Approach to M2M in Mobility Field

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Machine-to-machine communication (M2M), which has evolved as one solution to social issues such as energy saving and reduction of environmental impact, now makes it possible to have advanced analysis and prediction by making use of big data and is being applied to an increasingly wider range of fields. Application of M2M is expanding also in the field of mobility, which can contribute to a next-generation car-oriented society, such as in emergency call and theft tracking systems that will be made mandatory and in promotion of car sharing by ultra-small vehicles. FUJITSU TEN is also moving ahead with the development of in-vehicle communication units and working to realize telematics services based on having drive recorders connected with a cloud service. This paper describes FUJITSU TEN's approach to mobility M2M. It also presents technology for installing VoIP radio transceivers in vehicles and for automobile control systems related to smartphones that can be used to solve issues related to communication stability and information security that need to be overcome when connecting vehicles to a network.

1. Introduction

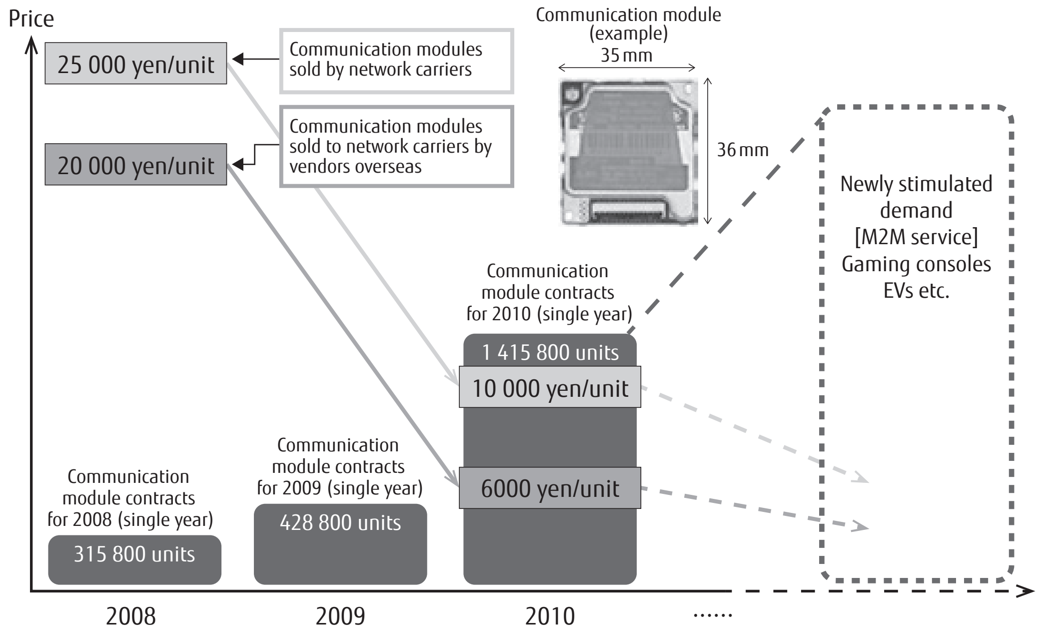
Machine-to-machine communication (M2M) refers to a system in which units communicate autonomously with other units within the same network. Its applications are rapidly expanding in tandem with the advancing telecommunications technology and cloud-based services. Some estimate that the market will reach the 1.2 trillion-yen mark in 2018.[1)] One of the reasons for such an expansion is the government-level initiatives to establish information infrastructure based on M2M as a means to save energy resources, reduce environmental impact, lower the number of fatal road accidents and tackle other social problems. There are also policy-led introductions of M2M systems in the field of mobility, such as compulsory equipment of systems for automatically making an emergency call (e-call) or anti-theft tracking system, and promotion of car sharing schemes using ultra-small electric vehicles (EVs). In tandem with a wide diffusion of network-connected car navigation systems (sat navs), downscaling and lowering prices of communication modules are also backing the expansion of M2M. As shown in **Figure 1**, communication modules compatible with 3G telecommunication networks have become smaller than 40 × 40 mm in size, and the price is less than half of the 2008 price, thus making them applicable to a wider range of modules. The scope of the M2M applications is expected to further expand in the field of mobility in the future.

This paper presents projects on mobility M2M at FUJITSU TEN, describing challenges in relation to realizing automotive electronics to introduce M2M to the mobility sector, with accounts of an actual project to address these challenges.

2. Mobility M2M at FUJITSU TEN

FUJITSU TEN pursues the development of in-vehicle communication units for an automated emergency call system, through which an emergency call is made to a public safety answering point (PSAP) when a vehicle is involved in an accident. It is also developing a Voice over IP (VoIP) radio transceiver that transmits voice data in data packets over mobile networks. Other development projects include a vehicle allocation system for taxi operators, and a remote control system using smartphones that allows the user to start the engine and lock/unlock the vehicle doors from a distance.

Our initiatives in view of the future mobility M2M



Source: The Ministry of Internal Affairs and Communications Telecommunications Bureau Numbering Plan Office: Inquiry to the Telecommunications Bureau regarding the "Regulations on telecommunication numbers in view of the increasing number of mobile phone numbers" (presentation material). http://www.soumu.go.jp/main_content/000116195.pdf

Figure 1
Changes in price of communication modules for mobile phones.

are described below.

1) Development of cloud-based drive recorders

This is a project to connect drive recorders to a cloud service, aiming to make it easier to offer highly functional assistance to drivers for safe driving. Originally, drive recorders were used mainly to record images of the circumstances when accidents occurred. Through connection to a cloud service, the data gathered by the drive recorder—data about the vehicle behavior and also image data—can be made available for analysis, and collected as probe data. The big data thus accumulated at the data center has been used to analyze time periods and locations that are closely related to a high incidence of hazardous behavior such as sudden braking. The analysis enables us to send alerts to drivers when they are driving in such hazardous zones, thus adding more value to our service.

The analytical performance is also enhanced by applying image recognition/measurement technology to drive recorders; measurements of the distances between the vehicle and road marker lines as well as the range to the car driving in front are used to analyze the driver's tendencies and support their safe driving.

We also pursue the development of a predictive driving assistance service, in which the information from a vehicle is relayed to the cars that drive behind it, sending warnings to the drivers behind and advising them to change lanes or routes in the event of traffic restrictions following a spontaneous traffic accident.

By strengthening the communications between automobile systems and the data center, we aim to roll out a highly functional driver support system based on mobility M2M.

2) Enhancing development efficiency

We also consider it important to efficiently develop telematics services to promptly respond to ever-diversifying market needs. For the development of automotive telecommunication units, therefore, we are developing hardware and software platforms that make it easy to customize in-vehicle functions.

The platform also includes middleware that handles common processes such as data analysis and management, and FUJITSU Intelligent Society Solution SPATIOWL that leverages locational data. By developing and installing apps to combine drive recorder services, or commercial vehicle operation services tailored to the user's needs, these form the cloud service platform (**Figure 2**).

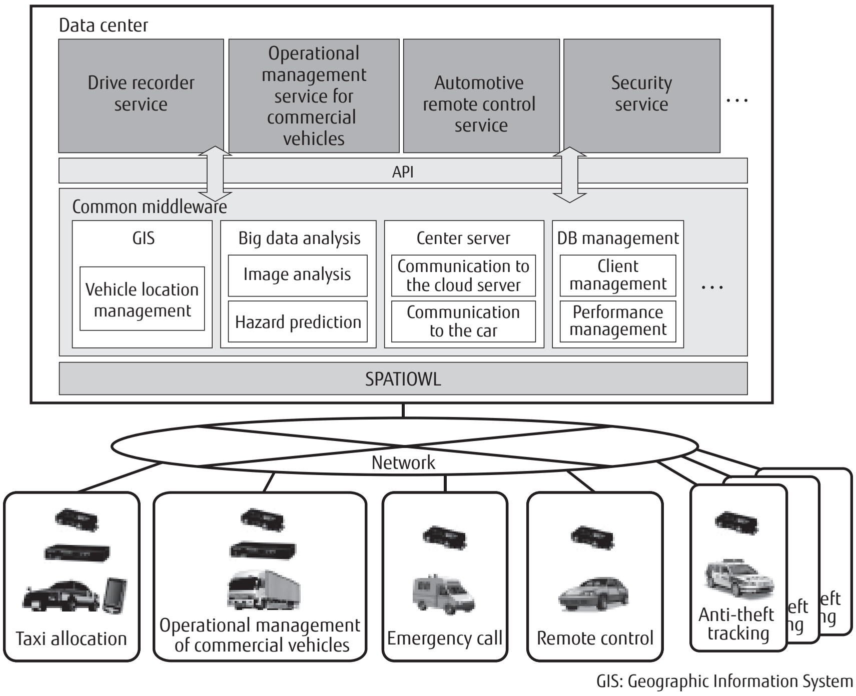


Figure 2
Structure of system for telematics service.

In this way, FUJITSU TEN is efficiently developing a comprehensive package covering areas from in-vehicle communication units to a cloud system, offering this telematics service to the market.

3. Challenges in mobility M2M

Unlike the M2M used for remote monitoring and management of elevators or vending machines, mobility M2M is characterized by connecting moving objects—travelling vehicles—to a network, and this gives rise to the following challenges:

1) Stabilizing radio communication

When a moving object such as a travelling car connects to a network, the environment for communication is not always stable. Wireless communication, base stations may switch while the car is moving, and the communication speed may fluctuate. There must be a mechanism that facilitates correct data exchange under such circumstances.

2) Ensuring information security and safety

While a car is an asset to its owner, it is a machine that can potentially endanger human lives. A remote M2M service must not increase the risks of theft or road accidents. Therefore, it is important to give thorough consideration to the foreseeable risks and choose the best means of information security. It is equally important to give the system a means to remotely verify the conditions in which the vehicles find themselves.

3) Preserving the vehicle battery (lowering power consumption)

Transmitting and receiving data using the in-vehicle communication units certainly needs electric power. In the case of vehicles' electronic units, however, the power source is the car's batteries, whose reserve is finite. Therefore, it is absolutely necessary to lower these units' current consumption even by a few mA, particularly for those mobility M2M features to monitor the vehicle while it remains still.

In the following, we describe the technology that addresses the three challenges stated above.

4. Stabilizing radio communication

Mobility M2M typically uses the wide-area wireless communications network for mobile phones, and it sometimes suffers from fluctuating communication speed and unstable connections while the vehicle is travelling. Therefore, we need to provide our services while taking these environmental factors into

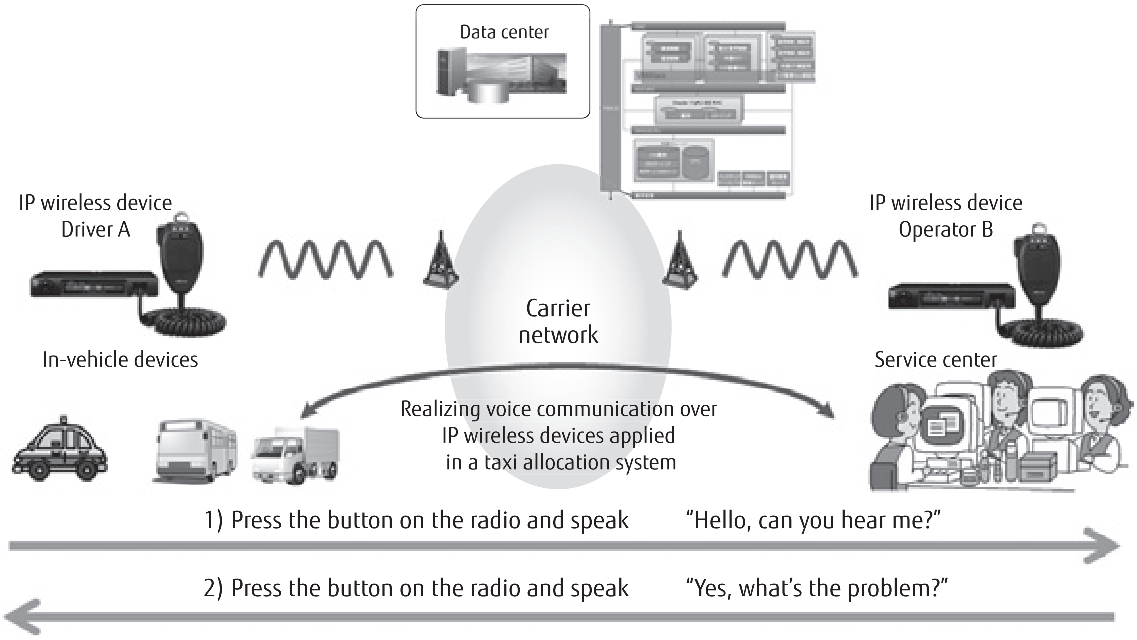


Figure 3
VoIP wireless communication system.

account. One of the answers is realized by VoIP wireless technology. **Figure 3** illustrates the structure of a system that utilizes VoIP. This system is developed primarily to replace the public-safety radio service and taxi radio transceiver, and it has already achieved the Press Talk[note 1] system. Its key feature is seamless, stress-free voice communication. To receive the voice data sent in data packets in real time, the communication speed is crucial; if it slows down, the timing at which packets are received is delayed and the voice is interrupted, whereas a segment of the voice may be lost if the next packet is received before the previous sound finishes. In view of this, we adopted a mechanism to queue up a certain amount of voice data in a buffer before playing back the voice (**Figure 4**). With this mechanism, we have successfully achieved a communication stability that matches an existing digital wireless system.

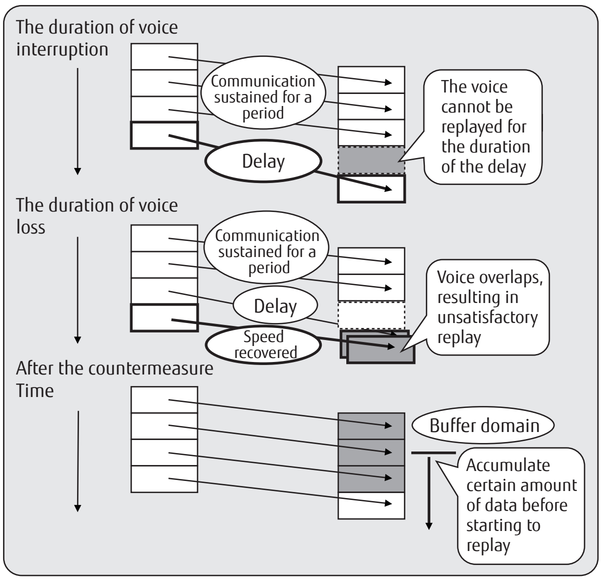


Figure 4
Voice processing.

5. Ensuring information security and safety

Incidents of cyber attacks such as fraud via networks have been featured often in recent news reports and networks are sometimes accessed by unauthorized parties to steal confidential information. Some point out that vehicles are also increasingly at risk of cyber attacks, as they are equipped with more and more sophisticated communications systems.

Thus, in tandem with the wider diffusion of

note 1) A simplex radio mode in which the operator presses a button to talk, and releases it to listen to the voice from the other end.

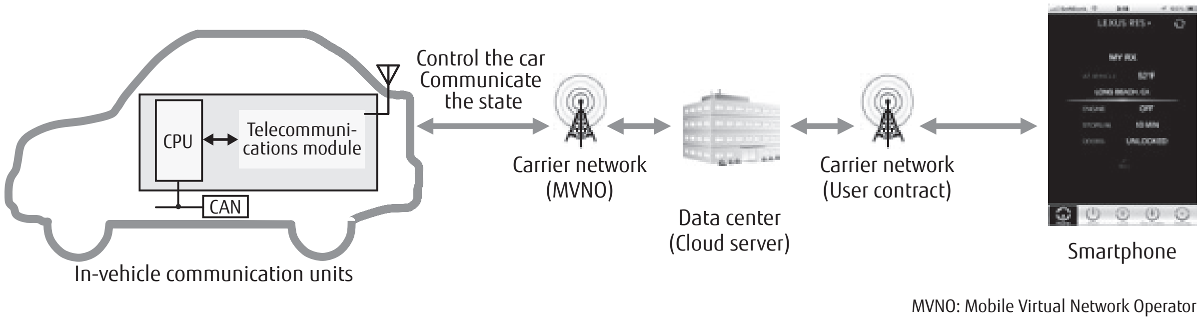


Figure 5
Vehicle control system with smartphone connectivity.

mobility M2M, there is a growing need for information security. We explain how information security and safety can be ensured, drawing on a case of a vehicle control system combined with a smartphone.

1) Application of information security

FUJITSU TEN's vehicle control system with smartphone connectivity consists of the data center that manages users and their vehicles, and tags the smartphone to the car; an in-vehicle communication unit for connecting the vehicle and the data center; and a smartphone that has a dedicated app (in both iPhone and Android versions) installed on it to operate this system (**Figure 5**).

The in-vehicle communication units for this system are connected with other in-vehicle controlling units via the controller area network (CAN) BUS. When it receives a request command from the data center, it first checks the vehicle status, then proceeds to determine whether or not to execute the requested command. The data center may resend the command automatically depending on the response from the in-vehicle communication unit, and log all the communication history between the data center and the unit. The in-vehicle communication unit, the data center and smartphone combined use both a public communications network and the Internet. Therefore, we analyzed the risks and involved factors for each network, and applied the security measures that are most effective to them. For example, communication between the data center and the in-vehicle communication units may be exposed to risks of connecting to an imposter who intends to steal the car or alter the data for the sake of causing trouble. To counter this security issue, we adopted an SSL server authentication system, using the TLS 1.2 authentication method.

Against data tapping, command and response messages are encrypted using the Advanced Encryption Standards (AES), which is relatively light in processing load. Furthermore, key exchange is renewed at each session to achieve higher levels of both response and security.

There are other risks. Because in-vehicle communication units are readily available at car dealers, unlike commercial remote monitoring units, they can be bought by someone with malicious intentions who may attempt to access and steal security-related data in the units. To counter this issue, we designed the communication unit with a special security IC chip with a high anti-tampering[note 2)] feature and it can add robust security to CPUs of relatively low processing capacity.

2) Considerations for safety

We now explain the safety issues in relation to the situation where a vehicle is controlled by commands from the service center via mobility M2M.

The smartphone-based vehicle control system involves operating a vehicle which is out of sight. For this reason, the in-vehicle communication unit includes a mechanism that determines whether or not to execute control commands upon verifying the condition of the car. Supposing, for example, that the bonnet is open, someone like other users or engineers may be checking the engine compartment. If the unit receives a command to start the engine under such circumstances, it cancels the command and returns the cancellation response together with a reason code to the service center.

note 2) A property to make it harder to modify or analyze the internal structure of software/hardware or stored data.

It also has a function to abort a remotely initiated engine start if there is a change to the door lock status or the gear is taken out of the parking position, as these changes may signify a possible attempt of car theft.

6. Preserving vehicle battery (lowering power consumption)

Cars are equipped with batteries as they need electric power to start the engine, ensure stable power supply while driving, and operate certain units while they are being parked. The average batteries mounted on a gasoline vehicle have a capacity of 26 to 106 Ah. The necessary capacity is determined by the current required for powering the starter motor and the amount of electric power the units consume while the engine is not running (standby power consumption). Automotive batteries are rather heavy car parts. Therefore, reducing the dark current is a significant step in lowering the overall weight of the vehicle body. In this section, we present the actual power-saving measure introduced to the remote control system, and explain the backup battery adopted for the e-call system.

As in-vehicle functionality advances, there are cases in which in-vehicle units other than multimedia mechanisms operate on microprocessors that run at a clock rate of 100 MHz or more. The remote control system consumes electric current even while the car engine is not running because, by design, it needs to receive commands to wake up a sleeping car. Taking this into account, we reduced the isolated current consumption of the microcomputer during the car engine's inactivity to approximately 1 mA by switching the clock that powers the processing unit to a slow-running mode to keep only the minimum functions active (e.g., receiving signal from mobile base stations and monitoring other in-vehicle units for status changes). However, the in-vehicle communication unit would periodically connect to the mobile network as long as the system is alive, thus pushing up the power consumption. Eventually the battery might run out if the car was left still for an extended period. The way to avoid this situation is to increase the battery capacity, but this would in turn increase the body weight and cost, thereby compromising the advantages for users. We therefore took another approach to lower power consumption by preventing the communication function block from attempting to connect to the mobile network after the car was inactive for a certain period.

Conventionally, in the case of an unexpected power loss, as in a broken battery cable or a melted fuse due to a fire caused by a short circuit, demand for power (such as for releasing an airbag or operating a drive recorder to retain image data in the event of a road accident) is handled by a built-in, large-capacity condenser. By contrast, the e-call system has a cell-type backup battery, to enable a speech call to be made after automatically establishing a connection with the service center in an emergency, and also for stand-by energy until the emergency vehicle arrives. We adopted lithium primary batteries for this backup battery owing to their superior functional capacity.

7. Conclusion

Mobility M2M needs to address important challenges of in-vehicle applications in terms of connecting moving objects to a network, as we described in this paper.

FUJITSU TEN's enterprise vision is "to contribute to the creation of a free and comfortable mobility society where people and vehicles, and the community and vehicles are connected," and mobility M2M is indispensable for realizing this. We are of the opinion that, in the mobility society, the demand for "environmental consideration," "safety and security" and "convenience" will continue rising.

Therefore, we will continue making diligent efforts to expand our vehicle electronics and data center services through the development of technologies to meet these demands.

References

1) IT Leaders: M2M market exceeds 1 T yen in 2018 while B2C e-commerce market reach 20 T yen-Nomura Research Institute discloses its ICT market forecast data (in Japanese).
http://it.impressbm.co.jp/e/2013/11/28/5286

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