GROWING IoT IN CHINA

How China Mobile has unlocked the value of IoT by delivering capability beyond connectivity

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About the GSMA

The GSMA represents the interests of mobile operators worldwide, uniting more than 750 operators with over 350 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces the industry-leading MWC events held annually in Barcelona, Los Angeles and Shanghai, as well as the Mobile 360 Series of regional conferences.

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About the GSMA Internet of Things Programme

The GSMA's Internet of Things Programme is an industry initiative to help operators add value and accelerate the delivery of new connected devices and services in the IoT. This is to be achieved by industry collaboration, appropriate regulation, optimising networks as well as developing key enablers to support the growth of the IoT in the longer term. Our vision is to enable the IoT, a world in which consumers and businesses enjoy rich new services, connected by an intelligent and secure mobile network.

For more information, visit gsma.com/iot or follow gsma.at/iot.

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1. Executive Summary

IoT has reached significant scale in China in recent years, but high cost is a barrier for potential market entrants wishing to create IoT based products and services. This, combined with a limited knowledge of IoT for these businesses, is inhibiting the opportunity for new product innovation.

China Mobile created the China Mobile IoT Company Limited subsidiary in 2012. Its core strategic focus is to grow IoT connections and provide a network service for the IoT ecosystem. However, it quickly recognised that to grow connections, its potential business customers needed more than connectivity alone and so identified the opportunity to develop a suite of capabilities to support the IoT market. To this end China Mobile created the OneNET platform to help its customers deliver IoT products.

This report describes how China Mobile, recognising the early potential of IoT, has identified some of the challenges holding back growth and has taken a holistic approach to the IoT ecosystem. This report provides an overview of the OneNET platform, its partnership programme, and innovative examples of IoT solutions. 'In summary, this report illustrates how a mobile network operator can successfully derive value in the IoT from capabilities beyond simple connectivity.

OneNET is a centralised cloud platform that enables the aggregation of data from various types of IoT device and provides easy access to the stored data by 3rd party applications. Coupled with a Management Portal, Device Management Platform (DMP) and a number of Application Enablement Platform (AEP) Features, the OneNET platform is designed to enable businesses to quickly integrate IoT services end-to-end, at low cost, and then scale up or duplicate in another industry vertical as required.

Along with the platform, China Mobile has also developed the OneNET Certification Programme (OCP) that aims to introduce high quality solution partners to the OneNET platform and the IoT ecosystem. Through this approach, and also through building and supplying IoT hardware, China Mobile has worked with a number of OCP partners to develop a range of IoT based services. A number of the use cases developed through these collaborations are described later in this report to illustrate the breadth of opportunity in the IoT industry.

This report describes how China Mobile has developed some core capabilities to produce a valuable IoT offering beyond connectivity. It provides an opportunity for the mobile industry to understand the China Mobile experience, consider how these types of capabilities can be developed and considers how the learning may be applied to their own markets. In the final section, China Mobile share an ambition to extend their experience outside of China by making the OneNET platform available to other network operators interested in addressing the market in a similar way.

2. China Mobile and the IoT Market

In China, the number of IoT connections has grown exponentially over the last 5 years. By the end of 2018, GSMA Intelligence estimated there to be over 670 million unique SIM cards registered on the mobile networks in China.

Despite this significant growth, however, the IoT market is still relatively immature worldwide. Solutions are commonly built on an ad-hoc basis, and there is a lack of tried-and-tested components, architectures and off-the-shelf solutions. Suppliers have been slow to productise and package most solutions.

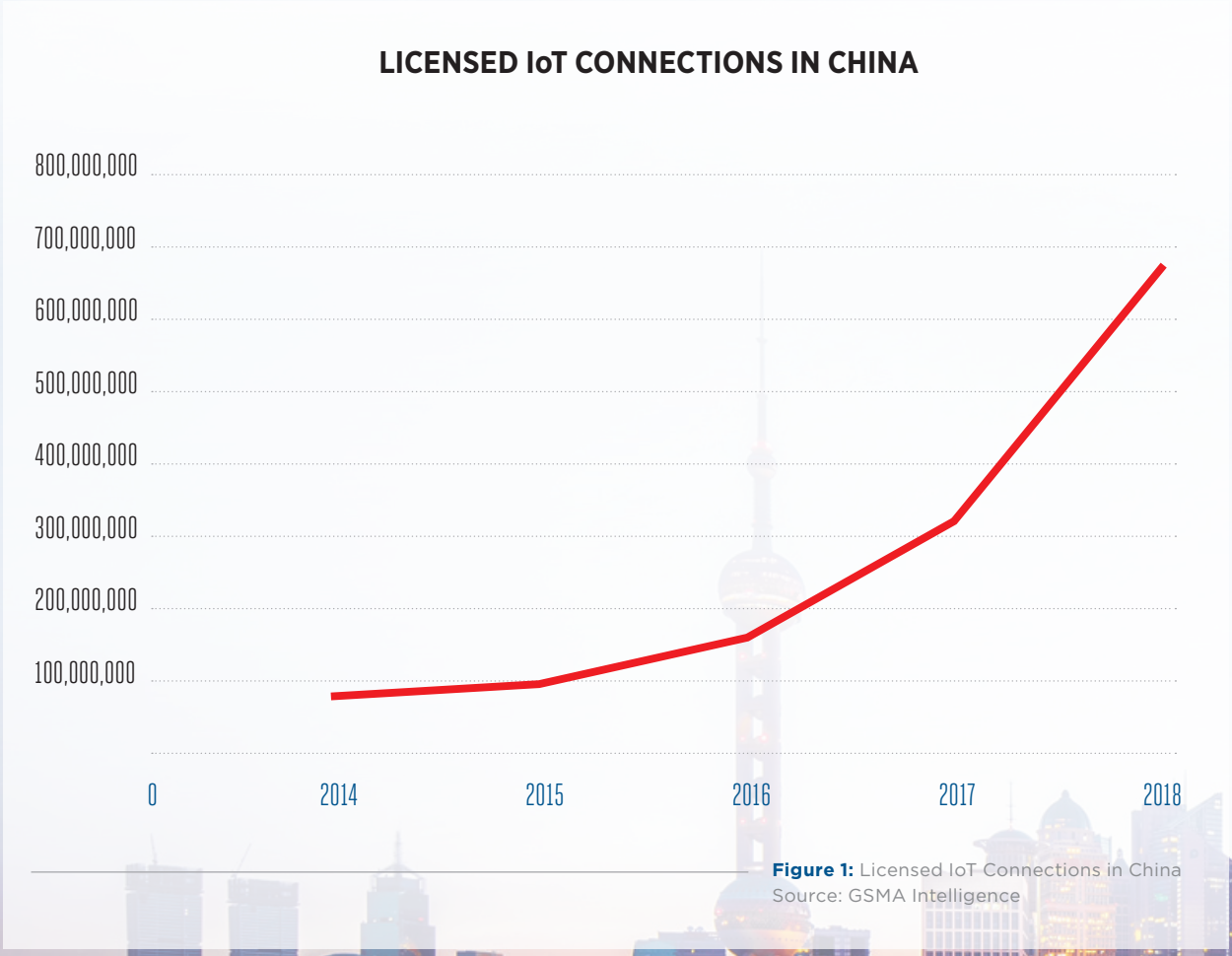


Figure 1: Licensed IoT Connections in China
Source: GSMA Intelligence

China Mobile's strategic focus is to make the IoT more successful, but it recognised that many businesses were finding the costs of developing IoT services prohibitive due to cost of hardware, development complexity and lack of standard components. China Mobile IoT Company has identified an opportunity to address this barrier to entry by developing a fully integrated IoT solution to enable business customers to quickly access the IoT market. To acheive this, China Mobile IoT has developed and packaged three core components - communication services, chips/modules and an IoT platform.

The OneNET Platform is a key component of the China Mobile proposition described in the next section.

> "China Mobile IoT Company has identified an opportunity to address this barrier to entry by developing a fully integrated IoT solution to enable business customers to quickly access the IoT market"

3. OneNET Platform

China Mobile is interested in accelerating the growth of the IoT ecosystem and IoT connections by reducing the cost and complexity for businesses wishing to develop IoT based products and services. OneNET offers a centralised platform solution that enables businesses to quickly integrate end-to-end services, at low cost, and then scale up or duplicate in other industry verticals as required.

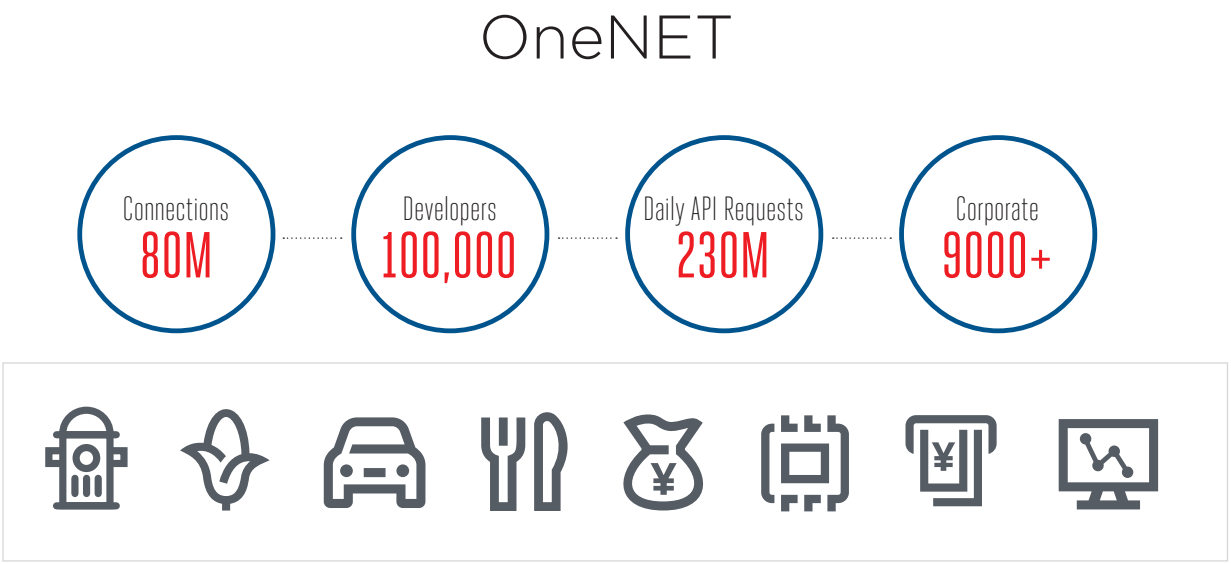


Figure 2: OneNet usage statistics by December 2018 (API Requests are per day)

PLATFORM OVERVIEW

China Mobile IoT Open Platform (OneNET) enables the aggregation of data from various IoT devices over a range of network environments and protocols. That data can be accessed, in a simple way, by applications, analytics services or intelligent hardware through a range of APIs and application templates.

It has a number of core features and these include bulk data storage, massive scalability (supporting many millions of connected IoT devices), secure transmission and a broad range of communications protocols. OneNET is an IoT platform that provides effective support for NB-IoT deployments having the capability to receive data from IoT sensors at scale and make that data available to third-party application platforms for further processing. The platform supports rapid rollout of IoT devices, and, provides a range of APIs supporting efficient operation of those devices. Capabilities of the platform include read and write APIs for device attributes, caching and push messaging.

Core Capabilities

The OneNET Device Management Platform (DMP) offers integrated SIM card management, device statistics, OTA (Over The Air) device updates and fault tracking to allow for full operational support with troubleshooting, relationship management between machine and SIM, terminal status query and terminal remote upgrade.

Customers using the OneNET platform have access to a management portal, which can also be configured to interface to external systems.

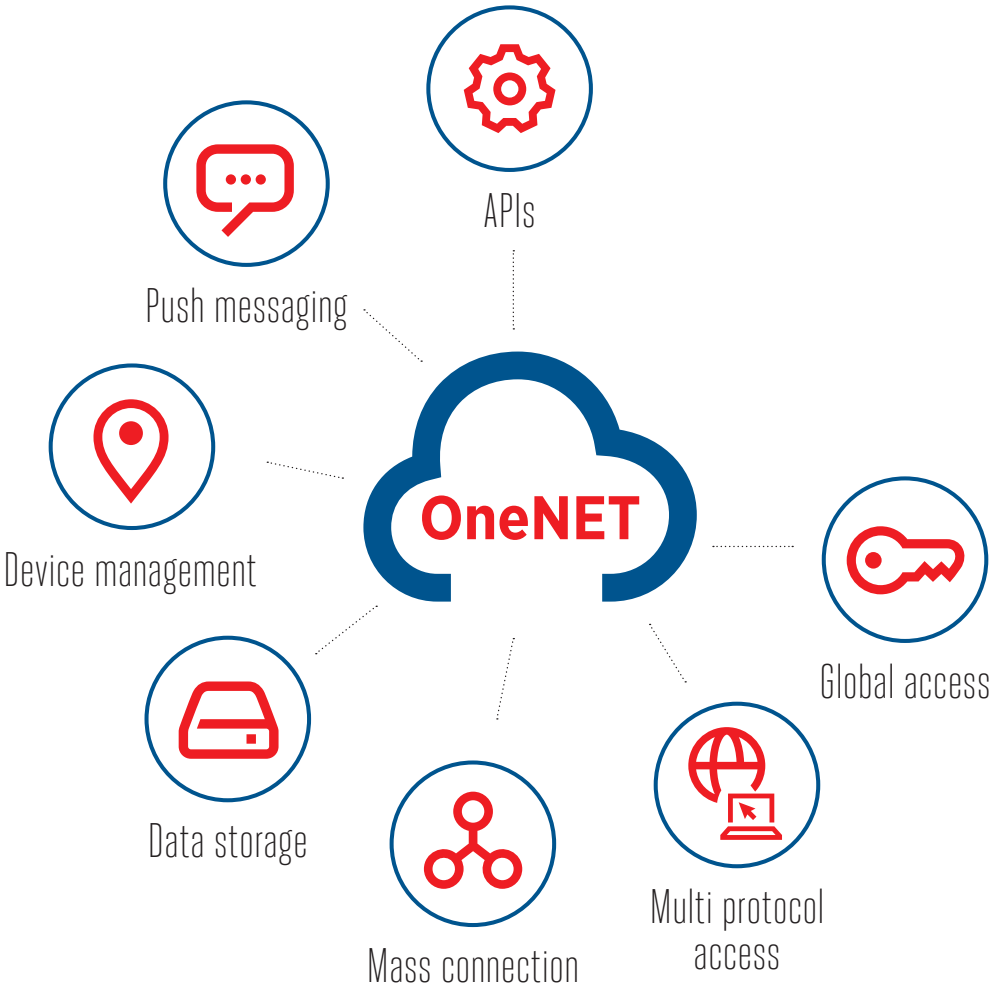


Figure 3: The OneNET Platform

The OneNET platform supports various protocols and APIs enabling data to be transferred to the platform from IoT devices, and, extracted from the platform for integration into developer applications. OneNET supports various industry standards including MQTT, Modbus, EDP and HTTP. Dedicated Software Development Kits (SDKs) are available for NB-IoT and MQTT.

The NB-IoT SDK enables IoT devices to be interfaced easily and quickly with the OneNET platform. The SDK incorporates functions such as reading and writing of device resources, data caching, OTA remote device updates, and Datagram Transport Layer Security (DTLS) for data transmission encryption etc. This SDK is specifically designed to suit a device environment with a lower power requirement, wider (and deeper) coverage footprint, volume deployment and device cost sensitivity.

Devices using the MQTT SDK can support message unicast and multi cast between devices, and enable the device to function either as an end node or application server. The MQTT SDK is particularly suitable for use in scenarios where devices and platforms need to maintain long connections. The OneNET message queue service (MQ) enhances MQTT security, and provides high performance and low delay, and this can be used to collect device messages/events at the application layer making this an efficient hub which can receive messages from a large number of devices, storing them in the OneNET platform and making the messages available to developer applications using simple APIs such as the OneNET public JSON/ HTTP API.

Application Enablement Platform (AEP) Features

A number of value-added service capabilities allow for the integration of multiple service types in the end to end solution. These are summarised in Table 1.

Table 1: Application Enablement Platform (AEP) Features

OneNET Edge	OneNet Edge computing enables low latency applications for enterprise customers at scale. IoT devices and applications can be monitored and managed in real-time locally, and real-time decision making can be made based on data wherever it is collected and stored.
OneNET LBS	Provide location based services by utilising the assets of the mobile network. The service is available for 2G/3G/4G networks with varying accuracies, as accurate as 20 metres in cities.
OneNET Video	SDK for developing end-to-end video applications. Video optimisation is supported.
OneNET AI	A package of eight off-the-shelf “Artificial Intelligence” capabilities: face contrast, face detection, image enhancement, image de-fogging, image content evaluation, image meter reading, motion detection and license plate recognition.
OneNET Voice	Intelligent voice interaction capabilities such as voice recognition, speech synthesis, voice understanding, and voiceprint recognition.

ONENET CERTIFICATION PROGRAM

The OneNET Certification Program (OCP)[1] is the core initiative of the China Mobile IoT Alliance Open Platform Executive Committee. It aims to introduce quality partners to the China Mobile OneNET platform, establish platform standards, and promote synergy to provide a full range of valuable services to corporate customers. It has five types of partner; hardware, software, solution, marketing and innovation, and venture partners.

OCP provides multiple benefits for OneNET partner companies, such as corporate certification, marketing, cost advantages and technical support.

Four hundred fifty-eight enterprise partners have joined OCP since it launched on 24 November 2017, and China Mobile are working together with the enterprise partners to help them achieve OneNET certified status.

Partner cooperation through the OCP, and using the capability of OneNET platform, has enabled the IoT ecosystem to develop further in China. Experience from the various parties has led to the innovation of new use cases and applications across multiple industries, including agriculture, transportation, medical care, urban fire protection, and consumer electronics. Some of these are described in the following section of this report.

“OCP provides multiple benefits for OneNET partner companies, such as corporate certification, marketing, cost advantages and technical support”

[1] https://open.iot.10086.cn/ocp/

4. Use Cases

The following use cases illustrate how a platform that can be easily integrated with third-party service platforms, and also support access to a wide variety IoT devices through a unified set of protocols and standards, can play a pivotal role across many vertical industries.

SHARING/RENTAL ECONOMY

The sharing and rental economy is a significant growth area in China where the concept has expanded from that of individuals sharing their own belongings (e.g. homes, cars etc.) to a broader concept which includes organisations offering products to rent for limited periods of time. Figure 4 shows the examples of battery charging points and a shared umbrella rental unit.

Figure 4: Shared charging station (left) Shared umbrella unit (right)

The sharing economy infrastructure requires remote access management to the shared products and also measurement of the period of time that the product is used by the consumer. The technical expertise required, investment cost and long development cycles may present barriers to entry for organisations or start-ups wishing to enter the sharing economy/rental market.

China Mobile observed that these barriers were preventing the industry from achieving optimal growth, and therefore set about developing a Platform as a Service (PaaS) solution to address the challenges faced by new market entrants. The objective was to support businesses to easily develop sharing economy solutions to grow the IoT industry.

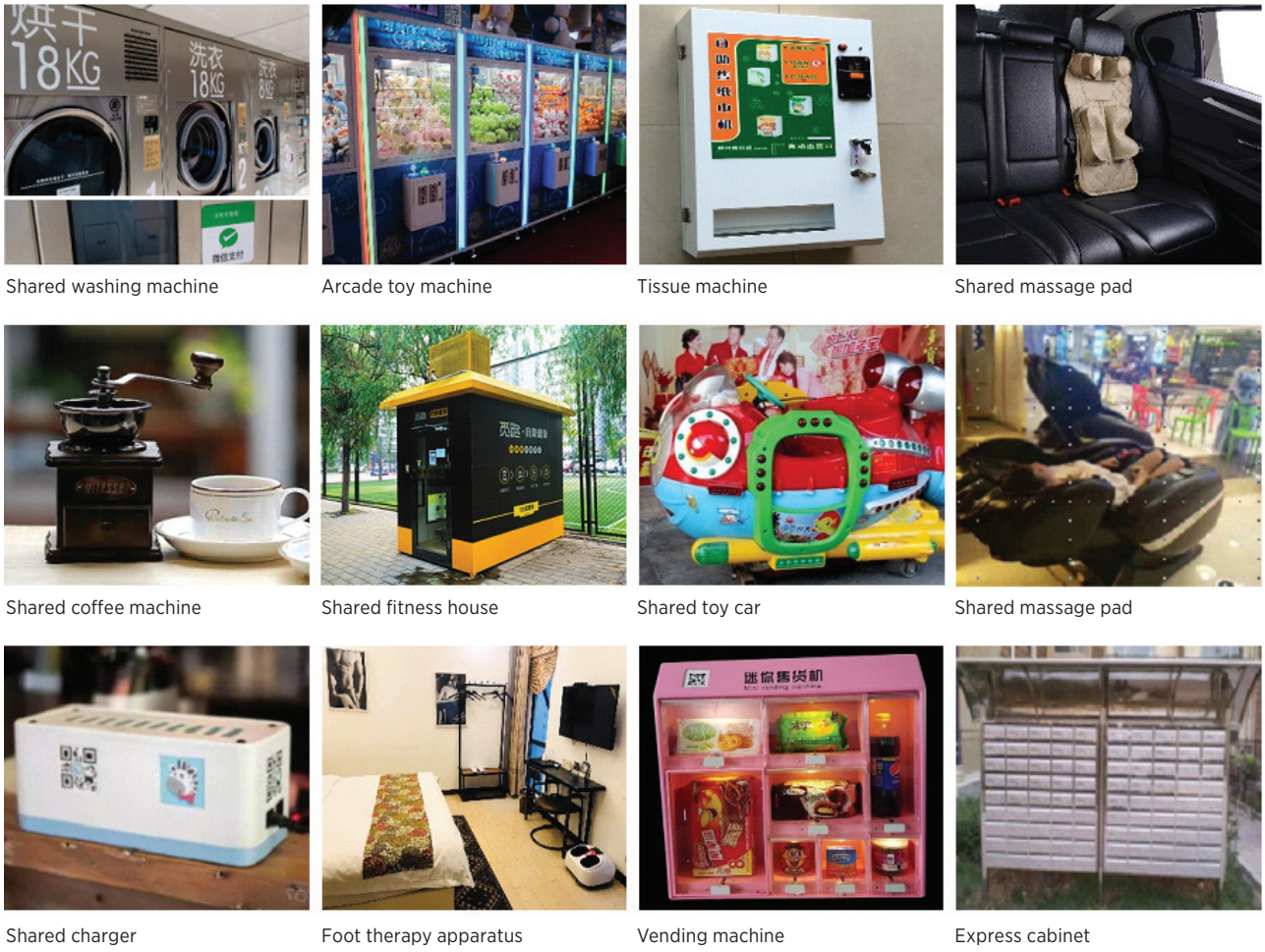
The OneNET Paas solution provides customers with Device Management Platform (DMP) capabilities such as equipment access, equipment management, data storage, concurrent processing as well as with Application Enablement Platform (AEP) features listed in Table 1 to address the pain points confronted by the industry and meet the needs of customers in all scenarios.

This, along with an easy to use management interface, and simple integration to 3rd party cloud platforms, supports both solution providers and terminal manufacturers and enables a wide range of application scenarios. Today, China Mobile IoT enables a large variety of shared economy services developed using the OneNET platform and services. These include shared massage chairs, massage pads, pedicure devices, amusement arcade toy machines, rocking cradles as well as umbrellas, power chargers and charging stations for consumers. The shared economy has also been successful in commercial industry delivering shared service access to washing machines, air conditioners, and water purifying equipment. Examples are shown in Figure 5.

China Mobile is working with partners[2], to jointly create standardised products in China's sharing economy, harnessing OneNET to provide industry customers with comprehensive end-to-end solutions.

> "China Mobile observed that these barriers were preventing the industry from achieving optimal growth, and therefore set about developing a Platform as a Service (PaaS) solution to address the challenges faced by new market entrants"

[2] Including Yilian IOT and Leyaoyao Technology



Shared washing machine | Arcade toy machine | Tissue machine | Shared massage pad

Shared coffee machine | Shared fitness house | Shared toy car | Shared massage pad

Shared charger | Foot therapy apparatus | Vending machine | Express cabinet

Figure 5: OneNET enables many Sharing Economy use cases

SMART BICYCLE

China is the world's largest producer and consumer of electric vehicles, and the electric bicycle (EBike) has become a popular means of transport for many city dwellers. However, a significant increase in electric bicycle numbers has introduced some challenges in China. In terms of safety, there has been a large increase in accidents, partially due to the increased volume of traffic and also due to the way people are driving. In addition, electric bike accidents tend to be more serious than those occurring with traditional bicycles. Security is also an issue as electric bicycles are at a greater risk of being stolen than traditional cycles.

In 2018, China Mobile IoT Company began working with an electric vehicle monitoring solution provider to look at how IoT could address the risks to public safety, the risk of theft and also support traffic management in cities.

The project deployed three million devices, which were developed using the OneNET platform NB-IoT kit, to electric bicycles in the city of Zhengzhou in Henan Province. The devices collected real-time data, including bicycle position, velocity and acceleration, and stored the information in the OneNET platform.

The electric vehicle integrated management platform, accessed the data in the OneNET platform and was able to track the location and trajectory of the bicycles. Using this data, combined with other valuable data sources such as the BeiDou Navigation Satellite System (BDS), the management platform was able to undertake big data analytics to address the safety and security concerns.

The big data analytics enabled the system to identify routes taken, rider behaviour analysis, as well as track the security status of the cycle. The analysis was able to support traffic management planning by the authorities, identifying popular routes and areas most prone to accidents or bad driving. The real time data and management platform combined, provide authorities with traffic misdemeanours data, such identifying bicycles that have jumped a red light, and also inhibit theft by preventing a bicycle from moving outside of a geo-fenced area.

Finally, in terms of security, because the devices allow the electric bicycles to be tracked, the owner has a greater level of confidence that in the event of theft, the vehicle will be recovered. Since the implementation of the project in September 2018, Zhengzhou has reported the recovery rate of stolen electric vehicles at over 40 percent.

“The big data analytics enabled the system to identify routes taken, rider behaviour analysis, as well as track the security status of the cycle”

SMART SMOKE DETECTION

China Mobile has launched the first interconnected fire detection and alarm system, the Intelligent Fire Protection Solution, in Jianggan District Hangzhou City, Zhejiang Province.

More than 300,000 wireless data collection and alarm information service points have been deployed in areas including the homes of "empty nesters" living alone, rented houses and shops. The system connects smoke, temperature and gas detection sensors through the OneNET IoT cloud platform using the NB-IoT network to enable real-time monitoring. If the sensors are triggered, the system sends an immediate alert to the relevant authorities such as the street command centre or fire station, via a pre-defined channel such as the telephone, SMS text message or a dedicated application.

As the sensors can be located in many places, including unpopulated locations or those with vulnerable people, and provide real-time fire alerts, the scheme can greatly improve the fire departments response times and reduce the possibility of fire spreading. Dealing with smaller fires quickly can reduce the potential difficulty for fire control supervision, reduce the contact time of the fire fighters, improve the efficiency of firefighting and rescue work, and effectively avoid heavy casualties and property losses caused by fire. The smart fire and smoke detection solution is an excellent example of the intelligent city.

SMART PARKING

Car ownership in Hong Kong is continuously growing and the urban infrastructure is failing to keep pace with demand. As a result, insufficient parking spaces makes it difficult to find a place to park and a lack of information makes it hard to efficiently utilise the spaces that are available.

China Mobile Hong Kong Corporation worked together with a traffic solution supplier[3], and a local equipment supplier and technical service provider[4], to develop a smart parking management solution to address the parking challenges.

The Smart Management system deployed a range of connected devices, such as cameras, ground geomagnetism devices, ground locks, and Bluetooth beacons in the targeted parking areas. Data was transmitted over the China Mobile network (NB-IoT/2G/3G/4G) to the OneNET platform. A cloud management platform application accessed the data from the OneNET platform to analyse and identify critical factors such as parking space status, schedule parking space reservations, license plate recognition, indoor navigation, payment due (connected to online payment system) and eligible parking discounts. Information was communicated to drivers via LED screens and mobile applications.

[3] Shenzhen Qianhai Yiche Technology Co., Ltd

[4] Jingjin Parking System Co., Ltd.

Testing has been carried out in a number of locations, including shopping centres, private residential locations and in the China Mobile Hong Kong data centre. The trial proved successful in achieving a city-level smart parking management solution.

Further work by China Mobile has estimated that the potential revenue for a smart parking solution covering the 2,600 parking lots and 20,000 roadside meter-parking berths in Hong Kong, could exceed HKD 780 million in the next five years.

Smart NB-IoT Agriculture

In April 2018, the GSMA convened a project comprising of China Mobile, the China Mobile IoT Company, China Agricultural University, and a number of China Mobile OneNET Certification Programme Partners, to test and learn how mobile connectivity, IoT sensors and data analytics can be applied to maximise the sustainable production of table grapes in China.

The purpose of the project is to demonstrate the use of connected IoT sensors and data analytics in creating relevant and informative insights to support sustainable grape production.

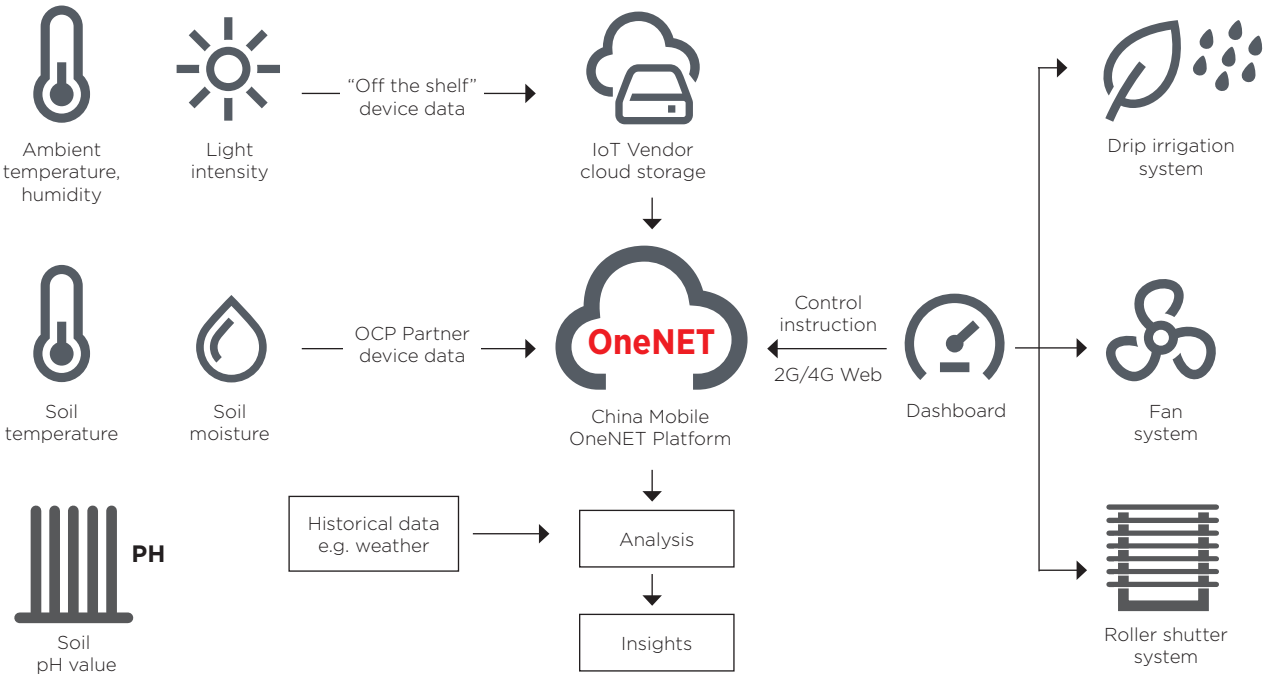
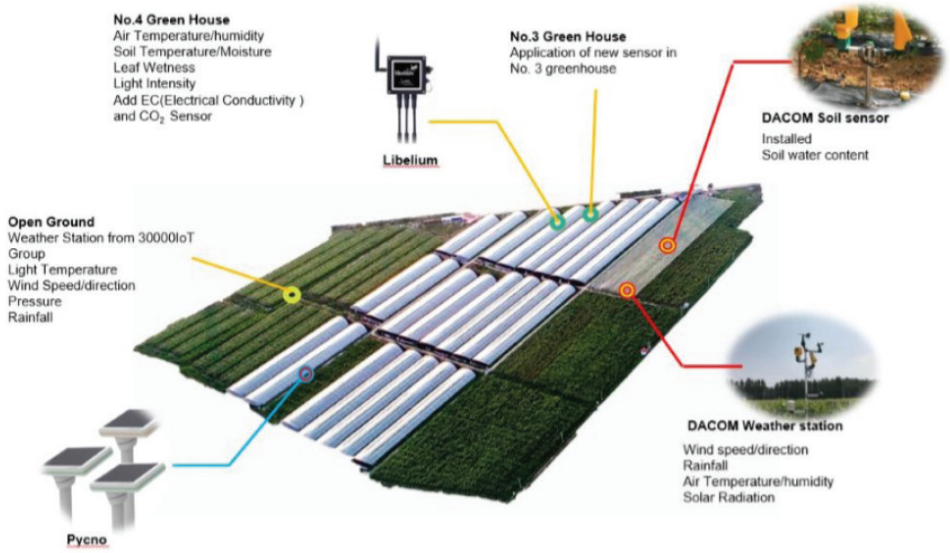


Figure 6 The OneNET Platform aggregates data from OCP partner devices and from "off the shelf" device vendor cloud services and manages access to the stored data by integrated smart hardware solutions (such as irrigation) and analytic applications.

China Agricultural University advised on the range of environmental data relevant to the cultivation of greenhouse grapes. IoT devices have been installed and luminous (light) intensity, soil condition (CO2 concentration, temperature, humidity) and leaf moisture data is being collected.



A 'connected' weather station has also been deployed to obtain more accurate environmental data at the location and support "intelligent" irrigation. Various additional devices provide air pressure meters, soil moisture sensors, irrigation controllers, solenoid valves, switches, and smart water meters.

Data collected from all devices is aggregated in the OneNET platform. A number of the devices, supplied by OneNET Certification program partners, are configured to send raw data directly to the OneNET platform. This agricultural data is sent to the OneNET platform using an NB-IoT agricultural data collection format developed by China Mobile based on LwM2M IPSO Smart Objects. Other "off the shelf" sensors send data direct to sensor manufacturers' cloud services and this data can then be copied to the OneNET Data Platform via API or CSV file. The OneNET IoT platform monitors the data received and, based on previously set conditions, trigger actions, such as the invocation of the smart irrigation system once the soil moisture level reaches a minimum.

The project is using the data gathered over a full growing season to develop a model for greenhouse grape production in northern China, to support the farmer and make informed decisions about the management and harvesting of the crop. China Agricultural University are leading the data analysis to inform grape growth research on issues such as current and predicted grape health, the influence of temperature on grape development stages, and the water and fertilizer requirement, or other factors, in grape growth.

Smart City

Longhua District, Shenzhen, an area covering one city and six districts, was officially established as a pioneering area for open and shared IoT data application on 7 January, 2017. The objective for the Smart Longhua project is to comprehensively integrate smart services in all new citizen and government service initiatives.

The OneNET platform has been used as a key management platform for developing the unified smart city by providing access and application management of various IoT devices in public security, transportation, environment and fire control in the Smart Longhua project. The longer-term plan is to extend the IoT functionality in the district to include smart street furniture (traffic light, street lights), manhole covers, smart parking, utilities (water, electric, gas) and video surveillance.

5. Global Partnerships

Having enabled successful launches for the IoT in China, China Mobile are offering support to other operators world-wide by making the OneNET platform available beyond China, providing this in the form of localised Software as a Service (SaaS) and supplying low cost hardware for potential partners wishing to improve their product portfolio.

Proposition

The proposition supports the same holistic approach taken by China Mobile IOT Company in China, enabling the storage and aggregation of IoT device data in the OneNET platform and with a portfolio of supporting information and applications. Operators wishing to take advantage of the proposition for local developments can choose their own device manufacturers and solution providers, or China Mobile can provide low price and high quality devices directly, leveraging channel advantages gained from being a Chinese company with high volume purchasing power. Similarly, with a wider range of solution provider partners and broad catalogue of experience, China Mobile may be able to provide economies of scale, and therefore price advantages, to other operators via a uniform, but customisable offering.

Offering technical experience and professional guidance, China Mobile suggests two potential business models for operators considering working with China Mobile and the OneNET platform to develop IoT service solutions and grow the market.

Model 1: Provide OneNET capability and consultancy, enabling local operators to develop their own local IoT market

China Mobile proposes working together with a mobile network operator to customise the OneNET based IoT solution to meet the local needs in the operator market, reducing the time to market for new IoT innovations. To support the technical deployment, China Mobile can also offer advice and recommendations based on the operational experience from China with areas such as business models, marketing strategy, network management and data analysis.

Model 2: Provide full platform and service end-to-end capability on behalf of the operator

In this model, China Mobile offers to develop and provision full end-to-end IoT solutions on behalf of the local mobile operator. This scenario may be suitable for operators that would like to develop IoT services, but do not have the resources available to do so directly. China Mobile offers a business model based on the OneNET platform and access to the IoT experienced gained through numerous projects, some of which have been described in this report.

About China Mobile IoT Company

China Mobile IoT Company Limited is a wholly owned subsidiary of China Mobile. Based on the overall strategy of China Mobile, China Mobile IoT Company aims to become the supporter of IoT business services, the provider of IoT chips & modules and the promoter of IoT products & applications. In practice, China Mobile IoT focuses on operating IoT private networks, designing IoT chips and modules, smart vehicle applications, smart home applications and wearables, development and operation of the IoT card connection management platform OneLink and the IoT open platform OneNET, delivering IoT solutions. Overall this makes a comprehensive architecture known as “Cloud-Pipeline-Device”. The China Mobile IoT Company collaborates with China Mobile provincial and professional companies to provide the community with the most advanced IoT technologies. Following the philosophy of openness, cooperation and sharing, China Mobile IoT strives to become a China based, leading global IoT Company which promotes IoT applications in various industries.

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