

ICT INSIGHTS

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On the Road to Digital Transformation

Huawei has become the enabler and preferred partner for the digital transformation of industries.

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Platform, Ecosystem, and the Future Sharing the Success in the Era of Industrial Digital Transformation

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



“It is the best of times and it is the worst of times.” After decades of working in the ICT industry, we have acquired a deep understanding of this industry and how it is being reshaped. Continued growth in data, applications, and connectivity is putting mounting pressure on enterprise IT budgets, which typically remain static. To address this issue, enterprises are increasingly investing in new third-party platform ICT technologies, such as cloud computing, Big Data, the Internet of Things (IoT), and Artificial Intelligence (AI), to help them innovate and grow.

According to statistics, the investment in new technologies in 2016 accounted for nearly 50 percent of customers’ total ICT budgets and this number will grow to 71 percent over the next five years. However, this brings both challenges and opportunities.

Digital Transformation: Why Are Fortune 500 Companies Choosing Huawei?

Since forming the Huawei Enterprise Business Group six years ago, we have experienced two distinct phases of growth. During our first three years the group’s average growth rate was 28 percent, and in the last three years it was 45 percent. The 2016 contribution from global partners accounted for 76 percent of total revenue.

In recent years, more and more leading enterprises from various industries are choosing Huawei to drive their digital transformation. In fact, based on internal data, 172 of Fortune 500 enterprises and 43 of Fortune 100 enterprises have chosen Huawei. Delivering these successful digital transformation engagements would not be possible without support from our partners.

As the business continues to grow, Huawei’s brand awareness is also rising rapidly within the industry. According to the latest statistics from Interbrand, an internationally renowned institute of brand research, Huawei climbed from 88th to 72nd place in the 2016 ranking of global brand awareness. In addition, Ipsos, one of the world’s largest

market research companies, commented in its 2016 brand research report that “promising,” “energetic,” “innovative,” and “progressive” increasingly define Huawei.

Let us take a look at some recent digital transformation cases.

Schindler is the world’s second largest manufacturer of elevators and escalators, with one million operating elevators, escalators, and moving walkways around the globe. Huawei and Schindler are partnering on a joint project named the Internet of Elevators and Escalators (IoEE), which has now entered the deployment stage. We plan to enable the networking of millions of elevators and escalators across the world in the next few years. This will allow operational data on the elevators and escalators to be transmitted to a monitoring center in real time for preventive maintenance, which will improve the operational security of elevators and escalators, and reduce labor costs. By making elevators and escalators smart, the traditional elevator and escalator industry can gain huge benefits from implementing digital transformation. Our customer said: “digitalization has been integrated into everyday service and has become an indispensable part of Schindler’s DNA.”

In China, Huawei has used multiple technologies, such as cloud, Big Data, and the IoT, to help customers achieve digital transformation. For example, Huawei provided a media cloud solution to *People’s Daily* to facilitate its transformation from traditional media to

In the era of industrial digital transformation, Huawei Enterprise Business Group's core strategy is to invest intensively in technologies to provide innovative, differentiated, and leading ICT infrastructure, build an open, scalable, secure, and flexible platform, and work with our partners to help customers achieve digital transformation. At the Huawei Eco-Partner Conference 2017 in China, the Huawei Enterprise Business Group officially announced the 'platform + ecosystem' strategy. >>

omnimedia. Other examples of Huawei's diverse solutions deployed in China include a converged Big Data platform for the Industrial and Commercial Bank of China, an IoT metering solution based on eLTE wireless broadband technology for the State Grid Corporation of China, and a Smart City solution for the City of Dunhuang.

Within today's digital landscape, we believe the cloud has developed from stage 1.0 to 2.0. Cloud 1.0 was created and led by Internet companies that provide OTT services, while cloud 2.0 is deeply integrating the cloud into various industries.

'Platform + Ecosystem': Huawei Enterprise Business Group's Strategy in the Digital Era

In the era of digital transformation, the Huawei Enterprise Business Group's strategy has evolved from our founding strategy of 'being integrated.' We aspire to become the driver of digital and intelligent social development, and be the best partner to help customers achieve digital, cloud, and smart transformation which is critical to future business success. Based on our main focus of ICT infrastructure, Huawei will work with our partners to build an open, collaborative, and mutually beneficial ecosystem.

Our strategy comprises two elements: platform and ecosystem.

The core of our platform strategy is to invest intensively in technologies to provide innovative, differentiated, and leading ICT software together with hardware infrastructure to build an open, scalable, secure, and flexible platform and work with our partners to help customers achieve digital transformation.

I think the main difference between Huawei's platform and other platforms is that Huawei's platform emphasizes

cloud-pipe-device collaboration. Digital transformation cannot be achieved with any one single technology, and the value of the cloud cannot be realized without other technologies. To capitalize on the value of the cloud, terminals need to collect vast amounts of data and utilize networks for transmission. This collaboration relies on decades of experience and represents our most powerful capability.

The digital transformation of an industry requires participation from customers, partners, and Huawei. Customers bring to the table a deep understanding of their business; partners excel in industry applications; and Huawei provides an ICT platform that helps customers realize their transformation journey. We aim to build a digital transformation community with multi-party collaboration to accelerate joint innovations. We will develop our ecosystem from four perspectives, namely; industry alliances, business alliances, developer platforms, and the open source community.

Huawei has adopted a popular Silicon Valley phrase of "Eating your own dog food," meaning that the development and testing of new products, services, and business models is based on our own company's needs before launching these technologies and capabilities to customers.

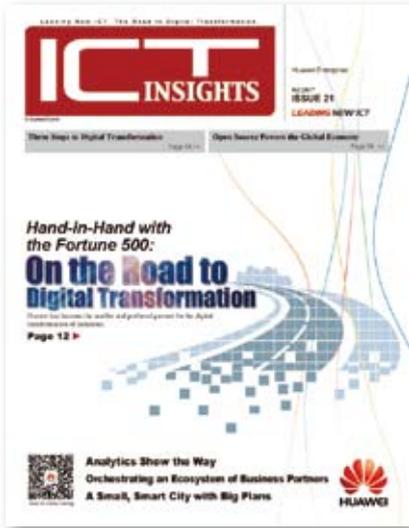
Huawei is a large enterprise with 180,000 employees and branches in approximately 180 countries and regions across the world. We process more than 600,000 orders every year. We have focused on driving IT agility and efficiency throughout our organization.

While many enterprises use 70 percent of their investment on Operations and Maintenance (O&M) and just 30 percent for transformation, at Huawei the numbers are reversed: We spend 70 percent of our IT investment on transformation and 30 percent on O&M. Furthermore, we plan to achieve full digitalization in the next three to five years. We believe that our experience and capabilities gained from this process will help customers from various industries.

A good digital transformation strategy cannot succeed without paying close attention to key details. Huawei has identified 10 key detailed issues regarding the building, utilization, and management of the cloud (see *ICT Insights Extra* cover story: *Embrace and Integrate with the Cloud to be a 'Digital Enterprise'*). Many people believe that digital transformation has a 50/50 chance of failure. However, by identifying and resolving detailed issues throughout the transformation process, I firmly believe our probability of success is far greater.

During digital transformation, customers, partners, and Huawei have their own positioning and values. Huawei focuses on the ICT infrastructure platform, while many partners provide industry applications at the upper layer. This approach has created value for customers in multiple fields, such as public safety, manufacturing, and finance.

Today, Huawei officially shares its 'platform + ecosystem' strategy and I believe that our collaboration with customers and partners will lead to successful digital transformation and drive new opportunities. ▲



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Technology News

| Source: PR Newswire

Glassbox Launches Feature to Automate Analytics and Anomaly Detection

NEW YORK CITY, NY, USA, Feb. 23, 2017 — Glassbox, a digital transformation company helping businesses optimize the entire digital lifecycle, today announced the launch of its Automatic Insights feature that offers automated anomaly detection and real-time analytics. The feature will build on Glassbox's automatic tag-less recording capabilities to provide an end-to-end enterprise-wide digital transformation solution.

Automatic Insights will proactively alert IT teams and marketing executives when there is a problem with online conversion rates so they can identify the root cause. The capability shows why users are dropping off a web page, share sample session replays, and provide insights for enterprises to better optimize their customer journeys.

Recorded Future Combines Technical, Open, and Dark Web Sources of Threat Intelligence for the First Time

BOSTON, MA, USA, Feb. 13, 2017 — Recorded Future, the threat intelligence company, today expanded its threat intelligence solution to give threat intelligence analysts and security operations centers access to an unrivaled breadth of technical, open, and dark web sources in a unified solution.

Manually turning data on cyber attacks, vulnerabilities, and exploits into actionable threat intelligence requires significant investment of time and resources. Recorded Future's patented Web Intelligence Engine automatically collects data and conducts deep analysis from the broadest set of sources from the open, deep, and dark web, as well as threat feeds, technical collection, and security reporting. Using machine learning and natural language processing, these billions of data points are extracted and organized to filter noise to help businesses surface emerging threats up to 10 times faster. This is why 86 percent of the Fortune 100 trust Recorded Future.

The Institute for Robotic Process Automation Expands Focus to Artificial Intelligence

NEW YORK CITY, NY, USA, Feb. 15, 2017 — The Institute for Robotic Process Automation (IRPA), today announced it has officially expanded the focus of its professional association and



knowledge forum to include Artificial Intelligence and is changing its name to IRPA AI. The organization's rebranding reflects the broader range of coverage and resources the institute is extending to its 7,000+ growing membership, widening the scope beyond RPA to include intelligent automation, cognitive computing, machine learning, and artificial intelligence.

"With our rebrand, we are changing more than just our name. It's the next chapter of a much bigger story that goes beyond technology — it's about how work gets done," said Frank Casale, founder of IRPA AI. "For most enterprises, it is no longer just about RPA. Many organizations have expressed their interest and need to learn more and quickly; they are anxious about the quickening pace of change. IRPA AI means we are expanding our role as educator, connector, supporter, facilitator and, occasionally, even therapist. We are aligning our focus to meet our members' escalating needs."

Intersil Announces Industry's Smallest Isolated RS-485 Transceiver

MILPITAS, CA, USA, Feb. 13, 2017 — Intersil Corporation (NASDAQ: ISIL), a leading provider of innovative power management and precision analog solutions, today announced the industry's smallest isolated RS-485 differential bus transceiver designed to provide 4 Mbit/s bidirectional data transmission for Industrial Internet of Things (IIoT) networks. The high-speed ISL32704E delivers industry-leading Electromagnetic Interference (EMI) and Common-Mode Transient Immunity (CMTI) in a small 4 mm x 5 mm QSOP package that is 70 percent smaller than competitive devices. It also provides 600 Vrms of working voltage, which is approximately 50 percent higher than the closest competitor.

UniPixel Prepares for Flexible Display Market

SANTA CLARA, CA, USA, Feb. 7, 2017 — UniPixel, Inc. (NASDAQ: UNXL), a provider of high performance metal mesh capacitive touch sensors to the touchscreen and flexible display markets, announced today positive results from in-house testing conducted on its XTouch touch screen sensors for use in future flexible/foldable display devices such as smartphones, tablets, and wearable devices.



UniPixel conducted tests in which its XTouch sensors were folded and opened more than 200,000 times at a 2-millimeter radius at the fold. During the tests, as well as at the conclusion of those tests, there was no damage to the XTouch sensors and no degradation to their performance capabilities. Flexible displays will also need to have a thin and pliable cover lens that will bend consistently without damage. UniPixel's Diamond Guard scratch-resistant cover lens technology is an excellent complement to XTouch sensors as it is applied in a very thin layer and will bend and seamlessly fold as it protects the underlying touch sensor metal mesh from abrasion damage.

Aurora Multimedia and Huawei to Introduce World's First 10G PoE Solution At ISE 2017

MORGANVILLE, NJ, USA, Feb. 7, 2017 — Aurora Multimedia Corporation, a leader in A/V over IP, is pleased to announce the world's first long-awaited network switch by Huawei that will allow the 10G PoE of Aurora's IPX transceiver to receive PoE directly from the network switch. This follows the initial introduction of Aurora's award winning IPBaseT technology and the IPX Series 10G with zero compression/zero latency, 4K streaming boxes and wall plates over two years ago.

Aurora's IPX Series is the first 10G streaming product to utilize PoE but has been waiting for a 10G network switch to complement the capability. The IPX Series comprises six products; three of which are 10G copper (IPX-TC1-C, IPX-TC2-C, and IPX-TCW3-C). Huawei will be releasing a 24 (S6720-32C-PWH-SI) and 48 (S6720-52X-PWH-SI) port 10G PoE/PoE+/PoE++ switch in Q2. Simultaneously, the products will exhibit the effectiveness of 10G PoE in real-world applications and rush in a new era of 10G products.

Aquantia Announces the Industry's First FPGA-Programmable Multi-Gigabit Ethernet PHY Device

SAN JOSE, CA, USA, Jan. 30, 2017 — Aquantia Corp., a pioneer and market leader in high-speed Ethernet connectivity solutions for data centers, enterprise infrastructure, and client connectivity, today announced the AQcite product line of FPGA-programmable Multi-Gigabit Ethernet Physical Layer (PHY) devices, integrating Aquantia's AQRate BASE-T PHY with a Xilinx® Kintex®-7 FPGA. The new AQcite product line targets a vast range of applications such as Audio-Visual (AV) over

Ethernet, machine vision, data center, enterprise, 5G wireless, industrial, metro environments, and more.

With the rising cost of Application-Specific Integrated Circuits (ASICs), many companies are resorting to develop, test, and commercialize products based on FPGAs. In applications where transport of data and networking is required, Ethernet is often the preferred choice. Foreseeing the need to deliver smaller footprints and cost advantages to its customers, Aquantia has developed AQcite, a unique device that integrates both Multi-Gigabit BASE-T PHY and FPGA functions in a single-chip package.

Enea Announces Industry First: Qosmos Signatures for Third Party Deep Packet Inspection Libraries

STOCKHOLM, Sweden, Feb 02, 2017 — Enea® (NASDAQ OMX Nordic: ENEA) today announced the availability of Qosmos® Signatures for networking and security product vendors who wish to extend their Deep Packet Inspection (DPI) libraries with the most complete and widely used signature dataset on the market.

Product vendors with in-house DPI libraries face the costly challenge of constantly updating signatures for protocols that change regularly and without prior notice. While some basic protocols are easy to manage since they are relatively stable, a growing number of proprietary and fast-evolving protocols such as websites, social networking, video streaming, and gaming applications require important internal resources for development, testing, and validation to keep signatures up-to-date. This can slow down product cycles and detract product developers from the development of their core technology.

Platform9 Launches Industry's First Infrastructure-Agnostic Managed Kubernetes Service

SUNNYVALE, CA, USA, Jan. 24, 2017 — Platform9, the open-source-as-a-service company making cloud infrastructure easy, today announced the general availability of its Managed Kubernetes service, the industry's first infrastructure-agnostic, SaaS-managed offering. Unlike legacy software distribution models, Managed Kubernetes is deployed and managed entirely as a SaaS solution, across on-premises and public cloud infrastructure. The company also introduced Fission, a new, open source, serverless framework built on Kubernetes. These offerings feature a drastically simplified operational and consumption model that eliminates the steep learning curve currently associated with Kubernetes and allows DevOps and IT teams to focus on solving core business problems. ▲



Steven Cost

Analytics Show the Way

| By Steven Cost, President of Safety and Infrastructure, Hexagon

Big Data and predictive analytics are on the cutting edge of Safe City technologies — and integral to public safety. Combined with connectivity, cooperation, control, and intelligence, these sources of analytics will help safeguard our cities. >>

In addition to everyday threats such as crime, cities are vulnerable to natural disasters, epidemics, and acts of terror. Even though we all know that these emergencies occur and how devastating they can be, few city infrastructures are adequately prepared to cope with them. Yet, technology stands ready to make our cities safer, while reducing costs and generally making cities more efficient.

Four Pillars of Safe Cities

Market research firm Frost & Sullivan defines Safe Cities in terms of four pillars. First, Safe Cities need integrated communications and other technologies that connect multiple agencies into a cohesive whole. This connectivity is important for emergency services as well as traffic and event management.

With the first technology pillar in place, the second pillar supports collaboration among the agencies. In many cities around the world, the police information silo is separate from the fire department or public works information silos. Cities that see this isolation as a problem can gain a lot of leverage from the connecting technology that makes cities safer and reduces costs.

The third pillar is command and control, where the aggregation of information can enhance situational awareness. Technology can enable smooth transfers of information between emergency and public service agencies as each situation requires.

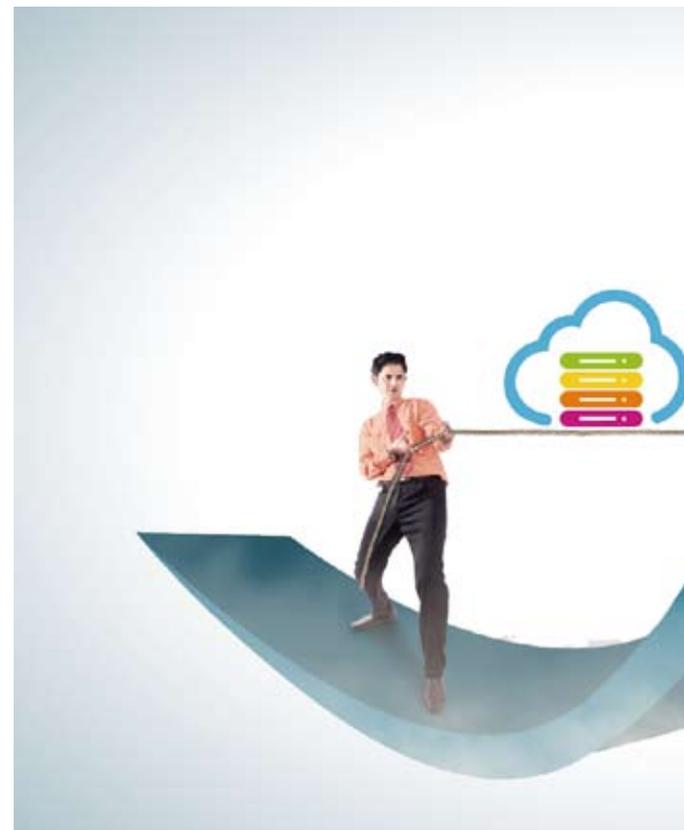
When you have all the data from all city agencies smoothly combined, what good is it if you cannot make sense of it? So, the last of the four pillars is intelligence and analytical capabilities. Gaining insight from data is essential to making data gathering worthwhile.

To implement these four pillars, you need a mix of software and hardware. That is why Hexagon and Huawei have partnered on many Safe City projects around the world.

The Joint Solution Created by Huawei and Hexagon

Hexagon is a leading provider of public safety software for integrated dispatch that is used in about 50 countries around the world. Huawei provides the Information and Communications Technology (ICT)

platform that helps Hexagon implement innovative solutions, including video capabilities and all of the necessary networking. The joint solution created by Huawei and Hexagon is the first worldwide converged command and control system. Before an emergency, this system provides good communications to meet everyday requirements. During an emergency, the system helps deploy the right resources. Afterward, the system supplies analytics and video recordings that help operators understand how to prevent future problems.



Real-world examples, such as New York City, illustrate these points. Serving a population of 8.6 million people, with more than 20.2 million people in the greater metropolitan area, the New York Police Department (NYPD) has more than 34,000 uniformed officers and 51,000 total employees. In 2013, the NYPD replaced its four-decade-old Computer-Aided Dispatch (CAD) system with a Hexagon solution. The new system enables the city to follow police cars visually on a map. When officers step out of patrol units, their whereabouts can be tracked using video surveillance. Today, the system permits the NYPD to handle about 30,000 calls per day. As a follow-on, the city's fire department and Emergency Medical Service (EMS) are adopting the same solution.

Chiang Dao, Thailand is a second example. Comprised of 11 rural districts and 12 suburban

areas, this city had many different, unconnected public safety agencies. Huawei and Hexagon installed a command and control system that aggregated the agencies' information to create a unified solution. Today, using a Geographical Information System (GIS) framework, the solution feeds video from around the city to agency personnel, establishing Chiang Dao's Safe City system as one of the world's most advanced.

An Interview with Steven Cost

In the following *ICT Insights* interview, Steven Cost, Hexagon's President of Safety and Infrastructure, answers how and why Hexagon and Huawei teamed up and where he hopes the partnership will take the two companies.

ICT Insights: How would you describe Hexagon's partnership with Huawei?

Steven Cost: I think the partnership has a bright future. Cities can use the software in the public safety space that Hexagon develops and marry that with the eLTE and broadband trunking technology from Huawei to bring an integrated solution to the table. Cities have a one-stop opportunity to buy everything they need for a state-of-the-art solution.

ICT Insights: So, Huawei hardware supports Hexagon software, which runs the show.

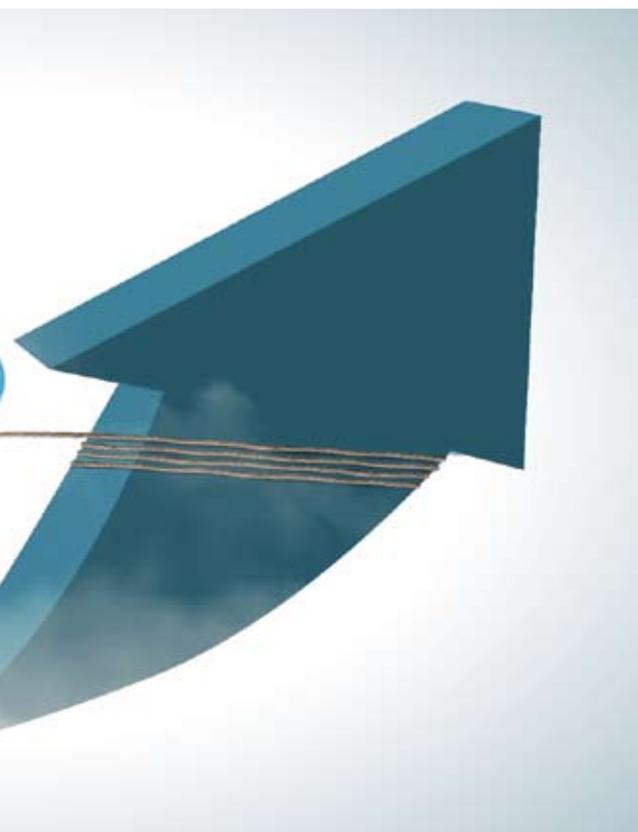
Steven Cost: Correct. As data becomes more and more prevalent, the opportunity in the public safety space to have real-time video sent to a 911 command center becomes invaluable. Live feeds from the scene allow you to really help protect citizens by deploying the right resources based on accurate information.

ICT Insights: Please share your thoughts on Hexagon as a leader in the public safety industry.

Steven Cost: We've been in public safety for about 25 years. Today, we protect about one in 12 people around the world with our systems. The company has progressed from a hardware platform to focus on software, and we continue to look at new tech-



The joint solution created by Huawei and Hexagon is the first worldwide converged command and control system. Before an emergency, this system provides good communications to meet everyday requirements. >>



nologies. The task used to be about getting the sensor data and aggregating the data. Now, the job is really about what you do with the data — how you use software to perform analytics. So, we’re turning all of these raw data points into information in a public safety setting.

ICT Insights: How can partners such as Huawei work with Hexagon to achieve your goals and influence the development of the ICT infrastructure?

Steven Cost: Hexagon and Huawei complement each other geographically. Hexagon’s public safety solutions are very strong in North America and Western Europe. Obviously, Huawei has tremendous strength globally but primarily in Asia Pacific. We talk about the layers of the solution, and we can also point out the relationships with the major cities in Western Europe. We are able to sit down with them and have a conversation about Huawei hardware and what the company’s great products can do. I think that’s the secret sauce that we’re after with the relationship.

ICT Insights: How is Hexagon changing the shape of the public safety industry?

Steven Cost: The analytics piece is a major focus. It answers the question, ‘What do you do with all this data?’ Our software reacts to all of the sensor data and is able to make sense of it. We’re working hard on creating predictive analytics around public safety to answer questions like “Where do I need smart patrolling? Where do we position the police car? When do we put an officer or officers on the street based on weather, time, historical data, or a specific event?” By piecing all of that together, we can help deploy the right resources in the right place even before a problem occurs.

ICT Insights: What is the expected impact of technologies such as Artificial Intelligence (AI), Big Data, and the Internet of Things (IoT)?

Steven Cost: AI and the other technologies will



We’re working hard on creating predictive analytics around public safety to answer questions like “Where do I need smart patrolling? Where do we position the police car?” By piecing all of that together, we can help deploy the right resources in the right place even before a problem occurs. >>

allow machine learning, so the system will actually make decisions before you even knew there was a decision to be made. As the information becomes available, the AI system will analyze the data before you ask the question.

ICT Insights: So, the AI and Big Data pieces are really a single piece?

Steven Cost: They definitely will converge. I think that, over time, all those lines will blend with Hexagon’s software. You see Huawei moving into software; you see these things moving together; and so these lines are all being blurred.

ICT Insights: What are the most interesting challenges that you’re currently facing, and what solutions are under consideration?

Steven Cost: One of the things that we’re spending a lot of time and effort on right now is smart patrolling. We’re working very closely with some robotics companies to replace their guards with robots. They’re mostly for factory or industrial site use, but they change two things.

First, you really don’t want to displace all of the people, but you can replace two-thirds of them and still have a smart command center. You don’t necessarily need an armed robot, but you can hang an unlimited number of sensors on a mobile sensor platform (robot). You can have a smoke sensor. You can have cameras and all types of detectors for biometric data, infrared light, or anything else. Ninety percent of security patrols are routine, so you mostly need information about changes. It’s when something is different from the last patrol that you need to react. We’re spending a lot of R&D there.

The second thing about robots is that their use can be greatly enhanced with good analytics. We need to use Big Data and create predictive analytics. So, I think that those two areas are really on the cutting edge, and they’re both obviously integral to public safety. ▲

The IoT in Future Electric Utility Environments

| By *Bosco Eduardo Fernandes, CEO, COMCON*



Bosco Eduardo Fernandes

Mr. Fernandes is an independent Senior Strategic Advisor and CEO of the German consulting company, COMCON, which focuses on IoT and future innovations for utilities. The COMCON CEO is senior member of IEEE and a member of the Internet Society and Russian ITA.

Beyond being smart, the high-voltage electricity utility grid needs to be active, meaning that it must be able to respond to changes in real time. To be useful today, the flood of data collected by power transmission networks and smart meters has to pass through analysis systems and human interventions in the utility's back office. In contrast, the active grid will leverage data to make real-time changes in the field. The active grid harnesses the power of the Internet of Things (IoT) to improve efficiencies and create value for both utilities and communities.

Path to the Active Grid

With a suite of technologies and associated business processes, the IoT gives all types of devices the ability to communicate their status to other systems and creates the opportunity to evaluate and act on these new sources of information. The electric utility industry has taken note of IoT applications and is using them prudently. While seldom on the bleeding edge, utilities have always leveraged available technology to optimize and control assets, increase safety, control the grid, and keep the lights on.

To explain how the IoT is used in the electric power industry, we will look at Supervisory Control And Data Acquisition (SCADA) and Advanced Metering Infrastructure (AMI).

SCADA's roots stretch back to the early 1950s and thus long predate today's IoT concepts. Yet the 'new'

IoT concepts clearly resemble those of SCADA, which uses sensors and actuators that communicate with and are controlled by a central master unit.

As a key component of the smart grid, AMI adds a two-way communication system of smart devices at both utility and customer sites using smart meters, communications networks, and data management systems.

Advances in computing, databases, and analytical tools now allow the rapid application of predictive and prescriptive analytics to large volumes of data from SCADA, AMI, and other commercial and consumer IoT devices.

For example, an Advanced Distribution Management System (ADMS) is an IoT technology that solution providers are developing to achieve situational awareness. An ADMS is an integrated

The electrical power grid will leverage IoT technologies to evolve into an active, intelligent system. >>





In addition to making the grid smarter, the IoT enables the connection of multiple new physical devices to the power grid and to the data networks that support the grid. They are all changing local distribution grids into bidirectional, multi-party marketplaces for energy. >>

software platform that takes advantage of new and existing applications to create a unified monitoring and control system. This control system must maintain reliability, leverage all manner of embedded systems and distributed resources, and safeguard property and people from the variabilities inherent in the grid. ADMS is an important step toward the active intelligent grid.

IoT Capabilities

IoT technology can improve the efficiency and performance of the power grid in three phases:

- By gathering data from sensors to improve the resilience of the grid
- Through enablement in which utilities leverage that data with continuous monitoring and algorithmic interpretation of electrical characteristics to actively manage resources
- Finally, through optimization in which all stakeholders can make informed decisions about power generation and use that are then built into the way the grid works

These three phases point to a future in which utilities can thrive in a more competitive environment. By providing the means to optimize real-time operations, the IoT helps realize the full value of the Transmission and Distribution (T&D) network. The potential use of IoT technology includes:

- Self-healing network automation
- Intelligent asset management and utilization
- Power outage and failure management

Additionally, security can be improved even as additional IoT devices are added. Traditional identity management platforms have been designed to support authorization policies only for URLs and lack the ability to address the unique needs of the IoT. Today's identity platforms offer new universal authorization capabilities that make it possible to secure IoT devices. These capabilities are similar to the ones used, for example, to unlock a hotel room with the guest's phone. Universal authorization makes it possible to define specific resource types or 'things' with custom actions to build solution-specific policies.

As with any industry-wide revolution, the transformations that the IoT will soon make in the energy

industry are so varied that it is difficult to discuss them all. From smart buildings and urban infrastructure to the democratization of energy and a greater push for renewables, the Energy Internet is undoubtedly a massive disruptive force. Highly responsive and granular control of our world's energy supplies and distribution will bring about changes that just a few years ago were unimaginable. Communities will be connected in ways never before conceived, and energy will be optimized for greater savings on scales not yet realized. In short, the IoT is the future of the electric power industry.

In addition to making the grid smarter, the IoT enables the connection of multiple new physical devices to the power grid and to the data networks that support the grid. Rooftop solar, electric cars, fuel cells, home battery storage, smart meters, smart thermostats, and smart appliances are all changing local distribution grids into bidirectional, multi-party marketplaces for energy that will replace the old one-way system for energy delivery.

These new connected devices could cause chaos on distribution grids that were never designed to handle these new dynamics, yet customers will still expect energy service to be safe, reliable, affordable, and, increasingly, sustainable.

Fortunately, as a result of advancements in Software-Defined Networking (SDN) and the affordability of increased computing power, it is now practical to deploy robust smart grid platforms. More importantly, for the first time, smart grid technology enables coordinated analysis and response among connected devices in ways that were previously impractical or impossible.

Robust processing power and memory also allow smart meters and grid sensors to provide a unified software and computing platform that simultaneously supports multiple communications and application protocols. Moreover, placing a significant degree of processing power in the endpoints combined with advances in software-defined communications have paved the way to solve critical connectivity and communications performance challenges that have long frustrated utilities deploying single-communications networks.



Versatile Communications Choices

Communication modules now combine RF mesh, Power-Line Carrier (PLC), and Wi-Fi communications on the same chip set. These diverse choices enable dynamic and continuous selection of the optimal communications path and the most appropriate frequency modulation based on network operating conditions, data attributes, and application requirements. This new platform also provides peer-to-peer and local broadcast communications capabilities that enable edge devices to communicate with each other individually or in select groups to support new distributed analytics scenarios.

Narrowband IoT (NB-IoT) or Low-Power Wide-Area Networks (LPWANs) using licensed spectrum, in-band, guard-band, and stand-alone deployments are expected to play an important role in connecting a wide range of low-mobility, low-power, and low-cost devices. These new networking technologies are designed to provide deep coverage of hard-to-reach places and support massive numbers of low-throughput, ultra-low-cost devices with low power consumption and optimized network interfaces.

Should the prediction of tens of billions of IoT devices come true, then LPWAN base stations could be supporting hundreds of thousands of concurrent device connections.

Important Role for Processors and Memory

More connected devices mean more data is created every second, which is uploaded, stored, processed, and shared. The abundance of sensors — including temperature, pressure, direction, speed, weight, paces, heart beats, and light intensity — will generate a flood of information to transmit. Continuous wireless data transmission requires far too much energy for battery-powered applications. One solution is to use powerful, yet low-power microcontrollers to pre-process sensor data and thus reduce the volume of data to be transmitted. However, efficient processing necessitates greater local memory capacity for stored data to be processed and programs to execute.

To further reduce the frequency of data transmissions, designers will make use of local data buffering. Systems on Chips (SoCs) — monolithic integration of memory in silicon — eliminate the need for a variety

For now, much work remains to be done as fragmentation and uncertainty have not been satisfactorily addressed. Security, reliability, and privacy issues are unresolved as are business models and regulatory regimes. >>

of separate components, although memory integration can lower chip yield and increase fabrication cost. Resistive RAM (RRAM) technology promises easier integration with CMOS logic circuitry compared with conventional flash memory.

IoT applications can gain tremendous benefits from the use of fast, low-power nonvolatile memory that can be easily integrated in very large capacities on a single SoC. Such devices may be able to operate for years without a battery charge or replacement.

IoT Platform in the Future

The rapid evolution of the IoT market has caused an explosion in the number and variety of IoT solutions. Significantly for the Smart Grid, a wide range of software platforms are now available, intended to reduce the cost and development time for IoT solutions by offering standardized components that can be shared across industry verticals to integrate devices, networks, and applications. Most of these IoT platforms can be categorized as connectivity-management, device-management, or application-enablement platforms, although many products offer overlapping functionality.

Globally, many electric power utilities are in a position to leverage these capabilities and the significant advances in distributed intelligence and analytics as they implement their grid modernization strategies. Ultimately, these strategies will connect to broader opportunities beyond operational efficiency, such as those of the Smart City.

For now, much work remains to be done as fragmentation and uncertainty have not been satisfactorily addressed. Security, reliability, and privacy issues are unresolved as are business models and regulatory regimes. All players and stakeholders in the IoT face critical decisions on the way forward. It is time to fundamentally rethink the technology strategy, business models, and product design — and involve regulators and others in the debate.

In the age of the IoT, we must keep up with the latest technology trends and enable new IoT applications that reach beyond connections and truly bring the power of action and intelligence to field-level devices. ▲

Hand-in-Hand with the Fortune 500: On the Road to Digital Transformation



Diana Yuan

Huawei has become the enabler and preferred partner for the digital transformation of industries

| **By** Diana Yuan, President, Marketing and Solution Sales, Enterprise Business Group, Huawei Technologies Co., Ltd.

By committing to become a promoter for an intelligent digital society, Huawei provides innovative, one-stop ICT architecture platforms that establish new benchmarks for cooperative and mutually beneficial ecosystems for sharing the exploration of digital transformation best practices in partnership with leading global enterprises. >>

Digital Transformation is the Only Way for Enterprises to Survive

In these past two years, as cloud computing, Big Data, and AI have developed, more and more people believe advanced digital technology products and infrastructure will take over people's work, leisure, education, sanitation, culture, and other areas. In the future, digital technology will diagnose diseases more accurately and Big Data will revolutionize the retail industry.

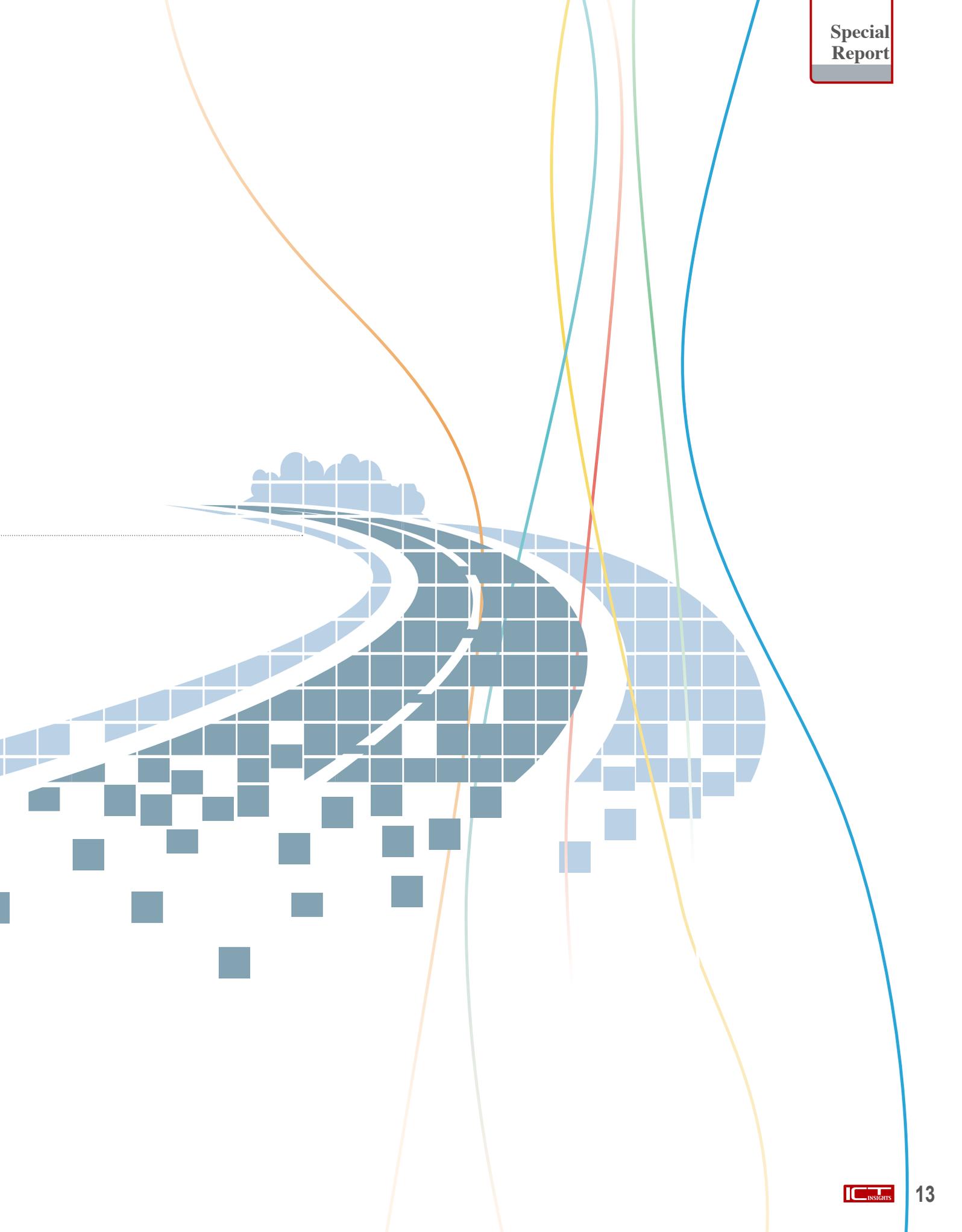
"Rome wasn't built in one day." Before the era of the intelligent society really arrives, the digitalization revolution will have impacted business processes across each and every industry. IDC's prediction for global IT industries after 2017 state that: By 2018, 67 percent of the world's top 1,000 enterprises will have selected digital transformation as a key strategy in facing the future. By the end of 2017, 70 percent of the Fortune Global 500 will have set up full-time digital transformation/innovation teams. In 2016, Huawei and Forbes conducted a survey on 212 industries and IT managers around the world. The survey showed that 25 percent of participating industries had already established a digitalization strategy and a plan to use it to

guide business transformation. 48 percent of enterprises have already added digital elements to their current services. More and more enterprise leaders believe that digital transformation is no longer a choice but the only way for their companies to survive.

Using the Fortune Global 500 to represent pioneering industries, we see they are implementing digital transformation from three aspects: commercial innovation, increasing efficiency, and improving customer experience. For example, Deutsche Post DHL Group, a world-leading mail and logistics company, signed a cooperation memo with Huawei in February 2017. The memo summarizes their intention to cooperate with Huawei to apply Internet of Things (IoT) technology to optimize DHL's global supply chain logistics. This project's goal is to achieve a fully digitalized connection between vehicles, transported goods, and drivers.

Preferred Partner for the Digital Transformation of Industries

DHL is just a grain of sand in the industrial transformation of every industry on Earth, and there is no denying that the road to transformation for each specific industry





The IoT is already impacting the rate at which terminals are being added to the network. To support this growth, Huawei's IoT solution includes one platform, two access methods, and one IoT network operating system. >>

will be unique and require its own special characteristics. Our question is 'How should Huawei enable the digital transformation of all industries?'

The Huawei Enterprise Business Group (EBG) is applying our deep understanding and reflection regarding the digital transformation across industries and issued its 'Platform + Ecosystem' development strategy. In the era of digital transformation, Huawei is building an open, flexible, and secure ICT infrastructure platform. Surrounding this platform is a prosperous ecosystem that is symbiotic, interdependent, and regenerative. To face the intelligent society of the future, Huawei EBG's newest position is to develop and promote an intelligent society. Huawei's goal is to become the preferred partner for the digital transformation of industries worldwide.

All industries have the need to create their own platforms, and the synergies built into Huawei's one-stop 'cloud-pipe-device' ICT platform is a strong differentiator when compared with our competitors. With thirty years' experience, Huawei has gained a deep understanding of how cloud, pipe, and terminal components must be coordinated in order to operate with the greatest efficiency. We know the key characteristics of every component and how each must cooperate closely with the others to construct highly functional networks and not just collections of technology islands.

In the cloud, we considered all the different stages in the enterprise IT transformation process, as well as the different core challenges that are faced at each stage. Huawei launched FusionCloud, an integrated, open-cloud infrastructure that supports private, public, and hybrid clouds. FusionCloud is currently operating over 420 cloud data platforms and providing over forty cloud services, including computing, storage, network, security, Platform-as-a-Service (PaaS), and Big Data, among others. More and more big enterprises are choosing to commission global communications public clouds, including T-Systems, a Deutsche Telekom subsidiary, Spain's Telefonica, France's Orange, and China

Telecom. Huawei's FusionCloud is driving each of these large public clouds from the bottom up.

The intelligent society we envision cannot exist without the ability to understand and process large amounts of data. The enterprise-level Huawei FusionInsight Big Data platform is purpose-built to provide highly efficient, agile, and precise information processing capabilities. Based on software components from the open-source Apache community, the FusionInsight core processing engine is built to handle massive amounts of real-time data in the areas of storage, query, and analysis to meet targeted Operations and Maintenance (O&M) and App requirements for financial institutions, telecom carriers, and other data-intensive industries. FusionInsight is an agile, smart, and reliable software platform that, because it is able to model operational middleware, enables enterprises to discover new value and business opportunities from large, unstructured data sets in a faster, more precise, and more stable way.

The comprehensive Huawei cloud network architecture is divided into three layers: ubiquitous connectivity, open cloud platform, and social media industrial applications. We support our enterprise customers to fully realize a Real-time, On-demand, All-online, DIY, and Social (ROADS) experience. Under Huawei's 'comprehensive cloud' architecture, the entire enterprise network is 'data center oriented,' where campus branches, the IoT, and other scenarios operate in an interconnected data center infrastructure. Unified network cloud management results in fast service deployments and easy cloud O&M for Software-as-a-Service (SaaS) environments that add business value with a combination of network resource transparency, fully open data across the network, and Big Data analytics to make sense of the complexity.

The IoT is already impacting the rate at which terminals are being added to the network. To support this growth, Huawei's IoT solution includes one platform, two access methods, and one IoT network operating system. Huawei is actively



In 2017, the number of Huawei OpenLabs will grow to twelve. And, in the next three years, Huawei will assign close to 1,000 employees to the OpenLabs facilities — a USD 200 million investment to construct sustainable, local ICT ecosystems. >>

working with many partners around the world to provide one-stop IoT solutions targeting the markets for public services, energy, transportation, finance, logistics, sales, and many other industries.

Huawei OpenLabs Grow Industry Partnerships

In the ecosystem domain, Huawei continues to act as the soil from which successful projects are grown. With Huawei's comprehensive, open ICT capabilities developers and partners across all industries are exploring the road to digital transformation. Together they are shaping symbiotic, interdependent, and regenerative communities of interest. Huawei's specific actions to build an open ecosphere include the following aspects:

- Driving big business through commercial alliances, such as the 5G Vertical Industry Accelerator (5GVIA) for the automotive-transportation industry based in Munich, Germany, and others.
- Establishing commercial alliances that enable continued commercial success, such as Huawei's cooperation with Hexagon to create Smart Cities.

- Providing platforms for developers that incubate new players using the newly created USD 1 billion Huawei 'Developer Enablement Plan.'

- Supporting the open-source software community and international standards development. Huawei is actively participating in many open-source projects, including OpenStack and ONOS.

Through 2016, Huawei has built and operates five global OpenLabs to support the large and growing number of partnerships involved in creating industry solutions to meet the real-world service requirements of our customers. Through a program of continuous optimization, the OpenLabs are innovation centers for industrial solutions and centers for joint development, verification, and experience testing. In 2017, the number of Huawei OpenLabs will grow to twelve. And, in the next three years, Huawei will assign close to 1,000 employees to the OpenLabs facilities — a USD 200 million investment to construct sustainable, local ICT ecosystems.

It is precisely because we have focused on building a single ecosystem that the number of partners



One-stop synergy: 'Cloud-Pipe-Device' ICT platform

we have attracted is growing non-stop. Through the end of 2016, we had already passed 12,000 global channel partners, 400 solution partners, and 2,100 service partners. Huawei has trained and certified 46,000 engineers worldwide. In 2017, the Huawei partner ecosystem and industrial-chain talent alliance continues to expand broadly.

Establishing Digital Transformation Benchmarks with the Fortune 500

Currently, over a third of enterprises in the Fortune Global 500 list have already chosen Huawei as their digital transformation partner. Among them, 40 percent of the top 100 enterprises, including France's BPCE bank, DHL, Deutsche Telekom, Siemens, Deutsche Bahn, SAP, ABB, and other industry-leading enterprises.

The financial industry is the pioneer of digital transformation and their IT systems are directly being used in enterprise business operations and decision-making. France's BPCE Bank Group, for example, is France's second largest bank and has over 8,200 branches and 40 million customers. Using Huawei's Agile Campus solution, BPCE Bank's over 8,000 branches achieve fast network coverage. Under a network unified management model, all branches' services can be provisioned quickly and business activities completed.

The partnership between Huawei and SAP is an example of two Fortune 500 companies that have joined forces to benefit their customers. Using Huawei's high-performance, high-reliability infrastructure and SAP's innovative HANA in-memory software platform, the two companies assist other Fortune 500 enterprises to reconstruct their businesses using flexible, economical, and efficient processes to manage business data, increase real-time operating capabilities, and achieve digital transformation. For example, Huawei and SAP are cooperating with Sinopec, fourth in the Fortune 500 list, to construct what is currently the world's largest Enterprise Data Warehouse (EDW) SAP HANA cluster system, greatly improving Sinopec's database-loading performance by reducing



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upload times from four hours to thirty minutes, increasing processing speed four to six times and, overall, improving the business efficiency of sales and financial analysis reporting, and operations decision-making.

Huawei is also collaborating with ABB, a leader in the electric power and automation technologies industry, to promote the deep integration of automation and information for the oil and gas industry. Together, Huawei and ABB have developed an integrated Supervisory Control and Data Acquisition (SCADA) solution for oil and gas communications. This solution is now widely used in the development and production of oil and gas fields, and for oil and gas pipeline transportation. Oil and gas pipeline administrators can monitor the pipeline's operational status and gather network parameters in real time to comprehensively understand the pipeline's operating situation in a timely manner, predict faults before they occur, and greatly reduce management risks to guarantee the safe, stable, and efficient operation of the transportation pipeline. Achieving the digital management of energy resources incorporates the application of eLTE industrial wireless private network solutions to ABB robots and industrial automation solutions to deliver remote wireless monitoring, management, and configuration. Application services include O&M, Big Data analysis, and visualized smart production. Huawei and ABB are working hand-in-hand to create full connectivity in the Industry 4.0 domain.

Currently, enterprises and industries have already entered a key period for digital transformation. Huawei is committed to becoming a development promoter of digital and intelligent society and a preferred partner for the digital transformation of industries. We do so by adhering to the two main strategies of 'platform' and 'ecosystem' to provide innovative, one-stop ICT architecture platforms for establishing cooperative, mutually beneficial ecosystems that explore the best practices in digital transformation and assist enterprises to achieve business success. ▲

Edge Computing Will Merge Human Abilities and Intelligent Objects

| By Yu Haibin, Director, Shenyang Institute of Automation, Chinese Academy of Sciences



Yu Haibin

Mr. Yu is Director of the Shenyang Institute of Automation (SIA) and a member of the Chinese Academy of Sciences (CAS). He won the 2016 Ho Leung Ho Lee Foundation (HLHL) Science and Technology Progress Award and the 2016 Excellence in Technical Innovation Award from the International Society of Automation.

Information and Communications Technology (ICT) is witnessing a movement to push computing applications, data, and services from centralized nodes to embedded networks. Behind this movement is edge computing, which enables process control and the generation of analytics to occur at the source of the data. By combining ICT with Operational Technology (OT), we are accelerating the merging interaction of human abilities with machines and objects.

Edge computing is a hot topic, but because it covers such a wide range of devices many questions about the direction for further research, applicable scope of use, and the relationship to the Internet of Things (IoT) and to the Internet itself are raised.

Interplay Between Edge Computing and the IoT
Shenyang Institute of Automation (SIA), focused on robotics and smart manufacturing, recognizes that ICT is important for accelerating the transformation of traditional industries. For example, ‘Industry 4.0’ — Germany’s 21st century manufacturing strategy — aims to employ Information Technology (IT) to consolidate its leading position in the global market. Also for the ‘Industrial Internet’ in the U.S., the goal is to maximize the country’s competitive edge in manufacturing using IT. In turn, China has intro-

duced the ‘Made in China 2025’ initiative for the purpose of extending China’s influence as a global manufacturing giant. These three initiatives represent the development directions of the leading industrialized countries of the world, with each emphasizing an increasing convergence of ICT and OT.

In manufacturing, China faces enormous challenges, including resource waste, high energy consumption, and deteriorating environmental conditions. Although not overshadowed by developed countries in terms of industrial infrastructure, China lags in operational efficiency. One contributing factor is that China has many low-grade mines where the set value of raw material components fluctuates considerably, with big differences between offline optimization and actual production. In this case, ICT-based interconnections are an effective way to boost efficiency by

The Internet of Things must share the computational load between processors located in data centers and at the network edge to provide the optimization necessary to meet the functional objectives for specific applications. Achieving this result will require a robust ecosystem of technical standards and industry solutions.
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The relationship between people and machines will change radically over the next 20 years. Human intentions, behaviors, knowledge, and expressions will present new challenges, and people will be increasingly engaged with edge computing on a regular basis. >>

enabling automation and monitoring of all processes throughout the industry chain.

Proposed by China's Premier Li Keqiang in his *Government Work Report* in March 2015, the 'Internet Plus' program is essential to meeting the goals stated for 'Made in China 2025.' Internet Plus refers to the application of the Internet and other IT advances to conventional industries. It is an incomplete equation where various Internet platforms (mobile, cloud, Big Data, and the IoT) can be added to other fields and foster new industries and business developments. In the virtual world, Internet Plus brings people closer together; however, in the physical world, Internet Plus has yet to play any significant role.

The IoT refers to the ever-growing network of physical objects that feature Internet connectivity and communication links between these objects and other similarly enabled devices and systems. A majority of IoT functions face fragmentation challenges in a variety of scenarios due to the sheer volume of different device types, communications technologies, and software used to manage, configure, and develop nodes and links. The unification of these different technology fragments is both mandatory and the biggest game changer, since it will level the playing field for small and large vendors competing for the best solutions.

Issues to be resolved by IT will be modular in nature and focused on the unification of computing models. In terms of OT, the intended outcome will require that IoT systems be dominated by edge computing resources that locate processing workloads in near proximity to the IoT sensors and endpoints themselves — in other words, at the edge.

Challenges Facing Edge Computing

Whether Industry 4.0 in Germany or the Industrial Internet in the U.S., technological innovations are successful because each new product generation and infrastructure uplift is relatively more efficient and effective (optimal) than its predecessor. Today, China urgently needs to converge the IoT and OT. Such convergence is beset with difficulties because OT and IT are two completely different technologies with separate models, concepts, and platforms. In

the face of increasing fragmentation on the edge, traditional IT terminals are not able to meet modern IoT requirements. New solutions and future-ready scenarios must be based on the convergence of chipsets and networks with edge computing.

In traditional industrial automation, OT is primarily tasked with the breakdown of procedural objectives and the generation of real-time feedback. The next step for industrial automation will be the ability to adjust the production objectives dynamically if and when commanded changes fail to achieve the intended outcome. This requires massive amounts of converged information, from design to development to production and then to management. IT offers many opportunities for convergence, the first of which is connectivity. The maturing Internet, for example, has established a platform of connections between humans and machines that permits users and businesses to store, share, and analyze tremendous amounts of historical and predictive data on which to base any secondary changes that need to be made in production.

At this point, the IoT is still in its early stages and has not matured enough to match existing industry standards. It is still fragmented due to all of its different technologies, hardware, and non-uniform development languages. It contains a large number of elements and is accommodating new content with the development of the IoT.

The public will also be a part of the IoT. The relationship between people and machines will change radically over the next 20 years. Human intentions, behaviors, knowledge, and expressions will present new challenges, and people will be increasingly engaged with edge computing on a regular basis.

In a traditional model, the IoT transmits collected data to a data center for processing and analysis. In the future, it will be impossible to manage and house billions of IoT connections using today's cloud technology. This issue will be resolved because of edge processing of data collection, storage, and presentation of results. By today's standards, it will be difficult to allocate tasks and perform automatic adjustments because the IoT data types have physical features (such as multi-dimensional heterogeneity and temporal-spatial correlations) that are totally different from



Edge computing needs to interact and grow with networks because the data to be processed is heterogeneous and real time. Edge computing will be primarily used in OT for distributed sensing, decision making, and control, thus meeting real-time service requirements. >>

current technology. These issues will be best resolved by edge computing rather than by edge networks with little or no local processing. The Huawei LiteOS kernel is an example of the type of lightweight, memory-resident operating system that will become a central foundation for severely restricted resource operations for enabling computing power at the edge, before transmitting the results to the cloud data centers.

Edge computing will be primarily used in OT for distributed sensing, decision making, and control, thus meeting real-time service requirements. The advantage of edge computing is sensor-processor response times within hundreds of milliseconds, which is a data interaction frequency that is much higher than is possible between sensors and cloud data centers.

Driving the Convergence

At SIA, we propose an open platform based on edge computing to address the fragmentation, data heterogeneity, and interconnection issues found in the open source environment.

An edge computing platform makes converged IT and OT a reality. Whether on the edge or the cloud, computerized processing must be modular, either digitally or semantically. Take the application of robots in the automotive industry as an example. Starting in the 1980s, people were replaced by automated robots in many situations, with little collaboration from outside sources. If a change needed to be made to the system controlling the robots, the robots needed to be stopped, reprogrammed, and then restarted. This

resulted in long wait times and, during the startup phase, led to many mistakes. By 2020, a great number of co-existent and collaborative methods will emerge, enabling robots to better understand people, and vice versa, by eliminating long reconfiguration periods and other manual tasks needed to interact with robots. Therefore, the convergence of human abilities, machines, and objects will become a major trend.

To overcome the difficulties arising from this convergence, we have established the ‘Edge Computing Industry Alliance.’ The alliance will start with the definition of an open platform specification to engage more industry vendors, drive ICT and OT convergence, and accelerate the development of edge computing in the form of Internet-like, rapid iteration. The alliance will capitalize on its technologies, standards, and test beds to achieve edge computing breakthroughs in manufacturing and the creation of new business models for ICT vendors.

Orchestrating a robust ecosystem to attract more players is a vision shared by the members of the alliance and the SIA. Members of the alliance will provide edge computing technology to combine industries, manufacturing, sensing, control, computing, storage, and networks. Their complementary advantages will fully meet edge computing requirements for technologies, standards, and industry solutions. Today, the entire ICT industry is attaching increasing importance to developments by ecosystems; edge computing cannot depend on just one or two enterprises for its success. ▲

Link: Shenyang Institute of Automation (SIA)

A research arm of the Chinese Academy of Sciences, SIA has more than 1,100 employees, two members of the Chinese Academy of Engineering, and more than 500 enrolled master's and Ph.D. students. In the robotics field, SIA studies key technologies and has a presence in institutions, sensing, and control in a variety of domains, including land, sea, air, aerospace, and medicine. With industrial robots, SIA has made remarkable achievements, including the founding of SIASUN, a leading robotics company in China. In the automation field, SIA is involved in industrial chipsets, smart devices, control systems, and holistic industry solutions. SIA's automation technologies have been widely used in oil exploration and the smelting and rolling of nonferrous metal, aerospace, and electrical equipment, as well as intelligent automobile manufacturing.

Building the Future Now with Smart City ICT

An IDC Government Insights White Paper

Smart Cities are designed for sustainable economic development and growth. With the right goals and a sensible approach in place, Smart City technology can pay its own way — and sooner than you think.

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The implementation of Smart City technology is as much about finding a business model that offers a return on the initial investment and support for system maintenance as it is about potential Smart City applications.

In this article, we explore how Smart City systems work and then provide an overview of ways the systems can be used. We conclude with nine best practices that have proven to help cities successfully roll out cost-effective Smart City technology. By following these best practices, cities can improve public safety and city services while limiting initial costs and boosting economic prospects for years to come.

Relying on the IoT

The Internet of Things (IoT) offers an abundance of capabilities for use by Smart City installations. The value of the IoT begins with new information. For example, strategically placed acoustic sensors that detect gunshots have shown that previous assumptions about the levels of gun activity in some

U.S. neighborhoods were wrong. Police departments believed that individuals called ‘911’ 80 percent of the time after shots were fired. In fact, this percentage could be as low as 20 percent.

The IoT also accelerates information dissemination. For example, city inspectors collect data on the structural integrity of bridges and other infrastructures but are often understaffed, preventing these inspectors from checking all the infrastructures as thoroughly as needed. Sensors on bridges, however, can provide structural integrity information at regular intervals, alerting inspectors when potential problems may need attention.

In general, the IoT provides more topical information — often in real time — such as status signals sent from parking sensors to smartphone Apps that alert drivers of available spaces. Another example





In addition to cloud computing and HPC, edge computing has emerged as a useful way to manage diverse types of connections with IoT devices, handle real-time services, optimize data, provide application intelligence, ensure security, and protect privacy. >>

could be the ability of transportation managers to continuously monitor the location of all public buses and mobile Apps that keep travelers updated with accurate bus arrival and departures times.

Device Enablement Meets Application Enablement

While it is common to think of the IoT as a loose collection of sensors and gadgets spread across the city, the true value of the IoT emerges in the higher-level applications that transform sensor data into useful insights. The sensors, surveillance cameras, and other data-gathering devices are networked with computers running software that brings intelligence to the system.

Even though they function at a relatively low level, device enablement services can still manage devices and ensure the back-and-forth flow of data. Key components include:

- Activation
- Certification
- Diagnostics
- Provisioning

Thus, device enablement focuses on the vertical movement of data between ‘things’ and computers. In contrast, application enablement concentrates on the horizontal integration of software applications that use IoT data. This form of enablement includes Big Data analytics and the ability to make real-time decisions about collected data. Intelligent analytics are vital for extracting the value of Smart City IoT.

Intelligence at the Edge and in the Cloud

Big Data analytics and other applications ideally run on cloud computing platforms or High-Performance Computing (HPC) systems. The latter are cost-effective for tasks ranging from the simulation of complex physical systems to real-time detection of credit card fraud.

In addition to cloud computing and HPC, edge computing has emerged as a useful way to manage diverse types of connections with IoT devices, handle real-time services, optimize data, provide application intelligence, ensure security, and protect privacy.

Edge computing (and a subset of edge capabilities called fog computing) is defined as computing performed near the edge of a WAN or near endpoint devices at the edge of an IoT network (as opposed to the computational processing that occurs at the cloud data centers). Edge computing allows organizations to satisfy the requirements for lower costs and faster responses that are impossible with data transmissions between endpoint devices and servers located in far-away data centers.

Edge computing — defined as processing at the perimeter of the network rather than at the data centers — offers value by analyzing raw, granular data close to the source, and 1) feeding only the results to higher-level applications, or 2) controlling local IoT devices in real time, at the lowest possible latency.

In addition to improving real-time response close to IoT endpoint devices, edge computing will likely develop into wide-area, decentralized cooperative platforms for IoT and data distribution business platforms by connecting with endpoint devices.

Smart City Goals

The uses for Smart City technology seem endless, but it is worthwhile to underscore a few of the most promising applications:

- **Municipal administration** — Smart City technology aggregates and analyzes information within city ecosystems and makes useful information accessible across departments and agencies. This data serves as the foundation for new or improved internal processes and decision-making procedures.

- **Smart lighting** — IoT-equipped LED lights can implement adaptable dimming, and the existing street fixture infrastructure is ideal for the installation of other sensors and devices. Streetlights thus become a platform for additional Smart City services.

- **Smart grid** — Smart grids enable more efficient management of electrical power outages and other revenue-impacting business processes. The deployment of intelligent endpoints will enable utilities to improve the management of electric usage and optimize the use of distributed generation sources. Smart grid systems include instrumented gas pipe-



Among the most powerful collections of Smart City technology are the Intelligent Operation Centers. IOCs enable cities to integrate disparate data sources in order to provide an operational and actionable picture of the city's assets. >>

lines, electric transmission and distribution networks, smart metering, smart home energy management, and demand response.

- **Smart transportation** — Transportation systems can leverage the IoT to monitor the movement of people and freight on roads, intersections, bridges, and tunnels, as well as track public transportation vehicles, such as light rail, subways, and buses.
- **Smart education** — Schools can use computing and communications capabilities to improve the management of facilities and student care along with implementing interactive classrooms.
- **Smart and connected healthcare** — The healthcare industry benefits from the use of intelligent devices (including smartphones and wireless medical devices) and pervasive broadband networks that provide always-on connectivity, along with Big Data analytics and cloud computing.

Funneling Data to an Operations Center

Among the most powerful collections of Smart City technology are the Intelligent Operation Centers (IOCs). IOCs enable cities to integrate disparate data sources in order to provide an operational and actionable picture of the city's assets. Near-real-time data visualization gives city managers the understanding and insights necessary to handle both day-to-day and emergency situations efficiently. IOC solutions can provide comprehensive support for Smart City businesses, acting as the central orchestration element for administrative systems (implementing business data exchange and coordination), industrial systems (integrating city needs with industrial planning), and environmental systems (monitoring and forecasting water, energy, air, and soil conditions).

It bears noting that command and control centers are completely different from IOCs. In times of crisis, however, IOCs are force multipliers for command and control situations — critical tools that enable public safety organizations to integrate a plethora of information sources. City agencies can, in this way, use advanced analytics, Geographic Information System (GIS) visualization software, and sensor data generated by the IoT and mobile applications. GIS technologies are vital. They picto-

rially make sense of the overwhelming flood of data with which organizations currently struggle.

Safe Cities

Both IOCs and associated command/control centers are important components to every successful Safe City effort. Safe Cities deliver social value, such as better overall quality of life, and economic value like industrial development, improved employment rates, and revenue generation from sources such as increased tourism.

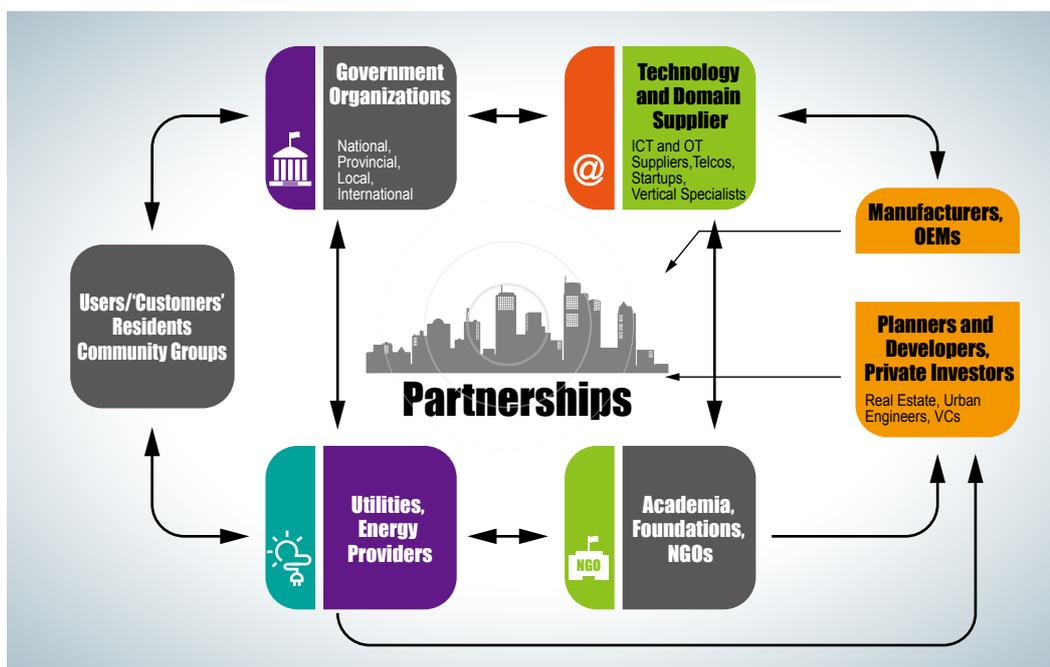
Today's Safe Cities utilize Information and Communications Technology (ICT) to predict, prevent, and reduce crime; address new and emerging threats; improve emergency/disaster planning and response; lower the cost of operations; and allocate resources more effectively. These cities work to create safer communities using advanced analytics, social media, mobile technologies, and collaboration and information sharing tools to support emergency response services, local law enforcement and policing, and the justice and corrections system including local courts and locally operated jails and prisons, as well as probation, community corrections, and parole departments.

Nine Best Practices for Smart Cities

Experiences with Smart City development have shown that the following best practices can help achieve useful results at a reasonable cost.

- **Create city-wide, inclusive Smart City strategies:** This approach serves to gather stakeholder input in order to prioritize each city's goals by focusing on specific challenges that stakeholders face, aligning departments around common visions with internal and external buy-ins, and different approaches to the chosen starting point for each city. By including external stakeholder participation early on, the strategy gains local buy-ins and legitimacy, and increases the likelihood for broad support of the initiatives.

- **Realize regional variation in IOC implementation:** Many cities are adopting open, city-wide platforms that use cloud-based technologies. Western cities are less likely to have large, multi-department operating centers, preferring to work with physically separate locations that share a data layer provided



Smart City best-practice planning and use of stakeholders

by cloud solutions. Integrated data visualization requires substantial buy-in from multiple stakeholders and departments. Once this is accomplished, however, the benefits of implementation will have far greater reach and impact for the city. Risk will also be shared across departments.

- **Look for quick wins:** The development of Smart Cities is a long-term, complex endeavor, but the implementation of discrete Smart City projects that fit into a long-term vision can be expedited. A recommended path is to develop a strategic vision and then identify small, measurable public projects that will demonstrate success. Examples include limited video analytics projects and body-worn camera deployments.

- **Focus on governance:** In IDC's case study research, many public safety groups have stressed that organizations starting multi-agency, data-sharing arrangements should pay special attention to governance. Comparatively, technology is the easy part.

- **Take a multi-agency focus from the onset:** IDC recommends that organizations tied closely to the economic challenges currently facing law enforcement fundamentally change their operational ecosystem. Various units within an organization and among multiple agencies can pool resources and create centralized cloud repositories.

- **Ensure data quality:** Data quality and validation are critical to using insights across multiple agencies. Organizations typically underestimate the amount of effort required to harmonize and integrate information from multiple systems. Information models such as the U.S.-originated National Information Exchange Model (NIEM) will become invaluable

in ensuring that data sharing can occur with optimal fluidity.

- **Seek out scalability and easy integration:** Irrespective of the cloud deployment model implemented by a city, that city needs to build or purchase a scalable architecture that can accommodate and manage all digital assets.

- **Go mobile:** Mobile devices and mobile-enabled core 'business' solutions are key for effective police service delivery. Police officers need the capability to enter and receive real-time data to enhance situational awareness.

- **Quantify business outcomes:** Municipal organizations seldom make it a priority to quantify business outcomes. However, IDC recommends that organizations define Key Performance Indicators (KPIs) prior to implementing an IOC in order to make a strong case for further business investments and set the stage for communicating success to citizens, tourists, and businesses.

Thriving in Smart Cities

The core goal of a Smart City is sustainable economic development and growth. Smart Cities use Smart City initiatives to attract more businesses, startups, tourists, visitors, and residents. By optimizing urban transportation, Smart Cities make it easier for people to shop, attend events, and go to work. Safe Cities and clean cities that follow sustainable environmental practices attract companies and individuals who want a good place to live and work. Many Smart City features pay for themselves in a short time, and nearly all of them offer long-term payoffs in the form of thriving social and economic activity. ▲



The development of Smart Cities is a long-term, complex endeavor, but the implementation of discrete Smart City projects that fit into a long-term vision can be expedited. A recommended path is to develop a strategic vision and then identify small, measurable public projects that will demonstrate success. >>



Shu Yong



Liu Zebin

Orchestrating an Ecosystem of Business Partners

| By Shu Yong and Liu Zebin, Partner & Alliance Management, Enterprise Business Group, Huawei Technologies Co., Ltd.

Digital transformation will present the greatest opportunities for many industries over the next five to ten years, and business ecosystems will be powerful tools used to seize those opportunities. During their transformation efforts, major players are building solution-centric ecosystems that maximize the advantages of collaboration for the purpose of gaining a significant edge in their respective markets.

In the face of converged production systems and ICT solutions, customers are heavily investing in new ICT platforms that depend on the complexities of the cloud, the Internet of Things (IoT), and Big Data. As a result, a robust business and technical ecosystem will be a customer's most important factor in choosing a supplier.

Channel Policy Maximizes Partner Opportunities

Huawei focuses on providing customers with innovative, differentiated, and leading ICT hardware and software. In the face of complex requirements and changing markets, Huawei works with partners to help customers address challenges arising from digital transformation to achieve business success.

Huawei's Enterprise Business Group (EBG) continuously invests in ecosystem development to maximize the skills of partners and expand their markets. The EBG program orchestrates a regenerative community that

shares common interests. EBG does this by promoting ecosystem awareness and cooperation within each of its internal organizations, from R&D to marketing, sales, delivery, and service. This ensures that all employees recognize the significance of the family of partners who have chosen to join forces with Huawei.

Streamlining Internal Processes to Support Ecosystem Development

To build a robust ecosystem with partners, Huawei has taken these five key measures:

- **Determine open cooperation strategies.** The EBG and its product lines formulate and refresh partner and alliance strategies every year in order to plan ecosystem development, operationalize annual business plans for solution ecosystems and alliance partners, and use strategies and business plans to drive open cooperation.
- **Streamline partner and alliance management systems.** Huawei has established the Partner Executive Committee (PEC), which authorizes decisions on

The principle of Huawei's channel policy is based on collaboration and implementation to maximize the efforts of our partners and customers in promoting best-in-class solutions in the enterprise business market. >>





An innovative ecosystem is a collaborative mechanism for jointly developing customer-centric solutions. Such an ecosystem creates substantial value that cannot be achieved by a single enterprise.

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corporate-level alliances, ecosystem strategies, policies, and business development. It also makes appropriate decisions based on partner levels to simplify decision making for partners. With the PEC's authorization, the EBG further classifies partners and clarifies management mechanisms from headquarters to frontline departments to facilitate hierarchical partner management.

- **Build the 'Manage Alliance Relationship' (MAR) process.** The MAR streamlines R&D, marketing, sales, delivery, and service activities to incorporate partner businesses in Huawei's primary service flows. With the MAR process, partners can easily join Huawei's ecosystem, obtain support from Huawei's R&D teams, and develop and roll out high-value solutions on Huawei's platforms. The MAR process also connects partners to Huawei's marketing and sales organizations.

- **Improve ecosystem organizations.** The EBG has assigned experienced managers and employees to set up the Alliance & Solution Cooperation Department. With the development of partner services, the EBG has built OpenLabs in many regions. An OpenLab consists of joint innovation, partner development, solution development, and industry experience centers. R&D, testing, and cooperation experts are scheduled to support the OpenLabs operations. OpenLabs aggregate quality resources in target markets and industries and develop joint solutions with industry-leading customers and players to expand the market and build a robust ecosystem. By doing so, OpenLabs enable partners to jointly develop truly innovative solutions, verify the solutions, and implement them.

- **Continuously optimize partner-oriented IT systems and tools.** A 'Partners' section is available on the Huawei Enterprise website (e.huawei.com/en/partner), where prospective associates can join the EBG Channel Partner Program and interact with Huawei online. The Partners section also provides a marketplace platform for solution partners to exhibit joint initiatives and integration capabilities.

Focusing on Customer Needs to Build an Innovative Ecosystem

While streamlining internal processes, Huawei's

EBG has also explored ecosystem development models. The goal of the ecosystem program is to achieve multi-win situations among customers, partners, and Huawei.

An innovative ecosystem is a collaborative mechanism for jointly developing customer-centric solutions. Such an ecosystem creates substantial value that cannot be achieved by a single enterprise, which is why any ecosystem jointly orchestrated by Huawei and its partners comprises the following:

- **Joint Huawei/partner developer platforms.** Huawei organizes customer requirements, interacts with partners, and develops open Application Programming Interfaces (APIs) to transform partners' creative ideas into reality.

- **Industry-oriented solutions.** By focusing on the '5 + 1' industries (government/public safety, finance, transportation, energy, and manufacturing plus telecommunications), the EBG works with partners to build industry solutions tailored to customer needs.

- **Customer-centric ecosystem.** Huawei's EBG analyzes the industry chains of key customers and works with partners and customers. For example, regarding banks and automobile manufacturing companies, the EBG works jointly with consulting companies, Independent Software Vendors (ISVs), and software outsourcers.

Managing Each Ecosystem for Maximum Advantage

For ecosystem business development, Huawei manages an ecosystem to maximize a partner's advantages and profits. Ecosystems are like a unified business, with full lifecycle service activities, from strategic planning to Go-to-Market (GTM).

Each ecosystem has its own features, and Huawei's role varies accordingly. Some ecosystems are dominated by Huawei as the 'conference moderator.' In other ecosystems, Huawei is a 'participant' only.

When serving as conference moderator, Huawei manages partner interaction, ecosystem rules, and other behaviors. When operating as a participant, Huawei uses its open platforms and interfaces to support ecosystem activities.



By the end of 2016, Huawei's EBG had cooperated with more than 400 solutions partners. Cooperation domains include Safe Cities, omni-channel banking, digital railway, better-connected grids, and omnimedia. >>

The Safe City ecosystem is an example that consists of alliance partners, such as Hexagon, a leading global IT solutions provider, and a variety of regional ISVs and Independent Hardware Vendors (IHVs). Huawei leads its Safe City partners in the search for market opportunities and rewards the most active partners with greater exposure to new opportunities. As conference moderator, Huawei invites U.S. experts to conduct enablement training sessions that include industry-leading ecosystem governance and operations methodologies.

Meeting Core Needs for Rapid Growth with Partners

After years of experience and research, Huawei recognizes that satisfying partners' core needs is the foundation of ecosystem success. This core needs lie in the improvement of business profitability. Large-company partners prefer to improve their own brand, marketing, and solution capabilities for long-term revenue growth. Small-company partners focus primarily on Return-On-Investment (ROI) and short-term market/brand benefits. Huawei teams with large-size solutions partners to leverage the expertise of all parties, improve our competitive edge, and better serve customers.

By analyzing the core needs of large- and small-size solutions partners, Huawei's EBG has built differentiated cooperation models:

- **For large-size solutions partners**, such as Accenture, SAP, and Hexagon, the EBG assigns dedicated alliance managers to cultivate cooperation opportunities in the enterprise domain; streamline two-party policies; manage alliance relationships; implement two-way interconnections between R&D, marketing, sales, and service representatives; establish dedicated alliance foundations; and invest in the incubation, GTM, and market exploration of joint solutions.

The Huawei and Hexagon team is a model to consider. By engaging a dedicated alliance manager, the two parties have rapidly built the world's first visualized and converged command center solution. The center enables active prevention before an incident, rapid response during one, and precise investigation afterwards.

- **For small- and medium-size solution partners**, the EBG has launched its enterprise business solution partner program, which covers Safe City, finance, transportation, electric power, and other industries. On Huawei's EBG website, interested parties can join the Enterprise Solution Partner program and register with an industry solution. Partners can then obtain online and nearby technical, testing, integration, and verification support from Huawei's global OpenLabs. Huawei also exhibits the verified solutions on its marketplace platform for its customers and channel partners.

- **Huawei's EBG also actively listens to partners.** For example, when a partner submitted an improvement suggestion regarding Huawei's platform interfaces and response, Huawei quickly organized the EBG's solution service team and IT R&D team to conduct several rounds of discussions, perform retrospections, figure out the final solution, and improve Huawei's response to partner issues and R&D information transparency.

By the end of 2016, Huawei's EBG had cooperated with more than 400 solutions partners, including SAP, Accenture, Hexagon, Infosys, Thales, Sobey, and Yusys Technologies. Cooperation domains include Safe Cities, omni-channel banking, digital railway, better-connected grids, and omnimedia. The EBG invited partners to deliver keynote speeches and exhibit solutions at Huawei's 500 marketing campaigns worldwide. In addition, Huawei set up a dedicated joint marketing fund amounting to USD 50 million to drive campaigns with partners.

A Future with Multi-Ecosystem Collaborative Operations

In line with its customer-centric strategy, Huawei will continue to orchestrate win-win, sustainable ecosystems as well as constantly improve ecosystem governance and operations capabilities. Today, Huawei is starting to build a unified IT platform for partners to perform end-to-end business interactions with Huawei online. Meanwhile, Huawei will continue to engage in collaborative operations of multiple ecosystems and join capability-building activities in external ecosystems. ▲

CIOs Prepare for Digital Transformation

| By *Fernando Velázquez, CIO, Latin America Marketing, Carrier Business Group, Huawei Technologies Co., Ltd.*



Fernando Velázquez

The rapid adoption of digital technology is changing the world as we know it. Companies that were born with a digital DNA are now taking over the market. Ten years ago, the list of most valuable corporations was dominated by Big Oil and multinational conglomerates. Today, companies such as Google, Facebook, and Amazon dominate the headlines.

Technology has affected companies' roles and the way they do business. Even if you don't fully understand the term 'digital transformation,' odds are you've got at least a couple of initiatives in the works that would fall under its umbrella. The time is now for companies to refocus on a full-fledged digital transformation strategy. That means CIOs must be able to help their companies understand how the disruptions that digital transformation will bring to business can create opportunities for growth. To do this, CIOs first have to reinvent themselves.

The New Digital Reality

Reinventing Information Technology (IT) to support

digital transformation requires far-reaching changes, from talent to infrastructure, and will take several years to complete. Fortunately, CIOs can educate companies to adopt an approach that delivers results quickly, while still reshaping IT for the long term.

This approach requires new, fast, agile IT to work alongside legacy IT, and a focus on one or two valuable business areas such as the web and customer engagement. This will enable a company to address its most critical IT areas within a few months before it needs to scale up to cover the remaining areas.

Successful transformations will avoid fractures between high-speed and legacy IT functions and will be driven by the CEO and business leaders who will

CIOs must become digital leaders who can help their companies understand how disruptive digital transformation will be and how those disruptions create business opportunities. >>



treat it as one of their top priorities, not just ‘another IT project.’

Change Ahead

Digital transformation will change the demands on IT in three principal ways:

- Increasingly sophisticated technology will be needed to improve companies’ operations and interactions with customers and clients. Examples include Netflix’s recommendation system and Booking.com’s proprietary search and caching system. Even coffee store chains are introducing sophisticated mobile-payment and loyalty Apps.
- Previously, efficiency was the most important IT performance measure. Now, everything matters: time-to-market, reliability, security, and, especially, scalability. The inability to scale up quickly makes it difficult to meet new business demands.
- Senior management will insist on much greater business engagement and oversight of IT departments. After all, the value at stake in IT digitalization will be much greater than before: up to 40 percent of revenue, 20 percent of costs, and, sometimes, the very survival of the business.

Preparing for Change

During prior technology shifts, such as from mainframes to minicomputers and then to client/servers, specialized IT organizations were required to sit between technology and the business in order to provision and support solutions. Today, ‘millennials’ (people born after 1982) are much more tech-savvy, having grown up around computers. The combination of tech-savvy users and Everything-as-a-Service (XaaS) offerings now permits businesses to procure and provision technology-enabled solutions without involving IT technical staff. Business managers also have higher expectations as a result of their own experiences with personal technologies.

These managers search for the same kind of experience at work. They expect to be able to get immediate help by conducting a real-time chat with a customer-support specialist, and they share their experiences — good and bad — on social media.



A recent KPMG survey of more than 600 IT leaders found that systemic issues are the main reason for a lack of IT innovation, with 66 percent of respondents citing environment or structure, processes, and standards as primary causes. >>

Therefore, digital enterprises are positioned to put the customer first anytime, anywhere, and at any place, based on customer expectations.

CIOs at a Crossroads

Digital transformation has put CIOs at a crossroads in their industries. Down one road, CIOs assume a leadership role that harnesses digital transformation disruptions and turns IT departments into sources of innovation. They work with business leaders to develop new products, services, and business models. Along this road, CIOs are expected to be business enablers, and CEOs expect them to build new vertical markets that promote more business opportunities with maximum cost efficiency. Down the other road, CIOs will preside over increasingly marginalized IT departments as other company clients go elsewhere for innovation.

What’s Wrong with Traditional IT?

- Legacy IT operations generally lack the agility, flexibility, and speed necessary to deliver high-quality solutions to support digital transformation. Traditional IT operations simply took too long, cost too much, and consistently failed to meet expectations. However, poor project execution was just one problem. A recent KPMG (the global audit, tax and advisory services firm) survey of more than 600 IT leaders found that systemic issues are the main reason for a lack of IT innovation, with 66 percent of respondents citing environment or structure, processes, and standards as primary causes.
- IT has a shortage of qualified digital professionals. Digital transformation requires new skills, but user experience design, security, mobility, the cloud, and other such skills are in very short supply. Also, certain new roles such as solutions brokers, product managers, and service managers require skills that may not exist in current IT organizations.
- Many CIOs are ill-prepared for the reality of digital transformation. Despite this, CEOs have high expectations on how much revenue this transformation can bring to their companies. CIOs will be challenged to strike a balance between risk and reward.

For example, if CIOs integrate new business



Reinventing IT to support digital transformation requires far-reaching changes, from talent to infrastructure, and will take several years to complete. Fortunately, CIOs can educate companies to adopt an approach that delivers results quickly. >>

solutions with existing applications, how do they ensure that disaster recovery and business continuity plans will work? Will they comply with internal and external policies and regulations? Additionally, cyber threats present a continuing state of risk.

- Current IT infrastructures cannot be provisioned quickly or cheaply. Digital transformation requires new IT capabilities such as a scalable, cloud-based infrastructure. Traditional IT is used primarily to maintain systems of record: stable, reliable, transaction-oriented applications that operate at the core of the business. New releases were measured in years. In the new digital world, the focus is on customer- and employee-facing systems in which the user experience is of major importance and new releases tend to be measured in weeks, even days. These systems result from close collaboration between IT and users, and are the product of iterative, rapid development cycles.

Creating New IT Environments

CIOs need to create or upgrade R&D functions or innovation labs to provide an environment where IT, business users, and external customers can explore and refine new digital solutions. According to the KPMG survey, 34 percent of organizations have an R&D function within IT or IT and business.

Because of the scarcity of digital skills, using a Digital Center of Excellence (DCoE) and/or Digital Acceleration Teams (DATs) can leverage this talent across the company in a much easier and faster way.

A challenge facing CIOs is that projects to solve legacy back-office issues take priority over advances in digital strategy. This makes it difficult to ‘evangelize’ the business value of IT. As a result, some CIOs appoint a second-in-command to manage operational issues.

A Digital Transformation Future

The positive effect of digital transformation for carrier operators should be the ability to produce more revenue streams. Enterprises can expect to see more profitable and sustained growth in key vertical markets such as Smart Cities, energy, finance, transportation, and manufacturing. The success of consumer-oriented companies will require continuous investment in Artificial Intelligence (AI), human-machine interfaces, Big Data, and other cutting-edge technologies in order to keep up with customer demand for smarter devices.

Huawei’s vision is to create a joint development model in which our company, our customers, and our partners grow together throughout the digital transformation journey. ▲

Link: The ‘Internet of Intelligence’

In the not-so-distant future, the ‘Internet of Intelligence’ will emerge from technologies based on the Internet of Things (IoT) and Artificial Intelligence (AI). With it, humans and machines will be able to make decisions together.

While the IoT has given us simple AI assistants like Siri, Cortana, and Google Now, those assistants are only a subset of AI known as contextual awareness. AI is the intelligence exhibited by machines or software. Major AI researchers and textbooks define this field as ‘the study and design of intelligent agents’ in which an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success. Only further investment in AI can lead us to a truly intelligent age.

For years, video gaming has been playing with AI and procedural generation — a method of creating data algorithmically. Advantages include smaller file sizes, larger amounts of content, and random, less predictable game play.

In the future, true AI will come from a consumer technology company, not academia. The Application Programming Interface (API) as we know it will be replaced by the AI Programmable Interface (APII). Keeping up with demand for smart devices in a futuristic, intelligent world will require continuous investment in AI and other cutting-edge technologies by organizations and vendors across the industrial and consumer landscapes.

Cultivating Leadership in a Post-Digital Era

A Forrester Consulting 'Thought Leadership' Article Commissioned by the Huawei Enterprise Business Group

Businesses must anticipate customer expectations and deliver differentiated experiences through new flexible technology architectures that will dominate the post-digital era. >>

To harness the power of technology in a post-digital world, as discussed in Part 1 (*ICT Insights* issue 19), companies must take an outside-in approach, investing in technologies that deliver outcomes most desired by customers. In the elevator industry, for instance, companies invest in technologies to optimize people movement between floors and minimize downtime; agriculture companies invest in technologies to increase farm yields; and cities invest in technologies to attract businesses and create a happy and safe environment for citizens.

All companies must first understand the needs, wants, and desires of potential customers and engineer an architecture tailored to better deliver these outcomes. Twentieth century architectures will not support the technology of tomorrow. New architectures must sense customers' evolving expectations and adopt and adapt to emerging technologies to better serve customers and drive revenue.

To do this, architectures must possess the following characteristics:

- **Be flexible and agile.** Businesses must rapidly evolve alongside customer expectations. A cloud approach maximizes flexibility and agility and helps organizations adapt quickly to dynamic market conditions and customer needs. In a competitive market, it is almost mandatory to minimize deployment costs across tens of thousands of mobile employees and allow digital touch points and revenue channels

to expand. Forty-four percent of companies with a full digital transformation strategy always use the cloud for core business applications, compared to just 17 percent of companies with a 'bolt-on' strategy. Thirty percent of respondents state that 'adopting cloud platforms' is the best choice to ensure business agility.

- **Support Big Data analytics.** Technology architecture must support real-time analytics to provide immediate value to customers and must be analyzed at the edge of the network to deliver the speed customers expect. Machine Learning (ML) and Artificial Intelligence (AI) will help create unique, high-value, and immediate customer outcomes. Successful businesses will anticipate customer expectations and needs and deliver differentiated experiences to meet them.

Twenty-three percent of survey respondents





To capitalize on new technology-driven revenue, executives must transform their business models and work collaboratively across the organization to deliver new outcome-based services. >>

selected ‘new data-based digital services’ as their top choice when asked about digital product design and development, while 22 percent selected ‘predictive maintenance through analytics’ as the best way to improve operational excellence. But cloud services must be tailored to the specific needs of the marketplace. Retailers in the U.S., for example, must expand their architecture to support peak customer loads during *Black Friday*, the busiest shopping day of the year.

- **Be ecosystem-enabled.** Not everything can (or should) be built in-house. Some digital capabilities will be delivered to customers through partners within an interconnected technology ecosystem. Organizations must be ready and willing to share their data across the ecosystem. Energy companies in the U.S. share peak energy forecasts with Nest to enable ‘Rush Hour Rewards’ that help Nest thermostat owners reduce their energy bills.

Post-Digital Business Models will Evolve

To capitalize on new technology-driven revenue, executives must transform their business models and work collaboratively across the organization to deliver new outcome-based services. Simultaneously, business operations must shift from slow, product-oriented processes to agile, customer-oriented processes to keep pace with evolving customer needs. While the new business models are not fully defined, some signs suggest the coming changes across industries:

- **Financial services adopting ML and AI.** Emerging Fintech companies already use computer models to manage financial portfolios and optimize returns, in some cases replacing humans. Sixty-five percent of financial services companies already use Business Intelligence (BI), analytics,

and decision-making support tools, with a further 28 percent planning to invest within the next 12 months. Also in the near future, financial services companies may drive revenue based purely on their ability to increase the wealth of their clients. Using advanced analytics to predict market moves, companies able to automate investments to outperform market averages will gain a significant competitive advantage.

- **Manufacturing evolves to build-to-order.** Using robotics, sensors, and a cloud-based ecosystem of suppliers, manufacturers will continue to evolve, building more products designed for the unique needs of each customer. Embedded sensors will allow monitoring of product quality and reliability for the lifetime of the product. Car manufacturers, like BMW, are already producing unique cars to fulfill each customer order. Future blockchain-enabled records will track all components that go into a product, including replacement parts, to increase reliability and performance. These advances require the means to connect to the product at any time, imposing even greater dependence upon high-bandwidth, high-availability 4G/5G data networks.

- **Logistics and transportation tap analytics, GPS, and sensors.** With GPS, transportation can track every movable asset, and low-cost cellular technologies provide the ability to transmit location and environmental data in real time. Data

analytics optimize everything from routing to scheduling. The logistics industry has been on a technology-enabled journey for 30 years, but the pace of change is accelerating. Cloud services provide new opportunities to optimize logistics across thousands of variables, including weather and traffic.

- **Higher education services tap digital for learning.** Syndicating learning through digital media is transforming higher education, and the ability to use digital learning tools to monitor and improve student performance will be critical to future revenue growth. Campus-based education institutions must digitally connect students to one another and teachers, not only in writing but with video as well. All of this interaction increases dependence on a high-bandwidth communication infrastructure. Future intelligent learning environments will adapt education materials to the unique learning styles of each student, while simultaneously monitoring progress and automatically adjusting to student needs. Augmented and virtual reality will eventually allow every student to experience 1:1 learning wherever and whenever they desire. The adaptation of computer-based game design to learning will increase the effectiveness of education and eventually become a source of differentiation.

- **Digital media and tech services companies build on clouds.** As the digital media and tech service provider industries mature, cloud-enabled services have become standard — 94 percent of media companies already use or plan to use public cloud services in the next 12 months. Companies now use emerging technologies to connect to their customers’ digital ecosystems, providing seamless services across multiple devices and locations. French TV company TF1, for example, uses a hybrid cloud approach for faster news production, from anywhere, at any time.



To succeed, the CEO and executive team must take greater ownership and responsibility for how technology is deployed across the enterprise. CIOs must help the executive team separate IT from Business Technology. >>

- **Energy companies seek to add value beyond utility.** With 72 percent of energy companies updating their legacy applications, and the remaining 28 percent planning to do so in the next twelve months, the energy sector is one of the most active in technology. Digitally enabled smart grids already allow more efficient power transmission: Nigeria's Smart Grid helped reduce line loss by 20 percent. By embracing sensors across the business model, from power generation to consumption monitoring, companies in the energy sector compete to provide customers greater value beyond the delivery of utility services. Today, U.S.-based Direct Energy partners with Nest to offer 'Rush-hour Rewards.' As one of the few sectors already connected to every home and business, energy companies can become enormous hubs for data collection, allowing them to generate new insights that help customers derive greater value from their relationships.

- **Public sector organizations become more accountable to citizens.** Government departments in countries as far apart as New Zealand, the U.S., and the U.K. are rapidly adopting digital technologies to drive greater efficiencies and become more connected and accountable to taxpayers. As public sector departments become more open in data sharing, private companies are springing up to leverage the data and create new services to improve the lives of citizens. In addition, cities are wiring together services, competing to become the safest, most digitally friendly city. Nairobi's Smart City project, for example, has reduced crime by 46 percent.

CIOs Must Move ICT from the Back Office to the Front

Between 20 percent and 30 percent of any firm's business capabilities account for its market differentiation; these capabilities are the reasons that a customer buys from Company A rather than Company B. In the past, product design and development capabilities have typically stood out as strategic; however, in the post-digital era, companies increasingly develop differentiation through the experiences they create for their customers and the technology that supports the delivery of better customer outcomes. As technology becomes a revenue driver, the company's ICT

can no longer be viewed simply as an expense to be constrained. Because CIOs must focus their scarce technology resources on the 20 percent to 30 percent of their differentiating business capabilities, they must also greatly simplify the remaining technology.

To succeed, the CEO and executive team must take greater ownership and responsibility for how technology is deployed across the enterprise. CIOs must help the executive team separate IT, which supports generic business capabilities, from Business Technology (BT), which supports differentiation and creates customer value. Installing the right business technology is now a critical success factor for every business. To help prioritize investments, technology governance and leadership must shift the focus to be more outside-in, working toward improving customer outcomes. At the same time, CIOs must lead a change in perception by changing how business leaders perceive the technology teams that support revenue models. CIOs must also become more accountable for driving revenue growth by:

- **Shifting ICT culture toward the real customer and revenue growth.** Just 36 percent of IT groups surveyed reported viewing all non-IT employees as business partners; the rest consider other employees to be ICT customers or a mixture of both. Business leaders most often view ICT as a supplier, not as a partner. CIOs must help their teams get to know the real ICT customer, who is also the real customer of the business. Shifting ICT culture toward the end customer helps clarify what is really important. ICT teams are rarely held accountable for revenue; however, just as CEOs expect CIOs to become more responsible for revenue generation, CIOs must also hold their teams accountable for driving revenue growth. This means empowering teams to innovate and partner across the business. Only then will ICT's true creativity be fully realized in service of customers.

- **Focusing on growth and agility over efficiency.** For years, CIOs have been challenged to use technology to improve enterprise efficiency. But in this post-digital era, the drive for business agility trumps the need for efficiency. CIOs must examine every opportunity to increase the agility of both the ICT team and the overall business, even at the risk of



Since your customers see your business differently than you, learn to see things through their eyes. Only by using technology to help customers get what they need, want, and desire will you secure future growth. >>

decreasing efficiency. Agility is needed to keep up with evolving customer expectations and secure future revenue growth. Efficiency remains important, but it is meaningless without revenue. Twenty-eight percent of respondents cite business agility as their leading approach when sourcing new software applications; 27 percent deploy cloud rather than on-premises solutions; and 27 percent are moving toward a hybrid cloud.

- **Simplifying technology and improving security.** CIOs must lead a push to dramatically simplify the architecture that supports overall business. When identifying their biggest IT challenge, 21 percent of respondents name applying new security protocols, while 20 percent point to keeping up with bandwidth demands and moving business applications to the cloud. Simplification, however, cannot be implemented overnight, and multi-year ‘big-bang’ transformations are no longer an option. The smooth transition from legacy to new, more secure, and agile business technologies, and the simplification of generic business capabilities, must be a continuous evolution. CIOs still must deliver world-class digital experiences to their customers throughout the technology architecture makeover.

Key Recommendations

As companies move beyond simply bolting digital assets to the existing business and to transforming the entire business into a technology company, executives must rethink their business vision, culture, and strategy. The big challenges ahead can be overcome but not without first changing the thinking of the leadership team. These teams must first build their business model around creating products, services, and digital experiences to help customers achieve the outcomes they desire.

Efficiency is important. Improving efficiency and lowering prices for customers is not a unique concept but making sure business agility remains the focus does not come easily. Your customers are evolving faster than your business can adapt; therefore, in response, your business must also constantly evolve.

Furthermore, it is now essential that your organi-

zation build its digital DNA for survival. This means more experimentation with emerging technologies, often without a clear Return on Investment (ROI). Encourage startups in your industry and create incubator programs to speed innovation.

CIOs face an enormous challenge in that almost every technology company claims to be a leader in digital transformation, yet few can demonstrate how. Executive teams share a responsibility for helping CIOs select strategic technology partners that can help transition today’s architecture into a platform for future revenue growth.

Becoming Customer-Obsessed

Without a clear focus on what matters to the customer, none of these changes matter. Your entire business must become customer-obsessed. Since your customers see your business differently than you, learn to see things through their eyes. Only by using technology to help customers get what they need, want, and desire will you secure future growth.

The technology investments of the past focused on operational efficiency — they were inside-out. Future investments must focus more on agility and the creation of customer value — they must be outside-in. Because the outcomes most valued by the customer will continue to evolve and vary by industry, the technology architecture has to be tailored to the industry, yet be flexible enough to adapt to change in the future. ▲

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Karabet Krikorian

The IoT's Potential for Transformation

| By *Karabet Krikorian, Head of Western Europe IoT & Industry 4.0 Solution Innovation, Enterprise Business Group, Huawei Technologies Co., Ltd.*

From cloud-based Big Data to low-power wireless connectivity, the usefulness of the Internet of Things is dependent upon a vast array of supporting technologies. >>

With a rapid decline in the cost of sensors and new ways to connect sensors wirelessly, the Internet of Things (IoT) is poised for dramatic growth over the next few years. To enable connected 'things' to achieve their true potential, the IoT needs many additional technologies to manage communications, extract meaning from collected data, and apply that meaning in useful ways. These technologies include Big Data analytics, Artificial Intelligence (AI), Augmented Reality (AR), cloud computing, edge computing, and 5G cellular communications. The IoT story is about these technologies as much as it is about huge numbers of things.

Further, the rise of IoT ecosystems and marketplaces will play a part in changing the way products and services are conceived, developed, and offered to market. Just as cloud computing permits enterprises to rent the infrastructure they need, IoT platforms and ecosystems enable enterprises to outsource more of their ICT infrastructure. Enterprises can fully leverage IoT technology while keeping a focus on their core business.

Big Data in the IoT

The main reason to connect things is to harness their data. The quantities of data generated by the IoT

create a wide range of opportunities for optimizing business processes and managing factories, networks, and fleets on a predictive basis.

Huawei and its industry partners have developed a number of solutions that combine IoT connectivity, device management, and predictive maintenance. Big Data offers exciting prospects for many kinds of decision-making support. Combining Big Data analytics with the IoT and real-time industrial networks enables correlation-based process and productivity improvements.

One example developed in 2016 is the Huawei Elevators and Escalators Connection solution, which





can connect and manage millions of elevators. The solution backhauls elevator operational data in real time using IoT technologies. Through Big Data analytics and collaboration with an external system, a data center implements remote management and predictive maintenance. The solution reduces costs by more than 50 percent, shortens service interruption time by 90 percent, reduces elevator failure rates, and helps ensure passenger safety.

IoT Architecture

Another important IoT development is the transition from special-purpose vertical management platforms (silo-type systems) to multi-purpose horizontal solutions. The latter promote collaborative partnerships, ecosystem development, and interaction between industry players, vertical service providers, public authorities, and communities.

Horizontal solutions are useful, therefore, in dealing with the complexity of managing an IoT infrastructure that may include devices, connection methods, protocols, data throughput volumes and collection intervals, time-sensitive networks, and application requirements. An overall architecture can handle many of these variables transparently for developers and managers. An architecture ecosystem can help cope with ever-changing requirements and provide users with the required platform capabilities, flexibility, scalability, tools, SDKs, and software libraries. Connection security and data flow integrity across the whole IoT domain still pose challenges, and further advances are necessary to make horizontal platforms practical.

In contrast, a lot of good work has been done to define the layers that make up the architectural framework of an End-to-End (E2E) IoT solution. Moreover, reference architectures show some commonality in the layers required to support very different vertical requirements and use cases. The basic layers include the following:

- Smart sensor/thing layer
- Network connectivity layer
- IoT cloud platform enabling interconnection

Huawei's IoT solution utilizes a '1 + 2 + 1' architecture: (one) Huawei LiteOS open-source Operating System; (two) access modes using IoT gateways and smart home gateways; and (one) unified open IoT connection management platform. >>

between all layers

- Data storage and analytics layer
- Application layers
- Backend enterprise systems such as Enterprise Resource Planning (ERP), Manufacturing Execution System (MES), Customer Relationship Management (CRM), and Business Support Services (BSS)

A considerable amount of R&D and innovation will be required to improve the technologies that make up these layers. Huawei's IoT solution utilizes a '1 + 2 + 1' architecture: *(one)* Huawei LiteOS open-source Operating System (OS), which is ideal for smart IoT devices; *(two)* access modes (fixed and wireless access) over enterprise Long-Term Evolution (eLTE), Narrowband IoT (NB-IoT), and 5G networks using IoT gateways and smart home gateways; and *(one)* unified open IoT connection management platform.

Huawei's OceanConnect IoT connection management platform is an open cloud-based system for use by operators, enterprises, and vertical industries. The platform permits connections both with and without SIM cards and supports connection management. The OceanConnect platform uses open APIs and agents to integrate with various Network Applications (NAs) and provide access to sensors, devices, and gateways. With these capabilities, the platform helps operators, enterprises, and industry partners implement fast NA integration and rapid device access, as well as secure and reliable connection management. At this point, the platform has a growing library of integrated applications across different verticals.

Low-power Communications

NB wireless connectivity enables low-power communications using low-cost hardware. Specifically, NB-IoT can be implemented using a Huawei module that costs about USD 5, operates for up to 10 years on one battery, provides good coverage (20 dB gain), and supports connectivity of 50,000 devices per cell.

This module can be used inside devices such as smart electric meters and other Smart City sys-



By providing edge computing capability, Huawei's agile IoT gateways meet local real-time computing and control requirements.

The gateways can run OSs, such as Linux, Android, and KVM, and can be equipped with third-party application plug-ins for local processing. >>

tems to achieve easy IoT communications. Huawei has been helping operators around the world perform tests of smart parking, street lighting, and similar projects.

Huawei was the first vendor to implement the standard for NB-IoT (3GPP Release 13) on a live network. Several of Huawei's networks with Tier 1 operators will go live with NB-IoT in the first quarter of 2017.

OneAir eLTE

To meet a variety of IoT connectivity needs, Huawei has integrated several communications technologies in a solution called OneAir eLTE. This solution implements enterprise private networks that provide broadband, NB, and many other industrial IoT services.

The OneAir eLTE solution can be integrated in manufacturing, rail transit, petrochemical plants, ports, Wireless Internet Service Provider (WISP) networks, open-pit mines, and railway yards. The solution complies with Message Queuing Telemetry Transport (MQTT), IP Proxy, and other standard IoT protocols to allow interconnections with industrial application systems or management platforms.

IoT Operating System

Huawei's LiteOS supports IoT hardware that has minimal memory, consumes little power, enforces excellent security, and offers the flexibility to work in a wide variety of applications. With a kernel of just 10 kB, the OS performs auto-discovery, auto-connecting, and self-organizing functions. These functions allow users to achieve rapid connection and large-scale deployments, while helping to ensure security at the kernel, transmission, and application layers. LiteOS is compatible with communications protocols that include ZigBee, Wi-Fi, Thread, LTE, Ethernet, and Bluetooth.

Agile IoT Solutions

In addition to the technology needed to implement individual IoT devices, Huawei offers IoT solutions that deal with collected data and enable communication with the devices. Two of the most important

parts of these Huawei solutions are gateways and controllers.

By providing edge computing capability, Huawei's agile IoT gateways meet local real-time computing and control requirements. The gateways can run OSs, such as Linux, Android, and KVM, and can be equipped with third-party application plug-ins for local processing. If sensors detect an engine abnormality in a vehicle-mounted system, for example, the local IoT gateway can take measures to deal with the problem — thus avoiding possible delays due to network faults or congestion.

At a higher level of the IoT architecture, Huawei's Agile Controller provides unified management of IoT terminals, gateways, computing resources, applications, and data. The controller uses standard northbound interfaces to achieve fast interconnections with applications and other resources. The controller's open software architecture permits virtualized, distributed deployment with seamless expansion capabilities that enable management of tens of millions of IoT devices.

LTE-V Solution for Vehicles

Along with general-purpose IoT solutions, Huawei offers the LTE-V solution specifically designed for Vehicle-to-Everything (V2X) applications that demand extremely low latency and reliable short-distance communications. While conventional cellular networks can handle the needs of vehicle telematics, Huawei's LTE-V uses mature 4G LTE technology to meet more stringent V2X requirements.

IoT Opportunities and Challenges

The IoT represents enormous opportunities for companies across nearly all industry verticals. The way forward will not be without challenges, of course. The IoT requires a dramatic re-thinking of how to embrace new technologies.

Huawei is committed to developing state-of-the-art solutions across the broad spectrum of IoT products and services in order to benefit operators, enterprises, and consumers, and make the world a smarter and better connected place for everyone. ▲

Disruptors Change Education Technology

| By Zhou Mingfeng, Marketing Manager, Marketing and Solution Sales Department, Enterprise Business Group, Huawei Technologies Co., Ltd.



Zhou Mingfeng

As we move through 2017 and beyond, it is appropriate to reflect upon the current status and future trends in the education market. During recent years, we have seen unprecedented integration of Education and Technology (EdTech), as educational influencers continue to reimagine and revitalize the industry by sharing knowledge and experiences with their digital campus solutions.

Mobile devices connected to the cloud are a disruptive way for students to customize eLearning at their own pace. What's more, global educational products and service platforms have moved forward through collaborations and partnerships while strategic Venture Capital (VC) investments continue to pour billions of dollars into the educational ecosystem with the objective of forever changing the way people learn.

Mobilizing Blended Learning

Digital classrooms enabled by smart cloud platforms are replacing traditional teaching methods.

Today's students are less attracted to a steady diet of teacher-led classroom courses; they expect new educational software and tools to suit their needs. These students are prepared for and count on individual learning, online live classrooms, and webcasts that make full use of mobile technologies.

Traditional learning environments are not only limited to places like classrooms, libraries, and dormitories but face a lack of access to the types of resources commonly available online. A broader move to learner-centered education is shifting the role of teachers away from the traditional role of lecturing to a tutoring role in which they mentor

The future of education will be defined by financial investments and their impact on trends in digital service platforms and distance learning curricula.
>>



students through customized curricula. The results are ‘blended learning’ environments that merge with smart educational platforms using student-centered instruction.

Blended learning combines classroom teaching with mobile smart devices for accessing resources and feedback anytime, anywhere. Schools empower EdTech by linking their physical and virtual campuses using digitized educational platforms with network access. This combined methodology also includes a progression toward network technologies built to support 4K video animation and multimedia learning tools. These forward-looking techniques support the goals of student-centered instruction by streamlining face-to-face interactions for distance education and vocational training.

Disrupting EdTech

Massive Online Open Course (MOOC) development and Artificial Intelligence (AI) will play larger roles in the future of higher education. MOOC expands the number of students available online and facilitates the coordination of course program development for college and university education as well as vocational training services.

MOOC-provided curricula disrupt online education with ‘live’ courses. For some entities, the courses will be produced by teams made up of graduate students and postdoctoral fellows working with film editors and code developers to convert videotaped lectures into on-demand courses.

The addition of AI to blended learning will create disruptive milestones for enhancing the efficiency of learning, improving the utilization of courseware resources, lowering educational costs, and promoting personalized learning. These EdTech solutions represent a big step forward on the learner-centered roadmap, easily providing real-time information everywhere along the education value chain.

Flipping Education Solutions

A ‘flipped’ classroom illustrates another typical



To move the industry forward, educational practitioners must exchange ideas and experiences to revitalize education through collaboration and partnerships. These educational influencers run the gamut from government officials to scholars, entrepreneurs, investors, academics, and enterprises. >>



example of blended learning. Students study at home on the Internet and then interact in the classroom with a teacher and fellow classmates who collaborate together to resolve problems and improve their knowledge base. Flipped classrooms turn extracurricular time into proactive learning activities. Content decisions are transferred from teachers to students who finish their studies after class by watching video lectures, listening to podcasts, reading eBooks with enhanced functions, or discussing topics with other students online. The goal of this approach is to allow teachers to spend more one-to-one time with each student.

Trending Innovations

Organizations and academic institutions worldwide are constantly searching for learning innovations that inspire. To move the industry forward, educational practitioners must exchange ideas and experiences to revitalize education through collaboration and partnerships. These educational influencers run the gamut from government officials to scholars, entrepreneurs, investors, academics, and enterprises. Linking government to the educational marketplace helps bring the public and private sectors closer together.

The goal of many colleges is to build digital campus service platforms that center on quality mobile learning services. This shift fulfills students’ requirements for on-demand and personalized learning in addition to making quality educational resources readily available. To ensure that learners have access to mobile courses from any place on campus, the go-to-classroom strategy is for schools to digitize teaching resources and implement an online learning management platform linked with a comprehensive wireless network.

Connecting Smarter Schools

As the first step, a wireless campus network needs wireless access that ensures coverage for high-density access requirements in campus cafeterias, auditoriums, and other high-density-



Distance education allows communication with a growing number of users in the same frequency band at the same time and is on track to becoming a mainstream standard. Wireless interactive whiteboards will also become everyday teaching tools with this increased connectivity.

>>

challenged buildings. Second, to ensure cyber security protection and distribute online resources, campuses need to choose solutions that can safeguard privacy and security against breaches. Moreover, the platforms need unified management of both wireless and wired networks to simplify campus network maintenance.

With the upsurge of wired campus networks, an increasing number of world-renowned universities, such as the U.K.'s Newcastle University, have established a 100G standard for their core network bandwidth. To expand the number of wireless users and increase the performance of wireless access, wireless networks now have Access Points (APs) that support 802.11ac Wave2, a technology that increases wireless speeds to a theoretical maximum. Distance education allows communication with a growing number of users in the same frequency band at the same time and is on track to becoming a mainstream standard. Wireless interactive whiteboards will also become everyday teaching tools with this increased connectivity.

Investing Impacts Worldwide EdTech

This past year has seen significant monetary infusion into the education industry. Disruptive technologies undoubtedly will continue to change learning solutions as well. For instance, a live cloud technology service provider is positioned to offer live online interactive broadcast services for educational and training schools that could result in a classroom product hosted in the cloud.

Smart Virtual Reality (VR) glasses and headgear are now being used as mobile Internet teaching devices for futuristic science, medical, and educational training purposes. By combining Augmented Reality (AR) with EdTech, companies and content providers are envisioning a completely immersive teaching model. Also in the works is the merging of Bluetooth-equipped smartphones with Internet of Things (IoT) smart education functions to complement connected homes and Smart Cities.

The IoT will eventually help automate tasks with tools for taking notes, checking schedules, and doing research. Universities are transitioning to connected devices that monitor students, staff, and resources to reduce operating costs and save money. Connectivity allows professors to gather data about students and customize lesson plans for future classes. These tracking capabilities will also protect and create safer campuses.

Making eLearning Fun

Advances in recommendation engines for analyzing and predicting student performance have received many strategic investments. Self-adaptive study engines that dynamically adjust also have new global investors. Meanwhile, financing intelligent speech technologies with smart audio and sound solutions demonstrates the impact of smarter speech recognition for online education.

In China, strategic cooperation is responsible for creating an educational design solution with a search engine that specializes in natural language processing, data mining, and sorting algorithms. A smart piano App uses a smart electric piano, online courses, and interactive learning with funding by famous Chinese pianist Lang Lang.

Through his venture firm Bryant-Stibel, former Los Angeles Lakers basketball superstar Kobe Bryant made a multi-million dollar strategic investment into Beijing-based VIPKID, financing an educational brand that teaches Chinese children to learn English online.

Investing in Tomorrow's Education

Clearly, disruptive influences are reshaping the future of education. Smarter educational institutions will also benefit from greener energy efficiency and lower Operating Expenses (OPEX), as evidenced by smart sensors and devices that are being installed to allow automated control of equipment and classroom lighting. For education industry leaders as well as EdTech disruptors, perhaps the time is right for further investments in the education industry. ▲



Ajay Gupta

Leading the Innovation Curve

| By Ajay Gupta, Director, Product Marketing, Network Product Line, Enterprise Business Group, Huawei Technologies Co., Ltd.

Huawei's visionary product innovations and strong global ecosystem comprised of partners and customers ensure industry-leading advances well into the future. >>

Nobody could have imagined that, just six years after the Enterprise Business Group (EBG) was formalized within Huawei, Gartner, a world-leading technology research firm, would name Huawei as a 'visionary' company for their enterprise switching and wireless products. It has not been easy to gain mindshare of enterprise CIOs and other CxOs due to the vast sea of competitive options in the global marketplace. Still, Huawei has reached a pinnacle of recognition for their innovation that some companies can only dream of achieving.

Visionary Companies Shape the Market

Huawei has shown its ability to shape and transform the market with innovative products. Gartner analysts report that Huawei not only has demonstrated sustained execution in the marketplace but will also have clear, long-term viability. In addition, Gartner gave kudos to Huawei's central strategy of providing End-to-End (E2E) campus networking and Software-Defined Networking (SDN) through its Agile Network solution.

In the book, *Built to Last: Successful Habits of Visionary Companies*, authors Jim Collins and Jerry I. Porras note that so-called visionary companies take leadership roles in their industries, offer innovative products and services, and consistently outsmart rivals. Great companies not only maintain leadership but also constantly experiment. Let's see how Huawei has fared with other industry analysts and publications.

Riding High in the Fast Lane

Fast Company, a highly regarded U.S. business and technology magazine, ranked Huawei the world's 13th most-innovative company in 2016. According to the publication, Huawei is one of only a handful of large technology companies that dedicate more than 10 percent of their revenues to R&D.

"To be recognized by *Fast Company* for our efforts in innovation is truly an honor," said Ryan Ding, Executive Director and President of Products and Solutions. "At Huawei, we're committed to building a better connected world, and innovation is one of our core principles. This recognition is a positive affirmation that the innovation we're trying to provide globally — building better societies, and connecting

the unconnected — is being recognized."

The monthly magazine notes that Huawei also commits 45 percent of its employees to R&D and cooperates with global innovators through its 16 R&D centers and 36 Joint Innovation Centers in countries including the U.S., the U.K., Germany, Sweden, France, Italy, Russia, India, and China.

Among Huawei's facilities is the Paris Aesthetics Research Center, where French luxury brand designers work with Huawei's engineers to align future fashion trends with technology. Huawei's newest R&D center is the Max Berek Innovation Lab in Wetzlar, Germany. At this lab, Huawei and premium camera maker Leica are jointly researching technologies to improve the image quality of mobile device cameras. Huawei also has more than 10 open labs in China, Europe, and other locations, where it works with more than 600 partners. At the same time, Huawei has launched a USD 1 billion developer enablement program to support partners and application developers.

'Best Brands'

Huawei ranked 72 in the *'Best Global Brands 2016 Rankings'* released by Interbrand, a San Francisco-based global branding agency. This is the second consecutive year Huawei has climbed up Interbrand's list. In 2014, Huawei became the first mainland Chinese brand to be recognized as a 'Best Global Brand.' In this latest report, Huawei moved up 16 spots from its ranking in 2015. What's more, Huawei's brand value, approximated at USD 6 billion, increased by 18 percent compared to the previous year. Interbrand's annual report recognized Huawei as one of the fastest rising brands in the technology sector. Huawei's significant progress is based on various innovative



products, services, and solutions that can help build a better connected world.

Additionally, Huawei's innovations have been recognized by the following organizations:

- **MIT Technology Review:** Each year, the Massachusetts Institute of Technology's *MIT Technology Review* selects the 50 companies that best combine innovative technology with an effective business model. They identify 50 companies that are 'smart' in the ways they create new opportunities. Huawei ranked 10th on their list.

- **The World Intellectual Property Organization (WIPO):** Huawei is a global leader in international patent filings, with 3,998 applications in 2015 alone.

- **The Boston Consulting Group (BCG):** Huawei was ranked among the top 50 companies in BCG's 10th annual listing of the world's '50 Most Innovative Companies.' The BCG list is based on a survey of 1,500 C-suite executives (high-ranking executive titles) who were asked to rank companies across industries and within their own industry. Huawei's ranking is a marked improvement from a decade ago, when there were no Chinese companies on the list. Analysts say China's presence is still growing.

Innovative Huawei Enterprise Solutions

Huawei's enterprise business has reached a Compound Annual Growth Rate (CAGR) of more than 30 percent thanks to increasingly more industry customers realizing added business value with Huawei products and solutions. Standout products include:

- **Enterprise wireless domain:** The

Huawei Agile Distributed Wi-Fi solution, including converged Wi-Fi and LTE technologies, was selected as a finalist for the '2016 Best of Interop Award.' This innovation significantly improves wireless performance and addresses signal coverage problems in high-density environments — especially hotels, dormitories, and hospitals — without increasing customer investments. The solution also encompasses innovative breakthroughs in large-scale Multiple Input, Multiple Output (MIMO), full-duplex antenna technology which features high bandwidth and multi-path fading cancellation.

- **Servers:** Huawei EBG launched KunLun, the industry's first 32-socket x86 server, which fully meets the needs of enterprises for core applications that require ultra-large memory.

- **Big Data Analytics and Artificial Intelligence:** Huawei developed the world's first open source streaming processing library on Spark, the open source engine for large-scale data processing. Huawei also released the industry's first deep learning-based 'single-turn dialogue generation model,' that will, for example, enable on-demand, automated service agents to better understand and mimic human conversation.

Consortiums, Industry Alliances, and Standards Organizations

Huawei's enterprise investments and contributions also extend to professional groups. It has become one of the most influential companies in the OpenStack consortium and has set new directions for the Network Functions Virtualization (NFV), container, cloud management, and large-scale data center domains.



By the end of 2015, Huawei had become a member of over 300 standards organizations, industry alliances, and open source communities — holding more than 280 important positions. >>

The ICT solutions provider helped establish several key industry alliances on NFV/SDN and NB-IoT to bring together industry players. In May 2015, ICSA Labs presented Huawei with the '10-Year Excellence in Information Security Testing Award' — demonstrating that Huawei's product security capabilities have been recognized in the industry.

By the end of 2015, Huawei had become a member of over 300 standards organizations, industry alliances, and open source communities — holding more than 280 important positions. It is a board member of IEEE-SA, ETSI, WFA, TMF, OpenStack, Linaro, OASIS, and CCSA. In 2015, Huawei submitted over 5,400 of 43,000 total proposals.

Envisioning the Future

There is no question that Huawei has come a long way; however, not everyone may realize the strides that Huawei has made to become a global player. Its success has extended from the carrier market, to the enterprise domain, and now the smartphone market.

Rising from humble beginnings, Huawei is a force to be reckoned with on the world stage. With focused strategies and effective execution, Huawei's strong global position has paved the way for the company to continue as one of the most innovative and visionary companies to ever emerge from China. ▲



Cheng Kai

Accelerating the Transition to Financial Clouds

| By Cheng Kai, Senior Marketing Manager, IT Data Center Solution Market Management, Enterprise Business Group, Huawei Technologies Co., Ltd.

As industry professionals rapidly reshape Information Technology, banks are incrementally adopting cloud architectures. >>

To retain customers, financial institutions must meet increasingly higher requirements for services. Transitioning to cloud computing offers bankers a way to become more competitive while improving their efficiency.

Competition in the banking business is fierce, and nowhere more so than in China. A few months ago, for example, China's Ant Financial Services Group, an affiliate company of eCommerce giant Alibaba Group Holding Ltd., closed the world's largest round of private equity financing for an Internet company at USD 4.5 billion (CNY 30.9 billion) that gave the company a post-money valuation of roughly USD 60 billion (CNY 412 billion).

The China Banking Regulatory Commission recently began to explore the construction of public financial clouds for the banking industry as well as hybrid clouds that would combine private and sector-specific applications. The commission suggests that banks implement cloud computing architectures that decouple applications and infrastructure, and is

encouraging banks to migrate their Internet-oriented information systems to cloud computing platforms by the end of 2020.

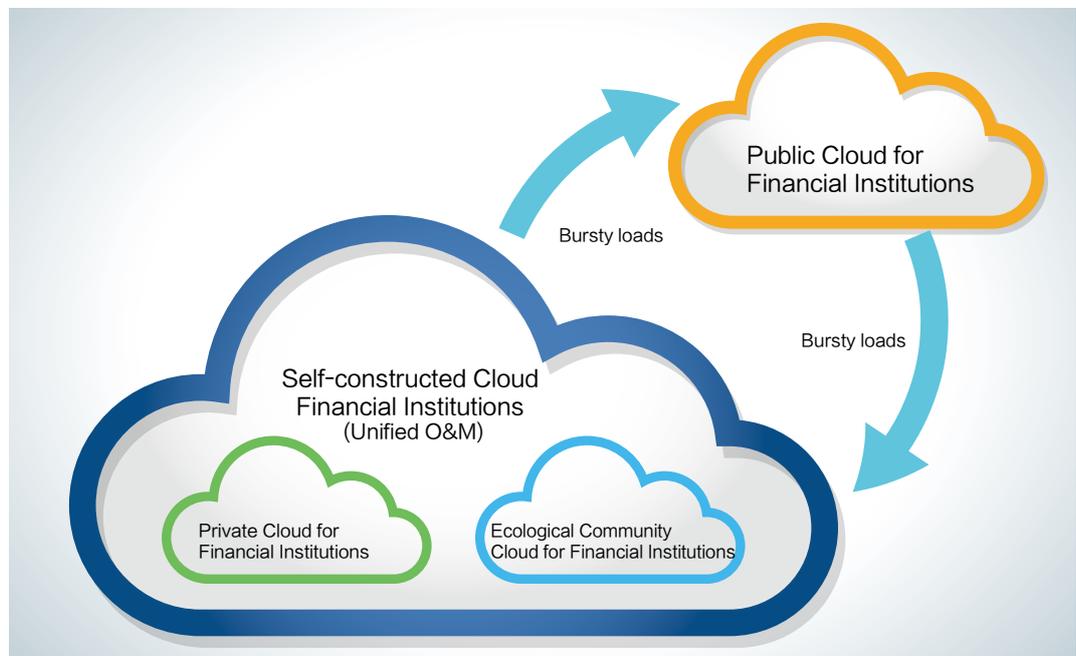
Huawei views this migration as three stages that will gradually increase the use of cloud resources.

New Clouds on the Rise

Financial clouds represent a business approach in which specific data, processes, and services are moved to cloud computing platforms. The major objectives of financial clouds include:

- Improved user experience
- Enhanced system agility
- Greater computational capacity
- Restructuring of data value

The goal is to enable financial institutions to pro-



Financial clouds for specific data, processes, and services



Modern financial institutions need unified pools of computing, network, and storage resources that enable collaboration across business applications. Unified resource pools are coordinated among multiple data centers to instantiate business-driven automated management and scheduling. >>

vide improved services to their customers while reducing Operating Expenditures (OPEX).

Private clouds are built for internal purposes, self-owned branches, and key services. Early adopters have begun to lease surplus resources and services to other financial institutions, branches, and upstream and downstream partners. Internet-based services that have bursty loads or less stringent security requirements are candidates for being reassigned to a public cloud.

For cloud computing or any other Information Technology (IT) architecture, managers of mission-critical systems must choose servers, software, and storage that suit reliability and performance goals. Around the world, managers are rethinking traditional choices. The trend in China is that businesses are actively seeking to reduce their reliance on the so-called 'IOE' system. IOE stands for IT network components based on the names of three suppliers: IBM, whose servers are packaged with the UNIX operating system; Oracle, the database management system vendor; and EMC, a supplier of data storage hardware. Dubbed the 'De-IOE Movement,' this effort has been ongoing for many years and is a key motivator in the drive toward the wider adoption of cloud infrastructures.

A qualifying factor for the movement of banks to replace UNIX-based servers is the widespread availability of open platforms that are based on x86 servers and Virtual Machines (VMs). The reality is that many x86 servers do not provide the performance, reliability, and availability necessary to match the long-proven, mission-critical reliability of the UNIX platform. Just one example is the inability of x86 servers to support component replacements without service interruption.

Huawei's KunLun 9032 x86 Mission-Critical Server is designed to accommodate the replacement of CPU and memory modules as well as other core components without interrupting ongoing services. With up to 32 CPUs and 576 cores, a single KunLun 9032 delivers levels of performance that rival mainstream UNIX servers. When deployed in conjunction with Huawei's OceanStor

18000 V3 high-end storage, the KunLun 9032 meets the high-performance and low-latency requirements for efficient and trustworthy banking services.

From Virtualization to Cloudification

Many banks around the world necessitate that all new applications be deployed on VMs. Huawei refers to this stage as Financial Cloud 1.0. While VMs are certainly useful, they apply only to the layer where computing nodes reside. This limitation raises questions concerning network and storage devices, and how managers will efficiently configure thousands of service policies and deal with the databases on physical nodes.

To help address these concerns, Huawei's Financial Cloud solution employs enhanced OpenStack-enabled Ironic components while leveraging Huawei's extensive experience in Software-Defined Networking (SDN) and distributed storage. The Ironic-based solution installs management software for network and storage automation onto a 'bare-metal' architecture that enables banks to roll out new services quickly without having to modify databases manually or write scripts.

Stepping up to Financial Cloud 2.0

Cloud management platforms are the most important core element of the stage that Huawei calls Financial Cloud 2.0 — and basic virtualization and resource provisioning are not enough. Modern financial institutions need unified pools of computing, network, and storage resources that enable collaboration across business applications. Unified resource pools are coordinated among multiple data centers to instantiate business-driven automated management and scheduling.

To implement these platforms, financial institutions choose from three main approaches:

- Undertaking in-house, open-source software development projects. This is a short-term approach that features low costs on a small scale.
- Purchasing proprietary, commercial off-the-shelf software. Although this path features mature



The Huawei Financial Cloud solution uses a cloud platform architecture to manage self-help service directories and resource pools for web and App resources, transaction data, Big Data analytics, and virtual desktop infrastructure. >>

applications, the trade-offs are high upfront costs and poor compatibility with other software.

- Purchasing commercial open-source software, which also features mature applications and is standards compliant (highly compatible) but requires long-term planning.

Traditional financial institutions prefer the third approach, particularly when operating within the OpenStack architecture. As a de facto standard for private clouds, OpenStack has matured rapidly. Fortune 500 companies, such as BMW, Disney, and Walmart, are all using OpenStack in their production environments. The number of financial institutions deploying OpenStack is increasing year by year.

Huawei provides solutions that both enhance OpenStack and decouple OpenStack modules. The ability to decouple modules from the software stack allows components to be upgraded individually, without impacting services. On the order of 200 Linux security patches are released each year, and, generally, it is expected that entire VM arrays will need to be restarted for each patch to take effect. Cloud industry statistics reveal that, on average, more than 70 percent of hot patches require VM restart. Amazon Web Services (AWS) registers at about 50 percent. By comparison, Huawei supports 75 percent of the patches without VM restart, which significantly helps banks that employ 2,000 to 10,000 VMs.

Disaster recovery and security compliance are two other critical aspects of financial IT. For mission-critical services such as online banking, the Recovery Time Objective (RTO) must be less than six hours, and the Recovery Point Objective (RPO) must be less than 15 minutes. To confidently migrate their operations to the cloud, banks need automatic emergency handover, Backup-as-a-Service (BaaS), and other powerful functions.

In 2015, Huawei initiated an OpenStack project to provide users with data protection orchestration — or, Data Protection-as-a-Service (DPaaS) — for applications, VMs, and network resources in the cloud environment. Now called Karbor, this project's software integrates various backup software

packages to provide back-end, enterprise-grade backup and recovery capabilities.

The Next Stage

Financial institutions need to provide users with mobile Apps and services designed to support distributed deployment and are extremely fast and offer flexible scalability. Furthermore, these institutions must consider the construction of platform capabilities based on Infrastructure-as-a-Service (IaaS) so they can introduce quicker iteration capabilities to the full App lifecycle (development, testing, releases, and upgrades).

Huawei calls this stage Financial Cloud 3.0, where the container-driven, lightweight Platform-as-a-Service (PaaS) model is a key technology. PaaS is especially applicable to newly constructed cloud native application systems. In addition to supporting physical and virtual resources, IT infrastructure resource pools must support unified deployment and management of container resources.

Based on the industry's mainstream open-source architectures, such as Docker and K8S, Huawei's Financial Cloud solution provides a number of enhancements and advanced functions that fully leverage the advantages of lightweight containers. In the development and testing environments of banks, the solution has improved the application deployment density by four times and reduces the amount of time taken to deploy individual applications from minutes to seconds.

For financial institutions that must release version updates periodically, this functionality is especially useful in the development and testing period. Additionally, Huawei offers the FusionStage PaaS platform, which gives enterprises a complete environment for App development, deployment, operation, and management. This open architecture provides a wide range of middleware services, including those for Big Data and the IoT as well as application components specific to different types of enterprises. FusionStage supports mainstream development languages and protocols, and allows customers to deploy millions of containers as well as new microservices in less than a minute.



The Huawei Financial Cloud solution allows users to combine their own private clouds with managed cloud services to implement unified management and service-oriented utilization of their own and third-party data assets and resources.>>

Huawei has implemented container-based I and P layers to implement full-process automation of IBM WebSphere® Application Server (WAS) Apps across regions and data centers, improving IT resource utilization and service agility. By introducing distributed Server Load Balancers (SLBs) that support the gray release function, Huawei has achieved access for global routes.

Unified Asset and Resource Management

The Huawei Financial Cloud solution uses a cloud platform architecture to manage self-help service directories and resource pools for web and App resources, transaction data, Big Data analytics, and virtual desktop infrastructure. The solution allows users to combine their own private clouds with managed cloud services to implement unified management and service-oriented utilization of their own and third-party data assets and resources.

The solution also enables the implementation of financial IT infrastructure platforms that support smooth evolution based on IaaS and PaaS resources provided by private clouds. Huawei's solution includes reliable hardware, a cloud operating system, cloud management platform, and PaaS platform. At the same time, the solution's open-source architectures and standard Application Program Interfaces (APIs) support third-party PaaS and are compatible with native standard northbound and southbound interfaces.

Thanks to ecosystem-friendly features, Huawei's solution has attracted contributions and support from more than 150 financial software vendors globally, including India's Infosys, France's Sopra Banking Software, and China's Yucheng Technologies and ChinaSoft International. These firms collaborate with Huawei to develop innovative applications and provide leading solutions to over 300 financial customers worldwide. ▲



Jarrett Potts

A Small, Smart City with Big Plans

| By Jarrett Potts, Worldwide Director of Sales and Marketing, Enterprise Business Group, Huawei Technologies Co., Ltd.

In cooperation with GELSEN-NET and Huawei, the city of Gelsenkirchen, Germany developed a model 'Safe City' solution. >>

Gelsenkirchen, a city in northwest Germany, has big plans to increase the quality of life for its citizens. First, it worked to improve air quality as required in Germany's 1991 Renewable Energy Sources Act. Widely known for massive coal production — and smoggy skies — since the beginning of the Industrial Revolution, the city now focuses on 'green energy' to improve the climate and help Germany lead the world in the production of renewable energy. Today, Germany's largest solar power plant is located in Gelsenkirchen, and two wind energy plants recently started producing CO₂-free electricity. This technology is also creating new jobs.

But the city wanted more for its citizens: A city-wide security platform that would unite local businesses, city officials, and law enforcement to maximize safety, minimize theft and other crimes, and provide future city services. They also wanted to set an example for all other cities in Germany to use digital technology in innovative ways.

Vision for a 'Smart City'

To do this, Gelsenkirchen had to think big: What did they want their city to be like in the future, and how would they achieve this vision? They also needed to figure out how to deal with their existing infrastructure.

Authorities in Gelsenkirchen realized that Information and Communications Technology (ICT) is changing the way we live and cities operate. The city needed a comprehensive system featuring top-level design, integration, operations, service applications, and a new ICT infrastructure. Gelsenkirchen wanted to converge key data from city operations and management systems so managers could intelligently respond to a variety of governance, livelihood, and business needs.

Gelsenkirchen decided to partner with Huawei and a regional technology services provider, GELSEN-NET, to implement the country's first Safe City solution.

Huawei and GELSEN-NET

Huawei's Smart City solution incorporates cloud, network, and platform technologies, along with robust security. The solution is safeguarded with physical, network, host, virtualization, application, and data

security mechanisms, and is supported by proprietary chipsets and source code.

GELSEN-NET, founded in 1983 as a regional German phone service provider, today offers the latest ICT services to over 72,000 residential and business customers. Recently, the company added extensive cloud services to its IT offerings, providing local businesses with external hosting, access to scalable storage, and cloud-based disaster recovery.

Fast, open exchange of data is key to building better cities, so Huawei and GELSEN-NET worked together to provide a secure cloud data center based on an open architecture. They also developed open, customer-centric solutions and built a sustainable ICT ecosystem. The cloud data center integrates and shares city information resources to improve government service efficiency and decision-making accuracy.

Smart City Features

With Huawei's wired and wireless broadband networks and the Internet of Things (IoT), ubiquitous broadband coverage places services at the public's fingertips.

The Huawei and GELSEN-NET IoT network accommodates data services for new industry applications with a lightweight IoT operating system, LiteOS, and a wide range of access gateways. Huawei is also a major contributor to Narrowband IoT (NB-IoT) standards organizations and brings those advances to bear on its Safe City infrastructure.

The two companies provided the town with an ICT capability disclosure platform for encapsulated, packaged ICT capabilities that enable developers from



any third-party company to make open interfaces and develop integrated Smart City service applications. A Big Data support platform was also provided in order to share historical and real-time city data with all agencies.

An application enablement platform combines Huawei applications (Big Data analysis, security management, and video processing) with third-party applications, such as a Geographic Information System (GIS), public services, unified identification, and Single Sign-On (SSO). The result is a faster exchange of data resources, new software, and improved Operations and Maintenance (O&M) for Smart City applications.

The New Gelsenkirchen

An extensive 13,000-kilometer, fiber-optic cable network connects all industrial parks, hospitals, and schools as part of the Gelsenkirchen Smart City solution. Some 40,000 customers use existing Internet service, while 50,000 users take advantage of the new public Wi-Fi. Comprehensive Wi-Fi covers a pedestrian zone and two city centers. Free coverage is also available on public transport and in the city zoo — *ZOOM Erlebniswelt Gelsenkirchen* — one of the most modern zoos in Germany.

GELSEN-NET also provides mobile hotspots that integrate public transport in the Smart City. One example is the transport company Bochum-Gelsenkirchen Streetcars Corporation (BOGESTRA) that offers free onboard Wi-Fi to passengers in its PowerBus. A mobile eLTE access point in the bus supplies passengers with unlimited access to the Internet via a fast broadband connection. The technical solution for the bus was developed in cooperation with Huawei.

So far, 240 access points are available in the Gelsenkirchen city zone. “We look forward to establishing Gelsenkirchen as a pioneer for a

future-oriented, networked city,” said Thomas Dettenberg, CEO, GELSEN-NET. A large, free-of-charge Wi-Fi hotspot area covers two kilometers of the Bahnhofstrasse, Gelsenkirchen’s main street. This innovation won the city of Gelsenkirchen the *2016 Smart City Award* from Huawei.

Developments in Gelsenkirchen are perfect examples of what the other cities in Germany are aspiring to provide. The Gelsenkirchen solution helps improve the everyday life of citizens and businesses in the city and could be used in any city worldwide. Huawei and GELSEN-NET offer innovative solutions for Smart City applications that include free-of-charge Wi-Fi access in public spaces, Internet access on buses, and better coordination between security and emergency agencies.

“Huawei has developed one of the most advanced Smart City solutions in Germany,” said Hans Hallitzky, Deputy Sales Director at Huawei. “Using Smart City communications, Gelsenkirchen is able to offer its citizens a wealth of new services in the Schalke 04 football stadium and the zoo. Also, the connectivity of schools plus new safety technology make life more attractive and are promoting the influx of new residents and companies.”

A Promising Future for Tomorrow’s Safest Cities

According to the United Nations, over 85 percent of the world’s population will likely live in a city by the end of the 21st century. With such a large number of people in these cities, governments will struggle to provide essential services. While future Smart Cities are unlikely to look much different than cities of today, they are destined to interact differently with their human inhabitants. Gelsenkirchen is on the cutting edge of what any city of tomorrow could look like. ▲



Developments in Gelsenkirchen are perfect examples of what the other cities in Germany are aspiring to provide. The Gelsenkirchen solution helps improve the everyday life of citizens and businesses in the city and could be used in any city worldwide. >>



Ehud Langberg



Sean Chen

Blockchains in Mobile Networks

| By Ehud Langberg, Strategic Planning and Business Development, Wireless Access Department, and Sean Chen, Senior Director, Wireless Software Competence Center, Huawei Technologies Co., Ltd.

Blockchains are a Distributed Ledger Technology (DLT) with the potential to disrupt many industries by enabling open and trusted exchanges over the Internet without using central servers or an independent trusted authority. Blockchains facilitate transparent, verifiable, and secure digital asset transactions with proof of rights and ownership.

Based on cryptography-driven consensus building, blockchains use a decentralized database and peer-to-peer computing nodes to offer equal incentives for conducting transactions over a secure, trusted layer. In 2008, a blockchain was first used to introduce Bitcoin, an electronic payment network, and is now emerging as the underlying technology to power a new 'Internet-of-value' paradigm.

Each digital ledger block contains a timestamp and a link to a previous block. Units of value go from owner A to owner B via network nodes that track account balances. Ownership is verified through links to all previous transactions. Each node records all transactions. Authentication is achieved by consensus, and trust is generated by the transparent and auditable flow of information.

By storing information in multiple cryptographically validated ledger copies across a network, blockchains eliminate single points of failure, hacking attacks, or control by any single entity. Compromising an entire

global network is difficult because the historical transaction data is embedded within multiple nodes.

Opportunities for Mobile Carriers

Blockchain technology offers mobile carriers superb opportunities to support the transformation of business models through new network layers, which can revolutionize how data integrity is verified and value and rights are transmitted and/or tracked over the infrastructure to subscribers.

Tier 1 mobile carriers are likely to create new blockchain partnerships with universal digital ledgers to improve industry-wide interoperability. This will control costs, provide wide coverage, and effectively redefine the intermediary role of many industries.

A number of blockchain projects are based on concepts well aligned with the goals of specific 5G architectures, ranging from distributed systems and databases to low-latency/high-performance distributed computing nodes. Adding blockchains to old and new

By transporting valuable digital assets over mobile networks in a secure and transparent framework, blockchains can speed the growth of the digital economy, deliver new services, and enhance user experiences. >>





Mobile networks can be critical in blockchain success. The carriers that step up will generate momentum for blockchain integration by tackling new use cases to enhance the digital experience of their subscribers. >>

distributed systems can make operations more secure, autonomous, flexible, and profitable. Network protocols and infrastructures will need to address the network timing requirements of blockchain-based applications, scale to support millions of nodes, and ensure that transactions are reaching all participating peers. Each transaction over the mobile network must be digitally signed to ensure authenticity. By enabling mobile network elements to be exchanged dynamically, blockchains can encourage mobile network growth by enabling a market for access rights to other network resources.

Mobile carriers are well positioned to offer a ‘blockchain-as-a-service’ ecosystem for content providers, who could store their offerings throughout the mobile network and use the blockchain infrastructure for access control and monetization. Smart contracts will protect copyrights, automate the sale of content online, and eliminate the risk of copying and content redistribution by hackers. In addition, blockchains provide for variable, demand-based pricing of content through automated discovery

Keys to Adoption

Mobile networks can be critical in blockchain success. The carriers that step up will generate momentum for blockchain integration by tackling new use cases to enhance the digital experience of their subscribers.

With significant technical barriers to entry, moving blockchains beyond the proof-of-concept stage will require major industry players able to support many types of use cases over the public network to work in collaboration with private entities and government regulators that represent the legal systems of different states, provinces, and countries.

Service providers can offer low-cost, low-risk, blockchain-service platforms to various developers. The core strategy must be the installation of new infrastructure components to support the deployment of blockchain frameworks that are then backed by network and distributed cloud computing platforms. Mobile carriers will own and support the backend blockchain that application developers can utilize to create new trust and transaction applications.

Many large industry players are competing for control in the IoT space, investing in blockchain

technologies with a focus on security, encryption, and smart contract innovations. To compete, mobile carriers need to offer blockchain frameworks that leverage the IoT, Big Data, content delivery, and digital identity.

Mobile carriers must look beyond simply extending the connectivity of existing telecom infrastructure. They need to create value, authenticate digital information, and execute smart contracts that are supported by market analytics, predictive maintenance, and the mass-scale automation of management applications and services. Smart IoT contracts will allow the automation of remote IoT-based systems and facilitate the autonomous exchange of data and value among devices and virtual or physical objects over the network.

For the next wave of technology, industry players need to design a global network of computing nodes for validating and relaying blockchain transactions. This network must:

- Allow secured nodes to join the network voluntarily to manage the database and provide incentives to participate in the computation.
- Feature speed, volume, and low latency.
- Duplicate ledgers across thousands of servers and perform regular updates and reconciliation.

Blockchains will be integrated with Artificial Intelligence (AI) and behavioral analytics, enabling infrastructure providers to obtain insight from the transactions.

Blockchain Uses in Mobile Networks

• IoT

Today, IoT connections must scale up to secure billions of interactions among machines and sensors. This results in network slowdowns and higher costs. Without managing microtransactions and settling payments, billions of daily transactions will engulf traditional financial services.

The integrity of the data exchanged among billions of IoT devices is ensured using blockchain’s decentralized approach. Trusted communications between peer-to-peer devices (distributed file sharing and autonomous device coordination) will increase system throughput and cut costs.

Smart contracts will automate IoT devices and objects, and guarantee secured access to trusted IoT



Blockchains can assist in 5G wireless access technology deployments by providing seamless access across a diverse number of networks to devices and IoT endpoints. Improved internal processes, such as OSS and BSS, will reduce costs and increase competitiveness.
 >>

data. Each blockchain can be addressed directly to allow for registration and control.

- **Smart City**

Blockchains enable transparent, safe, and reliable transaction infrastructures that speed up digital services by connecting trusted peers with municipal stakeholders.

Smart contracts will make value-added services more secure, private, autonomous, and anonymous; they will increase efficiency and resource sharing. Open data and verifiable integrity allow multiple parties levels of transparency that simplify joint operations and maintenance with increased and unifying trust. Further, the marketplace can now decide new city services monetization.

For enhanced protection against cyber attacks and fraud, blockchains help authenticate device identity, protect sensory data used in transportation, and manage access to city facilities.

Smart City-driven shared economies will include collaborative ownership and maximize urban asset uses. For instance, blockchains can record solar energy production for purchasing excess renewable energy credits. Electricity can be generated locally and transferred to neighbors or by selling back to the grid.

Linking smart contracts with IoT applications will further increase new service launches. Smart devices and real-time data will help users make choices that facilitate:

- Autonomous negotiations between car sensors and traffic data for charging fees instantly to driver accounts.
- Reduced carbon footprints by taxing cars for pollution and other metrics.
- Monitoring environmental conditions and generating data for sale.
- Reduced insurance rates based on authenticated maintenance and safety records.
- Discovery and data mining across devices for cryptographically protected automated neighborhood surveys.

5G architecture and IoT connectivity are primary Smart City initiatives, allowing mobile carriers to supply blockchain solutions based on wireless infrastructure. Other critical innovations may include:

cryptocurrency, zero-factor authentication, application fault tolerance, consensus network protocols, Peer-to-Peer (P2P) autonomous protocols, and private and public smart contract frameworks.

- **5G Service Enablement**

In place of the current and aging cellular system, a blockchain framework will assist a new generation of distributed wireless networks by allowing seamless provisioning between heterogeneous access nodes and devices. With blockchains, provisions and agreements between access nodes, networks, and subscribers are negotiated on-the-fly as digital smart contracts. Any device can negotiate the best service, and the carrier can dynamically adjust the code in the smart contract in any network node. This permits seamless services and new charging and business models among networks, providers, and 5G access nodes. Blockchain-enabled mobile services can be adapted to location and subscriber needs, and adjusted to supply and demand.

Blockchains can assist in 5G wireless access technology deployments by providing seamless access across a diverse number of networks to devices and IoT endpoints. Improved internal processes, such as Operational Support Systems (OSS) and Business Support Systems (BSS), will reduce costs and increase competitiveness.

Networks will be flattened and latency reduced by delegating OSS and BSS functions to the edge using distributed P2P negotiation.

- **Content Distribution**

For large content delivery providers such as Netflix, placing secured content closer to users via a platform running on blockchain technology will let creators upload content and transfer it ‘similarly to Bitcoin.’ This would create an open marketplace for content trading and consumption by all with access. Privacy tools will enable users to manage and resell data to which they have acquired rights.

Content providers can decide on the specifics of applying digital rights management to their assets. Also, decentralized storage protects against hacking or lost data, accelerates data transfer, and minimizes streaming time.

- **Integrity Protection**

Two shortcomings of traditional public key cryptogra-

phy are the possible compromise of private keys and the expense of signature verification. Blockchain-based Keyless Signature Infrastructures (KSIs) deliver scalable, signature-based authentication of digital data. KSIs are fast, efficient, and scalable.

- **Cloud Computing**

A decentralized mobile cloud solution can permit users to allocate portions of their processing assets. This allows cloud applications to be protected and encrypted.

- **Dynamic Sharing**

Blockchain's dynamic sharing functions offer:

- **Simplified authentication:** Open standard authorization protocols can be applied to any or all parts of the mobile network.

- **Billing, invoicing, and other transactions:** Blockchain cryptography protects information and creates a fully recorded transaction audit trail.

- **Roaming connection management:** This method manages roaming connections globally.

- **Shared network infrastructure and spectrum:** Network carriers can dynamically transfer infrastructure elements among themselves or other parties on demand via

secure, auditable transactions.

- **Mobile money:** This currency relies on blockchain.

- **Recordkeeping:** This step can protect public records from fraud.

Blockchains and Beyond

Blockchains can transform the digital economy and enable organizations to meet their goals for open and trusted exchanges over mobile networks. Mobile operators can leverage the development of 5G and blockchain technologies to deliver a broad range of new services. Verizon is the first U.S. operator to provide access rights to digital content based on subscription type. Rights are transferred by keys that migrate content to new users — who can define new keys to protect the information.

Recently submitted patents reveal that Verizon has experimented with blockchain technology as a digital rights management platform for sensitive data storage.

A second wave of blockchain advances is from the open source community. These innovations are leading to new ventures, such as Swarm and Enigma, and other decentralized platforms and applications.

Furthermore, newcomers with cutting-edge blockchain technologies are addressing verticals like transportation (LaZooz), social networking (Synereo), and cloud storage (Storj.io).

Corporate Interest

Blockchain's potential is being explored by new startups in partnership with large institutions to offer a range of applications — including digital rights, trading platforms, and alternative digital currencies. Anticipating a growing demand for such products and services, U.S. venture capital funding has increased from USD 1 million in 2012 to over USD 300 million in 2016.

Major IT players, such as Microsoft and IBM, are enabling enterprises to set up blockchain infrastructures on cloud platforms. However, a number of blockchain adoption barriers must be overcome, and proven solutions will take time. This leaves room for vendors such as Huawei to provide solutions based on 5G infrastructures. ▲

Contributions from Debashis Bhattacharya, Director, Platform Software, and Zhibi Wang, Senior Engineer

Link: Blockchains, Smart Contracts, and the Shared Economy

Anything of value moved over the network can be recorded and validated by a blockchain ledger, including digital content and the electronic tracking of physical goods and services. From a user perspective, blockchains can have the appearance of an advanced distributed operating system.

Smart contract software that runs on the blockchain layer is executed by the entire network. At its core is a common ruleset that is evaluated autonomously to agree upon common standards. Many people expect 2017 to be a breakout year for increased use of smart contracts. These contracts can change how digital transactions are handled by creating a more collaborative economy, improving the efficiency of how value is exchanged across physical and cultural boundaries, and executing complex multi-party agreements. Existing enterprises that embrace blockchain technology will be well positioned to provide customized and transparent transaction-validation services.

Blockchain may have a big impact on the 'shared economy' concept as users will be able to reach and record transaction agreements without a controlling authority. Service suppliers could collaborate and deliver more value directly to customers by bypassing service aggregators and intermediaries.



Chen Cailin

A Maturing 'Power IoT' Market

| By *Chen Cailin, General Director, Energy Solutions, Enterprise Business Group, Huawei Technologies Co., Ltd.*

As the momentum of ICT continues to impact the electric power industry, the 'Power Internet of Things' will reshape future smart grids by enabling bidirectional communications between generation and transmission facilities, information systems, and end-user services. >>

'Power Internet of Things (IoT)' is a networked system that uses new Information and Communications Technology (ICT) and sensor innovations to sense, characterize, connect, and manage the status of grid infrastructures — including individual customer and environmental effects. Power IoT integrates information-sensing devices and communications networks to form physical entities capable of self-identification, proactive sensing, and intelligent processing. Through collaboration and interaction between intelligent endpoints, related objects are being built to provide real-time and near real-time control-related information. The result is a smarter, more reliable, and more easily maintained electricity production and consumption system.

Power IoT Ecosystem Advances

The rapid rise in distributed energy sources has accelerated a need for the electric power industry to integrate ICT into its technical systems. The future markets for power consumption will be stimulated by converging the roles of electricity producers and consumers. Undoubtedly, Power IoT will contribute to all aspects of modernizing smart grids. These advances will update the entire ecosystem by merging the metering systems for electricity, water, gas, air conditioning, and heat. Transmission loads will be automatically monitored and adjusted based on line status and demand. Smart power distribution and consumption applications will permit connections with new energy sources and fundamentally alter the business of selling electricity.

- **Terminals: More Availability of Products and Solutions**

Grid companies worldwide are exploring how Power IoT applications will become part of their plans to construct converged smart grids and communications. The State Grid Corporation of China has carried out such experiments. In one example, a smart community program has conducted a trial that uses a 'smart socket + wireless networking' method for managing the power consumption of household appliances.

Another example uses real-time monitoring via self-organizing wireless network technology in high voltage substations to deactivate faulty equipment due to changes in environmental conditions. Further, broadband carrier chips developed by Huawei's HiSilicon semiconductor subsidiary are specially designed to handle the complicated environmental conditions for transmitting data over high-voltage power circuits.

- **Gateways: Converged Access Becomes the Norm**

Rapid progress in ICT, sensor, and control innovations has raised the requirements for front-end signal processing. This change is the result of improvements in the integration between sensors and controllers, and has improved the compatibility across multiple data transmission methods. The improved compatibility illustrates the continuing industry-wide effort to combine information processing with intelligent feedback. In this context, the communications gateways that support multiple Radio Access Technologies (RATs) have become the best choice for processing front-end signals, and the further convergence of related technologies is the leading trend for future development.

Smart, converged gateways are understood to be the platforms for various sectors of the electricity generation industry to consolidate the communications interfaces and access protocols for delivering end-to-end systems and services. Multi-RAT gateways support custom applications over a diverse area, including security monitoring, production control, user interaction, and asset management. Augmented reality technologies that assist production control, remote inspection, and maintenance are becoming popular for comprehensive monitoring of transmission lines and substation environments. Converged gateways support user interactions through Advanced Metering Infrastructures (AMIs). Improved asset management tools use converged gateways for full lifecycle equipment management and warehouse supervision activities. Thanks to these enhancements, converged gateways will become a primary feature of Power IoT.



- **Communications: No Unified Standards on the Horizon — Yet**
Several communications technologies are available for the IoT, including IPv6 + MESH, Long Range (LoRa), and Narrowband IoT (NB-IoT). Faced with an evolving range of technologies, decision makers must choose the most suitable resources for their Power IoT installations. Although vendors are stepping up their R&D efforts and delivering products on an increasingly large scale, no technology is capable of fulfilling all industry requirements. The NB-IoT technologies that utilize licensed frequencies versus the LoRa products that operate over non-licensed frequencies is one such example of the strength of the Power IoT network-layer market. Both NB-IoT and LoRa solutions are expected to co-exist.

- **Applications: The Trend of New ICT**
Power companies are integrating cloud computing into their power systems to ensure reliability, visualize scheduling and maintenance, and improve internal networks. By combining cloud computing with Big Data analytics on smart grids, power companies are optimizing the processes of data collection, storage, and transmission of power system status during power generation, distribution, and consumption. ICT platforms are critical to fulfilling business goals that rely on intelligent data collection, automated production, and information-enabled management.

For example, power companies are using the intelligent cloud to divide the huge computing loads of their power systems into smaller blocks. Multiple servers are processing large quantities of information in the shortest possible time. By using cloud com-

puting and Big Data analytics, power companies have insight into vast data collections sourced in real time from intelligent terminals throughout their grid monitoring systems. Big Data analytics are combined with power system models to diagnose, optimize, and predict the operating status of transmission grids to ensure security reliability, and the most economical grid operations.

ICT advances are empowering electricity distribution companies to explore the full market potential of collected Big Data. There are estimates that the global market for Big Data-based electricity management systems will reach USD 3.8 billion by 2020. As a result, companies engaged in electricity data collection, management, and analytics expect unprecedented development opportunities.

Accelerating Technology Standardization for Power IoT

The process of defining international standards for Power IoT technology is gaining momentum. The NB-IoT standards established in June 2016 have created a foundation for large-scale commercial deployments. This means that 2017 is anticipated to be ‘Year One’ for commercial NB-IoT networks. Additionally, Huawei’s broadband data over power line technology was officially certified as IEEE P1901.1 compliant in September 2016.

Power IoT standardization is receiving particular attention from countries and organizations that wish to see greater cooperation across the IoT industry as a whole. These efforts are promoting the interweaving of R&D and the definition of standards throughout the Power IoT industry by focusing on the improved utilization



As ICT, sensor, and energy storage expansion continues to shape the future of Power IoT, industry standardization is creating a solid foundation for the healthy development of the entire ecosystem. >>

of resources while providing advantages to members of the industry chain. The net effect is acceleration in the overall growth of the Power IoT ecosystem.

Advancing the ICT Industry with Power IoT

Smart grids are a powerful driver for the further development of the IoT industry. The positive results of innovation are having an impact on the long-term planning goals in the areas of industrial manufacturing, production operations, and the details of everyday life.

Looking ahead, disruptive cloud computing and Big Data technologies based on converged communications gateways with edge computing will see widespread use.

For medium- and high-voltage power systems, the digitalization of substations, transmission lines, and switching networks will continue to generate vast quantities of data that call for the deployment of more reliable industrial communications technologies that will be based on Ethernet over optical and wireless circuits.

As ICT, sensor, and energy storage expansion continues to shape the future of Power IoT, industry standardization is creating a solid foundation for the healthy development of the entire ecosystem. Going forward, Huawei will maintain cooperation with its partners and customers to promote innovations in Power IoT with advances that add value throughout the industry. ▲



Wu Qi



Qiu Jing



Yu Jing

Three Steps to Digital Transformation

| By *Wu Qi, Deputy Geographic Unit and Country Managing Director; Qiu Jing, Research Manager, Accenture Institute for High Performance; and Yu Jing, Research Specialist, Accenture Greater China*

As the global economy enters a ‘new normal,’ countries must urgently find new means of growth, for which digitalization is an extremely effective new driver. In China, for instance, it is estimated that by 2020, digitalization will generate 3.7 percent growth for the Chinese Gross Domestic Product (GDP). Such an impressive scale of growth is expected to a lesser extent in other developed economies, including the U.S., U.K., and Japan, as well as developing economies like Brazil.

Despite the alluring prospect offered by digitalization, companies seem to hesitate before investing in this gold mine. In an survey of global companies in 32 countries, Chinese CEOs ranked only 26th in terms of their enthusiasm to invest further in IT.

Hindering the Pace of Digital Transformation

‘Not knowing what to do’ is the biggest problem mentioned by these business leaders. Of the enterprises that are ‘crossing the river by feeling the stones’ or reforming step by step, some just perceive digitalization as a simple technical project that is of interest to them when they try to introduce information technologies to improve the control of production processes. Some companies even take a simplistic view that equates digitalization with the construction of online business channels and eCommerce.

Such an unexamined start often ends well below the expected return, which, consequently, discourages businesses from making continuous investments in digitalization. To seize the enormous potential of

digitalization, enterprises must take a three-step approach to planning digital transformation.

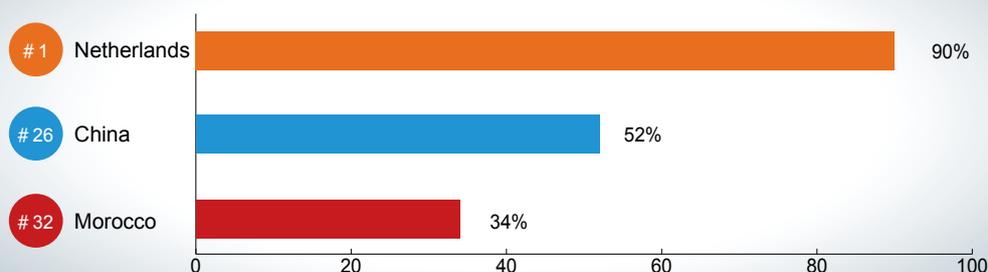
Step 1: Develop Objectives

Have a clear understanding of the necessity and objectives of digitalization. In this stage, company leaders need to conduct a comprehensive analysis of many factors, including the development trends of technologies, industries, and consumption, and then define the company’s optimal objectives for digitalization.

One major objective is to enhance operational efficiency; another is to increase revenues. The former focuses on the use of digital technologies to optimize processes and improve business agility. The latter emphasizes digital technologies to build new sources of revenues; for example, using new technologies to improve the consumer experience and develop new pricing modes. As an example, Walmart established a goal of creating digital campaigns to improve marketing accuracy. The U.S. retailer set up a new search engine based on innovation and algorithm optimiza-

To seize the enormous potential of digitalization, enterprises must carry out meticulous planning and effective implementation, and begin their journey into digital transformation guided by a three-step approach. >>

Global ranking of enterprises planning to increase IT investments (32 countries over the next 12 months)



Source: Accenture Analysis

Global ranking of enthusiasm for IT investment



To sustain operations of its digital business models, a truly digitized company needs a corporate culture that encourages faster adaptation to change, higher levels of collaborative cooperation, and a stronger willingness to accept risks.>>

tion that enables the company to push the most relevant merchandise to consumers by analyzing their search history and social patterns. This search engine has brought a 10 to 15 percent increase in trading volume for Walmart.

Step 2: Take Initiatives

Once enterprises have defined clear objectives, they must start a more profound process of internal evolution in which they will undergo changes from mindsets to capabilities.

Companies need to increase their company-wide recognition of the significance of digital transformation and establish a ‘digital way of thinking’ to help make changes. These include a mindset change from self-sufficiency to open cooperation for establishing competitive advantages; a switch from linear development to rapid testing in terms of product design and development (a modification from machine replacement of human beings to human-machine cooperation); and a shift from compulsory compliance to proactive pursuit to support information security.

It is a given that new digital technologies will keep emerging, so companies must make informed decisions on creating digital businesses and winning over digital consumers.

To develop into digital businesses, enterprises should make use of the Industrial Internet of Things (IIoT), Artificial Intelligence (AI), agile innovation, and other digital technologies to upgrade their operations so they can improve their internal operating efficiency.

To win digital consumers, enterprises need to get rid of the long-accepted, conventional, product-driven development approach. Companies must truly understand customers’ explicit and implicit demands so they will be able to provide solutions and

user experiences that are closely related to the personalized needs of their customers. For example, a Japanese convenience chain collected and analyzed data from 40 million loyal customers around the world to optimize its marketing investment programs and improve shelf space allocation and utilization. This initiative brought a net profit of USD 1.24 million (CNY 8.5 million) from an annual revenue growth of more than USD 125 million (CNY 858.5 million).

Step 3: Maximize Results

Eventually, enterprises must associate their digital transformation initiatives with sustainable digital business models, as well as operating models that will support the successful operation of these models.

To establish a sustainable business model, companies have to identify and integrate digital resources within the ecosystem to provide customers with differentiated value propositions. For example, consumers want to enjoy the most cutting-edge product features within a reasonable price range for the best user experience. Therefore, successful digitized companies need to identify the best resources in their own value chain and integrate them into their asset allocation systems. In this context, profit maximization is no longer the goal of a single company but the goal of a group in the value chain — consumers, upstream

suppliers, downstream distributors, and others. Participants in this enterprise ecosystem actively work together in different ways to provide products or services collectively that will cost-effectively deliver the best user experiences.

To sustain operations of its digital business models, a truly digitized company needs a corporate culture that encourages faster adaptation to change, higher levels of collaborative cooperation, and a stronger willingness to accept risks. First, companies must form a collaborative atmosphere within teams that encourage parties to resolve problems more quickly and, second, encourage innovative ways to approach work that form new sets of employee behaviors. General Electric (GE), as an example, released Predix, an operating system for the IIoT, to attract more talented people to participate in the development of IIoT programs. In 2015, more than 4,000 engineers developed over 500,000 software programs and applications on this platform.

Empowering Enterprise Digitalization

As enterprises continue to undergo a profound digital revolution, they must be aware that digital transformation cannot be achieved overnight and that they have to implement systematic, long-term planning, a clear definition of their objectives for digital transformation, and effective implementation. Specifically, enterprises need to enhance the recognition of digital transformation from within their organization and encourage digital thinking and capabilities.

Digital transformation must become the top priority of each enterprise. Those companies that quickly leverage the power of digitalization will become the most vital and competitive businesses within their respective markets. ▲



Jim Zemlin

Open Source Powers the Global Economy

| By Jim Zemlin, Executive Director, Linux Foundation

No single company has the resources to create its own software, get it to market in time, and still compete. The result is that top global technology companies are leveraging open source software development for their future. >>

In an incredibly short time, Huawei has transformed from one of the world's largest equipment makers to one of the largest ICT software solutions companies. How was Huawei able to achieve this so quickly? The answer lies in one key insight: In a world powered by software — whether for Software-Defined Networking (SDN), Network Functions Virtualization (NFV), cloud computing, or the Internet of Things (IoT) — there is simply too much software to be developed.

The Linux Foundation is working with thousands of organizations, including Huawei, to build the greatest shared technology asset in the history of the world. The Linux platform — worth billions of dollars — literally runs modern society.

Linux operates the vast majority of the world's stock markets, holds the majority share in the mobile device and embedded systems industries, and runs virtually all high-performance computing systems. By far the most successful software endeavor to date, it is not just the scope of the organization but the velocity at which it continues to accelerate: Each day, a Linux project adds an average of 10,800 lines of code, subtracts 5,300 lines of code, and modifies 1,800 lines of code — a daily net gain of 7,300 lines of new or modified code.

The Transformation to Open Source

Open source is here to stay. Today, more than 3.8

million open source contributors have created 31 billion lines of code across a wide variety of publicly available repositories. Billions of dollars have been and continue to be invested in open technology-based companies. In Silicon Valley alone, investors are backing hundreds of companies, 10 of which are worth over a billion dollars each. This is an amazing transformation — from a world where technology companies built everything themselves to one where they can no longer compete using that model.

The first generation of open source was much simpler: to create free alternatives of existing proprietary technologies. Whether operating systems (Linux) or databases (MySQL), these free alternatives shrunk the legacy markets. Today, however, that has all changed. We have entered a new era of open source development.

Open source ecosystems now make it possible to open new markets and create new opportunities.





Huawei is a top contributor to the open source movement. In addition to the Hadoop project, Huawei is a founding member of and top contributor to the Cloud Native Computing Foundation and a top-four contributor to Spark. >>

Emerging ecosystems include the Hadoop Big Data frameworks as well as container cloud technologies that have produced the Kubernetes and Docker projects. It is fair to argue that the future of all cloud technology lies with open source software.

At virtually every layer of the software stack, an open source project leads in innovation, developer adoption, and pace of development. These benefits are found in every aspect of the ecosystem, from the lowest layers of data plane services (Open vSwitch) to high in the management stack with Open Orchestrator (OPEN-O).

Huawei and China Mobile announced their OPEN-O project at the *2016 Mobile World Congress* in Barcelona, Spain. At this event, China Mobile said their future Operational Support System (OSS) will be based on three different open source JavaScript frameworks, including server-side JavaScript, the world's fastest-growing web technology platform.

The total effect is a form of organic innovation — a kind of natural selection with thousands of companies and tens of thousands of developers competing for who can develop the best code. The aim of the Linux Foundation, which hosts most of these projects, is to accelerate innovation up and down the stack in order to create more secure and stable software for everyone.

The foundation is working with more than 20 of the top technology companies, including Intel and Huawei, on initiatives to teach open source developers to write more secure software, perform better threat modeling and testing, and create stronger, more responsible disclosure policies. More secure code means less vulnerability when the finished software is deployed in commercial products.

Creating Exceptional Ecosystems

The Linux Foundation is organized to enable all of these open source projects to create exceptional ecosystems that accelerate scaling. The companies that invest in open source projects recognize that software code and intellectual property assets will be freely available for decades to come. A core foundation activity is to speed the development of

open source by teaching thousands of organizations how to manage their intellectual property in an industry based on software assets. The successful companies are those that learn how to manage open source licenses, patent commitments, and other aspects of sharing intellectual property while protecting valuable assets.

Finally, the Linux Foundation works with companies like Huawei to create training and certification programs to ensure that, as the pace of open source adoption increases, developers will be available to meet the demand.

A Top Contributor

Huawei is a top contributor to the open source movement. In addition to the Hadoop project, Huawei is a founding member of and top contributor to the Cloud Native Computing Foundation and a top-four contributor to Spark, a fast, general engine for large-scale data processing.

More than five years ago, Huawei decided to take open source seriously. The company created internal groups that specialize in managing open source and devised a strategy to pick the right open source projects for their products. Huawei integrated open source development into their procurement and engineering processes, enabling them to bring code in, modify it, create products, and then share their revisions with the original open source projects. This approach created a beneficial innovation cycle, not just within Huawei but with hundreds of other companies as well. It took considerable effort in planning and training. The results have been effective because Huawei understands, as do all leading technology companies, that we simply need too much software for any single company to develop it alone.

As we all work together to create the greatest shared technology asset in history, not only do we recognize that there is too much code to be written in-house by any single company, we also understand that together we are smarter than any one of us alone. Good companies create products, but great companies create ecosystems based on open source. ▲



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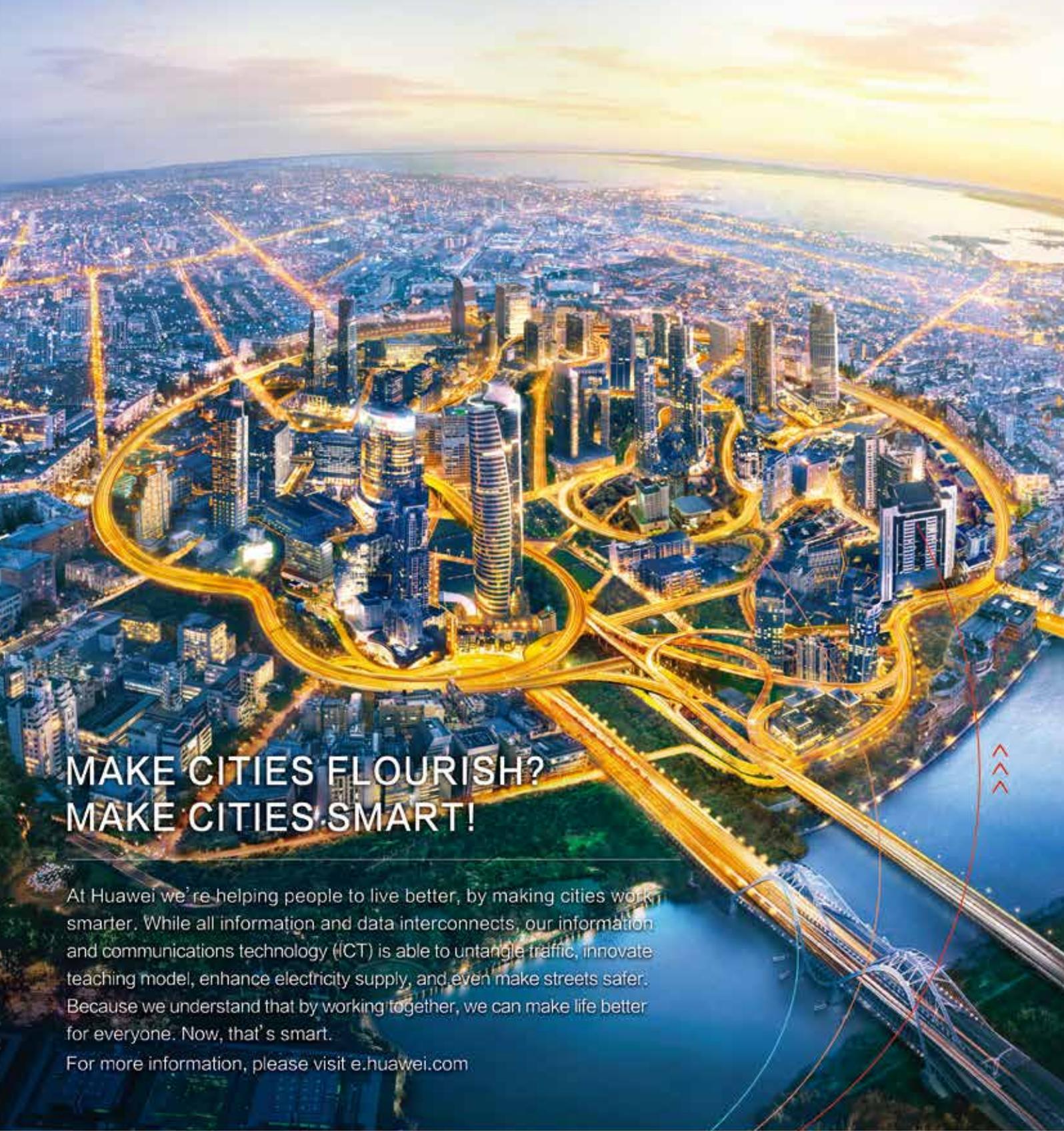
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