Smart Transportation

Maximize mobile network's value beyond connectivity

XLabs
Wireless
Xploration Begins Here

Contents

Executive Summary

As a significant component of modern economy, transportation accounts for 6-12% of the gross domestic product (GDP) in many developed countries. Although transportation has greatly improved our lives, quite a few costly problems remain unsolved, including traffic accident, congestion and vehicle emission. Smart transportation has recently become a hot topic in the Internet of Things (IoT) area, and is considered as the solution to the problems mentioned above. In this report, we examined smart transportation from an innovative perspective and divide the topic into a few sub-topics. Based on the market size and the demands for mobile network, we have identified four major opportunities for Mobile Network Operators (MNOs), including telematics service with Usage Based Insurance (UBI) and Fleet Management, smart parking service based on the Narrow-Band IoT (NB-IoT) network technology, Emergency Service Network (ESN) based on Long-Term Evolution (LTE) network and enhanced Advanced Driver Assistance Systems (ADAS) based on LTE-V or 5G network.

In each vertical market, we analyzed the value chain, major players and their strengths and weaknesses. Based on these analyses, we proposed new positioning and practical guide for MNOs, which we hope can inspire them to think differently and strategically.

The key messages we would like to deliver in this report include:

1 The market of connected car service is expected to reach US$145 billion in 2022. For MNOs, the three categories of connected car service – infotainment, telematics and data-enhanced automated function – all have their business opportunities in the market.

▸ In the area of infotainment, along with the rise of sharing economy, more and more people choose to travel without driving by themselves. This has posed opportunities for the in-car entertainment business. MNOs could provide business-to-business (B2B) data plans to service providers, like Uber or Didi, to help them provide differentiated services.

▸ Telematics is still an area that needs to be explored by MNOs. With more favorable policies and regulations, a higher awareness of road safety and the growing number of vehicles, there are many opportunities in the aftermarket. When compared with original equipment manufacturers (OEMs), MNOs have their own advantages, including wider customer base (generally speaking, the concentration of telecom industry is higher than that of automotive industry), mature sales channels, well-developed call centers, higher awareness of data security and privacy, and better service continuity across automotive brands. For MNOs, to quickly enter into the telematics market, they could enhance their capabilities through acquisitions or partnerships with telematics service providers (TSPs). In the long term, telematics service will focus on the new car market. With the capabilities built up in the aftermarket, MNOs could cooperate with OEMs and play a greater role in the new car market.

▸ UBI and Fleet Management are two hot topics in telematics service. It is expected that UBI users will increase to 107 million in 2018 from 5.5 million in 2013, and the market size of Fleet Management will reach US$ 21 billion in 2022.

▸ In the area of vehicle-to-everything (V2X) and autonomous driving, MNOs shall actively participate in the development of technical standards and the building of network, to ensure the realization of V2X and autonomous driving. As the business case remains unclear, leading MNOs need to act more proactively to lobby government for legislation supports and standard selection, convince OEMs to establish partnerships, and cooperate with different service and solution providers for total solution options.

2 Smart parking market will continue to grow in the next few years. Different countries are in different development stages of smart parking service, with various market demands. In general, this is still a fragmented market. Smart parking is usually

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The market of connected car service is expected to reach US$145 billion in 2022.

regarded as a part of smart city, and MNOs could become the end-to-end service providers in the smart parking market through partnering with government authorities. NB-IoT based smart parking solution features smaller investment and wider applicable areas, thus could ensure the realization of smart parking functions. In addition, the upgrade of network infrastructure will bring about benefits for the overall smart city program, which could be leveraged to obtain parking resources.

3 Governments have realized the key role efficient Emergency Service Network (ESN) could play in case of emergency to save life and reduce economic loss.

> **It is estimated that the global wireless network market in the area of national security would reach US$22.9 billion in 2020.**

Compared to separate dedicated networks, ESN that is based on MNOs' LTE network could save a great deal of cost for governments. MNOs in countries with no ESN shall lobby their governments to be aware of the importance of ESN, and MNOs in countries with ESN shall provide service with higher quality and lower cost, so as to win over more business opportunities. Especially in countries with limited spectrum resources, MNOs shall exchange network resources with the government for more benefits.

All in all, MNOs have unique advantages, in terms of policies and regulations, customer base and technology, to facilitate the development of smart transportation. Beyond keeping upgrading network and providing quality network services, MNOs shall consider playing an all-new role in smart transportation in the coming years.

Introduction

The development of transportation is considered as the most significant driver for social progress. It allows people to interact and enables delivery of goods and services around the world.

6-12%

In many developed countries, transportation accounts for 6-12% of the GDP[1] . Generally, higher income levels are associated with a greater share of transportation in consumption expenditures.

10-15%

On average, transportation accounts for 10-15% of household expenditures[2].

8%

In addition, transportation has a great impact on people's daily lives. On each workday, people spend about 8% of their time commuting to and from work[3].

While such development has greatly improved our lives, there are quite a few costly problems remaining unsolved: more than 1 million people died in traffic accident each year worldwide[5]; vehicle emission has been one of the major causes of global warming; traffic congestions has caused incredible amount of logistic fee for enterprises and huge time consumption for daily commuters.

Along with technology development, "smart things" have permeated people's daily lives, such as cloud computing, big data, evolution of wireless network, Machine to Machine (M2M) and IOT. Government authorities and thousands of business enterprises have conducted numerous studies from multiple perspectives and they believe that the development of information and communications technology (ICT) will greatly benefit economics and residents' life qualities. The Global Connectivity Index (GCI) study conducted by Huawei

also proves the same conclusion, that a strong digital infrastructure can improve the quality of economic growth. The study also found that an increase of one point in a nation's GCI score correlates with 2.3% increase in productivity[6]. Meanwhile, the International Data Corporation (IDC) estimates that worldwide IoT revenue will reach US$1,295.8 billion in 2019[7]. Considering the significant influence of transportation on the whole economy and people's daily lives, we focus on smart transportation in this paper, which draws wide attention from various vertical markets, such as automobile, insurance, logistics and smart parking.

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[1] "THE GEOGRAPHY OF TRANSPORT SYSTEMS, third edition", Routledge, 2013.

[2] Ibid

[3] "Commuting, Migration and Local Employment Elasticities", NBER Working Paper 21706, 2015.

[4] "2006-2011 5-year American community survey", US Census Bureau, 2012.

[5] "Global status report on road safety 2015", WHO, 2015.

[6] "Global Connectivity Index 2016 Whitepaper", Huawei, 2016.

[7] "Worldwide Internet of Things Forecast Update 2015-2019", IDC, 2016.

»» 1 Value proposition of smart transportation

Improved safety, higher productivity and efficiency, more environmental friendliness and better life quality are the four major purposes of smart transportation.

Safety: Car connectivity and automation are hot topics and have received great attention from both internal and external of automotive industry. V2X and autonomous function are designed to avoid accidents caused by human errors. For example, the Insurance Institute for Highway Safety (IIHS) estimates that the standard auto brake will prevent 28,000 crashes and 12,000 injuries in three years in the US[8].

Environmental friendliness: Transportation contributes about 28% of the US' total greenhouse gas (GHG) emissions[9] – and emissions from transportation are growing faster than other sectors. Outside of the US, same situation is occurring in all developing countries with much higher growth rate of car sales.

Productivity and efficiency: From macroeconomic perspective, traffic congestion reduces productivity, increases labor force and further impacts the entire economic system by lowering efficiency. According to a report by The Economist, in 2013 the expenses caused by traffic congestions summed up to US$200 billion (0.8% of GDP) across the four countries (UK, France, Germany and US)[10]. And for logistics companies, the routing plan, fuel consumption and accident cost are causing headaches. Fleet Management in smart transportation could provide fleets a much smarter solution in terms of increasing efficiency and productivity with a different methodology from traditional planning

Better life quality: From an individual's perspective, traffic congestion has become one of the greatest concerns for commuters. According to a recent report from TomTom, on average the time commuters spend on road during rush hours in the evening costs more than doubled comparing to ordinary or off-peak hours[11]. It is reported that Chongqing is the most congested city in mainland China, and it ranks the 12th most congested city worldwide. According to a survey result of an authoritative Chinese media, the commuters in Chongqing spend about 140 minutes every day on road, equivalent to more than 600 hours a year. This is quite a long period of time that should be otherwise spent on more important activities, such as personal development or quality family time. In addition, with the development of self-driving car and sharing economy, commuters can deal with work or enjoy the leisure time on the road, as they don't need to drive by themselves any longer. For US drivers, autonomous vehicles could free up almost 50 billion hours each year.[12]

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[8] "US DOT and IIHS announce historic commitment of 20 automakers to make automatic emergency braking standard on new vehicles", IIHS, http://www.iihs.org/iihs/news/desktopnews/u-s-dot-and-iihs-announce-historic-commitment-of-20-automakers-to-make-automatic-emergency-braking-standard-on-new-vehicles, accessed June 2016.

[9] "Moving Cooler: Surface Transportation and Climate Change", Urban Land Institute, Apr 2012.

[10] "The cost of traffic jams", The Economist, Nov 2014.

[11] "New TomTom Data Reveals Rush Hour Traffic Doubles Journey Times for Commuters", TomTom, http://www.businesswire.com/news/home/20150330006108/en/TomTom-Data-Reveals-Rush-Hour-Traffic-Doubles, accessed June 2016

[12] "The massive Economic Benefits of Self-Driving Cars", Forbes.com, 8th Nov. 2014.

»» 2 Future of smart transportation[13]

In the modern society, everyone has suffered from situations mentioned above. Have you ever imagined a better life in the smart future? In a world with cars fully connected, there will be lots of self-driving cars running on the road, and there will be no more professional drivers. Existing self-driving cars in the market only connect to immediate surroundings based on board computer. In the future, connected cars will offer people a perspective collision avoidance and route optimization under a dedicated transport network with high security and high performance and cloud computing. At the same time, with sharing economy you will no longer need to spend money to own your car as a property,

and you will no longer have to worry about parking tickets any more. Smart transportation services will be provided to you immediately, whenever and wherever you need it. In the smart future, the higher efficiency of whole transport system, less traffic accident, less commute time, better passenger experience will lead us to a wonderful transportation world. But how could the MNOs participate in the magic smart journey as a wireless network operator? Could the MNOs only be the pipe providers or play more important roles and create more values in this market? In this paper, we will discuss the positioning for MNOs in four vertical markets – telematics service, V2X, smart parking and ESN.

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[13] "Who is in the driving seat?" EY, 2015

Vertical market analysis

»» 1 Connected cars

1.1 Four stages of connected cars[14]

Connected cars are defined in various ways by different professionals, businesses and end users. Without an official definition, one concept is certain: connection to the Internet is no longer its definition. Having internet access has gradually become a basic function of modern cars. Thus, without a standard definition for connected cars, we chose to categorize the connected car services into four different stages, and each stage involves technology improvements, business case developments and social/government acceptances.

a. Connect to the Internet – Focus on driving entertainments

With modern technology and high demand for internet access, drivers and passengers' habits have changed dramatically since the invention of smartphones. Today, the demand for in-car infotainment access has become a must for attracting end users. DVD players, touch-screen media modules and real-time navigation system have become the standard equipment on all cars. In addition to those hardware, as 4G network matures, many in-car infotainment facilities are designed to operate via WiFi hotspots on the end users' demands.

b. Connect to remote service – Focus on remote services

Through embedded or plug-in modules, vehicles are enabled with add-on services by real time data collections such as vehicle status, driving behavior and vehicle locations to achieve safer conditions for the vehicles, the drivers and the passengers. Vehicles are connected to remote service providers through a network. Such features include e-call, remote vehicle control functions or real-time vehicle locator, vehicle status or to provide additional support to the driving experience, such as real-time navigation and vehicle maintenance alert. The existing business cases include telematics services provided from car makers for new vehicles' market and

also some MNOs' products for the aftermarket as add-on service selection.

c. Connect to immediate surroundings – Focus on driving safety

The vehicles are designed to be connected via different methods to achieve safer driving. With hardware and software supports, connected cars are well equipped to achieve collision prevention by communicating with its immediate surroundings, such as roadside infrastructure, other vehicles and pedestrians – the so called V2I, V2V and V2P. In this stage, technologies including collision avoidance system and advanced driving assistance are used to prevent accidents.

d. Fully connected – Focus on full connectivity and ultimately autonomous vehicles

In this final stage, vehicles are designed to be able to communicate with extended surroundings and other vehicles to avoid collision and traffics. Through high-speed network and cloud services, each vehicle on the road will be able to communicate with other parties that are sharing the area. With the functions of V2X and driving assistance hardware, the ideal is to achieve safer and more economical society. With the help of connected car technology, drivers could be freed from the wheels.

Figure 1: Different focuses of connected cars

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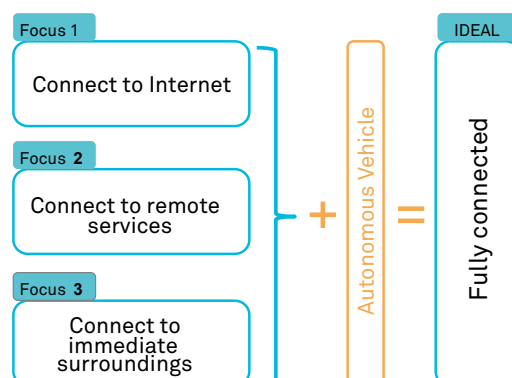
[14] "Digital in automotive", EY, April, 2016
"Who is in the driving seat?" EY, 2015
"How many human do we need in a car?", EY, 2015

The National Highway Traffic Safety Administration (NHTSA) defines five levels of vehicle automation[15]:
Non-Automation (Level 0): Driver in complete control at all times

▸ Brakes, steering, accelerator, and motor power are under driver control
Function-Specific Automation (Level 1): Automation of one or more specific function

▸ Examples include electronic stability control or vehicle-assist with braking
Combined Function Automation (Level 2): Automation of at least two primary control functions designed to work together

▸ Example is adaptive cruise control in combination with lane centering
Limited Self-Driving Automation (Level 3): Driver can cede full control of all safety-critical functions under certain conditions. The vehicle monitors for conditions requiring transition back to drive control

▸ Google's self-driving car is an example of Level 3
Full Self-Driving Automation (Level 4): Vehicle is designed to perform all safety-critical driving functions

▸ Includes occupied and unoccupied vehicles

Figure 2: Levels of vehicle automation
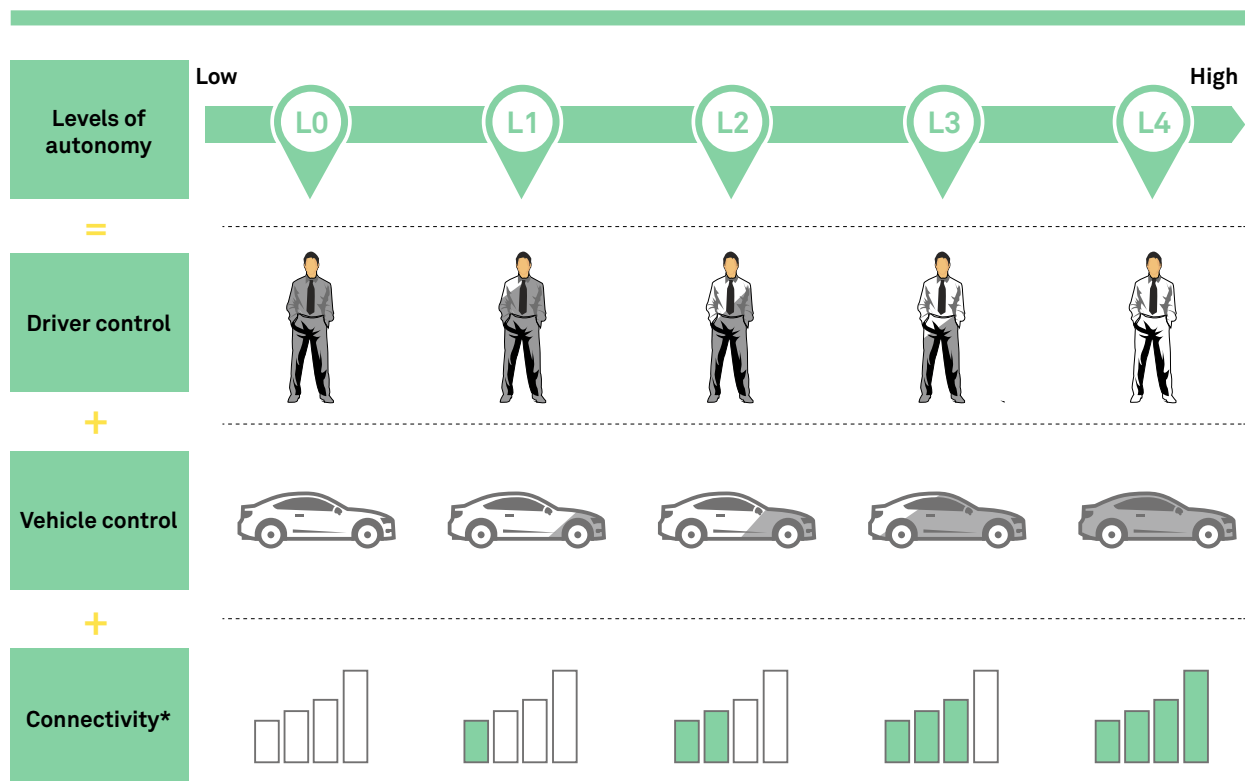
[15] NHTSA, "U.S. Department of Transportation Releases Policy on Automated Vehicle Development," http://www.nhtsa.gov/About+NHTSA/Press+Releases/U.S.+Department+of+Transportation+Releases+Policy+on+Automated+Vehicle+Development

Connected car is a huge definition, which contains a lot of business opportunities. In revenue terms, Huawei estimated the addressable market for MNOs would be three to four times lager in 2022 than it is in 2016.

▸ $US 92.3 billion from infotainment and telematics services, such as mobile data traffic, web-based entertainment, call center support and remote diagnostic services (up from $27.3 billion in 2016)

▸ $US 21 billion from the fleet management for enterprise customers(up from $8.7 billion in 2016)

▸ $US 31.5billion from the V2X service. With the introduction of C-V2X (Cellular Vehicle to X) standard by 3GPP and the development of 5G communication network, the V2X service is highly anticipated. In addition, the establishment of 5GAA would hopefully speed up the development of V2X, and the future market size of V2X service is expected to further expand.

Figure 3: Revenue forecast of connected cars

US billion

Addressable market of connected cars for MNOs
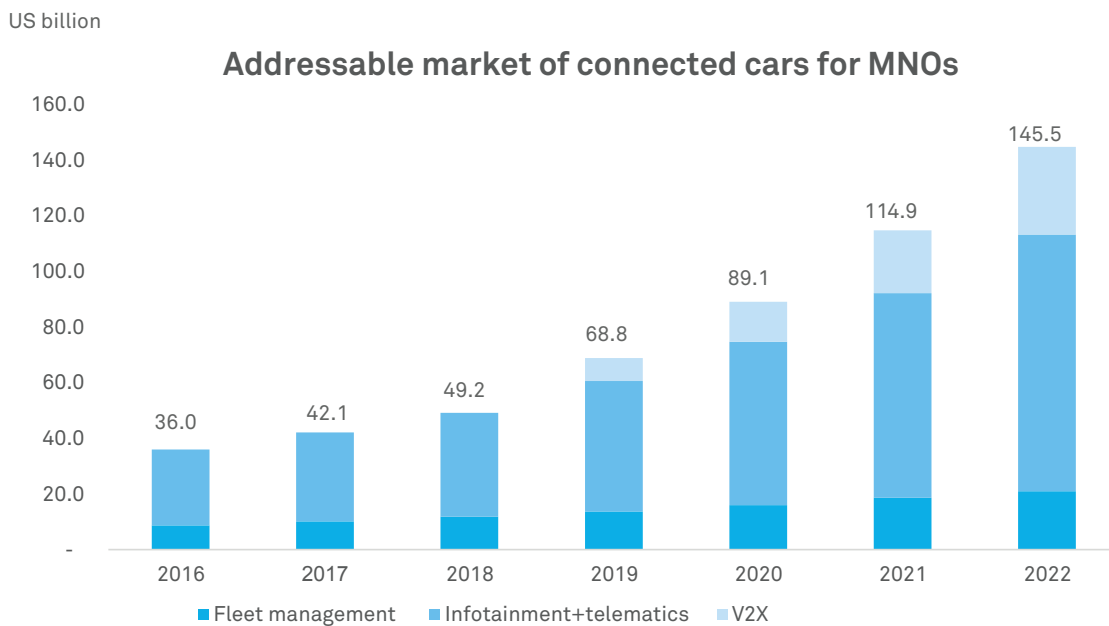
1.2 Connected cars give great opportunity for MNOs

Safer and more enjoyable driving experience are the two main drivers of connected cars market development. The existing services in the connected cars market could be categorized into three focuses – infotainment, telematics and data-enhanced automated functions. According to Telefonica's survey conducted in Spain, Brazil, US, UK and Germany, which attracted more than 5,000 participants, safety and telematics related services are topics mostly mentioned. Although consumers are more likely to pay for safety (V2X, Telematics) than just infotainment, infotainment is a "nice to have" function without paying extra fee for passengers, which means data plan for infotainment could be sold in B2B market.

Figure 4: Categories of connected car service
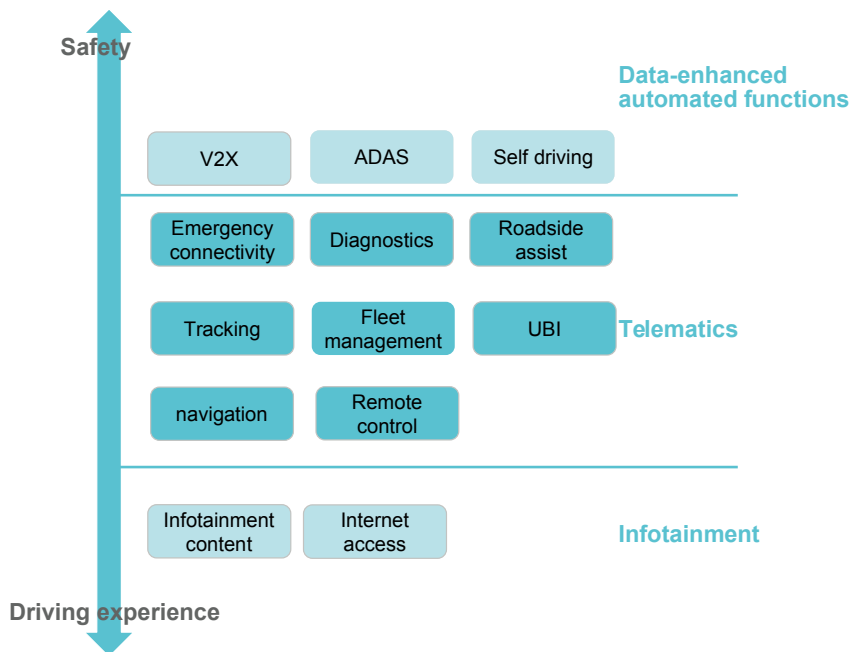
1.2.1 Infotainment

In this dimension, MNOs take the leading role in the value chain of selling data plans to end users. With embedded vehicle hardware, plug-in devices or smartphones, end users enjoy the connection of Internet in their vehicles as an extension of mobility. With development of sharing economy, the mindset of car ownership is changing. Sharing ride is a rapidly developing vertical market, more and more people are getting used to the more economical and flexible urban mobility option. It is said that a third of urban mobility will be sharing ride in the future. It will also change the demand of in-car entertainment, as more people do not need to drive by themselves. In-car WiFi could be a competitive advantage for some sharing ride companies, such as Uber or Didi.

For MNOs, the current utilization of 3G/4G network is not sufficient, so the

> B2B data plans would be a new and quick revenue stream without further network investment.

1.2.2 Telematics

Telematics is the most popular star that attracts all the attention from OEMs, MNOs, TSPs, device manufacturers, solution providers and other content providers, especially on the consumer market. The end users get features such as emergency connections, road-side assistances, real-time navigation, UBI, remote diagnostics. It is well accepted by both new vehicles market and after-market.

Figure 5: Key players in telematics service market
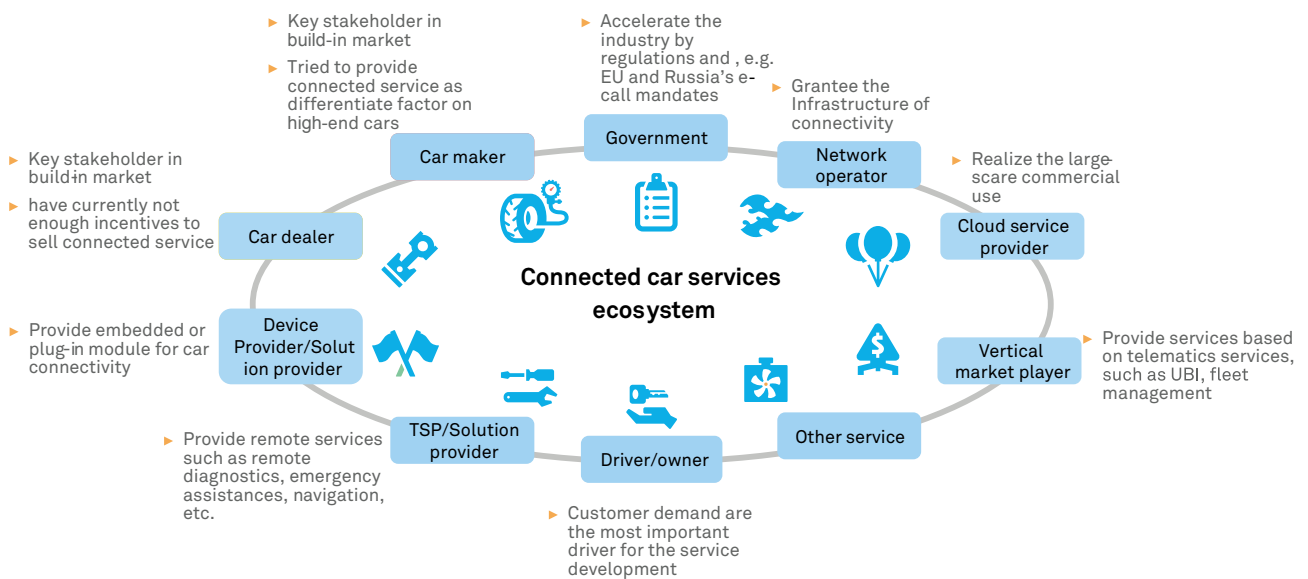
There are three major business models of telematics service. On the build-in market, the OEMs provide telematics services as a premium service with free or low charge for the high-end cars. On the aftermarket, MNOs or TSPs provide similar service with a plug-in module and charge service fee.

In the case led by OEMs, leading auto makers chose to develop their own telematics for brand specific embedded solution. GM's On-star solution is one of the most reputable in this dimension. In 1995, in order to provide end users with better and safer driving experiences, GM initiated its specialized telematics services for GM vehicles only known as the On-Star. By partnering up with MNOs such as AT&T in the US and China Telecom/China Mobile in China, On-star provides services including road guidance, vehicles security and protection to the subscribers. The OEMs are the absolute leaders in the value chain, MNOs can only be able to achieve its revenue through selling their data plan either to OEMs or to end users. Today, almost all the major OEMS have similar service to provide, such as Connected Drive from BMW and MB Connect from Mercedes-Benz.
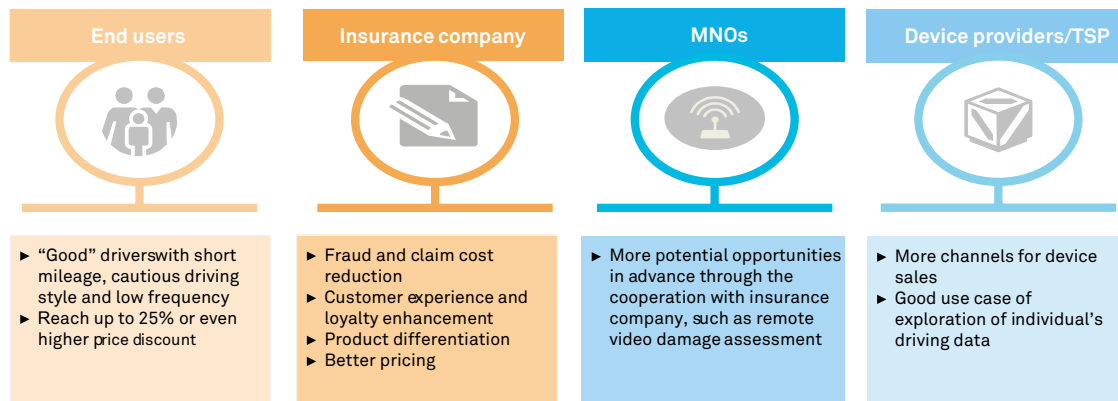
Also some TSPs play a leading role in the after-market. VOXX international is a device manufacturer for automobile devices including plug-in devices, specialized car seats and mobile apps. Through OBDII (On Board Devices) provided by TSP providers, end users are able to achieve connected car function even with their obsolete models as early as 1996. VOXX's car connection 2.0 TSP is provided by a data company called Agnik, while the telecom giant AT&T provides data transmission services. Through multiple channels including its official website, e-commerce store (Amazon), AT&T partnership sales and other VOXX dealers, VOXX established the successful business model for TSPs.

Verizon sets a total solution provider example by investing in different parts within the telematics value chain to play a much greater role than being just the data pipe. In the business case with Verizon, it acts as an end-to-end solution provider, from customer attraction, device deployment, data collection, transmission,

analysis to related service provision. Through payments for the bundle service fee to Verizon, the entire cycle of telematics service becomes activated and simple for end users. The acquisition of Verizon over Hughes Telematics in 2012 is a key success factor in this case, while data analysis and service provision are the core capabilities on the value chain. Another telecom giant – Vodafone – made a similar acquisition in 2014. Cobra Automotive Technologies was acquired by Vodafone PLC in August 2014 for €145 million to offer end to end solutions, including automotive telematics and electronics.

To explore more value of individual's driving data, Verizon also cooperated with some insurers, which could provide UBI for end customer. UBI, also known as "pay as you drive" is a data based automobile insurance, which determines each insurance premium based on individual's data, such as driving mileage, driving behavior, time and place.

Figure 6: The benefits to adopt UBI for each party

End users	Insurance company	MNOs	Device providers/TSP
► "Good" driverswith short mileage, cautious driving style and low frequency ► Reach up to 25% or even higher price discount	► Fraud and claim cost reduction ► Customer experience and loyalty enhancement ► Product differentiation ► Better pricing	► More potential opportunities in advance through the cooperation with insurance company, such as remote video damage assessment	► More channels for device sales ► Good use case of exploration of individual's driving data

UBI is a win-win product for both insurers and end consumer, as for those "good drivers" with short mileage, cautious driving style and low frequency, the price discount could reach up to 25% or even higher, which is believed fair enough. And for insurers, the data recording could help to reduce claim costs, avoid fraud, enhance customer experience and customer loyalty, achieve product differentiation and even acquire better pricing .

The UBI is not a new phenomenon as the US insurer Progressive Insurance introduced the first UBI to the market in 1998. After that, key players, i.e., MNOs, TSPs, OEMs and device providers entered the market to share the revenue. With development of whole telematics service, the amount of UBI customers is expected to grow from 5.5 million in 2013 to 107 million in 2018 with a compound annual growth rate of 80%.

Fleet management is another topic we could not ignore on enterprise-customer market, especially for the logistic industry. It offers real-time visibility into virtually every aspect of fleet operations - driver performance including vehicle location, fuel consumption, travelling mileage, speed and idle times. According to a report from Verizon (2015), which surveyed more than 1,100 business owners, fleet operators, and general managers, seven primary benefits of GPS fleet management are expected to realize under two categories, operation improvement and cost saving. Another report from Frost & Sullivan (2013) finds that fleet management system increase productivity up to 10-15%, with 20-30 minutes per driver per day saving. Users also experienced 10-15% reduction in overtime. With these significant outcomes, fleet management industry is expected to grow in upcoming years. Huawei estimated that the Global Fleet management market is expected to reach US$21 billion by 2022.

Figure 7: Top 7 benefits of FM（%）
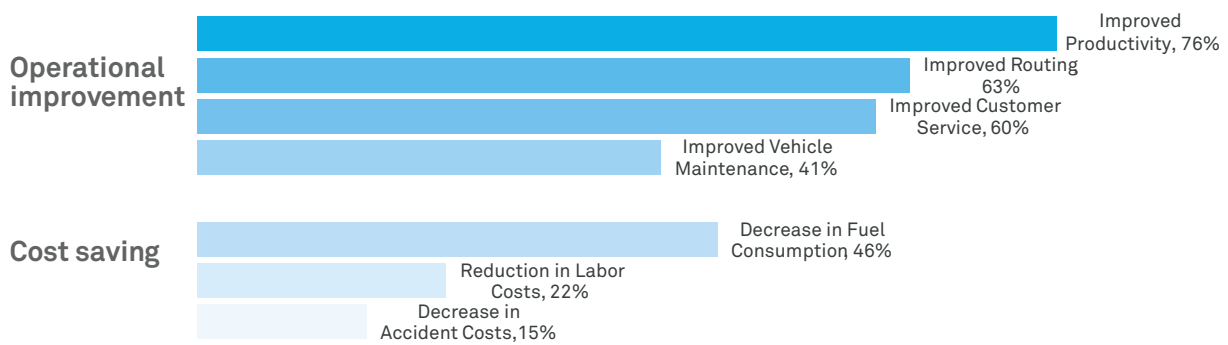
Source: Verizon Fleet and Vehicle management Survey Report 2015

According to a report from Analysys Mason (2014), fleet management generated higher average revenue per connection (ARPC) rate than average for M2M. In developed markets, the average fleet management ARPC is about US$25 per month, and can be as high as US$50 for an end-to-end service. However, pure connectivity ARPC can be as low as US$5 per month. In the B2B market, OEMs-led, solution providers-led and MNOs-led business models are common in most countries and regions. Verizon Networkfleet as Verizon fleet management solution combines patented GPS and telematics technologies to create a comprehensive fleet management system. The installed Networkfleet units can monitor vehicle location, engine diagnostics, and other fleet performance metrics and provide vehicle alerts, track vehicle locations, and driver behavior via desktop computer, smart phone, or tablet to fleet operator. As we talked above, Verizon has the capability to provide the end-to-end solution, while they acquired a TSP company Hughes Telematics with its subsidiary Networkfleet as a part of the Verizon own fleet. In order to enhance the capability and competitive advantages in this market, Verizon recently acquired Fleetmatics, a global leading telematics provider in Fleet management market, for US$2.4 billion.

More objectively, MNOs have unique advantages in telematics service such as network technology, huge customer base, better understanding and capability of data privacy and security, abundant experience of customer support service; meanwhile they also have disadvantages, such as lower bargaining power and limited industry knowledge. In a nutshell, telematics service is a good immediate revenue resource and also the only way to a have better positioning in the fully connected car world.

For consumers and small size or low-end OEMs, the aftermarket are still attractive in the next few years.

The aftermarket still has a huge potential in the next few years, and there are some obvious advantages of the aftermarket, which could be more attractive for consumers and also for small size or low-end OEMs on build-in market. Car performance and data-based services do not have positive connection. The aftermarket could offer more customer-centric and innovative services. And for small size or low-end car makers, the high cost of embedded modules and the lack of capability to provide telematics service are the pain points. The active cooperation with powerful aftermarket players can satisfy the customer needs in a right way and avoid a lot of risks, such as reliability of device quality, guarantee of data privacy and security.

a. In the short term, MNOs could acquire or partner with various sector stakeholders (such as device provider and TSPs) to launch services in the aftermarket as soon as possible.

   ▸ Build core competence through acquisition of telematics service, which will in the long term be beneficial to smart business in more vertical markets.

   ▸ Accelerate device deployment, customer experience and flexibility of partnerships under different situation are keys to win the aftermarket.

   ▸ The business models of UBI and fleet management are relatively clear. MNOs could generate revenue immediately and also have the opportunity to dig more value in the vertical markets, such as precision advertising, video damage assessment services and digital insurance support services.

b. Meanwhile,

connected car services will lean to built-in market. MNOs need to establish partnerships with OEMs to have discourse power.

▸ MNOs could leverage data collection and data analytics capabilities to support OEMs.

▸ Partner with OEMs to offer customer support services such as subscription management and charging/billing services.

1.2.3 Data-enhanced automated functions and self-driving[16]

Vehicle-to-Everything (V2X) communication, which enables vehicle to communicate with other vehicles, traffic lights, toll gates, pedestrians, and even the owner's home, is the automotive sector's answer to safe, clean and ultimately self-driving vehicles. With V2X technology, real-time vehicle data will be collected by on-board hardware, and through networks, be processed to the cloud services and analyzed for correct information to push to other end users within the appropriate range. The application such as intersection collision warning, traffic light speed advisory, road work warning, emergency vehicle warning, in-vehicle signage, etc., are only supported by V2X.

As the most developed communication technology for V2X, Dedicated Short-Range Communication (DSRC) came into being in the 1990s. In the past 20 years, various governments, standard institutions and OEMs have invested heavily in DSRC technology development and application. The US Department of Transportation specifically sets up its strategic priorities for 2015 to 2019: to realize connected vehicle implementation and advancing automation based on DSRC technology. But till now, there is no unified standard of DSRC technology worldwide. The US, European Union and Japan have been

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[16] "Digital in Automotive", EY, April. 2016

developed separated standard of DSRC, which limited the whole industry development to some extent. And another critical reason for the slow development of DSRC is that some OEMs do not believe that DSRC will fulfill all the requirements for future autonomous driving and ITS system.

LTE-V, also known as LTE Vehicular or LTE-V2X, is developing fast and attracts more and more attention in recent years. LTE-V can be rapidly and inexpensively deployed by reusing the existing cellular infrastructure and spectrum. With the feature of one chipset for all, LTE-V generates lower integration costs for car OEMS.

> **Comparing with DSRC, LTE-V has its special features, such as lower latency, which means that LTE-V can be better suitable for high density or bad weather situation.**

According to Huawei analysis, with the same user density, the reliability of data transmission by LTE-V is much higher (70%) than DSRC. From economic perspective, LTE-V is a better solution for V2X deployment, which complies with the development of sharing economy. The value of LTE-V has aroused the interest of some MNOs, car OEMS and other parties. For instance, MNO giants from European countries have started to work with several car companies on trials of LTE-V technology, although some car companies have spent a lot of money and more than 10 years on DSRC's technology assessment and commercialization. Thus, there are some LTE-V supporters, who believe that with the late-mover advantage the new technology would supplement or even totally replace DSRC in the future.

Despite all the challenges for all players such as data privacy, safety and security, and lack of clear business model, OEMs, governments, MNOs and several other kinds of players are still enthusiastic in this market. The end users show high willingness to pay for safety related service and are also interested in advanced technology, such as self-driving car, which could take place of the eyes and ears of the drivers in their future driving with fully developed and mature V2X technology.

Self-driving technology will make more economical, efficient and secure transportation a reality. It will also bring car-sharing to a new era by maximizing car-use efficiency. One self-driving car can serve various people at different times of a day, which shortens inefficient use time and improves convergence of car using. Currently, some major automobile manufactures plan to launch self-driving car in upcoming years. More and more IT companies also come across sector border to develop self-driving car projects to pose a significant threat with a larger play in the mobility ecosystem. Though there is no requirement of mobile Internet access for those V2X technology or self-driving prototypes, in the long run, network that supports data communication in-between vehicles would be essential to enable the solution of autonomous driving, such as 5G, or even maybe a kind of dedicated network for better data safety and security.

So it is important for MNOs to think of strategies and solutions for a better position in the value chain to free itself from the limitation of being a data pipe. As business case remains unclear, Leading MNOs need to act more proactively to lobby government for legislation supports and standard selection, convince OEMs to establish partnership, and cooperate with different service and solution providers for total solution options.

> **In the long run, 5G or maybe a kind of dedicated network would be essential to enable the solution of autonomous driving.**

»»» 2 Smart parking

2.1 Better life with smart parking
Searching for parking spot wastes time, petrol, and might also cause traffic congestions and CO2 emissions.

8% to 74%

Based on a UCLA study (Shoup, 2007), 8% to 74% of traffic congestions in downtown areas are caused by drivers cruising for parking spots[17].

US$129,561

According to a study by Transportation Alternatives (2008) in 15-block area in Manhattan, drivers circling for parking translates to waste more than 50,000 hours and US$129,561 worth of fuel.

325 tons

And in Manhattan, it cause 325 tons of CO_2 emissions annually[18].

But all these problems will be solved easily with smart parking, which uses the technology of IoT and mobile payment to optimize the parking experience. In addition, smart parking could reduce traffic congestion and maximize the parking lots utilization.

The better mood for commuters starts from smart parking. Stephan will no longer worry about being late to the appointment with clients. He could find a parking spot near his destination and book it in advance. He could find the exact parking space even in a huge indoor parking lot through real-time navigation. And after his meeting, he could directly leave without going through the parking lots to pay for his tickets or wait in line before he could drive out home. The smart parking solution includes a function that allows the parking fee to be paid automatically. How could this all become real? While the NB-IoT times comes! By using IoT cellular module

under parking spot, real-time status and allocation of parking spots are able to transmit to a platform where the driver's parking demand being collected and matched at the same time. It is very easy to install the cellular module indoor and outdoor by digging a hole underneath the ground. This sensor module is designed with energy-saving technology and expected to last over eight years.

2.2 Government and solution providers are the key drivers
In general, areas with high population density and increasing automotive growth rate face more critical challenges, such as New York and Los Angeles in North America, Beijing and Singapore in Asia. Based on local factors like population and per capita car, different regions face different pain points in parking. These local factors significantly influence the business models that smart parking providers focus on. For example in China,

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[17] "Cruising for Parking," Elsevier Ltd, http://shoup.bol.ucla.edu/Cruising.pdf, accessed May 2016.

[18] "Driven to Excess: What under-priced curbside parking costs the Upper West Side," Transportation Alternatives, https://www.transalt.org/sites/default/files/news/reports/2008/Driven_to_Excess.pdf, accessed May 2016.

due to the development of e-payment, majority smart parking solution providers enter the market through optimizing the parking payment experience. In contrast, solution providers in the US are mainly focusing on providing parking spots navigation to drivers, as the result of heavy traffic in certain downtown areas, and they are usually funded by government.

In the recent decade, several cities are actively piloting smart parking in two models: as smart parking is considered one of the most important components of the smart city concept, local government usually plays the leading role and invests the majority of the capital in smart parking pilot in Europe and North America, such as Barcelona, Westminster and San Francisco. The other common business model is led by smart parking solution providers, such as ParkMe, ParkHelp and Streetline.

Figure 8: Business model of smart parking

Type	Description	Feature	Case
GOV-led	▸ Government chooses partners to trial in certain areas; ▸ usually combine it with smart city solution platform.	▸ Majority funds from GOV ▸ Connected to smart city platform	▸ Orange with Streetline ▸ Telefonica
Solution provider-led	▸ Solution provider provides integrate solution, combining payment provider and parking lot providers	▸ Lots of solution providers in market ▸ No one has monopoly position	▸ ParkMe ▸ ETCP ▸ Easy Parking

Smart parking in France was led by the government, and Orange is a leading partner joined forces with Streetline (a smart parking solution company) to develop the solution. Orange relies on its expertise providing network to connect sensors to the management platform and is responsible for deploying infrastructure and providing support to the solution. As one of the leading smart parking solution providers worldwide, Streetline plays a more important role in the value chain, such as data collection, data analysis and related service provision. The top-down approach also appeared in Westminster (London), Santander and Moscow.

ETCP is currently the most remarkable smart parking service provider in China, whom has received US$50 million in its first round financing, the largest financing in the smart parking industry. With the ETCP App, drivers can be navigated to proper parking lot near the destination. In addition, ETCP has developed a non-stop electronic payment system for parking, which uses camera to catch the license plate number of car and bills the driver automatically. ETCP has successfully implemented its modules in over 2000 parking lots covering twelve cities in China, and it aims at achieving 7000 by 2016. In the typical solution provider led case, ETCP controlled the whole value chain, from infrastructure rebuilding, customer attraction, data collection to data analysis and billing. Only the bill payment was conducted by the third party. There are some similar cases such as Easy Parking in China and Park 24 in Japan.

2.3 MNOs can lead smart parking to a smarter era

Without a major player dominating in the smart parking market and continuous improving upgrades on the method itself, MNOs have the opportunity to boost its market share in the industry with its advanced technology and customer experience as a total solution provider.

Firstly, comparing with other players in the ecosystem, MNOs have more opportunities to cooperate with government (be the unique partner of government and combine smart parking with smart city solutions).

> If the MNOs lead the smart parking market, the infrastructure upgrade, such as NB-IoT network, will benefit the whole smart city program.
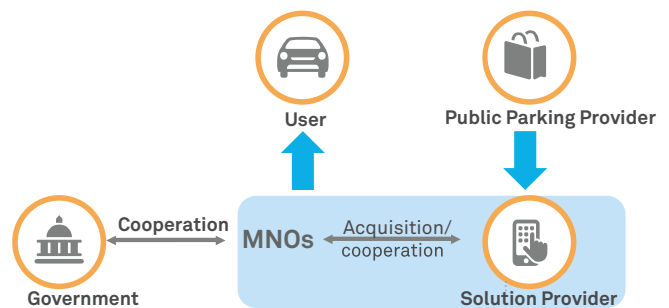
Several MNOs have already launched their smart city platforms with smart parking services through cooperation with third party service providers, such as Orange with Streetline and Vodafone with smart parking. At the same time, MNOs could ask for public parking lots resource supports from the governments.

> Secondly, smart parking without broad parking lots coverage or large amounts of end users would never be able to realize real "smart".

MNOs have the largest customer base and the widest network comparing with any other players in this market, while they also have expertise in infrastructure reconstruction and end customer attraction.

Of course, MNOs should carry out various marketing entry strategies in different markets. For example, acquire parking solution providers to provide the whole solution in fragmented market such as China, but be strategic partner of parking solution providers in the relative closed market region, such as Japan.

Figure 9: Ideal business model for MNOs

User — Public Parking Provider

Government — Cooperation — MNOs — Acquisition/cooperation — Solution Provider

»» 3 Emergency Service Network (ESN)

3.1 Outdated ESN could no longer meet the demands of homeland security and emergency services

Have you ever imagined what will happen in an emergency if there is no secure, reliable and fast network service? In case of road accidents, terrorist attack or nature/human-caused disasters, critical services, i.e., police, fire-fighting and rescue, and ambulance, must have the highest priority for accessing reliable network services to save lives and avoid more loss. Globally, the necessity and benefits of ESN is acknowledged by all the governments, and many of them have adopted different types of emergency network according to their own status. But there are still a lot of issues remained in the current ESN:

▸ **Low efficiency:** In most cases, police, ambulance, fire/rescue have their own network and communication system. It is very hard to collaborate all the rescue resources effectively and efficiently in such case. When there is any huge event, the time consumption in-between information mismatch of different platforms significantly delays the quick response team to take action to emergencies.

▸ **Low performance:** Some ESN were built with an out dated technology, it still relies on the technology that supports with audio services only, with no data transfer function. Nowadays, emergency service operation have become increasingly information driven. In the US and the UK, the police officers are equipped with body on board cameras which can record the images instantly onto the cloud from what they see. The cloud then processes with live stream of those videos from the first person perspective from any officer and deliver to all the nearby officers

for situation assessment and support. In Australia, Victoria Police's traffic enforcement vehicles also use mobile broadband with in-vehicle video, automated number plate recognition systems for alerting officers of stolen or unregistered vehicles.

▸ **Low security:** In many countries, medical emergency service workers are still using open public radio frequencies, which can be received by all personnel with a radio. This maybe a remaining security backdoor when terrorists or criminals hack into the public channel.

▸ **High cost:** Fragmented service network by region or service function means more than one type of system, software, and hand device. The total cost for several service network cost more.

In order to build a more efficient, more reliable, less costly and more collaborative ESN, many governments are increasing their funding into this subject. Markets and Markets forecasted that Public Safety and Security Market can increase from US$220.82 billion in 2015 to US$370.64 billion by 2020, at a 10.9% compound annual growth rate (CAGR). At the same time, the global wireless broadband in public safety market is estimated to increase from US$15.5 billion in 2014 to US$22.9 billion in 2020, at a CAGR of 6.8%.

3.2 Lean to cost saving or absolute guarantee are keys to technology selection

Governments take the ultimate leading role in the ESN's ecosystem. They have the decision power of the ESN budgets and methods, which affects the whole industry's business model, the network and related partners. More and more countries have begun to consider the wireless broadband as a new technology solution for the ESN, which is expected to bring the greatest opportunity for the MNOs to show their strong capabilities of network construction, operation and maintenance. Currently, there are three typical approaches adopted across the global market: separate dedicated network, negotiating priority access to commercial networks, and "spectrum-as-a-service".

Figure 10: Use cases of Emergency Service Network

Model	Dedicated network	Priority agreement with commercial network	"spectrum-as-a-service"
Example country	▸ US(FirstNet), Canada, South Korea, Finland(population centers)	▸ UK(ESN,Lot2), Belgium, Finland(remote areas)	▸ Australia
Description	▸ Separate network solely for emergency service use. ▸ Always operates on dedicated spectrum	▸ Commercial network(s) with priority for emergency service users. ▸ Does not normally include dedicated spectrum, but it can	▸ Commercial network wit priority access for emergency service users. ▸ Variable amount of spectrum dedicated for emergency services use when required
Ownership	▸ Government	▸ Commercial	▸ Commercial
Costs	▸ Fixed(high)	▸ Fixed(lower)	▸ Variable
Infrastructure	▸ Require new infrastructure	▸ Uses existing infrastructure	▸ Uses existing infrastructure
Bottom line	▸ Reliable but expensive	▸ Lower cost, some increased risk	▸ Possible compromise between risk and price

The US government has started building a separate dedicated network (FirstNet) for emergency responders since 2012. The massive project is not expected to be finished until 2022. In this project initiated by the US government, 2.8 million first responders will be participating in the new ESN, including firefighters, law enforcement officers, emergency management officers, Federal government protection services and also other public safety employees. FirstNet emergency network is a separate (4G LTE) wireless broadband network operating separately from the commercial broadband, which covers all the soil of the US. The advantage of such dedicated network is that it enables the absolute usage of network for the ESN responsive teams. However, the whole new set of network costs the government US$7 billion, the state and local implementation US$135 million, and research institutions US$100 million.

In order to control the high cost of dedicated ESN, the UK government chose EE (Everything Everywhere) to deliver a commercial 4G network based solution for the British ESN, which is believed to save £1 million per day compared to previous cooperation with Tetra. With the extensive coverage, high resilience, more efficient and appropriate security offered by the EE 4G-LTE, the British government will pay £1.2 billion network rental fee in five years for EE. In addition, EE would benefit from enhanced customer experience though wider coverage.

The Australian federal government has initiated a formal cost benefit analysis for allocating spectrum to a dedicated national ESN and sought out a compromise solution between cost and grantee. LANES (LTE Advanced Network for Enterprise Services), whose dedicated spectrum can be ramped up when required, with usage based price, has been trialed with police forces in Australia. The most essential partner of this model is Telstra, which provides a "spectrum-as-a-service". The provisioned spectrum is a combination of a fixed amount of spectrum dedicated for the use of first responders and a variable amount of priority public spectrum allocated on an "as needs" basis. This spectrum holds an absolute priority over other networks. It is a win-win solution for both government and Telstra. For the government, the ESN service could be launched with relatively shorter time and much less initial costs while the dedicated spectrum is guaranteed and the existing network infrastructure can be fully utilized. As for Telstra, the expansion of network could benefit its customers and enhance its brand and coverages.

3.3 Irreplaceable positioning creates great opportunities for MNOs

MNOs have the irreplaceable role in terms of network construction, maintenance and daily operation in the ESN ecosystem. The extensive coverage and high resilience commercial network offered by MNOs provides an alternative resource in emergencies. Given the increasing needs of those service upgrades in each country, the MNOs have great potential to go into the emergency service network business. In countries that have not developed ESN, MNOs could lobby the governments to invest in this area.

> For countries with existing dedicated ESN, the MNOs could demonstrate enough reserve capacity to justify government's technology selection

with the existing business model with the UK and the Australian governments. It provides much higher quality and lower cost to appeal those governments to accept potential transformation. In countries that have limited spectrum resources, MNOs can exchange network resource with government. For example, the government assigns spectrum at a discounted price or free to MNOs, and in return, the MNO should guarantee the absolute priority of network for public safety service.

In addition, with increasing concern levels of transportation-related terrorism, cases of theft and disturbance of public transport systems, the demand of video surveillance is becoming higher and higher. MNOs' mobile network is critical for the areas without broadband coverage.

Managing the smart transformation journey

Although governments and OEMs are playing leading roles in the transportation ecosystem, MNOs have the capabilities to accelerate the development of smart transportation. From the technological perspective, commercial network with characteristics of wide coverage, high reliability and low latency supports data communication in-between vehicles and surroundings, which would be essential for the realization of fully connected world. In addition, MNOs are well positioned in construction and operation of dedicated network, which are the key competencies for ESN. Furthermore, MNOs have huge customer base and frequent customer interaction with end users. More importantly, as the industry is closely connected to homeland security and people's daily lives, telecom operators have naturally close relationship with government. MNOs could lobby the government to issue related regulations and laws, policies and technology standards.
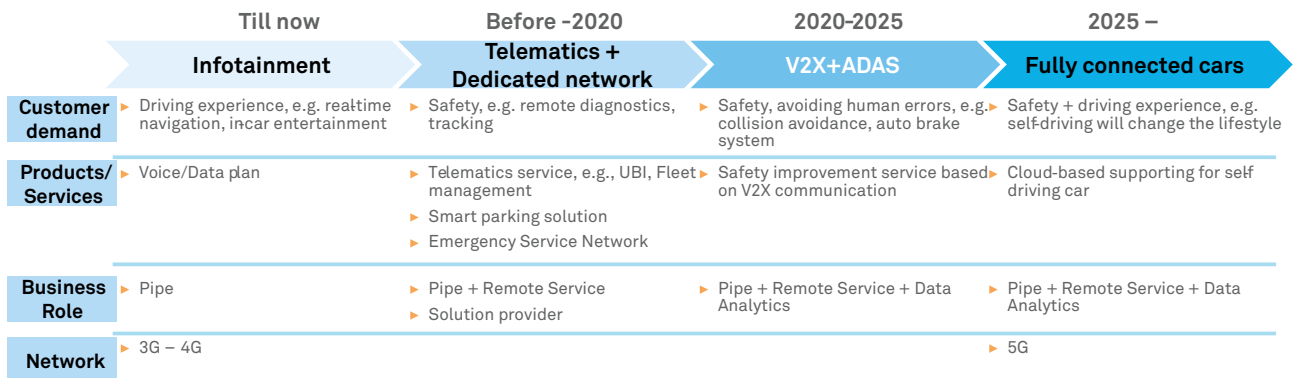
Figure 11: Core competency of MNOs
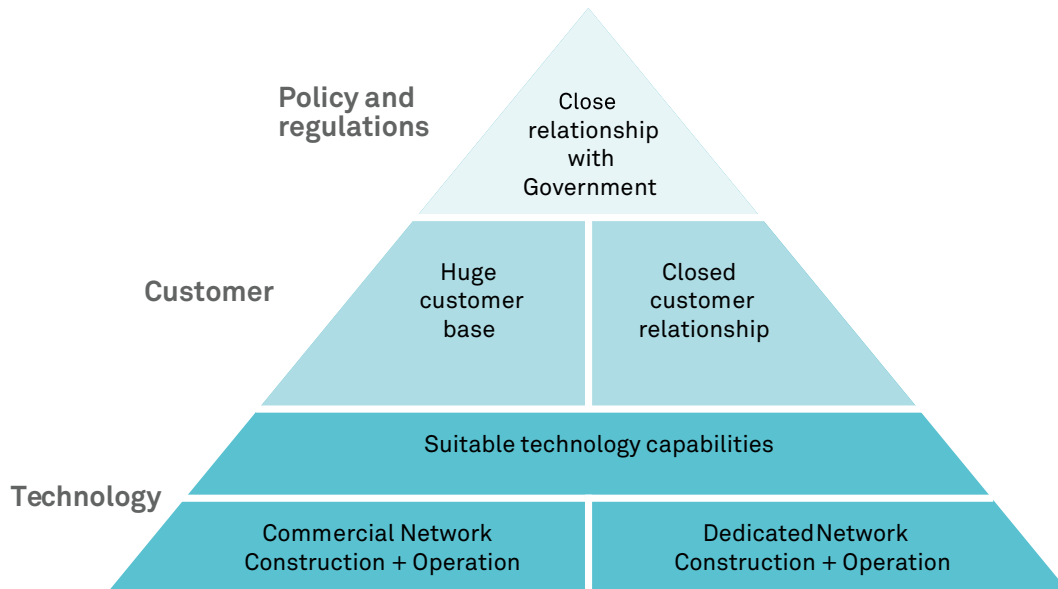
Based on customer demands and technology maturity we design the roadmap for MNOs to play valuable role in smart transportation. They have three major actions to be taken in the next five years:

▸ **Proactively involve into telematics service market from embedded new vehicles market and add-on solutions for second-hand vehicles market.** They should, through fast end devices layout, collect consumer data and develop data analysis capability so as to lay a better foundation in the upcoming V2X and fully connected cars market.

▸ **Leverage their advantages in existing technologies to provide end-to-end solution** of smart parking and create new revenue stream based on NB-IoT technology.

▸ **Lobby the governments to accept the concept of ESN and understand the developments of ESN based on the public commercial network,** which is a highly reliable but low-cost solution. Play the irreplaceable role of network construction, maintenance and daily operation.

	Till now	Before ~2020	2020-2025	2025 –
	Infotainment	**Telematics + Dedicated network**	**V2X+ADAS**	**Fully connected cars**
Customer demand	▶ Driving experience, e.g. realtime navigation, incar entertainment	▶ Safety, e.g. remote diagnostics, tracking	▶ Safety, avoiding human errors, e.g. collision avoidance, auto brake system	▶ Safety + driving experience, e.g. self-driving will change the lifestyle
Products/ Services	▶ Voice/Data plan	▶ Telematics service, e.g., UBI, Fleet management ▶ Smart parking solution ▶ Emergency Service Network	▶ Safety improvement service based on V2X communication	▶ Cloud-based supporting for self driving car
Business Role	▶ Pipe	▶ Pipe + Remote Service ▶ Solution provider	▶ Pipe + Remote Service + Data Analytics	▶ Pipe + Remote Service + Data Analytics
Network	▶ 3G – 4G			▶ 5G

In this report, we discussed the potential opportunities for MNOs in four vertical markets of smart transportation, including telematics, V2X, smart parking and ESN. We analyzed the ecosystem, key players and current business models for each market and also proposed new positioning for MNOs, for example, to be the TSP through acquisition like Verizon in telematics; to be the total solution providers through upgrading network to NB-IoT and aligning smart parking with smart city programs; to be a leading player, actively involving in the technology standard setting of V2X and upgrading network to guarantee the achievement of V2X; to be a new solution provider to lobby government to have second thoughts on the new technology options for ESN. Considering regional policy and regulation, market environment and different strategies of MNOs, we hope this report could stimulate your inspiration to explore or create more use cases, leading us to a wonderful smart future.
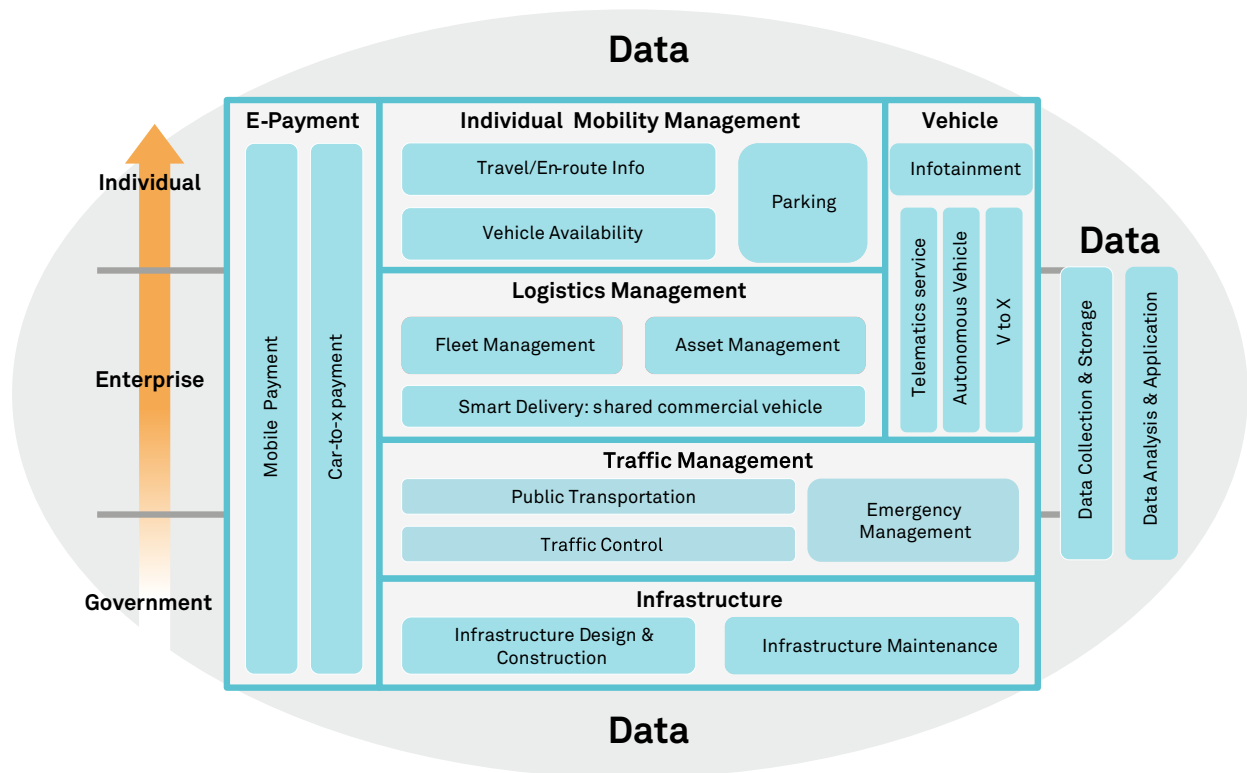
Methodology

According to the concept of Intelligent Transportation System (ITS) from the US, Japan and European Union common practice and based on our research and understanding, we have designed a framework of smart transportation as bellow:

Figure 13: Framework of smart transportation

The definition of smart transportation contains a very wide range of sub-topics, considering different target customers (government, enterprise and individual). We further divided smart transportation into five domains, including infrastructure, traffic management, logistics management, individual mobility management and the vehicle itself. Through the segmentation analysis of both potential market size and demand for wireless network, we have identified four major opportunities for MNOs, i.e., telematics services including UBI and Fleet Management, smart parking service based on the NB-IoT network technology, ESN based on LTE network and V2X service based on LTE-V or 5G network.

Based on the ecosystem analysis for each vertical market including market size analysis, key player comparison, current mainstream business models and SWOT analysis for MNOs, we propose the future positioning beyond merely being a pipe and also the high-level roadmap for MNOs.

In order to confirm our understanding for the future stage of MNOs, we interviewed multiple executives of leading telecom operators and players from vertical industries. Although they have different strategies and focuses in the IoT markets, they further affirmed the market analysis of our preliminary research and agreed with the advices for future MNOs business expansions we put forward.

Acknowledgments

This report provides a unique perspective to analyze MNO's new business proposition and addressable market based on the value chain analysis of Intelligent Transportation Industry. And the paper points out a new way on how the transportation industry could realize digital transformation by leveraging the capabilities of MNOs.

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