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CIOs: Are you ready?

If you'd asked someone ten years ago which executive is the key company decision maker, they'd have probably said the CEO, CTO, or CFO. Few would have thought of the chief information officer (CIO), or even had a clear idea of what one does. Not so today. Digitization is placing CIOs at the vanguard of enterprise strategy, with all the accompanying responsibility and pressures.

Huawei rotating CEO Eric Xu believes we need to redefine the role of CIOs. "I" no longer covers "information" alone – the wave of digital transformation sweeping the globe has brought "innovation" and "interconnection" into the fold. As the main promoters, planners, and drivers of transforming operations and business models, CIOs must be innovators. They must also serve as interconnectors, forming the bridge that links customers, partners, and company employees. Moreover, they must be the leaders of IT architecture cloudification, which is today's definition of "information" in the CIO context.

Digital transformation takes the CIO's role beyond managing internal IT applications. They need foresight and business acumen; they need to fully understand what transformation really means; and they need to understand the tech and how it will change their enterprise.

Otherwise, CIOs won't be able to pin down the Internet model that can sell their company's products and services, develop robust and agile IT strategies that are good for at least five years, or persuade other C-suite execs and senior managers to jump aboard the digital transformation train.

To transform, CIOs must Integrate new IT architecture, develop flexible IT service models, and establish E2E management processes and methods. Externally, they need head up teams dedicated to forging strong partnerships with service providers.

We know that enterprises cannot go digital all in one go and we know that CIOs cannot go it alone. They'll need to work closely with CTOs and put together smooth, user-centric processes. In the future, we might see the CIO and CTO roles replaced by a CTIO (chief technology innovation officer) to drive enterprise development.

But today the burning question is: CIOs, are you ready?

sally

Sally Gao, Editor-in-Chief

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Shape the cloud
Bridge today and tomorrow

Cloud evolution in the enterprise domain shouldn't be isolated. To cross all borders, companies across the planet require a global cloud on a global platform coupled with uniform APIs, architectures, and ecosystems.

By Zheng Yelai, President of IT Product Line, Huawei

Despite the fact that cloud computing is one of the most disruptive technologies to hit the IT industry in the past decade, only 20 percent of enterprise applications run on cloud. Issues like security, data sovereignty, and the availability of enterprise applications are the major reasons for this. Over the next ten years, enterprise cloud transformation will accelerate, with cloudification moving beyond non-

critical services and standardized applications to encompass production systems and business-critical services. By 2025, more than 85 percent of enterprise applications will run on cloud.

Cloud-driven innovation will make enterprises able to make smarter decisions. Automated management, agile innovation, and more open ecosystems will feature strongly in this new dawn for business.

Finding the right enabler

To help enterprises on their journey, Huawei plans to simplify its box devices and make our software platforms more open. Openness yields greater choice, which in turn benefits customers. But, we're not planning to make apps, meaning we will avoid entering the enterprise domain of application systems. We also won't collect or monetize

20%
of applications
run on cloud
now

85%
of applications
will run on cloud
by 2025

Security
Data Sovereignty
Enterprise Application
Compliance
Process

Intelligent Decision
Automatic Management
Agile Innovation
Open Ecosystem

customer data. Why? Because we believe that corporate data is a core business asset and we prioritize data sovereignty and data privacy.

Helping verticals cloudify

Supported by customers and partners, this year saw Huawei's entry into the Challengers quadrant of Gartner's Magic Quadrant for the server market for the first time. We also jumped into the Leaders quadrant for the storage market, ranking first globally for shipment growth. In the software domain, Forrester's Wave report on global private clouds described us as a "strong performer" based on the open architecture of our FusionSphere cloud operating system. Huawei is known in the industry for product innovation, which is attracting increasing numbers of Fortune 500 and high-growth companies as partners.

In the banking sector, Huawei is working with many financial companies, including Industrial and Commercial Bank of China and China Merchants Bank, to promote the application of new technologies like precision marketing and real-time risk control. In the government and public service sector, Huawei has deployed the largest government cloud in Africa and teamed up with EMM in South Africa to build a reliable smart Digital City, ensuring

uninterrupted services 24/7.

In the energy business, we've established a joint innovation center with the world's largest oil company, Saudi Aramco, and deployed a high-performance SAP HANA database system for the Spanish Petroleum Company (CEPSA), dramatically increasing its business performance.

In manufacturing, Huawei deployed a high-performance computing platform (HPC) for Mercedes-Benz to apply in various scenarios, including design simulations and crash simulations for chassis. The HPC platform has enabled the car maker to improve multiple features in its luxury vehicles, ranging from comfort and heat management to aerodynamics.

In the media domain, Huawei's IT products have helped customers meet their service requirements for information gathering, editing, broadcasting, management, and storage. Huawei's storage modules were used at the Rio Olympics, forming a core component of CCTV's production and broadcasting system. Huawei also provided an innovative media solution for French TV during the UEFA European Championship in June and July 2016.

IT clouds improving value

Enterprises' key services can be

automatically deployed by cloudifying the IT infrastructure that enables them. A large bank, for example, could reduce the deployment time of a database from two to four weeks to one day using a bare metal service.

Using incorporated resource pools for general services lets enterprises' original service software continue to work. Jiaxing local government, for example, applied an incorporated resource pool solution to host more than 70 services provided by 23 bureaus, commissions, and offices. Doing so cut costs by 35 percent and slashed administrative approval from 1 month to just 2 days by streamlining the process.

Container technology is a solid choice for IoT and other emerging services that are naturally born in the cloud. Huawei's online mall VMall can experience a jump to 2.4 million concurrent users in seconds, but container technology enables the system design capabilities to support over 100,000 transactions per second.

Having worked closely with customers around the world, Huawei knows that Internet-based services and enterprise service models are very different. First, unlike traditional enterprises, Internet companies don't have large numbers of legacy services and systems. Second, Internet companies' consumer-facing

IT Cloudification Creates New Value

Automation
Bare Metal Service

- 1,000+ Physical Servers
- 100+ Servers/Month Deployment

30 Days > 2 Days
VM Resource Pool

- 23 Bureaus, Commissions, and Offices
- 70+ Services

100 k Trans./sec
Container

5,000 → 2.4 Million Concurrent Users in Seconds

services are free for end users, and standardized user sharing models are widely adopted.

Enterprise IT systems are mainly used to produce high-quality products that are reliable, stable, and secure. Their service types are wide-ranging and their IT systems are complex, contrasting sharply with Internet companies' single service models.

Different service requirements give rise to different types of clouds. In the Internet scenario, the customer must adapt to the cloud; in enterprise scenarios, the cloud must adapt to the customer.

Innovating enterprise applications

Huawei aims to build a single global cloud network with operators and other key partners around the world, complete with uniform APIs,

architectures, and ecosystems.

To help customers transition to cloud architecture and maximize the value they get, we've launched 31 new cloud services in 10 categories. These services include computing, storage, networks, security, data analysis, databases, development and testing, and management services; for example, big data analysis solutions, development and testing for cloud solutions, high-performance computing, storage, and network services for enterprise applications.

These new cloud services showcase Huawei's many innovations in enterprise service scenarios. Solutions include the SAP HANA database cluster, which provides 7 TB memory using a flexible, memory-optimized computing service so Huawei's cloud can run even more SAP applications; a new vGPU virtual machine service for GPU resource sharing, allowing

one GPU card to be virtualized into four vGPUs and raising resource utilization more than 60 percent higher than experienced with a GPU pass-through solution; and a new M-OLAP solution with over five times the data analytics performance of open source SPARK SQL.

Adapting to enterprise scenarios

For key services, Huawei's bare metal service can help customers cloudify their databases and other key services, achieve loss-free database performance equivalent to non-cloud scenarios, and boost the deployment efficiency of Oracle databases by 10 to 30 times.

For development and testing, Huawei's R&D cloud services provide a one-stop development and testing solution that helps enterprises boost R&D efficiency more than tenfold. The convenience and efficiency of

To fully meet enterprise needs, Huawei builds deliverable and operable hybrid cloud solutions and full-stack solutions from hardware and software to services.

Huawei's development and testing cloud has already been verified by over 90 companies in Dalian's Software Park.

For emerging services, Huawei's container service supports deployment of a single cluster of 100,000 containers, with total management capacity of 1 million containers in a group of clusters, currently the highest container management capacity in the industry. These cloud services are built using either Huawei's IaaS platform, FusionSphere, or our PaaS platform, FusionStage.

Supporting enterprise R&D

Huawei FusionStage 2.0 has open architecture and offers a complete development, deployment, and management environment. It also provides a large number of middleware services, including big data, databases, and IoT, for enterprise applications. For industry customers, Huawei provides different industry components for different industry scenarios. With the ability to deploy up to 1 million containers, FusionStage 2.0 also supports mainstream programming languages and protocols, cutting deployment time for new micro services to under a minute.

Cloudification does not require the customer to change their applications.

FusionStorage 6.0: Full convergence

Huawei's three independent storage solutions for distributed blocks, distributed files, and distributed objects have been widely adopted commercially, including an enterprise private cloud that runs the industry's largest number of virtual machines at 450,000, which is supported by Huawei's distributed block storage solution. Huawei's mobile cloud storage platform serves 130 million mobile users and runs our distributed file storage solution, which has in turn driven the rapid growth of Huawei's smartphone business. CERN's R&D cloud empowers data collection by 150 million God particle sensors, which is supported by Huawei's distributed object storage solution.

Huawei's latest converged cloud storage product FusionStorage 6.0 can now manage blocks, files, and objects on a single cloud platform. The three key characteristics of FusionStorage 6.0 are integration, flexibility, and openness. In terms of integration, FusionStorage 6.0 can store distributed blocks, distributed files and distributed objects. Flexibility is ensured by 4,096 nodes. Installed on x86 servers, openness is achieved by compatibility with OpenStack.

FusionStorage 6.0 overcomes the problem of data silos in cloud environments and lets data flow freely, meeting requirements for service diversity and data explosion in the cloud.

To fully meet enterprise needs, Huawei builds deliverable and operable hybrid cloud solutions and full-stack solutions from hardware and software to services. Thanks to Huawei's capabilities and experience in localization and globalization and our strength in open cloud ecosystems, we accompany customers all the way on the cloud journey to the cloud, beginning with the end in mind. ◨

Reinventing business with industry clouds

Industry Cloud is more than Industry + Cloud; it's a dramatic convergence of technology and business that will enable business-driven digital transformation.

By Yan Lida, President of Enterprise BG, Huawei

LEADS is here

Unlike the technology focus of Cloud 1.0, Cloud 2.0 is business driven. It positions cloud as a core technology for digital transformation and will serve as a catalyst for industry innovations where companies focus on creating value rather than saving costs. Leading companies in all industries are exploring how to reinvent traditional business processes, production techniques, and business models using the latest digital technologies.

Smart cities: People-centric and service-focused, smart cities are built to serve the needs of residents,

companies, and governments, using IT like cloud computing and big data to integrate information across sectors.

Banking: Banks used to focus on managing bank accounts, meaning customer resources and information were fragmented and siloed. Today's banks are putting the customer first with Finance Cloud and big data technology.

Healthcare: The healthcare industry is shifting from a focus on illnesses to a focus on people. Healthcare Cloud will enable better connected healthcare models that will link people, medical services, and data so that information can be shared. Medical resources will transcend time and geography, and everyone will be able to access higher quality and more comprehensive healthcare services.

Media: The media is shifting its position from producer to producer-consumer. New ICT architecture like Media Cloud is forming always-online, open media platforms that enable massive amounts of content and resources to be pooled and shared in real time.

Cloud, networks, and smart devices are forming new ICT infrastructure where data is a vital economic resource, as important as people, capital, and physical assets.

But, what is the essence of Industry Cloud? After all, we can't change the nature of each industry; as Huawei founder Ren Zhengfei puts it, "Bakers still have to bake, builders still have to build." But, Industry Cloud will

converge technology and business in a way that will promote business-driven digital transformation.

What are the key elements of Industry Cloud?

The digital enterprises of the future will need to form new architectures for their ICT infrastructure to support the generation, transmission, and processing of the data that will underpin all company processes.

No single technology can support digital transformation alone – collaboration between cloud, data pipes, and devices is required. When industries go digital, the value of cloud won't come from the cloud alone, nor will the challenges facing devices be solved at the device level.

In the cloud era, data will be an enterprise's core asset. Huawei's knows that data is industry-specific, with data generated from different sources used for different purposes. So, the value of data can only be truly realized within a specific industry context. That's why Huawei has always followed a path of close collaboration with customers and industry app developers.

So, what do we need to consider when deploying Industry Cloud?

First, we must ensure smooth migration to the cloud, so that companies continue to deliver a consistent, uninterrupted, and secure experience. As they address this challenge,

companies will need the support of a professional cloud team that offers one-stop services. And they will need the capacity to operate and manage cloud themselves, to ensure secure operations as they innovate new services.

Second, enterprise digital transformation is a complex project involving a wide range of hardware and software systems, so enterprises cannot transform alone. The right platform will help them avoid complexity in underlying hardware and software systems. They can then concentrate on improving and innovating services.

Enterprise digital transformation will be like the transition from feature phones to smartphones. It involves creating a platform that's open, elastic, secure, reliable, and flexible to support the many different applications of a company. Only this kind of platform will draw in the large numbers of app developers needed to form the new, vibrant, creative ecosystem necessary for a company's digital transformation.

Leading New ICT

Ren Zhengfei believes that, "Over the next two or three decades, humanity will evolve into a smart society. The depth and breadth of this change will be beyond

anything we could ever imagine." As companies move into the cloud, they will need trusted partners. A powerful platform will help them to address future challenges and uncertainties.

In early 2016, Huawei Enterprise BG launched its new strategy: Leading New ICT. This strategy reflects our vision and goals for the digital transformation of industries. Through technological innovation, Huawei will build an open, elastic, flexible, and secure platform that enables collaboration between cloud, data pipes, and devices. Based on this platform, Huawei will build a sustainable ecosystem. To do so, we've set up five OpenLabs in different countries that are open to industry customers and serve as centers for joint innovation, R&D, verification, and experience. Huawei has also established 36 joint innovation centers with our industry-leading customers.

We're committed to building an open, collaborative ecosystem of shared success. We're committed to becoming the best partner in the Industry Cloud era. And we're committed to helping our customers achieve business success.

Industry Cloud is more than Industry + Cloud: it's a convergence of technology and business that will let us reinvent business together. 🅷

Industry Cloud is more than Industry + Cloud: it's a convergence of technology and business that will let us reinvent business together.

Turn, unlock, activate

Network and cloud are the two keys to enterprise digitization

Cloud is the tool for reconstructing, evolving, and optimizing enterprise networks through digital transformation. But, enterprise networks must keep pace with service cloudification so enterprises can compete in the future.

By Liu Shaowei, President of Network R&D Dept., Huawei

The right network for the digital age

Huawei believes that a network should be *For the Cloud, By the Cloud*. This concept describes how the two core elements of digital transformation, cloud and network, relate to each other for enterprises. Cloud technology will simplify network operations and management, while network optimization will make the cloud faster and more agile.

Change is the only certainty

The two major changes to hit networks from past to present are a speed increase from gigabits to today's 100G and the unification of

protocols into IP-based networks.

Like Huawei, telcos around the world know that cloud and network reconstruction and the digital transformation they enable are the future. The three Chinese carriers, AT&T, Deutsche Telekom, and Telefonica, for example, have all developed network reconstruction strategies.

The challenges involved in cloud transformation will disrupt traditional models and bring SDN/NFV to the fore. Network reconstruction and cloud transformation based on SDN/NFV will underpin enterprise services and play a central role in post-reconstructed networks. SDN/NFV is also the first step towards full digital transformation and the delivery of the flexible, secure, and stable networks

that telcos, Internet companies, and enterprises expect today.

Virtualization is one way to address digital transformation and service cloudification as it meets the needs of upper-layer applications. But, virtualized networks cannot realize digital transformation alone. **SDN** is widely believed to be the solution for rapid service deployment, flexible resource allocation, and reducing OPEX by shifting O&M and policy management to the SDN controller.

Upcoming network changes

For the Cloud considers whether the cloud can be used to optimize enterprise networks and create cloud networks.

By the Cloud means provisioning and using networks on a needs basis to enable DIY services like e-commerce based on simpler network O&M and strong security.

To help enterprises transform, Huawei has launched five major network cloudification solutions: Cloud Campus, CloudVPN, IoT, Cloud Fabric, and Cloud Security.

Cloud Campus

Gartner reports that campus network OPEX accounts for more than 70 percent of overall network costs.

The main ways to reduce OPEX are to increase efficiency and accelerate service deployment, both of which cloud is good at.

In 2013, Huawei released an agile SDN-based campus solution that deploys controllers on campus. It then considered whether it was possible to deploy more services on the cloud and enable sharing through a management platform. Such a solution would save costs, deploy services more quickly, and eliminate the need for skilled technicians on-site.

Cloud Campus was born. As Huawei's first cloud management platform for large-scale campuses, network management is enabled by cloudifying various management components, including controllers, network management systems, VAS, and other tools that can be cloudified and placed on an open platform so more people can use them.

Cloud Campus can provision services in minutes and automate cloud management network-wide, reducing O&M labor costs by up to 80 percent. The solution also provides decision-making support for network optimization using big data analytics, and its open architecture enables secondary development based on the platform.

Using cloud tech to simplify network

management, Cloud Campus has the following features, advantages, and benefits: One, it's scalable and can be deployed in scenarios of various sizes; two, it supports 100 different devices, including Wi-Fi, routers, switches, and security products, with more planned for the 2017 release; three, as a cloud management platform, the solution provides full lifecycle management, covering everything from network planning, design, and deployment to network testing, O&M, and fault location and recovery.

Available for leasing or purchase, Cloud Campus cuts costs and simplifies campus network deployment, management, and operations.

CloudVPN

Enterprises also face a network OPEX bottleneck. For example, deploying VPN leased lines for large multinationals is expensive and takes at least a month, and more when deploying across regions or for multiple carriers. Moreover, system deployment is siloed, making deployment and O&M extremely difficult.

Huawei's CloudVPN is a true, component-rich E2E solution. For operators, it offers enterprise CPE, SD-WAN with multiple link choices, cloud data center solutions, VAS

management, service orchestration, management, and portals.

Huawei provides Internet-based leased lines that are cheaper than traditional leased lines and offer excellent accessibility. Businesses can leverage both types of leased lines in tandem, with non-core services running over the Internet leased line and services requiring high transmission performance, zero-packet loss, and low latency running over traditional leased lines.

CloudVPN lets users choose between Internet-based and traditional leased lines, with full user configurability, which cuts costs, bandwidth use, and deployment time.

A crucial component of CloudVPN is Agile Controller 3.0, which makes CloudVPN more powerful and supports unified control and flexible deployment scenarios.

Agile Controller 3.0 offers four distinct benefits:

One, the functions of Agile Controller 3.0 can be provisioned separately or in combination, providing tailored support for CloudVPN to cover more areas, for example, traditional data centers, campus networks, entire WANs, IoT, optical networks, branch offices, enterprises, and campuses. Some or all of its functions can be deployed

depending on requirements.

Two, Agile Controller 3.0 can be expanded to up to 128 clusters to support network expansion, with provision for backup nodes to take over services if a node becomes faulty, thus ensuring network security.

Three, it can manage 256,000 virtual switches in a virtual network.

Four, Agile Controller 3.0 is based on fully open ONOS and ODL architecture, so it's compatible with the ODL YANG open model and API architecture. Users and partners can thus do more and go further with SDN.

IoT: The great transformer

IoT is the future of IT. In 2015, Huawei released a cloud-based IoT solution that's been applied in many industries.

Need a lift?

On September 19, 2016, Huawei and Schindler Group launched an IoT connectivity project to develop smart IoT components for connecting elevators and escalators. With more than 1 billion people using Schindler's solutions every day, efficient management of its assets is critical, particularly for safety and reducing maintenance costs. For example, one elevator undergoes on average two days' downtime per

year for maintenance and, in China, several deaths from faulty escalators and elevators have been reported in recent years.

Huawei and Schindler's Internet of Elevators (IoE) solution will connect all the company's elevators. Big data analytics in the cloud will predict faults, with the aim of reducing downtime by 90 percent and slashing maintenance costs. Ultimately, Huawei hopes to open up the IoE platform to third parties via the cloud, for example, for advertising or for construction companies to offer services. The completed project will form a core element of Schindler's digital platform that will help it better monitor, analyze, and use the generated data.

Powering up

Huawei has also released an IoT solution for the electric power industry, which has been deployed in a number of countries, mainly to integrate power distribution and utilization.

Ikeja Electric, for example, is Nigeria's largest power distribution company. Its major pain points are collecting electric power fees, power theft, and high energy losses. Ikeja Electric decided to adopt Huawei's AMI solution for smart meter reading and higher energy efficiency.

The AMI solution includes smart

meters, concentrators (the Huawei AR530 IoT gateway), and power management systems. It applies Huawei's wide-band Hi-PLC carrier technology, which is more than 20 times faster than narrowband PLC and has a daily metering success rate of 100 percent. This allows for real-time bidirectional communication with meters, allowing full data collection and fee control for future smart power grids.

The solution has helped Ikeja Electric build an IT-powered operating platform that can deploy a pre-paid management system and prepayment cards plus various payment methods like counter machines and online payments. The solution also uses analytics to monitor power theft and load management. Visualized management makes monitoring by the operator extremely easy.

The solution has brought Ikeja Electric three major benefits: one, reducing power loss by 31 percent; two, cutting meter reading and payment collection time from three to four months to completion in real time; and, three, slashing labor costs by 90 percent by removing the need for door-to-door meter readers.

For the Cloud, By the Cloud

Digital transformation has transformed enterprises in

astonishing ways. Many other examples exist alongside Schindler and Ikeja Electric: In 2015, China's Didi Taxi completed 1.43 billion rides with 16 million connected vehicles, while in the telco world AT&T reduced service launch time by 95 percent.

For businesses, digital transformation links data and information to experience and knowledge. Companies need to build future-oriented networks and cloudify their architecture to get as close as possible to users, and provide the differentiated services and superior experience that can boost competitiveness.

Clouds and networks are the two sides of the coin that power enterprise digitization. Cloud technology can meet the demands on digitized networks for on-demand deployment, DIY services, simple management, and security and reliability.

Huawei's Agile Network Solution epitomizes the For the Cloud, By the Cloud concept. It cloudifies services for enterprises (For the Cloud) and supports network optimization and reconstruction through cloud technology (By the Cloud).

Huawei's five major network cloudification solutions form five keys to long-term partnerships and digital transformation for enterprises. H

Eric Xu
徐直军
Deputy Chairman of the Board,
Rotating CEO, Huawei
华为 副董事长、轮值CEO

HUAWEI CONN

Huawei Rotating CEO Eric Xu
on enabling telco transformation

By Wang Feng, Chief Writer, Harvard Business Review, China

H uawei was founded in 1987. In 2011, it began to expand beyond its telecom operator business into the enterprise and consumer spaces. Since then it has evolved from a telecom equipment vendor into a leading global provider of information and communications technology (ICT) solutions, with its products and

services reaching almost every corner of the globe. In 2015, the company's sales revenue hit US$60.8 billion (395 billion yuan), of which 58 percent was from outside of China.

At the National Science and Technology Innovation Conference held in Beijing last May, Huawei CEO Ren Zhengfei predicted that

the company's revenue would soar to US$150 billion by the year 2020. While this revenue target is acting as a new spur for increasing efforts in Huawei, it also brings with it new challenges. Over the past few years, the telecom industry has come under great pressure, as the fast-growing OTT industry has chipped away at telecom markets. Threatened telcos
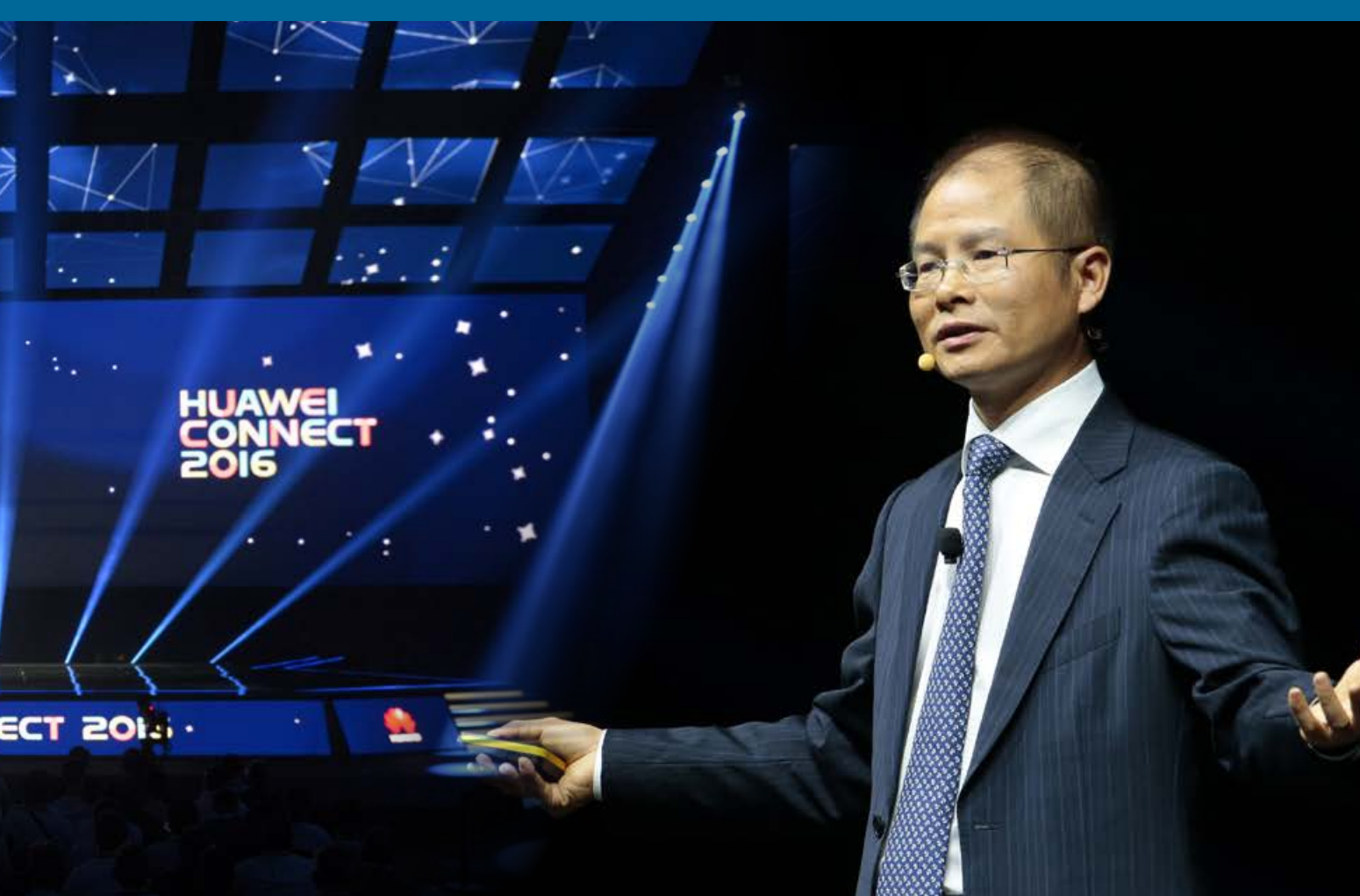
are in dire need of end-to-end digital transformation.

In early 2016, Huawei launched its All Cloud Strategy, which focuses on ICT infrastructure. This strategy positions Huawei as an enabler of both the intelligent world as well as enterprise cloudification and digitalization. Its goal is to help its partners achieve digital transformation, digitalize their operations, and deliver a ROADS experience – a Huawei concept that stands for Real-time, On-demand, All-online, Do-it-yourself, and Social.

On September 28, 2016, Harvard Business Review China (HBR China) interviewed Eric Xu at the company's headquarters in Shenzhen, China. The interview concentrated on a single topic: telco transformation.

End user satisfaction drives everything

HBR China: Many Internet companies born in the cloud have appeared over the past decade. They deliver a premium user experience and innovate through rapid iteration. These companies have transformed the business models of many vertical sectors, and represent a significant shock to the telecom industry. What is the state of the telecom industry

today?

Eric Xu: The entire telecom industry is under pressure to transform. This pressure comes from stakeholders' demand for a better experience, and from the ecosystem. There are six aspects worth noting.

First, consumers think that data services are too expensive and the experience is unsatisfactory. For enterprise customers, it often takes a month or more just to get a private line installed. Their needs for connectivity, bandwidth, reliability, and security are still not being met.

Second, Internet service providers use

Customer satisfaction is the key. Once issues around customer satisfaction are resolved, everything else will fall into place.

telecom networks to serve their customers, but they think they're paying too much for bandwidth and data traffic throughput. This is a global problem.

Third, governments are trying to cut the prices of telecom services. The EU is in the process of abolishing mobile roaming charges within Europe. The Chinese government is pushing for cheaper telecom services. Other governments around the world are trying to find ways to lower prices.

Fourth, telcos are having a hard time because growth and profitability across the industry are in a downward spiral.

Fifth, telecom equipment vendors are suffering because their fate is tied to that of telcos.

Sixth, investors are struggling due to low ROI.

HBR China: Then what is the way forward?

Eric Xu: There are only two options: The industry either takes action to resolve these issues, or it lies down and waits for others to send it the way of the dinosaurs. Obviously, telcos are at the heart of the industry. The telecom industry can only become healthy when telcos themselves are healthy. In the same way, the industry can only complete its digital transformation once telcos have successfully gone digital. The situation is urgent: Google and Facebook are trying to build entirely new types of networks so as to bypass telcos and deliver services directly to their users. If this attempt proves successful,

they could consign the entire telecom industry to the dustbin of history.

HBR China: What is the key to resolving these issues?

Eric Xu: Customer satisfaction is the key. Once issues around customer satisfaction are resolved, everything else will fall into place. But how can telcos ensure customer satisfaction? The key is a significant improvement in user experience when consumers buy and use services.

In the past, telcos focused on experience mainly in terms of usage: how users were making phone calls, sending texts, or using the Internet. But customer satisfaction often also depends on their experience with gaining access to those services in the first place: finding out about the services, purchasing, making payments, after-sales service requests, and so on. Complicated procedures and long waiting periods before a new service is activated make customers lose interest. The ability to deliver a superior experience when consumers buy services is what sets OTT players apart from telcos.

ROADS: Goal of digital transformation

HBR China: What is the key challenge to improving user experience at the purchase stage?

Eric Xu: The key challenge lies in whether telcos can engineer user-centric digital transformation. The operations systems of almost all telcos today serve their

own employees – sales staff and maintenance engineers. These systems have been digitalized, but they're still called "internal IT systems." If telcos hope to future-proof their businesses, they must go beyond the digitalization of technologies and products. Telcos must become digital enterprises that are able to offer users a ROADS experience throughout the process of buying and using telecom products and services. Huawei has developed the ROADS experience model based on its own experience and the best practices of Internet companies. We believe that once telcos can deliver the ROADS experience, they can resolve all the issues that affect customer satisfaction. We can think of ROADS as the goal of digital transformation.

HBR China: What does it take to deliver the ROADS experience?

Eric Xu: Ubiquitous connectivity is the prerequisite. There are two sides to it. One is internal: Within the company, there must be ubiquitous connections between people, between things, and between people and things. The other side is external connectivity: The company must be fully connected to its users, customers, partners, and suppliers.

HBR China: What value will ubiquitous connectivity create for telcos?

Eric Xu: First it will help slash operating expenditure (OPEX) and boost efficiency. With ubiquitous connectivity, your purchase order for a supplier will flow directly into their systems, and you can gain visibility into the end-to-end supply process. Your users can also directly access your systems. You can even connect your IT systems with those of partners. This will greatly reduce your OPEX and maximize efficiency. Based on our experience with the Honor brand, we believe ubiquitous connectivity can reduce OPEX by at least 10 percent. For telcos, a 10 percent reduction in OPEX will deliver immediate improvements in profitability.

Second, ubiquitous connectivity will foster innovation in operating models and business models. This will be vital to telcos' digitalization strategies, because it represents long-term value.

Innovation and transformation of operations systems

HBR China: Are telcos' existing operating models and business models outdated?

Eric Xu: Let's look back at what telcos have done. They've been taking a long, hard look at Internet companies, and they've launched numerous applications to specifically compete with these companies. But these applications haven't performed as they hoped. I think the fundamental cause is that their operating models can hardly support Internet products. Their DNA, technology architecture, and operating models are not Internet-based. Even if they copy the way the Internet companies make products, they are highly unlikely to succeed.

HBR China: Why don't Internet products fit well into telcos' existing operating models?

Eric Xu: Telcos' organizations and systems are old-fashioned and technology-centric. Barriers have built up between their marketing, network management, and IT functions, and their front-end and back-end systems aren't integrated. By contrast, Internet companies keep their eyes fixed on their users, and have streamlined their organizations to rapidly respond to user needs. As a result, a product that takes Internet companies a few months to develop and launch might take some telcos one or two years. With such a long time-to-market, telcos can hardly stay ahead of the competition in the Internet era, where everyone is fighting for rapid iteration and innovation.

Telcos need to learn from Internet companies, including their approaches to design, operations, and technology architecture.

HBR China: So transforming operating models is crucial to realizing the ROADS experience.

Eric Xu: Changing the mindset is important. Telcos need to learn from Internet companies, including their approaches to design, operations, and technology architecture. They need to overhaul the operating models of the telecom industry in the following three ways.

First, they need to shift the focus of their operations from "network experience" to "user experience". At present, user experience is often measured solely based on network performance indicators such as bandwidth, latency, and packet loss rate. In the future, telcos should look to end-to-end user experience, from how users find out about telecom offerings to how they buy them and obtain after-sales services.

Second, telcos need to introduce real-time, autonomous systems to replace human-operated systems. As telcos get better connected, they'll be able to make their operations simpler, more efficient, and more intelligent by building big data and AI systems that support real-time decision making.

Third, telcos need to evolve their closed IT architecture to a cloud-based, Internet architecture. Cloudification must be agile, intelligent, and open, so that telcos can effectively connect their internal and external operations systems and create a robust ecosystem in which telco staff, customers, partners, and suppliers can collaborate efficiently and openly to share success.

HBR China: What will future operations systems look like?

Eric Xu: First, they'll no longer be internal IT systems or support functions. They'll become production systems. An example is our Honor brand: Our online store directly engages with our customers. After the customer places an order online, the order is transmitted directly to our production line and, once the product is ready, it's shipped directly to the customer.

Second, future operations systems will be entirely user-oriented and fully open.

Third, how good an operations system is won't be judged by the telco itself, but by its users.

HBR China: Is the transformation of operations systems the key part of telcos' transformation journey?

Eric Xu: Yes. Digital transformation necessitates changes to telcos' organization, processes, and culture, and that will take a long time. Telcos face two roadblocks on their digital journey.

The first roadblock is the conflict between long-term transformation and the need for short-term performance. Most telcos are public companies. When they grow rapidly, their CEOs get to stay in place for a long time. But when these companies run into difficulties, CEOs are replaced frequently, and this is very unhelpful for a long-term project like digital transformation. Digitalization involves changes to the organization, corporate culture, processes, and IT systems.

It may also mean redundancies and recruitment of employees with new skillsets. This deep re-engineering of a company takes at least five to ten years.

The second roadblock is resistance from within the organization. Most telcos worldwide have generally followed a common development path. They started as monopolies and have since been split up into several companies. As a result, they have similar organizational structures, and their monopoly mindset and culture remain unchanged. This will stifle transformation. Thus far, there are very few telcos that are willing to put their heart and soul into transformation.

Eliminating major obstacles

HBR China: How can telcos overcome these two major obstacles?

Eric Xu: They'll find it hard to surmount the obstacles on their own. Usually, there are only three or four telcos within a country. Even if the business environment is changing, so long as none of their competitors are committed to change, telcos can continue to get by without transforming themselves. So telcos need external enablers. Once one telco takes action and transforms itself successfully, the

others will suddenly realize that they need to change as well. And they will be able to move quickly, because they can learn from the lessons and experience of the first mover, and use the knowledge and the pool of workers with new skills that the first mover has created.

HBR China: What specifically should telcos do?

Eric Xu: There are two key actions needed to overcome these obstacles.

First, the board of directors and CEOs must commit themselves to transformation, and use strong leadership to drive the initiative from the top down.

Second, telcos need the support of external enablers.

Huawei's carrier business has positioned itself as a driver and enabler for telcos' strategic transformations over the next decade. We're bringing together the industry's best minds; we're preparing the technologies and expertise that telcos will need. Globally there are three to four hundred telcos, and most of them are our customers. We hope to be a partner for any telco that is committed to transformation. We have the full set of end-to-end capabilities, from strategy development to execution, that

telcos need in order to transform and become digital enterprises that can deliver the ROADS experience.

HBR China: What is Huawei's enablement roadmap?

Eric Xu: Our All Cloud Strategy, launched in early 2016, is essentially an enablement roadmap for telco transformation. Based on the ROADS experience model, we enable telcos to rebuild their telecom equipment, networks, services, and operations. This transformation will not only help telcos sharpen their competitive edge in new markets such as IoT, video, and cloud, it will also support the cloudification of networks and operations systems to make telcos more agile. Our enablement efforts will focus on three areas: expanding telecom networks to include more connections; increasing the traffic flow capacity across telecom networks; and transforming operating models to make telcos more competitive against OTT players.

HBR China: During this enablement process, what do you work on, specifically?

Eric Xu: We're currently working with several telcos. We don't perform big bang transformations. Instead, we make ongoing adjustments and improvements in specific areas, gradually stepping up investment

and checking our progress to ensure that whatever we're doing is creating value. In practice, we focus on the following four key points:

First, solutions must primarily address small-scale, limited problems. Together we can use these solutions to pilot changes and quickly adapt them as necessary. We don't expect to create complete, fully-tested solutions by working with just one or two customers. We prefer to test different parts of our solutions with different customers. This is an ongoing process of learning and building up experience, and gradually the complete solutions emerge.

Second, the transformation of operations systems is a long process. It requires patience. Telcos should not expect their vendors to be able to immediately spit out a complete set of technologies, organizational architecture, corporate culture, and strategic solutions which they can simply plug in

and achieve instant transformation. This is just impossible. Transformation is difficult, and it needs to be conducted one step at a time. Huawei is committed to helping our customers step up to the inherent challenges and progressively pick up speed, but we estimate that the process will take at least ten years.

Third, telcos should stay focused on the value of transformation and close the loop by creating value with each change. It must be made clear to everyone that every change, no matter how small it is, can bring demonstrable value. By doing so, telcos can create Internet-based operations systems with cloud architecture to deliver a ROADS experience.

Fourth, the value and positioning of Chief Information Officers (CIOs) should be redefined. CIOs oversee information technologies and systems, and they support corporate goals through the adoption

of IT. But I think CIOs should become CI³Os, with the I³ representing Innovation, Interconnection, and Information.

Redefining CIOs

HBR China: You mention the need to redefine the role of CIOs. This will clearly expand CIOs' duties, their influence on other executives and managers, and their weight within the organization. Why is this necessary?

Eric Xu: Let me explain the meaning of I³. The first I is Innovation. CIOs know more about technological changes than other executives. They have ICT expertise and understand cloud concepts and technologies, what benefits these technologies will bring, what the Internet model is, and how the company should sell products and deliver services following the Internet model. CEOs don't necessarily have this level of knowledge, so CIOs need to take on a bigger role. They're no longer the directors or managers of IT applications. They should become the major drivers, planners, and even enablers of transformation and innovation in operating models and business models. This change poses new challenges to CIOs: They need to convince CEOs about the need for transformation, and they must have the ability to help CEOs achieve transformation.

The second I is Interconnection: CIOs need to enable the interaction between the company and its customers and partners.

The third I is Information: It means CIOs must

lead the cloudification of the company's IT architecture.

HBR China: Given this change in the role of the CIOs, how should functions be merged?

Eric Xu: Under telcos' existing organizational structure, the CIO's role is to oversee operations, the CTO manages networks, and the CMO manages marketing. After the digital transformation, the CIO, CTO, and CMO will need to collaborate closely and streamline processes to set up a user-centric production system. Based on what we've seen, telcos usually start by merging the CIO and CTO roles into a CTIO.

HBR China: In recent years, Huawei has emphasized the building of ecosystems as well as complementary and collaborative partnerships. Over the next five to ten years, what key value will Huawei create as a member of its ecosystem?

Eric Xu: The unstoppable rise of digital business is the key trend. Therefore, companies have to build strengths within their ecosystems. Huawei is committed to being an enabler of the intelligent world. We will actively contribute to the cloud ecosystem, promoting openness, collaboration, and shared success. We will be the enabler and preferred partner for enterprise cloudification and digitalization. We will stay customer-centric and help all companies and other ecosystem players contribute their unique value to a robust ecosystem for All Cloud and digital business. **H**

Huawei is committed to being an enabler of the intelligent world. We will actively contribute to the cloud ecosystem, promoting openness, collaboration, and shared success.

Data technology is the heir to the IT throne

A new IT revolution has arrived. New capabilities created by platforms based on cloud and big data – collectively referred to as data technology (DT) – are replacing support systems and traditional IT models. To keep pace, operators must develop robust transformation strategies from now until 2020 – the time when DT will have matured.

By Li Changwei

From IT to DT

Four stages of development exist for ICT: IT (support), DT (enabling), artificial intelligence (service), and scenario intelligence (intelligent).

During the 1980s and 1990s, the US transitioned from the analog to the digital IT era. Digital tech like computers, storage, and databases transformed society, with companies like IBM, Oracle, and Dell EMC as the pioneers.

The advent of IT saw a process of global horizontal integration led by IBM. The generalization

of IT hardware coupled with the standardization of software led to compatible computers becoming standard across all industries, improving cost efficiency models across the board.

Analog society had gone digital.

Through its App Store and open APIs based on iOS, Apple has built an ecosystem of Internet-content apps that combine tech, art, and culture. This has created a stream of innovation in devices and service experiences, with the iOS-based vertical integration model of experience replacing the IT era's horizontal integration model of
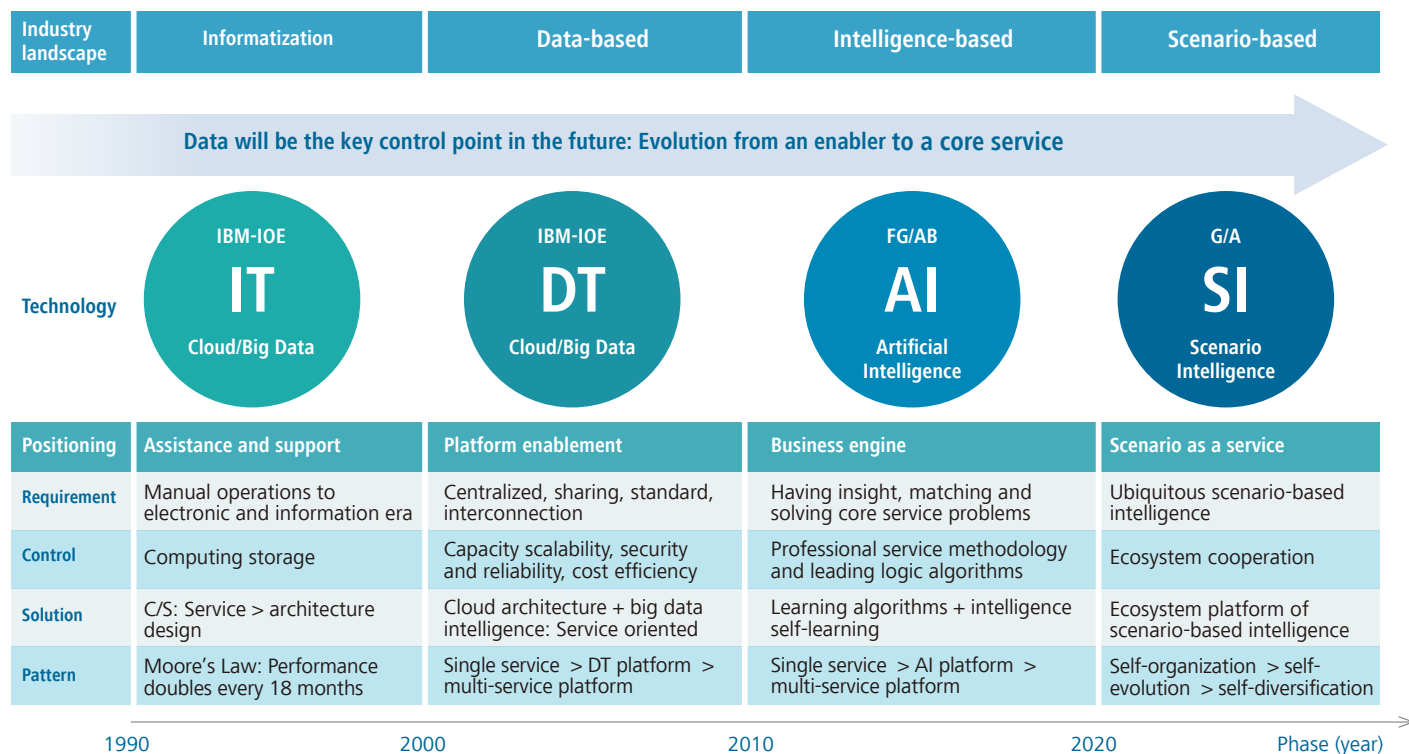
efficiency.

It's time to transition

Now, we're quickly transitioning into the DT era, with cloud, big data, and smart technology at the helm.

Since 2000, the Internet has propelled innovation in cloud and big data innovation forward. The Internet provides far cheaper computing, storage, and service logic than traditional IT, bringing with it a much more agile service model that redefines what a platform is. In turn, DT has evolved from an auxiliary support system to a platform enabler and service engine.

New DevOps models have been developed for DT platforms to provide Internet services with a ROADS experience (Real-time, On-demand, All-online, DIY, and Social). Internet companies define DT as data-driven cloud, big data, and smart technologies, which is distinct from IT.

Since 2010, continual breakthroughs have been seen in intelligent data analytics and service innovations. In some areas, artificial narrow intelligence (or weak AI) like IBM's Deep Blue and Watson and Google's AlphaGo have already exceeded human capabilities in specific fields, laying the path for the possibility of

Industry landscape	Informatization	Data-based	Intelligence-based	Scenario-based

Data will be the key control point in the future: Evolution from an enabler to a core service

	IBM-IOE **IT** Cloud/Big Data	IBM-IOE **DT** Cloud/Big Data	FG/AB **AI** Artificial Intelligence	G/A **SI** Scenario Intelligence
Positioning	Assistance and support	Platform enablement	Business engine	Scenario as a service
Requirement	Manual operations to electronic and information era	Centralized, sharing, standard, interconnection	Having insight, matching and solving core service problems	Ubiquitous scenario-based intelligence
Control	Computing storage	Capacity scalability, security and reliability, cost efficiency	Professional service methodology and leading logic algorithms	Ecosystem cooperation
Solution	C/S: Service > architecture design	Cloud architecture + big data intelligence: Service oriented	Learning algorithms + intelligence self-learning	Ecosystem platform of scenario-based intelligence
Pattern	Moore's Law: Performance doubles every 18 months	Single service > DT platform > multi-service platform	Single service > AI platform > multi-service platform	Self-organization > self-evolution > self-diversification

Technology

1990   2000   2010   2020   Phase (year)

The four stages of ICT industry development

artificial general intelligence.

Humanity will then enter the stage of scenario intelligence (SI), where all scenarios and industries are intelligence-driven.

Two types of integration

Like IT, DT will integrate in two ways: horizontally and vertically. Over three decades, we're seeing three major trends.

1995-2005: IBM's horizontal integration delivers low-cost PCs. IBM developed the 286/386/586 series of PC-compatible computers that, when popularized, gave rise to global information sharing and the modernization of industry, forging a trillion-dollar IT industry that drove global development. Humanity entered the information age.

2005-2015: Apple's vertical integration innovates with experience. The iPhone and App Store spawned two million apps, creating the mobile Internet era and a new trillion-dollar industry. In this decade, humanity entered the mobile Internet age. Here, the stage was set for DT to replace and surpass inefficient, expensive IT, drive industrial digitization, and take us into the data-driven DT age.

2015-2025: Amazon's horizontal integration positions cost efficiency at the core. In Q3 2015, the number of AWS's business customers tripled over the short span of three years to hit 1 million, helping the company to finally start making profits. In this stage, the cost efficiency of cloud services will

accelerate innovation, market segmentation, and data transformation for verticals. Horizontal integration will also gather speed.

Google's vertical integration results in specialization and intelligence: IBM's cognitive computer Watson, Google's AlphaGo, and government cloud transformation exemplify the start of vertical market integration, which is likely to peak in 2035.

DT-driven vertical integration and horizontal integration will be how industries develop in the future under a fully transformed device-pipe-cloud model. To survive, enterprises must find a place in this model and innovate.

DT's three major schools

Under the specialized and enabling ideal, DT transformation is divided into three schools: industry, over-the-top (OTT), and telecommunications.

Industry: The competitiveness of vertical integration depends on specialization

As well as horizontal integration, DT transformation will accelerate the vertical integration of industries. Industry leaders will apply DT as a general technology to make breakthroughs in their sector.

With Industry 4.0, for example, German companies such as Mercedes-Benz, BMW, and Bosch are making decisive moves into IoT, big data, and intelligent factory management, production, logistics, manufacturing processes, and other scenarios. Boosting production and technical capabilities and management

efficiency by more than 50 percent, such data-driven strategies have strengthed the leadership position of each in their respective sectors.

OTT: DT-enabled competitiveness extends to general industries

Internet companies are using innovative data-based solutions to transform business models in industries like logistics, retail, finance, and banking, and becoming leaders as a result. Big-name examples are Google, Apple, Facebook, Amazon, Baidu, Alibaba, and Tencent.

However, these OTT companies are hindered by a lack of specialized know-how, preventing them from entering highly specialized sectors such as manufacturing and healthcare, despite attempting to do so with M&As. In these sectors, the current leaders must transform to quickly establish leadership in new areas.

Operators: Localization and integration are the way to go

Operators lack services and scenarios in horizontal integration for DT. Without a background in DT, incentivized cultures, or mechanisms for rapid iterative innovation, it's tough to compete with OTT and vertical industry leaders.

The only option for operators is to provide customized vertical

integration services for mid-level customers that have a greater need for localized resources. When it comes to horizontal and vertical integration, operators should adopt the models of OTTs and industry leaders and bundle and use local resources to provide data-driven customizable services at a local level.

How to transform

With big data and specialized services as the best starting points, service scenarios form the foundation for adopting DT. Operators' DT transformation strategies therefore require an inside-out model that first upgrades and transforms internal resources and service platforms (+ DT = IT 2.0) and then upgrades customers' service platforms (DT + = DT 1.0).

In the data transformation era, a new operator landscape comprising four groups is taking shape around the world. The US, Japan, and South Korea are the leaders. Close behind is China with rapidly developing Internet and LTE networks. Europe has fallen behind, forming the third group. The fourth is made up of developing markets.

The US: AT&T is a typical example from the leading group when it comes to data transformation. In its core strategy Domain 2.0, AT&T has replaced access and carrier network hardware with commercial-off-the-

Internet companies are using innovative data-based solutions to transform business models in industries like logistics, retail, finance, and banking, and becoming leaders as a result.

shelf hardware and formed a Central Office Re-architected as a Datacenter (CORD) model with its data centers. It has cloudified control and operations management, making it smart and data-driven to form an ECOMP platform.

China: China Telecom's data transformation strategy sets out three cornerstones – making its networks smart, implementing operating intelligence, and creating a service ecosystem.

Europe: Telefonica's data strategy, Onlife Telco, outlines three horizontals – connectivity, enablement, and services – and two verticals: data and data-enabled capabilities.

Despite the different names, these strategies have the same architecture and apply the same methods: applying data to improve services and platforms.

+DT = IT 2.0

DT transforms networks, O&M, services, management, and process services under an inside-out model. Operators can take both a collaborative or competitive approach.

Collaborating: Telefonica and Amazon and China Unicom and Alibaba are examples of strategic collaboration on DT. The partners are building DT-driven operations, business, and management systems that are run in-house, aiming to engender data sovereignty coupled with fully internal DT-based operations and service capabilities.

Competing: To compete with OTT leaders' strategies, like Facebook's TIP strategy and Google's SDN and B4 strategies, AT&T quickly

rolled out Domain 2.0 to transform its network into a DT platform for Internetized services. SDN/NFV, cloud, and data technology will minimize cost, support a ROADS experience, and enable Internet and service innovation.

Transforming data services and platforms inside-out enables operators to upgrade to XaaS data services for core service scenarios, enhancing DT-enabling services for primary service scenarios like data centers, CDN, cloud computing and storage, data analysis, and smart tools.

There are four main service scenarios that will help deliver profitable breakthroughs for operators:

Digital Shopping Mall (DSM): Localized innovation and collaboration are key here. KDDI's Smart Pass, DoCoMo's Smart Life, and Telefonica's aggregated pan-Hispanic content DSM are successful examples of DSM that compete well with OTT services such as Netflix, YouTube, App Store, and Google Play. Operator DSMs emulate the Apple's App Store model, but offer customized and localized services.

Fixed-mobile convergence (FMC) 2.0: BT, Sichuan Telecom, PCCW, and DirectTV (an AT&T acquisition) have all achieved success with FMC 2.0. In 2015, 17 carriers from the Global 500 implemented FMC 2.0, with the three fastest growing all providing FBB and video as core services. Explosive growth in video triggered by LTE has quickly shifted service scenarios to an FMC 2.0 model that includes broadband and video, presenting a great opportunity in the post-LTE market, especially as video requires data support platforms.

Enterprise E2E services: To use DT to meet enterprise needs for cost-efficiency, security, and reliability, AT&T provides Fortune 500 companies with services such as ubiquitous broadband access networking, 40-plus data centers, software and hardware security, enterprise-grade application proxies, and DevOps online data transformation support.

Industry DT strategy: Localized and customized, horizontal integration reaches 60 to 80 points in DT competitiveness based on cost efficiency indicators, while vertical integration DT scores 90 to 100 points.

Industry leaders will need to adopt a customized top-down model for DT transformation. Big names like Mercedes-Benz, Bosch, Huawei, and China Merchants Bank offer unique services and implement rapid iterative upgrades. They've all chosen to build vertical data-based platforms and service ecosystems, unlike small businesses, which must choose the most cost-effective horizontally integrated DT platforms. Operators have advantages in the medium enterprise market, particularly the government market, where customers expect high-grade service security, reliability, data sovereignty, and localized services.

With the demand for data sovereignty increasing across the globe, government clouds and other data-based services represent a key opportunity for operators over the next five years; for example, Deutsche Telekom is an early mover, providing localized government cloud services with data sovereignty protection and service security to the German government.

Every enterprise needs DT

As complementary forces for the data transformation that shifts IT to DT, horizontal integration creates cost efficiency, while vertical integration promotes specialization and smart operations.

Data transformation is user-inspired and service-oriented, with customer demand for an Internetized ROADS experience shaping platforms. Initially, operators will choose an inside-out transformation model that first targets their network, support, O&M, and service systems, and then provides platform-based services to other companies on a collaborative basis. There is also the fourth way of providing platform services for other companies: localization, customization, bundled infrastructure resources, and telecom-grade service protection.

However, one thing is clear: DT is the future and every enterprise must transform to embrace it. **H**

As complementary forces for the data transformation that shifts IT to DT, horizontal integration creates cost efficiency, while vertical integration promotes specialization and smart operations.

The full story on digital transformation for telcos

The pressure's on for telcos to go digital fast. They need to get customer-focused, enter partnerships where they're not obscured by a big-name partner, and look for high value-added margins rather than a sluggish trickle of profits down the dumb pipe. Martin Creaner, ex-CEO of the TM Forum and Chief Architect of Huawei SPO Lab, gave us his thoughts on the current state of play and where he sees things heading for telcos.

By Gary Maidment

Communicate: What are the benefits of digital transformation for telcos?

Martin Creaner: Digital transformation is a huge focus for the telecom industry due to the gradual decline in revenue from traditional services. So, the industry needs to transform by improving efficiency, and by introducing a whole lot of new services.

We're seeing music and video of course, but services around smart home, IoT, e-health, connected cars, security, and financial services are increasingly emerging. Transformation is all about changing telcos so they can begin to make money on these new services to compensate for the fall in traditional services.

Communicate: Is it fair to say that smaller, less conservative telcos can adapt more easily to the transformation process?

Creaner: That's a good question, and both small and large telcos are trying to adapt. The number one decider for how well a telco adapts is how committed the CEO is.

In terms of size, one of the most successful at doing so now is pretty much the largest telco of all, AT&T. Some middle-sized telcos in the

Martin Creaner
Ex-CEO of the TM Forum and Chief Architect of Huawei SPO Lab

Middle East are also adapting very rapidly, like Ooredoo. In contrast, smaller telcos may lack the finance or bulk to move quickly.

But, I think telcos of all sizes can adapt if the CEO has the commitment to stay the course during transformation.

Communicate: In some telcos, we're seeing something of a scattershot approach to digital transformation. How can they implement a more coherent and cohesive strategy?

Creaner: A lot initially go through a period of stopping and starting, because they don't know what to transform towards. Many initially start with something that they can immediately understand, like, "I want to transform my customer experience."

Let's go back to my point about the CEO and the board. When they really accept the need to change and are willing to drive it through

the organization, that's when you begin to see a real, consistent transformation program moving forward. Of course, they'll always focus on one area first, but it's as part of coherent plan driven from the very top, rather than focusing on just individual departments improving what they do.

Communicate: How can telcos' customers redefine their relationship with customers to make what they're doing more relevant?

Creaner: Many telcos have a direct relationship with their customers in that they provide them with very basic services – voice, broadband, and data. Compared with telcos, however, the customer relationship is much stronger with say Facebook and WeChat, or other services like Google that are overlaid on telco services. The telcos of course are in danger of being pushed down into a dumb pipe because it's the over-the-top players that are developing increasingly strong customer relationships. Telcos have to fight their way back up that relationship chart with users.

They can do so by offering services that go above and beyond basic services. But they need to make users think they're buying the whole management service from the telco, not the third-party. That means I'm

buying a connected car service from my telco in partnership with my automobile provider, or I'm buying a healthcare service from my telco in partnership with my healthcare insurer. I think that's how the telcos' relationship can get solidified with users. And then of course, there are the things we think are simple, but are in fact very hard to do like online services, the ability for a user to change everything they do online and so on. So it's a mixture of these things, services, and also just making the way the users interact with the telco seamless.

Communicate: What are we seeing with partnerships between telcos and third-party providers?

Creaner: We're beginning to see telcos working with healthcare insurers. We're seeing telcos working with companies that provide, say, home management systems. All the big automobile vendors are now working with telcos, and I think that's at the very forefront of what's happening.

These relationships are solidifying, and some of them will eventually work out really well and make serious money. Now, it's more speculative, and it's about trying to build the position. But money will be made with those services relatively soon.

Communicate: How do partnerships between content providers and telcos benefit telcos?

Creaner: I think the challenge for telcos in these relationships is who is perceived as bringing value. For example, Orange and Visa: is this seen as a partnership of equals? Does the end-user perceive that Orange is bringing something valuable? Or do they just perceive them as the pipe? And that's key in all these relationships. Telcos have done it very badly over the last seven or eight years. Look at Amazon's Whispernet where Amazon.com provides books over Whispernet, at first using Sprint and now AT&T. The telco gets hidden in the relationship, and the user's perception is that Amazon is offering the service.

These partnerships look very good on paper, but the telco gets subsumed in the relationship. Therefore, the telcos must focus on maintaining a stature within those relationships. It costs money to market that relationship of course.

Communicate: Where do you think telcos should target their investment?

Creaner: There's obviously the emergence of NFV and SDN, the whole virtualization of network elements, and it's where a lot of telcos are beginning to invest. And that's going to drive down costs, probably not anywhere near as much as we were predicting two or three years ago, because the cost of managing operations and orchestrating those virtualized environments are going to be much higher than previously envisaged.

Of course, there's a huge buzz around 5G – it won't be with us until 2019, 2020, 2021, but people are beginning to look at investing in that. From Huawei's point of view, the infrastructure enablement system drives down costs by moving towards autonomously managed networks, rather than automated networks. Driving down the cost of the business enablement system is not really cost-centric at the business system level. That's more about how you increase the telco's monetization

ability.

Communicate: So, in terms of monetizing data, what sort of things can we expect to see from telcos?

Creaner: Well there are two aspects: external monetization and internal efficiency. Telcos have access to massive amounts of data, but a lot of it isn't monetizable because it's been gathered without monetization permission. Permission is the starting point, and there are lots of ways to do it – Google does it all the time, Facebook does it all the time, Uber and Airbnb do it all the time. Telcos need to learn some of the tricks that are there. And then of course, there's how do you analyze the data?

Communicate: When it comes to low ARPU markets, like emerging markets, what kind of strategies do telcos need to adopt to balance deployment, operating costs, and investment with the money they're getting back?

Creaner: In a low ARPU market, you can't assume that you can just offer additional services to very low GDP per capita markets. Data becomes hugely important there, and there's obviously a whole range of services we're seeing across Africa and India, like Safaricom's financial services, which are layering on top of services that can generate additional revenue

per user. But ultimately, I think, if you're in one of these really low ARPU markets, you have to look at third-party monetization.

We've been looking at a range of potential services, like smart agriculture, where you're subsidizing agricultural services, so you can aggregate the data and then monetize that to people like commodities markets, people like Monsanto who sell seeds. So there's ways of generating and increasing the revenue in low ARPU markets without trying to just extract it from the really poor people who are using your service. You do that through permissions, through data, through overlay services, and not traditional telecom-type services.

Communicate: You mentioned the role of vendors like Huawei earlier in terms of infrastructure. Can you expand on that a little bit? How can vendors help enable telcos to digitize?

Creaner: Vendors have provided a huge amount of innovation that telco partners need on an ongoing basis, and that innovation now just needs to expand towards helping digital transformation from inside the telcos.

There are obviously systems, consultancy services, and new capabilities in CRM that can help

From a technology point of view, we're going to see virtualized autonomous networks that are obviously moving into 4G, 5G. It will be data-centric and security-centric.

telcos transform. My advice is that a vendor has to be in partnership with a telco in the role of trusted transformation partner, helping the telco in a range of ways. Systems are one part, networks are one part, but organizational transformation, skills transformation, there needs to be a holistic approach to helping a partner transform, not just let's sell a better system, sell a smarter box, or sell better software. The vendor has to be more holistic, and move up that chain to become the trusted transformation partner.

Communicate: What do you think digital telcos will look like in 2020?

Creaner: I think from a technology point of view, we're going to see virtualized autonomous networks that are obviously moving into 4G, 5G. It will be data-centric and security-centric. I think we're going to see telcos becoming service enablement partners for SMEs and B2B, and they'll maybe have a slightly smaller focus on B2C and an increasing focus on B2B, or B2B2C. Telcos will have service enablement capabilities, offering a broad range of services to consumer and business partners. They will be organizationally very different – now, they're very much stovepipe organizations where we've got network people, IT people, finance people, marketing.

I would say we'll see the whole omni-channel, 360 degree customer experience management. So telcos will be much more focused on using all the channels available both to get to market and also to get to customers and take information from the customers.

Communicate: For those that are slow to transform, now's a crucial time. What will happen to telcos if they don't transform?

Creaner: That's a difficult question to answer, because if you don't act, you still have the network, you still have the spectrum, you will become the ubiquitous dumb pipe. But dumb pipe is still a business. Maybe your margins are shifting down to commodity margins, 5 to 6 percent sort of margins, rather than the potential value-added margins of around 20 percent. So you'll get shoved down into a lower margin business, but it's still a business that can carry on for a long time because you've got spectrum, licenses, and so on.

But some companies will transform themselves so they enter the higher-margin end of the business. They're not just involved in the infrastructure; they're enabling new services. They've got a strong retail position, because they have shifted their persona to be much more service-based.

If you look at the speed of companies like Uber and Airbnb, who are not directly competitors of telcos, their services are moving really fast. We didn't know the name of those companies five years ago, and now they're household names.

Everybody has to move fast if they want to catch the waves to next-generation services. ▪

Everyone's heard of digital transformation, but what does it look like?

With consumer expectations on a constant upwards trajectory, all verticals know they must go digital. In this time of digital Darwinism, companies that invest intelligently in digitalization will start pulling out ahead. But, what exactly will a digital telco or service provider look like? It's not all that clear – the benchmarks and definitions are still germinating.

By Suo Kun & Lin Xin, Strategy Planning Dept., Carrier Software BU, Huawei

As yet, no definitive standards for charting the digital maturity of a telco exist. But, Huawei is working with other ICT industry players to pin down the best route and how to measure it.

What do customers want?

Infrastructure no longer dominates the design of software and user interfaces. Instead, a more customer-centric approach has spawned new forms of infrastructure to satisfy the explosion in demand for computing resources by digital businesses.

Digital Darwinism

With fast movers gaining significant advantages, businesses are competing and evolving through SMAC: social, mobile, analytics, and cloud. In their report *The Digital Advantage: How digital leaders outperform their peers in every industry*, Capgemini Consulting and MIT Sloan Management School show that digital maturity corresponds to financial performance.

Telecommunications is one of the industries that digital transformation affects most. Knowing this, some CSPs have already made impressive strides forward. According to its FY2015 *Analyst Meeting Material*, DOCOMO's Smart Life business generates about 11 percent of the company's total revenue. Equally, M-Pesa is a successful mobile money service provided by Vodafone subsidiaries in several regions. Kenya's central bank, for example, reports that 87 percent of the country's US$55-billion GDP passed through M-Pesa in 2014.

Taking it on the chin

Many failed transformation projects can unfortunately be found behind the success stories. The main reason? Digital transformation is basically uncharted territory and poorly understood.

One solution is to guide digital transformation through a digital maturity model that provides a unified standard for measuring achievement levels and boosting performance. The following dimensions for digital maturity have already become clear: strategy and culture, experience, services, operations, and platforms.

Excellent customer experience

Huawei brings the digital customer experience together as five uniquely

Strategic
Organization, goals & positioning

Qualitative
Digital experience, digital service, digital operation, digital platform

Quantitative
Numerical evaluation of digital performance in different fields

Three layers of assessment under ROADS

digital characteristics under ROADS (Real-time, On-demand, All-online, DIY, and Social).

Using ROADS as experience criteria, Huawei believes that a digital maturity model for a CSP comprises three layers of assessments: strategic, qualitative, and quantitative.

Strategic layer

The strategic layer focuses on enterprise strategy, transformation goals, and organizational structure. CSPs can build the right strategy for examining their current business and set a clear vision for digital transformation. Because CSPs' starting points and goals vary, different combinations of maturity metrics can be used to meet specific goals. For example, an efficient broadband provider will concentrate on reliability and reducing cost,

while a digital service provider will aim to build a digital ecosystem that provides services and content to customers.

Qualitative layer

The qualitative layer focuses on pinpointing the impact of ROADS on system requirements, aligning digital capabilities with business objectives, identifying where digital capabilities fall short, and determining digital transformation priorities. Huawei defines a qualitative metric framework with a ROADS experience at the core.

Real time: The goal here is for the consumer to receive a service with no perceivable delay and in the fewest number of steps. A good example is real-time transactions where vendors communicate with customers during a purchase. For vendors, it ensures

that customers don't lose interest mid-transaction because responses are immediate. However, different services have different thresholds for what people are willing to accept. In its April 2016 article *How latency is killing online gaming*, venturebeat. com reports that gamers will accept a delay of up to 100 ms for online shooters like Call of Duty. In contrast, even a 4 second delay for loading a webpage will retain 75 percent of users according to hobo-web.co.uk, though page abandonment increases with each second.

A real-time experience requires bimodal architecture to separate an agile front-end from a stable back-end, while real-time analytics provide a just-in-time understanding of user needs. Finally, automating as many processes as possible delivers services on a high-speed low-latency network.

On-demand: Users can request and receive services from an unlimited selection, with personalized services based on predictive preferences yielded by data analytics – an essential step to stop users having to sift through mountains of content. Third-party product ecosystems are powerful boosters for satisfying diverse user demands, while open APIs enable data exchange and secondary development.

On-demand provisioning, charging, and scaling require the orchestration of different domains, running from business operations to network infrastructure. Underpinning on-demand are flexible business models such as pay-as-you-go and freemium, a cloud infrastructure, and next-gen networks.

All-online: The consumer shift to online channels reduces expenditure for vendors on staff and physical stores. CSPs need a consistent and continuous presence on all major online channels, enabling consumers to switch smoothly from app to web store to offline store. As network infrastructure providers, CSPs should be building ubiquitous connections for users.

DIY: Putting control in the hands of consumers, DIY or DIWO (Do it With Others) where consumers help design or improve services increase satisfaction levels. There are two key takeaways from DIY: one, personalization must be proactive based on big data analytics to create markets of one; and two, services and products should be flexible and easy to configure so users can adjust services as needed.

Social: The fact that people like sharing on social media should be reflected on the customer journey. CSPs should use multiple and targeted social media platforms to promote, engage, and serve customers. Building communities around services and products allow users to communicate and support each other, and to listen to feedback on social media from users and potential users to analyze sentiment. Engaging with consumers will maintain relationships and encourage them to spread the word as advocates, especially if they have the tools do so.

Quantitative layer

The quantitative layer uses monitoring tools to measure performance in digital systems and transformation domains. These give a number rating and detailed recommendations for improvement.

Specially designed granular objective metrics and tools can measure the systems in one domain and recommend how to optimize that domain. Huawei's U-vMOS solution, for example, uses metrics to measure the experience and performance of video services and give suggestions on improvements. Other such solutions can be designed for other domains.

A digital maturity model should be a comprehensive system that covers organizational strategy and operations. The industry as a whole can come together and enrich the maturity model beyond the capabilities and insights of any single company. ▉

The industry as a whole can come together and enrich the maturity model beyond the capabilities and insights of any single company.

Stepping up to the plate
of digital transformation

Traditional service providers are getting ready to face a number of new, tough challenges as the telecom world digitalizes. At the same time, Internet players like Google and Facebook are investing heavily with a view to taking the reins of the industry and leading it forward.

By Karim R. Lakhani, Professor at Harvard Business School,
Daniel P. Donahue, Principal at Keystone Strategy,
Zhao Bo, Solution Architect at SPO Lab, Huawei

Karim R. Lakhani
Professor at Harvard Business School

Three forces are making the telecommunications sector especially volatile. First, the nature of communication services is shifting to become asynchronous and more fault tolerant. Second, a major technological change in infrastructure is happening with software defined networking (SDN) and the commoditization of hardware. Third, a new generation of network players have the incentive and means to reshape the telecom sector.

Critically, new business models coupled with rapid revenue growth and higher profitability have given Internet players financial parity with telcos. These Internet companies are taking advantage of network advances, partnerships, and vertical integration on a global scale at an increasing pace. By substituting and commoditizing traditional communications services, they're shrinking telcos' margins and forcing them to innovate.

Although the challenges are certainly real, telcos have a diverse asset pool that can help them counterpunch: They control last-mile connectivity, have existing billing relationships with customers, run retail distribution networks, and operate support networks that are difficult for Internet players to replicate. By combining these assets with the power of new digital platforms, telcos can deliver differentiated offerings in many of the emerging digital communications areas, from smart homes to connected cars to drone data platforms and industrial IoT programs.

Our research team comprises researchers from Harvard Business School, consultants from Keystone Strategy, and members of the Huawei SPO Lab leadership team. We joined forces to study the

Five-step Best Practice

1

Create a roadmap for service transformation

2

Adopt top-down ownership

3

Assemble the right capabilities

4

Engage customers in experimentation

5

Run rapid iterations

Define the best starting points for digital transformation to begin creating value, key milestones for service transformation, how a company will differentiate itself through service innovation, and how it will monetize these offerings at different stages of evolution.

The strategic direction must be established by leaders and echoed throughout the organization.

Providing post-transformation telecom services will require new capabilities in areas like data science and software development. A successful approach must integrate these new capabilities with deep product, operations, and business knowledge.

Companies need to share their roadmaps and engage with customers in joint data-driven experiments, using their roadmap and simulation results to test and refine hypotheses.

Minimize the scope and time it takes to run experiments, start delivering outcomes to customers, and provide rapid feedback.

challenges that exist in the sector and develop a plan for addressing them. Over the past few years, we've studied digital transformation across dozens of industries and examined opportunities and challenges in various companies, including General Electric, Facebook, Nike, and Uber.

We've talked to hundreds of executives and accumulated data from many industries to examine how traditional business and operating models are changing. And they're changing fast – we believe the next five years will be instrumental in deciding which new companies will sustain their momentum and which old ones will transform and survive. We learned that there are certain basic principles to digital transformation and that the ability to adapt relies on understanding the forces that are causing business models to change.

The impact

Our research shows that digital transformation requires changes in management, organization, and technology. It also examines how competitors in traditional verticals like telecommunications view their business and operating models: business models define the direction taken by an organization and how it creates and captures value; operating models define how an organization heads in this direction and how it delivers the value promised by its business model.

First, digital technology changes the way an organization can create value. Digital value stems from new, network-centric ways that a business can connect with partners and customers with new business combinations. Value is captured by new data and embedded

and shared in networks, increasing as the network expands. This means that business models are increasingly network-centric and data-oriented.

Second, the opportunities for capturing the value an organization creates are rapidly expanding with pricing technology innovation, ubiquitous sensors, and increasing business instrumentation. These factors offer completely new ways to drive price differentiation, efficiency, and accuracy. An increasing portion of the value captured is also shared with partners, customers, and community participants, because the locus of any business model expands into business networks and communities.

Third, delivering these new business models is tricky and requires new operating models. This is because operating digitally can change the very foundation of an organization, including timescale and locus, the way it experiments with new concepts, and how it delivers products and services to customers. Digital transformation can provide significant opportunities for using legacy assets to create and capture value in new ways. But without adopting a new, digital operating model, the same assets will be stranded and lagging organizations will be on their way out.

Despite the different nature of digital

business models, traditional telcos can still leverage significant assets and capabilities to innovate and drive sustainable differentiation for new entrants. However, delivering new digital business models requires building a digital operating model as a platform, like Amazon AWS or Salesforce's force.com. This platform is essential because it embodies a set of technological building blocks for creating new solutions more quickly and packaging decades of capability, investments in assets, infrastructure, and a vibrant partner ecosystem.

A platform for telcos

With a strong regional asset base and good customer relationships, telcos have a number of advantages over Internet companies. But, they need platform capabilities to innovate beyond traditional business models and direct monetization. We see a clear opportunity for a multi-sided platform approach to bring global scale, ecosystem engagement, and indirect monetization capabilities. This is necessary to compete in the ecosystem control points that are emerging across consumer and industrial IoT in areas like smart homes and drone tech.

Both a top-down and bottom-up approach is required to build support for key horizontal platform enablers. For example, data platform, analytics, and marketplace capabilities should

be explored within the context of specific pilot offerings to support a broad set of initiatives.

AT&T's Digital Life platform is an example of combining traditional assets with a digital platform to produce a differentiated offering. AT&T developed an open API program and partnered with hundreds of device manufactures to provide its existing customer base with an array of home security and automation services. The telco's dense network of installation capabilities and existing customer support operations let it quickly roll out the offering within its own regional network. Now AT&T has extended the digital platform and partner ecosystem that enable Digital Life to other telcos around the world. In summary, they're using their own regional assets to deliver smart homes to customers.

The emerging drone ecosystem allows telcos to explore opportunities beyond connectivity, because they can bundle services and capabilities that build on their unique, regional assets. We recently worked with a global telco to evaluate a digital platform for drone operators and identify the market opportunities for data processing, management, and analytics that fit telco offerings. With existing regional cloud infrastructure assets, strong enterprise sales and billing relationships, and the

Digital transformation is most effective when it drives collaboration and experimentation across different stakeholders in the value chain.

capabilities to address unique connectivity and edge compute requirements, telcos are uniquely positioned to consolidate this nascent, highly fragmented space.

Platform-fueled innovation

We've distilled the best practices observed in our research into five steps:

One: Create a roadmap for service transformation

A roadmap is necessary to set a clear, aligned long-term vision and strategy. It should define the best starting points for digital transformation to begin creating value, key milestones for service transformation, how a company will differentiate itself through service innovation, and how it will monetize these offerings at different stages of evolution.

Two: Adopt top-down ownership

Because of the complexity of transformation, senior level ownership is an absolute must. More so than for other technology disruptions, digital transformation requires multiple company functions to act in concert, so the strategic direction must be established by leaders and echoed throughout the organization.

Three: Assemble the right capabilities

Providing post-transformation telecom services will require new capabilities in areas like data science and software development. A successful approach must integrate these new capabilities with deep product, operations, and business knowledge. Engineering, service operations, and sales and data science teams should work together in an integrated manner. But while digital transformation initiatives should subsume multiple business functions, it's important to insulate the teams that develop new products and services from the pressures and incentives of traditional business so as to maximize their effectiveness. Digital transformation projects can be incubated within business development or the CTO's office, and then expanded outwards.

Four: Engage customers in experimentation

Digital transformation is most effective when it drives collaboration and experimentation across different stakeholders in the value chain. Companies need to share their roadmaps and engage with customers in joint data-driven experiments, using their roadmap and simulation results to test and refine hypotheses. It's important to pilot opportunities that use the scale of available data to go beyond what either the telco or customer can do alone, and focus on new, quick wins that emerge from collaboration.

Five: Run rapid iterations

Minimize the scope and time it takes to run experiments, start delivering outcomes to customers, and provide rapid feedback. We've observed a wide range of new and traditional organizations, and in virtually every case, the right solution can surface through rapid, low-cost, iterative experiments with customers. **H**

Smooth border crossings for transformation

The need for telcos to transform is well-known. How they should go about doing so is less clear, especially for those with border-spanning businesses. Challenges for multinationals include non-standardized network architectures coupled with a slew of inconsistent regulations, market maturity levels, and local talent profiles.

By Eddie Gonzales & Christian Kelly, Accenture Strategy
Min Dengfeng, Senior Manager at SPO Lab, Huawei

With telcos limited by their current infrastructures and business models, webscalers are sprinting ahead in the innovation race. To keep up, telcos must think about executing five key initiatives:

Future networks: updating networks to IP- and SDN/NFV-based architectures that automate and make infrastructures smarter, and moving from closed architectures under single vendor systems to open architectures with multi-vendor solutions and retiring legacy PSTN networks.

Digital customer engagement: digitalizing the customer experience to provide consistency across continents and digitalizing OSS and BSS, and increasing the share of e-transactions and interactions to reduce dependence on costlier physical interactions.

New business models: providing converged experiences and products and alternative monetization

strategies, and collaborating closely with partners to drive innovation and replace declining legacy revenue streams.

Developing talent: acquiring new talent and re-training existing talent. Next-gen networks require new capabilities from staff, but in many countries layoffs are difficult, expensive, and time consuming. Retraining existing employees is a better alternative.

New service focus: providing value added services like cloud, IoT, platforms, and XaaS.

While each initiative is important, it's unclear how operators should orchestrate transformation because executing any of the five is complex in a multinational environment.

Learning from the leaders

Some of the current best practices include:

Execute a global operating model regionally: The global organization must set the transformation vision, but allow regions to act autonomously. Regions can then use their local market expertise to make quicker decisions, empowering local teams – those closest to customers – to execute transformation. Headquarters must define the boundaries of each region's authority by carefully balancing autonomy with ensuring consistent operating models and capabilities across the broader organization. CTOs have pointed out that trust is a key issue in this regard.

Balance the five transformation initiatives: OpCos can't prioritize just one initiative, because core transformation

initiatives are co-dependent. For example, new services can't be launched without a future network, which in turn can't be deployed without the right talent.

Simplify product portfolios and shed non-core businesses: These steps can reduce transformation complexity and focus management attention on the products and services that will drive future growth. Operators must balance simplification for the future with serving current customers, bringing them along on the transformation journey. Examples include focusing on specific segments, setting up digital channels, and increasing mobility. By rationalizing its products, one global operator cut costs by 29 percent across the following areas: product development, IT, sales & marketing, order management, installation, and customer support and billing.

Develop product/customer-centric organizations: As operators integrate fixed and mobile services, they should restructure their organizations to reflect product and customer segments. Managers can then better understand customers, tailor current offerings, and develop future strategies. A study of 37 firms that executed similar customer and tech restructurings demonstrated an average increase in ROA of more than 11 percent after five years.

Experiment in small markets: Leading operators with OpCos in multiple countries can trial new products in different markets. Doing so in smaller countries is easier due to quicker execution speed and lower risk, and allows operators to refine processes and make rollouts in larger markets faster and less risky. One European

operator trialed IP migration and its first NFV projects in Croatia, Hungary, and Slovakia based on risk and speed advantages due to these countries' sizes.

Acquire new skills and retrain existing employees: When legacy networks are phased out and SDN/NFV based networks are deployed, operators must define a new talent strategy. New network architectures require new skills and agile methodologies that existing staff may not be able to learn. Leading operators will have a plan for attracting new talent, retraining existing employees, and transitioning employees who can't be retrained. Operators must get the timing and extent of these transitions right to match business needs in each phase of transformation.

One European operator, for example, expects to run its network with 50 percent fewer employees by 2025, and plans to retrain its existing workforce. It's moving its SDN experts from its systems integration organization towards the telco infrastructure domain to support the IT side of the new setup.

According to a recent system integrator survey, hiring and retaining talent is a top concern of 81 percent of executives, and 84 percent agree that the workforce of the future will be structured more by projects than by functions.

Balance the old and the new: Operators can't transition to next-gen networks and operating models immediately, and must transition customers away from legacy products and services in each of their OpCos under a workable plan. The pace of transition will vary between regions, and should include global targets for retiring legacy offerings that allow local management to adjust goals based on local market realities. Operators who don't balance their legacy and digital worlds are not meeting customers' increasingly demanding needs and will struggle.

A recent system integrator survey showed that 30 interviewed executives agreed that: "If [legacy operators] switch off too early, they lose their customer base, they lose revenue, they lose market share that will be almost impossible to recoup."

Big scale, big advantages

Even the most advanced multinational operators will find transformation a complex undertaking. A successful approach requires operators to embrace all five transformation initiatives and learn from industry leaders. This will position them to better compete with webscalers and translate their scale, access to talent, and diverse business culture into lasting competitive advantages. **H**

A successful approach requires operators to embrace all five transformation initiatives and learn from industry leaders.

Collaboration LEADS developers to help industry hurdle the last mile

Developers play a critical role in supporting industries over the last mile of digitization and cloudification. With a commitment to LEADS (Lab as a Service, End-to-End, Agile, Dedicated, and Social), Huawei is developer-centric and aims to become a supporter, enabler, and agent of developer success.
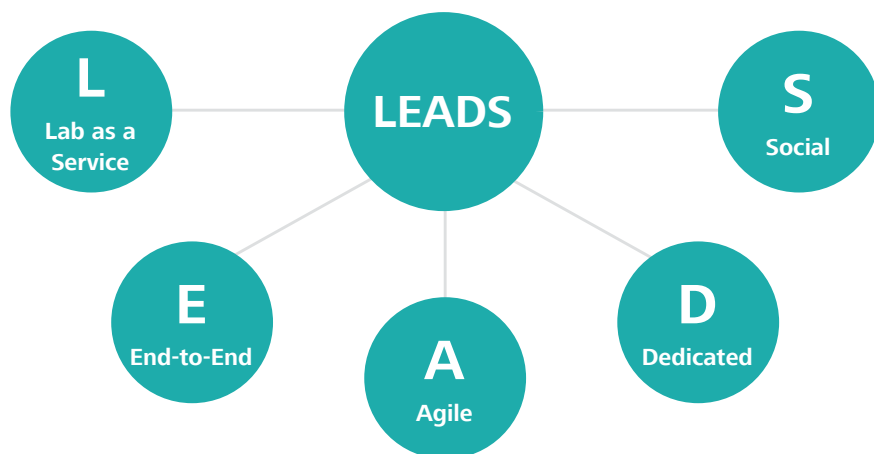
By Ryan Ding, President of Products & Solutions, Huawei

Developing an application within 10 minutes and launching it globally within 5 minutes…This isn't a vision for the future, but an experience that can be realized today. On September 1, 2016 at the Huawei Developer Community booth at the Shanghai World Expo Exhibition & Convention Center, one of Huawei's partners demonstrated this dramatic innovation. Using Huawei's video communications and online translation solutions, they successfully used drones to inspect long-distance power grids, a job which previously had to be done by an inspector in person. And the developers were able to send data back to data centers in real time.

There are many more examples. At HUAWEI CONNECT 2016 in Shanghai, Huawei demonstrated how to use FusionStage to launch online applications for mobile office work on Digital inCloud and deliver rapid upgrades. It took just five minutes to add three functions to a partner application: reimbursement, procurement, and general. These are stunning new levels of speed and efficiency.

These examples are just some of the results that Huawei has achieved with its Developer Enablement Plan over the past

Together: Dream Big, Fly High
在一起，梦飞扬

CONNECT 2016

HUAWEI

L Lab as a Service

LEADS

S Social

E End-to-End

A Agile

D Dedicated

At Huawei Developer Congress 2015, Huawei announced that it would spend US$1 billion on its Developer Enablement Plan.

year. At Huawei Developer Congress 2015, Huawei announced that it would spend US$1 billion on its Developer Enablement Plan. So far, Huawei has invested US$300 million. US$200 million was used to build a developer enablement platform, improving the developer

experience and enabling developers to create innovative solutions more quickly. The remaining US$100 million was used to build a global marketing platform, where Huawei works with its partners on co-marketing and helps them monetize their solutions and applications.

LEADS: Redefining developer experience

Lab as a Service: Huawei has increased the number of Open Labs from 1 in Suzhou to 13 around the world. We now have Open Labs in the UAE, the UK, Italy, and Latin America. These Open Labs help to migrate end users from traditional networks to cloud-based networks, and give global developers local access to Huawei resources.

End-to-End: Huawei aims to provide end-to-end solutions. In addition to supporting the development of applications, Huawei also provides services such as online learning, experience management, service delivery, and online verification. The most important thing is that Huawei provides a marketing platform for its partners. A few months ago, Huawei launched the Marketplace, which allows partners to demonstrate their solutions online.

Agile: Within just three months, Huawei's developer enablement platform has evolved from individual tools to a whole suite of tools, including online APIs, Huawei-guided product development, and an application development pipeline and dashboard. For example, vMOS, a tool used to measure video experience,

and gMOS, a tool used to measure game experience, were created specifically for developers. Huawei has opened up its network capabilities, which used to be a black box that developers couldn't access. Now they have a better understanding of the interactive experience, loading experience, and streaming media experience that their games offer, and can make targeted improvements to applications based on location or specific use scenarios.

Dedicated: Huawei has upgraded its product-based services to scenario-based services. For example, in the financial sector, Huawei can offer big data services for credit checks, helping banks check the credit ratings of those who apply for credit cards. And Huawei doesn't just give traditional technical support; we also support customers as they use our products in different scenarios. We also don't just give online services like DevCenter, video, e-mail, and hotline; we also offer offline support such as expert training and learning.

Social: Huawei interacts with developers in a variety of ways, including a dedicated website, forums, WeChat, and our developer apps. Through these channels, Huawei communicates with developers, offers feedback and support, and collaborates with them on new innovations. Huawei also takes engagement offline. For example, in April 2016, Huawei held its first three Huawei Developer Gatherings (HDG) in Shanghai, Nanjing, and Xi'an. We plan to bring these to Chengdu, Wuhan, Beijing, and Shenzhen in

the coming months. In 2017, Huawei will take this event to Europe and the Middle East.

In just one year, the number of developers registered on the Huawei Developer Community has jumped from 2,000 to more than 25,000. They've created more than 230 innovative solutions and over 800 applications. Huawei hopes that the community will attract 1 million developers by 2020.

FusionStage: Accelerating innovation for partners

Huawei will enhance its capacities in three areas. First, Huawei will expose more of its ICT capabilities to support industry digitization. Second, Huawei will create a new innovation platform – FusionStage – based on the LEADS concept to accelerate innovation by our partners. Third, Huawei will continue to improve its marketing platform by offering one-click access and a global reach as soon as developers sign a contract with us.

At Huawei Developer Congress 2015, Huawei said that it would focus on LEADS, expose platforms like eSDK to support developers, work with partners to drive industry digitization, and jointly build a Better Connected World. At HUAWEI CONNECT 2016,

Huawei expanded the LEADS concept and upgraded eSDK to FusionStage, a new developer enablement platform that makes innovation easier for developers.

In 2016, Huawei increased its number of communities for developers from 12 to 14. We're now able to improve and integrate APIs for different scenarios, and are focusing on innovating industry-specific solutions. FusionStage is one of the first group of PaaS products developed by Cloud Foundry-certified providers. It's been well-received due to its high efficiency, high performance, and ease of use. For example, FusionStage's big data analytics function has allowed Suzhou Bank and Sichuan Rural Credit Union & Cooperative Bank to cut the time it takes to complete a credit investigation from two to four weeks to two to five seconds.

With FusionStage, debugging time has been cut from hours to minutes, the number of unresolved bugs is down by 90 percent, and system launch time is down from days to minutes. Developers can use FusionStage to develop, test, deploy, and operate their solutions, all via Huawei's one-stop-shop services. With its evolving developer enablement platform, Huawei aims to work with partners to create an open developer ecosystem in which all parties win and develop the

With FusionStage, debugging time has been cut from hours to minutes, the number of unresolved bugs is down by 90 percent, and system launch time is down from days to minutes.

With a commitment to LEADS, Huawei is developer-centric and aims to become a supporter, enabler, and agent of developer success.

industry together.

Helping partners rapidly monetize solutions

At HUAWEI CONNECT 2016, Huawei demonstrated Digital inCloud, a highly efficient global marketing platform. We demonstrated how it provides comprehensive support so that developers can monetize their innovations more easily. Digital inCloud offers one-click access coupled with a global reach. It allows developers to understand local markets, share global business opportunities, and work with Huawei to promote and sell products. One of Huawei's partners, which provides call signature services, made only 70,000 yuan in 2014. After it registered on Digital inCloud, its service was used by 24 carriers in 15 countries, bringing the company 40 million paid users and 4 million yuan in revenue.

In marketing, Huawei has jointly exhibited with its partners at ICT roadshows in 300 cities around the world, and 8,000 independent software vendors (ISVs) have worked with us. We've delivered more than 500 projects with ISVs, helping them increase sales by more than US$300 million. Huawei's Digital inCloud is connected to more than 200 carriers and nearly 400 million users from over 175 countries. Since its inception, we've racked up over 4.4 billion app uses, including SMS and call services, connected through our APIs.

Huawei is one of the few companies in the industry that can credibly provide both CT and IT products. Our open platform provides every capable developer with huge opportunities for innovation. The Developer Enablement Plan, which includes our open ICT capabilities, an innovation platform, and a marketing platform, is forming a virtuous cycle of new businesses.

With its developer enablement platform, Huawei hopes that it can quickly help more partners succeed. And Huawei is confident that with its global sales channels, it can help more partners achieve commercial success more quickly.

Wulian, an IoT solutions provider based in Nanjing, developed a Smart Home solution by innovating on Huawei's OpenLife platform. Just six months after its launch, the solution has been successfully deployed in the Smart Home project of China Unicom Sichuan. And it will soon be offered by Beltelecom in Belarus and also in six Latin American countries.

There is an urgent need for more developers in every industry. Developers play a critical role in supporting industries over the last mile of digitization and cloudification. With a commitment to LEADS, Huawei is developer-centric and aims to become a supporter, enabler, and agent of developer success. Together with developers, we dream big to fly high. ▪

Cloud Era: Growing Together with Partners
云时代，与伙伴一起成长

HUAWEI CONNECT 2016

Up in the clouds together

"If you want to go fast, walk alone; if you want to go far, walk together." The cloud era is not dissimilar to this saying – openness and collaboration are the keys to enabling Huawei, telcos, and our partners to thrive together.

By Zou Zhilei, President of Carrier BG, Huawei

A lasting new era

It's hard to imagine exactly what changes the cloud will bring, because looking into the future is always difficult. So, let's reverse direction and look back to the Industrial Revolution. The first steam engine was invented in 1860 by Scotland's James Watt. Back then – 156 years ago – it was impossible to imagine that the next century would bring with it such a flourish of roads, railways, bridges, airports, harbors, and other man-made structures. Could people then have pictured what our lives today would look like? Probably not – the changes have been too vast. We believe that the cloud revolution will be the same, far outstripping the power of imagination.

We also believe that the cloud era will see a market divided into different segments, where dominance by just one or two companies in a given industry will be impossible and where every company worth anything will find its own place. We're now ready to explore for ourselves the railways, roads, airports, harbors, and bridges of the cloud revolution. We're now ready to ask the question: What exactly is the business logic of the cloud?

Cloud is connectivity

The connectivity engendered by cloud includes both the number and quality of connections. The first telco, Bell, was founded 140 years ago. Since then, global carriers have connected 7 billion mobile subscribers and 800 million broadband subscribers with

> *Cloud is now shifting from a support system to a production system. Virtual reality (VR) and augmented reality (AR) are growing in stature, as are their bandwidth and latency demands.*

7 million wireless base stations, 14 billion km of fiber strands, and 1.3 million km of submarine cabling.

Huawei has built 2.68 million base stations – that's one in every three across the globe. Our base stations can be seen everywhere, including the world's northernmost city, Longyearbyn, and its southernmost, Puerto Williams. At Mount Everest base camp, Huawei and China Mobile jointly constructed the highest base station on earth at more than 5,000 meters above sea level. Such extensive coverage is no easy task. It takes massive investment over multiple decades to build a global communications infrastructure, and so it's unlikely to become obsolete any time soon by a few drones or balloons.

Cloud is now shifting from a support system to a production system. Virtual reality (VR) and augmented reality (AR) are growing in stature, as are their bandwidth and latency demands. Cutting latency to 20 milliseconds requires a data center every 200 km, and that's why telcos are the best partners for developing the cloud. Likewise, telcos have an advantage when it comes to the connections that underpin the industry's move to the cloud: Their hard-earned infrastructure is both a power base and a competitive edge.

Cloud is service

The key challenges of building a cloud are running it and delivering services over it.

In Dongguan, for example, Huawei helped install 300,000 cameras in the city, which breaks down to 36 cameras per 1,000

people. In comparison, the US averages 96 cameras for every 1,000 people. To achieve the same coverage, Dongguan needs another 500,000 cameras. The international consultants HIS estimates that the number of cameras will double every two years, meaning that Dongguan will soon be home to 1 million cameras. Between 5 percent and 10 percent of these will be offline for maintenance every year. Who has the capacity to deliver the maintenance? We've identified many different scenarios that need to be addressed, including security for construction sites, restaurants with open kitchens, rural development, and CCTV for enterprises. Different needs require integrated solutions, so cloud service providers need to be in constant contact with customers to fully understand their needs. They must also be deeply integrated into local markets to deliver powerful services. Global telcos possess huge offline strengths, with a total of 5 million employees, 200,000 local exchanges, and countless customer service points across the globe. Thus they are in the best position to address offline challenges.

Another example is the e-Government Cloud in Jiaxing City. Jointly built by Huawei and China Telecom, construction was relatively simple, with service migration the major project feature. Jiaxing city government gave us a target: Residents should only have to queue up once to access any administrative service. We had to connect all municipal departments – industry and commerce, tax, police – to enable smart e-government. Huawei, China Telecom, and our partners worked with each department to find the right algorithms and how to connect them. That's why cloud is a service.

Cloud is transformation

Telcos everywhere are talking about digitization and cloudification, and they have vast untapped potential to deliver cloud services, big data analytics, artificial intelligence, the Internet of Things, and other new technologies and services.

Two years ago, our Carrier Business Group (BG) launched the Three Cloud platform comprising the Customer Solution Cloud, Experience Cloud, and Knowledge Cloud. The project moved our customer solutions, experience, and knowledge onto the cloud. We obtained 30 billion pieces of data from third parties, and used eight dimensions to analyze our customers' networks to better understand their needs and pain points. Many local staff distilled their practices and experience into algorithms. The algorithms that proved to be successful in market tests were named after their inventor, so now Huawei has a string of network algorithms named after its researchers. This system has proven to be a powerful motivator for unlocking the creativity of our experts.

After two years, our Three Cloud platform has 113 channels, 6 communities, and over 800 experts available for online consultation. As the platform has matured, we've seen an explosion in demand for expert consultation. Experts who give more

get more followers and recognition.

Many of our customers are worried about whether they can adapt to the networks, markets, and speed of the cloud era. We should not be afraid of experimenting, including jointly with our partners. By trying new things, we will find partners who share the same goals and be able to transform with cloud.

Cloud is trust

Over the next decade, enterprises will move 85 percent of their applications onto cloud. But, cloud's shift from a support system to a production system won't be quick, because the transition will involve processes, organization, profit models, human resources, and knowledge. Our partners and customers will all face challenges alongside us. Now and for much of the cloud era, everyone will be half-in and half-out of the cloud; for example, verticals that are crucial to our economic well-being, safety, and security like governments will naturally be extremely cautious about sweeping changes.

We must also engender the trust of our customers. When we signed an agreement to develop public cloud with Deutsche Telekom (DT), we faced a new market with new tech and new processes, which led to disagreements. But, we built up strong mutual trust with DT's

senior management, including the CEO. And that gave us the ability to experiment, to change processes and organizational structures, and ultimately to earn DT's trust.

Trust is not a simple contract. It means persevering to achieve mutual goals, compromising to recognize the interests of our partners, and facing unknowns together.

Cloud is ecosystem

Openness and collaboration are key features of the current era. This past year, Huawei has worked with DT, China Telecom, Telefónica, and other leading global carriers on public cloud development, and our success portfolio is growing into something that can contribute much to the global ecosystem.

Moving upwards together

Cloud is connectivity, service, transformation, trust, and ecosystem. Many players worry that they could lose their competitive edge overnight and get left behind; however, in reality now is the time to jointly experiment and grow together.

Everyone tends to overvalue the short-term impact and undervalue the long-term impact of cloud – it's here for the long haul. And to travel far, you cannot travel alone. ◧

Open source
powers the cloud ecosystem

In a world powered by software, there's simply too much software to write. No one company can do it all, and that's why the best tech companies in the world all use open source. Jim Zemlin, Executive Director of the Linux Foundation, wants everyone to join the Foundation's endeavor and thus build the greatest shared technology asset in history.

By Jim Zemlin, Executive Director of the Linux Foundation
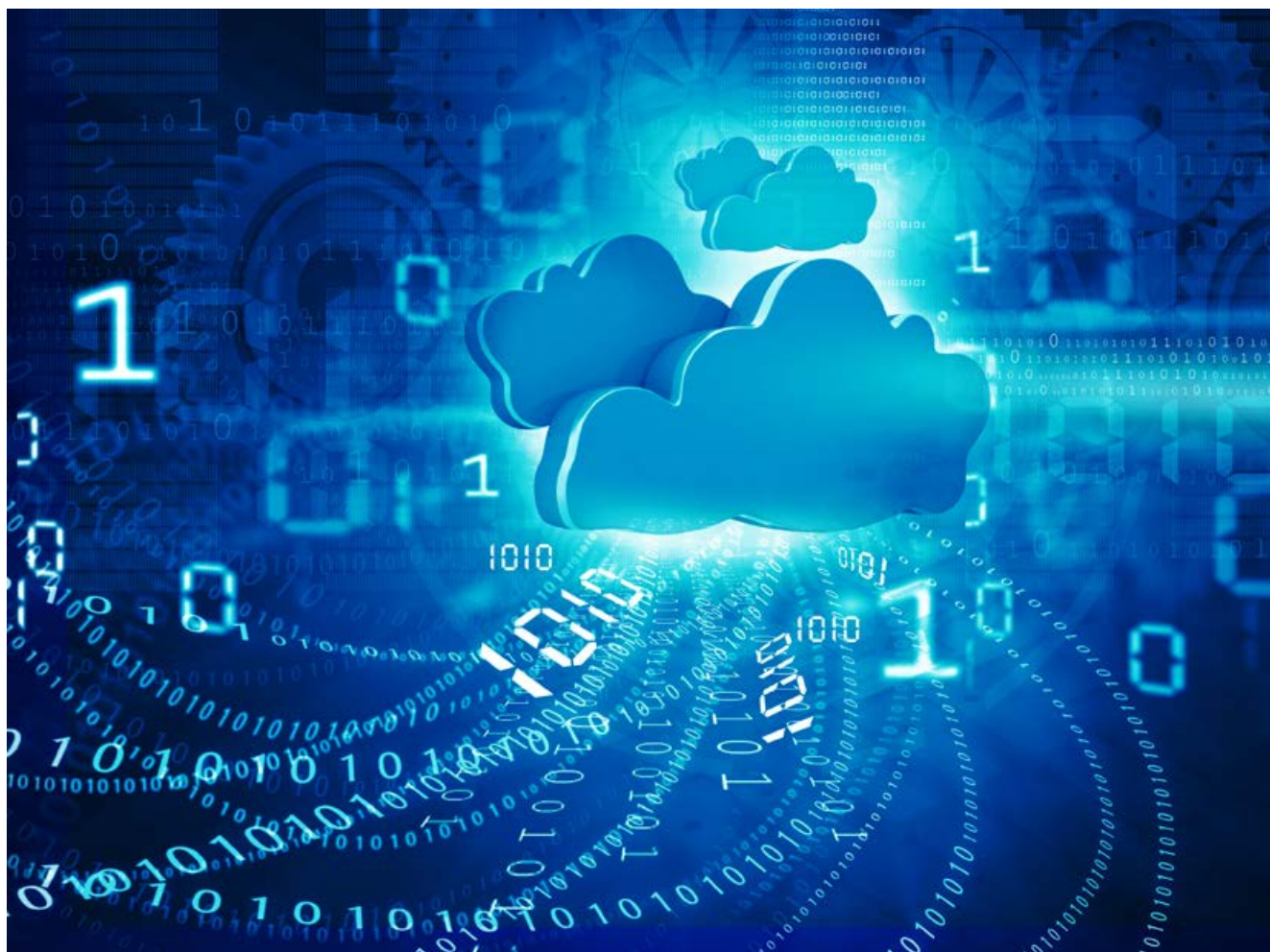
Jim Zemlin
Executive Director of
the Linux Foundation

Linux: Forging history

Open source is hugely important, and the Linux Foundation is working with thousands of organizations like Huawei to build the greatest shared technology in history. Linux is the best example of the power of open source and collective development.

Today, over 3,900 developers working for over 100 companies are producing over 53,000 files, 21 million lines of code – a Linux platform – worth billions of dollars. Linux literally runs most of modern society, it runs the vast majority of the world' stock markets, and it runs the global economy. It holds the majority market share in the mobile device-embedded systems industry. It runs virtually all high-performance computing systems. Linux is by far the most successful software endeavor in history.

And it's not just the breadth or size of Linux; it's also the velocity of Linux, which continues to accelerate: 10,800 lines of code are added, 5,300 lines of code are subtracted, and 1,875 lines of code are modified in Linux. One project every single day. Think about that, Linux changes eight times per hour.

No single company and no single organization can keep up with that development pace. And the good news is they don't have to. Any organization, any individual can use Linux for open source software and leverage it to create the technology products and services that are going to define the future. Because, the future is open, and open is here to stay.

Open is here

Today, there are over 3.8 million open source contributors creating 31 billion lines of code across a wide variety of open source repositories that are available to anyone on earth. There are billions of dollars being invested in open technology based companies. In Silicon Valley where I'm from, hundreds of companies are receiving investment, and ten of those companies are worth a billion dollars each. This is an amazing transformation from a world where technology companies that build everything themselves to one where you

Thousands of companies, tens of thousands of developers are all competing to get the best code into those projects.

cannot compete if you try to build everything yourself.

We're entering a new era of open source. The first generation was somewhat simple. Open source software was used to create a free alternative to existing proprietary technology, whether competing in operating systems with Linux or in databases with MySQL. These free alternatives to existing technology were essentially shrinking markets by offering free alternatives.

But that's all changed. Open source is opening up new markets. Open source software is creating new ecosystems. Open source software is creating the interoperability standards that power these ecosystems, whether it's in big data, or if you see companies based on Hadoop, or whether it's in container and cloud technology with open source projects like Coopernetics and Docker. What we're seeing here is the industry is recognizing that we can create new opportunities and new ecosystems by working with open source software, because the future of the cloud is going to be made of open source software.

At virtually every layer of the stack, an open source project is leading, in innovation, in developer adoption, in terms of the pace of development, in terms of every perspective of building ecosystems around them, whether it's at the lowest layer of the stack in data plane services to projects such as Open vSwitch and others, or whether it's a little higher up the stack in management or in orchestration with OPEN-O.

I stood on stage at the World Mobile Congress earlier this year and announced the OPEN-O project with Huawei and China Mobile. China Mobile said at that event that their future, the OSS (the operational support system that they use to run their network) is going to be based on open source software: OSS based on OSS.

Think about that. That's an amazing change. And all the way up to programming frameworks, like Node.js, with server-side JavaScript which is the fastest growing web technology platform in the world. At every layer of the stack, we see a form of organic innovation that you've heard about.

Thousands of companies and tens of thousands of developers are all competing to get the best code into those projects. And at the Linux Foundation, we host almost every one of these projects. We thought to ourselves that in addition to these projects, which are doing extremely well at every layer of the stack, how can we accelerate innovation up and down the stack?

As we're working with companies like Huawei, we created a series of new initiatives in the last couple of years, to create more secure and stable software for everyone. In security, we worked with organizations like Intel, Huawei, and over 20 top technology companies in the world to create an initiative where we can teach open source developers to write more secure software in the first place, to do better threshold modeling and testing, and formulate better responsible disclosure policies.

Our idea here is that if we can teach all of these developers to write more secure code on day

one, there will be less vulnerabilities when open source software is deployed as commercial products much later. We're creating a governance structure that allows all of these open source projects to create great ecosystems, to be able to scale up incredibly fast, and meet the needs of thousands of developers working continuously in harmony. We're creating a governance structure that allows all of these companies to invest in these open source projects and know that the intellectual property assets, that the code itself, will be freely available for everyone for decades to come.

We're accelerating open source by teaching thousands of organizations how to manage intellectual property (IP). In the technology industry that's based on IP, we want to teach organizations how to manage the open source licenses, the patent commitments, and other intellectual property aspects of sharing. We want to do this because it's important to teach everyone that sharing is important, but also how to keep what you want to keep while sharing at the same time.

Finally, the Linux Foundation is working with organizations like Huawei to create training and certification programs to ensure that as the pace of open source development accelerates, the availability of practitioners of that software will meet demand in the market as people adopt this software.

Huawei is leading the charge

It's truly an amazing time to be involved in open source. And Huawei is leading this effort. Huawei is a top contributor to OpenStack, which is one of the biggest cloud computing efforts in the world. They are a top five contributor to the Hadoop project, which is defining the big data space. They are a top two contributor to and a founding member of the cloud native computing foundation, which is home to Coopernetics and other cloud orchestration projects. They are a top four contributor to Spark, and they're leading almost every major open source project.

Huawei is not just a top open source company in China; it's a top open source company in the world. And here's the important thing, it's deliberate and a lot of hard work. You see, if 80 percent of the software in any technology product or service is open source, which is where we are today, companies who know how to manage external research and development are going to win.

If most of the code in your products comes from outside your organization, you need to be good at leveraging open source. And so, more than five years ago, Huawei made the decision to take this seriously. They created

organizations inside their company that specialize in managing open source, created the strategy to pick the right source projects to base their products on, and integrated open source development into their procurement process and into their actual engineering processes. They did this to bring code in to their company, modify it, create products with it, and then share the changes that they made to that code back with the open source projects that they got the code from in the first place, creating a virtuous innovation cycle, not just within Huawei, but with hundreds of other companies as well.

This took deliberate planning, this took training, and it took considerable effort. And you can see here, by just looking at the results of that endeavor, how effective it has been. Because Huawei understands what all leading technology companies understand, there's simply too much software to be written for any one company to write.

As we all work together to create the greatest shared technology asset in history, it's not just that there's too much code for any company to write by itself, it is in fact a more important idea: all of us together are smarter than any one of us is alone.

Good companies create products, but great companies create ecosystems based on open source.

5G will amp up connections

The unprecedented levels of connectivity offered by 5G will revolutionize the experience for businesses and consumers, with IT and hyper-connectivity driving the digital transformation of production, sales, and business models across all verticals and giving rise to an array of smart applications.

By Bing Hongyan

Mobile broadband, cloud computing, and smart terminals enable ubiquitous connectivity, transforming the way we sense the world around us. By 2025, it's estimated that the number of connected devices will hit 100 billion worldwide. From next-gen 5G communication networks, we can expect hundreds of billions of connections, ultra-low latency of 1 ms, and 10 Gbps transmission speeds.

Spanning all verticals, digital transformation is starting to shift user experience away from text, image, voice, and HD video. Immersive virtual reality (VR) and augmented reality (AR) are destined to spearhead the new wave of

5G-boosted experiences underpinned by mobile cloud.

5G will focus communication networks away from people and onto things. It will integrate mobile tech, big data, IoT, and cloud computing, and give rise to applications like enhanced mobile broadband (eMBB) services, intelligent driving, smart power grids, smart manufacturing, and mobile medicine.

eMBB: Always connected

MBB and smart devices will ensure that eMBB services and applications grow rapidly. Mobile video services already account for over 50 percent of the services delivered by telcos, and free-roaming VR and AR on mobile devices are emerging as the new direction for eMBB services. They will soon dominate social media, replacing text and image as the main information exchange mediums. To achieve this in high-traffic areas, Gpbs bandwidth and millisecond latency is essential for precise image processing, tracking, and transmission in real time.

5G will introduce new innovative solutions for uplink and downlink bandwidth, latency, network capacity, and energy-saving for a fantastic mobile experience.

The transition from 4K/8K HD video to anytime, anywhere free-roaming immersive services on mobile devices will place massive bandwidth demands on the

5G Network: Supporting the Digital Transformation of Different Sectors

eMBB Business

Smart Driving

Smart Grid

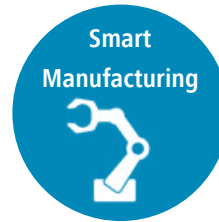**Smart Manufacturing**

Mobile Health

5G will enable anytime, anywhere free-roaming immersive experience, which will make eMBB services the killer apps in the early 5G era and drive the rapid growth of 5G tech.

Using 5G networks, intelligent driving technology will be safer and more efficient. By 2025, fully driverless vehicles are expected to become mainstream.
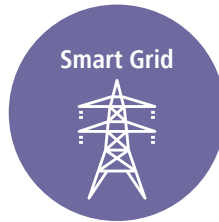
Smart grids integrate information, communication, and control technology with traditional power systems to improve power grid security, stability, and operating efficiency.

5G's unprecedented connectivity capabilities will transform production, sales, and business models that will benefit manufacturers and consumers alike.

Powered by 5G, the ubiquity of health monitoring and diagnosis will make for efficient, low-cost medical services that will lead to a much healthier world.

connectivity capabilities of network pipes. The strong demand for these services will make them the killer apps in the early 5G era and drive the rapid growth of 5G tech.

Smart driving hits the streets

Intelligent connected driving will connect vehicles to other vehicles and also to pedestrians, roads, and networks. Alongside big data analytics, the vehicular infrastructure will be interconnected and aware, improving safety and flow and lowering emissions.

Current short-range wireless networks can support communication over small areas

in ideal transmission conditions. However, non-line-of-sight (NLOS) communication involving complex road conditions or poor transmission environments complicates matters. Overviews of traffic information over wide areas for rapid alerts and collision avoidance are difficult with current technology. This is especially true in high-speed scenarios, where frequency offset, inter-cell handover, and interference from obstacles are all major issues because short-range networking tech is limited.

Cellular networks' propagation paths serving as connection channels will become far more significant as a result.

Using 5G networks, intelligent driving

technology will be safer and more efficient. By 2025, fully driverless vehicles are expected to become mainstream.

More energy with smart grids

Smart grids integrate information, communication, and control technology with traditional power systems to improve power grid security, stability, and operating efficiency.

Many nations across the world are implementing smart grid projects. In America, for example, smart grid initiatives more or less cover the nation. In 2009 with an anticipated 1:1 government: private investment ratio, the American Recovery &

Reinvestment Act (ARRA) allocated US$11 billion for smart grid investment covering 49 of 50 states. Numerous smart grid projects and R&D initiatives are also spread out over Europe.

Power generation facilities are undergoing the challenging process of digitizing form, scale, and power management and control. The communications systems for smart grids will cover all nodes on the power system, including power generation, transformation, transmission, distribution, and usage. Nodes in the power grid with communication requirements will include power generation facilities, transmission and distribution lines, substations, power plants, electricity meters, and dispatch centers. For example, with US$200 million in ARRA funding and US$378 million in private funding, the Florida Power & Light Company Smart Grid Project involves 2.6 million smart meters, 9,000 intelligent distribution devices, 45 phasors, and advanced monitoring equipment in over 270 substations.

End consumers of electricity are also becoming suppliers, providing power when they're not using it in a bidirectional usage model.

New energy strategies aim to improve the power efficiency of power systems by building an Internet of Power supported by high capacity, high-speed, real-time, secure, and stable communications networks.

As an exceptional integrator, 5G can support the diverse requirements of smart grids. 5G supports flexible wireless over-the-air connectivity, has excellent disaster recovery capabilities, and is more efficient and faster than fiber optic and short range wireless communications technology.

This is particularly true when constructing networks in places with complex topography such as mountainous areas or areas with water features. 5G network technology also supports ultra-high bandwidth, NLOS transmission, wide-area seamless coverage, and roaming.

Smart manufacturing

Smart tech for manufacturing will be based on communications infrastructure with higher capacity, bandwidth, storage, and data processing capabilities. Equipment will be automated and the system will provide flexible human-computer interaction and smart control.

Emerging manufacturing services will extend the boundary of products to include value-added after-sale services based on interconnected

Smart tech for manufacturing will be based on communications infrastructure with higher capacity, bandwidth, storage, and data processing capabilities.

Digital transformation is broadening and mixing business boundaries in all sectors, which will increase both diversity and uncertainty.

and controllable data collection and transmission systems covering the entire product lifecycle.

Typical smart manufacturing application scenarios include real-time E2E production process control, remote control, internal and external enterprise communications, and IoT for cargo. It includes supply chain management models that unify full product lifecycle management on a single network. 5G networks' wireless connectivity, high-speed, and low-latency capabilities will allocate supply chain resources and thus raise production and service efficiency.

5G's unprecedented connectivity capabilities will transform production, sales, and business models that will benefit manufacturers and consumers alike.

Mobile health for all

Mobile health applies mobile Internet tech to provide E2E healthcare, including disease prevention, counseling, treatment, and rehabilitation. Advanced wireless communications and information processing technology can streamline medical diagnosis and better allocate and share medical resources and data.

5G's advanced connectivity, integrated mobility, and big data analytics platform will give tomorrow's doctors the tools to achieve patient monitoring in real time and remote diagnosis. Patients will have access to remote monitoring and diagnostics through 5G networks and wearable devices that

can quickly transmit their health status and symptoms and enable diagnoses.

Institutions will be able to securely share electronic medical records between institutions. Medical practitioners will be able to monitor individual health trends and outcomes for tailored treatments, and correlate health status with factors like pollution, temperature, lifestyle, diet, and sleep based on ubiquitous sensors.

Powered by 5G, the ubiquity of health monitoring and diagnosis will make for efficient, low-cost medical services that will lead to a much healthier world.

Expanding business boundaries

Digital transformation is broadening and mixing business boundaries in all sectors, which will increase both diversity and uncertainty. But, with 5G's network design concepts and integrative capabilities, it's possible to combat these uncertainties. 5G provides a powerful tool for creating new blue ocean markets for businesses, and will provide industry customers the opportunity to revolutionize their businesses.

Connectivity drives socioeconomic digital transformation, with each generation of mobile technology offering different effects. With its unprecedented connectivity capabilities, 5G will take society to a whole new level, revolutionize industry and consumer experience, and truly make a Better Connected World possible. ⊞

One slice at a time: SDN/NFV to 5G network slicing

The network modernization journey is one that every telco must take. NFV and SDN are the fuel, software and cloud define the route, and customer experience sits waiting expectantly at the destination. Telcos need to approach this transformative journey with three buzzwords in mind: agility, efficiency, and speed. But, to be really effective, end-to-end (E2E) network-wide slicing needs to happen.

By Gary Maidment
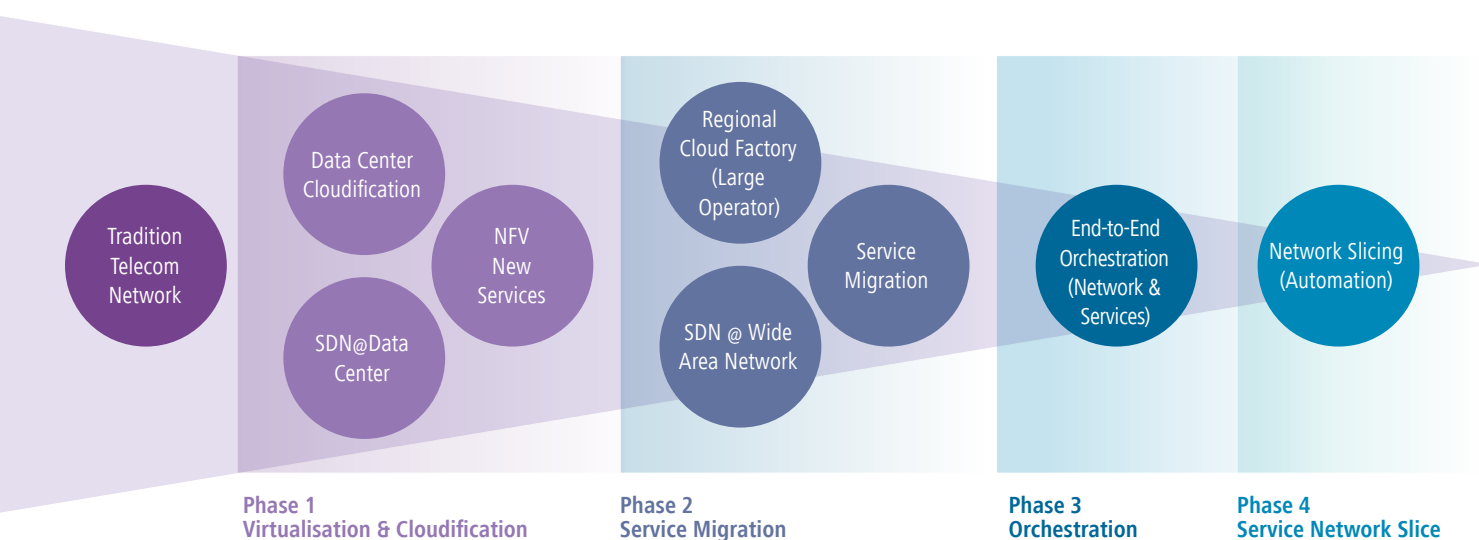Adapted from the white paper *NFV/SDN to 5G Network Slicing* by Dr. Ling Yim-Kwong

Fast, efficient, agile

The digital age has coalesced extremely quickly from the invention of the Internet as ARPANET in 1969 and the first mobile phone call in 1973. Ten years later, Motorola rolled out the first commercial mobile phone, around a decade ahead of when the Internet became big in the early 90s. It wasn't until 2007 that networked and mobile tech really joined hands with the first smartphone from Apple. A true game changer, this gave birth to the world of smart phones and apps from OTT providers that we know and love today.

Phase 1
Virtualisation & Cloudification

Phase 2
Service Migration

Phase 3
Orchestration

Phase 4
Service Network Slice

The four phases of NFV/SDN transformation

People's appetite for apps and social networking has seen network traffic shoot up, a trend that will continue as new IoT services come into full force for consumers and verticals. Up to 100 billion connections are predicted for 2025, with an estimated 8 billion of these coming from smartphones.

However, profits for the telcos that run the networks that underpin the modern world are one of the few things that aren't heading skywards. Ovum predicts that traffic on broadband networks will increase by 205 percent from 2015 to 2025. In contrast, global spending on broadband services will limp up by a comparatively weak 51 percent over the same ten years.

To stay profitable and meet traffic demands, networks need to be made more efficient. They need to provide a better experience at lower CAPEX and OPEX. They also need to be agile, so telcos can quickly innovate and roll out the services that people want when they want them. Efficiency, agility, and speed are set to become the hallmarks of success. And NFV and SDN are the tools for transformation.

To best apply this tech, 5G networks can be portioned into individual slices, where each has independent characteristics for best delivering a particular service type and sharing resources between services and slices.

Take it one step at a time?

Grand aims are one thing, but implementation is another when legacy networks and the maturity of the tech and ecosystem are factored

in. Additionally, it takes time for people to acquire the requisite skills and for organizations to transform the way they work into this new software- and customer-centric mode. There are four phases involved in transformation (as shown in the above graphic).

However, a far more bullish approach to construction is possible that compresses these phases and works like this: Build a separate NFV/SDN network, overlay it on the telco network, and migrate legacy services in one go. Despite the concertina effect that this approach delivers, it's still important to understand each phase.

Phase 1: Virtualization and cloudification

Virtualization separates the hardware and software functions of network

elements (NE) like routers.

It reflects a shift towards software-defined functions based on advances in computing hardware, which allows computing power and storage to be shared and offers far greater flexibility. Applications can run as efficiently on commercial-off-the-shelf (COTS) hardware as they do on specialist hardware.

Alongside virtualization, computing power and storage are shifting from PCs to a centralized cloud infrastructure that decouples functionality and location. Advantages include scalability and resource sharing, resilience, low power use, and efficiency. Centralizing large amounts of data for different uses from different users supports big data analytics and its wealth of corresponding applications.

NFV extends virtualization technology to network infrastructure. NFV decouples the software functions from dedicated hardware, allowing Virtual Network Function (VNF) software to run on commodity-based servers, which emulates an NE's function and performance. Commercially available products for doing this include vIMS and vEPC.

SDN takes control

Common transmission networks comprise dedicated routers and switches for data forwarding and network control. SDN, however, centralizes the control function in a single network controller – the software-based SDN Controller. Then, the network router and switch only perform forwarding, cutting costs on the elements that forward packets.

The SDN controller oversees a large part of the network and easily finds the best routes for packets, which is especially useful when the network is congested or part of it is down. The controller's decision-making ability is far superior to traditional routing where routers and switches make decisions based on a limited network view.

According to a Gartner report published in January 2016, only 2 percent of its clients have deployed SDN, with delays largely being attributable to a lack of standardized equipment. For telcos, large-scale deployment of SDN is still in its infancy.

Regional cloud factory

National network architecture normally comprises two or three layers, typically including access, aggregation, and core. Cloud infrastructure is also arranged in layers, which are normally local, regional, and national data centers. For both, layering is better for performance, scalability, flexibility, resilience, maintenance, and consolidation.

For example, each OpCo under a multinational telco usually has its own national network and platforms. With optical fiber reducing transmission costs, it's wise for multinationals to consolidate multiple national infrastructures into a cross-border international infrastructure. This concept – a common, unified, and converged platform – is referred to as a Regional Cloud Factory. For multinationals, it allows advantages like running a single VAS platform instead of one for each OpCo.

Although synergy benefits for pan-European or pan-African cloud factories are potentially huge, hurdles exist. These include regulatory constraints, data security, privacy, local customization versus regional content availability, and local versus regional support. For example, some services can be migrated to regional centers, whereas others might be best served locally.

Phase 2: Service migration

There are several strategies for implementing NFV and SDN and migrating services from legacy to new platforms. Each strategy must consider service criticality and the interdependence of multiple services. The main strategies are:

New service deployment such as

VoLTE with IMS and Bandwidth on Demand (BoD) services for enterprises.

End of lifecycle updates where legacy hardware and software need massive capacity upgrades, in which case it may be better to replace the platform.

Deploying a central SDN and NFV platform, which will allow big data analytics to provide new integrated services.

Unifying services to encourage the deployment of new, more efficient technologies.

Phase 3: End-to-end orchestration (EEO)

As independent but complementary technologies, both NFV and SDN can transform telco networks into software-based entities. But, network-wide applications with EEO on both technologies are necessary for the benefits to shine.

Orchestration yields the agility for operators to allocate network resources efficiently and cut TTM. Of the several initiatives to achieve EEO across NFV and SDN, Open-Orchestrator (Open-O) managed by Unix Foundation is a key one. First announced at MWC 2016, Open-O is a collaborative effort that aims to develop the first open source software framework and orchestrator

for agile SDN and NFV operations. Although early applications of EEO are in place, such as China Telecom's Cloud VPN, the first release of Open-O is scheduled for September 2016.

Phase 4: Network slicing

Existing traditional mobile networks operate under a monolithic model where a single network carries out all services, with protocols such as DiffServ in IP prioritizing different services. But, the protocols tend to be piecemeal, not E2E.

Network slicing is documented as part of the NGMN's vision for 5G. The technology optimally arranges network resources for maximal cost-efficiency to satisfy new and diverse 5G service demands. NGMN defines slicing as E2E, including on core and access networks.

The new 5G air interface supports network slicing. On a core network, network slicing can be implemented separately or ahead of the new 5G air interface. Each slice is a logical self-contained network where a service runs on its own network slice; for example, one slice could be for video, one for IoT, another for critical communication, and so on. But, it's also possible to group multiple, similar services on one network slice.

Each slice is optimized for a particular service type and each is E2E, including the RAN and core. Unlike LTE, 5G air interfaces can be sliced dynamically or semi-dynamically. Several concurrent network slices can be deployed on a common physical infrastructure; for example, a critical communications slice would provide ultra-low latency channels while the IoT slice would deliver a massive number of connections.

Putting it all together

Network slicing is based on NFV and SDN technologies. Both NFV and SDN need to be overlaid with orchestration, on top of which EEO is required to coordinate the two. Telcos like China Mobile, DT, KDDI, KT, NTT, and SK Telecom are making moves into slicing tech, with NTT already developing a slice management system – a key part of the overall solution.

What can Huawei do?

Huawei is a leading provider of NFV and SDN technologies and continues to play a leading role in developing both. Providing products, solutions, and consultancy services for operators, Huawei Consulting is adept at helping telcos transform into the future – a future in which SDN, NFV, and network slicing on 5G networks are poised to deliver service rollout benefits that can greatly ramp up profitability. ▮
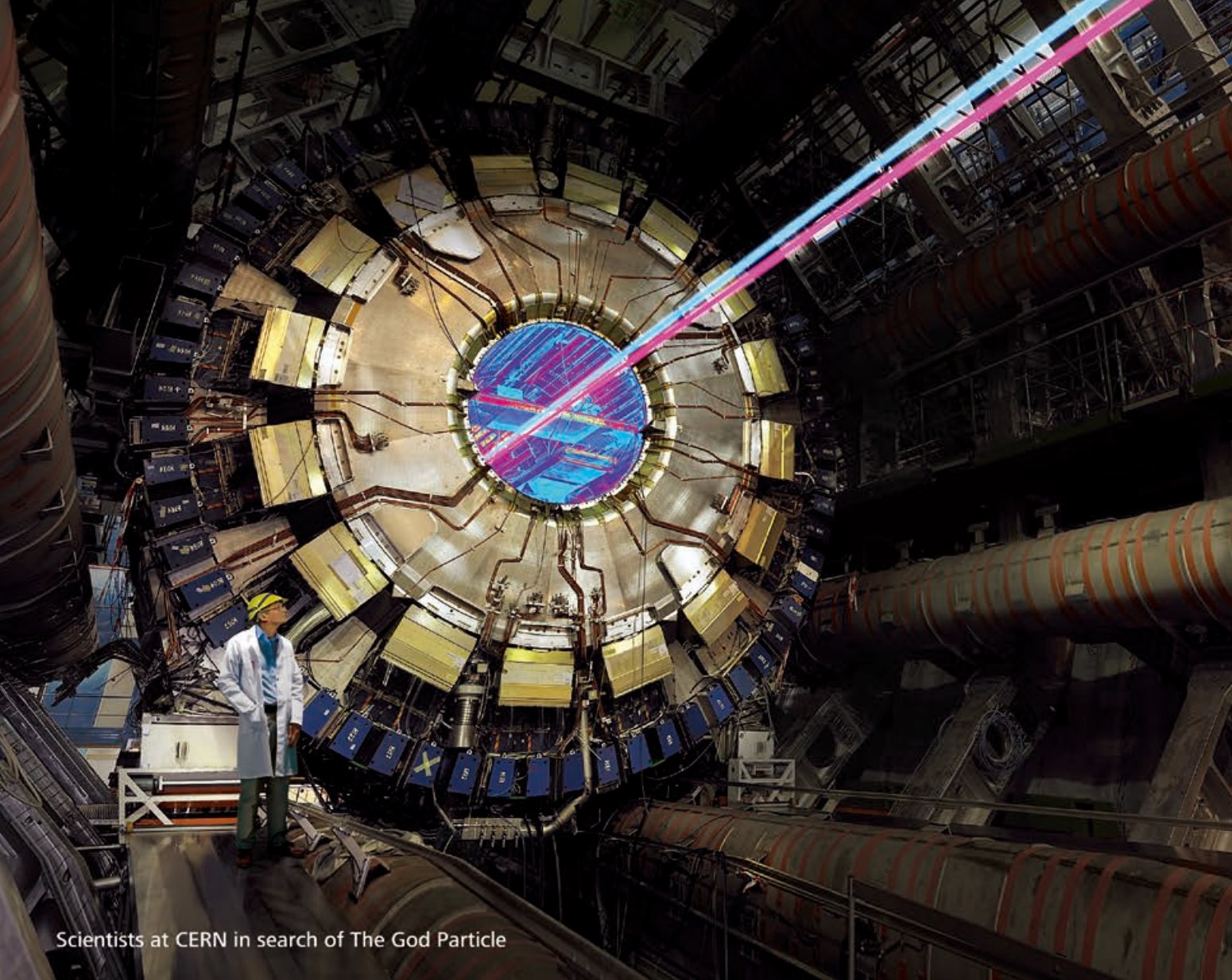
Scientists at CERN in search of The God Particle

Decades of patient investment,
for a moment of divine clarity

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