

Welcome to the new intelligent world – a world that anticipates our needs and doesn't just connect us to each other, but connects us to everything we see and touch.

In this new intelligent world, AI will be as ubiquitous as the air we breathe. It will be the invisible presence that constantly strives to make our lives better, dissolving borders, simplifying business, and bringing us closer as human beings.

It is our privilege at Huawei to be the ones that connect the world to its next leap in civilization – a leap forward where technology lifts the world higher, bringing digital to every person, home, and organization.

Building a Fully Connected, Intelligent World



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Tech for a Better Planet



The devastating bushfires in Australia, the thawing permafrost in Siberia, the record-high temperatures of 20°C in Antarctica – these and other environmental crises are a constant reminder of the urgent need to protect nature.

On the journey to an intelligent world, we're committed to realizing "Tech for a Better Planet" in four key areas: reducing carbon emissions, promoting renewable energy, contributing to a circular economy, and conserving nature with technology. This includes developing green products and solutions that help industries save energy and reduce emissions. We've made great progress in improving the efficiency of resource utilization in production, manufacturing, and logistics, and working with global partners to use ICT to conserve natural resources.

We base our energy-saving technologies on environmental impact assessments conducted throughout product lifecycles. Our full outdoor solution for wireless sites, for example, reduces power consumption by 40 percent compared with traditional site solutions. In optical transport, our unique optical fiber printing technology reduces power consumption by 60 percent. And to popularize renewable energy, Huawei has integrated IT into photovoltaic (PV), improving the efficiency of PV power generation. Since 2013, we've contributed more than 180 billion kWh of solar power to the world – the equivalent of planting over 200 million trees.

ICT has also displayed huge potential in protecting natural resources and biodiversity. Huawei is working with Rainforest Connection (RFCx) to reduce illegal logging and protect endangered species. Using upcycled Huawei phones and AI, RFCx has deployed rainforest "Guardians" in 14 countries, covering 3,300 km² of forest. In China, we've worked with partners to establish a monitoring system for the Northeast China Tiger and Leopard National Park, protecting endangered Amur tigers and Amur leopards and helping them to repopulate.

Over the next five years, we aim to reduce carbon emissions per unit of sales by 16 percent over 2019. We also intend to increase the average energy efficiency of our main products by 2.7 times compared with 2019.

We pledge to continue collaborating with governments, enterprises, and NGOs in a bid to protect humanity's home and build a fully connected, intelligent world for future generations.

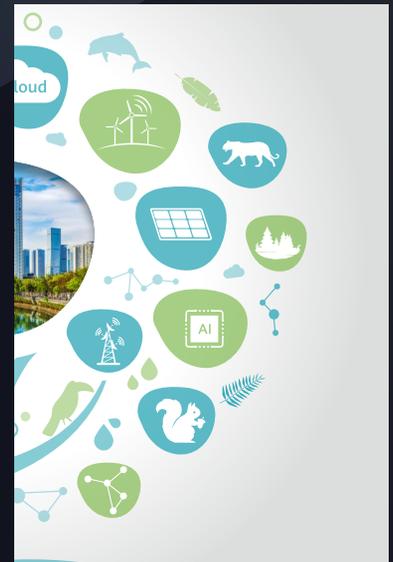
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Building a low-carbon society with green technologies

Climate change remains a global issue that threatens our long-term survival on this planet and that of other species. What role can technology play in combating these threats?



Kevin Zhang

CMO, ICT Infrastructure,
Huawei

The digital economy has become the new driving force of global economic growth. As pillars of the digital economy, technologies like 5G, cloud, artificial intelligence (AI), Internet of Things (IoT), and machine reasoning (MR) are being integrated into different industries, bringing new thinking, models, and practices, and revolutionizing production and lifestyles. The total value of the digital economy is projected to grow from US\$17 trillion today to US\$23 trillion by 2025, when it will account for about 25 percent of global GDP.

At the same time, climate change remains a global issue that threatens our long-term survival on this planet and that of other species: research shows close ties between climate change and the loss of biodiversity.

ICT has a dual role to play in climate change. First, the sector has to reduce its own carbon footprint. And second it must enable other industries to lower their carbon emissions.

Globally, the development of the ICT industry

has always been a key driving force in cutting carbon emissions across society. Remote meetings, for instance, have significantly reduced the number of trips corporate employees have to make, while systems such as short messages and instant messaging have greatly decreased the physical media people need to communicate, such as postcards, greeting cards, and letters.

According to the *SMARTer2030* report by the Global Enabling Sustainability Initiative (GeSI), carbon emissions generated by the ICT industry will start to decline as a proportion of total global emissions thanks to energy efficiency improvements in ICT products. By 2030, the ICT industry's carbon emissions are projected to reach 1.25 Gt, accounting for 1.97 percent of global emissions. The widespread application of ICT will also enable other industries to slash their carbon footprints. By 2030, ICT will help reduce 12 Gt of carbon emissions across every industry – about 10 times the ICT industry's own carbon footprint.

Over the past decade, technology and product upgrades in the telecommunications industry have driven a continual decline in energy consumption, with the sector playing a key role in helping other industries to save energy and curb emissions.

Driven by our vision & mission

Huawei's vision and mission is to bring digital to every person, home, and organization for a fully connected, intelligent world. But we also need to make sure this intelligent world is green so it can harmoniously coexist with nature.

ICT has a dual role to play in climate change. First, it has to reduce its own carbon footprint. And second it must enable other industries to lower their carbon emissions.

Huawei's vision and mission is to bring digital to every person, home, and organization for a fully connected, intelligent world. But we also need to make sure this intelligent world is green so it can harmoniously coexist with nature.

Our innovation focuses on providing our customers with leading green products and solutions. ICT has always played an important role in promoting a better environment – whether that's more energy-efficient 5G networks or data centers (DC), or the health impact of smart devices. We will continue to empower industries to conserve energy and lower emissions, so enterprises that use our technology can also reduce their carbon footprint.

Green product lifecycles

Using a lifecycle assessment (LCA) methodology, we discovered that for network equipment, carbon emissions generated in the use phase account for 80 to 90 percent of the total carbon footprint. As power consumption is specifically responsible, energy-saving technologies in our products are thus key to lowering the carbon footprint.

For many years now, we've been reducing the whole-lifecycle energy consumption of our ICT products, which has in turn helped numerous industries save energy and cut carbon emissions.

Wireless access

5G offers 50 times the energy efficiency of 4G in terms of bits per joule. But with its high bandwidth, ultra-low latency, and massive connections, 5G also increases

network energy consumption. So how can we have our 5G cake and eat it? By innovating on multiple levels.

We use advanced hardware materials, high-performance algorithms, and new heat dissipation technologies to enhance product energy efficiency. Technological innovation at three layers – equipment, sites, and networks – can improve the energy efficiency of 5G networks, helping operators cut their carbon footprint. For example, our 5G all-outdoor solution eliminates the need for air conditioning, reducing site energy consumption by at least 40 percent.

Data communication

In the digital world, DCs, metro networks (MANs), and backbone networks play a key role in aggregating and exchanging network traffic in cities, regions, and countries. Routers and switches in these locations must be ultra-high performance, which imposes strict demands on equipment heat dissipation and ambient temperature. To improve the power supply and heat dissipation efficiency of our products and thus lower energy consumption while ensuring product performance, we've made breakthroughs in magnetic blowout-based power switching technology, carbon nano-thermal materials, VC phase change heat dissipation, and mixed-flow fans.

In 2019, we unveiled the



CloudEngine 16800 series of switches for DC networks and the NetEngine 8000 series of routers for MANs. In the initial design stage, we focused on the two major technical problems of power supply efficiency and heat dissipation efficiency, and were able to lower the power consumption of routers and switches. Their energy consumption per bit is 26 to 50 percent less than other products in the marketplace. Each NetEngine 8000 X8 router can save about 90,000 kWh of electricity per year.

Optical networks

At the transmission network layer, our all-optical backplane technology allows us to print over 1,000 optical fibers on a backplane the size of an A4 sheet of paper. We've used this to develop the OptiXtrans series of optical cross-connect (OXC) products, which reduce equipment room footprint by a massive 90 percent and slash

power consumption by 60 percent.

In optical access, distributed forwarding architecture evenly distributes traffic to each service board, enabling us to push the limits of efficiency and power consumption. For example, our products achieve 43 percent lower power consumption than the level set out for broadband equipment by the European Union.

For home networks, our AI-based OptiXstar gigabit home optical networking terminal (ONT) reduces inefficient energy consumption thanks to product features like automatic usage sensing and off-peak intelligent sleep. OptiXstar ONT's consumption is 20 percent lower than that set out by the EU, and each device can save 38 kWh a year.

At the network level of enterprise campuses,



our all-optical campus solution can shrink equipment room and wiring footprints by 50 percent and energy consumption by 30 percent.

Site power

The increasing maturity of technologies like photovoltaics (PV), lithium batteries, and AI offers new potential to achieve zero emissions in site energy. In 5G, we've introduced solar energy and AI technology into our 5G Power site energy solution to maximize the use of clean energy in power sites, setting us on the path to achieving zero emissions.

Data center power

Data centers consume huge amounts of energy. We're using natural cooling sources applied through our indirect evaporative cooling technology to lower the energy used by DC cooling systems by 40 to 60 percent. By integrating big data and AI into the iCooling

solution, the DC learns to save power and can automatically optimize energy efficiency, decreasing DC power usage effectiveness (PUE) by 8 to 15 percent.

Slashing carbon emissions everywhere

Globally, ICT's energy-saving and emission-reduction benefits are generally recognized by all sectors of society – and increasingly expected.

We're using ICT and working with our partners to accelerate the wider adoption and application of renewable energy. By integrating IT and PV, we've improved the efficiency of photovoltaic power generation, converting every joule of solar energy into more photovoltaic power. Since 2013, Huawei's Smart PV solutions have generated more than 180 billion kWh of solar power for the world – the equivalent of

cutting more than 108 million tons of carbon emissions or planting more than 200 million trees.

We've introduced renewable energy solutions into our operations and have built PV power stations on our campuses. We're also promoting the wide application of Smart PV around the world to bring clean electricity to millions of homes.

In China, we built the first PV power plant in our Southern Factory in Dongguan. It generates 18 million kWh of electricity each year, representing 10 percent of the factory's total power consumption. In Saudi Arabia, we constructed the Sakaka 300 MW PV plant with our partners. Generating enough power for 45,000 households a year, the plant reduces carbon emissions by 430,000 tons per year. In Argentina, we jointly built a 300 MW PV plant in Cauchari, which generates approximately 660 million kWh of electricity annually – enough for 160,000 households.

We also help the power industry make better use of clean energy and curb its carbon footprint with smart digital technology. Huawei used cloud computing to help State Grid Qinghai construct a new-energy DC powered by AI and big data, helping more accurately predict renewable energy yields based on weather forecasts. And with multi-energy compensation, the total power

output fed into the grid is more stable.

As network connections become more ubiquitous, Huawei will continue to help the telecommunications industry conserve energy, reduce emissions, and develop solutions for low-carbon and eco-friendly communications.

For example, optical fiber uses 60 percent to 75 percent less energy than copper. To help global operators better fulfill their social responsibility for low-carbon development, Huawei will continue to promote green innovation in fiber networks, breaking through theoretical limits and developing greener optical network products.

Sichuan Telecom has used Huawei OXC equipment in 12 core transmission nodes in its network, forming an optical cube bearer network that can save 250,000 kWh per year, the equivalent of planting more than 2,000 trees.

With the intelligent era fast approaching, ICT will be applied in every industry. As the world's leading provider of ICT infrastructure and smart devices, Huawei will continue to innovate to help numerous industries save energy and cut their carbon footprint and ensure that technology and nature coexist in harmony for a fully connected, intelligent world. 

To help global operators better fulfill their social responsibility for low-carbon development, Huawei will continue to promote green innovation in fiber networks



On the road to intelligence with smart PV

Over the next 5 to 10 years, the world's major nations and regions will adopt renewable energy as the main power source for their electric grids. Huawei has further integrated Smart PV and its full-stack, all-scenario AI solution to deliver better leveled cost of energy (LCOE) so that every ray of sunlight is converted into more electricity.

By Xu Yingtong, President, Ascend Computing Business, Huawei & Chen Guoguang, President, Smart PV Business, Huawei

AI is playing a significant role in helping us deal with new challenges, pursue better lives, explore science, and coexist harmoniously with nature. During the COVID-19 outbreak, AI has formed a vital part of prevention and control measures, including analyzing the virus, developing vaccines, enabling intelligent temperature measurements, and providing auxiliary diagnosis.

Alongside 5G and big data, AI is an important part of China's New Infrastructure initiative to drive new technologies, new industries, and new economies. We believe that AI will spawn new technologies, products, industries, business, and business models, which in turn will transform production, distribution, exchange, and consumption.

AI's enabling power is improving value creation methods across all industries in completely new ways, and our collective mission today is leveraging this innovation to transform the world.

Since unveiling its AI strategy in October 2018, Huawei has been steadily and methodically implementing the strategy and promoting AI product development and commercialization. In 2019, with the launch of the Ascend AI processor, the all-scenario AI computing framework MindSpore, a full line up of Atlas products, and Ascend-based cloud services, Huawei completed its full-stack, full-scenario AI solution – a solution that today has been widely deployed in all industries, making AI ubiquitous.

In recent years, problems like global resource shortages and environmental degradation have intensified and we now stand at a fork in the

road for our survival. The only way to deal with the global resource crisis and climate change is to develop new energy and fundamentally change the current energy supply model. Led by photovoltaics (PV), renewables are set to be the main future trend in energy. But the main challenge lies in increasing the penetration of PV and transforming it from grid parity to a high-quality mainstream power source.

AI + PV: An industry first

Digital transformation is the foundation of intelligence. And the higher the degree of digitalization, the easier it is to realize intelligence. With the development of digital IT, Huawei's Smart PV has remained at the forefront of three eras of PV development: one, the digital + PV era; two, the Internet + PV era, and three, today's AI + PV era.

In 2014, Huawei pioneered intelligence in PV with the launch of the Smart PV solution. At the core of the solution was the string inverter. Smart PV transformed these string inverters into sub-array sensors, supporting precise information collection for each string, essentially enabling intelligent perception of PV power plants, in turn facilitating E2E digital transformation.

Between 2015 and 2018, Huawei integrated more digital technologies into PV, including wireless private network technologies, M-BUS technologies, Smart I-V Curve Diagnosis, and the intelligent O&M cloud center, and integrated PV into the agriculture and fishery industries.

Covering device, edge & cloud

In 2019, Huawei unveiled the first-ever Smart PV solution with AI. In 2020, Huawei further

The only way to deal with the global resource crisis and climate change is to develop new energy and fundamentally change the current energy supply model.

AI cameras installed on power transmission towers can check power transmission lines in real time and detect foreign objects and damage.

integrated Smart PV and its full-stack, all-scenario AI solution by creating core architecture for device-edge-cloud collaboration that will maximize the value of each PV plant and accelerate the intelligent evolution of the industry.

On the device side, Huawei has upgraded PV inverters to serve as smart PV controllers. This enables high-precision, real-time data collection, the real-time control of string-level energy yield optimization, real-time DC arc detection, and real-time response to grid-tied control. It also gives the system real-time inference, execution, and self-closed-loop control capabilities.

At the edge, Huawei has embedded an AI inference module into the sub-array controller to upgrade it with intelligence. The modules collect real-time device data and an AI model infers optimal power generation in real time, enabling optimal power generation and grid-tied control of sub-arrays.

In the cloud, Huawei has deployed an AI training and inference platform on the management system, supporting continuous AI training and optimization of the AI algorithm model without needing to modify existing devices. This enables system energy yields and potential fault diagnosis accuracy to be constantly improved and ensures device and edge inference models are promptly updated in batches for efficient collaboration.

Huawei's full-stack, all-scenario AI solutions have been used across a wide array of industries, including electric power, manufacturing, and healthcare, considerably enhancing the level of intelligence in these sectors. For instance, China Southern Power Grid has utilized the

Atlas 200-based intelligent O&M and inspection system. As part of the system, AI cameras installed on power transmission towers can check power transmission lines in real time and detect foreign objects and damage. The unmanned inspection of transmission lines reduces risk to engineers from climbing up pylons and proximity to live lines, significantly improving both O&M efficiency and safety.

50-percent higher O&M efficiency

Over the next 5 to 10 years, the world's major nations and regions will adopt renewable energy as the main power source for their electric grids. PV is set to become the mainstay of renewable energy. Ensuring the safety, reliability, and cost-efficiency of power generation assets will thus become a major challenge.

After extensive consultations with global industry experts, Huawei believes that the rapid development of emerging ICT like AI, cloud, big data, and 5G, as well as power electronics technology, will enable smart PV to create value in four major ways: lower LCOE, increase power-grid "friendliness", achieve intelligent convergence, and boost security and trustworthiness.

In the PV industry, labor costs are the main focus of cost control. PV plants have traditionally required human labor to complete a large amount of O&M tasks, which often involves high levels of risk, repetition, and precision. The COVID-19 pandemic this year has led to a shortage of workers, reigniting discussion in the industry around PV-station O&M. Having previously conducted numerous unmanned O&M trials in response to the pandemic, Huawei and its many PV customers successfully implemented



unmanned O&M. Huawei's AI BOOST Smart I-V Curve Diagnosis supports one-click remote scanning of all PV strings and can automatically output a diagnostic report for a 100 MW power plant in 15 minutes, including maintenance requirements, fault diagnosis, and precise fault location for plant engineers. Unmanned inspections improve PV power station O&M efficiency by more than 50 percent.

As labor costs increase, the traditional maintenance method involving site visits by experts will be gradually phased out. AI technologies that integrate extensive expert experience will conduct diagnosis and make decisions in place of O&M specialists, while heavy, repetitive O&M workloads will be achieved by drone inspection and robot-based automatic O&M instead of human workers. As simple, repetitive, and hazardous tasks are

increasingly completed by AI systems, this will reduce labor costs and improve efficiency, while enhancing speed and accuracy. For instance, drones equipped with HD or infrared cameras negate the need for manual inspections and can complete real-time failure analysis and diagnosis with much higher efficiency and accuracy. Unmanned is certain to be a future development trend in PV plants.

AI can be integrated into all aspects of the power grid. Our Smart DC System (SDS) integrates previously independent components, brackets, and inverters to form a closed-loop system of bifacial PV modules, trackers, and multi-channel MPPT smart PV controllers, which optimizes the entire DC generation system. The SDS also improves on the traditional astronomical algorithm. Its smart PV controller acts like a smart brain that

The self-learning AI can identify the electrical features of a PV plant and automatically match the grid-connected algorithm to the power grid.

can self-learn a tracking optimization algorithm and continually evolve. AI training and modeling use a neural network to adjust the trackers to the optimal angle to maximize the potential of every string in a PV station.

In Suixi, Anhui, tests showed a 1.31 percent increase in actual energy yield over 183 days. In tests on PV solar farms owned by China General Nuclear Power Group and Huanghe Hydropower, energy yield was increased by 0.5 percent to 1 percent.

Huawei's smart solar inverters integrate world-leading algorithm architecture and greater control capabilities, bringing impedance reshaping AI technology and leading grid-connected algorithms, such as dynamic damping adaptation, into the PV industry. The self-learning AI can identify the electrical features of a PV plant and automatically match the grid-connected algorithm to the power grid. Huawei's industry-leading solar inverters also support high-voltage, direct current (HVDC) scenarios, a minimum power grid short circuit ratio (SCR) of 1.5, high-penetration power without derating, a better connection to weak power grids, and fault ride-through (FTR) capability.

In the future, the grid-tied control capability of solar inverters needs to be continuously improved to support connection to weaker power grids, ensuring that PV plants can run stably without disconnecting from the power grid even in the case of low SCR. Huawei's Smart PV has helped PV stations evolve from grid adapters to grid supporters. Now, it can help them reconstruct the grid and form independent networks so they can transform PV from grid parity to a high-quality mainstream power source.

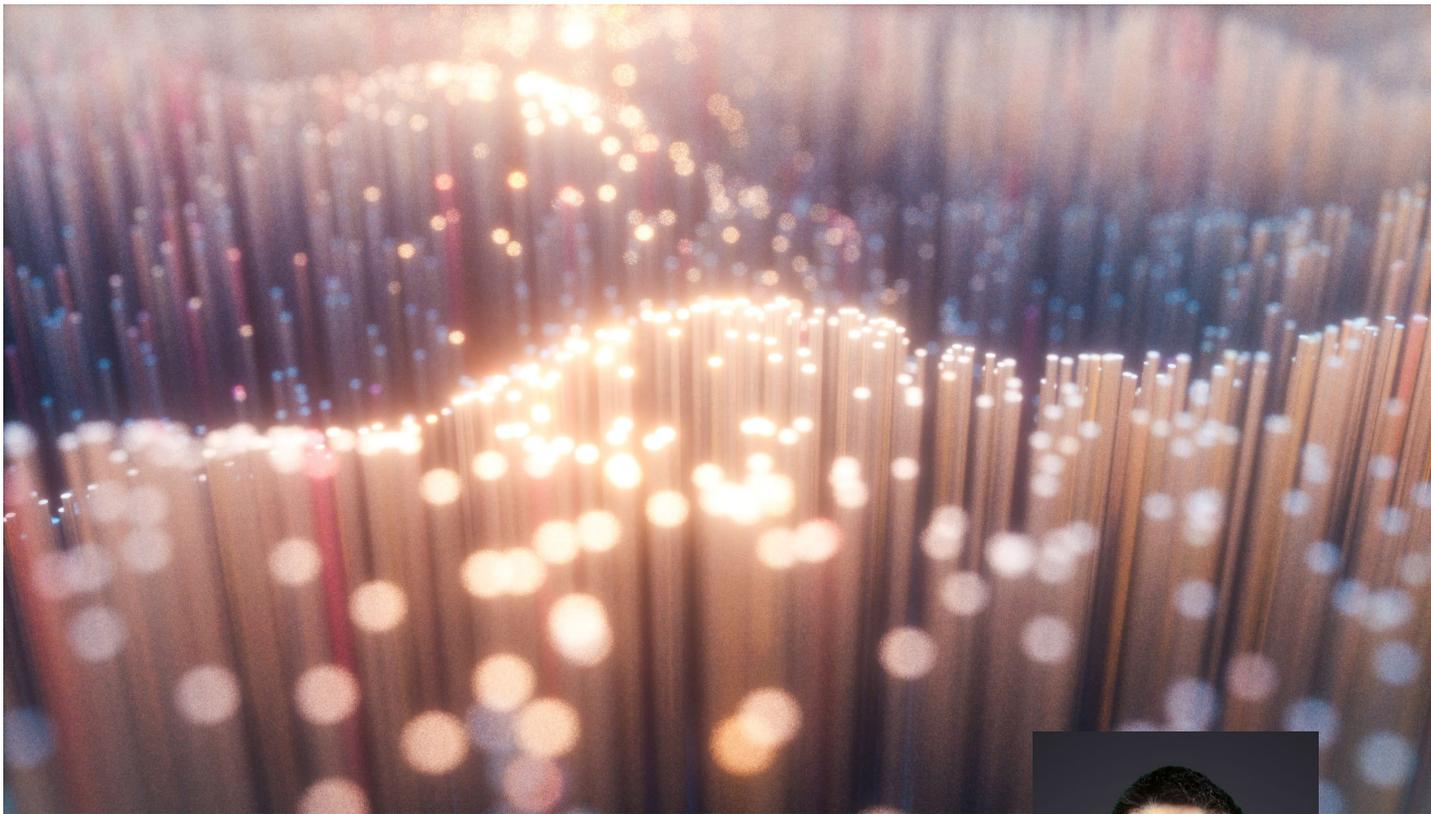
Ensuring safety is also very important. In

an industry-first, Huawei has integrated AI algorithms into the arc-fault circuit interrupter (AFCI), providing more accurate arc detection and faster fault protection, to fully secure the safety of distributed PV systems.

AI BOOST's AFCI has three unique features. First, powered by the AI model, it can continuously and efficiently learn to recognize more arc features, fueled by a database of over 1 million arc features. Second, the strong computing power enables AFCI to actively identify, and analyze more than 92 arc characteristics comparison points, and identify arcs with high accuracy. This means no false positives or false negatives, delivering all-around upgraded protection. Third, it can shut down and cut off the power supply within 0.5 s, which is much quicker than the industrial standard of 2.5 s, helping to prevent fires and ensure rooftop PV plants are safe. We believe that our new AFCI standard is set to become the industry standard both in China and internationally.

AI + PV = a green smart world

In the future, AI will be as pervasive as water and electricity. In the PV industry, it will become the new main engine of intelligent transformation. 2020 marks the first year when cloud, AI, and 5G are truly integrating. We believe that we're poised to become an intelligent society in the next 30 years. Digital technology and new energy are reshaping the world. When PV meets AI, the PV industry will break through its limits and be restructured and redefined. When AI meets PV, a greener world where all things are sensing, connected, and intelligent will come into being. 



Building all-optical green cities with ubiquitous optical technology

Fiber has emerged as the greenest connectivity method to date. To maximize its benefits, Huawei's green optical network products can minimize energy consumption in optical transmission sites and build the foundation of green cities.



Simon Lu

President, Transmission Network Domain, Huawei

Building green connectivity is a central mission for the entire ICT industry. According to Huawei's Global Industry Vision (GIV), by 2025 the average carbon emissions per ICT connection will fall by 80 percent and the ICT sector will enable global

energy savings and a reduction in emissions that far exceed the energy and emissions the industry itself consumes and produces.

Of the connectivity methods we've used to date, optical fiber is the most eco-friendly, offering unparalleled advantages

in bandwidth, latency, anti-interference, and reliability. Compared with copper, it offers ten times the bandwidth, one-tenth the latency, and 60 to 75 percent lower energy consumption.

Reshaping optical transmission sites is a major direction for innovation

across the entire industry. As a leader in the field, Huawei is designing green optical network products to minimize energy consumption in optical transmission sites.

9-in-1: Optical cross-connect for 3D backbone

New types of services and network cloudification are driving a shift in network traffic from north-south to east-west, characterized by frequent irregular and random bursts of traffic. This has led to extensive data exchanges between network nodes and a high level of uncertainty in network services, which calls for efficient traffic grooming.

In the past, reconfigurable optical add-drop multiplexers (ROADMs) have mainly been used to handle cross-connect scheduling for coarse-grained services. However, traditional ROADMs require many optical fibers to connect multiple modules, resulting in a large number of fiber interconnects in equipment rooms, increasing O&M difficulty and taking up a large amount of space.

Huawei has launched the industry's only commercially available optical cross-connect (OXC) product – the OptiX OSN 9800 P32. Harnessing technological breakthroughs like all-optical backplanes and highly precise liquid crystal on silicon (LCoS), a single device boasts Pbps-level cross-

connection capacity. It is able to replace nine traditional ROADMs, reducing the footprint in equipment rooms by 90 percent and power use by 60 percent.

OXCs also support up to 32-degree optical cross-connect scheduling. OXCs on multiple optical transmission nodes also help build a 3D backbone network, simplifying backbone transmission network architecture and realizing architecture-level energy savings across the entire backbone network.

Huawei has been working with leading operators globally, including China Mobile, China Telecom, China Unicom, and Indonesia's XL Axiata, to innovate and deploy OSN 9800 P32 products on 50 commercial networks, covering backbone transmission sites and metro core sites.

6-in-1: Optical-electrical integration for MANs

When it comes to metropolitan area network (MAN) optical transmission sites, the explosion in service requirements from 5G, HD video, and enterprise leased lines has created an immense challenge for MAN architecture. To meet the requirement to carry multiple services on integrated bearers, operators are focused on best using the limited space in MAN equipment rooms and minimizing energy consumption.

Huawei's OptiX OSN 9800 M24

provides an industry-leading integrated optoelectronics platform. Incorporating six functions into one device – optical, ponder, SDH, ETH, ODU, and OSU – it supports full granularity of service access from 2 Mbps to 400 Gbps, cuts the equipment room footprint by 70 percent, and uses 30 percent less power.

The large-scale deployment of OSN 9800 M24 in MANs can flatten MAN architecture, decreasing the amount of equipment required, maximizing space utilization, and reducing power consumption in MAN equipment rooms by integrating bearing for multiple services. Huawei has shipped thousands of OSN 9800 M24 optical transmission products worldwide, which have been deployed commercially by operators such as CTS in Malaysia.

X in 1: All-optical anchor point for unified bearing

As data centers continue to move closer to the user side and network architecture oriented towards data centers becomes mainstream, the service volume of the access layer has risen sharply at integrated service access sites, especially with the rapid growth of services like 5G, gigabit broadband, and gigabit enterprise. As such, integrated service access sites have become more important and operators are prioritizing maximizing the utilization of limited site resources to support full-service development. And with the requirement

to carry multiple high-value services, operators must maximize network reliability, transmission performance, and automated O&M capabilities, while lowering space and power use in equipment rooms.

Huawei's OptiX OSN 1800 V Pro slashes the equipment room footprint by 75 percent and power consumption by 50 percent. It also boasts access for multiple services, including SDH, PDH, SONET, SAN, and SDI, for full-scenario coverage. Indoor and outdoor cabinets and OLT/BBU shared cabinets are supported, making it suitable for installation in all cabinets. The product meets bearer requirements for high-performance transmission as well as eco-friendly energy efficiency in the integrated access site.

Adopting OptiX OSN 1800 V Pro will help operators carry 5G fronthaul bearers, premium leased-line bearers for government and enterprise, UHD video bearers, and other such services over a unified platform, and build all-optical anchor points, greatly reducing the number of fiber connections at integrated access sites, accelerating the removal of SDH equipment from the network, and slashing the number of switches.

It will thus promote overall energy-saving in integrated access sites.

Building green all-optical cities

From the 3D backbone network and simplified MAN to all-optical anchor points, leveraging end-to-end OXC and OTN equipment will help build all-optical city target network architecture that covers all transmission sites in the city.

This will provide one-hop direct connection for enterprises, households, and individuals in the

city using more eco-friendly optical connectivity.

The all-optical target network promotes the flattening of the entire bearer network, helps simplify network architecture, and integrates and co-opts multiple types of complex legacy networks, thus facilitating energy conservation across the entire urban transmission network.

To help end users provide higher-quality connection services, Huawei has also launched OptiXstar C800, the industry's first OTN CPE product. The plug-and-play device is the size of a book and offers less than 30 watts overall power consumption. It can fully co-opt old SDH and MSTP leased line services, helping enterprise clients to switch out multiple more energy-hungry devices from their equipment rooms, helping end users conserve energy.

With the wide adoption of eco-friendly optical connections across the industry, Huawei is promoting end-to-end innovation across the entire optical network to maximize its value. We've launched a series of Liquid OTN products, the first commercially available in the industry. They refine service bearer granularity from 1 Gbps to 2 Mbps, expanding the number of connections a hundredfold and meeting the service bearing requirements for SMEs and large enterprises, households, and individual users alike.

Ubiquitous optical connectivity enables ubiquitous ultimate experiences. The all-optical target network will accelerate cities' digital transformation; boost service experiences for every business, household, and subscriber; and help all industries achieve energy efficiency with green optical networks.

Thus, we will move into the era of green all-optical cities. 

The all-optical target network promotes the flattening of the entire bearer network, helps simplify network architecture, and integrates and co-opts multiple types of complex legacy networks.



Three levels of energy savings in intelligent IP networks

For the full-service intelligent era of 5G and cloud, Huawei will pursue network construction concepts, such as super capacity, intelligent experience, and autonomous driving, in its data communications products, and continue to innovate to help global operators build more energy-efficient intelligent IP networks.



Lu Yao

Service Router Marketing
Expert, Huawei

The quest for better experiences continues to propel service diversification. For example, cloud VR lets gamers experience a new level of immersion, 5G UHD video gives

surgeons the perspective they need for remote surgical guidance, and smart power grid O&M engineers use 5G private networks for video inspections and differential signal protection in distribution networks. The integrated

application of technologies like 5G, AI, and IoT is shaping a world where all things can sense, all things are connected, and all things are intelligent.

With the 5G and cloud era fast approaching, we will see applications with tens of millions of users, imposing immense demands on network bandwidth and resulting in a predicted 10-fold jump in network traffic over the next 10 years. The resulting expansion in network capacity and increase in sites will drive growth in equipment energy consumption costs, which could counteract some of the benefits brought by new services.

The ICT industry currently accounts for a considerable amount of the world's total power consumption. For telecom operators, electricity bills typically account for a sizable portion of their total operating costs.

A large proportion of the vast amounts of energy consumed is unnecessarily wasted. The IP network converges mobile services, enterprise services, and home broadband traffic, and connects to data centers, acting as the basic bearer network. Given this, it makes sense to maximize network efficiency and build intelligent, energy-efficient IP networks.

The first step is to look at the IP network from a network-wide perspective and introduce intelligence with a focus on improving network-wide resource utilization. The next is to build an ultra-wide network to respond to the urgent need to increase service bandwidth, improve energy efficiency per gigabit, optimize network architecture and topology, simplify layers and network sites, and lower redundant consumption. Last, the concept

of dynamic energy conservation should be applied to devices with components scaled out dynamically, enabling precise energy saving and cost reduction based on various application scenarios. Doing so can find the best balance between performance, function, and energy consumption.

Network-level energy saving

Intelligence can be incorporated in the IP network to optimize network traffic and resource utilization.

Traditional IP networks utilize shortest-path-algorithm routing protocols and best-effort data forwarding. This approach offers advantages in terms of accessibility, interoperability, and flexibility, but it can also easily lead to resource imbalances. There might be heavy loads on local links, such as backbone and metro ingress links, while the rest of the network links light loads. On the same network at the same time, loads may reach 80 percent or more on some links but only 10 percent on others. This can cause congestion and packet loss on certain links, which impacts service experience, while others experience low utilization and sit idle, wasting energy. Optimizing network-wide resources and improving utilization can significantly decrease power consumption and optimize the energy consumption ratio.

Optimizing network links and traffic first requires path adjustment capabilities to flexibly adjust paths based on various SLA requirements such as bandwidth and latency policies. But traditional traffic engineering, which involves manual planning and static configuration, is unsuited to handling complex

Optimizing network-wide resources and improving utilization can significantly decrease power consumption and optimize the energy consumption ratio.



traffic scenarios.

Based on different service requirements, Huawei's iMaster NCE + SRv6 enables intelligent routing, flexible and programmable network paths, and guaranteed connections. The solution also supports real-time visibility of network traffic status and automatic real-time adjustment of network traffic. An innovative ROAM algorithm provides capabilities of optimization based on multiple dimensions, such as bandwidth, latency, cost value, and priority, calculating optimal end-to-end paths for the whole network for optimal service paths and balanced global network traffic. Compared to legacy networks, the network utilization rate is increased by at least 20 percent and the overall network efficiency

is greatly improved.

Site-level energy saving

400GE builds ultra-broadband infrastructure networks and delivers optimum energy consumption per bit.

Traditional IP bearer networks are constructed with a focus on hardware. They're generally divided into five or more layers: the access layer, the convergence layer, the metro layer, the backbone layer, and the service layer. Along with the continuous expansion in network scale, explosive growth in network traffic, and a substantial increase in the number of multi-layer devices, networks have become more complex and energy consumption has risen.

IP network interface rates have continued to increase in response to acute demand from ever-growing service traffic. At the access point, rates have risen from the gigabit level to 10GE/50GE, and metro and backbone rates have shot up from 100G to 400G. The next-generation high-speed interface technology, 400GE, uses 75 percent less optical fiber and consumes 20 percent less energy than 100GE, slashing transmission costs and power consumption per bit and eliminating load imbalances caused by link bundling on 100GE. IP networks with 400GE-ready convergence, metro, backbone, and data-center layers will help operators build ultra-broadband networks that provide an ultimate experience, and dramatically boost their return on investment.

With trends such as enterprise services moving en masse to cloud and mobile core network user planes and home broadband content moving closer to the user side, reasonable network planning should be DC-centric. By simplifying network hierarchy and the number of sites and devices, the energy consumption of the bearer network lowers proportionally.

In backbone sites, Huawei has integrated P and PE nodes using an integrated backbone solution, substantially cutting the cost of backbone network construction, reducing the network layer from two layers to one, and delivering overall energy savings of 10 percent.

In metro sites, Huawei uses metro fabric architecture to deconstruct the traditional metro router, separating network bearer and services. This allows the network to be flexibly expanded on-demand in scale-out mode, slashing the number of switched network

components needed in traditional metro scale-up. Overall metro network construction costs are cut by 30 percent and energy consumption by 50 percent. The solution also provides large-capacity, non-blocking forwarding capabilities.

Device-level energy saving

Serialized high-efficiency components + intelligent dynamic design enhances device energy efficiency.

The growth in traffic and pipe interface rates will inevitably lead to an increase in the capacity requirements of devices. With ever-larger router capacity, the power consumption of the whole device will rise significantly. Energy-intensive hardware will lead to a host of problems.

First, energy-intensive equipment will not only bring about higher power consumption and a sharp climb in operating costs, it will also produce a substantial amount of carbon emissions. Second, energy-intensive hardware imposes high requirements on equipment room power supply systems. Air conditioning and other support infrastructure also need to be upgraded. Third, excessive internal temperatures will impact the reliability and service life of energy-intensive devices. Statistics show that a 1-degree rise in ambient temperature increases component failure rate by 10 percent, greatly diminishing reliability and impacting the stable operations of equipment.

Huawei's NetEngine routers boast low-power components, efficient heat dissipation, and efficient power supply technology to break

Statistics show that a 1-degree rise in ambient temperature increases component failure rate by 10 percent, greatly diminishing reliability and impacting the stable operations of equipment.

through limitations and decrease the overall power consumption of equipment.

Low-power chips

Specialist experimental analysis reveals that 80 percent of the energy a router uses is for powering the line card, while 60 percent of the energy the line card consumes is used by the chipset. Therefore, device energy saving mainly depends on the power consumption of the chipset. NetEngine routers use low-power chipsets (under 0.4 W/Gbit), which consume 30 percent less overall energy than similar products, cutting carbon emissions by 30 percent over the industry average. A single router can save up to 180,000 kWh of electricity and 360 tons of carbon dioxide per year, the equivalent to 10,000 square meters of forest coverage.

Efficient heat dissipation

Mixed flow fan + VC phase change heat dissipation solves air cooling limitations.

Most mainstream devices adopt air-cooled heat dissipation systems. In most cases, a heat sink radiator and thermal pad are placed on the chipset and a fan remove the heat from the device, thus achieving heat dissipation. Therefore, the key components that determine the heat dissipation capacity of air-cooling systems are heat sinks and fans.

Copper heat sinks and silicone grease traditionally used to conduct heat have low overall thermal conductivity and average heat dissipation effects.

Huawei does several things differently. First,

we use a carbon nano thermal pad to convert irregular heat dissipation to directional heat dissipation, significantly improving thermal conductivity. Second, we use a vapor chamber (VC) liquid-gas phase change heat sink. The inside of the radiator has a vacuum chamber with a capillary structure filled with a refrigerant and a low boiling point, which quickly dissipates heat through the phase transition from liquid to gas.

The VC phase change heat dissipation and carbon fiber thermal pad technologies can increase chipset heat dissipation efficiency by up to four times and lower chipset temperature by 19 degrees compared to traditional heat dissipation methods, reducing heat build-up in the motherboard and greatly improving reliability.

One of the keys to determine the cooling effect of fans is air volume. The fan blades of typical fans cause airflow disturbances when inhaling air, which affects the amount of air inhaled. Huawei's mixed-flow fan uses a special fan blade design that decreases airflow disturbance and turbulence near the fan blades, tripling air volume. Fan efficiency is increased by over 10 percent with the same air volume, saving 200 to 300 W per fan tray assembly.

Moreover, adjusting the maximum power of traditional fans is difficult. When the overall power usage of equipment fans is high, power distribution requirements on equipment rooms are also high. Huawei's mixed-flow fans offer software-defined maximum power, flexibly adapting to fan power requirements, and reducing power distribution requirements on the equipment room.

Efficient power supply

There are three levels of conversion from the external power supply to the power supply unit of equipment motherboard components.

Traditional first-level power supplies adopt N + N power backup, which not only takes up more space but also sets certain requirements on the external power supply. Huawei uses the dual-input power supply module with millisecond-level switching. Adopting N + M backup mode, it offers a substantially smaller power module and a 90-percent power efficiency improvement.

The module also uses magnetic blowout technology, enabling fast millisecond-level switching. Backup power supply switchover time is under 6 milliseconds, providing superior power supply reliability.

Multi-level conversion results in a loss of energy, so a 1-percent improvement in conversion efficiency in a single piece of ultra-high capacity hardware, which can exceed 10,000 W, can save nearly 1,000 kWh of electricity a year. Maximizing the power conversion efficiency of each piece of equipment can, therefore, have a big impact. Huawei's NetEngine 8000 router products support AC, DC and HVDC hybrid power supply modes and can increase the forwarding rate by 4 percent.

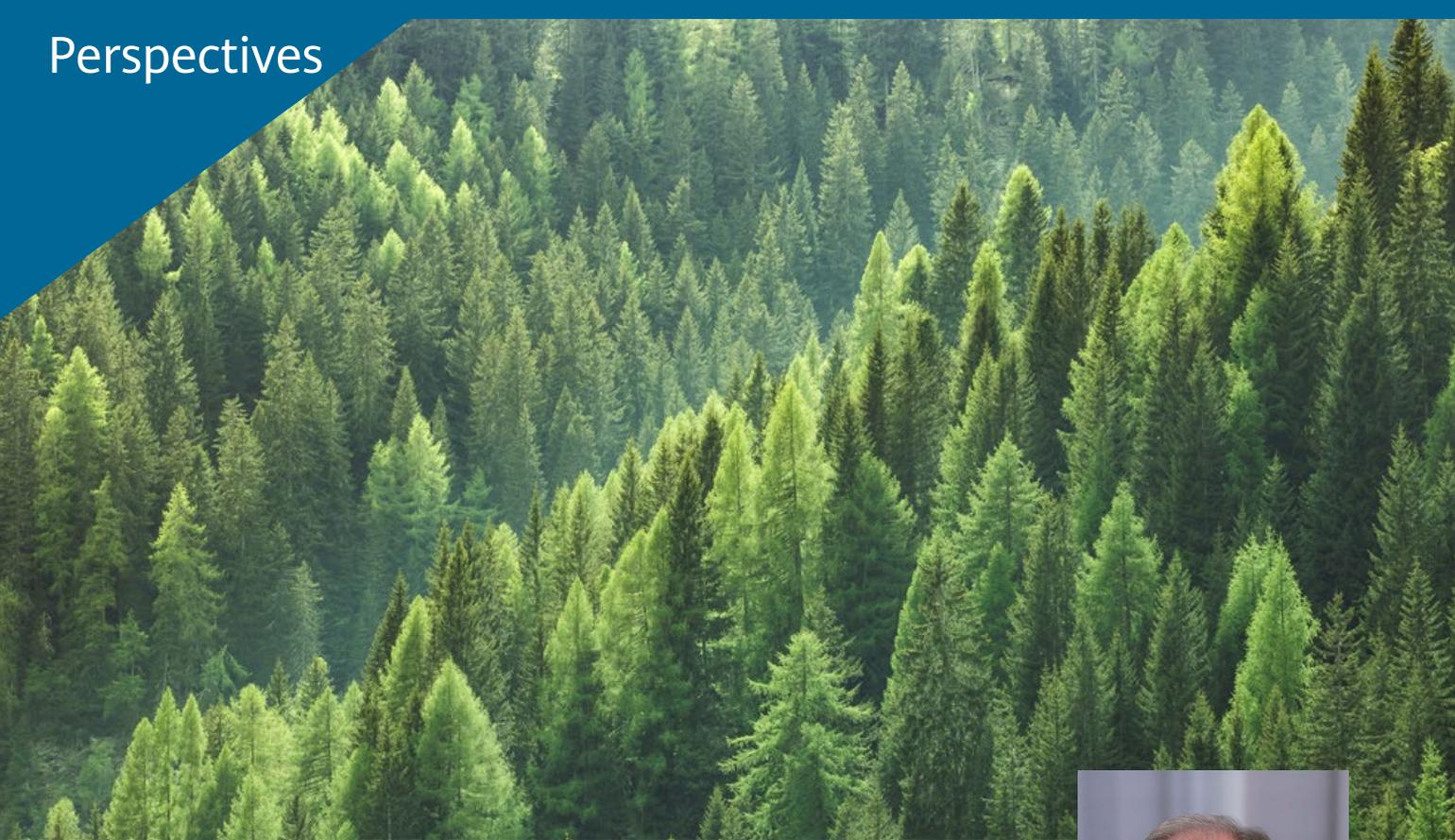
Intelligent dynamic energy saving

IP network traffic is bursty, with high loads when equipment is busy and low loads when it's idle. This has led to dynamic energy-saving technology, which is used in Huawei's NetEngine routers. As well as offering the typical dynamic shutdown of unused line cards and ports, Huawei's NetEngine routers are also specially designed with dynamic energy-saving technology for traffic. This allows the number of working network processor cores and clock frequency of chipsets and the number of SerDes buses to be adjusted in real time according to traffic, maximizing the ability to lower energy consumption in various traffic scenarios.

Energy conservation is a gradual process that needs to be considered alongside other factors such as current network situation, evolution trends, and cost. To choose the right architecture and evolution strategy the whole network must be taken into account from a range of dimensions, including network, sites, and equipment.

For the full-service intelligent era of 5G and cloud, Huawei will pursue network construction concepts like intelligent super capacity, intelligent experience, and autonomous driving in its data communications products, and continue to innovate to help global operators build more energy-efficient intelligent IP networks. 

A single router can save up to 180,000 kWh of electricity and 360 tons of carbon dioxide per year, the equivalent to 10,000 square meters of forest coverage.



Accelerating environmental protection & climate action through Digital with Purpose

Estimates from the United Nations hold that on its current trajectory, the world will be unable to deliver the 2030 Agenda for Sustainable Development. How can we make sure this doesn't happen?



Luis Neves

Managing Director, Global Enabling Sustainability Initiative (GeSI)

In its *Digital with Purpose: Delivering a SMARTer2030* report, Global Enabling Sustainability Initiative (GeSI) highlights three core pillars of sustainability as key agenda items that must urgently be addressed:

1. The biosphere is under threat from rising CO₂ emissions.

2. Equality is declining.

3. The economy continues to drive the unsustainable consumption of natural resources.

Solving these issues, which cut across sectors and transcend borders, requires innovative and integrated solutions — solutions that digital

technologies are well-positioned to provide. *Digital with Purpose* identifies seven digital technologies (see Fig 1), chosen as broadly representative of the way digital capabilities will evolve in the medium term.

Digital with Purpose argues for the utilization of these seven digital technologies due to their proven

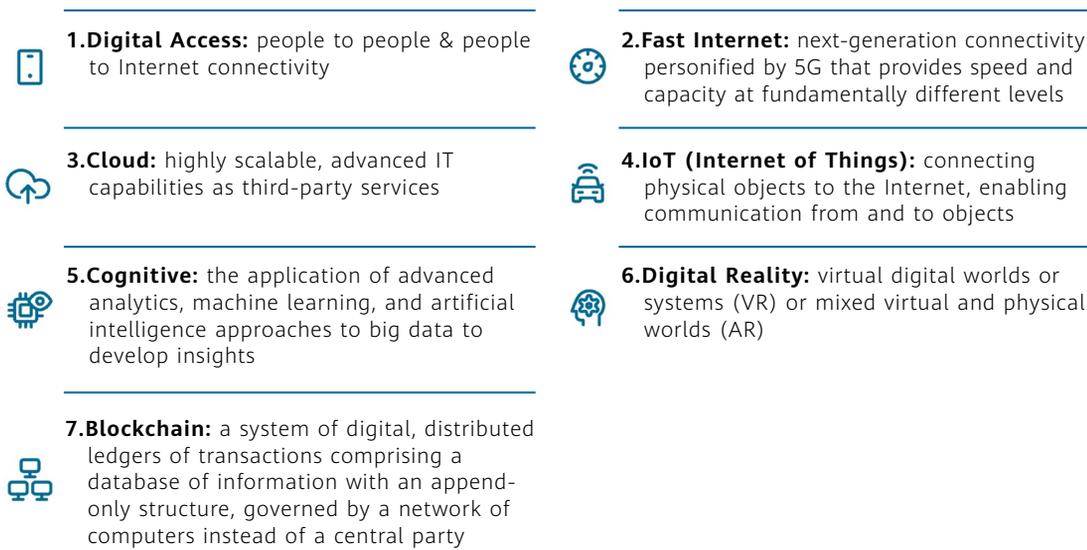


Fig 1. Seven Key Technologies for Sustainable Development / Source: (GeSI) *Digital with Purpose: Delivering a SMARTer2030*

impact on 103 of the 169 total Sustainable Development Goals (SDGs) targets. Delving into protecting the biosphere, *Digital with Purpose* finds that digital technologies are particularly important in monitoring and tracking the state of the natural world, and analyzing and optimizing energy usage to reduce climate change.

Monitoring and tracking

As the planet continues to undergo immense stress in regards to the environment, developing an accurate insight into the full extent of degradation and the most heavily affected areas is critical to identifying key environmental indicators. Monitoring and tracking informs key decision makers, as well as the general public, on the immediate actions that can be taken to mitigate or adapt to the effects of climate change. Additionally, digital technologies can keep people, organizations, and states accountable to ensure that commitments are distributed fairly.

Among many issues, *Digital with Purpose* delves into increased water and energy usage that result in rising levels of pollution and waste. As a response, digital technologies, such as IoT sensors, are currently being used to monitor human usage of utilities, and it's through this real-time monitoring that stakeholders can make decisions efficiently across a vast network.

An example is the work of GeSI member Taiwan Mobile, which uses remote detection devices to monitor base station energy consumption, gathering real-time data without manual meter-reading, thus reducing emissions from travelling. The use of Smart Meters also allows Taiwan Mobile to accurately anticipate and predict the consumption of energy, providing valuable information for optimization and efficiency. Taiwan Mobile reports that it saves about 25.4 tonnes per year in CO₂ emissions and reduces manual meter trips by 8,439.

Analyze, optimize, and predict

Another issue explored in the report is

Deforestation and desertification caused by human activity is a critical issue that must be urgently addressed as both pose a risk to the global terrestrial ecosystem.

deforestation as the major cause of land degradation. With forests covering almost 31 percent of the Earth’s surface, deforestation and desertification caused by human activity is a critical issue that must be urgently addressed as both pose a risk to the global terrestrial ecosystem.

Protecting forests is essential as they mitigate climate change-induced environmental conditions and protect watersheds, which account for 75 percent of the world’s freshwater. Additionally, forests reduce the risk of natural disasters such as floods, droughts, and landslides. The combination of land degradation and the increase in global population means land shortages and an increase in demand for limited land and resources. With digital technologies such as cloud and machine learning, the remote detection of illegal logging and other harmful activities is possible through the aggregation and analysis of data to design targeted interventions.

GeSI member Huawei, in partnership with Rainforest Connection, uses hidden repurposed smartphones or “Guardian” devices to monitor sounds within rainforests and collect data in threatened areas. With Huawei’s mobile network, audio data is sent to the Huawei cloud platform and run through a machine learning framework to be analyzed in real-time. Huawei’s utilization of digital technologies allows not only the detection of species and identification of high-risk areas, but also the location of sounds of illegal logging and initiation of alerts through cloud technology, digital access, and IoT.

Looking at current trajectories, the world is not on the path to meeting the goals of

the 2030 Agenda, including global climate targets. While digital technologies can make a significant contribution to accelerating action, these solutions must come with transformative changes across economic, social, and political spheres.

The ICT sector as a climate leader

For GeSI and the ICT sector in general, transformative change means leveraging the digital technologies identified as catalysts to push for climate action. *Digital with Purpose* identifies the ICT sector as a leader in the effort to tackle climate change with Arabesque finding that “nearly 70 percent of companies in the ICT sector are operating in a way that is consistent with meeting...the Paris Agreement to limit climate change to 1.5°C.” For the wider market, only 52 percent of companies are operating to meet these same goals. In addition, the sector also outperforms the wider market in terms of the proportion of corporates with an approved Science-Based Target (SBT) for greenhouse gas emissions. While in 2019 about 5.5 percent of companies around the world have an approved SBT, for the ICT sector this was 11.5 percent over the same period.

Recognizing the ICT sector as a key player in sustainable development and climate action, analysis from the report concludes that:

1. The ICT sector has a critical role to play in enabling progress in achieving the SDGs. It will contribute an estimated 20 percent of all progress.
2. This impact will support the forecast growth of the industry of around 4 percent per



annum up to 2030, contributing an additional €2.3 trillion a year to the global economy, increasing ICT sector employment by over 45 percent to nearly 80 million, and increasing R&D by over 50 percent to €378 billion.

3. The sector is expected to enable economic growth of between 2.5 and 4 times in the broader economy, reaching €10 trillion by 2030.
4. Emissions are expected to grow by 92 megatons of CO₂ over the period, but this is less than the growth in Gross value Added, implying a reduction in emissions intensity of over 28 percent.
5. ICT sector emissions need to be considered against the ability of the sector to abate the emissions in the rest of the economy, which is estimated at over seven times the change in emissions from the ICT sector.
6. Public commitments of key players in the ICT sector, together with previous studies, suggest that the emissions footprint could be managed down from this number with the appropriate external environment and interventions.
7. The long-term prosperity of the sector requires

both a resolute focus on SDG progress, together with management of the challenges created, specifically in the areas of emission and resource management, but also around other societal issues such as inequality.

While *Digital with Purpose* demonstrates the strong performance and potential of the ICT sector relative to the wider market, it's important to recognise the need to deepen commitments to reducing emissions as the sector continues to grow. In addition, the ICT sector has the responsibility to address negative externalities that come from the development and deployment of digital technologies such as the misuse of information and e-waste.

Multi-stakeholder organisations and Private-Public Partnerships (PPPs) are essential in turning these ambitious goals into tangible action, as well as to keep actors accountable and transparent, ensuring that the *Digital with Purpose* vision becomes a reality. Recognized as one of the key multi-stakeholder processes in building a planetary digital ecosystem, GeSI is proud to have a global network of members and partners as we build on a global "Purpose" movement towards the achievement of the SDGs following the publication of the *Digital with Purpose* report. 



Translating green energy into 5G success for operators

The ICT sector is pivotal to a smart future, but it must also lead the way into a green future. And as a heavy energy user, the sector must cut its own carbon footprint with smart green solutions.

By Jiang Junmu, C114

As we hurtle into the intelligent era, it's time to make saving energy and reducing emissions central to our thinking – both for the planet and for bottom lines.

The ICT industry is the linchpin of the smart

world of the future, but it's also a heavy energy consumer and carbon emitter itself. The World Scientific and Engineering Academy and Society (WSEAS) reports that the ICT industry accounts for 2 percent of the world's total electricity consumption – a proportion that's rising rapidly to an expected 5 percent by 2030.

Starting at the beginning

5G uses just one-tenth the energy per bit of 4G, but 5G will also create a surge in power consumption due to the traffic increase that's predicted to total dozens of times current levels. This issue can only be addressed by thinking green from the start – at the design stage – of large-scale construction.

Peng Jianhua, President of Huawei Telecom Energy, spoke to us about how Huawei has been contributing to global energy efficiency efforts. As well as reducing its own energy consumption and emissions and that of its supply chain, Huawei's Digital Power division has been providing customer-oriented green power generation and energy-efficient products and solutions, and strengthening collaboration with the industry and stakeholders.

"Energy hardware which was a part of the support infrastructure in the past has now become a linchpin of the network," says Peng, adding that as 5G enters more households and is adopted by more industries, ICT will become further integrated. "The value of site energy will become self-evident. Huawei believes that connectivity and computing in the intelligent era will only make sense if it is green," he says.

Green is trending

As we enter the third decade of the 21st century, challenges such as climate change, melting glaciers, smog, and the collapse of biospheres aren't going away – they're getting worse. Fortunately, governments and international organizations have spearheaded global initiatives for energy conservation and emissions reduction. Meanwhile, technological

advances have allowed us to start addressing environmental degradation.

In January 2020, the European Parliament voted to support the European Green Deal with an overwhelming majority. The aim of the European Green Deal is for the European Union to become the world's first climate-neutral bloc by reducing net CO₂ emissions to zero by 2050. In 2006, the Chinese government started to include energy conservation and emissions reduction in its five-year plans, since which time it's made solid strides.

GSMA, ITU, the Global Enabling-Sustainability Initiative (GeSI) and the Science Based Targets initiative (SBTi) set science-based emission reduction targets (SBT) at the end of February 2020, committing to helping the mobile industry achieve net-zero carbon emissions by 2050. Twenty-nine operator groups, representing 30 percent of global mobile connections, have already committed to the SBTs. Vodafone has also promised to reduce its carbon footprint by half by 2025 and purchase all electricity from renewable sources.

It's against this background that Huawei's Digital Power product line aims to provide solutions for generating green power and efficient power use to help drive industry transformation towards clean and renewable forms of energy and efficient energy utilization.

Peng says that Huawei Digital Power has four major areas of focus: photovoltaics, telecom energy, data center energy, and automotive energy. In telecom energy, its solutions integrate power electronics and digital technology to help build green network power with efficiency at three levels – components,

As of the first quarter of 2020, Huawei Digital Power's solutions had helped conserve 273 billion kWh of electricity and reduced CO₂ emissions by 170 million tons, the equivalent of planting 220 million trees.

systems, and collaboration – helping to achieve "bits manage watts" and "zero watts if zero bits" targets.

As of the first quarter of 2020, Huawei Digital Power's solutions had helped conserve a total of 273 billion kWh of electricity and reduced CO₂ emissions by 170 million tons, the equivalent of planting 220 million trees.

3 levels of efficiency

5G entered a critical stage of large-scale deployment in 2020, a year after its commercial launch. According to the latest data from the Global mobile Suppliers Association (GSA), 80 operators in 42 countries and regions had launched 3GPP-compliant commercial 5G services as of mid-May. Moreover, 384 operators were investing in 5G networks in the form of tests, trials, pilots, and planned and actual deployments. In China, 200,000 sites have been built and 800,000 are expected to be completed by the end of this year, covering more than 340 cities across the country.

4G changed life, but 5G will change society. As the key enabling technology for the fully connected, intelligent world, 5G's attributes reach far beyond ICT itself. 5G's advanced nature and the fact that its energy consumption per bit far surpasses 4G are indisputable. However, adding 5G to sites will

bring a series of challenges to power supply infrastructure. These include insufficient mains grid capacity, insufficient power capacity, insufficient battery backup, and the inability to provide high-power AAU remote power supply.

3 concepts in 3 layers

"We've distilled our expertise and successful industry practice in 5G network evolution, materials science, and technologies in areas like power, power electronics, thermodynamics, IoT, and AI into a concept for a target telecom energy network that's 'simple, smart, and green,'" says Peng. This covers everything from components to the network and has, he adds, culminated in "5G Power, our next-gen site power solution, and CO-MIMO, a full-scenario equipment room solution."

Rectifier efficiency is the sole focus in traditional power supply systems and, limited by structure and capability, other parts of the power supply are ignored. Setting out from components, sites, and the network, Huawei Digital Power can help build end-to-end green energy networks that can also help operators achieve 5G success.

At the component layer

Huawei's industry-leading 98-percent efficient rectifier, heat resistant materials, and phase-change cooling temperature control help save 5,000 kWh of electricity



per site per year.

At the site layer

Operators can eliminate the need for diesel generators and add solar panels in all sites, realizing at least 50 percent energy savings in typical sites, based on the following measures:

- Reconstructing old and inefficient sites.
- Converting indoor sites to outdoor sites.
- Adopting AI-powered iSolar digitalized overlaid solar cells.
- Adopting super-fast charging.
- Implementing intelligent network management scheduling and intelligent collaboration.

At the network layer

Cloud-based intelligent network management allows intelligent network-wide coordination between the mains supply, power supply systems, energy storage, and loads. It can also accurately identify inefficient sites. These functions support precision energy efficiency management and energy consumption optimization at sites across the whole network.

Intelligent upgrades have been a powerful part of Huawei Digital Power's arsenal in recent years. By adopting AI, big data, and IoT, its solutions realize the real-time coordination and global management of energy and services, enabling smart power output and smart O&M for site power systems, in turn driving the full smartification of the energy network. On the power side, Huawei has developed functions

such as intelligent voltage boosting, intelligent peak shaving, precision backup, precise power-off, and intelligent hybrid battery use. On the O&M front, benefits are being delivered through functions such as a digital dashboard for network-wide site power with visualized energy consumption per bit, intelligent anti-theft, and remote maintenance.

By reserving space for future capacity expansion and additional hardware, carriers can achieve smooth expansion and save costs when evolving to multi-band 5G. Huawei is enabling them to do this by making breakthroughs in the power density limit, driving constant increases in power and energy storage density. 5G Power enables 5G deployment in various scenarios without needing to modify the mains, build equipment rooms, add cabinets, or replace cables, thus helping customers rapidly deploy 5G and achieve optimal TCO.

5G Power: Site energy gets smart

At the Global ICT Energy Efficiency Summit in October 2018, Huawei unveiled the industry's first complete 5G Power solution – the best energy solution for network evolution.

According to Peng, “Traditional power solutions took piecemeal steps to treat the symptoms, not the disease”. In contrast, he says, Huawei's 5G Power uses AI and other techniques to provide a unified power supply platform for all scenarios. It supports “1 site, 1 cabinet” and “1 site, 1 blade” site construction models, which help operators build and operate 5G networks faster, more economically, and more easily. The solution

will help realize a generational transformation in communications power akin to the leap from “basic sites” to “smart sites”.

In terms of energy conservation and emissions reduction, Huawei's 5G Power not only supports higher power module efficiency, but it can also reduce secondary losses by boosting voltage, increasing end-to-end energy efficiency by 3 percent. It can also help increase site energy efficiency by 5 percent thanks to precise temperature control and on-demand cooling.

The solution also adopts a modular design and supports connections to solar power supply modules. With industry-leading maximum power point tracking (MPPT) technology, Huawei's self-developed efficient solar modules can output 30 percent more electricity than traditional solar solutions, thus using sunlight more efficiently.

Huawei's 5G Power can reduce reconstruction costs per site by more than 12,500 yuan (US\$1,831), conserve 4,130 kWh of electricity per site per year, and cut carbon emissions by 1,125 kg per site per year. 5G Power scooped the Global Industry Award for Sustainable Impact at the 2019 ITU Telecom World Awards, in recognition of its outstanding contributions to energy conservation and emissions reduction in mobile networks. As of 2019, 5G Power had been deployed by 84 operators worldwide.

Smart batteries

Smart lithium batteries play a crucial role in 5G Power. In a basic site, site backup power was mainly provided by lead-acid batteries,

which supplied simple backup power. In smart sites, smart lithium batteries have supplanted not only lead-acid batteries, but also ordinary lithium batteries. Smart lithium batteries are smaller, lighter, and have a longer service life. And they can be coordinated with intelligent power supplies, as well as store and recycle electricity, much like money in a bank, thus creating what Huawei has dubbed a “power bank”. In fact, a single smart lithium battery module can be as effective as two ordinary lithium battery modules.

For equipment room scenarios, Huawei's simplified CO-MIMO power solution boasts new architecture and compatibility with all standards. It offers 55-percent lower volume, 70-percent less load, 30-percent higher capacity, and an E2E efficiency boost of between 80 and 92 percent. The solution can help customers retrofit and expand the capacity of services at the original site without needing new leases, new equipment rooms, or engineering work, thereby supporting simplified evolution towards 5G for CO equipment rooms. CO-MIMO also supports connections to renewable energy, ensuring power supply for converged IT/CT equipment and MEC-ready capabilities. And its unique CO BoostLi power storage system supports a maximum of 6000A ultra-high power and comes equipped with intelligent automatic fire-extinguishing technology for lithium batteries, an industry first that maximizes system safety.

In the future, it will be necessary to further open the capabilities of site energy systems, so they can evolve from traditional communications towards site-sharing and energy-sharing, helping to maximize site

energy efficiency. Huawei's industry-first super site power supply MEC solution maximizes site resource utilization to help sites evolve from communications towards multi-functional "social stations", maximizing their value and generating greater value for society.

The solution leverages intelligent integrated power supply and unified power supply architecture that's compatible with all input and output standards. It also offers flexible modularized expansion, ultra-high power supply and backup capacity, ultra-high heat treatment capacity, and class A environmental adaptability. These support the co-deployment of ICT devices and full-scenario applications.

Thanks to the large power supply and backup capacity, the MEC solution enables site power sharing – providing backup power and electric vehicle charging/power exchange for businesses and residents. Flexible multi-standard output capabilities mean sites can be leased for diverse functions such as security monitoring, disaster detection, and outdoor advertising.

“Huawei believes in openness and cooperation and actively collaborates with third-parties and industry partners,” states Peng. “Huawei was the main technical contributor to the ITU international standard for 5G power, released at the start of 2020, and was the first vendor to release a 5G Power solution that meets the standard.”

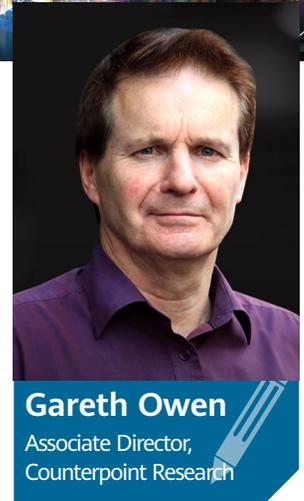
Huawei Telecom Energy, he concludes, has led the global development of site energy technology thanks to its tireless innovation – and it's only through continuous technological innovation that we can hope to make energy greener and society better. 

A single smart lithium battery module can be as effective as two ordinary lithium battery modules.



The race to Open RAN is a marathon, not a sprint

5G will place enormous demands on network infrastructure. To meet the resulting challenges, major changes will be required of RAN architecture.



Gareth Owen
Associate Director,
Counterpoint Research

The architecture of the Radio Access Network (RAN) has evolved significantly since the early 1990s, with the introduction of distributed and centralized RAN architectures now deployed in many parts of the world. However, 5G will place enormous demands on network infrastructure due to the massive volumes of data carried over numerous spectrum bands to multitudes of users with increasingly high user experience requirements. To meet these

challenges, RAN architecture will undergo its most dramatic changes yet – virtualization and cloudification.

4G/5G RAN architectures

Traditional RAN components in cellular networks are designed for optimal performance using proprietary technology.

In a typical distributed 3G network, a base

station consists of a remote Radio Unit (RU) at the top of a tower connected to a Baseband Unit (BBU) located at the bottom of the tower with a fiber optic cable using the Common Public Radio Interface (CPRI) standard. To enable virtualization of the RAN, a different architecture is used in 4G/5G networks in which the BBUs are split into two parts: a Central Unit (CU) located on a centralized server and a Distributed Unit (DU) located either directly at the tower or at another location several kilometers away.

Mobile Network Operators (MNOs) have numerous options regarding where they locate DUs and CUs. In practice, the exact placement will depend on multiple variables such as business requirements, transport capabilities (for example, is fiber available?) and RAN coordination features.

Locating the DUs closer to the edge of the network reduces latency; conversely, centralizing the DUs can optimize the network by minimizing interference within a group of sites, but at the cost of higher latency.

The concept of Open RAN

The RAN market today is dominated by a small number of incumbent vendors, of which Huawei is one. In a bid to generate more competition and increase vendor diversity, some MNOs support the concept of Open RAN in which proprietary RAN technologies are replaced by open standard alternatives. This involves two key initiatives:

- **Open interfaces:** replace existing RAN interfaces with open standard alternatives. Replacing the CPRI fronthaul interface

with an open interface, for example, would enable MNOs to mix and match RRUs and BBUs from different vendors.

- **Software and hardware disaggregation:** separate RAN software from associated ASIC-based hardware platforms. This would enable MNOs to select BBU software from alternative software vendors, which could be run on Commercial Off-The-Shelf (COTS) hardware based on standard x86-based processors.

Open RAN standards

A number of companies are developing an ecosystem of software and hardware based on the Open RAN approach and collaborating in a number of standards organizations.

Two Open RAN organizations actively promote Open RAN: O-RAN Alliance and the OpenRAN project, which is part of the Telecoms Infra Project. The members of each include MNOs and software and hardware vendors.

- **O-RAN Alliance (ORAN).** Founded in February 2018, ORAN is developing a complete reference architecture for building a virtualized RAN with open hardware. Standardized interfaces would enable an open and interoperable supply chain ecosystem. Various technical work groups cover several topics, including overall architecture, open midhaul and fronthaul interfaces, RAN intelligent controller and AI interface, and white-box hardware and software architecture.

In February 2019, ORAN published the first open standard specification for the fronthaul

The most likely opportunities for open RAN are in new network builds or in emerging markets where 4G and 5G is still in the planning stages.

interface between the RUs and BBUs. Other standardized open interfaces include the X2 interface, which interconnects BBUs.

- **OpenRAN:** A project group within the Telecoms Infra Project (TIP), OpenRAN has the broad mission of developing open source-based software services across all telecoms and IT infrastructure. Its main objective is to develop fully programmable RAN solutions based on disaggregated software running on General Purpose Processors (GPP) using COTS hardware.

OpenRAN is also defining an open white box device using standard server and accelerator components that meet the needs of operators for the speeds and densities required for 5G NR. The TIP projects use O-RAN interfaces and specifications.

Market transition

A few years ago, MNOs were excited at the prospect of drastically reducing the cost of mobile infrastructure by replacing proprietary hardware with Open RAN interfaces that would enable the mixing and matching of RUs and BBUs from different vendors. However, Open RAN proved to be much more difficult to implement than initially envisaged, and several planned deployments were postponed. Today, the tide is beginning to turn.

At present, however, Open RAN deployments consist of a handful of mostly greenfield commercial deployments and numerous legacy network trial deployments. With the majority of MNOs having already selected their initial 5G infrastructure partners, it's unlikely that any of the new Open RAN

vendors will capture a significant share of any major MNO's initial 5G build.

In the short term, Counterpoint Research believes that the most likely opportunities for Open RAN are in new network builds or in emerging markets where 4G and 5G is still in the planning stages. Several MNOs are also looking to deploy Open RAN in rural markets. Other opportunities include small cell deployments, particularly in-building deployments and 4G/5G private networks. However, other opportunities may open as 5G matures and MNOs start thinking about upgrading and enhancing their networks.

Companies that want to build their own enterprise networks are also potential customers. Many large-scale industrial conglomerates are interested in building private cellular networks, particularly with the increasing availability of unlicensed spectrum bands (such as the CBRS band in the US) and the imminent availability of 5G NR-U technologies specifically designed for unlicensed bands. Counterpoint Research believes that the private network market is probably one of the best short-term market opportunities for Open RAN vendors once 5G NR becomes available.

Key challenges

Although a small number of major MNOs are believed to be starting limited commercial deployment, Counterpoint Research believes that numerous challenges and issues still need to be resolved before the widespread adoption of Open RAN commences:

Open interfaces: These are essential to



enable multi-vendor networks and a more competitive and vibrant supplier ecosystem, and can be realized on both traditional proprietary and new Open RAN platforms. The main fronthaul interface standards are the 3GPP-developed eCPRI and O-RAN 7.2x open standard from the O-RAN Alliance, both of which are in the initial phases of deployment. However, open versions of other RAN interface standards are required. These are still under development by the various Open RAN industry groups.

Performance: The performance and cost differential between custom-built and generic open COTS hardware will be a critical deciding factor for MNOs. At present, proprietary ASIC processors are more power-efficient and less expensive than x86-based CPUs. The performance gap is significant for demanding

workloads, for example, networks that operate 5G MIMO mmWave antennas. In addition, there are form factor requirements, as the processors may need to be fitted into standard industry enclosures designed to be attached to roof top fixtures or onto street light poles.

With the possible exception of rural networks that focus on coverage rather than serving densely populated areas, Open RAN deployments are not being run on standard x86 COTS processors. For example, in the case of Rakuten, its partner Intel had to implement considerable hardware acceleration via FPGAs to run the baseband software stack supplied by another vendor.

The conclusion is that running heavily virtualized baseband stacks based on standard x86 CPUs isn't feasible without

additional bespoke accelerator platforms based on FPGAs, GPUs, or possibly new chip architectures, such as those being developed for AI applications, all of which have cost and power implications.

Scalability and coverage densification:

Scaling to meet capacity and coverage demands, particularly in large macro networks or large indoor venues, such as stadiums, is unproven today. Coverage densification in cities, particularly at millimeter wave frequencies, is also a major challenge for Open RAN. However, several vendors have recently initiated trials with major MNOs to test and improve performance in such environments.

Increased operational complexity: Perhaps the biggest concern of MNOs is the increased complexity of an Open RAN network. Virtualization has a steep learning curve and MNOs have struggled with the sheer number of Virtual Network Functions (VNFs) that must be integrated into existing network architectures and linked to their operations systems.

In a conventional network, MNOs typically have access to a single vendor that's available to resolve issues and problems. However, with an Open RAN network, where software and hardware are sourced from many vendors, it might not be immediately clear which product is malfunctioning and hence which supplier should be contacted.

Total Cost of Operation (TCO): Although some MNOs claim significant cost savings with greenfield deployments of Open RAN, MNOs in general remain unconvinced about the TCO

benefits of Open RAN for legacy networks. As a result, MNOs are looking for additional benefits such as the ability to deploy new applications that can generate new revenue streams, for example, edge compute and IoT. However, the business cases for many of these new services remain unproven.

No white box RU market: At present, Counterpoint believes that RU units supporting the O-RAN alliance 7.2 specifications are only available from two vendors, although several other vendors are believed to be engaged in developing such products.

In late February 2020, TIP announced the launch of the Evenstar RU initiative, which will develop reference designs aligned with 3GPP and O-RAN Alliance specifications. First RU products are believed to be Band 3 (1,800 MHz) units, which are expected to become commercially available towards the end of 2020 with an ultimate price target of US\$1,000. Evenstar RUs will support the O-RAN Alliance 7.2 split architecture.

Interoperability: The ability to mix software and hardware from different vendors is often touted as one of the major benefits of virtualization. However, it's also one of the greatest hurdles. At present, there are no well-defined standards or testing methodologies to guarantee the interoperability and performance of software and hardware products from different vendors.

At this stage, vendors are just testing their own products to see if they comply with O-RAN standards rather than testing interoperability with each other's products.

However, the recent opening of two test and integration centers in Berlin and Beijing is a positive step that should ultimately resolve this issue.

Viewpoint

Although there's considerable momentum behind Open RAN at present, the transition to fully interoperable, multi-vendor, cloud native RANs is a marathon, not a sprint. Counterpoint believes that there is still some significant research, lab testing, and trials, plus a few major milestones to be overcome before wide scale Open RAN adoption happens.

While MNOs are clearly looking for vendor diversity, Open RAN technology and standards need to mature before the technology can be deployed in commercial networks at scale as MNOs cannot risk exposing their customers to unreliable infrastructure.

Network performance is still a major challenge, as general-purpose x86-based hardware struggles to achieve performance and OPEX costs on a par with dedicated ASIC-based hardware. Open fronthaul interfaces will be critical to allow interoperability between RUs and BBUs and, although the first Open RAN interface standard was released by the O-RAN Alliance in February 2019, an ecosystem of truly interoperable Open RAN white box hardware will be required before Open RAN can be deployed en masse. Other important issues to be resolved include improvements in scaling and coverage densification, which will be required to meet capacity and coverage demands, particularly in large macro networks and in large indoor venues such as stadiums.

Nevertheless, the fact that major MNOs, such as Telefonica and Vodafone, are prepared to give smaller Open RAN vendors even a small share of their business should be a signal to incumbent infrastructure vendors that MNOs are serious about Open RAN. However, it won't be easy to dislodge the incumbents that Counterpoint believes are well positioned to control the adoption of Open RAN.

Major MNOs have already started selecting their initial 5G radio partners. There are millions of 5G NR-ready radios in the field that can be upgraded with minimal hardware, or in some cases remotely. This complicates the business case for new Open RAN entrants. As a result, it may take three to five years for these players to gain a sizeable market share, and in that time, not all will survive. Furthermore, increasing network complexity, coupled with the application of new technologies such as AI-based automation, may favour incumbents as they have more technical resources to deal with the ever-increasing complexity of mobile cellular infrastructure.

As a result, Counterpoint believes that mainstream adoption by major MNOs will only happen when it's clear that the operational benefits and flexibility offered by Open RAN network solutions outweigh and compensate for the hardware, power, and system integration costs, while attaining the same high level of network performance and reliability. Although some limited commercial rollouts can be expected during 2020, Counterpoint Research therefore believes that large scale Open RAN deployments are probably at least 18 to 36 months away. 

Although there's considerable momentum behind Open RAN at present, the transition to fully interoperable, multi-vendor, cloud native RANs is a marathon, not a sprint.



iCooling@AI: Smart cooling for data centers

As data centers grow in size and number, the energy they consume is becoming more problematic. Each data center faces the challenge of increasing energy efficiency to lower power usage effectiveness (PUE). Huawei's iCooling@AI solution can achieve exactly that.

By Fei Zhenfu, Director of Data Center Infrastructure Product Dept, Huawei
Song Xiaoxin, Senior Engineer of Data Center Infrastructure Product Dept, Huawei

PUE is a KPI that measures the energy efficiency of data centers. Cooling – a key component of a data center – is closely related to equipment heat dissipation, equipment configuration, facility environment, and external climate conditions. Thus hardware-based energy savings or optimizations based on human expertise alone cannot reduce power consumption any further.

Based on its extensive experience in data center construction, Huawei launched the iCooling@AI solution powered by big data and AI. The solution reduces the energy consumption of data centers, enables smart cooling of large data centers, and cuts PUE.

AI in chilled water cooling systems

The chilled water cooling system of a data center saves energy in two ways: design and O&M.

Energy-saving through design comes from designing the right cooling systems and selecting the right equipment, which focuses on using hardware to save energy. However, energy-efficient hardware does not necessarily result in the most energy savings because energy efficiency is closely related to the O&M of a data center.

Traditional O&M depends on an experienced O&M team. Based on their experience, the team determines how to adjust the parameters of a cooling system for different seasons, ambient temperatures, and load rates to maximize the energy efficiency of the cooling system. However, relying on experience that varies between team

members doesn't always result in accuracy.

For a complex chilled water cooling system, a new control algorithm is needed to achieve overall optimal performance. That's where big data and AI come in. AI can be used to determine the relationships between the PUE and the data of different features and then predict a PUE value. With the PUE value, the data center can make optimizations as expected based on the current climate and load conditions to achieve the energy-saving target.

Using key technologies for smart cooling

Powered by AI and big data technologies, Huawei's iCooling@AI solution enables smart cooling systems for data centers. The key technologies used in this solution include:

Big data collection: Given the complexity of data center cooling systems, information about the power supply system, cooling system, and environment parameters must be collected.

Data governance and feature engineering: First, a mathematical tool is used to perform data governance on the raw data collected, providing high-quality data for subsequent model training. Second, feature engineering is performed on large amounts of raw data to identify the key parameters that affect PUE. Selecting too many or too few parameters will affect the accuracy of the final model. Too many parameters will lead to overfitting. The trained model will have a better fit from the trained data than from the tested data, but it has poor generalizability. If too few parameters are found, underfitting occurs. The trained model performs poorly with both the trained dataset and the

The use of big data and AI, as well as the combination of software and hardware, has allowed Huawei to set a new benchmark for green data centers.

tested dataset.

Creating a PUE model using a neural

network: Neural networks are a set of machine learning algorithms that can simulate the cognitive behavior of interactions between neurons. Deep neural networks can play a role in increasing the cooling efficiency of data centers. The machine learning algorithms of these networks can find the relationships between parameters of different pieces of equipment and systems. A mathematical model or the PUE model of the data center is created based on large amounts of data from sensors.

Inference and decision-making using genetic

algorithms: Based on the input PUE model and the operating data collected in real time, the algorithms find the best policy in four steps: parameter traversal and combination, service rule assurance, calculating the energy consumption of the cooling system, and selecting the optimal policy.

Building green AI-powered data centers with both software and hardware

The use of big data and AI, as well as the combination of software and hardware, has allowed Huawei to set a new benchmark for green data centers.

Software includes the teamwork control system and the data center infrastructure management (DCIM) system. The teamwork control system of a data center mostly uses the programmable logic controller (PLC) or direct digital control (DDC) and has active and standby servers. The system has a regular control mode and an

energy-saving control mode.

Regular control mode: The teamwork control system automatically executes all control logic, including adding or removing equipment, adjusting the rotational speed, switching the cooling mode, bypassing, and charging/discharging chilled water. The DCIM system monitors status information.

Energy-saving control mode: The teamwork control system is subject to the control of energy-saving algorithms. It executes the instructions issued by the algorithms, including adjusting the amount of operating equipment; adjusting target values of control loops like rotational speed, power, temperature, and pressure difference; and switching cooling mode. When no control instructions are issued, the teamwork control system controls the operations.

As the centralized management system of a data center, the DCIM system manages all the links within the cooling system. The energy-saving optimization instructions are generated by the AI algorithm and then sent to the teamwork control system, which then conducts final execution.

Hardware includes different sensors such as smart meters, pressure/differential pressure sensors, water temperature sensors, flow sensors, and outdoor dry/wet bulb thermometers.

To ensure the best optimization, variable-frequency components should be used for chillers, water pumps, indoor units of air conditioners, and cooling towers. The entire cooling system can be automatically controlled.

Data is collected every five minutes to maximize quality. The number of collection points depends on the size of the data center. The first time data is collected and at least three months of operating data need to be recorded. After that, data is uploaded once daily. Data can be uploaded in two ways: The refrigeration station data is uploaded to the DCIM system through the Building Management System (BMS); or the IT load data is uploaded to the DCIM system through the cabinet information collection system.

Efficient data governance includes identifying and deleting abnormal data based on Gaussian distribution; unifying the timelines of all parameters; normalizing geographical locations; deleting data irrelevant to PUE (such as alarms and maintenance information); and supplementing missing data based on the data center O&M experience and the operating parameters of equipment like chillers.

To complete subsequent model training, mathematical tools such as the chi-square test can identify key parameters that affect PUE. Common parameters of a data center include five types of control parameters (for example, the amount of equipment, temperature of water supplied by chillers, temperature difference between supplied and returned chilled water, approach of the cooling tower, and temperature difference between supplied and returned cooling water);

14 types of process parameters (such as water flow, pressure difference, and equipment power consumption); and two types of environment parameters (outdoor temperature/humidity and IT load rate).

The biggest challenge with data-center O&M is determining which parameters in the system to change and finding the perfect combination after one parameter has been adjusted. There is no formula or algorithm to reference in current O&M practices.

To address this issue, copious amounts of historical data are used to train an AI neural network. AI uses machine learning algorithms to analyze the relationships between the PUE and the data generated by data center components. These discover the impact of different pieces of equipment and system parameters on the overall system. Dynamic model training, inference, and decision-making are the key to this process.

A neural network has an input layer, an output layer, and multiple hidden layers. An input eigenvector reaches an output layer after it is transformed at hidden layers, and classification results are generated at the output layer. AI-powered PUE optimization uses deep neural networks, which includes five hidden layers.

All data that has undergone

governance and feature engineering are randomly divided into three parts. Ten percent of the data is used for preliminary training, 80 percent for in-depth training, and 10 percent for final verification. A data center's PUE model is generated after training and verification.

Finally, the prediction model (PUE model) is sent to the inference platform. With the powerful inference and computing capabilities of the inference platform, possible cooling policies are traversed and simulated by using genetic algorithms. Within one minute, the AI energy-saving algorithm can identify the optimal parameter combination under the current outdoor conditions and IT load from 1.4 million combinations, perform multi-layer filtering based on the O&M requirements of the data center, work out an optimal set of instructions, issue them, and provide feedback on what happened.

iCooling@AI technology has been commercially deployed to provide smart cooling for multiple large data centers. Field tests show that the PUE of these data centers can be reduced by 8 to 15 percent. As the iCooling@AI solution and AI technologies are widely used in data center operations and management, concepts such as intelligent O&M and unattended operations are no longer just buzzwords – they are becoming reality. 



Building greener homes with eAI optical modems

While we all enjoy the convenience of technology, most people are likely to agree that this enjoyment shouldn't come at the expense of the environment. Here's how we can enjoy the best of both worlds.

By Zhang Xiaolin, Deng Feifei, Senior Marketing Manager, Transmission & Access Domain, Huawei

Most home devices are Wi-Fi-enabled, with Wi-Fi networks now a key part of home infrastructure for every family. And that's especially true this year with millions of households using online education and online office applications.

VR education will soon enter the home – and with good reason: studies show that students' attention and beta brain waves last six times longer in a VR environment than in a traditional learning environment. Indeed VR may become standard for language classes in the next five years, with VR- and AI-powered digital virtual avatars likely to be the future direction of language teaching.

Gaming has also evolved – from the first stand-alone consoles to mobile games, web games, client-hosted games, to today's massively popular online games. Gaming is imposing higher and higher requirements on the Internet, as online games' user numbers and scale rapidly expand. Having amassed 350 million players as of May 2020, Fortnite, for example, places very stringent latency requirements on the network, because it needs high data read and write speeds given the huge numbers of players online simultaneously.

The key node that connects all home services to the network is the optical modem, aka the optical network terminal (ONT). And while we all enjoy the convenience of technology, most people are likely to agree that this enjoyment shouldn't come at the expense of the environment. We're paying more attention to product size, function, energy-saving capabilities, safety, reliability, and whether devices and their materials are toxic-free and safe.

This has in turn increased the requirements on the design of these products. The electronic components, source materials, and power consumption must pass international environmental protection certifications like WEEE and RoHS to guarantee the quality of the entire product.

Huawei started researching and designing its optical modem back in 2007 and has spent the 13 years since developing and innovating the technology. We've shipped more than 250 million units to over 150 countries and regions around the world and expanded the range of technologies supported by the ONT from simple Layer 2 forwarding functions, to Layer 3 forwarding functions, to 4K and VR services. Today, the product supports the latest embedded AI (eAI) intelligent service, which is capable of accelerating multiple services.

We have continuously improved the product's integration density within its effective area while limiting and reducing its power consumption. This has been driven by our deep integration of green concepts and goals for many years, and our commitment to exploring solutions for reducing energy consumption. We're making constant advancements in power supply circuits, adapters, function modules, components, and other technology areas. It also includes product planning, structure design, production, and through the introduction of intelligent algorithms. This is our commitment to environmental protection within our product responsibility.

OptiXstar V Series: Three levels of energy-saving

With the leap from Wi-Fi 5 GPON + 2x2 dual-

Customers who don't understand the characteristics of Wi-Fi 6 tend to believe that because its performance is better, it must emit more radiation.

band to Wi-Fi 6 XGPON + 2x2 dual-band, the overall improvement in the performance of home ONTs has increased power consumption. Customers who don't understand the characteristics of Wi-Fi 6 tend to believe that because its performance is better, it must emit more radiation. Therefore they want ONTs to enter deep hibernation when not in use, such as overnight, so that radiation is minimized before it connects immediately when they need to use it. This imposes high requirements on any energy-saving solution for the product. Such a solution needs to be intelligent.

Enter the Huawei eAI ONT

In 2019, Huawei launched the next-gen OptiXstar series of eAI ONTs. These products boast three levels of energy-saving measures. Maximum energy-saving is achieved across the whole device, from the internal software to the hardware to the exterior, at the algorithm, module, and structural level. Application Performance Management (APM) intelligent-scheduling achieves smart scenario-based energy-savings with peak and off-peak sleep modes. The superior product design realizes green communications energy conservation and emissions reduction, ensuring user service experience while delivering a high-quality lifestyle.

Data shows that Huawei's latest OptiXstar series of gigabit ONTs can save each customer 38 kWh of electricity per year, thanks to smart hibernation technology that takes its energy consumption levels down to 30 percent less than similar products and 20 percent lower than the level set out by the European Union's Code of Conduct on Energy Consumption Broadband Equipment Version 7. An ONT running 24 hours

a day would consume 0.47688 kWh of electricity a day, or 174 kWh of electricity a year. The smart hibernation technology of the OptiXstar gigabit ONT reduces this to 0.37 kWh or 135.05 kWh a year, saving households 38.5 kWh per year. Converted to carbon emissions, this would equate to 24 kg of CO₂, which is equivalent to the carbon dioxide absorbed by a single mature tree. OptiXstar ONTs' energy-saving function helps families to metaphorically plant a tree a year and contribute to saving the natural environment.

eAI ONT for greener homes

Home broadband users are shifting expectations from a broadband experience to an ultimate service experience. As the number of full-4K users and services grow, online education, online office, cloud gaming, and cloud VR are entering the "experience level" of development. Huawei's OptiXstar V series of eAI ONTs uses 100-percent hard forwarding, Wi-Fi dual acceleration, and eAI smart identification capability of up to 1 million packets per second, improving the entire home broadband service experience.

In a typical home, Huawei's eAI ONT starts work early in the morning as the first data packets are transmitted: At 9 am, the kids start online classes in a quiet home environment, with the ONT serving as a silent enabler. As it's then off-peak for broadband service traffic, the ONT stays in hibernation mode.

By 6 pm, everyone is back after a busy day. Dad is relaxing playing VR games with his daughter, while Grandpa watches their virtual battle. Grandma is exercising to a live stream of dancing on an IPTV broadcast. Mom is watching online videos while helping the family's



youngest child with his homework. This type of lively family scene signals the peak period for broadband services, with the ONT operating at full speed in the background.

At 10 pm, the whole family gets ready for bed, with just mom and dad left watching videos and using social media. As broadband service traffic gradually decreases, the ONT slowly adjusts back into hibernation mode after working at full speed. By midnight, the whole family is asleep and broadband service traffic has fallen to zero. After transmitting the last data packet, the eAI ONT has also completed its day's work and enters deep sleep mode.

Gigabit eAI ONTs enhance the family's real-time service experience of the home network as well as improving their experiences and making life more convenient. Our goal is to facilitate greener and more livable environments for people to live in. We've invested extensive resources in our products' technology, quality, and energy conservation capabilities, continuing to reduce the power consumption of ONTs in the home network and maximize energy saving.

With eAI ONT, Huawei hopes to provide a greener home gateway to the Internet and make the home a greener place. 



Building smart energy services with IoT

State Grid Hunan Integrated Energy Services (IES) and Huawei have developed a Smart IES IoT solution based on cloud-edge-device IoT architecture, aiming to tackle common problems in developing integrated energy services.

By Xiang Yunkun, Business Operation Director, State Grid Hunan Integrated Energy Service
Huang Wei, Senior Engineer, Data Communication Product Line, Huawei
Zhang Haoxiang, Senior Marketing Manager, Wide Area Network, Huawei

Chinese power grid companies have been transforming from traditional electricity suppliers into integrated energy service providers in response to the opportunities and challenges brought about by the green energy revolution.

State Grid Hunan Integrated Energy Services (IES) and Huawei have developed a Smart IES IoT solution based on cloud-edge-device IoT architecture, aiming to tackle common problems in developing integrated energy services. These problems include a lack of basic data and platforms, difficult O&M management, software and hardware coupling, multiple access scenarios, and on-site deployment difficulties.

The Smart IES IoT solution comprising apps, a breakthrough IoT gateway with smart edge computing capabilities, and a multi-container technology that decouples software and hardware. It supports flexible service expansion, open data-sharing, and smart cloud-edge collaboration, and provides an intelligent, open, and efficient digital platform for integrated energy services, powered by big data, AI components, and microservice architecture.

Hunan's Better Life Group adopted the solution to transform over 100 of its stores to provide refined energy management, real-time energy consumption management and control, and intelligent air conditioning and lighting management. This has helped Better Life save more than 20 percent in energy, boost corporate management, and meet its green targets.

Green energy revolution

With fossil fuels becoming scarcer, pollution increasing, and climate change becoming more severe, the efficient use of green energy and renewable energy is essential for society to progress. As a green, clean energy type that's high-quality, efficient, and renewable, electric power can meet most energy needs.

China is committed to creating a global energy Internet and promoting clean and green ways to meet global electricity demand, pledging to accelerate reform for building an energy sector that's clean, low-carbon, safe, and efficient.

Power grids, transmission, and distribution will remain under central control, with free market forces allowed to act on power generation and consumption. This will establish a more complete, fully competitive, and effective energy market, and facilitate efficient energy use and healthy development.

Grid companies are targeting new opportunities in the IES market. State Grid Hunan IES set up an integrated energy service subsidiary to transform from a traditional electricity supplier into an IES provider, and established new service types to help satisfy diverse energy demands, boost user stickiness, and increase income from value-added income.

Main obstacles to IES

Integrated energy services can meet diverse energy production and consumption needs, including energy planning and design, engineering construction and investment, multi-energy operations and services, and investment and financing services.

State Grid Hunan IES develops personalized



services for energy-intensive customers for whom air conditioning makes up a large proportion of electricity consumption, such as commercial buildings, industrial enterprises, and large campuses.

On the supply side, it established an electricity-based multi-energy power supply system that helps customers reduce energy costs, including distributed power generation, tri-generation (combined heating, cooling, and power), and energy storage.

On the energy side, it developed an electricity-centric device energy consumption system to help customers improve energy efficiency. The solution provides energy-saving services, energy O&M, and energy consumption monitoring and analysis. It promotes energy and information integration and makes full use of technological, resource-, and funding-based approaches.

When State Grid Hunan IES first launched integrated energy services, the main issues it faced were the lack of detailed energy consumption data and a basic digital platform for support service development.

Energy customers don't usually have detailed data about energy use, like energy by category and item, consumption time and spatial distribution, overview and indicators, or abnormal energy consumption warnings. That means there's no data to analyze energy use, no way to manage energy, and no way to verify energy efficiency transformation.

When State Grid Hunan IES first launched, it lacked an intelligent digital platform for the remote management of equipment and software upgrades or energy data analysis to support mass data analysis and flexible applications, which severely restricted how fast it could develop its services.

Smart IES IoT

State Grid Hunan IES teamed up with Huawei to develop an innovative Smart IES IoT solution based on the cloud-pipe-edge-device core architecture that would allow them to build an integrated energy service digital platform to support data perception, edge processing, and smart applications; meet the IoT application requirements of integrated energy services in multiple scenarios; and support the development

of such services.

• **Cloud: Visualized remote management**

At the cloud layer, we adopt a cloud management architecture comprising an application layer and a platform layer.

The application layer provides an open northbound interface for industry integrators to build app service packages and provide professional services for energy customers. This leverages industry vendors' deep understanding of the industry and the technology of the application scenarios.

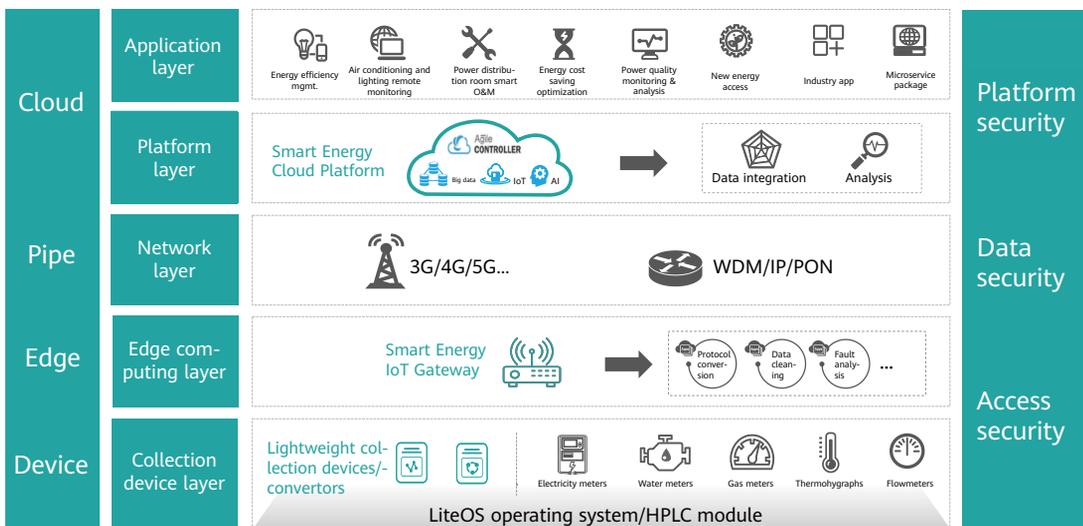
The platform layer provides the IoT platform, a big data component, and an AI component. It supports remote visual management of the full lifecycle of millions of end devices, real-time monitoring of whole-network status, rapid fault location, and the analysis and processing of mass energy consumption data. It incorporates the latest industry policy changes, identifies high-value data, and discovers energy customers'

requirements.

• **Edge: Edge-cloud collaboration is more efficient**

At the edge computing layer, we use edge computing technology to redefine the energy gateway device and give it a smart brain. The Smart IES IoT Gateway acts like a smartphone – functions can be customized or added on-demand and it can flexibly share data so it can link to different service ecosystems. This creates a multi-functional device and avoids redundant development of other hardware systems.

Cloud-edge collaboration is also used to support hierarchical data analysis and processing for efficient applications. The cloud and edge collaborate efficiently – with the cloud mainly handling big data analysis of energy consumption, human-computer interaction, and strategy generation, while the edge mostly deals with data pre-processing and strategy decomposition and execution.



Top-level design of the Smart IES IoT solution

Huawei's Smart Integrated Energy Service IoT solution digitally manages vast amounts of energy assets, realizing efficient device-to-device, device-to-people, and people-to-nature synergy.

- **Device: Full electric, water, gas, and heating/cooling data collection**

At the data collection device layer, we use lightweight data collection devices and lightweight converters that adopt industrial-grade high-speed power-line communication (HPLC). That means devices can network over power lines; have plug-and-play capability; and use ordinary power lines to collect energy consumption data economically, reliably, and efficiently. They also support multiple-wired/wireless-interface conversion, which fully meets the service access needs of scenarios like electricity, water, gas, heating/cooling and provides basic data for integrated energy services.

Refined energy management

In 2020, the energy consumption of one company, which has partnered with State Grid Hunan IES, was projected to rise to over 500 million kWh. With energy costs increasing every year, the company's major priority was to improve energy efficiency. By conserving energy and reducing energy consumption, it could strengthen its competitiveness and ability to survive.

A lack of data for energy efficiency transformation and manual energy management were general issues affecting the company's stores. Energy consumption data was collected through manual meter reading, which is inefficient and error-prone. There were also no detailed data measurements by item such as air-conditioning, lighting, and freezers. Moreover, energy consumption data from individual stores was siloed, making it impossible to generate cross-comparison data.

State Grid Hunan IES and the company signed a strategic agreement for integrated energy services, building a three-level energy management and control platform that adopted Huawei's Smart IES IoT solution. The platform can collect data from over 50 different types of appliances, including air conditioners, elevators, sewage pumps, large advertising screens, and quantitative lighting.

It also provides a package of sub-services. These include energy efficiency transformation and operation monitoring for devices, line status early warnings, abnormal operation warnings, load forecasts, energy consumption rational analysis, use management for lighting and other appliances, energy efficiency improvement recommendations, and the construction of charging piles for parking lots. Thanks to these functions, the platform has helped the company implement refined energy management, implement "last-mile" energy management, and build an integrated energy service management and control platform. Services like energy-saving, power O&M, and energy consumption monitoring and analysis, have helped the company improve energy efficiency, reduce energy costs, eliminate potential energy safety hazards, ensure green and safe operations, and improve corporate management.

State Grid Hunan IES will continue to work with Huawei to create leading energy solutions based on 5G, AI, cloud and other innovative ICT capabilities to better serve energy customers. Huawei's Smart Integrated Energy Service IoT solution digitally manages vast amounts of energy assets, realizing efficient device-to-device, device-to-people, and people-to-nature synergy, helping partners establish integrated energy services for a better future. 



Kevin Huang
VP & CMO, Transmission
and Access Network
Product Line, Huawei

Connecting with nature through green connectivity

China Telecom Sichuan has completed China's first province-wide, all-optical network, achieving 100-percent fiber coverage of the province and creating a green bridge to the world. How did it achieve this?

The human need for connection has existed since ancient times. In China's west, the Shu roads – the winding mountainous roads connecting present day Shaanxi and Sichuan – provide a spectacular example of how human

ingenuity and spirit can overcome what is ostensibly impossible. Immortalized by the iconic Tang poet Li Bai in the “The Hard Road to Shu”, building and traveling these roads was monumentally challenging. Today, the kind of things we talk about for connecting people

Ensuring that technology and nature coexist in harmony is the philosophy behind Huawei's commitment to environmental protection, a commitment we continue to fulfill.

– network technologies – present their own challenges that we must face.

While the nature of our desire for connections hasn't changed in the 3,000 years since the Shu roads were carved out of mountain rock, the relationship between people and nature has. Today we have the ability to impact natural ecosystems to an extent that was once impossible. And we do so often to the detriment of the environment: global climate risks are rising, extreme weather events are increasing, and biodiversity is declining. The relationship between society and nature has been thrown off balance.

We believe that technology shouldn't work against nature, but instead the two should exist in healthy symbiosis. The ICT industry is the cornerstone of the intelligent world and is playing a vital role in helping us achieve the UN's Sustainable Development Goals. To do so, the global ICT industry must prioritize energy saving and emissions reduction in its technologies, products, and solutions. China Telecom Sichuan and Huawei are doing exactly that in the Shu roads, while fulfilling the connection needs of communities.

Optical fiber harmonizes connectivity and nature

Committed to low-carbon telecommunications and green technologies, China Telecom Sichuan began replacing copper cables with fiber back in 2012 with the aim of building an all-optical network. Optical fiber is the greenest transmission media, using 60- to 75-percent less energy than copper. After three years, China Telecom Sichuan completed China's first province-wide all-optical network, achieving

100 percent fiber coverage of the province's 21 cities and prefectures, 183 counties, 3,716 towns, and 22,700 villages.

With this green network extending from the urban metropolises to remote villages to snowy peaks, China Telecom Sichuan has established a bridge connecting Sichuan to the world.

How did it do this?

Ensuring that technology and nature coexist in harmony is the philosophy behind Huawei's commitment to environmental protection, a commitment we continue to fulfill. To help China Telecom Sichuan and other operators around the globe better implement low-carbon strategies, Huawei continues to promote green innovation in optical networks, break through theoretical limits, and create greener optical network products. Huawei's OptiXtrans series of optical cross-connect (OXC) products meet Huawei's commitment to low-carbon development.

OXCs boast ultra-large capacity, liquid crystal on silicon (LCoS) technology, 1.5 Pbps single-cabinet capacity, and 32-degree scheduling. It also offers device integration at nine times higher density than traditional ROADMs.

For zero fiber connection, we've developed unique optical backplane technology that allows us to print over 1,000 optical fibers on an optical backplane the size of an A4 sheet of paper, realizing fully automated fiber optic scheduling.

At the digital optical layer, we use our in-house optical label technology, which supports wavelength-level network status monitoring



and end-to-end visibility of more than 50 optical parameters, enabling full automation of optical layer O&M.

Thanks to technological innovation at multiple layers, Huawei's OXC products reduce equipment room footprint by 90 percent and realize power savings of 60 percent. Huawei OXC equipment has been used in 12 core transmission nodes in China Telecom Sichuan's network, forming an "Optical Cube" network that saves 250,000 kWh of electricity each year, the equivalent of planting 2,000 trees.

All-optical cities for a green future

Replacing copper with fiber was the prologue in China Telecom Sichuan's construction of an all-optical city, but introducing OXC was the start of a whole new chapter. End-to-end (E2E) OXC, E2E OTN, and E2E intelligent management comprise the all-optical city's three-layer optical network architecture. And 200G/400G high-speed optical transmission technology will double connection rates in cities. These will

form an all-optical city network for the next decade.

For sectors like government administration, finance, and healthcare, China Telecom Sichuan will supply high-quality private line services, enabling the digital transformation of vertical industries. It will provide homes with enterprise-grade, high-quality services, bringing VR and HD live streaming to numerous households. And it will deliver high-quality 5G connections for everyone and everything, accelerating the incubation of 5G applications.

In the future, when Sichuan completes the all-optical city project, it will save 8 million kWh of power – the equivalent of planting over 64,000 trees – per year.

The green Shu roads are just the beginning. We will continue working to protect the environment. We are willing to work with governments, enterprises, and other organizations to jointly ensure the harmonious development of society and nature. 🇨🇳



Yan Jianfeng

Global Brand Director,
Smart PV, Huawei

Smart PV: Breathing life into a desert landscape

Huawei's Smart PV (photovoltaic) solution harnesses digital technology to convert solar energy into electricity ultra-efficiently, promote the adoption of clean energy, and create a more sustainable world.

In October 2018, the United Nations Intergovernmental Panel on Climate Change (IPCC) issued a special report on the impact of global warming at 1.5°C above pre-industrial levels. The report pointed out that, in contrast to a 2°C increase, limiting global warming to

1.5°C wouldn't just have clear benefits for people and natural ecosystems, but also culminate in a sustainable and fairer society.

The report also emphasized that to limit global warming to 1.5°C, it will be necessary to achieve "rapid

and far-reaching" transformations in land, energy, industry, and cities. By 2030, global net anthropogenic carbon dioxide (CO₂) emissions must be reduced by about 45 percent compared to 2010 levels, and "net-zero" emissions must be achieved by 2050.

Increasing the use of clean energy, boosting the utilization efficiency of resources and energy, and developing a greener energy infrastructure are fundamental to responding to the energy crisis and climate change.

Turning crisis into opportunity

Huawei and Baofeng Group both take a proactive approach to tackling problems such as energy shortages, pollution, and environmental destruction. With a belief in the power of technology, the partners are responding to the global call for clean and efficient energy systems with practical action.

Historically, Binhe New District on the eastern banks of the Yellow River in Ningxia forms a harsh ecosystem with sweeping deserts.

In 2014, Baofeng Group began managing 107 square kilometers of desertified land by planting alfalfa to improve the soil. The company then began planting goji berries, a business that stretches back 1,000 years in Ningxia. Reviving goji farming has also revived an otherwise dead expanse of desert.

To make full use of the land resources bestowed by nature, Huawei Smart PV built a solar power system over the goji plantation, in effect draping a green blanket over the land.

Goji farming and smart PV technology

have integrated in perfect harmony, creating a rich layer of “edible rubies” topped by a pristine blue sea of solar cells. It represents a new model of mixed land use involving two complementary industries: agriculture and PV – a model that’s leading the transformation of goji farming and new energy in the Ningxia region.

Under the sun, a desert becomes an oasis

The planned 1-GWp solar power system will cover a total area of 20 square kilometers. The 640 MW PV power plants that have already been constructed are connected to the grid, creating the world’s largest PV power plant with smart tracking.

Huawei’s smart solution adopts world-leading, horizontal single-axis automatic tracking technology, allowing the solar panels to track the sun like sunflowers, which in turn greatly improves power generation efficiency compared to traditional PV power plants.

Once the project is completed, it will save 557,600 tons of coal, reducing emissions of CO₂ by 1.695 million tons, sulfur dioxide (SO₂) by 51,000 tons, nitrogen oxide (NOx) by 26,000 tons, and dust by 462,000 tons each year. This will increase the annual environmental capacity by about 2.23 million tons for the future growth of the energy sector in Ningxia.

Although the sun still beats down on

this land, the once barren, endless desert has slowly been transformed into an economic blue ocean, representing the future and hope – all thanks to time and advances in technology.

Huawei and Baofeng are leading the transformation of goji farming and new energy in Ningxia, accelerating the development of new technologies, industries, businesses, and models. This new agriculture + PV, multiple land use model isn’t just bringing new life to Ningxia, it’s forging a new ecosystem where humans and nature coexist harmoniously, adding an extra shade of green to the world.

Powering the world with light

Huawei’s Smart PV solution adopts technology to blanket the desert with greenery and breathe new life into Ningxia. Huawei and Baofeng will continue to use the new agriculture + PV model to generate clean energy and improve the climate of desert regions.

Huawei looks forward to working with more partners globally and taking an active role in reducing reliance on fossil fuels and moving towards renewable energy to help put humanity on the road to resource-saving, environmentally friendly, and low-carbon sustainable development. We will continue to harness the power of technology to develop new practices in response to global climate change and protect the Earth, our home. 



Wang Yinhua
Metro Router Solutions
Specialist, Huawei

Intelligent IP networks help Tencent build green data centers

The UN reports that to avoid serious climate change impact, global warming must be limited to 1.5°C – a huge challenge for the global economy that will require collaboration and advanced technologies.

Climate change continues to grow more serious, with CO₂ emissions causing a greenhouse effect that's threatening the planet. The UN reports that to avoid serious climate change impact, global warming must be limited to 1.5°C – a huge challenge for the global economy that will require the joint effort of all governments and industries.

The digital economy has propelled

continuous growth of the ICT enterprise economy. As world-leading ICT providers, Huawei and Tencent aim to minimize the environmental impact of their ICT products through continuous technological innovation.

Tencent implements green data center design

Today you can upload photos to cloud photo albums, order food and anything else online, play online

games, and make mobile payments, all with a few swipes of your finger. And at any one moment, China's 854 million netizens are using the services of countless data centers.

These "smokeless steel mills" are creating economic value but are also highly energy-intensive. Data centers consume an astounding amount of electricity to power the massive amounts of data they handle. Such huge power consumption means data

centers are classed as an energy-intensive industry.

A total of 74,000 data centers of different types were operating in China by the end of 2019, accounting for 23 percent of the total number worldwide. Their annual electricity consumption exceeded 204.5 billion kWh, totaling 2.7 percent of total electricity consumption in China.

With the advent of 5G, the energy consumption of data centers will continue to grow, and reducing energy use and emissions from data centers will become crucial, setting the stage for the emergence of green data centers.

Optimized data center power supply architecture

The *Data Center White Paper* issued by the China Academy of Information and Communications Technology (CAICT) and the Open Data Center Committee (ODCC) provides guidance for data center construction and outlines the need to simplify the power supply architecture of data centers.

Uninterruptible power supplies (UPS) dominate traditional data centers and their industry chain is mature. However, they offer low energy conversion efficiency. And with the rapid growth of the data center industry and soaring construction costs and energy consumption, high-voltage direct current (HVDC), which boasts high reliability and low costs, is a new choice for data center power supply systems. The HVDC + direct mains supply model can increase power supply efficiency by 94 to 95 percent. And HVDC is already widely used by large Internet firms, including Tencent, Alibaba, and Baidu.

Tencent's third-generation data center power supply systems adopt a 240V HVDC + direct mains supply architecture. After energy-saving

sleep mode is turned on, power supply efficiency can reach 98 percent – over 2 percent more energy-efficient than dual-channel HVDC systems and over 6 percent more energy-efficient than traditional UPS. The system overall offers at least 10-percent more energy savings, not counting the additional energy-conserving benefits from the reduction in energy used for power system cooling.

On the infrastructure side, using HVDC power supply offers higher reliability for data centers than UPS. The third-gen system also delivers significant advantages over traditional data center power supply architecture in terms of equipment investment costs and O&M.

Power supply modules on Huawei's full range of router products support HVDC power supply. They feature a magnetic field generated by a magnet and pointed grills to reduce arc intensity and quickly guide electrical discharges. This prevents arcs (sparks) so that one standby module can protect multiple active modules, improving the power supply capacity of the equipment. The change from N+N redundancy to N+1 redundancy reduces the hardware footprint by 45 percent and improves power modules' forward conversion efficiency end-to-end.

In 2016, Huawei router power modules offered 83 percent conversion efficiency. As of 2019, Huawei had boosted this to an industry-leading 88 percent through measures such as changing the module components, topology, structure, and bus.

Lower power consumption of core equipment

Server power consumption has continued to rise with the rapid increases in router capacity. According to a survey by Colocation America,

average power density per rack in data centers was about 6 kW in 2008. This increased to 12 kW in 2016 and is projected to hit 16.5 kW by 2020.

The power consumption of IP equipment that makes up servers is constantly breaking per-rack limits, and Huawei is continually smashing router capacity limits. We're also committed to reducing the power consumption of the hardware and customers' construction costs.

Huawei's metro router products achieve a per Gbit energy consumption rate as low as 0.3 W, more than 50 percent lower than the previous generation of products. The chipsets use SuperCooling heat dissipation, which reduces chip temperature by over 10°C and increases board reliability by 20 percent. The technology harnesses vapor chamber (VC) liquid cooling and carbon nano thermal pads. With this technology, Huawei is more than two years ahead of the industry.

In a VC liquid-cooling system, a process of condensation quickly circulates in the vacuum chamber, achieving efficient gas-liquid two-phase heat dissipation, offering 100 times the thermal conductivity of traditional radiators.

Carbon nano thermal conduction converts irregular heat dissipation to directional heat dissipation, achieving six times the thermal conductivity of

traditional silicone paste thermal pads. Huawei is the first in the industry to apply it.

Huawei leverages 20 years of experience and continuous innovation in heat dissipation in the design and production of highly complex heat sinks.

Powerful fan addresses single-point heat dissipation

It's not just running core components that contribute to data centers' high energy consumption and electricity bills. While computers and mobile phones can get very hot with extended use, data centers contain hundreds of billions of chips and can get much, much hotter. Therefore a large amount of electricity is used for cooling and heat dissipation to ensure data center equipment can operate normally. According to data center energy savings guidelines published in 2007 by the US-based Green Grid, only 35 percent of electricity is consumed by the actual ICT equipment – 36 percent is used for cooling and 9 percent is used by air conditioning systems.

Rising power density is far exceeding the processing capacity of most cabinets. When engineers designed data center cooling and air conditioning in the past, they were working on the assumption that IT workloads were even and dispersed. However, this is not the case in real operating environments, especially

in high-density cabinets. Companies have found that there is never enough cooling capacity to solve issues with single-point heat dissipation with regular fans, which leads to uneven temperatures and excess energy consumption in high-density cabinets compared to non-dense cabinets.

Huawei has worked with a well-known international fan company to develop the industry's first mixed-flow fan for servers. It offers up to three times higher heat dissipation capacity than rival products, reducing the heat dissipation requirements of equipment rooms. A unique magnetic permeability motor and mute dampener ring in the fan reduce noise by 6 dB.

Working together for a green planet

Every country, enterprise, and even individual needs to fully integrate green thinking into concrete action.

Huawei is doing so with its own products and solutions and is urging upstream and downstream industry players to take part in carbon-neutral initiatives. Like Huawei, Tencent has integrated all its platforms and product resources, applied integrated digital solutions in the areas of green operations, green community building, and green partnerships, and is working with the government, public, and non-profit organizations, to help protect our planet. 



A green network for a green paradise

Optical networks are one of the first steps to building a smart hotel. Doing so with minimal impact on the surrounding environment and embedding intelligent technologies are also parallel steps. Here's how it's done.

By Jia Lin, Chief Marketing Expert, Campus OptiX, Huawei
Liang Yali, Marketing Communication Expert, Huawei

Tengchong city in China's Yunnan province is nestled in a valley rich in volcanic rocks. The volcanoes and geothermal heat lend Tengchong a warm, comfortable climate as well as magical natural scenery that attracts artists and creators from all over the world, including world-renowned architect Kengo Kuma. Inspired by the natural scenery, he designed The Lost Stone Villas & Spa, the largest hot spring resort complex in Asia. The resort's buildings are crafted from six different types of local stone in a mosaic pattern. Seen – or rather not seen – from a distance, they are gently camouflaged, unobtrusively dotting the mountains.

The Lost Stone aims to reflect harmony between people and nature, a theme reflected in the resort's guest rooms, catering, and leisure facilities. The 400 resort villas are nestled in a mountain valley, scattered across 300,000 square meters. In each, hot spring temperature control, room lighting, and room service are all underpinned by intelligent tech.

The Lost Stone blends perfectly with the natural landscape of Yunfeng Mountain. So, how was the network that carries the resort's smart services integrated into the resort?

The optical network is the first step to building a smart hotel

At the design stage, Kuma left his creative mark everywhere, pre-designing a pattern for each wall including the size, thickness, color, and even shape of the stones. Walking among the villas today, it's impossible to find any repeated patterns.

As technology advances, new types of experience continue to emerge. Upgrading bearer networks in reinforced concrete buildings is done every day, but in iconic architectural works like The Lost Stone, cabling solutions must be designed early on to minimize any damage to the buildings.

With the buildings scattered over some distance, a long-distance network was essential, with the developer considering optical fiber right away. Without the 100-meter barrier of traditional copper LAN cabling, optical fiber wiring could be flexibly extended around the complex. Fiber would also negate the need for the many equipment rooms that are indispensable to copper LANs. Network upgrades would only require replacing terminal equipment, enabling continuous upgrades to bandwidth and experience.

O&M has never been so easy

Blending both technology and art, The Lost Stone resort harnesses technology from check-in to check-out, providing a concierge-like service every step of the way.

Each villa is equipped with three telephones to call staff and an outdoor private hot spring pool. Water temperature can be adjusted either by calling housekeeping or through a smart device. With sprinkled rose petals and a blessing ceremony performed by staff, the experience is designed for guests to feel a sense of serenity and unity with nature when sliding into their hot spring pool – the fatigue and stresses of city life melting away. The phones and smart control systems for water temperature are connected by the same fiber network. Offering a service life of up to 30

years, optical fiber will not oxidize or corrode in the humid environment of the mountain.

The Lost Stone fiber network acts like a neural network, sensing the individual needs of guests in real time. As well as water temperature control and phone and room service, the fiber network carries over 10 other applications, including light adjustment, wired Internet access, wireless entertainment, and security. Different services can be categorized and carried according to priority, so that the hotel can respond to every guest's needs. Services based on fiber are long-lasting and stable, and can cement the resort's reputation for an outstandingly smooth and reliable network experience, one that doesn't take guests out of an otherwise relaxing experience.

The Lost Stone adopted Huawei Campus OptiX solution to carry multiple services over one fiber, with the simplified network architecture making O&M easier. Each villa is connected to the fiber network with optical terminals, which require zero configuration to go online, deployed in every room. For a traditional LAN, a resort needs a maintenance team of three to five people. Now, just one staff member can manage the network, lowering O&M pressures and operating costs. In a traditional multi-layered network layout, there are more network nodes to be maintained. The fiber network manages all services on the physical layer, which significantly reduces the amount of engineering needed.

Green optical for green operations

Made from quartz sand, a pure natural raw

material, optical fiber uses 60 to 75 percent less energy than copper. Huawei Campus OptiX solution for hotel campuses employs a passive optical LAN. As fiber offers a stable signal and lower attenuation during transmission, transmission efficiency is higher and network architecture is also simplified. At The Lost Stone resort, using an all-optical network to carry multiple services over one fiber reduces energy consumption by 30 percent and reduces wiring footprint in rooms by 80 percent, compared to a traditional Ethernet switch network of the same size.

By adopting the Huawei Campus OptiX solution, The Lost Stone has been able to extend connections over long distances, minimizing the need for equipment rooms and saving energy costs on air conditioners and other hardware. The system saves around 200,000 kWh of electricity a year, equivalent to a 160-ton reduction in carbon emissions – or planting an additional 15 acres of forest on Yunfeng Mountain.

Tengchong's local stone is a gift from nature and the villas are artistic gems scattered throughout the valley. Organically connecting technology, nature, and art, the fiber network enables the hotel to better serve guests who come from far and wide to see this enchanting place.

"Huawei Campus OptiX solution provides high-quality network connections for hotel smart services and promotes green operations," said Chen Lei, Deputy General Manager of The Lost Stone Villas & Spa. "It also represents the future trend of network construction in the hotel industry. I believe that our partnership with Huawei will boost our competitiveness and continue to provide customers with excellent services." 

The Lost Stone fiber network acts like a neural network, sensing the individual needs of guests in real time.



Xing Jingfan

Senior Marketing
Manager, Huawei

The return of the big cats

A telecom network, camera traps, and AI: Technology is helping restore biodiversity in China's northeast forest region and enable two critically endangered species, the Amur tiger and Amur leopard, survive, thrive, and repopulate.

On the eve of the International Day for Biological Diversity, two sightings of the extremely rare white roe deer were reported in the Northeast Tiger and Leopard National Park. At around the same time, evidence of tiger dispersal was found in the western part of the park, heralding the rediscovery of the king of the jungle.

This was all made possible thanks to images captured by the pioneering monitoring system installed in the park – a system that's able to

send data back to the park's headquarters in real time.

100 years of human progress and habitat reduction

The Amur Tiger is the largest of the big cats, an apex predator that lives in the forests in the eastern edges of Russia and northeast China. As each female Amur Tiger requires a 500 km² area of forest to breed, they are indicative of the overall health of the region's ecosystem. However, habitat loss due to human activity over



the last century has seen their numbers dwindle to less than 600 in the wild.

In 2015, scientists from Beijing Normal University and Russia's Land of the Leopard National Park began monitoring these animals in the hope of ensuring their survival. They found that at least 38 Amur tigers and 84 Amur leopards still roamed the China-Russia border. Of these, 27 tigers and 42 leopards were found on the China side in Hunchun, Jilin and its surrounding areas. However, they were concentrated in a narrow corridor of just 4,000 km².

Penned in by the sea to the east and south and railway infrastructure and marshlands to the north, the cats have to expand westwards into China's northeast forests if they are to survive.

Change, hope, and the return of the big cats

To ensure that the tigers and leopards can

return to their historical habitats, ecologists are hard at work restoring the forests of northeast China.

In August 2017, the Northeast Tiger and Leopard National Park was officially inaugurated. Taking in parts of Heilongjiang and Jilin provinces along the China-Russia border, the park represents the only settlement area with a breeding population of wild Amur tigers and Amur leopards in China.

Covering 14,600 km², it forms a suitable environment for the cats to expand their territories, in turn creating one of the highest pockets of biodiversity in the northern hemisphere.

It also represents a pioneering approach to protecting biodiversity. And the process to doing so begins with collecting information – where the animals are living, how they are hunting, behavioral patterns, and more. Earlier research efforts had seen scientists and conservationists install camera traps in the wild.

Each year through camera footage, conservationists are discovering multiple litters of cubs in the tiger and leopard populations of northeast China, giving hope to those who work to protect the future of these majestic animals.

But these cameras needed to be maintained, their batteries replaced, and their memory cards switched out – time- and labor-intensive processes that frequently resulted in data and images that were several months old, making it difficult for conservationists to make accurate decisions.

Technology lights the way

Several habitat preconditions are necessary for tigers and leopards to prosper – a sufficiently large landscape connected by natural corridors for roaming plus a complete food chain. To protect these cats, conservationists need to understand and monitor population dynamics, habitats, the relationships between different species, and the influence of human activity. In partnership with the National Forestry and Grassland Administration Amur Tiger and Amur Leopard Monitoring and Research Center, a Sky-Earth monitoring system was established in the park, making it the world’s first real-time conservation system of its type.

Powered by a 700M wire-wireless LTE hybrid network built by Huawei and Jishi Media, the system comprises three parts: field data collection, real-time data transmission, and data analysis. Data from the camera traps and HD images in real-time include monitoring footage from road checkpoints and fire prevention systems. Sensors in the ground, air, and water provide detailed and accurate information about the ecosystem in the park. The system also helps conservationists maintain a clear line of communication through voice and video.

In December 2019, the National Forestry and Grassland Administration tested the system

across 5,000 km² of the park. Forty-two LTE base stations and more than 3,000 monitoring terminals observed an area of the China-Russia border spanning about 200 km, the location where the cats are most active. The network monitored their movements and habitats, as well as the overall state of the ecosystem.

Humans and nature working towards harmony

Each year through camera footage, conservationists are discovering multiple litters of cubs in the tiger and leopard populations of northeast China, giving hope to those who work to protect the future of these majestic animals.

At the end of 2020, the system will cover the whole park. With monitoring terminals, conservation has become intelligent, efficient, and accurate – three capabilities that are necessary to fully protect these endangered animals and help restore their majesty in the wild.

Huawei will continue working with the National Forestry and Grassland Administration Amur Tiger and Amur Leopard Monitoring and Research Center to improve pattern recognition technology, big data analytics, and 5G, so that the technology can be rolled out in national parks across China.

The return of the king of the jungle is a sign that the forest is recovering – the health of an ecosystem is often reflected by how well its apex predator is faring. In this case, the signs are good. As we move forward, we hope more partners will join us on this journey to create technology that allows nature and humanity to exist in harmony. 🇨🇳



Protecting the Palawan rainforest in the Philippines

Palawan loses about 5,500 hectares of rainforest every year – the equivalent of 7,700 football pitches. Now technology is helping the forest to fight back.

By Xing Jingfan, Senior Marketing Manager, Huawei

Known for its beauty and promise of adventure for tourists across the globe, Palawan is a long, narrow island in the southwest Philippines that's home to a rich array of flora, fauna, and marine life.

Accounting for the bulk of the nation's forest cover, the Palawan rainforest is considered to be the last ecological frontier in the archipelago nation. It not only plays a crucial role in maintaining the ecological balance of the entire region, it also ensures that local people have sufficient clean drinking water and is pivotal

to preventing landslides. As one of the world's 35 biodiversity hotspots, the rainforest is home to various rare species, including the Philippine forest turtle, which the International Union for Conservation of Nature (IUCN) lists as a critically endangered species, and binturongs, a vulnerable species famed for a distinctive odor similar to hot buttered popcorn.

With the continued encroachment of agricultural and residential land, prevalence of commercial and illegal logging, and frequent forest fires, Palawan loses about 5,500 hectares of rainforest every year – the equivalent of 7,700 football

itches. Moreover, forest rangers patrolling the rainforest face extreme danger due to illegal loggers carrying weapons – it’s estimated that from 2001 to 2019, the death of 18 rangers can be attributed to illegal loggers.

A protective partnership

The good news for the Philippines is that a technology-driven protection project for the rainforest has been initiated by the Department of Environment and Natural Resources (DENR), PLDT’s wireless and mobile operator Smart Communications, Rainforest Connection (RFCx), and Huawei.

A new monitoring system comprising mobile devices and AI powered by Huawei Cloud has been deployed to prevent illegal logging and animal poaching in five protected areas across Palawan: Cadlao Island, Maranlao and Pasadena in El Nido, and New Guinlo and Pancol in Taytay.

Powered by solar panels, this Rainforest Guardian system comprises old cell phones that monitor and record sounds of human activity, like chainsaws and vehicles, and capture data on animal behavior patterns. Identified by AI, forest sounds and data are uploaded to cloud on the Smart Communications’ network and then sent to forest rangers via RFCx’s mobile app. DENR forest rangers receive real-time alerts of sounds from chainsaws, trucks, and other indicators

of forest destruction, so that they can take action quickly.

"The dedication of the local DENR forest rangers in Palawan is known worldwide. They spare no efforts in protecting this last frontier of Filipino wilderness from logging and environmental threats, and face enormous challenges and great danger. Huawei and Smart Communications teamed up to give RFCx an opportunity to help these brave people," said CEO of Rainforest Connection (RFCx) Topher White.

As RFCx's first Filipino telco partner, Smart Communications covers the five pilot sites in Palawan with wireless connectivity. Results have been promising since the rollout of the Forest Guardian system in January 2020, with DENR reporting that several alerts of illegal logging have been verified and addressed by forest rangers.

"The DENR welcomes this collaboration between the government and the private sector to help protect the country's forest cover," said Nilo Tamera, Executive Director of the DENR Environmental Protection and Enforcement Task Force. "It supports DENR Secretary Roy Cimatu's resolve to level up the enforcement mandate and capability of DENR by employing technology to complement our current systems. I look forward to the success of this project and to replicating it in other

areas that face a similar situation as the Province of Palawan,"

According to Alfredo S. Panilio, President and CEO of Smart Communications and Chief Revenue Officer of PLDT, "At Smart, we are championing eco-efficiency through various programs that reduce the impact of our operations, people, and products on the environment. On top of that, we have always been at the forefront in using technology to support meaningful initiatives that protect our forests to curb the devastating effects of climate change."

Huawei believes that the Forest Guardian system can be quickly and easily adapted to more countries and more scenarios. It expects that in 2020, the system will more than double the amount of forest it covers from 2,500 km² to 6,000 km². RFCx estimates that the amount of forest protected by the system will boost CO₂ absorption by 30 million tons, which is the equivalent of taking 6 million cars off the road.

RFCx and Huawei will also continue to optimize the sound monitoring platform in 2020 by adding web and mobile interfaces and developing an API for aggregating sound data from various sources. This will help AI learning models capture and analyze audio on a much greater scale, so the solution can better monitor the health of the ecosystem and protect endangered species and their habitats. 



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