

# M2M Network for Smart Mobility

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In smart mobility, information is gathered from vehicles and in-vehicle devices and is analyzed as big data. The analyzed data is then provided to drivers and vehicle manufacturers as a service. To provide information to and gather it from a vehicle and an in-vehicle device, a wireless network is used as a machine-to-machine (M2M) network. However, when the number of vehicles providing data increases from tens of thousands to millions, communication traffic increases and quality degrades. Additional issues facing smart mobility include increased communications cost and the need to ensure security on the network while providing various services. Fujitsu ENhanced Information and Communication Services (FENICS) II Business Network, which is a set of network services offered by Fujitsu for enterprises, offers FUJITSU Managed Infrastructure Service FENICS II M2M service that can solve these issues related to M2M and Internet of Things (IoT). This paper describes our M2M network which can support smart mobility and explains FENICS II M2M service in detail, including application examples.

## 1. Introduction

In recent years, the information and communications technology (ICT) field has experienced diversification and high functionality of network terminals, expansion of bandwidth, further spread of wireless communications and global network roaming, diffusion of cloud services, as well as cost reduction in each area. As a result, greater attention has been given to the concepts of Internet of Things (IoT) and machine-to-machine (M2M) networks, which can connect a wide range of “things” over a network. Based on these concepts, M2M networks directly connect one machine to another and automatically controls them without human intervention, and are useful for cost reduction and improved efficiency. The use of M2M networks has begun.<sup>1)</sup>

In 1985, Fujitsu entered the telecommunications business, providing Fujitsu Enhanced Information and Communication Services (FENICS).<sup>2)</sup> Since 2002, the FENICS Service has been conducting a mobile virtual network operator (MVNO) project which employs a wireless network. Fujitsu has accumulated much know-how regarding M2M networks through its participation in the “IPv6 Deployment Field Trial” (2003–2006)<sup>3)</sup>

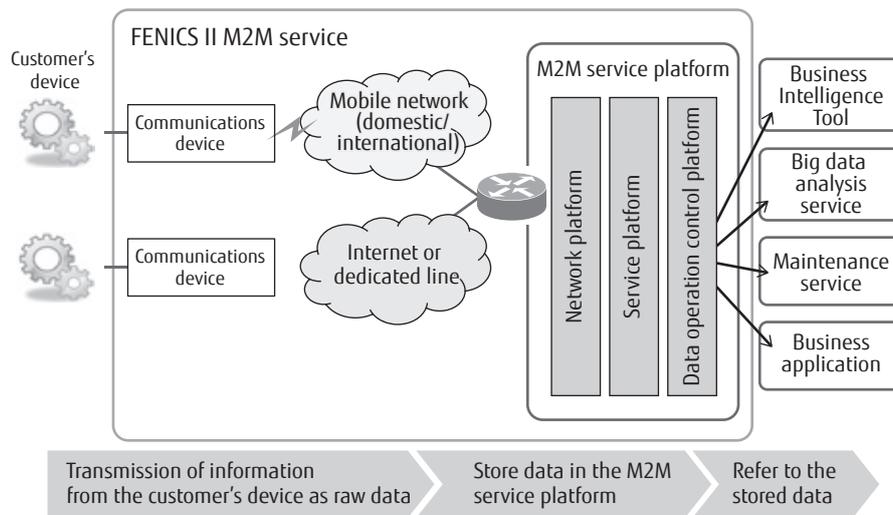
related to peer to peer (P2P) networks, where various “things” communicate in a similar manner as in an M2M network, held by the Ministry of Internal Affairs and Communications, and joint experiments in mechanical remote control with Amada Co., Ltd. (2007–2009).<sup>4)</sup> Furthermore, provision of FUJITSU Managed Infrastructure Service FENICS II M2M service<sup>5)</sup> (Figure 1) began in August 2010.

FENICS II M2M service provides subscriber identity module (SIM) cards, communication devices (M2M-GW<sup>6)</sup> etc.), domestic and international mobile communication networks, and a cloud environment for various “things” (machine tools, vending machines, construction equipment, farming equipment, and cars. etc.), all in one-stop.

This paper describes FENICS II M2M service in detail and includes application examples.

## 2. M2M network

In smart mobility, objects essentially move, so the M2M network connection should be wireless, not wired. Types of wireless setup and use methods are described below.

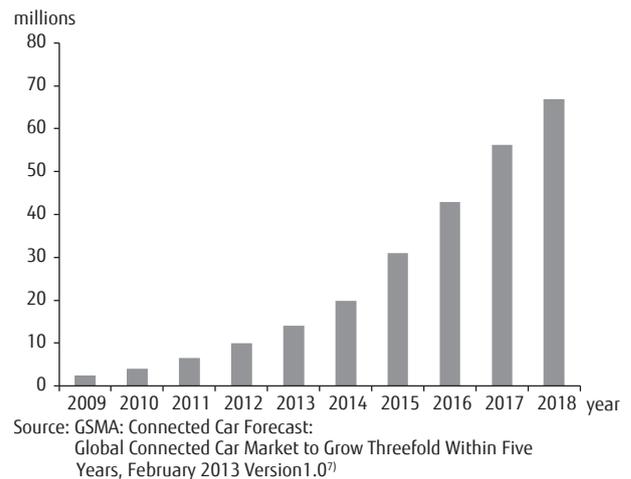


**Figure 1**  
FENICS II M2M Service Overview.

- 1) Mobile communications (roaming)  
Communication over a mobile carrier network, used for communication between a moving vehicle and the data center.
- 2) Satellite communications  
Communication via artificial satellites, used in isolated mountain areas and over the ocean where mobile communication is not available.
- 3) Wireless ad hoc network  
Wireless communication to connect a lot of terminals mutually. It is used for inter-vehicle communication and road-to-vehicle communication when information is collected from a parked vehicle.
- 4) Near field communication (NFC)  
Short range communication between devices (car audio and smartphone, etc.) within the vehicle.  
Currently, as communication range expands and the cost of communication modules decreases, the use of mobile communications are expected to spread rapidly (Figure 2).<sup>7)</sup>

### 3. Advantages and challenges of M2M network application

The advantages and challenges of application of the M2M network are described here.



**Figure 2**  
Actual sales and forecast of the number of communication devices for vehicles (2009-2018).

#### 3.1 Advantages

- 1) Drivers
  - A person in the vehicle does not need to input information.
  - Outside information services, such as real time drive support and online to offline (O2O) can be received.
  - Status of the vehicle can be obtained even when away from the vehicle (remote engine starter [RES], anti-theft measures, etc.).

- 2) Service companies (transportation companies and taxi companies)
  - Operation of the driver can be supported remotely.
  - Vehicles can be managed remotely, based on location information, etc. using location-based services (LBS), etc.
  - A reduction in fuel costs can be achieved by following the driving guidance based on fuel use information.
  - A reduction in accidents can be achieved by following the driving guidance based on traffic information, and insurance costs can be lowered.
- 3) Car manufacturers
  - New products and new services can be developed based on driver use information.
  - Inventory management, quality control, and recall countermeasure can be carried out based on vehicle use information.
- 4) Car sales companies
  - Information can be collected without actual observation of the condition of the vehicle or asking the driver.
  - Marketing based on the vehicle use information can be carried out.
  - Effective support can be provided by failure prediction based on the vehicle use information.

Moreover, new business models, such as a data platform service that collects information (big data) from vehicles and drivers in real time and a convergence service<sup>8)</sup> that provides analysis results from the information, have begun to appear.

### 3.2 Challenges

- 1) Increase in communications cost

When using an M2M network, continuous connection to the network while driving is needed in order to send real-time information such as car location and to receive services based on such information. In addition, as image sensor technology advances, large data files such as images and movies are more commonly used. These factors lead to an increase in communication traffic. Since most mobile communications in M2M network are metered, communications cost increases as communication traffic increases. Especially for countries outside Japan, charges are based on the amount of data communications, so this will be a major issue when using a local carrier or international roaming.

- 2) Vulnerability of the system through the network connection

When a vehicle is connected to the network, threats such as hacking, eavesdropping, and falsification of the car system are present. In particular, eavesdropping of controller area network (CAN) data and falsification of electronic control unit (ECU) firmware are of concern.

- 3) Greater system load

The number of the vehicles which would use the M2M network range between tens of thousands and millions. Consequently, as communication traffic and the number of persons accessing the system increase, there is greater risk in degradation of the quality of the communications or instability of the service.

### 3.3 Others

- 1) Privacy issues

In the smart mobility, information regarding personal vehicles and individual drivers is used. Therefore, much attention must be given to the handling of such personal information.

- 2) New business model

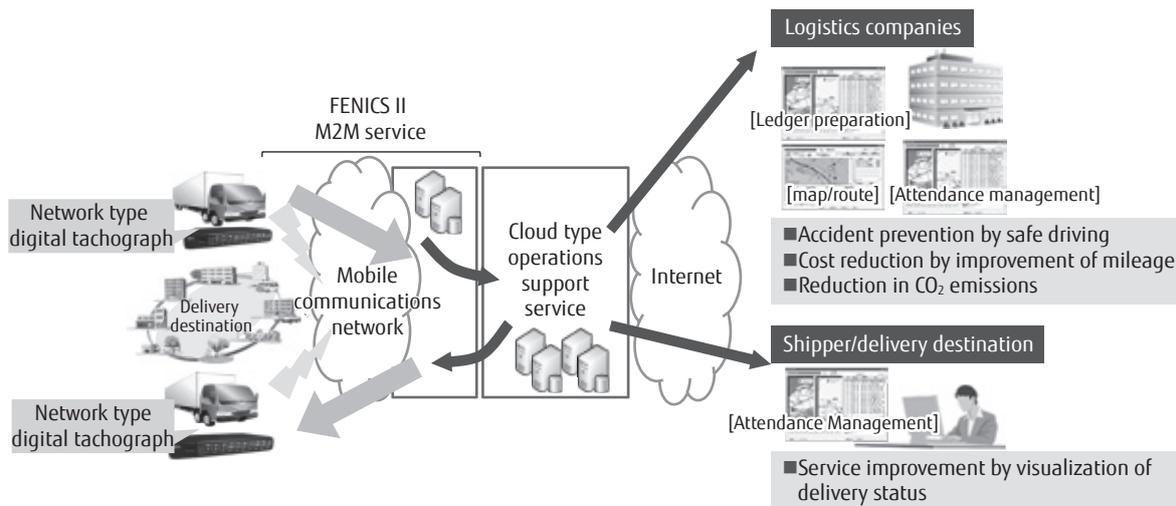
Most services which apply an M2M network for smart mobility are relatively new. Therefore, cost recovery for any added values, and careful consideration of the business model with regards to the appropriate price or even free of charge should be carried out in advance.

## 4. FENICS II M2M service

The FENICS II M2M service was developed to address the challenges in the M2M network as described in the previous chapter. This one stop service includes SIM cards that can be installed in the control objects, communication terminals, and modules, as well as a mobile network and a cloud environment which can be used both domestically and globally. In addition to converting individual identifying methods and various data forms from multiple telecommunication carriers, and providing them for application software in a unified manner, this system can temporarily store the operation information of the control object, and search by the customer application services as needed.

### 4.1 Features

- 1) Compatibility with multiple telecommunication



**Figure 3**  
Operations management solution.

carriers

By coordinating with multiple telecommunication carriers both local and international, a global mobile network can be provided. Multiple local carrier networks can be utilized by one SIM card. Since functions are provided through an integrated Web application programming interface (API), differences between carriers do not need to be considered.

2) SIM management, short message service (SMS) transmission

This service includes a SIM provisioning function which manages the start and stop of SIM usage fee charges and Wake up SMS function.

3) Compatibility with multiple protocols

A collection function that utilizes TTY communication, TCP/IP, FTP, or HTTP according the data output form of the communication terminals is provided.

4) One-stop support

M2M service can be provided 24/7 in Japanese or English.

5) High security (closed network)

An exclusive closed network is constructed and provided for each customer.

6) Type of service provision

Services, such as temporary data storage by the introduction of a WEB API, response to customer application software, and coordination with FUJITSU Cloud Service (FUJITSU Cloud IaaS Trusted Public S5:FGCP/S5<sup>9)</sup> etc.) can be provided.

## 4.2 Measures to address the challenges

1) Reduction in communication costs

Using services such as multi-carrier connection and/or small packet communication, the most appropriate plan can be provided to the customer. We can offer a competitive price based on the business results of the FENICS service.

2) Enforcement of network security

Unauthorized access to the network is prevented by utilizing Fujitsu's data center, encrypting all carrier connections, and constructing a closed network for each customer.

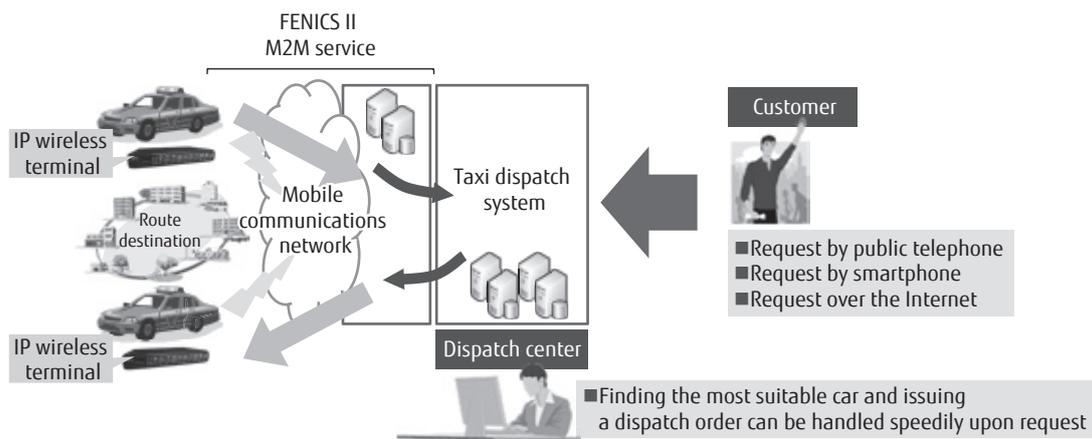
3) Control of system load

According to the work load of each customer, the FUJITSU Cloud environment offers reinforcement of the system and maintenance of the quality for the customer's services. Moreover, to avoid concentration of network connection verification or increase of communication traffic, suggestion can be provided for the customer's services based on our know-how of M2M service provision.

## 4.3 Application example of M2M service

1) Transtron Inc., a Fujitsu group company in Japan, launched digital tachographs in September 2009, and provided operation support solutions using a cloud system (Figure 3).<sup>10)</sup>

2) FUJITSU TEN LIMITED, a Fujitsu group company in Japan released Remote Engine Starter (RES)



**Figure 4**  
IP wireless taxi dispatch system.

system which can remotely start a car engine in North America in September 2012.<sup>11)</sup>

After downloading a dedicated application software and registering as a user, the user can remotely control engine start/stop, door lock/unlock of the vehicle from user's smartphone.

For these operation systems, FENICS II M2M service or FGCP/S5 is used.

- 3) In April 2013, FUJITSU TEN LIMITED released an IP wireless taxi dispatch system which could dispatch the taxi closest to the customer location by connecting a group of taxis to a network and collecting their information (Figure 4).<sup>12)</sup>

## 5. Future prospects

Currently, inexpensive 2nd/3rd generation (2G/3G) communication modules are mainly used. However, data generated by higher function sensors (such as video data from an event data recorder) requires a higher communication speed. Moreover, discontinuation of 2G services is planned (AT&T plans to end 2G in 2017)<sup>13)</sup> and reduction in the cost of communication modules is expected (Table 1). Hence, switching communication modules to a faster LTE network is considered in the near future.

Regarding SIM cards, progress has been made in the standardization of an Embedded SIM (eSIM) card which is built into a communication module. Data on the eSIM card can be re-written remotely and be used in a communication module on a local mobile carrier. When we apply an eSIM for a new local carrier, the eSIM

**Table 1**  
Change in price of communication modules and future prospects.  
(US\$)

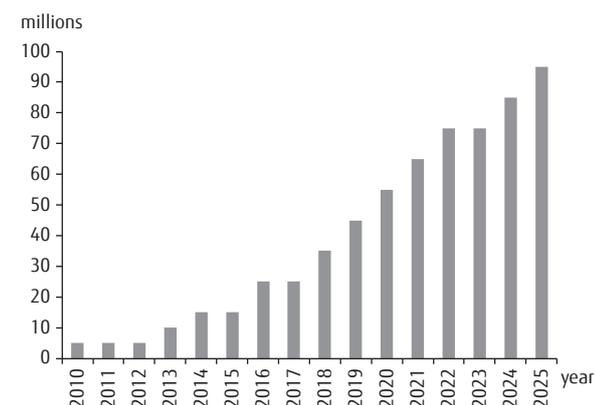
Communication modules for vehicles	2011	2013	2015
2G	30	25	20
2G/3G (WCDMA or CDMA EVDO)	65	59	55
LTE/3G/2G	N/A	120-150	80

Source: GSMA Connecting Cars: The Technology Roadmap February 2013 | Version 2.0<sup>14)</sup>

card does not need to be replaced. This feature will probably promote the use of eSIM when offering services in multiple countries.

With the installation of the Quasi-Zenith Satellite System (4 units will be in operation by 2019)<sup>15)</sup> in Japan, more accurate location information will be able to be obtained, and as a result, LBSs for vehicles are expected to further develop. Disclosure of information collected from vehicles and drivers makes it possible to link government open data<sup>16)</sup> more popular, such as traffic information of probe cars collected by individual private companies and vehicle operation accumulation and traffic restriction data<sup>17)</sup> jointly prepared by the Geospatial Information Authority of Japan and ITS Japan after the Great East Japan Earthquake. Services other than vehicle operation management, such as eCall (emergency call system by the European Commission)<sup>18)</sup> and in-vehicle infotainment systems (video and music streaming) have been also provided.

In this way, with further progress in technologies



Source: GSMA: 2025 Every Car Connected: Forecasting the Growth and Opportunity February 2012 Version 1.0 Figure 5.1.<sup>19)</sup>

**Figure 5**  
Actual sales and forecast of the number of built-in modules for cars (2009–2018).

and related service evolution, M2M network application in smart mobility is expected to continue its advance (Figure 5).

In addition to vehicles, KOMTRAX (Komatsu Construction Equipment Sales and Service Japan Ltd.)<sup>20)</sup> utilized an M2M network has been released for construction equipment. Further utilization of M2M services is expected to be progressed by expansion of M2M networks in other mobile objects, such as agricultural equipment, boats and ships, aircraft, walking support tools, and animal tracking, etc.

## 6. Conclusion

According to a researcher in a car manufacturing company, the basic development of a car, such as the engine, body, and interior, has reached its zenith. As described in this paper, network connection to a vehicle opens up new experiences for a driver. In addition, by sending vehicle/driver information and receiving outside information, new integration in the car environment and society is possible. Smart mobility application utilizing an M2M network is the new frontier of the car society. Fujitsu has been utilizing ICT and become a partner who can create new added-value services in this frontier for companies in the car industry.

FENICS II M2M service will continue to support the business activities of our customers and to provide added-value services not only in the car industry, but also in various fields and regions, as well as in current and new markets.

## References

- 1) Fujitsu: Fujitsu Releases FUJITSU Cloud IoT Platform, a Platform Service for IoT Data (June 10, 2015). <http://www.fujitsu.com/global/about/resources/news/press-releases/2015/0610-01.html>
- 2) Fujitsu: Fujitsu Unveils 'Network as a Service' Concept (May 16, 2007). <http://www.fujitsu.com/caribbean/about/resources/news/press-releases/2007/20071605.html>
- 3) KDDI, Fujitsu: Verification of enhancement of the "Home Care Support Service" using IPv6. (in Japanese). <http://pr.fujitsu.com/jp/news/2006/02/15-2.html>
- 4) Fujitsu: Amada Employs Fujitsu Cloud Service to Enhance Machinery Maintenance (April 21, 2010). <http://www.fujitsu.com/global/about/resources/news/press-releases/2010/0421-01.html>
- 5) Fujitsu: Fujitsu Provides World's First Service for Simple and Safe Connections to Various M2M Equipment Networks (October 09, 2013). <http://www.fujitsu.com/global/about/resources/news/press-releases/2013/1009-01.html>
- 6) Fujitsu Provides World's First Service for Simple and Safe Connections to Various M2M Equipment Networks. <http://www.fujitsu.com/global/about/resources/news/press-releases/2013/1009-01.html>
- 7) GSMA: Connected Car Forecast: Global Connected Car Market to Grow Threefold Within Five Years. [http://www.gsma.com/connectedliving/wp-content/uploads/2013/06/cl\\_ma\\_forecast\\_06\\_13.pdf](http://www.gsma.com/connectedliving/wp-content/uploads/2013/06/cl_ma_forecast_06_13.pdf)
- 8) Fujitsu: Big data use/application-Convergence service aiming for value creation by data fusion-(in Japanese). <http://jp.fujitsu.com/solutions/convergence/>
- 9) Fujitsu: Welcome to FUJITSU Cloud IaaS Trusted Public S5 Europe-UK. <http://welcome.globalcloud.global.fujitsu.com/index.html>
- 10) Transtron: In-vehicle information system. <http://www.transtron.com/en/products/information.html>
- 11) FUJITSU TEN: Introduction of a remote engine start system for smartphones utilizing cloud technology. [http://www.fujitsu-ten.com/release/2013/20130312\\_e.html](http://www.fujitsu-ten.com/release/2013/20130312_e.html)
- 12) FUJITSU TEN: "IP wireless taxi dispatch system" utilizing a mobile phone network now on sale (in Japanese). <http://www.fujitsu-ten.co.jp/release/2013/04/20130425.html>
- 13) AT&T: It's time to develop a migration plan for M2M. [http://www.business.att.com/enterprise/Family/mobility-services/machine-to-machine/m2m-applications/cd2migration/page=addl-info/#fbid=8UzjhLMi\\_6](http://www.business.att.com/enterprise/Family/mobility-services/machine-to-machine/m2m-applications/cd2migration/page=addl-info/#fbid=8UzjhLMi_6)
- 14) GSMA: GSMA Connected Car Forum. GSMA Connecting Cars: The Technology Roadmap February 2013 | Version 2.0.

- [http://www.gsma.com/connectedliving/wp-content/uploads/2013/02/GSMA\\_mAutomotive\\_TechnologyRoadmap\\_v2.pdf](http://www.gsma.com/connectedliving/wp-content/uploads/2013/02/GSMA_mAutomotive_TechnologyRoadmap_v2.pdf)
- 15) JAXA: Quasi-zenith satellites system (QZSS).  
[http://qzss.jaxa.jp/index\\_e.html](http://qzss.jaxa.jp/index_e.html)
  - 16) Ministry of Internal Affairs and Communications: Open Data.  
[http://www.soumu.go.jp/menu\\_seisaku/ictseisaku/icriyou/opendata/eng/index\\_e.html](http://www.soumu.go.jp/menu_seisaku/ictseisaku/icriyou/opendata/eng/index_e.html)
  - 17) ITS Japan: Vehicle operation accumulation and traffic restriction data (in Japanese).  
<http://www.its-jp.org/saigai/>
  - 18) eCall.  
<http://ec.europa.eu/digital-agenda/ecall-time-saved-lives-saved>
  - 19) GSMA: GSMA Connected Car Forum: 2025 Every Car Connected: Forecasting the Growth and Opportunity February 2012 Version 1.0 Figure 5.1.  
<http://www.gsma.com/connectedliving/mautomotive/gsma-connected-car-forum/>
  - 20) Komatsu Construction Equipment and Sales and Service Japan Ltd.: KOMTRAX (in Japanese).  
<http://www.komatsu-kenki.co.jp/service/product/komtrax/>



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