excellent technological solution and business model design, UCOWS has met with strong market demand. In August 2017, China Telecom's Ningxia subsidiary signed a contract with Ningxia Shangling Animal Husbandry for 50,000 sets. Then in September, China Telecom's deputy general manager signed contracts with animal husbandry companies from five provinces and autonomous regions – Inner Mongolia, Shandong, Shaanxi, Liaoning and Ningxia – for China Telecom to supply a total of 1.26 million product units. It's also caught the attention of operators in the Asia Pacific and Latin America regions, where China Telecom is already carrying out pilots.

The solution isn't limited to cows – it can be applied to cattle, donkeys, horses, sheep, and pigs, all of which have a demand for technology to monitor animal health, physiology cycles, location, and other types of data, so as to shorten time between breeding and increase breeding efficiency. According to conservative estimates, demand will be there for 300 to 500 million connected animals by 2020. Optimistic predictions put this figure in excess of 1 billion.

By applying ICT technologies such as NB-IoT to connect animals, the livestock industry will be able to completely transform and approach breeding in a much more scientific way. IoT will increase industry profits, reduce drug use, increase the well-being of animals, and increase the quality of livestock products.

The business model of the UCOWS solution was designed based on the SaaS model, which lets China Telecom leverage its NB-IoT networks, sales channels, and customer service capabilities.

Weifang Smart City lights the way ahead for China

Located in the center of the Shandong Peninsula, Weifang is famed as the birthplace of the kite over 2,400 years ago – legend has it that the philosopher Mozi created kites to send messages. Today, IoT technologies are being used to take the smart city concept to new heights.

Spanning 16,000 square kilometers, Weifang is Shandong Province's second largest city. It has a population of more than 9 million and, in 2016, ranked 32nd in economic output among prefecture-level cities in China. In 2014, Weifang established a smart city department to improve urban management, promote digitalization, and build a new type of future-ready smart city.

No Cards, No ID, No Cash

Weifang released the Weifang V app as a service platform to put smart city services at residents' fingertips. It provides public resources, such as education, healthcare, transportation, tourism, and administrative approval, in one place.

Taking advantage of the growing popularity of mobile payments in the shape of WeChat and Alipay, Weifang took things to the next level with its online financial services platform Cloud Pay, which is available on V App. Residents can use it to pay for local healthcare, education, public utilities, government services, and other non-tax revenue services. Cloud Pay also lets partner banks provide quick loans for residents and financial services for local eCommerce retailers.

In August 2017, the Shandong Provincial Public Security Department officially completed acceptance of the Zhiji platform in Weifang. Using their mobile phones to access the platform, which is based on the public security census information system, users complete a comprehensive verification process to receive an electronic ID in the form of a dynamic QR code. With the e-ID, residents no longer have to carry a physical ID card when they go out. This is a major innovation in online ID verification and a first for China. The Ministry of Public Security has already approved and initiated the project.

Using the Zhiji platform, Cloud Pay was upgraded into V Pass, a first-of-its-kind smart city pass for Weifang. The pass combines the user's ID, driver's license, health insurance card, bank cards, bus pass, bicycle card, access control cards, library cards, travel card, and other types of ID cards into a mobile app. Using just one app, residents can handle day-to-day affairs, travel around the city, and complete mobile payments for various public services, making life much more convenient.

After Shenzhen and Hangzhou, Weifang is the third city in China to enable mobile payments for medical cards and the first to implement e-ID cards. As a result, the city started a three-pronged campaign: No Cards, No ID, No Cash. V Pass currently has 600,000 active users, which is expected to top 1 million by the end of the year. With its broad range of usage scenarios, full digitalization, and convenient portability, V Pass can replace the physical city passes currently in use, which will inevitably have mass appeal.

Weifang's V App represents the starting

By Zhang Baoqing
Director of the Weifang Smart City Project

With e-ID, residents no longer have to carry a physical ID card when they go out. This is a major innovation in online ID verification and a first for China.

point of smart city construction in Weifang. It bypasses PC-based Internet, instead capitalizing on the rise of mobile Internet. In the PC-based Internet era, multiple website applications were the defining feature of the smart city – much less convenient than a mobile app.

Weifang lights the way in China

In the pioneering spirit of the philosopher Mozi, Weifang became the first city in China in October 2016 to build an urban smart lighting control system using Huawei's NB-IoT technology. This occurred only four months after 3GPP recognized the Huawei-led NB-IoT standard as a next-generation IoT technical standard.

In November 2016, Weifang's municipal government and Huawei signed the Weifang City IoT Application and Industrial Base Construction Strategic Cooperation Agreement, which led to the inauguration of the Huawei-Weifang IoT Application Innovation R&D Center and the Huawei-Weifang IoT Industrial Alliance. With the alliance's support, Huawei will build an IoT industrial park and work with Weifang to create the country's first NB-IoT model city.

As of October 2017, Huawei had completed construction of an NB-IoT network covering the whole city. The construction strategy was one network, one platform, and multiple applications. Some 1,574 NB-IoT base stations were built across the city, providing 94 percent network coverage.

At the same time, Huawei started to deploy a city-level IoT public service platform, the first of its kind. A total of 12 IoT city applications will be launched on the platform, including smart parking, smart eGovernment, the Internet of Vehicles, smart building, and smart lighting.

The Weifang municipal-level IoT public service platform integrates industrial IoT applications, solving the issue of fragmentation that has emerged with city IoT applications. It collects fresh, high-value big data on a city-wide level and with the support of the platform, reduces development costs for applications.

The platform allows for the unified management of IoT data through integrated device connection and IoT data integration. This enables the IoT application system to provide cross-departmental and cross-application data sharing, and unified data rendering for decision-making support on the integrated management platform.

IoT Weifang

Once construction of the Huawei-Weifang IoT Innovation R&D Center is completed, it will contain an IoT OpenLab that will carry out verification and testing on products and solutions for the IoT Weifang project. Additionally, an IoT exhibition hall will showcase applications built by Huawei and partners.

At the R&D center, we will broaden

cooperation with universities and research institutes, both Chinese and international. The center will also help local businesses enhance their IoT capabilities and business development, and compete for national and provincial-level research projects that push IoT Weifang standards to become national standards.

Construction on the Weifang IoT Industrial Park is set to begin. With the support of Huawei's intangible assets, such as brand profile and leading cloud services, we're seeking to create an entrepreneurial environment in combination with the IoT Weifang construction project, and attract both manufacturing and research businesses to the park.

The Huawei-Weifang Smart City IoT Industry Alliance has brought together 52 domestic and international IoT partners from domains such as city transport, city lighting, city management and services, environmental and ecological protection, agriculture, manufacturing, and warehousing and logistics.

Weifang's Changle County has been designated as the pilot county for IoT Weifang. Here, 39 departments and 17 enterprises and institutions are collaborating on the research of NB-IoT smart city applications based on the IoT Weifang public services platform. The work is completed in accordance with the development strategy for the whole city. They're also implementing 18 IoT applications, including eGovernment and smart solutions for parking, street lighting, and pipelines.

The PC-based Internet provided information symmetry; mobile-Internet provided efficient connectivity; and now, IoT will deliver a fully connected world. It is what will make a smart city truly smart. Specifically, the thinking behind it is that constructing a smart city with IoT that connects everything will create a nervous system for the city that's controlled by a management center that serves as its brain.

Notably, during the IoT Weifang project's start-up process, TelChina became a close partner in the project through a strategic partnership with Huawei. With exceptional insight, Shandong Provincial Department of Water Resources helped build a province-wide smart river chief management system using the Weifang IoT platform.

For Weifang, IoT is truly defining a new age of smart cities.

The PC-based Internet provided information symmetry; mobile-Internet provided efficient connectivity; and now, IoT will deliver a fully connected world. It is what will make a smart city truly smart.

By Liu Wei
Senior Director of IT, DHL Supply Chain

DHL: Smart management is smart business

Affiliated with Deutsche Post DHL Group (DPDHL), the global logistics giant DHL believes that customer-focused innovation is essential to maintaining leadership in logistics and setting the development path for the whole industry.

"Digitalization isn't just a vision or program at DHL Supply Chain; it's a reality for us and our customers, and it's adding value to our operations on the ground," says DHL Supply Chain CIO & COO Markus Voss. "Customers are very happy about the productivity gains and equally excited about using innovative technology in their warehouses." As DHL sees it, the future of the supply chain lies in the connected warehouse, with tech solutions, such as wearables for workers and sensors in warehouses, connecting everything to a single network. DHL is widely adopting interconnectivity in the shape of IoT to optimize its business.

DHL's 2016 Logistics Trend Radar predicted that IoT would be the major force in the logistics industry over the next five years. DHL predicts that by 2020, IoT will generate up to US$1.9 trillion in additional value in the industry and as such, is a major area of exploration for the company.

Partnering with Huawei

In September 2016, DHL and Huawei agreed to set up a special innovation team to focus on IoT and cloud computing, and jointly develop logistics ICT solutions for industry customers.

In January 2017, Huawei and DHL Supply Chain completed POC testing on an NB-IoT-based smart cold chain monitoring solution as well as an eLTE-based wireless logistics park solution in Shanghai, which verified the feasibility of Huawei's IoT solutions in DHL's logistics business scenarios.

In February 2017, DHL and Huawei signed an MOU to deliver a range of smart logistics solutions for customers using IoT technology. Huawei and DHL agreed to collaborate on IoT-focused innovation projects to connect large numbers of devices with minimal power consumption, and deliver an integrated logistics value chain by providing critical data and visibility in warehousing operations, freight transportation, and last-mile delivery.

In September 2017, DHL and Huawei

completed a joint pilot test of an NB-IoT-based yard management solution at Plant A of a major automotive conglomerate for which DHL provides in-plant logistics services. The solution focused on solving issues such as delays in parts supply caused by manually scheduling loading bays at automotive factories. By enabling the visibility and intelligent scheduling of loading bays using NB-IoT, the solution enhanced unloading efficiency and led to significant reductions in labor costs.

Yard management empowers smart logistics

A yard is the outdoor area of a manufacturing plant or logistics park, comprising all areas outside warehouses and workshops. Commonly, they contain multiple waiting bays and loading docks for suppliers' vehicles to park and unload. Because the yard intersects the transportation and warehousing stages in logistics, loading and unloading efficiency directly impacts a factory's operational efficiency.

Proof-of-concept for the yard management solution has been carried out in plant A, which is supplied by over 350 different parts suppliers. Their vehicles make over 1,000 trips a day to the plant, where they unload parts at 86 loading bays.

Previously, DHL allocated bays to different suppliers and manually scheduled unloading. The main problem with manual scheduling was the uneven allocation of loading bays, with some heavily congested bays seeing five times more traffic than less used bays, sometimes totaling more than 50 arrivals per day. Additionally, traffic congestion in and around the park based on a first-in first-

By enabling visibility and intelligent scheduling using NB-IoT, the solution enhanced unloading efficiency and significantly reduced labor costs.

unload approach plus fines for exceeding time limits meant that suppliers tended to arrive ahead of schedule, leading to queues, congestion, and competition for bays. Delays in unloading due to traffic congestion could result in manufacturing interruptions while workshops waited for materials to arrive. Moreover, adjusting the schedule due to changes in production planning was impossible.

At Plant A, suppliers and DHL had different unloading and scheduling demands. The plant wanted a higher on-time delivery rate and higher unloading efficiency from suppliers. In turn, suppliers hoped for a reduction in waiting times and an improvement in vehicle turnover rates, while DHL required better visibility of loading bay availability to enable intelligent digital scheduling and reduce labor costs.

Based on analysis requirements, DHL and Huawei developed a yard management solution that used NB-IoT technology and Huawei's IoT platform. The solution applies loading bay availability as a key data dimension to make loading bay availability visible and enable smart scheduling.

NB-IoT is a narrowband radio technology standard for IoT defined by 3GPP. It offers low power consumption, deep coverage, and high connectivity, features that have already been verified in scenarios like smart meter reading and smart parking. There were three main reasons for selecting NB-IoT for the yard management solution: One, Huawei had already verified that an optimized solution for sensing and reporting the availability of loading bays could meet the requirements of logistics services in terms of power consumption, coverage, capacity, reliability, and delays. Two, the NB-IoT network was provided by a mobile operator that could take care of network maintenance and overcome the difficulty of deploying a network in Plant A. Three, the solution is highly replicable, with around 30 NB-IoT networks build globally in 2017 and

experience at doing so growing.

Huawei Public Cloud for rapid integration

With features such as device management, connection management, big data analytics, operations management, security and open APIs, Huawei's cloud IoT platform OceanConnect can rapidly integrate devices and enable application development.

Applying OceanConnect to the yard management solution allowed the development and integration of the whole solution to be completed quickly. When it comes to replicating the solution in the future, the cloud-based IoT platform will provide greater flexibility in network service choice and greater convenience for device and application interoperability.

DHL's yard management application collects loading bay information in real time to make loading bay availability visible. It digitalizes the service process and schedules operations by synchronizing information from PC terminals and apps used by drivers and operators onsite.

By using loading bay availability as core information, the yard management application fulfills a host of functions. It monitors and displays bay availability in real time, plans and gives notification of delivery windows, provides a driver app that displays information about site entry and assigned bays, collects and analyzes data on on-time delivery rates and unloading efficiency, and optimizes bay allocation and scheduling by analyzing historical data.

In September 2017, the first stage of the solution was piloted in Plant A. Unloading efficiency was boosted by 25 percent and average job time was cut from 2,330 to 1,750 seconds. DHL reduced on-site manpower costs by 50 percent due to automated loading schedules and cut schedule creation time from 185 to 15 seconds, an 87 percent increase in efficiency. Digitalizing vehicle entry, waiting, and unloading times boosted on-time delivery from 40 percent to 70 percent.

Joint innovation

The success of the first phase led to the green light for the second phase – extending the solution to the whole plant. Its value has been felt industry-wide, with one luxury-brand car maker already planning to introduce the solution at one of its new facilities by early 2018.

DHL's yard management solution is continuously being optimized, integrating upstream and downstream systems to enable whole-process intelligent scheduling, further increasing efficiency and lowering costs.

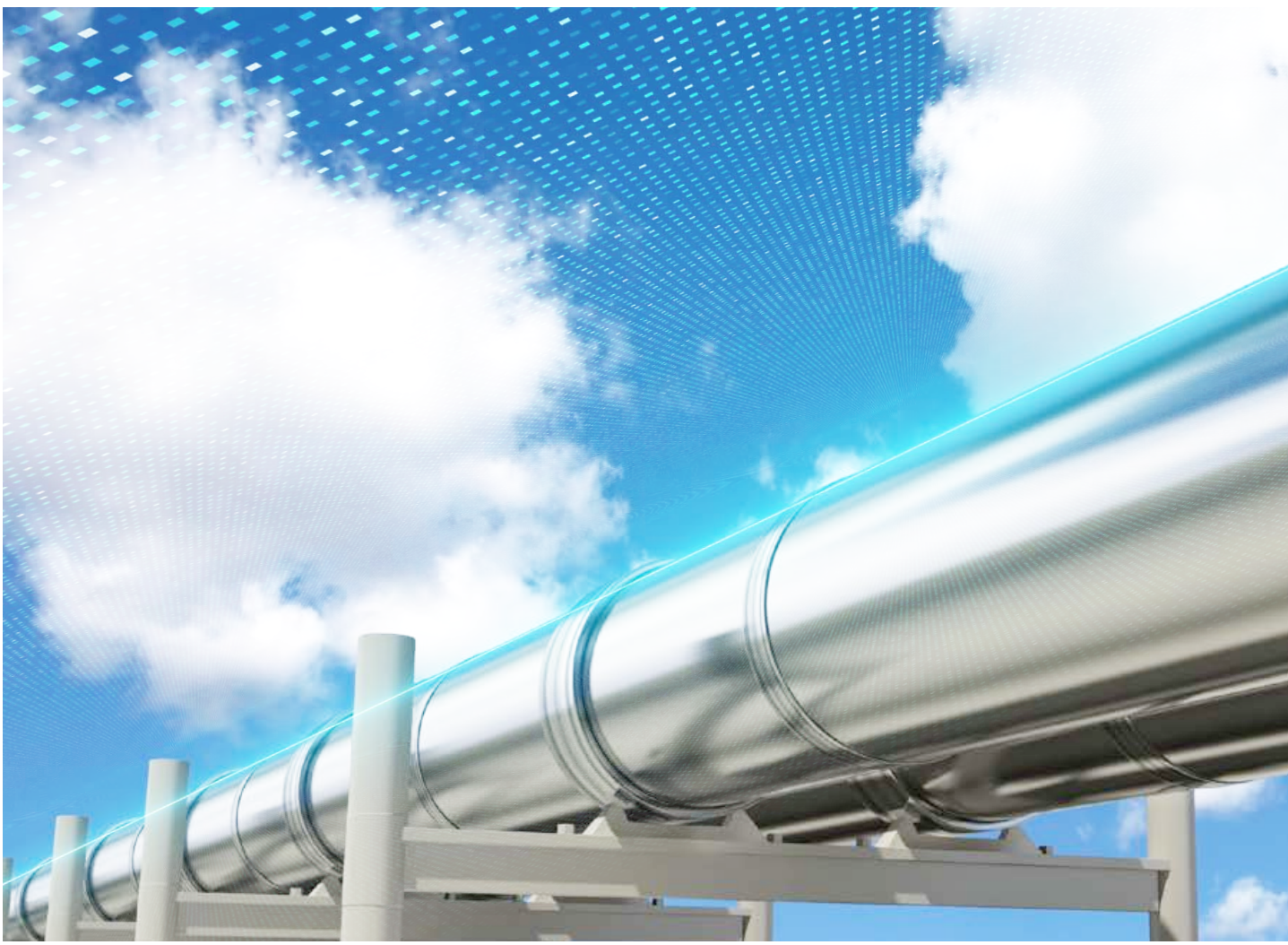
As their cooperation on IoT innovation deepens, DHL and Huawei are exploring innovative customer-facing logistics solutions on a global scale, including tracking and sharing high-value logistics containers, logistics asset inventory, and intelligent logistics parks and warehouses. Just as a journey of a 1,000 miles starts with the first step, DHL and Huawei will continue moving forward to ensure that IoT helps DHL go digital.

As their cooperation on IoT innovation deepens, DHL and Huawei are exploring customer-facing logistics solutions on a global scale.

By Wang Zhe
Vice President, Goldcard Smart Group; General Manager, Goldcard Cloud Division

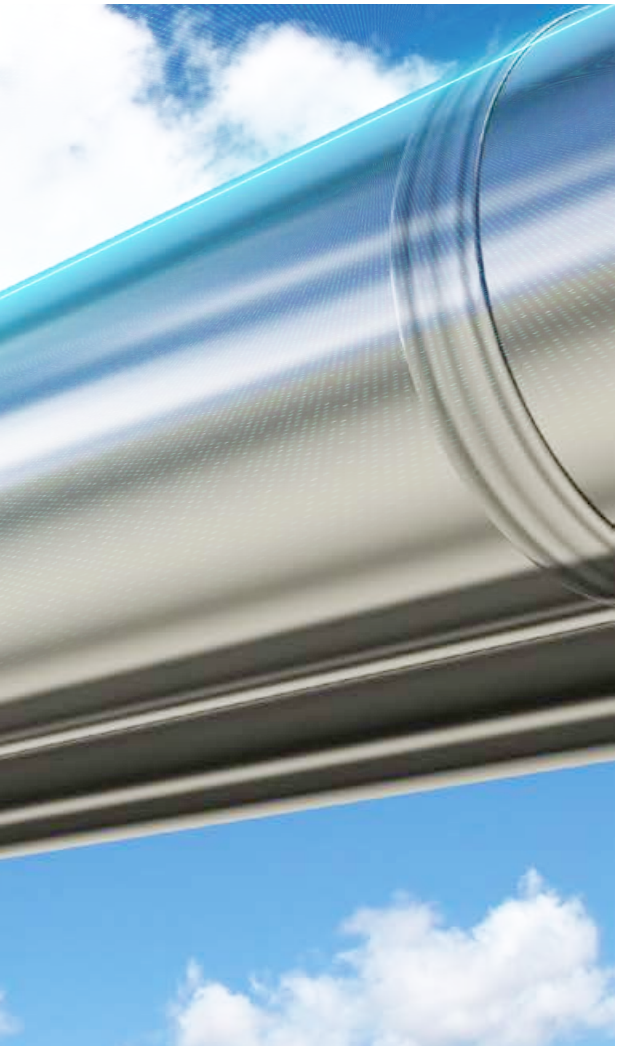
Gas goes digital with IoT

With the widespread application of new ICT technologies, smart gas solutions based on NB-IoT and cloud computing will power unprecedented innovation in the gas industry and disrupt existing service models.



Challenges facing the gas industry

The urban gas industry has seen massive development due to a major government drive for clean energy. However, gas services involve a range of interests on many sides, including urban safety, customer satisfaction, enterprise profitability, and balancing energy demand and supply. Gas providers are also beset with multiple management problems.



Meter reading and bill payment

Gas companies deliver their product via pipeline networks. To supply and sell gas and provide services, they use meters to measure amounts and calculate charges. The accuracy and frequency of reading gas meters and the rate of timely payments directly impacts business profits and the collection efficiency of receivables.

Traditionally, meters are manually read, with bills calculated and issued at the end of each month. Paper bills are sent twice to customers who must visit service centers at the beginning of the following month to make payments, which leads to poor customer satisfaction due to the time and effort involved.

Gas supply and consumption safety

Poor network distribution and transmission and distribution leaks are other major threats that impact gas company profits. Problems include leaky pipes, metering errors, and an inability to monitor and stop theft quickly enough, leading to losses during transmission.

Gas safety is also an important aspect of gas networks. Pipeline corrosion, gas leaks, excessive pressure and temperature, and dangerous customer behaviors are issues that require remote monitoring to quickly resolve.

Tiered pricing, energy conservation, and emission reduction

Many cities across China have begun

The urban gas industry has seen massive development. However, gas providers are beset with multiple management problems.

NB-IoT is a powerful, secure and inexpensive long-range wireless communication technology that can solve issues with smart metering.

to implement tiered pricing for residential gas to balance regional supply and demand and encourage users to conserve energy and reduce emissions. With these more complex billing prices in place and increasingly frequent price adjustments, gas companies now require accurate metering. As such, traditional management models are no longer suitable.

To face these challenges, many gas companies have introduced smart gas meters based on conventional technologies including prepaid IC card meters and wireless remote reading meters. However, the former requires IC cards to store money for purchasing gas, meaning gas companies cannot monitor users' gas consumption behavior. The latter needs advanced wiring, which results in high deployment costs.

Some businesses have introduced short-range wireless meters to enable centralized meter reading using unlicensed frequency bands – the small wireless method. However, there are a number of issues with this solution, including unstable data transmission, the inability to guarantee data security, high power consumption by meters, and poor wireless network coverage.

Problems with gas companies' smart meter reading applications are more likely because different smart gas meter vendors use different communication methods for their devices, usually with propriety communication protocols and different back-end software from different vendors. For large-scale deployment, interoperability is highly complex.

NB-IoT for new energy

NB-IoT is a powerful, secure, and inexpensive long-range wireless communication technology that can solve issues with smart metering and guarantee wide coverage, low power use, and a high number of connections.

The public utility solutions provider Goldcard Smart Group and Huawei have teamed up to develop a smart gas solution based on Huawei's NB-IoT connection technology, IoT platforms, and Goldcard Smart Gas software.

With more than 2,000 customers in the gas sector, Goldcard innovations include smart meters that take automatic readings, automated cloud-based billing, self-service bill payments, and top-up services via GPRS and NB-IoT networks. It's already connected over one million smart meters to its public cloud and provides services to more than 300 gas companies that supply over 30 million households.

In September 2017, Goldcard and Huawei jointly released the NB-IoT Smart Gas Solution white paper and, in collaboration with China Telecom and Shenzhen Gas, commercially deployed the world's first smart gas meter reading application.

The IoT Smart Gas solution adopts a cloud, pipe, device architecture that uses smart IoT meters to accurately read gas consumption and securely transmit meter readings and device data to cloud over new IoT networks such as NB-IoT. The cloud application system uses distributed computing and big data analytics to connect large numbers of meters, provide real-time billing, and enable efficient data analysis and decision-making. The system interconnects the cloud control center and meters based on service rules, facilitating functions such as remote valve shutoff alarms. It allows smart interactivity between devices and service information and between service personnel and customers on social media.

Layers and SaaS

The terminal layer combines a variety of IoT sensing terminals, with standard NB-IoT modules integrated into gas meters, flow meters, pipe network DTUs, and smart home devices. Information is uploaded to the IoT platform via NB-IoT base stations.

The network layer can be easily upgraded to provide national coverage through existing cellular networks. Compared to other LPWAN technologies, NB-IoT offers advantages such as low network construction costs, fast rollout, and wide coverage, and is the standard of choice for mainstream carriers.

On the cloud platform layer, Huawei's IoT platform supports business applications for all kinds of scenarios. Goldcard and Huawei jointly developed a standardized gas terminal model that connects to a variety of gas terminals via a southbound plug-in. A gas micro-service suite facilitates customer billing services and seamless connectivity for remote device data acquisition and control.

The solution provides a full range of SaaS applications for small and medium gas companies, including applications for demand-side management (customer management, meter reading, and billing services) and supply-side precision management (network construction, production and operations, and device O&M), which gas companies can buy on demand.

Staying secure

Goldcard and Huawei optimized a general-purpose E2E security system and introduced a Datagram Transport Layer Security (DTLS) mechanism that provides lightweight security protocols and algorithms. The system maximizes data security and minimizes terminal power consumption, and connectivity between gas meters. The EPC is based on 3GPP AKA protocols to ensure certified devices access legal networks.

3GPP NAS and AS establish secure channels between gas meters and the core network. IPsec creates a secure network channel between the wireless side and EPC. At the data transmission layer, DTLS and DTLS+ form a secure data channel between smart

Thanks to Goldcard's rich experience in gas services and cloud services and Huawei's NB-IoT technology and platform, gas companies can quickly implement various applications.

gas meters and the IoT platform. A public network HTTPS between the IoT platform and gas industry applications establishes a secure transmission channel.

Digital transformation

Smart gas integrated with IoT has changed the way users perceive gas services. Combined with service channels such as WeChat, Alipay, online service portals, and ATMs, users can obtain information on gas consumption, bills, and other data, and pay bills quickly and easily at home.

IoT smart gas solutions disrupt the traditional model of manual meter reading, end of month billing, and queues at service centers. Operations and service costs for gas companies are much lower and gas consumption and gas supply security risks are eliminated, while users receive value-added services. Accurate gas consumption monitoring and supply and demand analysis provide the government with quantitative information on saving energy and reducing emissions, thus supporting clean energy strategies.

Cutting meter reading costs

In 2016, a district of a city in Guangdong implemented an IoT smart gas solution, upgrading conventional meters to IoT meters. In one year, 200,000 households were upgraded to the new meters. The system carried out daily meter readings and bills were calculated automatically by a control center, allowing customers to pre-pay for their gas online. After the system went into operation, meter successful reading ratio increased from 93 percent to 100 percent. This saved the need for 135 meter readers and one service center, leading to savings in labor costs of more than 10 million yuan per year.

Reducing gas losses and increasing revenue

In 2015, a city in Hebei carried out IoT upgrades on 2,000 gas meters in three neighborhoods that used natural gas boilers for heating. After one winter period lasting months, gas consumption increased by 225,000 m^3 over 2014, contributing to a 15 percent rise in revenue from gas supply. Thanks to automated meter reading using IoT technology, the successful reading ratio rose from 96 percent to 100 percent, with a 5 percent reduction in lost gas due to measures such as the online monitoring of gas consumption and troubleshooting. Precise ladder pricing calculated at the cloud end increases billing income by 6 percent over estimated billing.

As government policies continue to open up national gas networks and services, the natural gas market is set to see real-time bidding over the whole network and the introduction of on-demand allocation, market pricing, and the integration of spot commodities and futures.

Thanks to Goldcard's rich experience in gas services and cloud services and Huawei's NB-IoT technology and platform, gas companies can quickly implement various applications like smart meter reading, advanced metering, smart network scheduling, and smart home services.

Making IoT good for business

Progress in technologies like sensor and networks has been impressive since the term "Internet of Things" was first coined in 1999. Today, mobile Internet is propelling a period of explosive growth in the large-scale commercial adoption of IoT. However, the road isn't completely smooth and industry verticals are slow to jump aboard the IoT train.

By Jiang Wangcheng

- Flexible, open architecture and the rapid integration of applications
- A diverse range of access networks
- LiteOS enables the smartification of devices

- Device-side anti-attack capabilities
- Malicious device detection and isolation on the network side
- Cloud platform and data protection
- E2E security standards and policy guidance

- US$1 billion investment by Huawei to support developers
- OpenLabs open the capabilities of Huawei's IoT solution
- Huawei jointly innovated and launched a variety of IoT solutions for vertical industries

A matter of security

In practice, while IoT services like smart door locks, Internet of Vehicles (IoV) and home security cameras have made life more comfortable and convenient, poor security has opened the floodgates for repeated hacks on IoT equipment. While operators and enterprises have forged ahead with IoT network construction, they cannot deal with the software development required for specific vertical industry scenarios, because the IoT ecosystem and application scenarios are too complex.

For the large-scale commercial use of IoT to take off, the entire industry must come together to build an ecosystem with the following features: cost-effectiveness and convenience, security and reliability, and efficiency and shared success. Huawei extensive forays into the IoT field include tailoring IoT tech for specific verticals, launching industry solutions, and advancing the commercial use of IoT.

Cost-effectiveness and convenience

High service development costs, risks, and complex deployment discourage verticals from investing in IoT. Given this, IoT solution providers should make developing IoT services economical and convenient, with lower barriers to entry.

Huawei's IoT solution comprises chipset and LiteOS for devices, gateways, networks, and a cloud platform. Its IoT cloud services support flexible, open architecture and the rapid integration of industry applications. The full scope of IoT-based service capabilities include device integration, device management, and application enablement. Huawei's vertical

Huawei offers a diverse range of access networks to meet the demands of IoT access in any scenario.

application suite provides solutions for Smart Utilities, IoV, Smart Manufacturing and Smart Home.

When enterprises develop applications, they can invoke various open APIs to accelerate the development of industry applications and the launch of new services, including basic northbound APIs (such as secure access, device management, rule engine, and push messaging), industry APIs (including smart utilities, IoV, smart manufacturing, and smart homes), southbound device APIs (such as the sensor ecosystem, gateway ecosystem, and camera and chip module ecosystem). These APIs provide device development enabling suites and serialized agents for device developers.

Huawei offers a diverse range of access networks to meet the demands of IoT access in any scenario. NB-IoT addresses the needs of cellular IoT for low-power, wide coverage, low-cost, and a large number of connections. eLTE (enterprise LTE) uses unlicensed spectrum to support integrated broadband and narrowband services on a single network. This meets enterprises' different production and operations needs and helps them complete digital transformation.

EC-IoT (Edge Computing IoT), that is, enterprise IoT gateways with edge computing power, are widely used in smart elevators and smart buildings. Smart home gateways support home health, entertainment, security, and home automation services, enabling operators to extend their services from traditional home broadband to smart homes.

With a heavy industry focus on the device side at the moment, Huawei provides the LiteOS IoT operating system, which enables the smartification of devices, quick access to the IoT network, and visualized and simple device management. Huawei LiteOS is a lightweight, open-source IoT operating system that provides unified and open APIs through an open-source model, allowing partners to quickly develop IoT devices for verticals like smart utilities, IoV, smart manufacturing, and smart homes. After a device has been integrated with Huawei LiteOS, it can securely connect to Huawei's cloud platform, which provides complete device management, including visual management on devices, remote firmware and application software upgrades, and device fault location.

Security and reliability

The outlook has not been optimistic for IoT security so far, with multiple instances of hacks against devices like cameras, smart locks, and even children's watches. In October 2016, the Mirai virus attacked a huge number of smart cameras, smart gateways, smart home appliances and other vulnerable IoT devices, turning them into botnets for hackers. There is also widespread industry concern over security issues surrounding IoV and smart cars; for example, in 2015 Chrysler was forced to recall 1.4 million vehicles due to the vulnerability of its in-vehicle networking equipment.

Huawei's answer

Huawei proposes a "3+1" deep security defense system with device-side anti-attack capabilities, malicious device detection and isolation, platform and data protection, and secure control and O&M on the network side.

As many IoT devices have limited storage and computing resources, Huawei has designed lightweight IoT secure connection protocols to support distributed authentication and meet low RAM and ROM requirements, solving communication security issues between IoT devices and cloud.

On the network side, Huawei security solutions provide traffic surge prevention. With a deep learning design based on malicious behavior detection, the solution can quickly identify and isolate malicious devices.

In terms of platforms and data protection, Huawei uses cloud platforms and big data security technologies to prevent IoT platform data from being attacked or leaked. Personal data in the cloud is also fully protected, in line with local privacy laws.

Huawei has also built a set of E2E security standards, including daily security assessments, automatic security awareness, and other security risk alarm and detection capabilities. These are designed to guide O&M personnel in operations and establish security control mechanisms.

Beyond technology and products, Huawei is also contributing to IoT security by working with other ecosystem players.

First, Huawei provides strong support to partners as part of its device security solution. Huawei is a leader in designing device security and security testing guides. Through its Huawei OpenLabs, which are located throughout the world, Huawei plans to make security testing tools available to its industry partners.

Second, Huawei is helping to develop IoT security standards. It has already proposed an optimized DTLS (DTLS+) protocol and lightweight device authentication method. It also sits on government and industry organizations, encouraging them to increase involvement in IoT security policy guidance and laws, and in constructing the industry ecosystem.

Efficiency and shared success

In 2015, Huawei announced a US$1 billion investment to support developers. Huawei has built 14 OpenLabs in various cities, including Shenzhen, Xi'an, Shanghai, Tokyo, and Dusseldorf. These enable partners to use the open capabilities of Huawei's IoT solutions at any time. Huawei has also jointly built eight OpenLabs with operators, including Vodafone. OpenLabs services include joint solution innovation, integration, and verification to accelerate TTM.

In 2017, Huawei and its partners jointly innovated and launched a variety of IoT solutions for vertical industries; for example, smart water services with Shenzhen Telecom and Shenzhen Water, and smart meters with the module manufacturer u-blox and Portugal Telecom to automate electricity data collection, reduce line loss rate, and minimize arrears. Huawei has developed a smart parking solution with Shanghai Unicom and SureKAM that collects parking information and queries, reducing manpower costs, raising the utilization of parking spaces, and increasing parking revenues. Huawei worked with China Telecom to provide a NB-IoT-based smart lock system for the bike sharing giant ofo, slashing bike unlocking speed and greatly improving customer satisfaction.

As a positive contributor to the IoT industry, Huawei believes that integration and partnerships are at the heart of a thriving IoT ecosystem.

Closing the gaps in IoT security

The security of the Internet of Things (IoT) is critical given the potential damage hackers can cause by hijacking huge numbers of networked objects and creating zombie botnets. Yet, awareness of enterprise IoT security is generally very poor. In fact, IoT products from many companies have zero security protocols.

By Wang Xiaojun & Yu Junhua

IoT security threats and challenges

HP's Security Research *Cyber Risk Report 2015* shows that 27 percent of IoT control systems have been compromised or infected, over 80 percent of IoT devices have simple passwords, more than 80 percent of devices retain hardware debug interfaces, 70 percent of device communication processes are not encrypted, and over 90 percent of device firmware updates are not signed or verified. A large number of IoT communications protocols also lack security mechanisms, according to the report.

This reality has allowed a successive spate of attacks targeting or originating from IoT devices in the past few years, including an Internet outage over a large swathe of the US, a simulated attack on a Tesla car, and a power blackout in Ukraine.

The large-scale US Internet outage on October 21, 2016 was the worst DDoS (distributed denial-of-service) attack in the country's history, leading to Internet services going down over a large area of the east coast. The attack originated from tens of millions of IP addresses – mostly IoT devices such as DVRs, IP cameras, routers, and Linux servers – infected by the Mirai virus. These devices were vulnerable to becoming bots for a DDoS attack because they were using standard, fixed hardcoded passwords and other unsecured mechanisms.

There are two major challenges facing IoT security. The first is complex deployment environments and

network structures, including access and data processing for massive numbers of devices, complex network structures, excessive numbers of communication protocols, and the different security requirements of different industries. The second is limited computing and network resources. IoT sensors and some gateways have tight cost and power consumption constraints plus limited computing power and storage capacities. As a result, it's difficult to run complex security protocols on them. Furthermore, their network bandwidth tends to be limited, with many local networks only offering tens of kbps of shared bandwidth.

3T+1M architecture security

The security requirements of IoT devices, networks, platforms/clouds, applications, and privacy compliance are much higher than they are for traditional networks. The key to IoT security lies in building device security and protection capabilities. IoT devices can be roughly divided into two categories based on their features: weak devices and strong devices/gateways. Each faces different security threats and demands.

Access and data processing for massive numbers of devices, particularly in high concurrency access scenarios such as surge attacks, is a huge challenge for IoT networks and platform security. In scenarios with massive numbers and amounts of devices and data on the network and platform side, it's critical to be able to quickly detect malicious device behaviors like DDoS attacks and malicious tampering. This must be followed by fast threat diagnosis and response in the form of warning and isolation processes.

Protecting data such as user location, consumption data, and health data has much higher privacy compliance requirements for cloud-based IoT platforms, especially in verticals like electricity and the Internet of Vehicles (IoV), which have high certification requirements.

The cloudification of IoT services brings greater challenges for end-to-end (E2E) security operations and management such as smart security inspections and situational awareness in visual security.

Huawei developed its 3T+1M (technology + management) security architecture with the following in mind: IoT security threats, IoT

Analysis of the security requirements of IoT devices

Type of device	Main features	Typical threats	Security requirements	Typical applications
Weak devices	Weak computing power, limited memory resources, sensitive to cost and power consumption	No or weak passwords, no certification, easy to counterfeit, not upgradable, vulnerable to theft	Must meet some basic security requirements that consider computing power and cost; for example DTLS/+, remote upgrades, and password management	Water and gas meters, vehicle parking, logistics tracking, wearables, and agricultural sensors
Strong devices	Powerful computing power, embedded operating systems, multiple means of attack. Attacks have greater impact	Illegal device startup, illegal upgrades, plaintext storage, virus attacks, and system defects	Basic and enhanced security requirements must be met, including secure startup, PKI, TPM/TEE, virus protection, and system hardening	IoV, cameras, IoT gateways, and handheld interactive devices

Building a device security system is the first line of defense in ensuring IoT security.

application scenarios, and specific IoT security requirements. 3T+1M architecture encompasses devices, pipes, clouds/ platforms, data security, privacy protection, and E2E security O&M.

Device and cloud anti-attack measures

Building a device security system is the first line of defense in ensuring IoT security. The security capabilities of devices need to be configured to match their functions and computing resources, including memory, storage, and CPU. For weak devices, such as NB-IoT water and gas meters, where resources are limited and cost and power consumption are issues, basic security capabilities are a must. These include basic two-way authentication, DTLS, encrypted transmission, and remote upgradability. Scenarios like meter reading, where power consumption is a key factor, best suit lightweight, optimized, and secure transmission protocols.

Strong devices with more powerful computing capabilities that don't have power consumption constraints and are operationally critical, such as industrial control terminals and car networking equipment, require advanced security capabilities, including trusted devices, intrusion detection, secure startup, and anti-virus protection. Device chip security and security for lightweight operating systems such as LiteOS need defense capabilities in line with the functions of strong devices.

Cloud is also an essential piece of the security puzzle: Coordinated device and cloud defense systems will enable security situation awareness, monitoring, and device upgrades to be carried out on the cloud.

Detect and isolate

To quickly detect and identify malicious behavior in massive numbers of IoT devices and carry out isolation and warning alarm processes, network and IoT platforms require malicious terminal detection and isolation technologies. First, the network side needs to have surge and DDoS attack protection capabilities. Second, the network must be able to coordinate with the IoT platform to identify malicious devices using rule matching, big data analysis, machine learning, and other rapid detection analysis algorithms like device behavior traces, traffic anomalies, and packet analysis. The IoT platform also needs to be able to quickly diagnose and respond to device behavior according to the application scenario and specific situation based on device behavior detection results. Responses include early warnings, observations, isolation and forcing devices offline, and instructing networks to take appropriate measures. This is the second line of defense in IoT security.

Platform and data protection

The requirements for cloud platforms and data protection are much higher for IoT, including the platform's own security, data storage, processing, transmission, and sharing functions. As well as cloud native

security such as WAF, firewalls, and HIDS, data privacy protection, various other measures are required to meet specific IoT data protection requirements; for example, data lifecycle management, data API security authorization, tenant data isolation, and encrypted video data storage, plus compliance with national IoT data privacy compliance requirements. This is the third line of defense in IoT security.

Security operations and management

Establishing O&M system tools and the operating capabilities of O&M personnel is critical to IoT security O&M. For the coordinated handling of layered device-pipe-cloud architecture, O&M system tools provide E2E whole network visual security situation awareness, daily security assessments, O&M security reports, and smart security inspection. Providing security O&M guidance for IoT O&M personnel and standard security operating procedures for O&M operations enables O&M personnel and policy makers to perform service management. This improves the capability of the whole IoT security system, from preventative early warnings and detection and analysis to dealing with events after they occur.

When building a 3T+1M IoT security defense system, it's crucial to develop key support technologies. These include lightweight security protocols, lightweight device system security, malicious device behavior rapid detection algorithms, and visual security situation awareness.

The security ecosystem is essential

The IoT security ecosystem must focus on device security, but the technological capabilities of many IoT verticals in device security are very limited. With this in mind, Huawei's various OpenLabs are designed to help industry partners develop device security capabilities.

OpenLabs provide E2E IoT security testing and verification services for devices, networks, and platforms, with security features comprising a key part of IoT partner certification. The lab provides partners with technical specifications and test cases for IoT device security to develop corresponding black box testing tools to ensure the access security of different devices. To build a healthy and open IoT security ecosystem, Huawei has opened its IoT network and platform security capabilities and O&M tools to carriers and vertical industry partners.

With research on IoT security ecosystems and standards development just getting underway, Huawei believes in collaboration, combining the strength of upstream and downstream manufacturers to lead trials and experiments that will drive the maturity of key technologies, solutions, testing and verification, and industrial applications in IoT security.

Huawei will also encourage industry standards organizations to develop and improve IoT security standards as quickly as possible, and regulate IoT security certification to enable the rapid development of the IoT industry.

NB-IoT is a blue ocean for operators

IoT transformation for operators isn't just about building new networks. It involves challenges like growing users, occupying controlling positions in the value chain, and avoiding pipefication – challenges that telecom operators around the world are now facing.

By Xu Jianmin & Zhu Cheng

After voice and data, the Internet of Things (IoT) represents a third opportunity for operators. With the sluggish growth of people-to-people connections and the near-saturation of traditional services, IoT is a new blue ocean for operators that can help them compete and expand. IDC forecasts that in 2020, around 28.1 billion IoT connections globally will generate over US$7 trillion in revenue. There is vast room for growth for all players in the IoT industry chain. Operators can develop IoT services and move into the enterprise market. Doing so early will open up commanding positions.

What's the catch?

Operators' existing networks aren't designed for IoT scenarios. They primarily lack coverage and end devices are too power-hungry to provide IoT services successfully. This is a considerable handicap

for operators looking to expand into the enterprise market.

For example, when bidding for a £2 billion smart meter reading project in 2013, the British government's Department for Energy and Climate Change eliminated one carrier in the second round because its GPRS solution couldn't meet coverage requirements. In the project's smart meter scenario, the winning operator had to guarantee over 99 percent coverage – an extremely high requirement.

NB-IoT is designed specifically for IoT. Hence, it provides wide coverage and supports a high number of connections and, on the device end, consumes little power and is low cost. NB-IoT is the first cellular network with the capability for large-scale IoT, and is optimized for LPWA (Low Power Wide Area) applications like smart metering, smart street lighting, and tracking in logistics. For operators, it's recognized as the best route into the IoT market.

Since NB-IoT standards were fixed, the NB-IoT industry has entered a period of steady upward growth, with over a year of development under its belt. Operators that previously had to take a wait-and-see stance or that carried out technical pilots are now going ahead with large-scale commercial deployment – as of December 2017, 28 operators in 21 countries had launched commercial NB-IoT networks, including nationwide networks in China, South Korea, Belgium, the Czech Republic, Ireland and the Netherlands. There are approximately 500,000 active NB-IoT base stations around the world as of today. This undoubtedly positions NB-IoT as the biggest IoT network in the world.

Move quickly

When it comes to choosing a network technology, enterprise customers are mainly concerned about coverage and price. In particular, LPWA applications have stringent coverage requirements. For example, for asset tracking services, they demand continuous coverage over a wide area. In addition, changing an IoT device subscription from one operator to another can be extremely difficult. In many LPWA use cases, including smart utilities and smart cities, most customers sign five- to ten-year contracts. Operators know that they must rapidly achieve nationwide coverage to quickly stake a claim in this new market.

In June 2017, China Telecom activated 310,000 stations, becoming the first operator to implement an NB-IoT network with nationwide coverage. It also released its first IoT tariff. The network's successful implementation greatly boosted enterprise customers' confidence. In less than six months, China Telecom had secured around 10 million connections with a host of companies, including Shenzhen Water, Shenzhen Gas, Tianjin Jinran, Haier, and ofo, each of which signed contracts for the carrier's IoT services.

Multiple channels

The enterprise market covers many different types of businesses. It can be divided into

Since NB-IoT standards were fixed, the NB-IoT industry has entered a period of steady upward growth.

Operators should focus on the B2B market because B2B services are easy to implement and the results are fast.

three sectors based on business type B2B, business-to-government (B2G), and B2C. The B2B market can be further sub-divided into the B2SB (small business) and B2BB (big business) sectors. Each sector varies in a number of ways: size, ease of expansion into the market, and ways to expand into the market.

Operators should focus on the B2B market because B2B services are easy to implement and the results are fast.

Supersizing with B2BB

The B2BB market includes major players like the home appliance manufacturers Haier and Midea and the bike-sharing giants ofo and Mobike.

The B2BB market has the following characteristics:

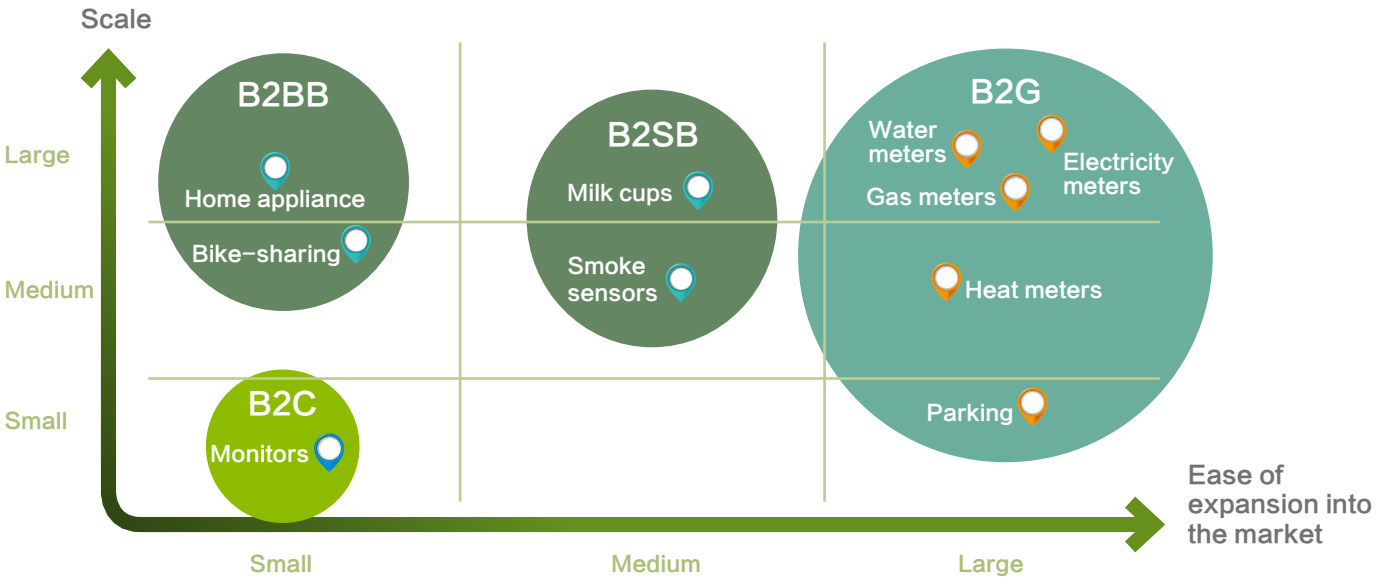
Short profit chains and easy to replicate: Home appliance enterprises, for example, are service operators as well as device manufacturers. Services in this market can be implemented without third parties and easily replicated in various countries.

Device enterprises are global and have strong capabilities for market expansion: Haier, for example, exports to over 100 countries and produces tens of millions of units a year. Operators can leverage device company's sales channels to quickly increase the number of connections.

The B2SB market is similar to the B2BB market in that it has relatively short profit chains, involves companies that are both device manufacturers and service operators, and enables relatively simple service deployment. Small companies, however, lack resources for international market development. Consequently operators can leverage their own sales channels to resell the devices and services of these small businesses, increasing the value of their connections. For example, to monitor dairy cows, device manufacturers can join forces with operators and use operators' national channels to deploy a nationwide NB-IoT monitoring solution. They can then share revenues.

The **B2G market** is typified by government control of resources, long decision-making chains, and difficult project acquisition for private operators. However, B2G projects (like smart street lighting, smart parking, and smart metering) are usually very large in scale. With many players involved in the B2G market, the operator has little influence in the value chain, and decision-making power rests with the industry customer.

Operators in the B2G market can collaborate with industry customers



and integrators in lab trials to let industry customers become more involved in technical verification to boost their confidence in NB-IoT network capabilities. However, the decision-making cycle is very long in this market, so operators need to prepare for a drawn-out process.

In the **B2C market**, products are sold to individual consumers using a retail sales model. Tracking bracelets are an example of a B2C product. But, volume is hard to achieve and returns are slow to materialize. Operators, though, already have extensive experience in the B2C market and can leverage their existing sales channels, especially customer stores.

Lessons from Internet companies

In the Internet era, OTT enterprises are scrambling to become traffic hubs by locking in massive numbers of users with freemium products plus user-based profit models. For example, although WeChat didn't profit from its 800 million users in 2016, Tencent generated almost 152 billion yuan (US$23.4 billion) in revenue mainly from games, payments, and online stores. With a large user base, a company can continuously create new profit models to monetize traffic.

In the IoT era, connections have become a new type of traffic hub that e-commerce platforms can be built on. IoT providers can construct multiple profit models around connectivity; for example, water purifiers that automatically order a new filter when the old ones become ineffective, refrigerators that report their contents to the platform so brands can push discounts to refrigerator displays, air conditioners that report motor data so that manufacturers can carry out preventive maintenance and offer value-added services, and cars that report data to insurance companies to provide personalized policy pricing based on individual driving behavior.

With these new business platforms, operators will need to innovate profit models rather than focus on the prices of connections themselves. They will also need to build control points by leveraging IoT platforms and avoid being reduced to a new kind of dumb pipe, watching on as OTT players feast on the rich profits of the enterprise market.

NB-IoT is the best starting point to transition from connecting people to connecting things. Operators need to leverage NB-IoT so they can start developing commercial IoT services.

Another rule from the Internet era is the principle of winner-takes-all. IoT connection service contracts are mostly long-term, with customers locked in to the operator's platform and ecosystem, so transferring subscriptions to other networks is difficult. As such, it's essential for operators to quickly transform and build NB-IoT networks, ecosystems, and organizational capabilities.

Organizational restructuring

With mobile broadband, operators are ordinary consumers and most services are B2C. In the IoT era, customers will come from different industry verticals, with services provisioned in multiple models, including B2B, B2B2B, and B2B2C. Operators will therefore need to carry out organizational restructuring and build operations capabilities for specific vertical industries.

A number of pioneering carriers have successfully carried out organizational transformation.

AT&T set up an enterprise sales team comprising several hundred sales experts, enabling it to penetrate various industry chains. It also established an advanced solutions team to provide IoT solutions services for the B2B market. In the US, AT&T enjoys a 43 percent IoT market share.

China Telecom has established group- and provincial-level IoT sales and service centers with integrated sales, support, and service teams that combine front- and back-end services to quickly respond to customer needs. In August 2017, China Telecom reported that it had made nearly 28 million IoT connections in China, on course to double its 2016 year-end number. The general manager of China Telecom, Yang Xiaowei, predicts that in 2018, its IoT subscribers will exceed 100 million.

Transforming organizational structuring and capabilities is a long process. Operators can harness NB-IoT as a starting point by which to optimize their organizational structure. They can gradually accumulate the organizational capabilities for forming an ecosystem, integrating solutions, and expanding services in the enterprise market as they roll out IoT services.

IoT represents a historic opportunity. OTT companies are already keenly aware of the enormous business opportunities, with Internet giants such as Amazon, IBM, Alibaba, and JD.com already deploying IoT services on cloud platforms. For telecom operators, the clock is ticking. NB-IoT is the best starting point to transition from connecting people to connecting things. Operators need to leverage NB-IoT so they can start developing commercial IoT services, involving nationwide network deployment, attracting new customers, launching new profit models, organizational restructuring, and quickly transforming from carriers into information service providers. Doing so will give them a strong hand in the hyper-connected world of the future.

Six IoT models

Which should telcos choose?

IoT for enterprises is breathing new life into carriers' operations – an opportunity that's come at the right time given the saturated consumer market and dwindling revenues.

By Cheng Qingjun

New opportunities and challenges

Vodafone's *The IoT Barometer 2017-2018* reports that the number of companies implementing large-scale IoT networks with over 50,000 connected devices doubled between 2016 and 2017.

In China, 20 percent of cellular connections are IoT connections. The sharing economy and mobile payments have helped IoT applications thrive, like bike sharing services, which now has almost 1 million connected devices. We forecast an explosion in the IoT market over the coming three years so that by 2020, the number of IoT connections will account for the majority of mobile connections.

Carriers must shift focus from connecting people to connecting things, and access the industry vertical market via IoT to open up new revenue sources. On top of market competition from other telcos, carriers face many challenges.

These include how to avoid devolving into a mere pipe provider (pipefication), incubating high-value customers and applications across a fragmented industry, building IoT platforms suitable for industry, and monetizing value.

Pipefication

Industry customers still regard operators as mere providers of pipes and SIM cards. When competing for industry customers, they need to beat competitors that provide unlicensed spectrum-based connection technologies and solutions like LoRa. They also need to deal with the fierce price competition, as operators offer undifferentiated pipe services.

Attracting large clients and a high market share is the only viable option carriers have. For example, revenue from one IoT SIM card accounts for just 10 percent of the revenue a single consumer generates. Moreover, the value of pipe connections represents just 2 percent of the entire IoT industry chain; for example, gas and water companies make it clear that they can afford communications fees of only 6 yuan/year per meter.

Fragmented scenarios

The IoT industry is extremely fragmented and doesn't benefit from economies of scale. Incubating applications calls for deep integration with the production and service processes of individual industries and enterprises, meaning carriers need expertise in and expert personnel from many verticals to become trusted enablers. But before they can develop large-scale industry applications, operators need to resolve the tricky questions of what industries to choose and how to generalize common industry requirements based on individual requirements.

Monetizing the value of IoT platforms isn't easy

Once things are connected, operators hope to become the key enablers of these devices through IoT platforms and complete the transition from M2M to IoT. They face two problems here.

First, do industry players need operators' IoT platforms? Many indicate that they've built their own end-to-end applications and only need operators to provide pipes.

Second, how should operators determine what to and what not to offer if strong demand exists for IoT platforms and thus truly act as enablers?

After all, platforms have to attract and retain industry players, build an active partner ecosystem, and also generate their own value and control points.

Break into the market with new business models

A general trend we're seeing with how leading operators have implemented IoT is that during initial implementation, operators break into the upstream and downstream ends of the value chain with application services and devices. They then extend from the two ends to tap value from ICT industry customers and avoid pipefication. The typical model for operator IoT implementation is "1+N+X", where:

1 = IaaS + Connectivity management platform

(CMP): infrastructure and connection management services, where operators have inherent expertise.

N = Device management/Application enablement platform (DM/AEP): construction of enablement platforms with partners.

X = SaaS: opening up capabilities and tapping value from ICT industry customers.

IaaS and CMP are the basis of 1+N+X, with PaaS capabilities enabling the connection and management of devices in scenarios with a high number of connections or high concurrency. This is expanded to enablement platforms, SaaS applications, and industry solutions. At each successive layer, value from IoT increases.

Traditional models of network construction, service rollout, and selling data traffic cannot be applied to developing IoT services. So, the issue is how to reconstruct the business model.

Six typical business models

Smart devices and upper-level applications are higher value, comprising about 60 percent of the industry chain, while the value of connections and platforms yields just 20 percent. Moreover, industry data generated by high numbers of connections also create opportunities for big data applications.

As a result, all ecosystem players wish to use their existing strengths to move into upstream and downstream sectors and occupy leading positions on the value chain. There are six connectivity-based business models for doing so, with more services provided and greater value obtained from each successive type of model.

Model 1 – IaaS: This model is the traditional M2M market. Operators sell SIM cards, but don't know where or in what scenarios they're used, and provide only general network guarantees and billing functionality. This very simple approach uses a data package sales model.

Model 2 – PaaS: The operator constructs a CMP for the IoT market, providing SIM card management services and offering customer-facing services like self-service allowance queries and top ups, and volume activation/shutdown. At this stage, the operator can also adopt a message-based billing method as well as the traditional one based on data usage. Because CMP provides a link to industry customers, operators can package cloud services on top of connectivity services and also move into the module market.

Model 3 – PaaS+: This typical platform model includes building an AEP that lets operators integrate Communications as a Service (CaaS) capabilities, like voice, SMS, video calls, and data storage, with third-party capabilities, such as voice semantic identification/control, image recognition, and maps. The operator can open these capabilities to developers and industry customers through cloud APIs. In addition to a billing model based on data usage or messages, customers can be billed according to API invocations or functions packages.

Model 4 – SaaS: The operator builds

There are six connectivity-based business models, with more services provided and greater value obtained from each successive model.

general-purpose industry suites by refining solutions for common industry requirements. Customers just need to do a small amount of development and customization to meet specific needs for different scenarios like smart homes, smart metering, or warehouse management. The billing model can be based on either the number of connected devices or the industry suite.

Looking at how leading operators around the world have implemented IoT services, we recommend three possible business models.

Model 5 – SaaS+: Similar to Model 4, but with an extra layer. The carrier provides connectivity as well as device and upper-layer application platforms, realizing the E2E integration of upstream and downstream ends of the chain. It participates in industry back-end O&M through service provision. By generating value for industry customers, the operator can acquire even higher returns and participate in value distribution through revenue sharing. This model suits new application scenarios in small-scale industries that are easier to enter but offer high value.

Model 6 – BaaS: This is the most advanced form of industry application. The operator obtains a business license and operates in a cross-sector manner.

Models 1 to 3 are horizontal models – the operator only needs to offer standardized products rather than differentiated products or services designed for different verticals. Profits derive from economies of scale. Models 4 to 6 involve operators more deeply in the vertical industry, expanding from connectivity/platforms to either end of the chain. As involvement increases, so does service complexity and value returns.

Looking at how leading operators around the world have implemented IoT services, we recommend the following three classic business models: Model 2 (connection specialist), Model 3 (platform provider), and Model 5 (solutions provider).

Model 2 – connection expert: Connectivity and cloud are the core here. The operator provides bundled basic cloud services, meeting industry cloud service requirements, increasing service stickiness, avoiding price wars, and increasing average revenue per connection (ARPC). It suits operators that are new to IoT and have a strong network foundation, but lack IT service capabilities and experience. SingTel is an example of an operator that has adopted this model.

Model 3 – platform provider: Focused on platforms, it offers rapid integration and TTM as well as the cross-selling of products such as carrier cloud and big data. It provides open APIs, creating an IoT ecosystem with development tools for industry developers, operating environments, device management, data aggregation, data processing, business analysis, and smart decision-making. There's vast potential for future development with this model. Model 3 is currently a popular choice among operators with ecosystem capabilities. AT&T and Telefonica both follow this model.

Model 5 – solution integrator: This model focuses on service integration – SaaS and devices – and value sharing with industry players. The operator must have high capabilities in multiple areas and be able to offer customers package

solutions including terminals, software apps, and integrated services. Operators need strong network and IT capabilities and a deep understanding of the target industry. Vodafone and Deutsche Telekom are two operators that have adopted this model.

IoT development with business models

Typically, there are three steps for operators to develop IoT services. The first involves providing connectivity services for verticals and then quickly scaling up. The second step involves providing platform services to companies that want to build IT capabilities and enabling industry players step-by-step on the IoT platform. In the third step, the operator provides E2E solutions for three to five vertical industries, first refining, then optimizing, and finally standardizing the solutions to replicate them at scale.

Connectivity is the area in which operators are strongest and platforms are the key for them to achieve future success in IoT. In the initial phase of establishing an IoT service, many industries and application developers demand reduced development costs and fast TTM. The first to provide cloud-based open platforms, low-cost IaaS (connections and cloud), open access management, and extensive pre-integration capabilities will have a head start in building IoT ecosystems and obtaining a wealth of applications from industry partners and massive amounts of accompanying data.

How should operators leverage IoT platforms to bring together ecosystem partners and tap value from industry and applications based on existing connections? There are three models to follow:

CMP and industry enablement platforms to lure partners: This model focuses on building a CMP on which multiple industry enablement platforms can coexist. Industry DM or AEP is operated in partnership with partners and revenue is shared. China Telecom, for example, focuses on public services, IoV, and home appliances as its key verticals, with infrastructure/cloud services and CMP at its core. To attract partners to co-construct service enablement platforms in IoV, China Telecom built an IoV cloud enablement platform with its partners using IaaS and a CMP that provides services for auto makers and after-market companies. China Telecom has also developed the market by working with them to expand into pre-installation and after-sales services, sharing revenue and value.

CMP + SI: This involves building a CMP, G-PaaS capability decoupling, and multi-vendor co-construction, focusing on SaaS and integration services. For example, Deutsche Telekom built its Multi-IoT Service Platform with open, universal platform capabilities, bringing a raft of platform providers such as Huawei, SAP, and Microsoft onto the G-PaaS. The carrier also focuses on its own SaaS, providing rapid integration service capabilities, IoT ecosystems, and consultancy services for industry players.

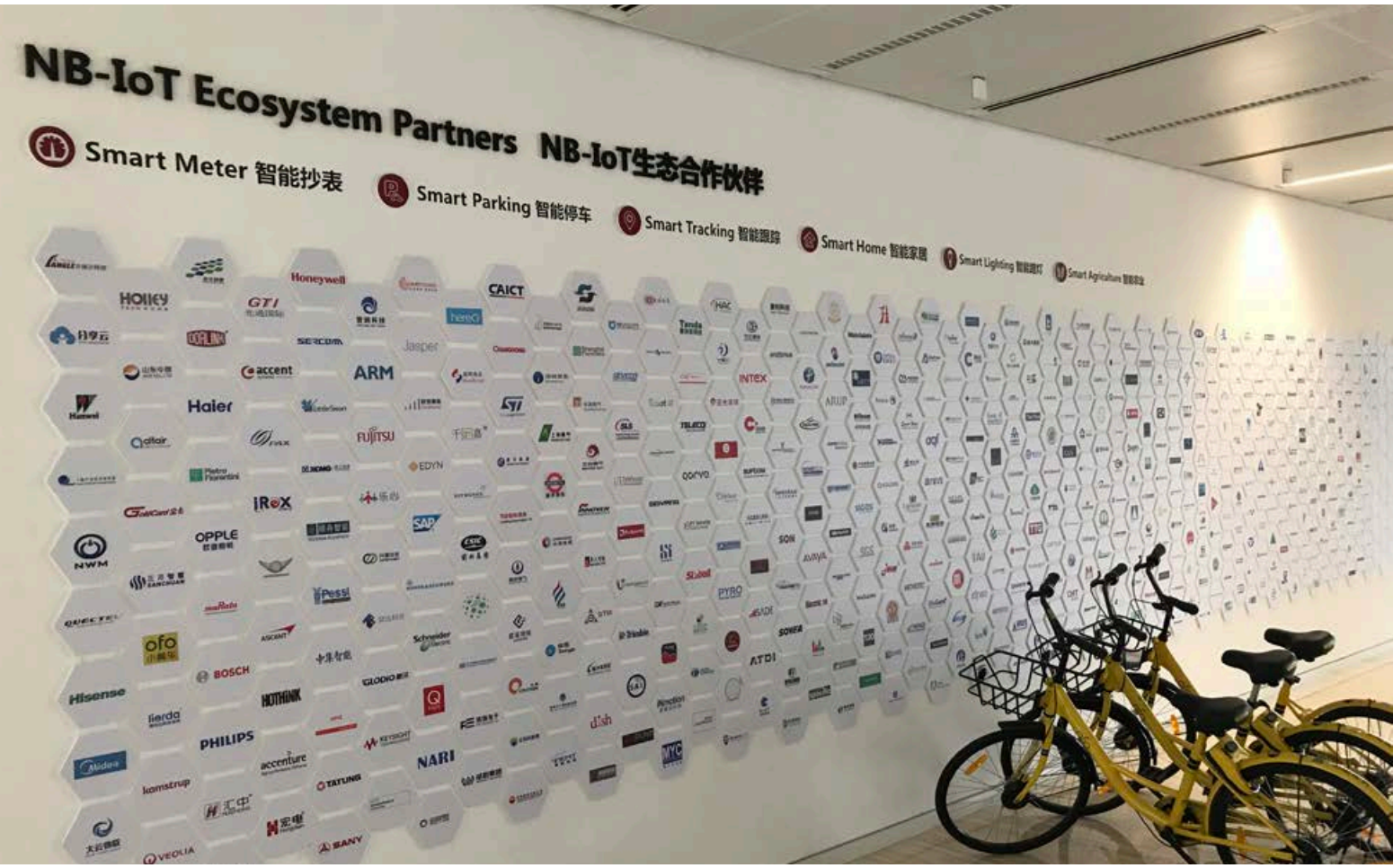
Centralized CMP + SaaS operations: China Mobile's IoT subsidy, OneNet, carried out top-down planning, service standardization, and whole-network centralization operations. Underpinned by its network, it moved into downstream development, launching its own brand of communications modules to carry out upstream development, build an IoT platform, (called OneNet) and collaborate with others to provide vertical industry applications. At present, China Mobile has sold close to 2 million own-brand IoT modules that are used in areas like public utilities, cars, and consumer electronics.

The IoT sector is a very close match for operators' strengths and resources. However, if they want to avoid pipefication and exploit the coming explosive growth in IoT, they must get out of the comfort zone and into areas of high-value with strong strategies and new capabilities.

How OpenLabs
can boost global IoT success

With 22 OpenLabs around the globe, including 8 jointly developed with telcos, Huawei is committed to open partnerships and success for all in the IoT domain. So, what can OpenLabs do for customers and partners?

By Wu Xiaodong & Wang Weiqiang



Based on the ideas of openness, collaboration, and shared success, Huawei's IoT OpenLabs help partners create E2E IoT solutions based on Huawei's open IoT capabilities. Partners can use the services at the labs to develop solutions in domains such as public utilities, smart homes, Internet of Vehicles, manufacturing, and consumer products. Huawei has established 14 of its own OpenLabs and 8 with telcos, which are dotted around the globe, and has plans to build more.

The scope of services provided by Huawei's IoT OpenLabs includes:

Joint solution design: working with partners to design IoT solutions.

Joint solution integration: guiding partners on developing solutions and integration testing.

Technology certification: certifying partner products and issuing Huawei certification.

OpenLabs provide four types of services for different technology scenarios: NB-IoT, EC-IoT, home gateway, and the IoT platform

Based on the ideas of openness, collaboration, and shared success, Huawei's IoT OpenLabs help partners create E2E IoT solutions.

In addition to an NB-IoT network, Huawei also provides the OceanConnect IoT platform, CloudEPC, and the IoT operating system LiteOS.

OceanConnect. To apply for them, partners can join Huawei's IoT Solutions Partner Program.

NB-IoT

In addition to an NB-IoT network, Huawei also provides the OceanConnect IoT platform, CloudEPC, and the IoT operating system LiteOS. The partner supplies a service software system and device for a particular vertical industry scenario and connects them to Huawei's OceanConnect platform.

Technical support and integration documentation for developers

Huawei provides E2E development support and assistance. For device development, guidance documentation is provided, including module design guides, application guides, and PCB design references. For applications, development documentation on APIs, profiles, and codec plug-ins is available.

The SoftRadio tool

Partners can use the SoftRadio PC software to access the IoT platform and applications through the Internet at any time, without the need for chips, modules, NB-IoT base stations, or core networks. They can perform basic E2E function commissioning between NB-IoT terminals and application servers, greatly increasing commissioning efficiency. During early device development, partners complete basic functions verification locally using SoftRadio. They can then apply to Huawei OpenLab to carry out testing and verification after terminal module integration.

The complete wireless testing environments of 700M, 800M, 850M, 900M, and 1800M frequency bands are all supported, as well as Standalone, Guardband, and Inband testing scenarios, meeting a variety of testing requirements.

OpenLabs also provide a comprehensive set of wireless testing equipment, including spectrum analyzers, DC power analyzers, VAM/adjustable attenuators, shielded boxes, welding machines, multimeters, and general toolboxes.

Device testing and analysis tools

UE log analysis tools are available to help partners quickly analyze KPI information on devices and improve testing efficiency. NB-IoT codec plug-in detection tools enable partners to check their own code for errors, improving development efficiency.

Scenario-based testing cases

E2E testing cases covering testing scenarios such as device access, basic services, performance, stability, reliability, power consumption, and maintainability are provided. Scenario-based testing cases for different service scenarios are provided to help partners carry out verification.

EC-IoT

The Huawei EC-IoT solution consists of a device communication module, an edge computing gateway (AR500 series), and an agile controller. The device communication module supports smart interconnection for IoT sensor networks. The edge computing gateway provides deep and open edge computing capabilities, simplifying the

development of edge applications for customers. Based on cloud management architecture, the agile controller connects to different partners' industrial application systems through an open API, ensuring rapid adaptation to the smart edge data processing requirements of different industries. This provides support for various key smart services such as real-time services, smart decision-making, data optimization, and smart security.

Interoperability with various open interface protocols

For device-side agile gateways, open containers are available for third-party deep development or the dedicated use of network communications. Southbound standard protocol communication interfaces for IoT smart hardware allow partners to ensure compatibility with mainstream communication protocols. Bottom-layer sensors are connected via various wireless and wired interfaces to process and interoperate with different industrial protocols, providing local computing capabilities and facilitating local processing and the local survival of services.

The northbound RESTful interface is provided for application-side agile controllers so that industry applications can quickly integrate device management capabilities and access network metadata and other information.

Self-service testing

Partners can apply for agile gateways to realize sensor/agile gateway interoperation and develop industrial applications from their own premises.

The EC-IoT Remote Lab provides a free 24/7 cloud lab environment for developers. Developers can develop Huawei products on the self-service management platform using the Remote Lab without needing to buy any products, and complete testing certification for remote interconnection.

Home gateways

The home IoT gateway solution provides a smart gateway and smart home control center. These enable southbound exposure of device capabilities and support multi-protocol access and interchangeability for working with multiple vendors' devices. The open gateway platform exposes home capabilities and operator pipeline capabilities, ensuring service aggregation.

Complete software and hardware resource packages for development

The intelligent integration of hardware allows partners to obtain various types of Smart+ open plug-ins so that they can quickly and easily develop differentiated smart home products.

SDKs can be used to quickly integrate and develop the home user app for the management of home networks, users, and smart hardware and applications, and to grow smart home services through application innovation.

Hardware device and integrated testing environment on cloud

Partners can apply for the local development of home gateway devices and carry out commissioning on the cloud platform, which can be remotely accessed worldwide. Huawei also provides online and offline technical support for issues that arise during development.

OceanConnect IoT platform

The OceanConnect IoT Connection Management Platform is a unified, open ecosystem based on the core technologies of IoT, cloud computing, and big data. It provides data, device, and operations management, and enables unified, secure network access; flexible integration with various devices; and the collection and analysis of massive amounts of data.

The OceanConnect platform provides IoT Agents, which simplifies development for various device vendors and eliminates

Huawei's IoT solutions partner management system is a comprehensive process that helps partners to incubate their products.

complex equipment interfaces to ensure rapid access by different devices. The platform also provides powerful open capabilities for various industries, helping enterprises quickly roll out different IoT service applications and meet unique service requirements.

Development guidance

The OceanConnect IoT platform provides a comprehensive set of development resources and support, including basic introductory guides, API interface documentation, development samples for industry customers, and SDKs. It also contains a dedicated developers' portal with applications and devices for developers to quickly carry out online development and commissioning. The portal integrates various tools such as device management, profile development, plug-in self-service management, simulators, and API commissioning. Developers can use the device simulators with northbound applications to complete device commissioning without requiring actual devices.

Online and offline integrated testing services

Partners can use the online service environment deployed over the Internet. Developers can apply for a temporary OceanConnect account on the Huawei Developer Zone's Remote Lab for self-service IoT platform experience, integration, and commissioning.

For complex collaborative integration projects, Huawei provides offline support for joint commissioning and integration through technical experts at OpenLabs. OpenLabs provide northbound application demos for quick device integration testing for partners that only develop devices or that haven't completed application development.

OpenLabs also provide E2E test cases for technical certification. Partners can quickly complete self-testing for *Huawei Enabled* certification based on test cases and test report templates.

IoT technical certification

Huawei provides technology certification for partners through the Huawei Certification service. The scheme enables Huawei and its partners to provide verified solutions for customers.

There are three categories of Huawei technology certification: **Huawei Validated**, **Huawei Compatible**, and **Huawei Enabled**.

Huawei provides IoT technical certification for partner products that pass testing as part of its technology certification system, giving Huawei's technical endorsement of IoT product pre-integration. Certification is valid for a given duration and partners can promote their products using the certification logo.

Huawei's partner management system for IoT solutions – Manage Alliance Relationship (MAR) – is a comprehensive process that helps partners to incubate their products. Partners can obtain IoT OpenLab resources to complete integration testing and technical certification through the MAR process.

5G shifts Connected Vehicles up a gear

By Zhu Zhiqiang, Zhao Taifang & He Chao

Connected Vehicles (CV) is a broad-ranging concept that includes technology, products and services, application scenarios, business models, and policies and regulations. CV in the form of telematics has been around since 2009. Since then it hasn't evolved much past additional types and applications thanks to advances in mobile Internet technology. Telematics has yet to create any network value.

With governments and regulatory bodies forming policy standards and actively promoting CV, four main CV threads have developed: connected, autonomous, shared, and electric. These apply across the verticals that embrace CV: automotive, communications, Internet, and shared mobiles services.

The Society of Automotive Engineers of China's (SAEC) Intelligent Connected Car product form is a good example of this concept. SAEC advocates the integration of in-vehicle ADAS (advanced driver-assistance systems), which

ICT is essential for connecting cars. As one of the world's leading ICT solutions providers, Huawei's work in CV focuses on devices, pipes and cloud.

comprises laser radar, millimeter-wave radar, camera vision recognition, and ultrasound, with communications technology. Integration would enable autonomous behaviors like data collection, awareness, identification, tracking, judging, and decision-making to be transmitted, shared, and analyzed by the network, leading to improvements in traffic safety and efficiency and, eventually, to the development of next-gen autonomous vehicles.

ICT is enabling CV

ICT technology is essential for connecting cars. As one of the world's leading ICT solutions providers, Huawei's work in CV focuses on three areas:

Devices: For a car to connect to a network and transmit data, it requires an in-vehicle communication module called a T-box. Huawei's first product is a customizable 3G/4G T-box for CV.

Pipes: CV applications in their current telematics stage do not require low latency on the wireless network side, with most current CV products using WCDMA networks. Mainstream CV services do not require high-speed network transmission, and very few manufacturers have adopted 4G LTE. 4G modules are very expensive and are mainly used to provide in-vehicle Wi-Fi hotspots. However, as 4G modules and data tariffs become cheaper and 4G networks more prevalent, 4G applications will gradually become dominant.

Huawei is also developing a cellular vehicle-to-everything (C-V2X) solution based on LTE-Vehicle (LTE-V) for scenarios such as autonomous driving and smart traffic integration. The solution is still in the stage of setting standards and PoC.

Cloud: Here, "cloud" refers to a combination of Huawei's OceanConnect IoT cloud platform and public cloud. While OceanConnect wasn't specifically designed as a CV vertical platform for the automotive industry, it is in fact a cross-industry IoT platform product designed for a high number of connections. It offers features such as big data analysis, the rapid enablement of industry applications, and hierarchical decoupling for services and applications. The OceanConnect CV solution is a typical IoT application scenario in the auto industry.

The three stages of CV evolution

Based on its understanding of industry trends, Huawei has identified three stages of CV evolution: one, the current telematics stage led by automotive companies; two, multi-partner intelligent CV; and, three, the future intelligent transportation system (ITS) and shared mobility stage. Huawei's key focus is on the last two stages, with the goal of developing intelligent transportation services through multi-industry collaboration between automakers, transportation departments, telecom operators, and cloud providers.

Stage 1: Intelligent CV based on the OceanConnect IoT Platform

Huawei hasn't been involved in traditional car

networking platforms for telematics. Based on the digital transformation taking place in the car industry, Huawei has emerged as a Cloud Platform-as-a-Service provider, using its OceanConnect IoT platform to build an industry ecosystem and become a cross-industry services enabler.

OceanConnect enables car companies to transmit in-vehicle data securely, reliably, and efficiently to the cloud. Cars become a core digitalization asset, creating a next-gen digitalization engine for automakers. The in-vehicle data is also made available to a wealth of upper-layer applications, and the platform supports evolution to LTE-V and AI.

OceanConnect offers basic capabilities on three levels: connectivity management, device management, and application enablement. Regularly released CV suites help industry partners quickly implement different IoT service applications. The solution also provides unified, secure CV access through layered security architecture and IoT agents for T-boxes and in-vehicle infotainment systems, which simplify adaptation to different device manufacturers' protocols. Interoperation is made possible with car companies' existing IT/OT systems, enabling unified data presentation and management and lowering business investment costs.

OceanConnect also opens up cloud computing, big data, and networking capabilities. These are combined with pre-integrated partner capabilities and packaged as different enabling suites. Car companies can use these suites to choose the services they need on the platform and meet end users' travel requirements.

Stage 2: LTE-V-based intelligent CV

V2X (vehicle-to-everything) involves the communication of information between cars and all the entities that may affect them, with the aim of reducing accidents, easing congestion, reducing pollution, and providing informational services. V2X incorporates vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-network (V2N) and vehicle-to-pedestrian (V2P).

There are currently two main forms of V2X technology – dedicated short range communications (DSRC) and LTE-V. DSRC was first introduced in the US and has seen a number of years of development and testing since standards were released in 2010. C-V2X emerged as cellular mobile communications technology. The C-V2X technology LTE-V offers advantages over DSRC in chip costs, technology, and business models, and has as such experienced rapid development.

ETSI has defined 53 V2X application scenarios and 3GPP has defined 27. The main ones include:

Road traffic safety scenarios: includes alerts for emergency braking, vehicle problems, intersection collisions, dangerous road conditions, and vulnerable road users.

Road traffic efficiency scenarios: includes speed guidance for traffic lights, green wave, congestion alerts, and traffic lights priority for emergency vehicles.

LTE-V utilizes existing cellular networks and spectrum to provide V2X information exchange. LTE-V has two modes: LTE-V-cellular and LTE-V-direct. The former is centralized, with communications taking place through the Uu interface. The latter is distributed, with direct car-to-car and car-to-road communication achieved through the PC5 interface.

LTE-V standards were frozen in 3GPP R14. China's standards bodies C-ITS and CCSA are accelerating the standardization of LTE-V, and Huawei is one of three appointed reporters for LTE-V standards. In September 2017, LTE-V 5.9 GHz spectrum testing was completed under the guidance of the

Huawei is working with its partners around the world to accelerate the arrival of autonomous driving based on 5G.

National Radio Monitoring and Testing Center. Testing results were in line with expectations and are expected to be released in 2018.

Stage 3: 5G-based ITS and shared mobility

5G will enable a fully connected world, and the car industry will be among the first wave of sectors that will be transformed by 5G technology. Offering ultra-low latency, ultra-high bandwidth and reliability, 5G networks will enhance safety and efficiency in the transportation sector.

5G will help make self-driving vehicles a reality because 5G networks will satisfy the extremely high requirements key CV service scenarios place on network performance. It will accomplish this with innovative technologies like network slicing, and by providing end-to-end latency as low as 1 ms and peak rates up to 10 Gbps.

Standardization of NR-V2X is speeding up, with Uu air interface and Sidelink standards anticipated to be fixed in R16 and R17. This will enable the commercial adoption of CV based on 5G networks, which will be a considerable boost to the development of the autonomous driving sector.

The main application scenarios of 5G CV include tele-operated driving (TOD), high-density vehicle platooning, and rapid and coordinated lane-change assistance.

TOD solutions will leverage remote driving control systems supported by high-performance 5G networks to transmit 360-degree views of a vehicle's surroundings to a control room via on-board cameras and sensors, acting as the eyes and senses of the driver. This will enable closed-loop remote control of cars, as remote drivers will be able to make decisions and operate cars based on this information.

In June 2017, China Mobile, SAIC Motor, and Huawei jointly completed the first demo of 5G-based remote driving technology in China. During the demo, which took place in Shanghai, the remote driver was able to drive a car from tens of kilometers away with accuracy and ease, enabled by the 5G network's ultra-high bandwidth and ultra-low latency.

The remote driving scenario required a 50 Mbps upstream rate to transmit the multi-channel HD video collected by the car in real time to the driving console. The driver's control signals were transmitted to the vehicle tens of kilometers away in under 10 ms via the ultra-low latency 5G network – as fast as if the driver was in the car.

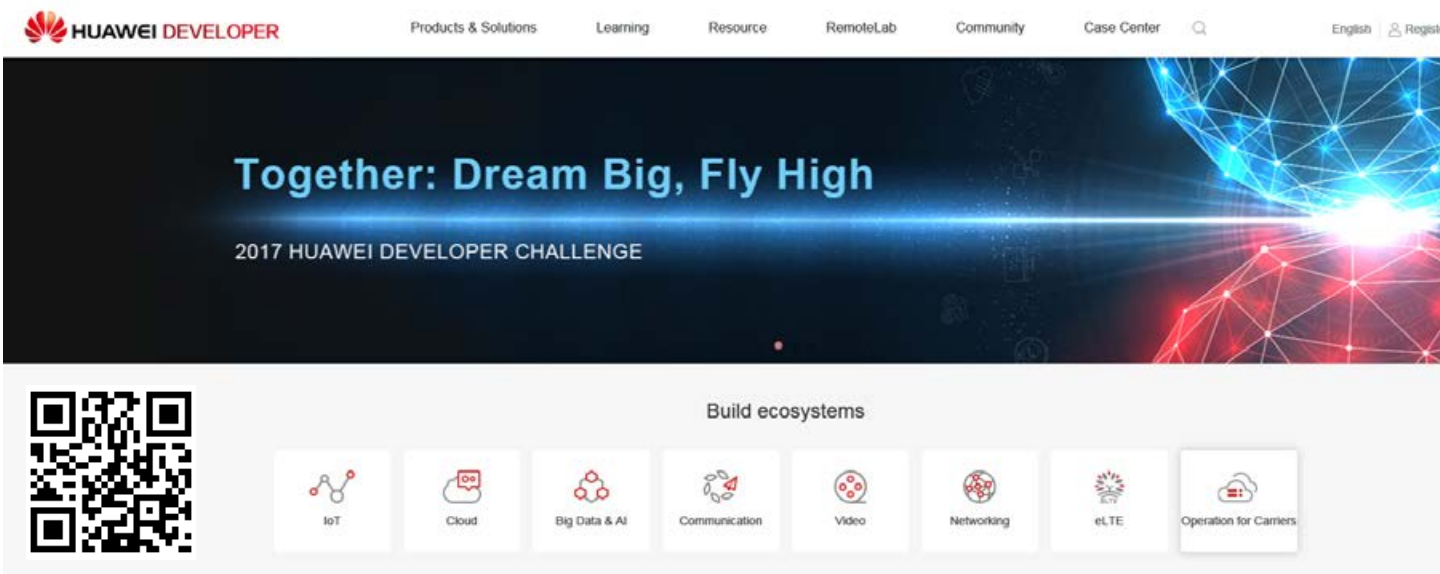
TOD technology will have many application scenarios in places with fixed road routes, such as airports and ports, as well as in harsh environments like mining sites or for compacting ground on construction and waste disposal sites. It will also be used in the future to complement autonomous vehicles such as taxis or shared cars services, with vehicles remotely driven and coordinated.

Huawei is working with its partners around the world to accelerate the arrival of autonomous driving based on 5G.

Open IoT gets developers in the zone

Digital transformation in industry verticals requires an open ecosystem. By using Huawei's stable equipment and infrastructure capabilities, developers can create IoT solutions for enterprise customers in various domains

By Jin Yeqing & Yang Yunliang



Unified support platform

Huawei has opened the capabilities of all its product lines through open APIs. To make Huawei's highly specialist products more accessible to developers, it launched the eSDK capability opening platform in 2013.

The platform includes various programming languages and protocols, and provides standard APIs for opening capabilities that developers can invoke at any time. This allows them to focus more on solution innovation without having to understand the specifics of the products, increasing the efficiency of secondary development.

To provide a better service for developers, Huawei launched the Developer Zone platform. It includes E2E technical support and resources for understanding, learning, development, testing, certification, launch, and commercialization. It's designed to vastly lower the threshold for developing solutions using Huawei products.

A full range of IoT products

Open capability invocation

In 2015, Huawei launched its

1+2+1 IoT solution, which comprises **one** open source IoT operating system, Huawei LiteOS; **two** connection methods, wired and wireless, which include Agile IoT (gateways and controllers), smart home gateways, eLTE, NB-IoT, and 5G; and **one** open unified connection management platform – OceanConnect.

The Developer Zone's Case Center showcases solutions developed by partners based on Huawei's products.

To drive the widespread adoption of Huawei IoT solutions, the Developer Zone introduces the opening capabilities of all Huawei's IoT products, including Huawei LiteOS, NB-IoT, EC-IoT, OceanConnect, and OpenLife (smart home), as well as solutions based on these products. Developers can quickly invoke the bottom-layer capabilities of Huawei IoT products through the IoT interface on the Developer Zone, so they can develop innovative IoT applications that meet their own demands.

For example, on the Developer Zone website, the OceanConnect platform provides a wealth of useful open APIs and serialized Agents. These help operators and enterprise/industry partners accelerate application integration, while simplifying and speeding up device access and ensuring network connectivity. This enables seamless connectivity between upstream and downstream partners' products and provides a one-stop service for partners that includes technical support, marketing support, and business collaboration.

Harnessing OceanConnect, developers can connect massive numbers of IoT devices to the IoT cloud platform with ease, allowing two-way communication between devices, platform, and partner applications for collecting data, issuing commands, efficient and visualized device management, data aggregation, and analysis. By invoking the platform's powerful open capabilities, developers can quickly develop innovative IoT services.

Showcasing industry solutions

With such a wide range of IoT applications that span smart transportation, environmental protection, public administration, public safety, personal health, and many other domains, the best way to build vertical-specific IoT applications is a concern for both enterprises and developers. To help developers better grasp how Huawei's IoT products can be applied in various industries for building solutions, the Developer Zone introduces methods from various sectors, such as smart homes, Internet of Vehicles, and public utilities, to help developers quickly gain a basic understanding.

IoT success stories

The Developer Zone's Case Center showcases solutions developed by partners based on Huawei's products. In the IoT sector, these include smart solutions for parking, street lights, agriculture, water, homes, and more. Each case was analyzed and broken down into six areas: overview, business background, solution, customer benefits, capability invocation, and partner introduction. Capability invocation explains how the partner invokes Huawei's open capabilities to achieve its required functions and gives other developers a more intuitive understanding of the capabilities Huawei products deliver.

Developer training

To help developers quickly understand the open capabilities of Huawei's IoT products, the Developer Zone also provides developer training and certification. Training consists of different levels of courses that meet the needs of different levels of developers. The training courses cover almost all of Huawei's IoT products, including LiteOS, OceanConnect, EC-IoT, and NB-IoT. Each stage of each course includes three to five days of instruction and hands-on practice, helping the developer master Huawei products' open capabilities from concept to implementation and enabling them to develop solutions using Huawei products.

Remote lab support

Before developers start, they need to prepare the commissioning resources and environment. However, because they don't want to spend too much on equipment in the early stages of project development, the Developer Zone provides a RemoteLab that gives developers access to the low cost resources they need without having to travel. For IoT, the Developer Zone uses the latest version of the OceanConnect platform, so that developers can remotely invoke capabilities, with access lasting three months at a time.

All-round resource center

In addition to basic product development guides and interface documentation, the Developer Zone provides coding samples and commissioning tools, greatly boosting development efficiency. As many developers cannot develop NB-IoT solutions without NB-IoT modules and networks, the Developer Zone provides SoftRadio module software. The software simulates NB-IoT modules, base stations, and core networks on PCs, enabling developers to carry out development work efficiently, even if they lack access to modules and networks.

After using SoftRadio to complete development work, developers can easily switch to working with real NB-IoT modules and networks, shortening commissioning time in real network environments.

Another aspect to consider is that many developers do not do E2E development, with some focusing on devices and others applications. To help specialist developers, the Developer Zone provides southbound and northbound simulation tools, dividing the E2E development process into two steps, enabling the commissioning of each to be carried out separately.

HDG IoT Salon

To bring IoT ecosystem partners together, help customers build local ecosystems, and incubate innovative and high-quality developers and high-value scenarios, Huawei Developer Gathering (HDG) organizes a series of salons. Experts can introduce the latest advances in IoT solutions and partners can share their experiences of applying Huawei IoT solutions. The salons provide a platform for exchange between Huawei and developers, and give developers a chance to interact.

Online Q&A from industry experts

Although the Developer Zone provides various services, developers may still encounter a variety of problems when working on actual projects. The Developer Forum and DevCenter are provided as support. On the Developer Forums' IoT board, Huawei experts share information about product functions, internal architecture, commissioning experiences. Developers can also share their development experiences.

The DevCenter provides a trouble ticket system, which developers can use to get in touch with Huawei experts. Developers submit tickets online describing the development problems they encounter and receive fast and efficient technical support from Huawei experts, completing a full E2E service that will help expedite a thriving IoT ecosystem.

OceanConnect

Cloud IoT for the future

OceanConnect funnels cloud and IoT into industry enablement suites that take business domains like IoV, Smart Homes, and public utilities to the next level.

By Du Jidong & Mao Yaqing

Large-scale IoT deployment is accelerating, with IDC predicting 28.1 billion IoT connections across the globe by 2020. Industry players face numerous challenges with making these connections and extracting value from them.

Business challenges: New service deployment lags behind market development due to the complex customer decision-making process for IoT projects, high project costs, and long project cycles.

Integration challenges: Since most IoT devices are power-sensitive with rigid demands on power-saving and security, integrating devices and networks/platforms is a long, tough process for southbound device manufacturers.

Deployment challenges: Service development is difficult for application developers and system integrators due to competition and the diversity and complexity of cross-industry technologies. It's also hard to develop integrated deployment capabilities.

Ecosystem challenges: For telecom operators, monetizing connections and determining how deeply to move into vertical industries are both complex issues.

To solve these challenges, Huawei's IoT cloud services focus on building capabilities that improve functionality in public cloud services, O&M, and technical enablement.

Powering IoT

Full-stack IoT

Optimal connection management: Huawei works closely with operators to provide smarter IoT connection management services and a diverse range of services for enterprises, including customizing rules to control business risks, diagnosing SIM card status and network faults, enabling group self-management and customization of group members, delivering user self-service and support for B2B2C scenarios, and implementing automated multi-APN control for dedicated traffic billing.

Excellent device management: The powerful functions and user friendly interface of Huawei's IoT cloud services provide full device management capabilities, including device status visibility, remote configuration, remote fault location, device firmware/software upgrades, and maintenance.

Huawei also provides a series of NB-IoT integration features in conjunction with operators. They help customers make full use of NB-IoT's advantages, such as mass connectivity, high concurrency, and low power consumption, and are vital to operating large-scale NB-IoT networks. Features include data transmission delays for quasi real-time network-aware message delivery, which is 67 percent shorter than GSM; device keepalive and heartbeat-free messages to reduce application system overheads by 95 percent; and cloud-and-network collaborative low-power management that, compared to GSM, cuts peak current by 85 percent and average current by 50 percent. Moreover, network-wide information scheduling in real-time is 90 percent more efficient than on

Large-scale IoT deployment is accelerating, with IDC predicting 28.1 billion IoT connections across the globe by 2020.

A single rack can manage tens of millions of users and dynamically expand resources based on loads.

traditional platforms.

Flexible, open application enablement: To provide commercial-grade development kits for industry development, domestic and international companies perform security monitoring on code, with complete technical support safeguarding the security and reliability of industry application systems. Over 170 northbound APIs open up device management, AI, and big data capabilities and industry enablement suites for connected vehicles, public utilities, and smart life sectors to quickly incubate enterprise applications.

Secure and reliable connections

Huawei's IoT cloud services have a strict data privacy policy to ensure tenant data isolation for enterprise customers. Tenants can define storage policies themselves to prevent unauthorized access, storage, or analysis. Unique secure transmission and optimized transmission encryption via NB-IoT ensure full security using 50 percent less power, while anomaly detection on smart devices enables rapid detection and isolation.

Hybrid cloud for local global services

An open platform based on Cloud Native architecture provides customers with 99.999 percent service reliability and mass connections for up to 100 million devices based on flexible capacity expansion, distributed design, and microservices. With market conditions and regulatory requirements varying in different regions, the hybrid cloud deployment method uses Huawei public cloud plus local data centers, which are the best choice for enterprise customers in terms of efficiency, security, and cost. With local service teams in more than 170 countries and regions, Huawei can help customers accelerate global promotion and service deployment.

Cross-industry ecosystem

Huawei's IoT cloud services help enterprise customers easily integrate devices for fast service development and rollout. Developers can use the graphical tools on Huawei Developer Zone to define and adapt data formats to achieve codeless, hour-level device integration. Huawei's IoT cloud services offer full support for 2G, 3G, 4G, and NB-IoT access, as well as mainstream IoT protocols such as LWM2M, CoAP, MQTT, Modbus, and HTTP. Dozens of mainstream chips, modules, devices, and applications from thousands of partners in multiple industries are pre-integrated into the ecosystem, offering a wealth of business options for enterprise customers.

Complete O&M

For jointly operated public clouds such as China Telecom's eCloud, Huawei mainly handles auxiliary operations, with an operations manager helping customers develop business plans and operations strategies and assuming some service operations. In solely-operated public cloud scenarios, the operations manager also handles E2E management of the IoT product lifecycle and optimizes the operations process, including product solutions and content integration. After product launch, the manager facilitates

service development on the platform and aggregates the product ecosystem, bringing in third-party partners.

IoT cloud services feature a range of security measures, including Huawei's public cloud infrastructure security, service security, and O&M security, in addition to the Huawei 24/7 monitoring center. Commercial projects supported by IoT cloud services can connect to the monitoring center. In the event of service interruptions, zero invoking exceptions, or other anomalies, the monitoring center receives service warnings, and alerts O&M personnel, who can quickly locate and solve the problem.

Huawei's IoT cloud services come with a dedicated site reliability engineering (SRE) team that handles O&M for commercial projects to ensure secure and reliable services, fast service recovery, preemptive O&M, and service requests.

Service development strategies

Integrating public utilities partners

To provide users with convenient and efficient services, Huawei works with solution partners in various fields, including gas, environmental protection, street lighting, and parking, to deeply integrate applications and create SaaS services that combine the IoT platform and industry applications. The partner then validates the IoT cloud services platform.

Joint sales with SaaS partners

After Huawei and the enterprise partner complete solution integration, they co-market the solution on the global market and produce a solution white paper plus marketing materials that outline the joint sales business model based on SaaS. When growing its own services, the partner combines the IoT cloud services with its own services and provides both to customers. The partner also launches SaaS on Huawei's public cloud marketplace, with their applications targeting public cloud customers as separate services. By jointly promoting the integrated solutions, both sides benefit.

Successful cases

Full upgrade of China Telecom's open IoT platform

On December 18, 2017, China Telecom and Huawei released an upgraded version of China Telecom's open IoT platform. The upgraded platform optimizes connection and equipment management, helping to speed up digital transformation for industry partners. The upgraded open platform provides a variety of unique adaptation features for NB-IoT services, which helps China Telecom to realize its network's full potential and fully utilizes its full-coverage NB-IoT network, which in turn helps to drive the large-scale commercial adoption of IoT services across the sector.

Around 45 million IoT devices are connected to China Telecom's open IoT platform in six main sectors: smart gas, smart water, smart lighting, bicycles on-demand, smart home, and Internet of Cows.

Huawei's IoT cloud services help enterprise customers easily integrate devices for fast service development and rollout.

iSoftStone builds cloud-based smart solutions for environmental protection

In August 2017, Huawei launched the beta version of its OceanConnect IoT platform on Huawei public cloud. Enterprise customers can connect massive numbers of IoT devices to the IoT cloud platform with ease, enabling two-way communication between devices and the platform for collecting data and issuing commands, visually managing devices, and integrating and analyzing data.

By invoking the platform's powerful open capabilities, customers can quickly develop innovative IoT services.

iSoftStone is a Huawei Cloud partner. Based on the Huawei Cloud, the two sides will collaborate on building solutions, training personnel, and migrating applications and operations. They will also promote government and enterprise clouds and accelerate digitalization in those sectors. iSoftStone has built a cloud solution for environmental protection on Huawei's IoT platform, which it plans to use in environmental monitoring projects in Jinshan, Shanghai, and Kaifeng, Henan.

iSoftStone and Huawei are planning to set up joint labs and develop enterprise solutions. On the platform side, iSoftStone has gradually migrated its environmental protection service to Huawei's IoT cloud services using the Huawei OceanConnect IoT platform, strengthening collaboration between the development teams. iSoftStone is also working with Huawei to jointly develop IoT services for cities, such as smart security surveillance and water utilities. For marketing, iSoftStone and Huawei will establish a joint marketing system and work collaboratively on projects.

Groupe PSA developing travel services

The European auto giant Groupe PSA is currently building its Connected Vehicle Module Platform (CVMP), which will cover 89 countries and 8 million vehicles by 2025. The CVMP project focuses on user mobility needs and new driving experiences, aiming to open up the vast potential of the IoV market for Groupe PSA and help the company achieve globalized, cross-regional deployment and O&M. CVMP's main application scenarios include online car bookings by connecting with third-party platforms, car sharing, in-car entertainment, driving habits analysis, emergency breakdown rescue, fleet management, and car resale.

Groupe PSA selected Huawei's OceanConnect IoT Platform to build the CVMP platform and provide users with innovative mobile transport services. Groupe PSA used Huawei's Cloud Family public cloud to globally deploy CVMP. The platform supports a 100 million-level IoV network and will provide cross-industry connectivity capabilities for integrating IoV, smart home, and smart city solutions, enabling integrated services for people, vehicles, and public services.

With solutions already in play and a full platform ready to enable developers, Huawei is committed to accelerating the mass commercialization of IoT to benefit all aspects of life and society as a whole.

Making manufacturing productive again with IoT

Cloud computing, big data, and IoT are ushering in the age of Industry 4.0 – a time when manufacturing is becoming smart and data-driven. Huawei's smart manufacturing solution, developed in collaboration with industry partners, is designed to help manufacturing enterprises carry out digital transformation and build competitive advantages as the fourth industrial revolution begins.

By Zhang Mingwei, Zhou Yaling & Mao Feixiang

The growth of traditional industries has slowed almost in parallel with the booming development of the mobile Internet industry. Manufacturers have faced significant growth obstacles, including high manufacturing costs, low efficiency, and the lack of ability to innovate.

From 2011 to 2015, the annual average growth rate of global industrial productivity dropped from 4 percent, which had stayed constant for 20 years, to just 1 percent. One reason is labor costs: In China, for

example, costs doubled from 2004 to 2014, with productivity growth falling far behind. Innovation has been weak, with traditional manufacturers focusing on extending existing services and product features such as performance indicators.

The fourth industrial revolution

Over the past few years, each of the main global manufacturing powers has introduced new policies to promote digital transformation and stay competitive. Launched in 2013, Germany's Industry 4.0 strategy aims to create smart factories and smart manufacturing innovation centers. France's New Industrial France policy sets out plans for 34 new projects, from next-gen high-speed trains to electric aircraft, smart textiles, and factories of the future. The National Network for Manufacturing Innovation plan in the US will set up 45 innovation centers to develop innovative smart manufacturing technologies. Japan's Society 5.0 is the nation's vision for robots, new energy vehicles, and 3D printing, among other innovations. Proposed in 2015, China's Made in China 2025 outlines a three-stage plan for developing China's manufacturing industry in 10 priority sectors. And the UK's strategy for manufacturing extends to 2050, aiming to promote manufacturing and service integration and increase the number of skilled workers.

Alliances for the future

Germany, the US, and China have made the most progress in advancing smart manufacturing, with alliances set up in each of the three countries: the Industry 4.0 Alliance in Germany, the Industrial Internet Alliance (IIC) in the US, and the Alliance of Industrial Internet (AII) in China.

Germany's Industry 4.0 platform has developed more than 130 innovation projects in areas such as mass customization, adaptive factories, self-organization and adaptive logistics, human-machine interface technology, and smart product development and production. The IIC has set up over 30 testbeds and more than 60 projects to look at innovative applications in sectors such as energy and power, industrial manufacturing, transportation, healthcare, agriculture, and smart cities. China's AII, which now boasts 404 members, has launched over 20 testbeds, covering areas such as discrete manufacturing, energy and utilities, port logistics, and basic medical care; 17 industrial Internet use cases; and 8 industrial Internet big data use cases. These use cases include smart production,

mass customization, network coordination, service extension, production process monitoring and optimization, and remote equipment O&M.

IoT facilitates smart manufacturing

To help traditional manufacturers carry out rapid digital transformation, Huawei has leveraged its powerful ICT capabilities and joined forces with industry partners to launch a complete smart manufacturing solution. The solution can help industrial enterprises achieve smart manufacturing in four main areas: terminals and sensors, access and transmission networks, capability opening, and upper-layer applications.

On the terminals and sensors front, Huawei has collaborated with industrial partners to smartify the dumb terminals used in traditional manufacturing so they can upload equipment data and receive commands. There are two methods of smartifying dumb terminals:

Adding wireless chips: An eLTE or NB-IoT chip is added to the manufacturing terminal. The chip can transmit data generated by the terminal via the eLTE or NB-IoT network, enabling manufacturing data to be collected and commands issued.

LiteOS: Huawei's LiteOS IoT operating system is embedded into manufacturing devices, simplifying the development work of cloud-device interconnections.

For access and transmission networks, Huawei provides a converged wired and wireless network access method to ensure stable access for manufacturing equipment.

Wired access: Huawei's EC-IoT gateways support multiple interfaces and protocols to facilitate access for different types of manufacturing equipment. With the gateways providing edge computing capabilities, applications can be easily developed and deployed, enabling real-time device management and maintenance.

Wireless access: Huawei offers two wireless access methods: eLTE and NB-IoT. For communication within a manufacturing plant, an enterprise can leverage Huawei's solution to build their own eLTE private network, providing unified access for broadband, narrowband, and trunking, enabling functions like scheduling automated guided vehicles (AGV), camera access, collecting production data, asset inventory, monitoring energy

Huawei has joined forces with industry partners to launch a complete smart manufacturing solution.

consumption, monitoring gas, and trunking communications. Manufacturers can implement a multi-functional network to reduce the number of internal networks and cut management and maintenance costs.

For external communications, Huawei's NB-IoT chips can be embedded into devices and enabled to transmit data over a telecom operator's NB-IoT network to report data. On the platform front, Huawei's one-stop cloud services portfolio provides an IoT platform, IaaS, a database, big data analysis, security, and applications. For IoT scenarios, it offers references to typical architectures and optimization features for cloud services in different sectors. One of these services is OceanConnect, which provides connection management, unified access, visual device management, big data analytics, and capability opening for IoT devices.

One-stop connection management: M2M connection management capabilities include device management, operations management, pipe management, fault diagnostics, Dashboard, and automated monitoring for individuals and businesses. The API provides integration capabilities for external applications.

Unified model and quick access for massive numbers of devices: For southbound access to large numbers of devices, the IoT platform provides unified, quick access capabilities, preventing problems with different access protocols and enabling application and device decoupling. The IoT platform offers a unified model for northbound applications, helping them leverage device data. The IoT platform can adapt to different protocols through cloud gateways, device-side agents, and SDKs.

Visual device management: Provides upgrades, diagnostics, remote operation, and visual management capabilities for IoT devices plus LWM2M-based device management.

Big data analysis: The IoT platform provides secondary development and supports real-time and offline analysis and data sharing for new services. By establishing big data analytics models and collecting industry data, enterprises receive big data and statistical analytics services, including basic information resources use, business data, user behavior, and geographic location.

Capability opening: Network capabilities, connection capabilities, device management, and big data applications are opened up to the enterprise, helping it to quickly build applications.

Huawei has worked with industry partners to build manufacturing industry applications including MES, CAD, CAE, and ERP into Huawei's IoT platform and public cloud, so that manufacturers can build business systems. Huawei has also worked actively with industry ISV and IoT ecosystem partners to build scenario-based IoT solutions that accelerate IoT application innovation in industry verticals.

Real-world smart manufacturing cases

Huawei Songshan Lake Manufacturing Facility

Huawei deployed an eLTE-based smart factory solution at its Songshan Lake factory in Dongguan, China. Services include video surveillance, AGV control, robot status data backhaul, device data collection, device power consumption monitoring, asset inventory, and personnel and key asset location. The device power consumption monitoring and asset inventory functions leverage an eLTE-IoT narrowband solution, while the other functions harness LTE-U broadband technology. After the solution was deployed, productivity went up by 30 percent and OPEX and power consumption fell by 20 percent and 10 percent, respectively.

Automotive manufacturing

Huawei and the robot manufacturer KUKA have jointly tested an eLTE-based smart factory solution for reporting robot status at an automotive manufacturing plant. By enhancing network connectivity, the collaboration will enable more wireless services in the future, including mobile robots, AGV, and edge gateways, so that more LTE-based and 5G-based use cases can be verified. It will also optimize existing production lines, improve production efficiency, and shorten product release cycles.

Elevator industry

Huawei partnered with the industry giant GE to provide smart after-sales services for an elevator company. The solution harnesses EC-IoT gateways to collect data on elevator operations, providing predictive maintenance for elevators through big data analytics. With the solution, downtime was reduced by 90 percent and operating expenses by 50 percent.

Petrochemical industry

Jiujiang Petrochemical deployed Huawei's eLTE-based smart factory solution to enable the smart inspection of refineries and smart monitoring of hazardous gases. Since the smart factory was built using Huawei's solution, Jiujiang Petrochemical has made new breakthroughs in safety and environmental protection, energy saving and emission reductions, cost reductions and efficiency enhancements, and green/low-carbon manufacturing.

The future of manufacturing is data-driven. The right solutions and partnerships are the tools to make it happen and guide manufacturing enterprises through the digital transformation process.

The future of manufacturing is data-driven. The right solutions and partnerships are the tools to making it happen and guiding manufacturing enterprises through the digital transformation process.

Huawei LiteOS

A heavyweight in IoT connectivity

In the PC era, Microsoft Windows was the king of the PC OS. In the age of the smartphone, Google's Android and Apple's iOS took the reins and became the dominant duo in the mobile OS market. Now, in the IoT era, Huawei plans to join forces with industry partners and harness the open-source power of Huawei LiteOS to make it synonymous with IoT.

By Shi Jinfan

With people-to-things and things-to-things connections starting to overtake people-to-people connections, the IoT market holds almost unimaginable potential. In the future, IoT networks will connect hundreds of billions of devices that will need to run applications, perform simple calculations, and communicate with other devices, edge gateways, and clouds. They will typically run on low-performance microcontroller unit (MCU) chips and be battery-powered. A great variety of IoT devices in different industry applications will use different types of hardware and connection protocols. Meeting the diverse demands of massive numbers of devices will be a new challenge and opportunity for operating systems in the IoT era.

As a core part of Huawei's 1+2+1 IoT strategy, Huawei LiteOS is a software development platform that's designed to help rapidly develop the IoT device industry and the smartification of IoT hardware.

Since its release in 2015, Huawei LiteOS has assisted many exceptional products go to market, including high-end Huawei smartphones, wearables, and IoT chips. To date, 50 million Huawei LiteOS-powered devices have been produced.

Huawei is now working with third-party chipset and device manufacturers to drive the development of the IoT industry and help realize the era of 100 billion IoT connections, which is predicted for 2025. Huawei LiteOS provides a unified, open API that can be applied in domains as diverse as smart homes, wearables, Internet of Vehicles, and manufacturing. Huawei LiteOS provides an open-source, one-stop service for developers that lowers barriers to development and shortens the development cycle by virtue of a range of high-end features: It's lightweight, low-power, quick start, interoperable, secure, and stable.

Unique competitive strengths

IoT has distinct requirements on operating systems compared

with PC or mobile devices. IoT operating systems must be modular; have upgradable architecture and scalable kernels; use little power, support a variety of connection protocols and different types of hardware and chip solutions; and offer device-side security capabilities.

Huawei LiteOS provides a one-stop, complete software development platform for IoT device manufacturers to tackle the challenges of IoT OS design. Huawei LiteOS includes a modular middleware framework that lowers barriers to development and shortens the development cycle.

Lightweight

Huawei LiteOS is a lightweight IoT operating system. It offers strong interoperability and supports lightweight device-end security.

Scalable lightweight kernel: The smallest kernel (6 KB) on the market offers fast-start and low power consumption features.

Large numbers of connection protocols: The interconnectivity framework includes a comprehensive device and cloud interconnection application protocol stack that supports default connections with the Huawei OceanConnect IoT platform, as well as access to third-party platforms. Multiple network access protocols, including Wi-Fi, Bluetooth, Zigbee, Ethernet, and NB-IoT, are supported to meet the needs of different types of devices.

Huawei LiteOS provides basic security capabilities such as two-way authentication, DTLS encrypted transmission, and remote upgrades for weak terminals in LPWA scenarios. Weak terminals include water

meters, gas meters, and vehicle detectors, which have limited capabilities and resources in terms of memory, storage, and CPU, but have strict requirements on cost and power consumption.

In scenarios with extremely low power consumption requirements, Huawei LiteOS also offers lightweight and optimized DTLS+ secure transmission protocols.

Huawei LiteOS is embedded in the Huawei Boudica chip. The open API lets device vendors quickly develop device-end applications that can seamlessly interoperate with the NB-IoT network and Huawei OceanConnect IoT platform. This reduces the difficulty of NB-IoT device development and speeds up product commercialization.

Mature commercial adoption

Huawei has shipped more than 50 million units that use Huawei LiteOS. Since 4Q 2016, it has shipped 100,000 units, including smart door viewers, smart doorbells, security cameras, and other smart home devices.

With the large-scale commercial rollout of NB-IoT in 2017, shipments of various NB-IoT smart devices that use Huawei LiteOS, such as smart water and gas meters, vehicle detectors, street lamps, mailboxes, and smart bike locks, are set to exceed 3 million units.

Open

Huawei LiteOS already supports six of the top ten MCU manufacturers (NXP, ST, Microchip, TI, SiliconLab, and ADI); two of the top three Chinese MCU manufacturers (GigaDevice and MindMotion); more than 40 industry-standard MCU hardware development boards; and three NB-IoT development boards.

Huawei LiteOS's open-source community provides developers with a full suite of services, including knowledge, experience, downloads, learning, exchanges, and support. LiteOS is easy to learn and development is straightforward. The open-source community includes over 30,000 developers, and three versions of the operating system have been released since 4Q 2016.

Commercial use cases

Smart fisheries

Dangerous and hard, fish farming requires its farmers to inspect the rearing conditions of fish and crabs regularly, regardless of weather or time of day. To make things easier, Yiqi Software, a Huawei LiteOS partner, released the Fisherman's Friend solution. It enables uninterrupted monitoring 24/7 and provides decision-making support for fish farmers through data analysis.

As part of the solution, various devices are installed in fish ponds to collect different types of data on air and water conditions. The data is collected by the control box, uploaded to a smart aquaculture cloud via 2G/3G/4G or NB-IoT networks, and then processed centrally. The smart center analyzes service models, and monitors and manages the data throughout the process. The data is

easily monitored via mobile app, and sensors can be remotely controlled anytime, anywhere using a mobile phone, making life much easier for fish farmers.

The mobile outdoor sensors in the Fisherman's Friend smart fishery solution come integrated with Huawei LiteOS, the open capabilities of which allow outdoor devices to quickly connect. Although the sensors have a high transmission frequency, Huawei LiteOS's low power consumption allow a battery with just one-third the capacity of a mobile phone battery to run for a year.

Huawei LiteOS is also integrated into the control box. With the pre-integrated interconnect protocol stack and byte-stream transmission capabilities, development costs and network usage costs are reduced.

Huawei LiteOS is fully compatible and works in conjunction with NB-IoT chipsets. Profiles and codec plug-ins can be flexibly customized on the OceanConnect platform, enhancing the scalability, elasticity, and security of the Fisherman's Friend application.

When developing Fisherman's Friend devices, Yiqi Software was able to run Huawei LiteOS directly on MCUs without further migration thanks to Huawei LiteOS's complete ecosystem. Because Huawei LiteOS provides an NB-IoT interface encapsulation API and OceanConnect access code samples, device development and interface work was shortened from a month to a week. The reduced time was due to the fact that during device development, the partner didn't need to spend time learning the AT commands or platform southbound interface manuals. Monitoring device development was faster and the quality of development much improved.

With the Fisherman's Friend solution, fish farmers can fully understand the aquatic environment without having to set foot outside, and no longer have to lose sleep over changing water conditions. They can even consult experts online when they encounter problems in their fish farms. Fisheries departments can use big data analysis on back-end management systems to provide policy guidance for fish farms and help the sales of aquatic products.

Although the sensors have a high transmission frequency, Huawei LiteOS's low power consumption allow a battery with just one-third the capacity of a mobile phone battery to run for a year.

Smart mailboxes

Mailboxes are a familiar part of a country's infrastructure and tend to number into the millions, forming one the most common types of 'dumb devices' in logistics.

Because post carriers don’t know how many letters any given mailbox contains, they need to open and

Harnessing LiteOS's open-source model, Huawei hopes to foster an ecosystem that can work together to carry out joint innovation to drive the IoT era.

check every mailbox on their route. An empty mailbox equals a wasted run, and therefore a waste of labor.

Huawei's partner ThunderSoft built a smart mailbox solution using Huawei LiteOS. The solution collects data on the number of letters in a mailbox in real time. This data is transmitted to the application platform via a low-power NB-IoT network. Mail carriers can automatically plan their routes based on the quantity of letters, avoiding the unproductive use of labor.

The solution requires two sensors to be installed in mailboxes – one monitors deliveries through the mail slot and the other monitors operations when the mailbox door is opened and letters are collected. Data from the two sensors is collected and then filtered and processed by the monitoring devices. Data such as the volume of letters, signal quality, GPS location, and battery level are transmitted to the application platform by the NB-IoT network. The IoT platform carries out unified management on the monitoring devices and transmits mail data to the application platform, providing route planning, device status notifications, and other such functions.

Thanks to the advantages of the technology and the solution that Huawei LiteOS provides, the partner quickly completed integration and development of the smart mailbox solution. Huawei LiteOS integrates deeply with MCUs, lowering MCU operating power consumption with low-power processing mechanisms. Combined with the NB-IoT network, this provides a significantly extended device battery life, estimated to be sufficient for three years of continual operation at a frequency of one letter posted per hour. In addition, Huawei LiteOS's device/cloud suite makes developing monitoring hardware and connecting it to the cloud platform quick and simple. API interface encapsulation means the bottom-layer protocol connection process and communication mechanism are now irrelevant, making developers' jobs a lot easier.

Ecosystem and cooperation strategy

Huawei LiteOS primarily focuses on lightweight, low-power consumption scenarios. Harnessing LiteOS's open-source model, Huawei hopes to foster an ecosystem of chip makers, solution providers, device manufacturers and telecom operators that can work together to carry out joint innovation to drive the IoT era.

Huawei LiteOS has established a complete open-source system and support channel. Developers and business partners can access LiteOS support documents, technical information, and related solutions on Huawei's Developer Zone and on the Huawei LiteOS official website. They can also connect with experts on technical forums to receive rapid technical support, and the source code for Huawei LiteOS can be downloaded from GitHub. Huawei has also established a collaboration platform for Huawei LiteOS in the Huawei Solution Partner Program.

HUAWEI

DHL

Reinventing delivery

197 of the Fortune Global 500 companies choose Huawei as digital transformation partner.

Huawei's **Leading New ICT** is enabling DHL to develop smart logistical platforms.

Explore **e.huawei.com** for more information

HUAWEI

MateBook X, a 13'' notebook smaller than A4 paper

Product colour, shape, interface and functions are for reference only. The actual product may vary.
Intel, the Intel Logo, Intel Inside, Intel Core, and Core inside are trademarks of Intel Corporation in the U.S. and/or other countries.

HUAWEI MateBook

Business. Styled

MateBook E MateBook X MateBook D

Up to 7th Gen Intel® Core™ i7 processor
Intel Inside® Extraordinary Performance Outside.
Order here: consumer.huawei.com

HUAWEI