



GIV 2025

Unfolding the Industry Blueprint of an Intelligent World



GIV 2025 aims to set the direction for innovation to make the intelligent world a reality. It is designed to help industry decision-makers determine the path and pace of future growth while acting as a reference to help industries go digital. With this report, Huawei strives to lay the foundations for a fully connected, intelligent world with partners and industries.

For more information and to download the whitepaper, please visit: <http://www.huawei.com/minisite/giv>

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Foreword

Accurately Predicting the Future Now to Avoid Being Left Behind Later



The Industrial, Electrical, and Information Technology revolutions resulted in three major breakthroughs in human civilization over the past 120 years, and unleashed productive power far exceeding the sum total of the thousands of years of history that came before.

Today, our world is at another inflection point. The fourth technological revolution – founded on information and communications technology (ICT) and driven by artificial intelligence (AI) – is leading us into a new world where all things will be able to sense, all things will be connected, and all things will be intelligent. This intelligent world will be driven forward by data and shared intelligence.

The coming intelligent world has two defining characteristics. The first is that AI acts as a "general-purpose technology". The second is that +Intelligence becomes the soil in which all industries innovate. Key technologies such as 5G, cloud, video, the Internet of Things (IoT), and AI will converge and develop together, creating enormous value on an ongoing basis. They will unleash the potential of individuals, enrich home life, and inspire innovation in organizations.

New technologies are emerging rapidly, and innovative applications are being adopted in industries at an accelerated pace. The underlying drivers for the emergence of the intelligent world are all things sensing, more and better connections, and the emergence of intelligence in data usage.

By 2025, 40 billion smart devices around the world will be able to sense, and there will be 100 billion connections. This will virtually eliminate information silos and mean faster, more secure, and more intelligent data exchanges. Annual storage of data generated from this will reach up to 180 billion TB, a 20-fold increase compared with today.

The integration of the physical and digital worlds means that the experiences of individuals and homes will change. Organizations will take on growth models driven by data. Cities will discover new springboards for leapfrog development. But how will upstream and downstream

industries in ICT seize the opportunities that the coming intelligent world will offer?

Against this backdrop, Huawei's vision and mission are clear: We will bring digital to every person, home and organization for a fully connected, intelligent world. To this end, Huawei has developed the Global Industry Vision (GIV) 2025, aiming to unfold the industry blueprint of the coming intelligent world.

GIV 2025 is a window into Huawei's exploration and thinking regarding the roles and opportunities for ICT in the intelligent world. In this report, Huawei adopts a mix of data and trend analysis to elaborate on global ICT trends and lay out the blueprint for the ICT industry, all based on extensive research of historical data analysis, econometric forecasting, ICT trends forecasting, and business and industry trend predictions.

GIV 2025 provides the direction for industries aiming to ramp up the pace of development, as well as the foundations that will enable the diverse ICT industry ecosystem to truly transition into the intelligent world. It also provides ways for individuals and homes to incorporate intelligence into everyday life.

This is just the beginning. If we fail to accurately predict the future now, we will be left behind later. To unfold the blueprint and identify the right direction for the future, we must walk with others rather than alone. Let's take action now and join hands to build this fully connected, intelligent world.

William Xu

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Executive Summary

The fourth industrial revolution – founded on ICT networks and driven by AI – is leading us into an intelligent world where all things will sense, all things will be connected, and all things will be intelligent

On the path toward an intelligent world, ubiquitous sensing, high-speed connections, and sharing of knowledge will lead to unprecedented growth and value creation. Data will become an inexhaustible resource. Intelligence will decide how the value of data is transformed and delivered. Connections will carry massive quantities of data, and enable exchange of data and smart value creation.

The digital world is gradually being brought to every person, home, and organization, and this is having an unprecedented impact on life, business, and society. Along with these changes will come a digital economy valued at US\$23 trillion.

An intelligent world that goes beyond our expectations will be made possible when all things sense, all things are connected, and all things are intelligent. GIV forecasts that by 2025, there will be 40 billion AI-enabled personal smart devices, 90% of which will have an intelligent personal assistant. 12% of homes will have robots under their roofs, with enormous potential unleashed for individuals as they begin to be supported by sensing devices, two-way human-machine communication, and proactive information services.

At the business and societal levels, GIV 2025 predicts that there will be 100 billion connections by 2025, helping to

drive digital transformation in domains including public utilities, transportation, manufacturing, healthcare, agriculture, and finance. By that time, 85% of enterprise applications will be on the cloud, 86% of global companies will adopt AI, and data utilization rates will skyrocket to 80%. This means we will see 180 billion TB of data generated every year, a constant source of innovative intelligence and value creation.

Amidst this momentous transformation, the ICT industry assumes the responsibility for creating +Intelligence that will support the coming intelligent world. ICT must lead these efforts by first pursuing intelligent transformation of itself, then moving to help all other industries go intelligent.

The data provided in GIV 2025 covers more than 170 countries and regions, and came from Huawei as well as statistics from international organizations, consulting companies, and industry manufacturers. GIV 2025 breaks down quantitative data based on the three major enabling forces of the intelligent world (all things connected, all things sensing, and all things intelligent). Qualitative descriptions of this report focus on the trends and changes relating to individuals, homes, and organizations in an intelligent world.

GIV 2025 contains three core findings:

All things sensing, more and better connections, bringing everything to the intelligent world

The start of the intelligent world will be marked by the ability of all things to sense, and by the creation of 100 billion new connections. As the ability of people and things to sense and connect improves across-the-board, entirely new points of interaction between people and things will be created in the intelligent environment built by data. This is a required step on the way to the intelligent world.

Therefore, GIV 2025 provides multiple key quantifiable metrics relating to the number of smart devices, penetration rate of various methods of sensing, number of connections, bandwidth, and communications traffic. Descriptions and analysis are provided on how these metrics are enabling the development of the intelligent world.

We foresee that by 2025:

- There will be more than 40 billion smart devices around the world. The role of these devices will evolve from being tools to being assistants, and 90% of smart devices will have smart assistant functionality.
- Wearables will see rapid growth, with more than 440 million applications utilizing AR/VR, creating new modes of sensing for people.
- Mobile communications network coverage will reach 6.5 billion people. Gigabit access coverage will exceed 30%. Ubiquitous connectivity will gradually even out the unbalanced development between individuals and between regions.

This means that data will become the productive force in an intelligent environment, and will provide people with an intelligent experience across all scenarios as the integration of the digital and physical worlds deepens. As a result, the average person will see enormous extensions of their senses and other capabilities, and the disabled will regain prior abilities. In the coming era, people will be able to do more than they ever imagined and people with disabilities will live normal lives.

"Things" will be able to sense and connect in ways never seen or imagined before. By 2025, there will be more than 100 billion connected devices and things around the world. Connected people, things, and devices will all be able to interact and exchange information. As this happens, information silos will virtually melt away, and connections will be faster, more secure, and smarter than they are today.

The ultra-fast network formed by 100 billion connections will penetrate into every corner of the physical world. The efficiency gains unleashed by this enormous network of connections will result in productive value and vitality many times greater than today. It will drive increasing returns in all industries, and open the door to achieving new scaled growth through the full digitization of assets.

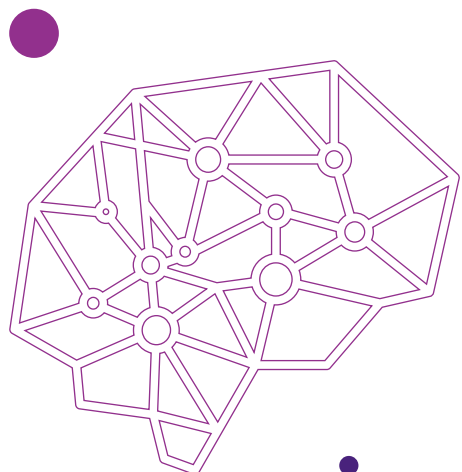


+Intelligence: Fostering new business species and driving leapfrog development for industries

When all things are intelligent, this will drive the generation of massive amounts of data. AI will serve society as a general-purpose technology. The massive quantities of data linked to the cloud will drive the rapid evolution of smart algorithms, which will in turn provide intelligent foundational resources that can be shared by all.

+Intelligence platforms built upon big data, cloud, IoT, and AI will become the springboards upon which enterprises improve themselves throughout their lifecycles. Moving data streams to +Intelligence platforms is a move every enterprise must make in order to survive and thrive.

Therefore, GIV 2025 provides quantitative forecasts for key metrics including the rates of global data utilization, enterprise cloud migration, and AI penetration. It also traces out a roadmap for how +Intelligence platforms can enable industry development, offered as a reference to industries as they hammer out strategic direction.



Research indicates that by 2025, 100% of enterprises will be on the cloud, and 86% of enterprises will be using AI

This means that enterprises lacking cloud capabilities will disappear as we enter the intelligent world. Conversely, enterprises that take early steps to differentiate themselves by using +Intelligence to gain competitive advantages will reap significant dividends. More accurate decision-making, more efficient operations, and more customized and innovative products will give enterprises that take this path a first-mover advantage in the coming intelligent era.

Enterprises that succeed in integrating sensing, connection, and intelligence into their businesses will be the biggest winners in the intelligent world. Enormous dividends can be reaped by improving the ability to sense, collect, and use data, and by incorporating AI to improve productivity, turning traditional industry resources into high-value knowledge resources.

In fact, some farsighted traditional enterprises and cities with underdeveloped infrastructure are currently working actively to ride the wave of +Intelligence platforms. These frontrunners are aiming to accelerate the consolidation and iteration of demand and technology.

Mass innovation: Tapping into the opportunities of a digital economy valued at US\$23 trillion

The intelligent world where all things are connected, all things sense, and all things are intelligent, is driven by its core productive force – data.

Data is also what balances out supply and demand, the intelligent leverage used to optimize the structure. Every connection that can sense can be viewed as an oil well. Cloud and AI are the refining plants, which collect, transmit, and refine data, and then send it to the source of demand for further "purification" and re-utilization. This cycle will be a foundational phenomenon of the intelligent world.

Behind the US\$23 trillion digital economy is a "wealth starting line" delineated by ICT industry development. Everyone can find their own opportunities to prosper, including in industry, transportation, energy, and media. There are opportunities to be found in the intelligent ecosystem for both unicorns and large enterprises.

Research shows that many cities and organizations are already working quickly to seize the first-mover advantage in the deployment of intelligent innovation platforms, aiming to lead in the intelligent world. There are also many regions and industries now standing at the starting line, attempting to build stamina to succeed in the new intelligent world by increasing the scope of their data collection, improving connection transmission efficiency, and strengthening their smart algorithm capabilities.

GIV 2025 describes the specific actions being taken by regions and organizations to enter the intelligent world, and outlines an industry roadmap for all of society to do the same and make the most of what this new world presents.

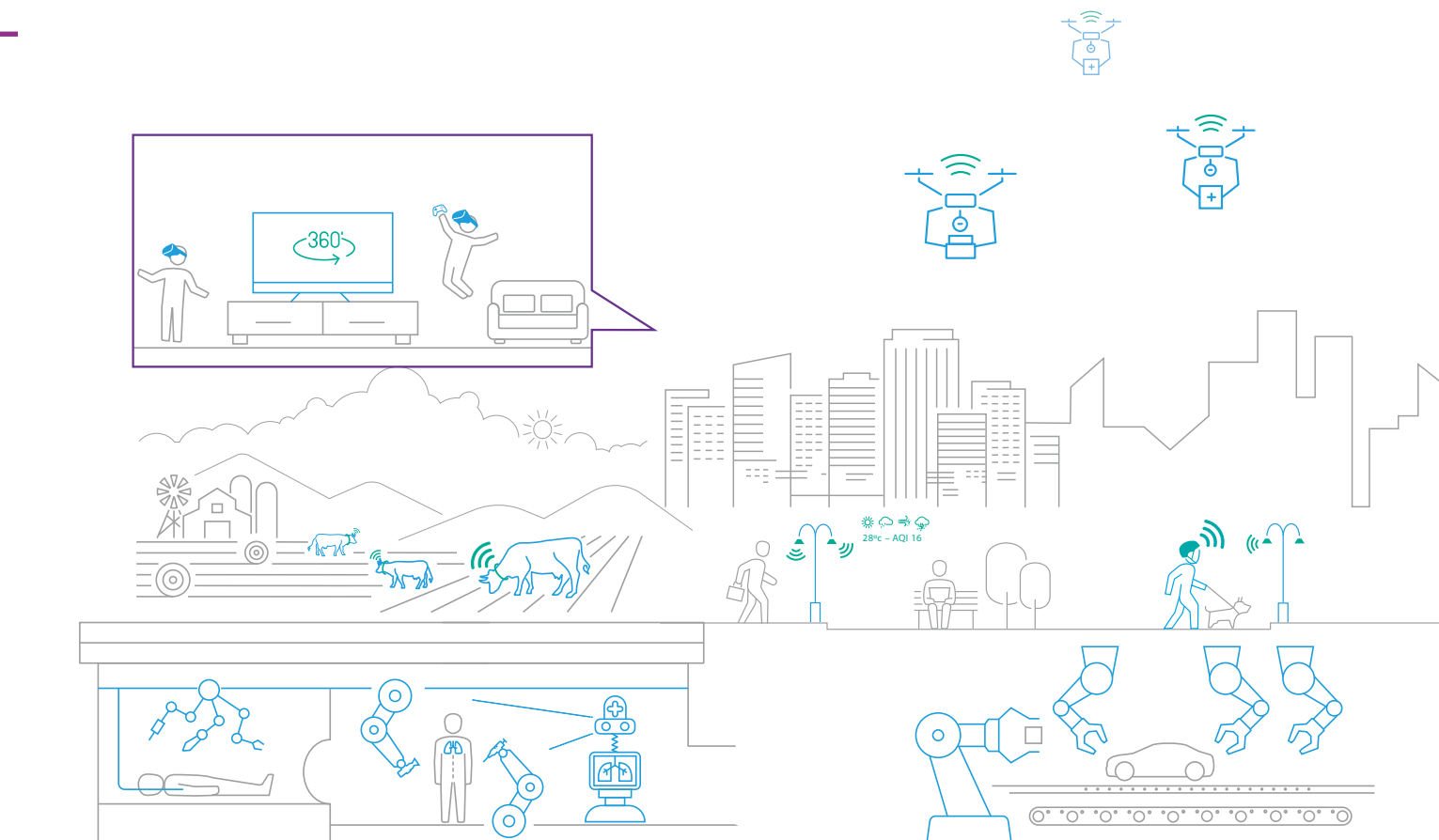
GIV 2025:

Unfolding the Industry Blueprint of an Intelligent World

Sensing enables intelligence. Intelligence improves perception. And perception reinforces sensing. This is a cycle of ever greater intelligence.

The evolution of intelligence, a process that has been taking place in humans over many millennia, is now playing out again amongst tens of millions of "things" in the world. The power of data will drive this evolution from three perspectives: sensing, connections, and intelligence, accelerating the evolution of intelligence in "things" millions of times over. More importantly, the revolution in intelligence will bring new intelligent capabilities to every person, home and organization. We are on the cusp of a new era.

Three forces – all things sensing, more and better connections, and the emergence of intelligence in data usage – will combine to make the intelligent world a reality and drive society to grow and develop in entirely new ways. The ICT industry will assume the important role of creating +Intelligence for the intelligent world. On top of this will be 5G, cloud, video, the Internet of Things (IoT), Artificial Intelligence (AI), blockchain, and other technologies that integrate the ICT industry, unleashing enormous industrial potential and setting off a new wave of economic development. They will further change the way people live and work, and ultimately reshape society as a whole.



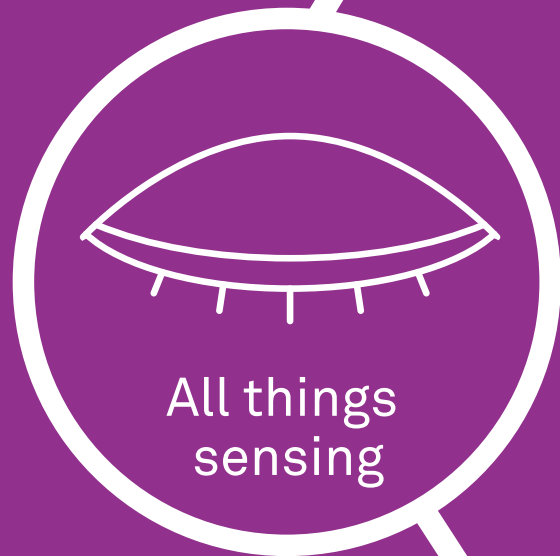
GIV 2025 provides insights into the coming intelligent world, exploring what it will look like, how it will work, and where we are headed. It does so from three perspectives: sensing and connection of things through data, intelligence as a driver of transformation in industry models, and intelligent economic ecosystems. GIV 2025 is divided into the following sections:

1. All things sensing, all things connected
2. A new window into large-scale industry development through +Intelligence
3. How everyone can benefit from intelligent innovation.

The aim of GIV 2025 is to help industries explore, create, and uncover new paths for future growth in the coming intelligent era. It aims to trace out a roadmap that will enable society to tap into the opportunities of an intelligent world.



440 million VR/AR Users
creating new modes of
sensing for people



All things
sensing

40 billion smart devices
More devices of
sensing



All things
connected



90%
of computing load within
data centers will be done in
cloud data centers

85%

of enterprise applications
will be on the cloud



Carbon emission reductions
per connection



All things
intelligent



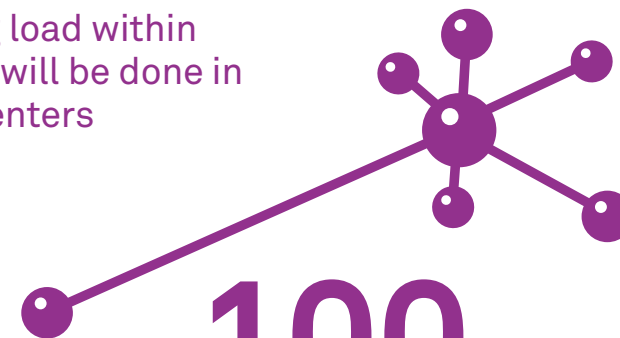
Data utilization
will skyrocket to around
80%



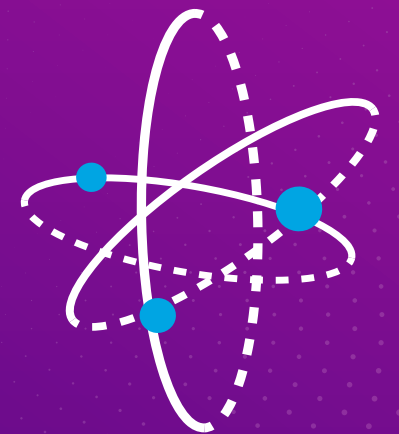
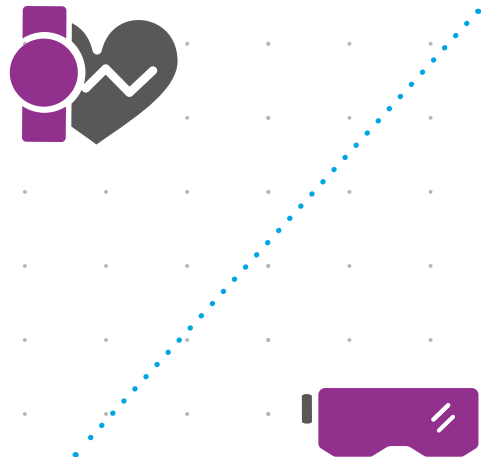
90% of users will have a smart
personal assistant



12%
of homes having smart
service robots



100 billion connections



Part 1

New Era

All things sensing, more and better connections,
bringing everything to the intelligent world

All things sensing, more and better connections, bringing everything to the intelligent world

The intelligent world will truly have arrived once all things can sense and all things are connected. The application of IoT technology will relentlessly assign "digital labels" to all people, things, and devices, making all things digital. From vehicles to drones, from robots to farm animals, and from surveillance facilities in cities to power grids, all things are gaining the ability to sense through the power of data. In the realm of people-to-people connections, breakthroughs in technology such as smart devices, wearables, HD video, and AR/VR will open all-new perspectives and possibilities. Unprecedented development and progress will be achieved by individuals, businesses, and society through these 100 billion new connections.

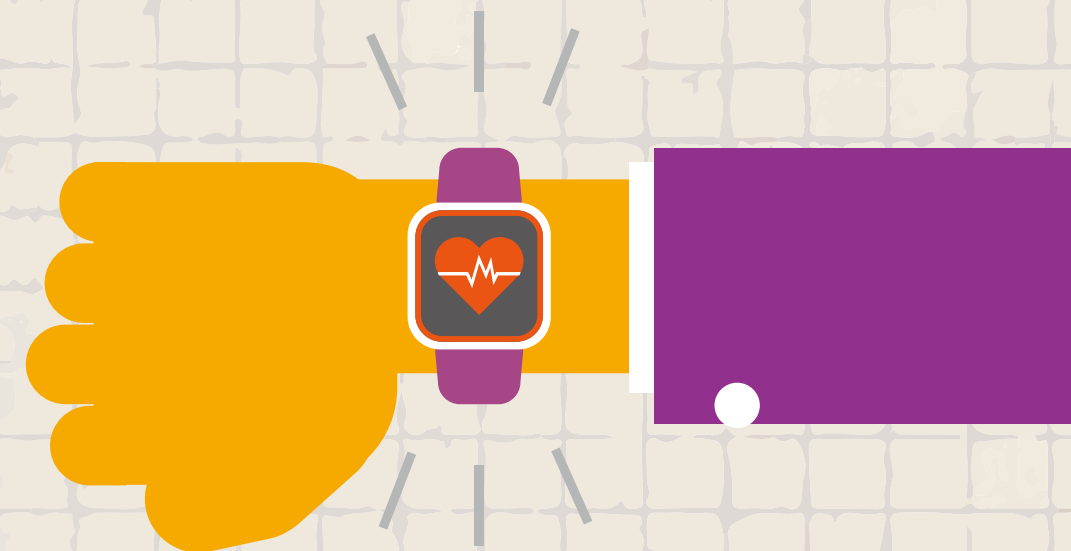
All things sensing

The convergence of the physical and digital worlds is marked by the ubiquity of things that are capable of sensing. In terms of individuals and homes, by **2025** there will be an expected 40 billion smart devices. Of these, there will be 8 billion smartphones, 3 billion tablets or PCs, and 8 billion various wearables. On average, each person will own 5 smart devices, and 20% of people will own 10 or more. At the same time, nearly 20 billion real-time online

smart home devices will become a natural extension of the sensing of individuals and homes. In all aspects of life and work, ubiquitous sensing will drive a gradual integration of the physical and digital worlds. This will create a smart foundational platform for consumption, education, travel, and work. Intelligent services derived from this sensing will be found everywhere.

40 billion
smart devices

20 billion
real-time online smart home devices



20% of people will own **10** or more smart devices

each person will own **5** smart devices

The market space in the connected vehicle domain
will exceed **US\$145 billion**

200 million vehicles connected to
5G networks.

100% of new vehicles will
be connected to the Internet



The ability for all things to sense will have a more direct effect on the development of industries and society. As IoT develops, "digital labels" will be placed on things across the world, including over 4 billion herd animals, 20 million shipping containers, 300 million LED lights, and 1.8 billion water meters. All things will gradually be connected to the Internet: vehicles on the road; devices in factories; containers being shipped; airplane engines; indoor or outdoor environmental monitoring equipment, and much more. The massive amounts of data generated by the ability for all things to sense will be extensively integrated in all industries, forming new industries like the Industrial Internet of Things and Connected Vehicles and providing critical new momentum for the development of the intelligent world and creation of new intelligent services.

Take connected vehicles as an example. By 2025 there will be 200 million vehicles connected to 5G networks. A full 100% of new vehicles will be connected to the Internet, and the market space in the connected vehicle domain will exceed US\$145 billion. Connections will be made between people, vehicles, and transportation infrastructure. This increase in connectivity will bring connected vehicle applications to the next level, moving from simple on-board entertainment to autonomous driving, vehicle fleet deployment and management, AI, and other related services. While expanding the market potential for connected vehicles, connections will help significantly lower transportation costs, from 66 to 29 US cents per mile. The automotive industry will also see many more opportunities arise for further intelligent transformation.

Better ability to sense

The physical and digital worlds will gradually integrate as things become better able to sense. The depth and sharpness of perception of the digital world will improve by many times over with the emergence of 4K, 8K, and even 32K video. The development of AR, VR, and other applications will add new perspectives to how people sense the world around them, enabling people to extend their ability to sense beyond the limitations of the physical world. We forecast that by 2025, there will be over 8 billion wearables globally, with 440 million users of VR/AR/MR. As cloud capabilities improve, devices become smaller and more portable, and universal computing becomes more powerful, the cloud VR market space will unleash greater commercial value, reaching US\$292 billion by 2025 ⁽¹⁾. These developments will be the catalyst for revolutionary changes in entertainment, communications, telecommuting, and other interaction models. People will have intelligent, interactive experiences with things and their environment. Immersive digital experiences will become the norm.

The better ability to sense will drive further advancement of smart devices and smart robots, turning them from tools into assistants. New smart robots will understand people better. They will provide active services as our assistants, providing help to the disabled, elderly, or other people in need. We predict that the penetration rate of smart assistants by 2025 will be 90%, with 12% of homes having smart service robots. New types of intelligence will possess powerful data collection capabilities, smart vision, and natural language processing abilities that will enormously improve user efficiency and decision-making. Smart assistants and smart service robots will be the catalyst for AI to truly integrate into individual and home life. Smart algorithms will rapidly penetrate the consumer application domain, creating a market worth hundreds of billions of US dollars.



wearables globally

8 billion



VR/AR/MR
users

440 million

smart assistants

90%

2025

Global connections will reach

100 billion



77%

population will
have access to
the internet



70%

population will have
access to gigabit
mobile networks

100 Billion Connections Will Eliminate Digital Siloes and Pave the Way Toward the Intelligent World

More and faster connections

With over 100 billion connections and gigabit networks, ubiquitous and rapid connectivity will become the norm for people, things, and the environment in which we live. Information silos will gradually disappear. People and things will gradually transition from "building connections" to "ongoing interaction". Imbalances in development between regions will gradually fade away.

We forecast that by **2025**, there will be over 100 billion connected devices around the world. A full 6.5 billion (80% of the world's population) will enjoy the service provided by mobile communications networks. In 2025, 77% of the world's population will have access to the Internet, and 70% of people will have access to gigabit mobile communications networks. During the same period, access to broadband will reach 75% of homes, of which 30% will have access to gigabit broadband.

The uneven distribution of connections between regions will gradually fade away, with the number of connections in emerging nations around the world to reach 7.5 billion. Connections in the intelligent world will bring more equal development opportunities to different regions and cities at different stages of development. At the same time, the powerful network effects of technologies such as cloud computing, IoT, and AI will directly catalyze new windows of opportunity for smart cities, smart agriculture, smart manufacturing, autonomous driving, and other industries in the intelligent world.

Massive data usage and high-value connections

As video usage drives exponentially greater data traffic, intelligent connections will help industries monetize and benefit from that data. By 2025, we forecast that average communications data usage per person globally will increase 10-fold, to an average of 4 GB per person per day. Average mobile communications data usage per user per day will increase by approximately 30-fold (average mobile data usage per user per day will reach 1 GB), of which 89% will be from video. Opportunities to profit from massive amounts of HD video data will arise, and video will generate intelligent value in cloud-based gaming, education, and healthcare.

The increase in efficiency of connections will directly drive an explosion in sensing capabilities. Through the

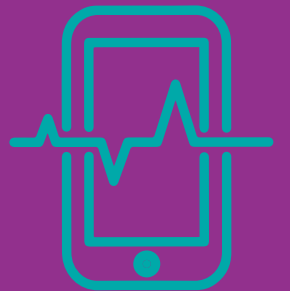
same network, new momentum for intelligentization will be unleashed across all industries. By 2020, the Cellular Internet of Things (CIoT) based on 5G applications will comprise 3 billion connections, of which 2 billion will have low power consumption and wide coverage⁽²⁾. Forecasts show that by **2025**, of the 100 billion connected devices, 55% of connections⁽³⁾ will be applied in the commercial IoT domain. Initial usage of IoT will be implemented by industries including the automotive, agriculture, and energy industries to develop a pool of intelligent technologies. They will be integrated with cloud, edge computing, and AI to enable digital production and intelligent services within the closed loop of data collection, processing, analysis, and application.

Average communications data usage per person globally will increase

10-fold

Average mobile communications data usage per user per day will increase by approximately

30-fold



Average mobile data usage per user per day will reach **1 GB**

Average of **4 GB** per person per day.



Video will contribute **89%** of individual traffic



Data Becomes Intelligence, Guiding the Operation of the Physical World to Reshape Individuals, Homes, and Industries

All things sensing and more and better connections will result in massive amounts of data. The intelligent world will begin to be driven by data and intelligence sharing. The massive amount of data produced by "digital species" in the future will not only form the basis of the way we live and work, but will also guide individuals, homes, organizations and society at large. Data flows

will begin to integrate and guide the flows of people, things, energy, funds, and regulation, and will break down barriers and promote deep integration of industries. At the same time, combined with cloud computing, IoT, AI, and other technologies, smart cities, smart agriculture, smart manufacturing, autonomous driving, and other industries will develop in leaps and bounds.

In the coming era, people will be able to do more than they ever imagined. People with disabilities will live normal lives, and the feeling of being at home will be anywhere and everywhere

With the expansion of broadband connectivity, chip performance, and display technology, as well as cloud capabilities, wearables will become smart assistants that proactively process data and provide smart support. They include smart watches, smart glasses, and smart headsets. In this new "extended reality", people will enjoy more intelligent, equitable, happier, and comfortable lives.

Guide robots for the blind and cloud capability improvements will mean 39 million blind people will be able to live normal lives

We predict that by 2025, 90% of users will have a smart personal assistant. AI health applications in conjunction with smart devices will play a major role. The wide adoption of AI-supported healthcare robots and other smart assistants will enable the disabled to live normal lives in the intelligent world. There are 39 million blind people and 246 million people with impaired vision around the world. With the assistance of guide robots, they can enjoy richer and more comfortable lives.

Smart guide headsets for the blind allow them to live normal lives

META is the first cloud-based smart wearable from CloudMinds. The guide headsets for the blind project being conducted by Huawei, CloudMinds, and the China Mobile 5G Joint Innovation Center will optimize META's cloud-based video presentation, using guide headsets to provide highly precise and real-time information to the visually impaired about location, paths, and barriers. The wide range of intelligent services provided by the solution (including facial recognition, situation identification, object recognition, and image categorization) can help the visually impaired overcome daily challenges.



Cloud Virtual Reality (Cloud VR) merges cloud computing and cloud rendering to VR applications. With high-speed connection, the cloud transmits the compressed display and sound output to terminal equipment, so that the cloud becomes a fully functional content service and rendering service platform. With the evolution of video technology along the 4K-8K-16K-AR-VR track and the significant bandwidth increase, Cloud VR will bring new applications for entertainment, social and other home scenes, as well as industry, medical, education, retail, and other sectors. "Immersive experience" will become a new norm, forging new markets with huge scale. According to Goldman Sachs, the global scale of VR software and applications will reach US\$45 billion by 2025, and opportunities from a wide range of scenarios will emerge one after another.

Cloud VR also entails huge change for personal and home life. VR entertainment and live broadcast will bring immersive experience with quality that far exceeds our imagination. When watching a live game, the user will be able to face the player, surrounded by the sound of the field

Cloud VR and high-speed broadband add a new dimension to our senses

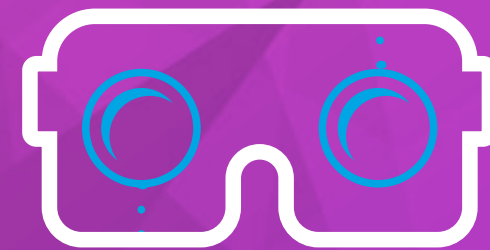
replicated by a dynamic panoramic audio system. Users will be able to do more than enjoy the game in 360 degrees. They will also be able to move freely in the scene, or interact with the player on the pitch. It is predicted that in **2025**, VR entertainment video will have 75 million subscribers, representing a market valued at US\$3.2 billion, while the VR live broadcast market will have 95 million subscribers with the revenue reaching US\$4.1 billion, making this an impressive potential market.

In the field of industry application, Cloud VR will become a powerful tool to activate digital twins on industrial Internet and IoT platform. With the digital mapping technology, industrial product design, equipment inspection, and maintenance can be implemented by professionals via the Cloud VR platform. In the healthcare field, VR will be widely used for surgery operation training, guidance, telemedicine, and rehabilitation. The VR+ medical domain is expected to reach US\$1.2 billion in 2020 and US\$5.1 by 2025, with the user base to reach 3.4 million.

VR entertainment video will have
75 million subscribers



reaching market value of
US\$3.2 billion



VR live market will have
95 million subscribers

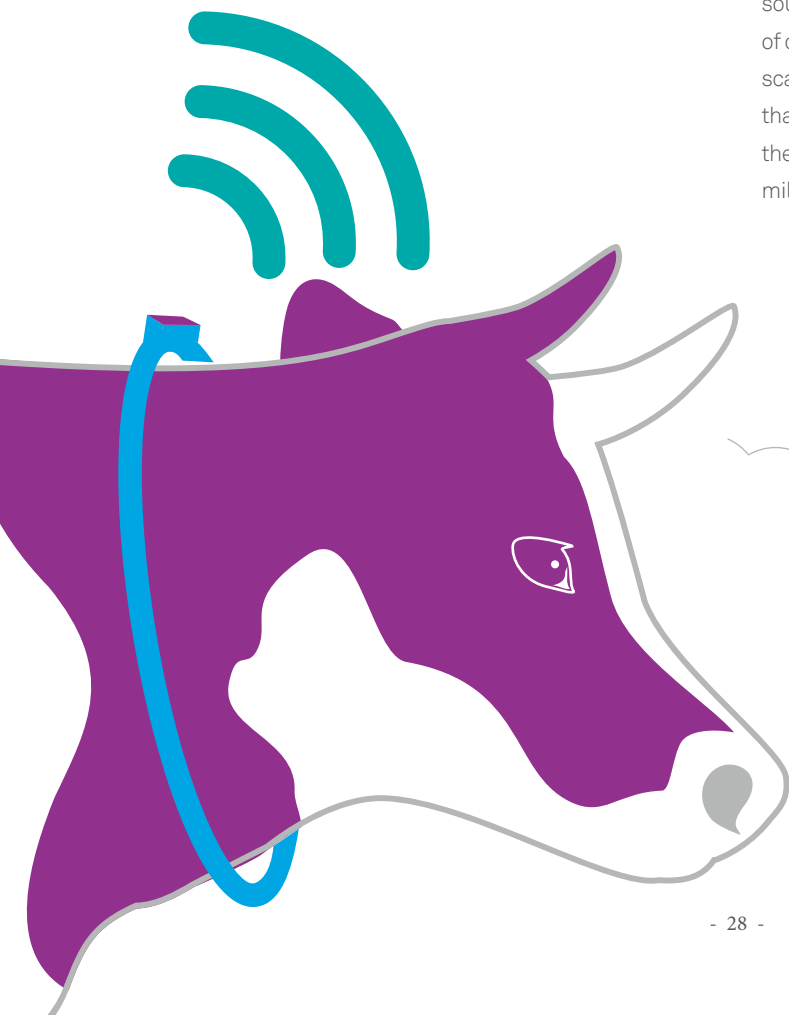
creating revenue of **\$4.1 billion**



By 2025, there will be over 1 billion connected cows, unleashing intelligent value for agriculture

The IoT for agriculture in the beginning was just about connecting agricultural equipment. Data still only flowed between things. The most important data pertaining to animals and crops was still collected and imported manually. This meant that data collection was very limited and contained significant errors. In the year 2000, there were 520 million farms around the world. Not a single one was using IoT technology ⁽⁶⁾.

The application of the agricultural IoT, based on NB-IoT, will gradually expand. The widespread application of sensors will break down data siloes, and data will be integrated from every crop, every animal, every farm, and every stage of production. Information about everything from crop and animal health management and biological cycles to production volume and data on water supply, processing, transportation, security monitoring, and other stages regarding agricultural products will serve as the sources of intelligence. Together with hundreds of millions of connections, such data will boost the productivity of scaled farming. By 2025 there will be over 1 billion cows that have been "digitally labelled" and connected. Across the world, 525 million farms will be using a total of 600 million sensors to support the IoT in agriculture ⁽⁷⁾.

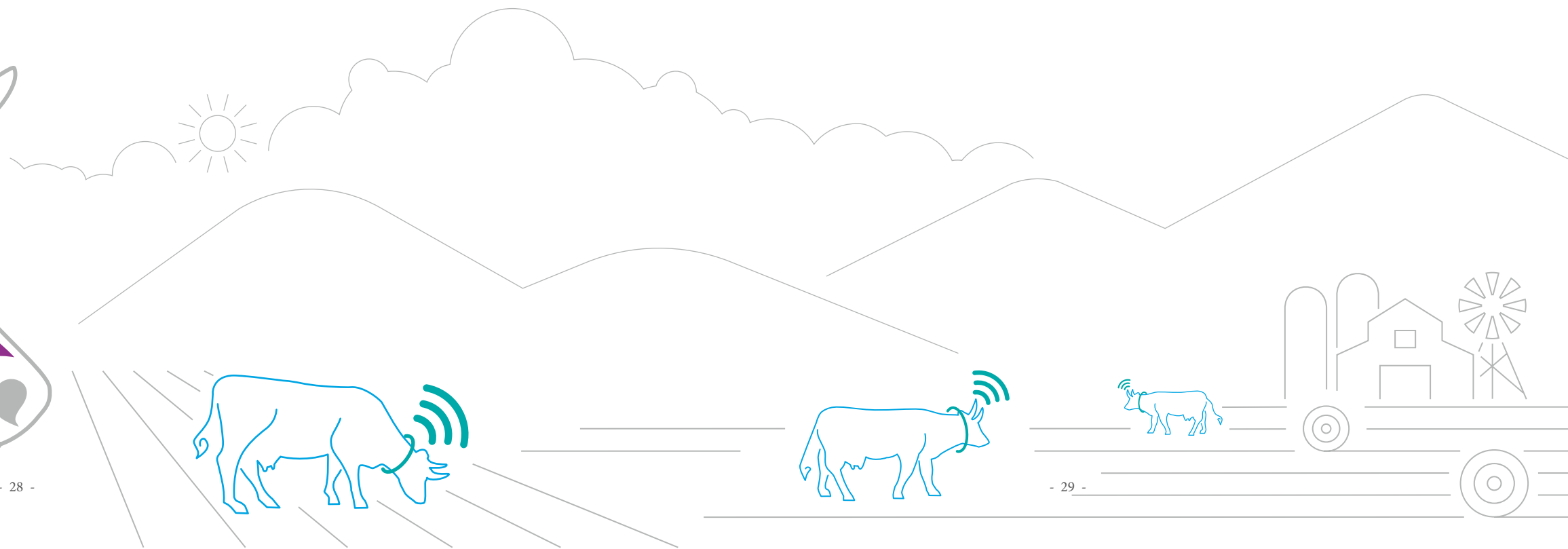


NB-IoT provides an "identity card" for cows

For the livestock industry, smart agriculture sounds easy, but is difficult in practice. Different dairy cows have their own specific biological cycles, and if an estrous cycle is missed then losses per cow can amount to approximately US\$2,000.

A dairy cow monitoring system based on NB-IoT can make the data collected by the smart collar worn by the cow available for transmission any time to the cloud for scientific analysis. In addition, a dairy cow information management platform can utilize the data collected from each cow to comprehensively monitor the health of the herd. If the electronic ear tag on a dairy cow detects illness, it will send an alarm and automatically segregate the sick cow.

The application of the IoT in agriculture will eventually extend to the entire livestock and feed industry, and become a "smart shepherd" for management of the business. By using technology to monitor animal health, physiological cycles, location, and other information, the road will be paved for future development of green food traceability and other new blockchain applications.



Smart cities: By 2025, the level of intelligence will be positively correlated to quality of life in 35 cities with 10 million or more residents.

According to a report by the World Economic Forum (WEF), by 2025 it is forecasted that there will be 35 cities around the world with a population exceeding 10 million. Future urban development will be inseparable from the development of ICT technology. Urban planners are currently attempting to use "urban intelligence" to achieve sustainable development in the domains of security management, transportation planning, and government operations. The aim is to unleash unlimited potential in smart cities, enabling city residents to enjoy the safety, convenience, and high living standards made possible by a digital life.

The extensive deployment of smart surveillance in cities and more and better municipal network connections are the first steps for development of smart cities.

As AI-assisted 4K UHD video surveillance becomes more prevalent, and as cities improve their open network connection capabilities, 24/7 uninterrupted collection of the "fine details" of every corner of the city will become possible. Facial recognition, license plate recognition, road information recognition, pollutant recognition, and other smart video analysis will continue to mature. City operations will become more efficient and environmentally friendly. Each sub-system run by the city will become better integrated into overall operations. Data on traffic management, safety surveillance, population density, and energy consumption tracking will be effectively integrated and analyzed in real time.

Smart City 2.0 – The application of ICT cluster technology to urban management

With the development of IoT and mobile edge computing, surveillance data about urban utilities (electricity and water) and other management systems will become integrated. Autonomous vehicle data platforms will integrate driving data, traffic management data, power grid energy consumption data, and energy data to improve the efficiency and accuracy of government decision-making. At the same time, the IoT and individual networks will completely connect and information about the usage of electricity, gas, and water as well as travel information will be managed on the same network.

To have an intelligent urban management platform is the ultimate goal of smart cities.

The aim is to build a better and more intelligent interaction platform for the communication between government and residents in terms of system equipment, network construction, application platforms, and services. Public utility services will be made intelligent through the use of smart devices, drones, smart robots, and other means. All results will be delivered through the intelligent urban management platform. This will inject vitality into the development of cities themselves while attracting more inbound investment in +Intelligence.

Three phases for developing Saudi Arabia's Yanbu into a smart city

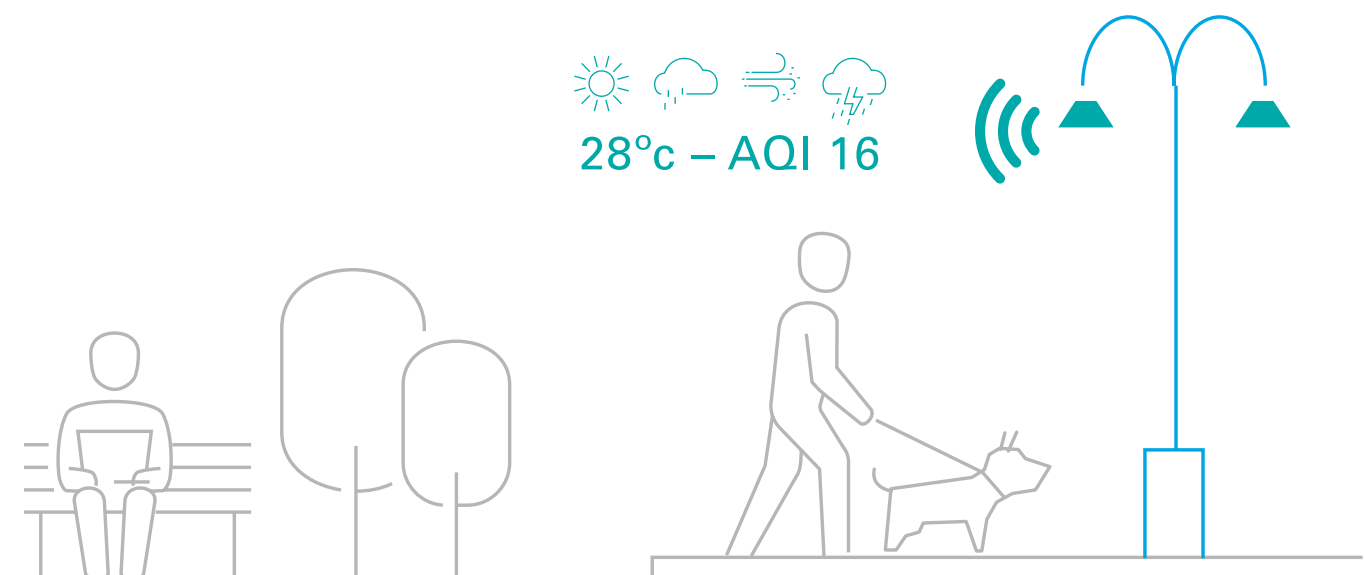
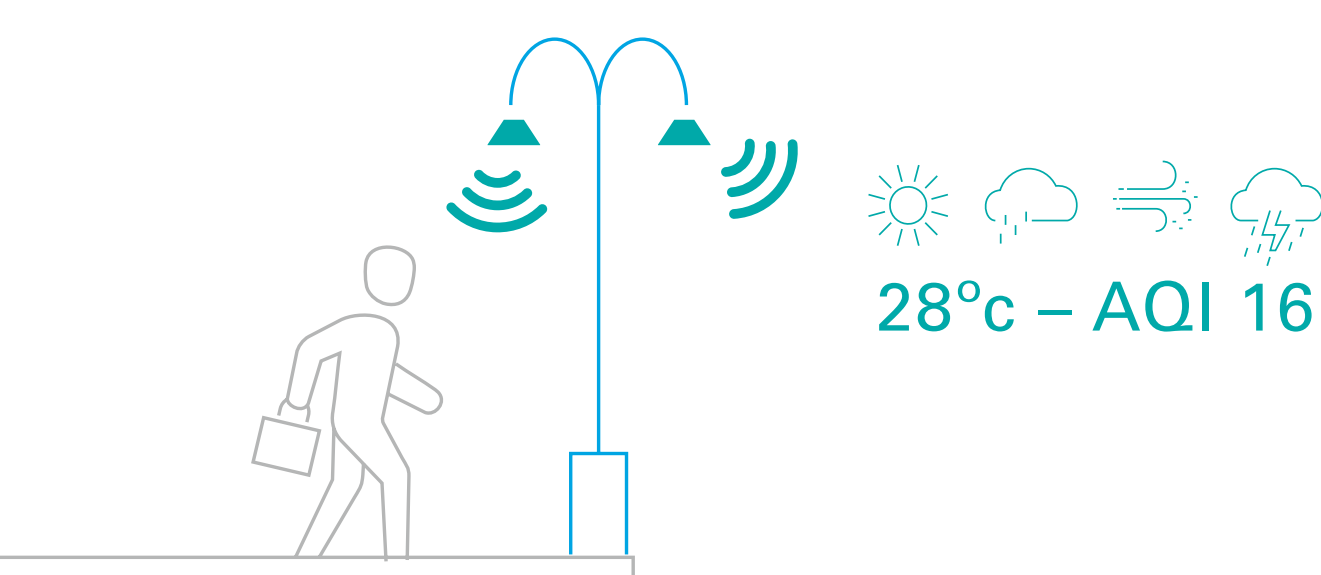
The industrial city of Yanbu in Saudi Arabia has aimed to build itself into a smart city by implementing a three-phase strategy aimed at bringing greater diversity to the city and improving the investment environment.

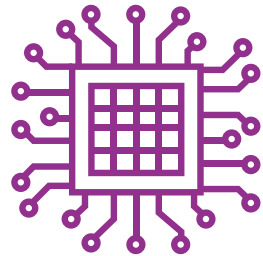
Phase 1: As the saying goes, "If you want to become rich, first build roads". Powerful connection networks are the superhighways of information needed by the intelligent world. Yanbu constructed wired and wireless broadband networks and open access networks across the entire city, providing high-speed Internet access services to governments, industrial zone enterprises, road works, and residents.

Phase 2: Once the information infrastructure was in place, Saudi Arabia turned its sights to smart applications. Aiming to enhance municipal administration, it focused on eight smart applications, including Heavy Vehicle Management, Smart Waste Management, Smart Streetlight, and Smart Parking. These applications improved municipal administration efficiency, enhanced

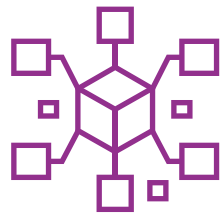
public safety, and created a better living environment for urban residents. Through these efforts, Yanbu was able to reduce road maintenance costs by 20%. The number of road accidents also dropped, with an overall drop in public lighting costs of over 30%.

Phase 3: With the completion of Phase 1 and Phase 2, Yanbu's smart city was materializing. Saudi Arabia then built intelligent urban management platforms including a big data analysis platform, IoT data platform, and communications integration platform. This not only improved the public services provided by the city, but also helped to attract more investment to Yanbu. As Yanbu grew into a smart industrial city, the growth rate of inbound investments reached 16 percent, representing average annual revenue of over US\$100 million.

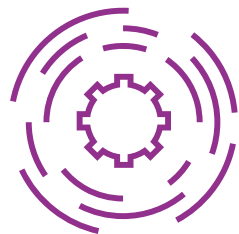




All things sensing



High-value connections



Data guiding the operation
of the physical world



Part 2

New Species

+Intelligence: Fostering new business species and
driving leapfrog development for industries

Industries Are Building +Intelligence Platforms to Achieve Leapfrog Development

The integration of the Internet of Things (IoT), cloud computing, artificial intelligence (AI), 5G, and other technologies combine to create business rules that use data flows to drive flows of people, things, energy, funds, and regulation. It also allows industries to create their own +Intelligence models and closed loops in data value creation. With high-speed connections, IoT, and AI-based cloud, +Intelligence platforms help industries achieve leapfrog development through intelligent analysis, decision-making, and assistance. These platforms will unleash enormous potential and value for industries through three paths: Cloud and AI becoming the underlying driving forces for progress; sensing and connectivity aggregating massive data into the cloud; and computing power and intelligence turning data resources into an intelligent source of large-scale innovation.



Cloud-based intelligence: Aggregating discrete data to unlock the value of intelligence

Cloud is the core element of +Intelligence platforms, as well as the basis of data, computing power, and algorithms on which intelligence depends. Given the underlying position of cloud in an intelligent world, companies lacking cloud capabilities may not survive even the eve of an intelligent world. On the other hand, companies that are able to use +Intelligence for accurate decision-making, efficient operations, and product customization and innovation will be able to tap into the opportunities of the intelligent world.

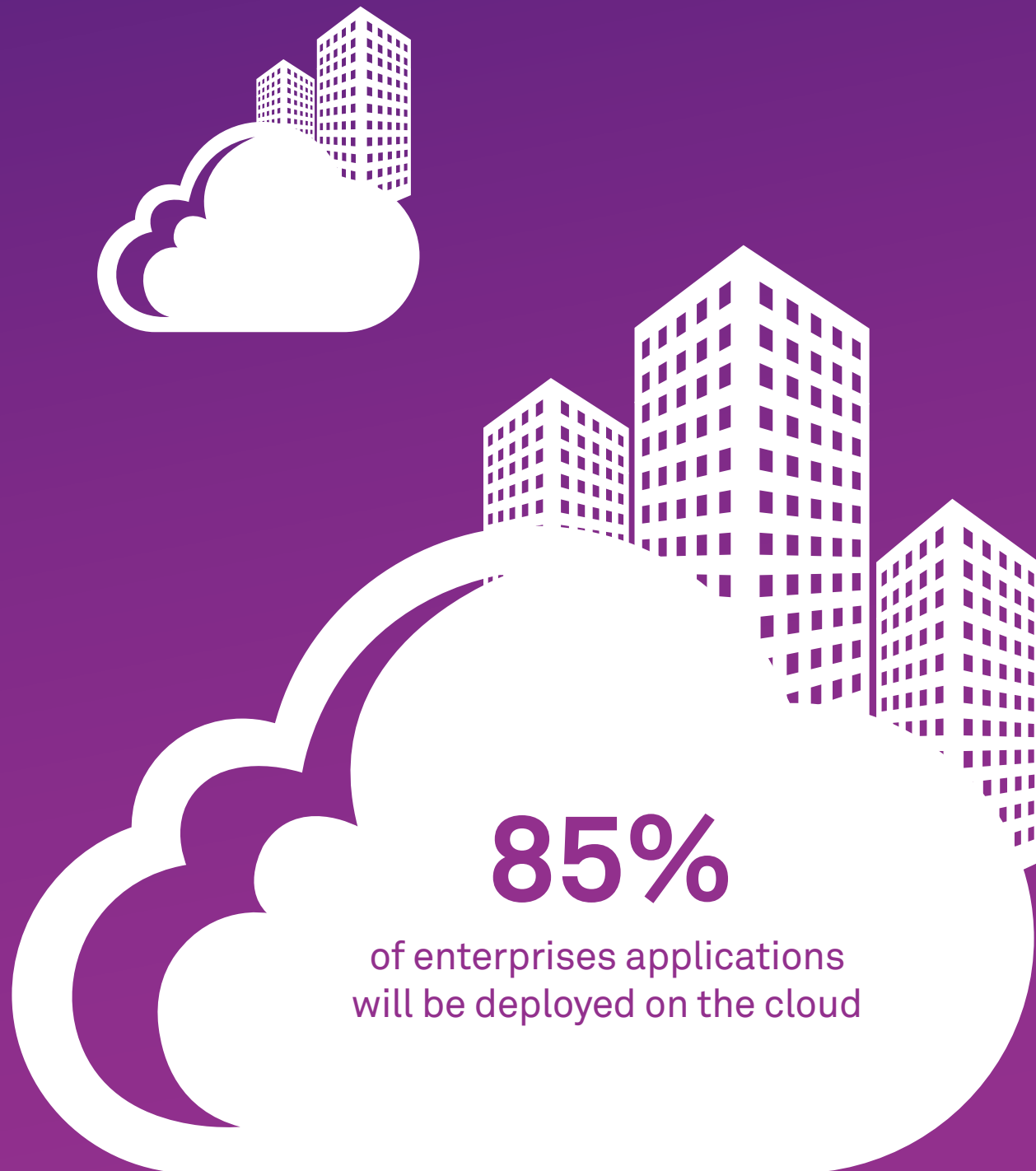
100%
of enterprises will connect to
cloud services



90% of computing load

92% of storage

within data centers will be done
in cloud data centers



Cloud is shifting from being an ICT support system to a decision-making system and a part of critical infrastructure. This means cloud services are key to the digital transformation of companies. Driven by digital transformation and customer needs for quick service deployment, elastic services, and intelligent management, by **2025** all companies are expected to connect to cloud services, and 85% of enterprise applications will be deployed on the cloud. At that point in time, cloud services will penetrate business operations just as the Internet does today. Cloud services allow companies to deploy applications with higher efficiency and lower costs, access stronger and more convenient platform services, and share resources more flexibly. For large companies offering a wide range of services, cloud will significantly increase operating efficiency, thus enabling more agile innovation and R&D, quicker response to market demand, more reasonable process optimization, and more efficient internal communication. Cloud services improve IT resource utilization, delivering greater benefits to society. The Clean Energy Emission Reduction (CLEER) tool estimates that if email, Excel, and customer management software are all deployed on the cloud, the energy consumption and emissions from computing can be cut by 87%.

Intelligent and automated operation & maintenance (O&M) is achieved through cloud computing system status, user base, service experience quality, and policy rules using a distributed architecture. It elevates cloud computing services to a new level by enabling flexible scaling of cloud computing systems, fault isolation, and troubleshooting. Cloud computing will see wider applications within data centers, quickly turning traditional data centers into cloud data centers across major economies. By 2025, 90% of computing load and 92% of storage within data centers will be done in cloud data centers. Cloud is set to become the key factor to drive the digital economy.



From chips to cloud: Ubiquitous intelligence

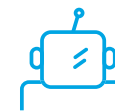
The coming intelligent world will be characterized by ubiquitous intelligence. This means that on top of devices that can sense, intelligence driven by data and computing power will penetrate the entire process of ICT data exchange across networks, devices, and the cloud. The result of this will be intelligence flows that benefit everyone. With the wider applications of smart chips with deep learning capabilities, smart devices have begun to significantly expand user capabilities in some fields. For example, the Huawei P20 combines AI and photography to support more than 500 scenarios where the device self-adjusts its own parameters. This is more than what the best photographer can do. This is just the beginning. By 2025 intelligence will be available through most of the 40 billion smartphones, wearables, and smart home devices in the world. These devices will be able to sense, analyze, and predict user needs at all times, and provide intelligent recommendations.

Edge computing continues to gain traction in IoT. Edge computing is an effective solution to a series of challenges such as lowering the response latency of devices, enlarging node scale, and increasing demand for data and transmission. IDC figures show that over 50% of data will need to be analyzed, processed, and stored on the edge of networks⁽⁸⁾. Edge computing will support the processing of different types of applications and data on the edge. This makes real-time and intelligent services possible, and enables other key intelligent services such as data aggregation and interoperability, security and privacy protection, as well as intelligent and efficient business decision-making. With a response rate at the millisecond or microsecond level, edge computing will ensure real-time delivery of services and solutions like intelligent video surveillance, smart home, smart transportation, and Smart City. Information about data traffic and control will flow back and forth between edge computing systems and data centers, balancing the computing load of the cloud, networks, and devices. This makes edge computing the ideal software and hardware platform for industry digitization.

Blockchain and quantum computing may disrupt the industry on the supply side and catalyze business innovation. Blockchain is a decentralized and distributed method for data storage and data transmission. It uses data blocks to minimize the dependence of networks on central servers, allowing untrusted parties to transact with one another. While the Internet transmits information, blockchain delivers value. As blockchain technology gains momentum, it will be applied in more sectors including finance, healthcare, logistics, and education, and a range of blockchain applications and solutions will gradually emerge. As fabrication technology moves toward the 10 nanometer scale, traditional computer architecture will approach the limits of Moore's law. Quantum computing is likely to boost computing power in the future, solving computing power challenges involving climate simulations, drug analysis, and molecular modelling. Quantum computing is set to become a new and powerful tool for technological innovation and breakthroughs, bringing flows of intelligence in ever faster.

Benefits from Intelligence for Industries: Enterprise Intelligence

All things sensing and all things connected will create an explosion in the amount of data, providing enormous quantities of raw materials for the intelligent world. As cloud and intelligent technologies gain in popularity, massive amounts of data will be converted to intelligent decision-making capabilities, and become the core driver of various industries. Industries can leverage their unique data resources and expertise to develop data sensing and invocation abilities, as well as appropriate intelligent algorithms. This will enable digital mapping of commercial strengths, and turn data from a production resource into an intelligent source of innovation.



+Intelligence shapes new business models, bringing digital to a whole new level

The integration of ICT and OT, as well as the application of intelligent technologies will be first used for asset and operation optimization. They will then gradually change the operating models of the manufacturing, energy, electricity, and other sectors, reduce costs, improve working environments, and drive digital transformation to make companies more competitive through digitization and intelligence. The convergence of cloud, computing centers,

high-speed broadband, big data, 5G, service robots, voice input, and smart devices will advance service digitization and intelligence further, resulting in diverse customized service delivery. Industries will move beyond asset optimization and operation innovation toward business model innovation. Over the next decade, technology breakthroughs and innovation will usher humanity into the Fourth Industrial Revolution and a new digital era.

Intelligent algorithms and big data analytics will become more important than ever as industries reshape their business models. Applying AI to core services and production processes is by far the best way to unlock the value of AI. With the wide adoption of AI technology that revolves around deep learning, machines will take over most information processing tasks, especially automatic processing of unstructured data. By **2025**, 86% of global companies will adopt AI, and data utilization will skyrocket to around 80%. One of the core tasks that companies will face is using machine learning to increase data asset utilization and maximize data value, so as to turn the +Intelligence revolution into reality.

The intelligence that companies need is not only AI technology, but Enterprise Intelligence that is more systematic and comprehensive. This means the ability to seamlessly integrate intelligence into companies'

operational and decision-making systems. By 2025, a large number of successful companies with Enterprise Intelligence as their core competency will emerge. With extensive experience in digital transformation, these companies will remain open and seek out shared success with ecosystem partners. They will integrate their digitization experience and technologies into enterprise application platforms, and Enterprise Intelligence into the key services of industries and companies, to boost operating efficiency and achieve new growth through business model innovation.

In the long term, the wide application of enhanced AI, neural computing, quantum computing, human-machine interaction, and other technologies will ultimately reshape business models. Sensing, connectivity, and intelligence are transforming the business world. +Intelligence will become an advanced method of production, changing how such processes are approached at a fundamental level. +Intelligence will also seamlessly integrate with various industries to take on a new business form. Companies are entering the +Intelligence era, one where data is the means of production, connectivity defines the relationship to production, and intelligent algorithms drive productivity.

86% of global companies will use AI
data utilization will skyrocket to around **80%**



Global data will increase from

8ZB in 2015 to

180ZB (180 billion TB) in 2025

95%

of data is currently
unstructured



180ZB
8ZB

2025
2015



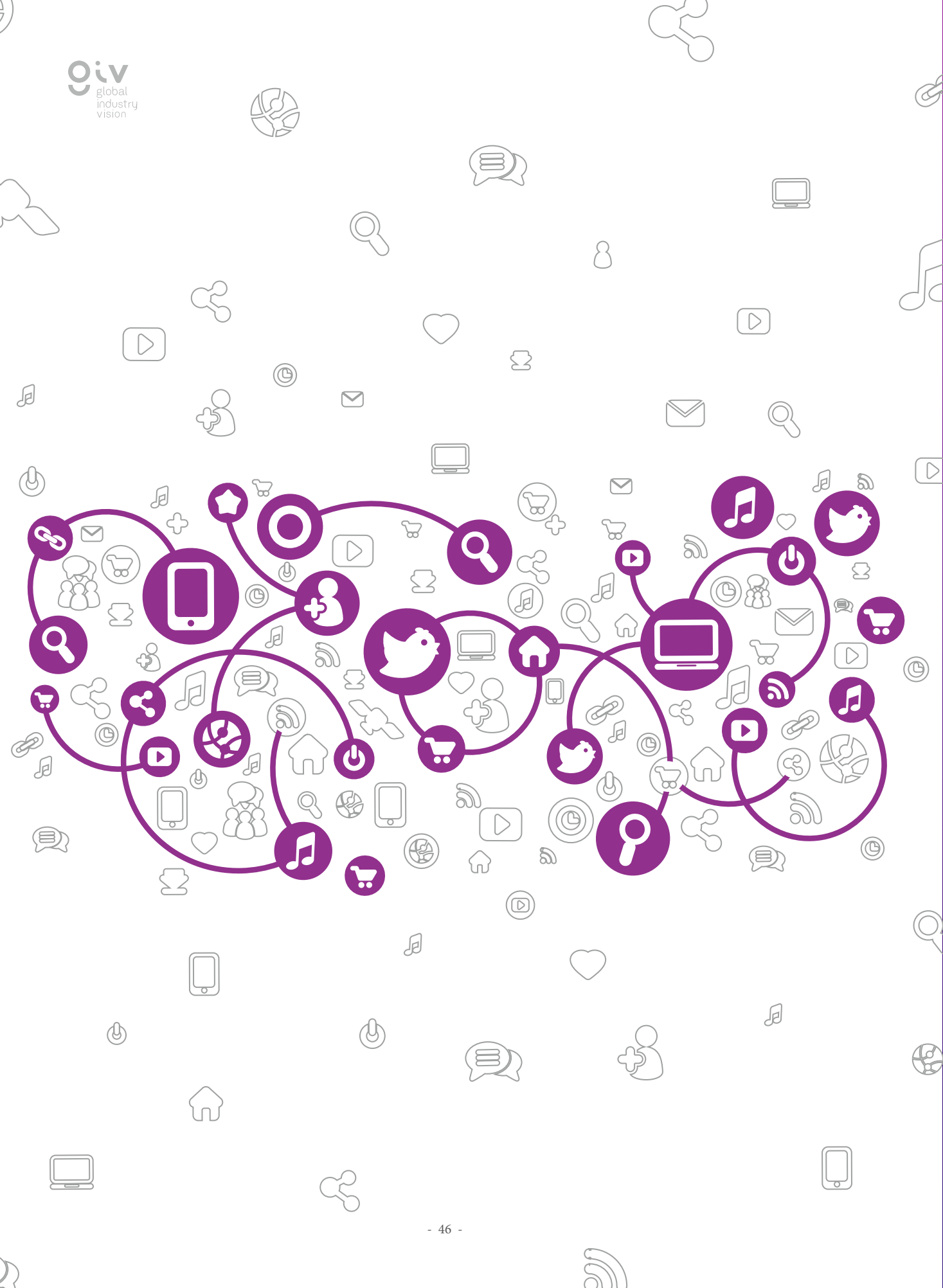
95%
88%

Data will become a core business asset

In the digital era, people are generating data everywhere at all times. The quantity of data is exploding. It is estimated that the amount of global data will increase from 8 ZB in 2015 to 180 ZB (or 180 billion TB) in 2025. About 90% of all data generated thus far has been generated and accumulated in the past 2–3 years⁽⁹⁾.

Only connected data creates value. The cloud migration of all companies will help traditional companies leverage their massive amounts of data that have

been accumulated over a long period of time, boosting computing power and facilitating breakthroughs, rather than being dragged down by the sheer volume of data to be processed. In the business domain, over 95% of data is currently unstructured, and most data is not being analyzed or used. As computing power increases and intelligent algorithms gain in popularity, this data will be converted to data assets that companies can analyze and use. In 2015, data utilization of global companies was only 10%, leaving the value of data assets untapped.



Part 3

New Economy

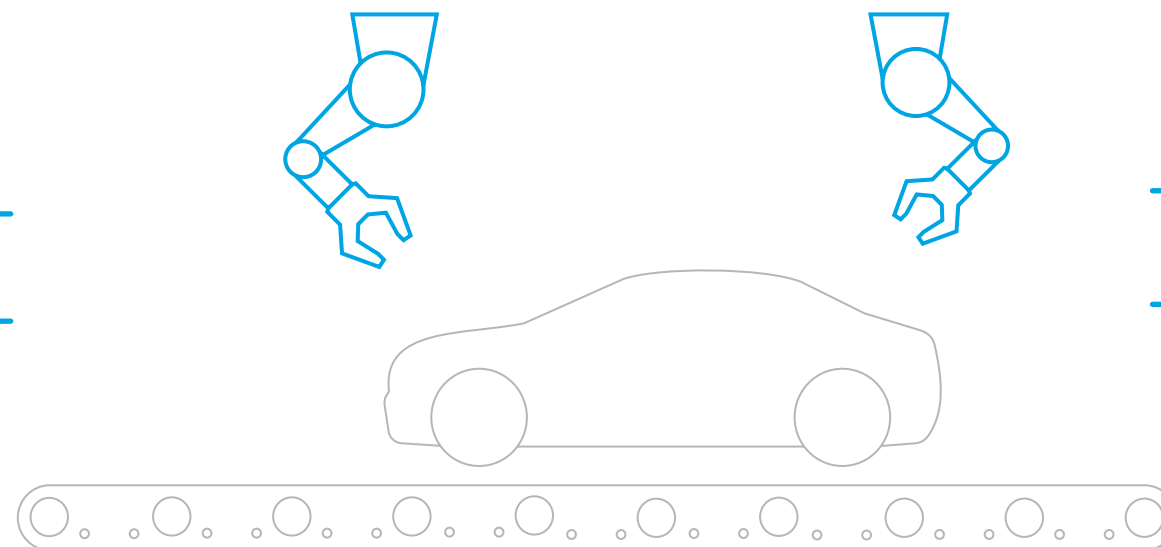
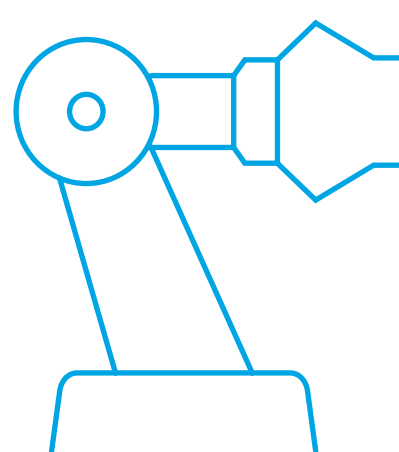
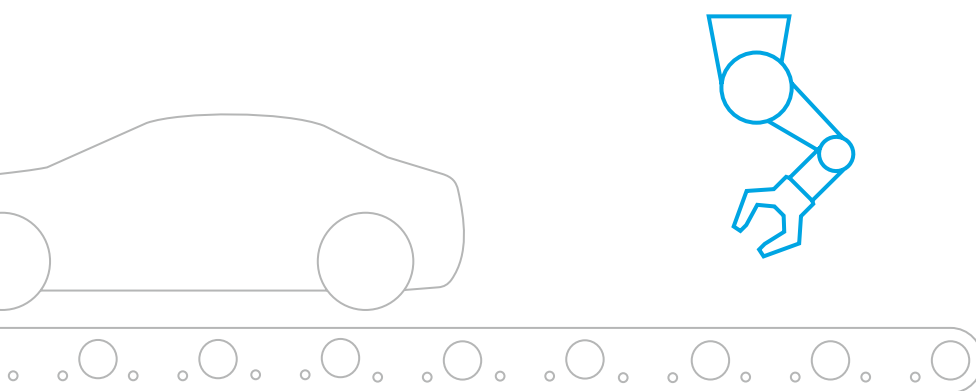
Mass innovation: Tapping into the opportunities of a digital economy valued at US\$23 trillion

+Intelligence Triggers Leapfrog Development of Industries, Reshaping Business and Social Landscapes

Driven by 5G, cloud, video, IoT, AI and other technologies, we can start to make out the basic form of the intelligent world. Data will be the new oil, sparking a new "black gold" rush. Every connection that can sense will be an oil well, pumping out data. This data will be channeled to the refineries of the cloud and AI. They will mine data, transmit data, and intelligently extract value. The intelligence that is refined from this will return to the user for use and consumption. This cycle of data will be the basic process that drives the intelligent world.

The ICT industry will provide +Intelligence platforms for the digital economy. This will be achieved by creating connections for all scenarios, building networks that can

sense, and popularize innovative intelligence. According to predictions made by Huawei and Oxford Economics in the Digital Spillover report for the digital economy in 2025, the long-term returns brought by ICT will be 6.7 times greater than in other industries, creating a digital economy worth US\$23 trillion. +Intelligence will shift from a concept exclusive to ICT, to a kind of infrastructure that benefits people, homes, industries, and urban development. Vast torrents of data will flow through every corner of society, spreading a culture of innovation as they go. Data torrents will reshape industries, give birth to new intelligent industries, and go beyond current paths to achieve leapfrog development.



The emergence of universal factories and the disappearance of assembly line thinking

Flexible production and smart supply chain made possible by the Industrial Internet

When you enter a factory of the future, you will see all sorts of APVs operating throughout the plant. Across the entire production floor, you will be hard-pressed to find a single person. It will mostly be a wide range of robots with different functions adjusting parameters on the production line and constantly waving around their mechanical arms as they move products further down the line. In the warehouse there will be automated packing. In laboratories there will be automated product monitoring and part repairs. The desktop of the back-end project management computer will be displaying real-time data in rapid succession collected from products, source materials, employees, and other sources. At the same time as this, research staff in the digital model laboratory will be wearing smart wearables as they carry out interactive testing in real-world scenarios...

This is a view of an intelligent factory made possible by the Industrial Internet, 5G, cloud, smart robots, and 3D printing technology. In this factory, physical equipment operates at the same time as massive amounts of data are transferred. It is a bridge between physical manufacturing and digital manufacturing, and is also the soil in which the entire production line and factory build their digital twins. According to GIV 2025, the quantity of connected industrial equipment will reach 26 billion by 2025.

Intelligent factories will be defined by two major characteristics:

- Interconnectivity and transparency of data across the lifecycle. Beginning when a sensor collects data from a product, all the way to the long tail when a customer places an order, every step of production and service will be interconnected in real time. KPI monitoring tools will be used to analyze public data in real-time, helping to optimize production, and balance the input-output ratio of source materials.
- Agile operations and forward optimization. Factories will be capable of receiving production commands at any time from the cloud, adjust production line sequence and processes, and arrange logistics inputs and outputs in real time, enabling decentralized and flexible manufacturing.

Amongst all of this nearly fully automated production equipment, employees will use intelligent devices, AR/VR interfaces, and natural language interfaces to engage in data monitoring, algorithm maintenance, data analytics, virtual testing, and troubleshooting. The factory itself will only be one stage in the intelligent manufacturing chain. Digital R&D, dynamic execution, synchronized planning, interconnected customers, intelligent supply, and other functionality will progress along with the number of connections and the ability to sense. Dispersed data will be connected and intelligently consolidated to streamline the entire supply chain and product development cycle. Actual production and delivery as well as synergies achieved in enterprise operations will all be driven by data.

Digital supply chain

Major advancements in machine learning and relationship analysis capabilities, plus an across-the-board improvement in machine vision, will allow intelligent foundational platforms to realize intelligent optimization of the logistics industry across the entire supply chain. It will become possible to fully leverage the value of data in automated decision-making and analysis at every stage of processes and increase opportunities for innovation. Intelligent goods identification and screening, intelligent route planning, intelligent packaging, autonomous intelligent shipping and intelligent inventory management based on forecasts of cost, product demand, and other elements will all help enterprises improve efficiency and reduce costs, creating unprecedented economic value.

Example from Huawei's global warehouse management

Through application of Huawei Cloud EI service, sorting and packing efficiency has been increased by 20%. By applying EI to realize intelligent packing, the optimal packing plan can be determined based on the nature of the goods. The shipping container can also be made completely visible in a 3D model, raising overall utilization rates by 6%. Logistics uses EI to plan routes, reducing exceptional expenses and costs by 30%.

Intelligent manufacturing: Software-defined universal factories

Upon the foundations laid by intelligent manufacturing, the full emergence of customized software-defined manufacturing models will occur in the intelligent world. The large scale of traditional manufacturing will be entirely eliminated. With the support of 5G, cloud intelligence, intelligent IoT, multifunctional robots, 3D printing, and other intelligent infrastructure, factory-grade digital twins will ultimately result in software-defined manufacturing. Universal factories will possess the ability to adjust product lines and manufacturing parameters in real time according to incoming manufacturing commands. This will mean that factories will become able to flexibly switch between product categories and even industries according to manufacturing requirements.

Traditional manufacturing is often restricted by overly complex product categories. When an innovative product is launched, a compromise often has to be struck between reducing manufacturing complexity and increasing economies of scale. A significant amount of time and expense is needed for this, and it is very difficult to truly balance market demand with supply. In the intelligent world, universal factories will satisfy a wide range of personalized production needs. Fixed scale production lines will cease to exist, and the entire ecosystem inside and outside the industry will offer the core competitiveness of customized innovation. This change will enable companies to respond to market demand through all-new business models.

Simultaneous production of multiple types of goods: One-click manufacturing in universal factories

- The operation, development, procurement, manufacturing, logistics, service, and other stages of running a factory will be completed through the control of a digital twin. Intelligent analysis and processing will be done on the cloud in real time for closed-loop data across the entire lifecycle. Workers will control processes through VR or MR, as if they were right there in front of the machines.
- Manufacturing will no longer be restricted by multiple individual items of equipment. Each stage of manufacturing will be completed by a multifunctional robot. Whether it is production and shipping or data analytics, everything will be done on the cloud, controlling robots to complete a wide range of tasks based on the requirements of business.
- Software will be used to create universal virtual production molds and open parameter adjustment and analysis. It won't just be sedans, SUVs, or mid-sized passenger vehicles that can be produced simultaneously using the same mold. Software-defined manufacturing will rely on the power of new materials, and make it possible to create motorcycles, automobiles, bicycles, and even mobile phones or pens all on the same mold. Adjustments to parameters like color, model, and specifications will be made in seconds. This will hail the emergence of universal manufacturing – the ability to produce multiple types of goods simultaneously using the same equipment.
- On the user end, "one-click intelligent manufacturing" will enable the entire process from order by a mobile user to automated production arrangements, finished product creation, and delivery into the hands of users. Business processes and production processes will be streamlined to allow for real-time data collection. Equipment and energy monitoring will be made easier and will become visualized. Traditional scaled production lines will cease to exist.

The emergence of a Digital Sky and the reduction of traffic jams

The logistics industry and traffic are the industry sectors that have most extensively applied intelligent transformation thus far. Delivery personnel, order allocation, quantity of goods, and other elements are no longer an issue thanks to the enablement of +Intelligence. Every logistics company seeks out competitive breakthroughs through technical innovation and personalized services.

Manual logistics will completely cease to exist, and the core competitiveness of the logistics industry will turn to innovative services

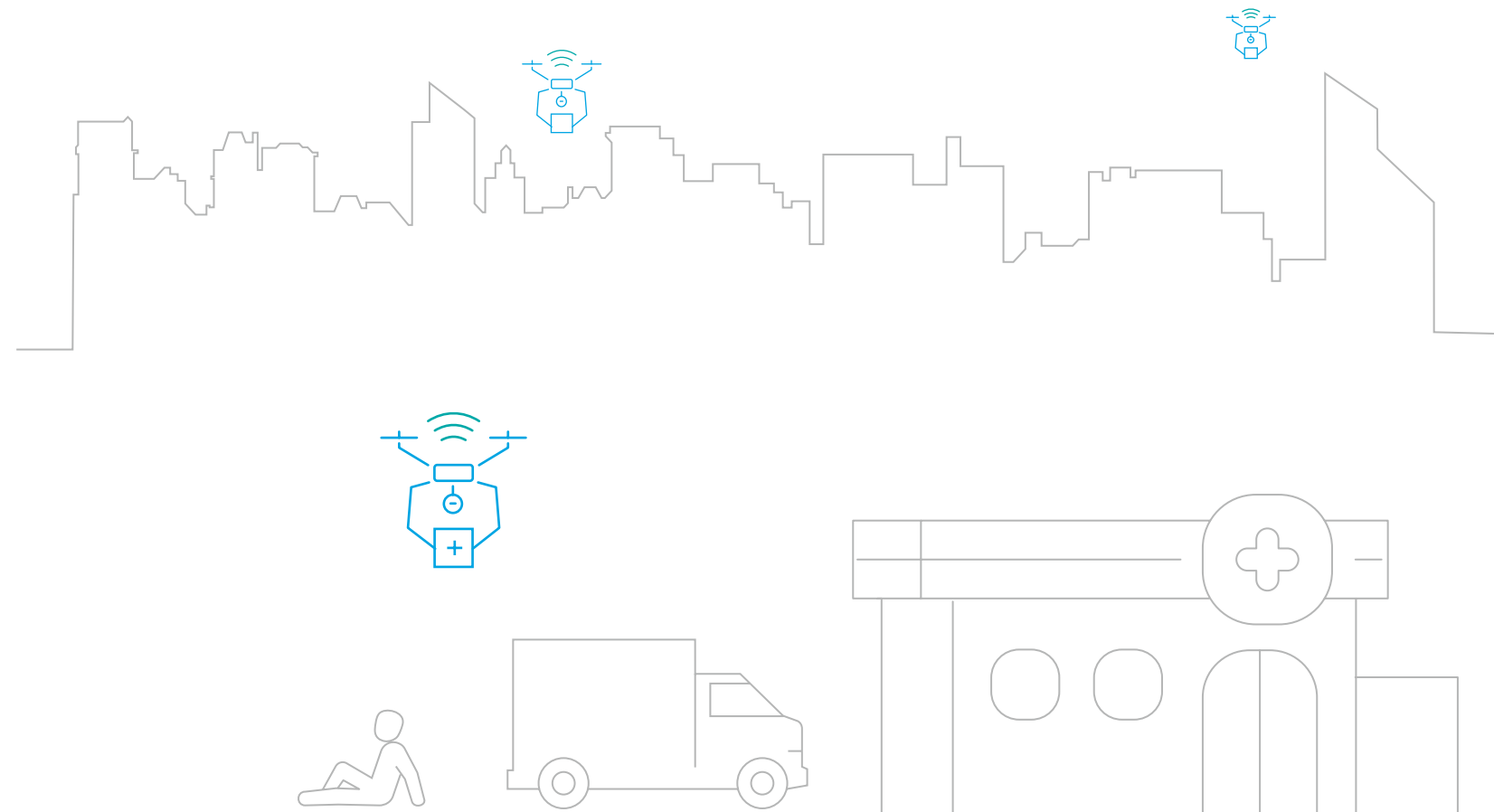
On a grassy lawn in the central Chinese city of Xi'an is an autonomous delivery transfer station covering an area of 14.4 square meters and rising 3.6 meters in height. Drones fly in from afar, land on the delivery transfer station roof, and automatically unload their goods. After the goods are distributed within the transfer station, delivery robots are automatically loaded, and leave the station to deliver the goods to their destinations. Today they are delivering fresh flowers from Yunnan Province. The majority of orders are for Valentine's Day. The transfer station connects the

back-end drones and the front-end delivery robots as well as managing app orders. It integrates intelligent supply chain, intelligent container shipping, and many other smart industry foundations to act as a core hub for completely autonomous logistics.

After leaving the transfer station, the delivery robots travel along the city sidewalks. From packages to hamburgers, robots traveling along sidewalks are now in operation delivering things to people in multiple cities. A six-wheeled robot developed by one American company can travel at speeds of up to 4 miles per hour, and carry goods weighing up to 10 kg. They will use 5G technology to find routes, and once the robot arrives at its destination, the customer will use an app to open the lid

of the robot and collect the delivery. When these robots begin to assist enterprises to provide courier services, delivery times within the same city will drop from hours down to minutes. The cost of deliveries will also drop by many fold from current levels.

There is now a lot of hype regarding drone delivery. In addition to using autonomous vehicles for shipping processes, one large warehousing and merchandising supermarket is using a central control system to deploy robots and direct routes. On the sales floor, these robots help customers find the products they want and collect goods for delivery. This achieves a significant reduction in wait time compared to human labor.



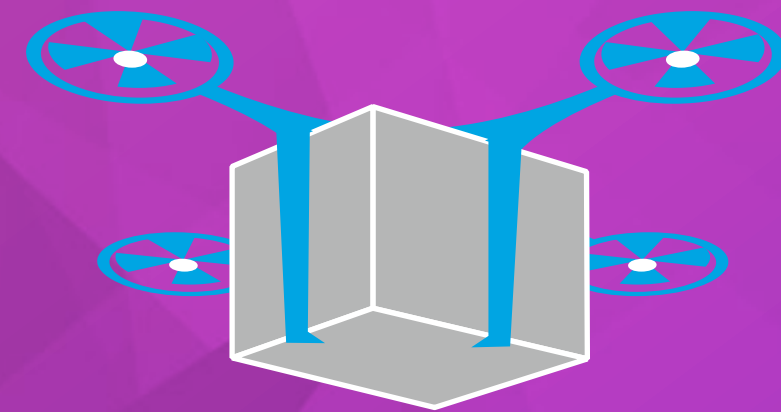
Digital Sky and autonomous passenger aircraft: The space through which people travel will expand, alleviating pressure on urban transportation grids

With the extensive integration of high-speed wireless technology and the drone industry, expansion of low-altitude network coverage, greater industry standardization, and increasingly efficient air space usage, innovative applications of new technology will emerge. These scenarios will involve connected drones applied in transportation, surveillance, emergency rescue, and other urban management functions, which will no longer be restricted to point-to-point communications between the drones and a remote control. Instead, business opportunities will be sought between drones and drones, and even between drones and people, unleashing enormous economic value.

The space in which humans operate will expand into the Digital Sky: The sky is quickly becoming digitized, driven by development of the drone industry and the application of 5G connection technology. Forecasts indicate that the miniature drone market will grow rapidly, reaching US\$33.9 billion in 2026 as compared to the US\$5.3 billion in 2016. These numbers encompass revenue from

software, hardware, services, and applications. And yet this is only the first small step on the path to realizing the Digital Sky. Due to restrictions in base station signal coverage, with the exception of civilian aircraft (over 6,000 meters) and special drone services below 120 meters, utilization rates are quite low for general aviation airspace (3,000–5,000 meters) and low-altitude airspace below 1,000 meters.

Huawei's Wireless X Labs Digital Sky Initiative is striving to expand network coverage in low-altitude airspace. The aim is to provide a leading testing environment for innovative drone applications, and even enable drone-based deliveries and shared taxi planes. Huawei's Digital Sky Initiative will also validate new service standards for remote flight control and massive data traffic transmission, enabling a digitized low-altitude industrial economy. At the same time, these solutions will create a rule-based intelligent airspace network for cities based on data and information, adding multiple interactive interfaces for people, machines, and goods. This will alleviate space restrictions, parking difficulties, and traffic congestion.



The miniature drone market will grow from

US\$ **5.3 billion** in 2016 to

US\$ **33.9 billion** in 2026

Intelligent urban planning: Shared taxi planes allow parking lots on the ground to be converted into parks and greenspace

Cities are the hubs of modern life, and also the centers of gravity for cars. An enormous amount of space in cities is given to roads and parking lots. Cities that are built around the use of cars are seeing major problems with congestion as they try to promote public transit and city expansion. City residents have the sense that city spaces are becoming more crowded and difficult to navigate. One professor from the University of California at Los Angeles has joked: "The US is a great place, if you're a car." This is a sentiment shared by residents in many cities around the world.

Autonomous passenger aircraft will act as the infrastructure to support the business model of shared taxi planes. They will take off like helicopters, fly like airplanes, and will not require a runway or special landing pad. The "vertical takeoff and landing" will resemble the model used by bicycle sharing. You could take off from your roof or backyard. Whether the user is commuting, going for a trip, going shopping, or just out for a work lunch, the aircraft will be available whenever

and wherever needed. This will address mobility issues in the "last mile" faced by the disabled and elderly that current modes of transportation cannot address. The space for flight in the air is a shared resource, with routes arranged intelligently based on data.

This will mean that the space on the ground will be freed up for other uses, and land formerly used for automobiles will be re-zoned for a healthier lifestyle, more greenspaces, and better environment. By eliminating parking lots and using one-way ring roads, half of road area will be reduced. This will mean more green space and more opportunities for investment in greenery and water resource conservation.

The emergence of interaction through augmented reality and the decline of one-way communication

VR+ social media platforms: Creating next-generation application interfaces

Virtual reality and interactive media will use Cloud VR to move a massive amount of rendering to the cloud. Light VR devices, high-quality video outputs, and other technologies will provide information to individuals, homes, and industries that change along with the scenario, and give people the experience of being in the moment through an interactive environment.

Remote meetings: More vivid and interactive, improving the quality and efficiency of communication

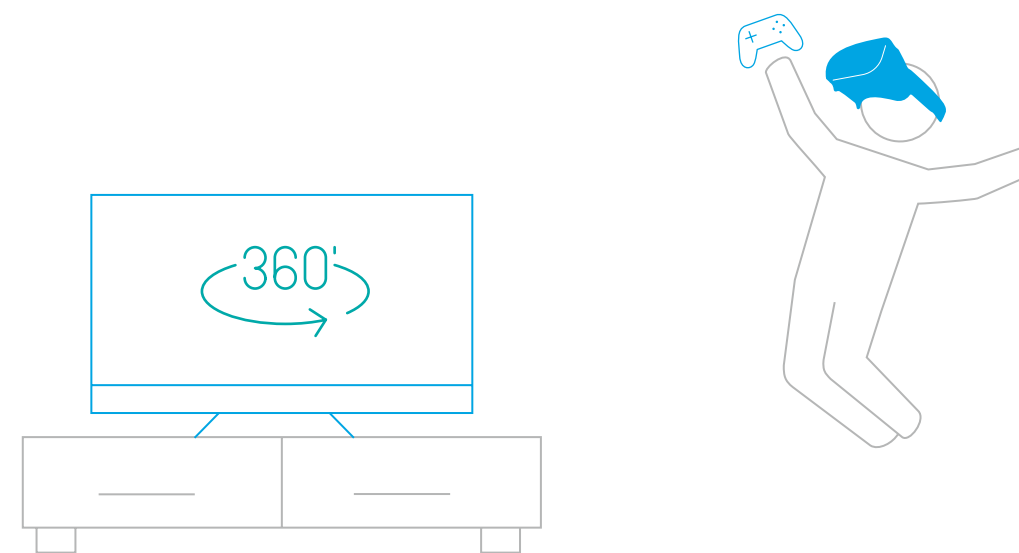
Employees can hold multi-party video meetings anywhere they happen to be, including parks, basketball arenas, or at a relative's home. During the meeting, participants will enter a virtual meeting room populated by true-to-life virtual images of the other attendees. It will appear as if you are sitting in the same room discussing a topic, making meetings more engaging and vivid, and improving the quality and efficiency of communication. Users of this technology will also be able to browse the web, draw 3D diagrams, share their screens, and discuss in an extremely convenient manner.



In addition to remote meetings, users will also be able to create their own virtual avatars similar to cosplay. It will be possible to enter the virtual spaces created by oneself or others, including environments like bars, game rooms, KTV, outdoor trips, and so on. In these virtual spaces, people will meet with friends and strangers from around the world. As VR experiences improve, social interaction will take on a whole new level. Numerous VR application aggregation platforms are likely to become social media interfaces, and VR social media will be an important focus for industry development.

VR+ online programs: Folk art driven by digital innovation will spur new opportunities for the tourism industry

Tourism resources and investment demand in the physical world will be efficiently balanced through the use of data. Intelligent industry innovation will unleash potential for more intelligent economic value. According to a white paper released by Huawei on Cloud VR, in addition to the tourism industry, by **2025** VR+ retail will enable the retail software sales market to expand to US\$1.5 billion. VR+ real estate applications will generate revenue of US\$750 million.



+Intelligence drives digital innovation in Kashgar handmade ceramics, accelerating cash profits in the digital economy of tourism

The techniques used in handmade ceramic production in Kashgar, originating from the Uyghur minority group in China, have long been recognized as a cultural heritage of the Xinjiang Uyghur Autonomous Region. However, market forces have meant that the older generation of ceramic artisans have not passed this art form down to younger generations, who are uninterested in learning this craft. The art of hand-molding ceramics has gradually faded from people's everyday lives.

However, a recent HD arts and entertainment video and VR interactive program has attracted attention to this nearly-forgotten art. High-quality video showcased every step of the ceramic production process in exquisite detail: Images of the pottery clay and the artisan's hands carefully shaping the ceramics were presented in captivating HD clarity, using reliable high-speed

networks to transmit these details to audiences around the world. Audiences can wear VR headsets to view the scene in 360 degrees, allowing anyone around the world to get an up-close experience of this art. They can even experience the heat emanating from the ceramic kilns used to bake the ceramics. If one were living in Beijing and wanted to go to study this art in Xinjiang, the cost could rise into over CNY10,000. But through large bandwidth connections, high-quality video, and VR technology, the same experience can be obtained for less than CNY100.

Local ceramic workshops are now a hugely popular tourist destination. The ICT industry's development has made it easier for people to learn about Kashgar's ceramic arts, but more importantly, it has attracted many large enterprises to begin "short, adaptable, and fast" projects, investing over CNY880 million in the three regions of Kashgar, Hetian, and Kizilsu Kyrgyz. This is accelerating trials in VR+ tourism to seek commercial success in the digital economy.

Spread of smart energy solutions and the end of manual meter reading

A fully connected smart power grid will make manual meter reading unnecessary, unleashing new productive power

Based on the development of IoT, edge computing and cloud, as well as big data smart analytics and other technologies, smart power grids will gain the ability to automatically detect risks and troubleshoot without human intervention. Intelligent power grid assessment robots will be deployed to forecast power consumption and supply needs of various regions in different time segments, enabling a better, more balanced allocation of energy supply. With the progress in blockchain technology, power grids will be able to meet the goals of advance planning, precise delivery from power generation to supply and consumption, and less downtime.

When all things and people are connected over a single intelligent and simplified network, it will become possible to centrally assess consumption trends, and provide guidance to cities on upgrades and improvements. This will be a result of power information sharing based on cloud resources, the connection and integration of IoT and individual networks, and the real-time connection of data from urban core power grids and individual devices. These developments will drive more efficient usage of power and more convenient ways to pay for power consumption. The role of the meter reader will vanish, with the focus of work turning toward improving city energy utilization.

From fully connected power grids to intelligent power grids: Facing the structural challenges of global energy

Traditional power systems are arranged in a single chain process from power generation to transmission, transformation, distribution, and then usage. Each stage has its specific function and role, and everything is clearly delineated. Intelligent power grids are very different. They are more like a ring whose front and end are connected. The functions of every stage are also different. For example, power generation could occur at multiple stages. In addition to the power grid itself, such networks are ICT-based, and carry information flows as well as business flows. They are integrated with energy grids.

We are seeing the wide adoption of new energy and distributed energy, flexible power grids characterized by a two-way relationship with consumers, as well as the intensive application of open energy trading platforms and smart devices. These changes are helping global power grids to evolve to intelligent energy information sharing networks. With open and equitable information and energy architectures, connected energy networks can be built to transport and balance out energy supply according to needs. GIV 2025 predicts that by 2025, the ICT industry globally will have helped save over US\$1 trillion in power consumption, enough energy to supply residents of New York City with power for 10 years. The global energy conservation and emissions reductions made possible through ICT-enabled industry digitization will grow by about 11-fold.

National power grid companies: Building an Internet of Energy for the future

In the coming 10 years, the Internet of Energy is going to be a major direction for development. This mainly means researching new directions of development for energy grids through Internet-based thinking, making power grids more open, equitable, shared, and interactive just like the Internet. The Internet encompasses LANs, WANs, and backbone networks. In the Internet of Energy, there are also three corresponding elements. The first is the Internet of Home Energy, or the emerging concept of a Home Energy Management System (HEMS). Such systems provide information about home appliance energy consumption, and help ensure households maximize energy efficiency from water, electricity, gas, and heat through effective monitoring. The second element is the Internet of City Energy, making it possible to deploy multiple types of energy within cities and reduce energy consumption and emissions in the most efficient way possible. The third element is the Internet of Global Energy, enabling environmentally friendly interconnection of energy grids across the world. Such connectivity requires the support of advanced ICT technology.



An Open, Inclusive, and Sustainable ICT Industry Ecosystem Inspires Mass Innovation

Behind the US\$23 trillion digital economy made possible by the intelligent world is the ICT industry ecosystem with all things sensing, all things connected, and all things intelligent. This is the foundation upon which to tap into enormous new opportunities. There will be opportunities for everyone to flourish in the open, inclusive, and sustainable ICT ecosystem. Startups and large companies alike will prosper and find ways to tap into the opportunities of the intelligent world.

1. The ICT industry ecosystem is undergoing unprecedented changes of its own as the intelligent world emerges. The rapid evolution from digital to intelligent is resulting in greater complexity in the requirements of every industry system. There are more connections and interactions between companies and between industries. Companies are facing complete upheavals in technology and architecture, and there is an urgent need for innovation in management models and business models. The majority of traditional ecosystems are linear in nature. Suppliers, producers, vendors, and customers form a complete ecosystem chain. But the ICT ecosystem is trending toward amalgamation of different demands of all industries. The capabilities of individual players are trending toward more comprehensive development, and the role of the ecosystem is expanding in scope, changing and flexibly adjusting according to the business needs. Business models are trending toward boundary-free innovation, and the boundaries of cooperation are becoming increasingly blurred.

2. Everyone in society will be at the same starting line, in an all-new era where value creation generates inclusive opportunities for growth. Data and Enterprise Intelligence will become the breakthrough points for all industries to benefit from the intelligent world. As AI matures, advantages from population size will gradually be eclipsed by the advantages of possessing and using data. AI algorithms will see rapid advancement. Major development will be seen in this domain when combined with massive quantities of data inputs. As Enterprise Intelligence (which will increasingly rely on deep learning for decision-making) integrates more deeply with multiple use cases, opportunities for innovation and all-new spaces for value creation will open up in the transformation of intelligent, automated industry systems. It is estimated that by 2030, AI will be generating industrial value of CNY10 trillion in China. Large companies and startups alike will enjoy development in the inclusive ICT ecosystem.



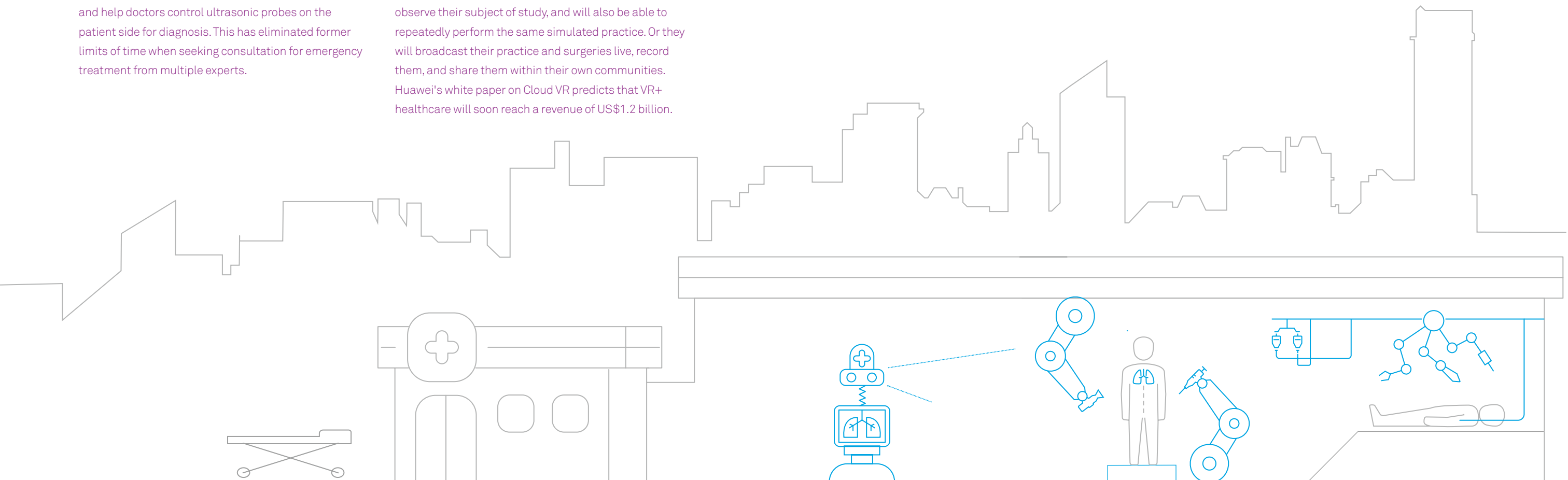
*All numbers are in US Dollars

Sources : EU KLEMS, Oxford Economics and Huawei

MGI: Wireless remote ultrasonic robots

Remote wireless healthcare is gradually entering the mainstream. This includes wireless transfusions, remote real-time consultations and diagnosis, remote ultrasonic exams, and even remote surgeries and operations. But if these applications are to be truly used to treat patients, they must be fully wireless. To this end, Huawei X Labs has joined with MGI to collaborate in the domain of telemedicine. They are using 5G network technologies to provide transmission bandwidths of dozens of megabytes per second for the real-time transmission of audio, video, and ultrasonic images, and help doctors control ultrasonic probes on the patient side for diagnosis. This has eliminated former limits of time when seeking consultation for emergency treatment from multiple experts.

Wireless technologies are going to unleash the innovative power of VR, and bring unlimited potential to the healthcare industry. On the diagnosis and treatment side, imagine a time when the large bandwidth and low latency of 5G networks allows data about the vital signs of an asthma patient to be transmitted in milliseconds to a doctor's VR and touch device, giving the patient those crucial few extra minutes to be treated effectively. On the education side, autopsy material was once very hard to come by. However, when using cloud-based VR education and surgery simulations, students will be able to clearly observe their subject of study, and will also be able to repeatedly perform the same simulated practice. Or they will broadcast their practice and surgeries live, record them, and share them within their own communities. Huawei's white paper on Cloud VR predicts that VR+ healthcare will soon reach a revenue of US\$1.2 billion.



Action recommendations: Seizing Industry Trends and Seeking out New Roads of Growth in the Industry Blueprint of the Intelligent World

GIV 2025 aims to trace out the industry blueprint of the intelligent world for industries, government, industry leaders, and ICT players based on quantitative data and qualitative descriptions. This is with the aim of uncovering the underlying logic and steps that the intelligent world will take as it develops, and to illuminate the way forward for industries and the diverse ICT industry.

Fostering "stamina" – three key steps to tapping into the opportunities of the intelligent world

Focus on the foundation of intelligent connections and ubiquitous sensing, making ICT infrastructure investment a top-level strategy:

The foundation on which data value can be unleashed is to make connections better, faster, and broader and enable digital sensing to penetrate every corner of society. Increased investment and application of ICT infrastructure is needed.

Combine +Intelligence with industry scenario needs:

Combine ICT industry development with specific strategic demand and strengths in industries, seeking out the most advantageous ICT investments to leverage. Gain an understanding of the value of existing data assets, and know how to use existing data, along with +Intelligence, to innovate in business. Move rapidly to maximize the value of +Intelligence in every stage of business, production, operations, services, and talent development.

Seek out paths of innovation to break through boundaries in intelligent data flows:

Amidst intelligent data where information finds people, and information finds things, boldly assess, trial, and deploy new models of business cooperation, industry enablement platforms, and ecosystem strategies. Seek out cross-industry and even fully-integrated business partnerships that go beyond the barriers in space, capabilities, and resources in the ICT ecosystem across all industries, looking to the unlimited opportunities for innovation that this space presents. Amidst the integration of cutting-edge intelligent technologies, explore all-new opportunities for innovation in business.

Recommendations:

Industry leaders, CXOs: Seize opportunities to overtake on the inside lane and profit from data. Formulate development strategies centered on ICT platforms.

Data will be the core resource of the intelligent world. A determining factor of enterprise competitiveness will be the acquisition and application of data. Enterprises need to do more than just mine data. They also need to convert data into Enterprises Intelligence.

The key to building enterprise data capabilities is the ability to produce, clean, and store data. It is about turning static data into usable mobile data, and applying it to support decision-making. With the support of a powerful ICT technical platform, all of this data will become part of the value cycle. Enterprises that overtake the competition on the inside lane will no longer just own and sell data.

ICT industry: Clearly identify the path of industry development, align technology with customer needs, and benefit from the fertile soil provided by intelligent production and services.

As the intelligent world approaches, investment in ICT technology platforms could exceed the amounts invested in energy, public utilities, and living environments. The ICT industry will support more effective, friendlier, and more experience-focused industry development. All of this will be inseparable from the ICT ecosystem.

Every participant in the ecosystem must cultivate their own capabilities that are aligned with technology, service, and resources. Roles in the ecosystem will be more than being simple suppliers of a given project. Participants in the ecosystem need to be trusted cross-domain partners. The roles of customer, vendor, and partner will no longer be so fixed and static, and will change and adapt according to business needs. Business models are merging, and core business capabilities will rest in technical innovation and demand.

Industry policymakers/ industry organizations: Standardize industry ecosystem development, gain insights into important technical applications, and determine the right direction for industry investment.

The road to tapping into the opportunities of the intelligent world is one that is open and very competitive. Industries that get to the starting line early will gain a first-mover advantage. However, getting to the point of being ready for industry upgrading is no small feat, and requires long-term hard work. Platforms characterized by openness and shared success will drive technical integration and rapid deployment. Enterprises, cities, and economies that pursue digital transformation from an industry ecosystem perspective will be the ultimate winners in the intelligent world.

GIV 2025

Huawei provides the direction for industries aiming to ramp up the pace of development, as well as the foundations that will enable the diverse ICT industry ecosystem to truly transition into the intelligent world.



Methodology

High-quality quantitative forecasting relies on a suitable methodology selected based on the historical data of each metric. GIV 2025 utilizes an approach that combines trend extrapolation and time series forecasting. A regression model based on historical data and business development patterns is the first choice in analysis. If the forecast results obtained from a simple linear regression model are not ideal, then the use of a multiple linear regression model or a time series forecast method is considered.

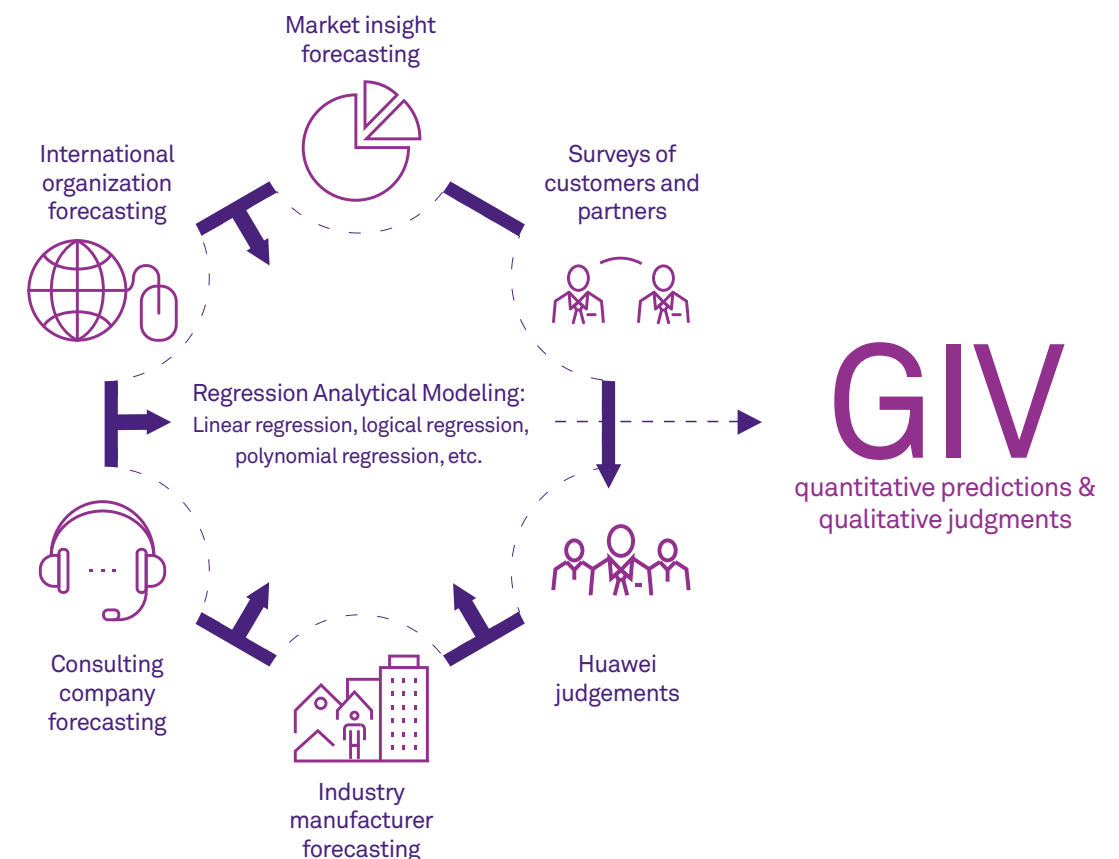
1. Acquisition of historical data of metrics

The foundational research data used for the forecasting in GIV 2025 was sourced from Huawei's own research results and from the statistical reports of various industry players. All data has been rigorously cross-validated. Of this data, the core metrics are based on Huawei's own industry statistics. These statistics encompass data that was lawfully acquired by Huawei during its business operations, surveys, and consulting services targeting telecom operators, enterprises, and consumers across more than 170 countries and regions. The data spans the cloud, networks, and devices, and covers the entire communications technology process from information processing, storage, and transmission to presentation. GIV 2025 also incorporated external data from the following sources:

Statistics from international organizations, including GSMA, ITU, IEA, and World Bank

Statistics from consulting companies, including Gartner, IDC, Ovum, McKinsey, and Goldman Sachs

Statistics from industry vendors, including Cisco, Ericsson, Microsoft, IBM, and Oracle



2. Analysis of historical data and initial selection of simple linear regression models

Statistical analysis was first conducted on the historical data for the metrics, observing time series trend characteristics of the data using scatter plots or line graphs. Simple linear regression algorithms were used for modeling, including linear regression, exponential

regression, polynomial regression, logical regression, Bass diffusion model, Gompertz model, and Pearl growth curve. The goodness of fit of the various models was validated and compared, with several models chosen as alternatives whose coefficient of determination (R^2) was close to 1.

3. Selection and optimization of alternative simple linear regression models

In cases where historical data was insufficient, there were generally multiple alternative models whose coefficient of determination was relatively ideal. In order to prevent the curve from being overly well-fitted, which would result in a reduction in confidence in the forecast, it was necessary to incorporate qualitative judgments about business development patterns, such as whether there would be steady growth, accelerating growth, slowing growth, or even the emergence of an inflection point. Business domain experts chose appropriate forecasting models based on insights into the research, as well as surveys of customers and partners. They also compared and reviewed

the trend forecast curves of various alternative models with the assumption that all macro trends remained constant.

If the alternative models' trend forecast results were not ideal, then another option was to remove some outlying noise in the data and rebuild the model. If there was plenty of historical data, and there was an apparent periodic trend, then a periodic fit was attempted, overlooking older outlier data, and only using recent data to rebuild a simple linear regression model.

4. Development and optimization of a multiple linear regression model

If a simple linear regression fit is much lower than the normal range and the fit of a periodic model is also ineffective, then new variables are needed to build a multiple linear regression model. Based on decisions by business domain experts, explanatory variables relating to the target variable were chosen along with their historical values. Then algorithms including multiple linear regression, log-linear regression, and polynomial

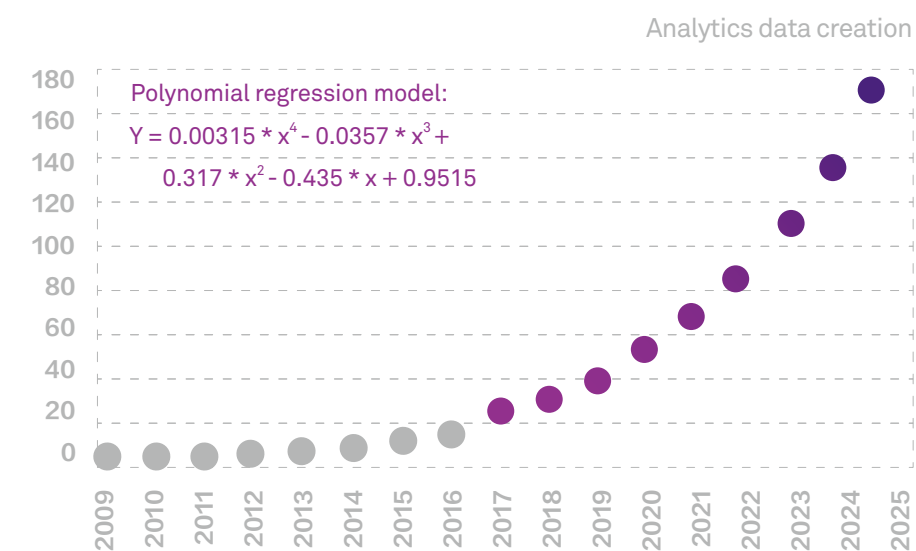
regression were used. Principal Component Analysis and other methods were used to rule out multicollinearity. Linear curve fit was done using SPSS software to build a multiple linear regression model. The model's fit and significance were then validated, with this process continuing until the new multiple linear regression model fit reached the ideal level.

5. General forecasts incorporating the time series analysis model

If the historical data of explanatory variables that were needed to build a mathematical model were lacking, then it is impossible to build a regression model. In such cases, we considered the use of exponential smoothing, Autoregressive Integrated Moving Average (ARIMA) model, and other time series analysis models for forecasting. Then, we incorporated business expert trend determinations and the above mentioned regression model method to make general quantitative predictions.

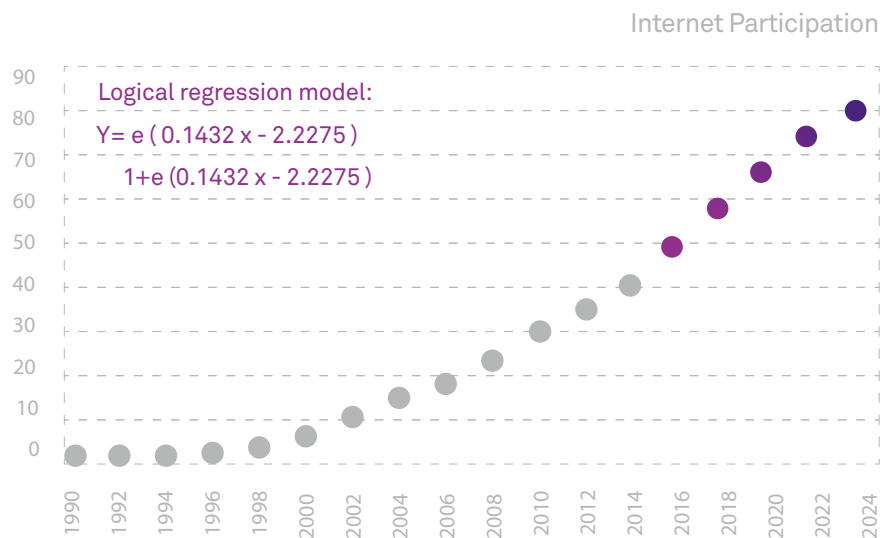
6. Examples of forecasting

Example 1: When forecasting global data volume, we used a polynomial regression model based on the historical data from institutions like IDC and Huawei, and also by incorporating the judgments of business experts at Huawei who specialize in big data. (Independent variable x being year series, $R^2 = 0.9962$). The following figure shows this model:



Appendix: Definitions of the Metrics Used in GIV 2025

Example 2: When forecasting global Internet penetration, we built a logical regression model based on the historical data from institutions like ITU and Huawei, and also by incorporating the judgments of business experts at Huawei specializing in related fields. We carried out periodic fitting to build the model, based on historical data that was generated after 2002. (Independent variable x being year series, R2 = 0.9981). The following figure shows this model:



7.The art of mathematical modeling for predictions

Quantitative forecasting is both a science and an art. It demands rigorous mathematical modeling and professional knowledge. At the same time, past experience and expert judgment can help ensure the efficiency of the modeling. The subjective element can never be fully eliminated. It is no doubt that quantitative forecast – which is more objective – is more valuable for industry insight and strategic planning. The value that GIV 2025 aims to deliver is precisely that: giving a forward-looking, quantifiable, and accurate picture of industry trends.

Macro Vision	Metric	Description
More devices that sense	Number of personal smart devices globally	All types of smart devices used by individuals (including the following)
	/Number of smartphones	Number of smartphones globally
	/Smart home devices	Devices that support a smart home using ICT, sensing, control, audio, video, and other technologies
	/Number of wearables	Smart devices that can be worn on the body
	/Number of tablets and PCs	Including tablets, laptops, and other personal computers
Transformation in how things sense	Number of individual VR/AR users	Number of individual users of VR/AR-like smart headgear
More connections	Number of connections around the world	Total number of devices with Internet connectivity around the world
	Number of people using mobile communications	Number of people around the world using cellular mobile communication networks
	Number of people connected to the Internet	Number of people around the world with any type of access to the Internet
	Number of individual connections in emerging nations	Number of individual connections (excluding M2M) in the 147 emerging nations and regions
	Penetration rate of home broadband globally	Percentage of the number of home broadband users with fixed network access or WT Tx access in the total number of global homes
Faster connections	Penetration rate of gigabit home broadband	Percentage of the number of home broadband users with network access speeds exceeding 1 Gbit/s in the total number of global homes
	Coverage rate of gigabit mobile communications networks	Percentage of total population with access to gigabit mobile communications networks (including 4.5G and 5G)
More data traffic	Average data usage per user per day	Communications data usage on average per user per day, including cellular mobile networks and fixed networks
	/Average mobile network data usage per user per day	Average data usage on cellular mobile communications networks per user per day
	Percentage of video in total data usage	Percentage of individual communications data usage accounted for by video, excluding industry video
	Average mobile video DOU per person	Average mobile communications video data usage of Internet users per person per month, excluding industry video
Cloud-based sharing	Cloud service utilization rate amongst enterprises	Percentage of enterprises using cloud services (IaaS/PaaS/SaaS)
	Percentage of enterprise applications on the cloud	Percentage of enterprise applications that have been deployed on the cloud
	Percentage of computing on cloud data centers	Percentage of data center computing load carried by cloud computing across global data centers
	Percentage of storage on cloud data centers	Percentage of all data center storage capacity held on cloud storage at data centers globally
Green connections	Carbon footprint per connection in the ICT industry	Amount of carbon emissions per connection across the global ICT industry every year
	Global power saving brought by the ICT industry	Global power savings in all industries generated by ICT
	Global emission reduction brought by the ICT industry	Global carbon emission reductions in all industries generated by ICT
Monetizing data	Annual increase in data volume globally	Annual volume of data generated and stored globally
	Enterprise data utilization rate	Percentage of data that is analyzed and used in the data available to enterprises globally
Intelligentization of services	Utilization rate of AI by enterprises	Percentage of enterprises that have applied AI technology in their business, operational management, and other processes
	Penetration rate of smart personal assistants	Number of users with smart personal assistants as a percentage of all users of smart devices
	Penetration rate of smart home robots	Total sales volume of smart home robots globally as a percentage of all homes globally

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(2) X Labs, one of the two types of critical 5G services: IoT

(3) X Labs, one of the two types of critical 5G services: IoT

(4) Beecham's research and analysis on the timeline of transformation globally for the agricultural IoT

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(6) IDC, China Manufacturing IoT Market Forecast, 2016–2020

(7) Huawei and Oxford Economics, Digital Spillover