Respecting and Protecting Intellectual Property: The Foundation of Innovation

Huawei White Paper on Innovation and Intellectual Property

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HUAWEI

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Executive Summary

Over the past 30 years, Huawei has focused on information and communications technologies and brought advanced and convenient network connections to more than 3 billion people around the world. We do everything we can to support secure and stable network operations in every place where we operate, including some of the world's harshest environments like the Arctic Circle, Mount Everest, the Sahara, the rainforests of South America, and in areas struck by disasters like earthquakes, tsunamis, plagues, and wars. Our vision is to bring digital to every person, home and organization for a fully connected, intelligent world.

To realize this vision, Huawei highly values innovation and research into technology. Every year, we invest at least 10% of our revenue in R&D. In 2018 alone, Huawei invested more than CNY100 billion in R&D, nearly 15% of our annual revenue. That put us fifth in the world in terms of R&D expenditure, according to the EU's 2018 Industrial R&D Investment Scoreboard. Our sustained investment has resulted in innovative products and efficient services for our customers.

Over the last 20 years, Huawei has invested heavily in R&D. As a result, we became one of the major 4G patent holders in the ICT sector, and we have cemented our leading position in 5G. We believe that respecting and protecting intellectual property ("IP") is the foundation of innovation. We share our own IP with other companies through licensing and cross-licensing to promote the industrialization of innovations. We also publish papers on the achievements of our research. Every year, we submit a large number of technical contributions to international standards organizations and open source code to open source communities, driving the industry forward.

This White Paper describes Huawei's practices in and contributions to innovation and the protection of IP. Key information is summarized as follows:

- Huawei makes sustained investment in R&D and open innovation based on the needs of our customers. Valuing and investing in basic research is the key to Huawei's ongoing success.
- Sustained investment has made Huawei one of the biggest patent holders in the world. As of the end of 2018, Huawei has been granted 87,805 patents, of which 11,152 are US patents.
- At present, Huawei publishes 100 to 200 academic papers every year. We have submitted more than 60,000 technical contributions to international standards organizations. We are also a major contributor to open source communities.
- Huawei's innovation brings enormous benefits to our customers, consumers, industry partners, and investors.
- Huawei respects third parties' IP and trade secrets. We have developed comprehensive systems of IP management and compliance, and make every effort to ensure that all employees abide by them.
- Huawei has entered into more than 100 patent license agreements (including unilateral license and cross license) through a process of amicable negotiations with many of the major global ICT companies, including Nokia, Ericsson, Qualcomm, Nortel, Siemens, Alcatel, BT, NTT DOCOMO, AT&T, Apple, and Samsung.

- Huawei has executed more than 10 outbound license agreements through amicable negotiations, pursuant to which we have received over USD1.4 billion licensing revenue from a wide range of companies in the US, Europe, and Asia since 2015.
- Huawei respects international rules of legally implementing third parties' IP through cross licensing or by paying licensing fees and royalties to third party IP holders. Over the past two decades, we have accumulatively paid more than USD6 billion for implementing third parties' IP.
- Huawei promotes legislative reform by providing its suggestions on and inputs to IP protection legislation and its amendment, as well as policy-making in major jurisdictions worldwide based upon its global view and successful legal experience. We are committed to contributing to a better environment for IP protection.

01 Sustained Innovation Is the Foundation of Huawei's Ongoing Success

Customer-centric and sustained R&D and innovation is the foundation of Huawei's survival and growth. Huawei has grown steadily for more than 30 years. In that time, it has become a world leader in many aspects of technology and in many of its solutions. This is the result of Huawei's sustained strategic investment for strategic breakthroughs.

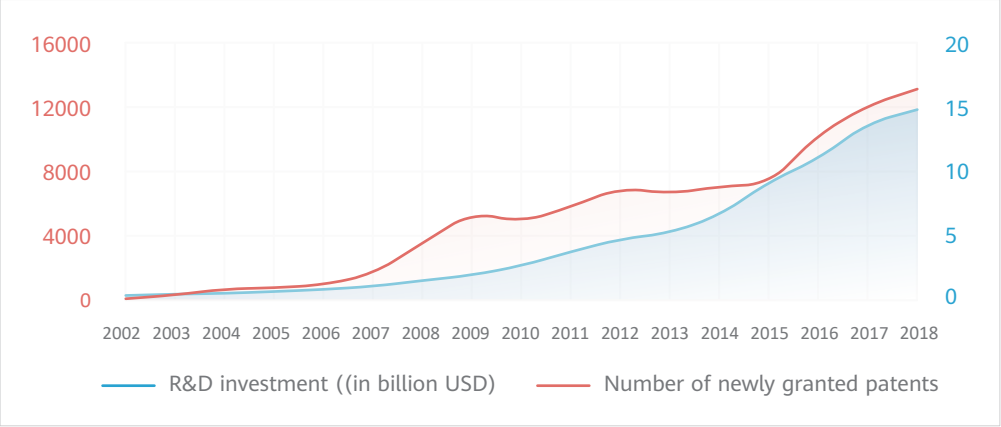
1.1 R&D Investment Is a Marathon, Not a Sprint

In 2018, Huawei was No. 72 on the Fortune Global 500 list. When a company grows from a small private firm to a place in the Fortune 500 in just 30 years, there are clearly many factors behind its success. But one of the key factors is an ongoing commitment to investment in R&D.

Huawei highly values innovation and research into technology. Every year, we invest at least 10% of our revenue into R&D, and in recent years it has been closer to 15%. In 2018, Huawei invested over CNY100 billion in R&D. That put us fifth in the world in terms of R&D expenditure, according to the EU's 2018 Industrial R&D Investment Scoreboard. Over the last 10 years, our R&D investment adds up to more than CNY480 billion (equivalent to USD73 billion). R&D is not a sprint; it's a marathon. Once you've started, you just have to keep running. That's why, in the next few years, Huawei will be increasing our R&D investment progressively to between USD15 billion and USD20 billion per year. As a result of this investment, the number of

patents Huawei applies for and is granted keeps growing every year.

Table 1. Huawei's R&D investment and number of granted patents



Sustained investment has brought rich rewards. It has resulted in innovative products and efficient services for our customers. Today our services reach over 3 billion people in more than 170 countries and regions.

1.2 Sustained Innovation that Serves Customer Needs

Huawei is committed to customer-centric innovation that serves customer needs. We deliver innovative products and solutions that help our customers to be more profitable, and create value for our customers on an ongoing basis.

1.2.1 Distributed Base Station: A Benchmark for Mobile Base Station Architecture Born in the 3G Era

Huawei's distributed base station was developed to meet the needs of our customers. Our innovation solved a problem faced by telecom operators around the world, and significantly reduced both their capital expenditure (CAPEX) and operational expenditure (OPEX).

In 2002 when 3G rollout started, Huawei began to develop the mobile network market in Europe. European mobile operators at the time were facing significant challenges from the high price of site acquisition. In a standard base station, the radio frequency unit and the baseband processing unit were in the same cabinet. The base station was a bulky piece of equipment and a major electricity user, and it was heavy and difficult to install. European nations were keen to maintain their living environments, and permission had to be obtained for every new base station and high prices had to be paid for the space. In an analysis of the total cost of ownership (TCO) of one of our customers at the time, the equipment represented only 15% of total costs while site acquisition represented 43%.

For example, simply the rent for a place for an outdoor base station could cost up to EUR7,000 per year. This meant a TCO of EUR70,000 over 10 years. For an average network of perhaps 3,000 sites, leasing sites at that rate would require EUR210 million over 10 years.

After months of site survey and research, Huawei proposed a new, distributed architecture. The BBU would remain in the existing equipment cabinets owned by the operators, but the RRU could be made out of waterproof material, and positioned on poles. This meant that the base station could be slimmed down into two separate small units, the baseband unit (BBU) and the remote radio unit (RRU). Customers would no longer need the space for large equipment racks, their power costs would fall, and the equipment would be much easier to transport to the site and install. It was a massive saving in network construction costs.

In 2005, our innovative distributed base station with separate BBU and RRU was deployed for the very first time by Telfort, a telecom operator in the Netherlands. When Huawei had completed the installation, Telfort calculated the actual reduction in their OPEX, and found that the savings were even greater than Huawei had originally projected. The Huawei distributed base station solved the problems of high CAPEX and OPEX for European operators, and it changed the way our customers perceived us. Since then, the distributed base station has become the mainstream architecture of the next generation of mobile base stations.

1.2.2 SingleRAN Marks a New Era in Mobile Network Architecture

By 2007, 3G technology was in widespread use, and 4G was approaching readiness. But maintaining multiple networks for 2G, 3G, and 4G inevitably drove up operators' costs, both CAPEX and OPEX. Operators needed a new way to manage network evolution and reduce the construction and operating costs of their networks.

To rescue this situation, Huawei introduced SingleRAN. This solution was described by a technical expert at Vodafone as "a very sexy technology." It enabled three different radio access technologies

(RATs) – 2G, 3G, and 4G – to be processed within the same equipment rack, so that operators could finally combine and evolve their networks without increasing the bulk of their equipment. At a stroke, it cut operator costs by up to 50%. It was a massive hit in the industry, and our competitors were unable to replicate its success for a long time. The reason was that this product relied on extremely complex algorithms.

The key in the SingleRAN solution was the GSM multi-carrier technology. This was widely recognized in the industry as being a key technical bottleneck, and for many years, no one had been able to solve it. "The chances of success are just 1%!" was the general consensus based on the information available. This means that turning this technology into commercially viable products was virtually impossible.

But we saw that 1% as a challenge, not a barrier. The Huawei wireless technology team and the algorithm research team headed into unknown waters, and achieved a major breakthrough. In July 2007, the teams finally cracked the GSM multi-carrier technology, making SingleRAN – a technology believed to be a disruptive innovation – a reality.

In 2008, Huawei installed the first SingleRAN network in the world for O2 – a subsidiary of Telefónica – in Germany, enabling them to handle both GSM and UMTS on a single network. SingleRAN was quickly embraced by customers worldwide and widely applied in the 4G era. It soon became the new de facto standard for global mobile network architecture.

1.2.3 USD2 Billion Investment in 5G over 10 Years Makes Huawei a Global Leader

3G and 4G gave birth to the mobile Internet, which has profoundly

changed the way we live. With 5G, the focus would not only be on connections between people; it would also extend the network to connected things. 5G would provide fiber-like connection speeds. It would offer almost zero latency, massive connectivity, and super-large capacity. 5G will provide the foundation for new applications in every industry, and will bring us into a digital and fully connected world.

In 2009, Huawei invested USD600 million to begin the research into 5G technology. In 2016, we invested an additional USD1.4 billion in speeding up the end-to-end development process of 5G products for commercial use. By this time, Huawei had spent USD2 billion on researching and developing 5G. This is more than the total spending on 5G by major equipment vendors in the US and Europe put together.

5G requires the use of much higher-frequency bands than 3G and 4G, but high-frequency signals have a shorter range. That means more base stations are needed for 5G networks. Our customers were struggling to increase coverage and cut network construction costs. Huawei worked with industry partners to develop a solution that decoupled the 5G uplink and downlink. Uplink and downlink signals have always traveled on the same band, but this limitation was now making networks harder to build. If the downlink can exploit the high-capacity high bands, while leaving the uplink to existing lower-frequency wavebands, this enables much better coverage and boosts speeds at the edge of a cell. For our customers, this means initial deployment of 5G networks will not involve many additional base stations, greatly shortening their network construction cycles. At the MWC Barcelona 2019, this solution was awarded the "Best Mobile Technology Breakthrough" by GSMA, one of the industry's highest honors.

Huawei offers the best-performance 5G solutions and simplified site solution. We also leverage our leading technologies in multiple fields to provide many unique value points that no other vendor can match.

For example, Huawei's proprietary technologies have enabled us to increase the capacity of microwave transmission from 1 Gbit/s to 20 Gbit/s. This means 5G base stations no longer necessarily have to have a fiber connection. The ultra-broadband backhaul they need can be supplied by microwave, which means that 5G can be deployed more easily.

Huawei continues to lead the industry in developing 5G. As of mid-June of 2019, Huawei signed 50 commercial contracts for 5G with leading operators around the world, and shipped over 140,000 5G base stations.

1.3 Valuing Investment in Basic Research

When society progresses, it walks on roads paved by science. Every industrial revolution is the result of major inventions and technological breakthroughs in basic research. Basic research and education is the foundation for creating and revitalizing industry.

In the ICT industry, we are closing in on the Shannon limit and pushing against the confines of Moore's law. There are no theories that describe how to handle the huge data flows and achieve close-to-zero network latency. We have entered uncharted territory, and have been increasing investment in exploring cutting-edge technologies and basic research for the future.

In 2011, Huawei consolidated its global R&D resources and established the 2012 Laboratories, the department which will lead our innovation, research, and platform development efforts. Its job is to build our technical and R&D competence for the future. 2012 Labs is where Huawei converts sustained investment in cutting-edge research into our competitive advantages. 2012 Labs carries out mid- to long-term research into network architecture, standards, materials

science, and cutting-edge technologies in ICT. It is not governed by short-term profit targets. It works on a 5- to 10-year timespan.

Many research institutes have been established within the 2012 Labs, including the Wireless Technology Lab, the B&P Lab, the Noah's Ark Lab, and the Network Technology Lab, each dedicated to the basic research in a particular domain.

The Wireless Technology Lab explores new technologies for wireless communications. It is responsible for Huawei's future wireless technologies, and for building our competitiveness in wireless access technologies in a fully connected world. This includes making more efficient use of the wireless spectrum, exploring new advances in physical-layer technologies, finding and proving new degrees of freedom, and pushing the communications capacity of the channel ever closer to the Shannon limit. The Lab explores the evolution of wireless technologies, measured by access speed, energy efficiency, spectrum efficiency, end-to-end latency, accurate positioning, high-speed mobility, and ground/air coverage. This Lab produced the Huawei 5G and Wi-Fi technologies that are now recognized as the industry's leading solutions.

The B&P Lab researches optical communications technologies. It is committed to creating easy-to-maintain information infrastructure with high bandwidth, low latency, and low energy consumption that will support the vast flows of data that a fully connected and intelligent world will generate. Over the last decade, this Lab has doubled the volume of data that a single fiber can transmit every three years. It has sparked a technological revolution in the core switching nodes of optical networks. And Huawei continues to lead the world in the evolution of optical network technologies: In 2018, Huawei introduced the industry's first ultra-large-capacity

all-optical cross-connect architecture, which enables networks to carry 10 times as much data as with the traditional electric cross-connect architecture. The all-optical cross-connect architecture also uses 10 times less energy, meaning a 100-fold improvement in overall energy efficiency. The B&P Lab has been researching optical communications since its inception in 2012, and is able to deliver all of the core technologies required for fiber networks: long-distance, ultra-broadband optical links; the ultra-large-capacity optical cross-connect; and highly integrated and energy-efficient silicon photonics.

The Noah's Ark Lab is the artificial intelligence research center within the 2012 Labs. It is organized as six labs focusing on different aspects of AI: computer vision, natural language processing, search and recommendations, decision-making and inference, human-computer interaction, and AI theory. Artificial intelligence is the "ark" in which Huawei will escape being submerged in the flood of data that a connected society will generate. AI will be a general-purpose technology, which will change every industry and completely redefine the information industry. The Noah's Ark Lab will play a vital role in realizing Huawei's vision of a fully connected and intelligent world. It is one of Huawei's most important research units, and is helping Huawei itself adapt to the AI era.

The Network Technology Lab focuses on data communications. It explores areas such as ultra-broadband, low latency, lossless networks, and new IP. The all-optical connected router that the Lab developed replaces the electric connected router and can easily scale out. The ultra-low-latency X-Ethernet technology enables forwarding latency to be held consistently in the hundreds of nanoseconds range, and is one of the key breakthroughs on which 5G core bearer networks will rely. Lossless cloud networks enable zero packet loss, zero throughput loss, and zero latency loss. They combine the computing networks, storage

networks, and application networks within a data center into one, and offer unlimited scalability. Deterministic IP enables an IP network to keep network latency within a range of 10 μs no matter how large the network is or how widely separated the nodes are. And in holographic networks, an immersive hologram will require 50,000 times the data rate of a 4K high-definition video. New IP is the technology that will enable lossless, real-time transmission of holograms around the world.

Over the last few years, Huawei has made huge strides in smartphones. This impressive progress is the result of our emphasis on basic research and intensive investment in R&D. Huawei has been researching telecommunications technology for 30 years, and we have research centers in many parts of the world: an aesthetics research center in France, a materials research center in Japan, an algorithm research center in Russia, an engineering research center in Sweden, a process research center in the US, and a heat dissipation research center in Ukraine.

Huawei began to operate in the mobile phone market in 2003. Over the past decade and a half, we have developed world-beating teams and processes in every aspect of phone development, from chips, software, and materials to design, processes, and heat dissipation. Today, our phones lead the market in terms of communications performance, photography, battery life, EMUI operating system, and phone design. They offer global users a premium smartphone experience.

Every year, Huawei invests huge sums in research. We have over 700 mathematicians, 800 physicists, 120 chemists, and a total of 15,000 researchers engaged in basic research. Their role is to turn money into new knowledge. We invest between USD3 billion to USD5 billion in this process every year. Based upon their discoveries, Huawei has

a team of over 60,000 product development engineers. They turn knowledge into commercial products, and back into money.

Basic research is like building Rome: It can't be done in a day. It takes decades or even 100 years to turn a basic theory into a large industry. But if we remain fixated on quick profits and short-term return on investment, then the basic research will simply never happen. A company needs strategic patience if it is to succeed in basic research. Some ideas must be incubated for a decade or more before they bear fruit.

1.4 Commitment to Open Innovation

Huawei pursues open innovation. We do not innovate on our own. Instead, we make full use of innovative resources from around the world to conduct joint research. We help scientists become lighthouses that guide Huawei and also the world forward.

Huawei works with more than 300 universities and 900 research institutes around the world on 7,840 projects. We have invested USD1.8 billion in these projects, signing more than 1,000 R&D cooperation contracts in which we pay third parties. In the future, we will invest USD300 million in these partnerships every year. With this investment, we will pay universities and research institutes for their research – purchasing the results of their research or paying for the use of these results.

Our collaborations take the following forms:

- Providing funding to universities and scientists that are strong in certain technical domains to make breakthroughs in basic theories.
- Establishing joint labs with business partners and research institutes to conduct joint research on cutting-edge technologies and share the results of that research.

5G polar codes are a case in point of this open innovation. In 2008, Professor Erdal Arikan published a paper on polar codes, offering a new option for channel coding. It is also the world's first channel coding technology that has been proved to reach the Shannon limit. Huawei realized the potential of polar codes in increasing the performance of channel coding. We then conducted further research building on Professor Arikan's work. After years of effort, we made many technological breakthroughs and removed key technical barriers in engineering. We managed to bring polar codes out of the

lab and turn them into industrial applications.

Huawei's Wireless X Labs focus on five major areas of research: connected drones, connected vehicles, cloud virtual reality and augmented reality, wireless eHealth, and wireless robotics. The aim of the Labs is to build an ecosystem for 5G applications. We work with regulators, application solution providers, telecom operators, and application users to explore future use cases and take concrete actions to drive growth. More than 270 industry partners have joined us to work together on more than 50 global innovation projects.

Huawei has established 36 joint innovation centers with more than 20 customers and partners around the world. We work with these partners to incubate new products and solutions and explore new business models. Our goal is to lead the industry forward and achieve shared success.

Huawei has invested over USD1 billion in the Developer Enablement Program, where we aim to help developers grow their ecosystem building capabilities on the Huawei Cloud platform. We launched the Huawei Cloud Academy to offer training, certification, development, and support services to developers. We also accelerate talent development and product launches, and give developers access to Huawei's global market, by providing commercial support such as physical goods, funds, cloud service resources, and enterprise connections.

In 2018, the number of registered developers worldwide reached nearly 300,000, 150% more than the previous year. We also had around 600 new certified joint solutions, and over 1,700 new developers in 2018.

02 Years of Investment Translates into an Innovative Brand and a Wealth of Patents

2.1 Winning Multiple Innovation Awards from Authoritative Third Parties

Over the past few years, Huawei has won multiple innovation awards. This shows that Huawei's innovation capacity is widely and continuously recognized by international media and the industry's authoritative bodies.

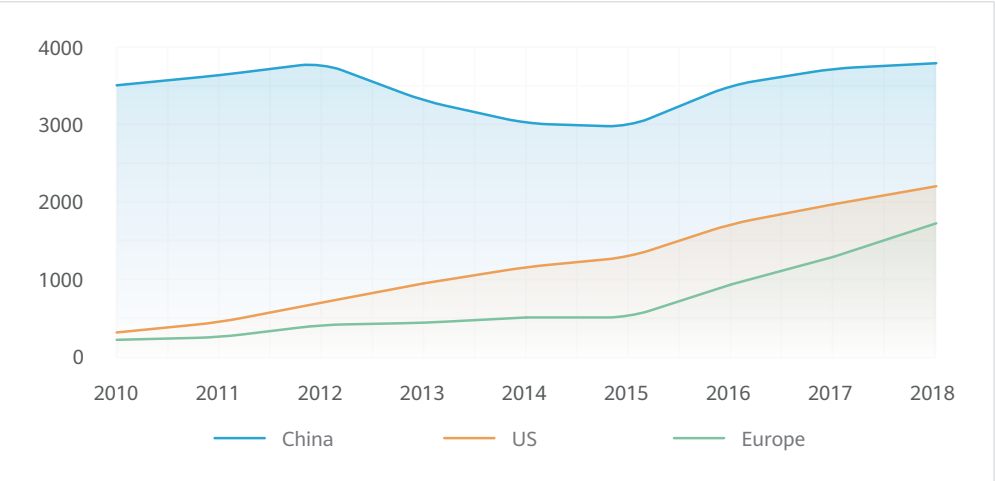
- In 2009, Huawei was selected as one of the top five most innovative companies by the US's Fast Company magazine.
- In 2010, Huawei was awarded the 2010 Corporate Use of Innovation Award by The Economist.
- In 2014 and 2016, Huawei was selected as one of the Top 100 Global Innovators by Clarivate Analytics and Thomson Reuters, respectively.
- In 2018, GSMA presented Huawei with the Award for Outstanding Contribution to the Mobile Industry, in recognition of Huawei's contributions to the mobile industry.
- In 2019, Huawei's innovative uplink/downlink decoupling solution for 5G RAN deployment won GSMA's Best Mobile Technology Breakthrough award. This award is a weighty award established by the GSMA to recognize technological innovation that has brought about a significant improvement in user experience, and is recognized as one of the highest honors in the communications industry.

2.2 Sustained Investment and Innovation Makes Huawei One of the World's Largest Patent Holders

As of the end of 2018, Huawei held 87,805 patents, of which 11,152 were granted in the US and over 6,600 patent families were granted in Europe. The patent prosecution process is also a process of disclosing technical details, through which we contribute our R&D achievements to industry and society. Huawei's patents are of profound value to the global information society.

Huawei ranks among the top in major countries and regions including China, the US, and Europe by the numbers of patent applications filed and numbers of patents granted. In 2018, Huawei ranked 16th by the numbers of granted patents in the US, and ranked 2nd by the numbers of patents granted by the European Patent Office. Huawei is also the world's largest patent holder in China. Below are the numbers of Huawei's granted patents in China, the US, and Europe between 2010 and 2018.

Table 2. Patents granted to Huawei in China, the US, and Europe between 2010 and 2018



Huawei is one of the largest PCT patent applicants in the world. In 2018, Huawei submitted 5,405 PCT patent filings to the United Nations' World Intellectual Property Organization (WIPO). Francis Gurry, WIPO's Director General, said, "It's an all-time record by anyone."

According to a well-known institution's statistics on patents for LTE standards, Huawei holds more than 10% of 4G standard-essential patents. According to ETSI's latest statistics about 5G standard-essential patents, Huawei holds 20% of the world's total. These patents are essential to mobile phones and network operators worldwide.

03 Huawei's Innovation Brings Huge Social Value

Huawei's innovation capacity and innovative products are widely recognized across the industry. Huawei also actively contributes its innovation to industry and society.

3.1 Creating Value for Customers and Consumers and Promoting Sustainable Social Development

Huawei is committed to bringing digital to every person, home and organization for a fully connected, intelligent world. From the remote Siberian wilderness to Africa's Kilimanjaro; from Mount Everest to the minus 40° C conditions of the North Pole; and from remote and epidemic-stricken African regions to world business centers like Paris, London, and Tokyo – Huawei connects them all, allowing people to enjoy communications services like web surfing, social networking, and video calls on their phones anytime, anywhere.

We help customers become more profitable and create value for them.

Together with our partners, we provide innovative and secure network equipment to telecom operators. We provide our industry customers with open, flexible, and secure ICT infrastructure products. In addition, we provide customers with stable, secure, and trustworthy cloud services that evolve with their needs. As of the end of 2018, more than 500 operators worldwide and 211 of the Fortune Global 500 companies – including 48 of the top 100 – have selected Huawei as their partner in digital transformation.

We advance technology for every person, home, and organization to bridge the digital divide.

According to the ITU and GSMA, 66.3% of the world's households remain unconnected, and half of the world's population has no Internet access. On top of this, more than two billion people around the world lack reliable mobile broadband services, and a significant number of them live in urban areas.

Huawei is committed to bridging the digital divide across the globe. Through continuous innovation, we are making technology simpler, more convenient, and more affordable, giving more people access to the benefits of digital and intelligent technology and creating new worlds of opportunity.

Our RuralStar solution has been deployed with over 40 operators in more than 20 countries and regions, including Thailand, Ghana, Indonesia, Nigeria, South Africa, and China. With RuralStar, millions of previously unconnected people are now able to access mobile networks for the first time.

In 2018, the RuralStar solution and two other Huawei's solutions – WTTx and PoleStar – respectively won the GSMA's Best Mobile Innovation for Emerging Markets award, the ITU's Global Corporate Award for Sustainable Development, and the GSMA's Outstanding Mobile Contribution to the UN SDGs in Asia award.

3.2 Contributing to Standards Organizations and Open Source Communities to Drive the Industry Forward

Huawei actively contributes to standards organizations, industry alliances, and open source communities. Huawei is an active member of more than 400 standards organizations, industry alliances, and open source communities, where we hold more than 400 key positions. Huawei is a significant contributor to major standards organizations and open source communities in the ICT industry. At present, we publish 100 to 200 academic papers every year. Our open source code and a large number of our standards contributions are used across the industry. Such sharing of technologies between industry players drives the industry forward.

Contributions to standards organizations

- Huawei is an active member of more than 140 standards organizations, where we hold more than 250 key positions. We are a member of the board or executive committee in organizations like the 3GPP, ITU, CCSA, ETSI, IEEE, WFA, and WWRF.
- Huawei has submitted core contributions to 5G by working together with key stakeholders across the industry to complete the first version of 3GPP 5G standards, paving the way for the commercial use of 5G. We submitted approximately 17% of the total number of approved 4G LTE standards contributions worldwide, making us the second largest contributor. Our approved 5G contributions accounted for 21% of the total number of approved 5G standards contributions, making us the largest contributor in the world.

- In 2018, Huawei submitted more than 5,000 standards contributions, bringing the company's total number of standards contributions to nearly 60,000.

Contributions to open source communities

Since 2012, we have joined open source communities, actively contributing to mainstream open source foundations and communities. Huawei is one of the top three contributors to mainstream open source communities, such as those for cloud services.

- We hold more than 10 different seats on the board for major international open source foundations and communities like the Linux Foundation, Apache, CNCF, OpenStack, OCI, ONAP, OPNFV, Akraino, Acumos AI, Hadoop, and Linaro, and serve in more than 200 Technical Steering Committee, Project Team Lead, and Core Committer roles.

- Huawei has led many projects, including ServiceComb, which was the first microservice project to graduate from Apache; Cyborg, which has quickly grown into a de facto standard for acceleration device management; CarbonData, which has gradually become one of the standard data formats for big data; and the OpenLab project, which achieves interoperability and pre-integration for cross-community projects, accelerating commercialization of open source. We introduced new features to the FD.io ecosystem including the DMM open source protocol stack framework. As a creative solution, the DMM makes it possible to use diverse protocol stacks for different applications. Huawei also built the Cross-domain, Cross-layer VPN (CCVPN) use case in collaboration with China Mobile and Vodafone in the ONAP community, which won the GNTC Innovation Award.

3.3 Huawei's R&D Strengths Bring Value to Industry Partners and Investors

Huawei's R&D strengths and the value of its IP have been recognized by industry players in many previous collaborative projects, joint venture partnerships, and mergers and acquisitions. Huawei's R&D team and its associated capacity for innovation are key factors when a company decides to acquire Huawei's business. The following are some examples:

- In 2000, Huawei became an original equipment manufacturer of Motorola. Huawei received customer requirements from Motorola and then went on to develop suitable products and provide technical support. During the following 10 years, Motorola purchased cutting-edge core network and wireless access products and technologies worth of USD880 million from Huawei.
- In 2001, Huawei sold Avansys Power – a subsidiary that specialized in communications power supplies – including related technologies and IP, to Emerson for USD750 million.
- In 2003, Huawei and 3Com set up a joint venture named H3C, in which 3Com made investment in cash while Huawei provided enterprise network technologies and human resources. In 2006, 3Com acquired Huawei's 49% share in H3C for USD882 million.

04 Huawei Respects Third Parties' IP and Protects Its Own

Huawei believes that protecting IP is the foundation of innovation, and has systems and processes in place to ensure that our employees respect third parties' IP. Huawei legitimately implements third parties' IP or shares its own IP with other third parties through cross-licensing or by paying licensing fees to third-party IP holders in accordance with international rules and national laws. In doing so, we share value with other industry players for joint success while seeking our own growth. We also contribute to the improvement of the IP laws and industry policies in countries where we operate.

4.1 Ensuring and Managing IP Compliance Through Organizations, Policies, and Processes

As Huawei is under spotlight, we set higher standards for the company as well as our employees when it comes to the protection of IP and trade secrets, and have systematic management systems in place. In addition, Huawei has compliance management teams across all our business and functional departments. Huawei's Chief Legal Officer also serves as the Chief Compliance Officer and assumes full responsibility for the legal and regulatory compliance of Huawei's business operations.

- The legal affairs department works closely with compliance teams in all our business and functional departments, with clearly defined responsibilities. This ensures that the company's

business activities, especially R&D activities that involve others' IP, are conducted in a lawful and contractual manner. Our key business processes such as Integrated Product Development and Integrated Supply Chain are regularly checked to update the key control points. We also make ongoing management improvements by correcting identified issues and learning lessons from everyday operations.

- Since its inception, Huawei has issued many regulations to protect third-party IP, including the *Regulations on Respecting Third-party IP and Other Legitimate Rights*, *Huawei Business Conduct Guidelines*, *Regulations on Respecting and Protecting Third-party Trade Secrets*, *Regulations on Managing Third-party Software*, *Rules on Management of Using Open Source Software and Making Software Source Code Available to the Public*, and *Regulations on Huawei Trademarks*. These regulations place clear and detailed requirements for strictly protecting third parties' confidential information, commercial software, patents, trademarks as well as other forms of IP in our business activities.

- All recruitment candidates are required to sign an IP and trade secret protection commitment letter during their interview and on-boarding. The purpose of this is to ensure that the individuals clearly understand that Huawei respects the confidential information of other companies and individuals. Huawei's employment agreement provides that employees shall not disclose to Huawei or use for work purposes any third party's technical secrets, trade secrets, or other IP, nor hold any third-party's confidential information in Huawei offices, on a work computer. After on-boarding, employees are required to take IP compliance courses.

- The company requires its employees to review the Huawei Business Conduct Guidelines (BCGs) and sign a BCG commitment letter every year. We organize self-checks and self-corrections and discipline any individual who violates the BCG to ensure that all policies are enforced.

4.2 Implementing Others' IP and Sharing Our Own Through Licensing or Cross-licensing

- Huawei actively participates in the discussions and amendment of IP policies for major industry standards organizations, including ETSI, ITU, IEEE and CCSA. We advocate the full respect of IP and completely oppose abusive usage of IP. We expect the IP policies formulated by major standards organizations to be conducive to the healthy development of the industry as a whole.
- It is common business practice in the telecommunications industry for patented technologies to be legitimately shared or implemented through cross-licensing or the payment of licensing fees on fair, reasonable and non-discriminatory ("FRAND") terms. Huawei makes every effort to fulfill its FRAND obligations. Since 2001, Huawei has signed over 100 patent license (or cross-license) agreements with major industry patent holders and companies such as Nokia, Ericsson, Qualcomm, Nortel, Siemens, Alcatel, BT, NTT DOCOMO, AT&T, Apple, and Samsung.
- Huawei pays royalties to legally implement third parties' patented technologies. Since its first patent license agreement signed in 2001, Huawei has paid over USD6 billion in royalties, with nearly 80% of that amount paid to US companies.

- Just as Huawei legally implements third parties' technologies through licensing or cross-licensing, we also actively share our own IP with our industry partners. We have executed more than 10 outbound license agreements through amicable negotiations, pursuant to which we have received over USD1.4 billion licensing revenue from a wide range of companies in the US, Europe, and Asia since 2015.
- Huawei intensifies its communications and collaboration with industry partners by actively participating in patent alliances and patent pools. In 2013, Huawei bid together with other companies to successfully purchase a digital imaging patent portfolio for USD525 million, reducing potential patent litigations and disputes in the industry.

4.3 Contributing to the Ongoing Refinement of IP Laws and Industry Policies with Our Own Practice

Huawei promotes legislative reform by providing its suggestions on and inputs to IP protection legislation and its amendment, as well as policy-making in major jurisdictions worldwide based upon its global view and successful legal experience. We are committed to contributing to a better environment for IP protection.

- Huawei actively contributes to the legislative processes for IP protection within China and introduces international judicial practices into China's judicial procedures, helping align China's IP protection with international standards. We make suggestions on the legislation and amendment of China's IP protection laws, including the Patent Law, Trademark Law, Copyright Law, Criminal Law and Anti-Monopoly Law, as well as their implementation rules and legal interpretations. In doing so, we aim to strengthen IP protection and help create a better environment for innovation and IP protection in China.
- Huawei promotes the ongoing refinement of legal standards for IP worldwide using its own practices. In 2015, Europe's highest court – the European Court of Justice – set a framework for injunctive relief regarding standard-essential patents named after Huawei. The framework was developed following the ruling of a case in which Huawei was the patent holder, and has since become a basic framework for standard-essential patent licensing negotiations between standard-essential patent holders and putative licensees as well as for different courts in their rulings for remedies.

- Huawei actively communicates with the National Intellectual Property Administration of China, the European Patent Office, the United States Patent and Trademark Office, the Japan Patent Office, as well as the World Intellectual Property Organization. We provide our inputs and suggestions, from an industry perspective, on IP application and protection. Huawei also attends international symposiums on IP between China and the US, as well as between China and Europe, where we share our views, experiences, and case studies. Our goal is to promote cooperation and exchanges around IP practice between major countries.

Conclusion

Sustained innovation has been the foundation of Huawei's survival and growth over the past 30 years. Huawei believes that protecting and respecting IP is the foundation of innovation. As an innovative company, we respect, apply, and contribute to IP rules. Huawei respects the IP belonging to other parties, and is committed to protecting its own. We have signed patent cross-license agreements with many international ICT companies, and we contribute to creating an environment in which innovation and IP are well protected both within the industry and in every country where we operate.

Like other global companies, Huawei's growth has been accompanied by IP disputes. We strive to resolve these disputes through amicable negotiations. We will also resort to judicial procedures or arbitration for dispute resolution if no agreement can be reached through negotiation.

Huawei has the ICT industry's broadest portfolio of products, and our sales are worth USD100 billion. Our innovation achievements and their associated value, as well as the resolutions of our previous IP disputes, all demonstrate a well-functioning mechanism for innovation and IP protection at Huawei.

Sustained innovation and respect for IP are the driving force behind Huawei's business success of today. They are also the very foundation upon which we will build a fully connected, intelligent world for the future.

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