

Connected Vehicle Insights

Trends in Machine-to-Machine Communications

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16. Abstract <p>This report describes Machine-to-Machine service architecture and how it is evolving over the next several years. Nearly 50 billion Machine-to-Machine (M2M) devices are predicted to be deployed by all sectors by 2025. The largest impediment to M2M deployment in the transportation sector is largely life cycle cost, which is driven by stringent design and certification processes. This paper speculates that a "service-oriented" architecture, one that allows any M2M device to be securely accessible to any application, would be desirable for faster market growth.</p> <p>This report is part of the <i>Connected Vehicle Technology Scan and Assessment</i> project. This two year scanning series of <i>Connected Vehicle Insight</i> reports will assess emerging, converging and enabling technologies outside the domain of mainstream transportation research. ITS America seeks technologies that will potentially impact state-of-the-art or state-of-the-practice in ITS deployment over the next decade, with an emphasis on the "connected vehicle."</p> <p>The <i>Technology Scan Series</i> notes trends, technologies, and innovations that could influence, or be leveraged as part of, next-generation intelligent transportation systems within the next five to seven years. The series' focus is on developments in applied science and engineering and innovation in data acquisition, dissemination, processing, and management technologies and techniques that can potentially support transportation.</p>					
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Introduction

The Global System for Mobile Communications (GSM) Association predicts that there will be nearly 50 billion connected devices by 2025, nearly ten times the world's predicted human population. ABI estimates that through 2012, Machine-to-Machine connected devices will grow by 100m units per year by 2012.¹

An M2M module uses a device to capture an 'event' (temperature, activation of airbags, etc.), which is relayed through a network, either wireless or wired, to an application, such as a software program, that translates the captured event into meaningful information (e.g., ice warning, crash notification). An M2M device typically converts analog sensor data into internet protocol (IP) packets for transmission over a communications medium.

M2M applications are often characterized by the absence of a human decision maker directly controlling communications intensity, frequency and costs, though there are M2M applications in the transportation sector that also require interaction with drivers.

M2M devices can be transmitted over a variety of communications mediums including mobile satellite services, cellular networks, and even combinations of carriers and carrier coverage areas across several networks. Hybrid wireless solutions include intermediary devices such as cellular modems connected to an M2M endpoint via wireless local, personal area or near field communications networks such as Wi-Fi, Zigbee, Bluetooth or Radio Frequency Identification (RFID). The most common communications system for M2M in use today in North America is second generation (2G) wireless, using either General Packet Radio Service (GPRS) or Short Message Service (SMS), which uses signaling protocols that set up and tear down voice calls to transmit small amounts of data.

The Machine to Machine Value Chain

There are numerous vertical M2M sectors which can be broadly divided into six categories: Transportation (Consumer and Commercial fleet); Consumer; Healthcare; Energy/Utilities; Security; and Industrial/Building Control.² The M2M value chain includes Mobile Network Operators (MNOs), Mobile Virtual Network Operators and Network Enablers (MVNOs and MVNEs respectively), and in the transportation sector, Telematics Service Providers (TSPs) and automobile manufacturers and other suppliers.

Mobile Network Operators have played an indirect role in the development of M2M applications, primarily as "data pipe" providers, though their role has expanded greatly through partnerships with M2M service and equipment suppliers. In the past, because of low M2M average revenue per user (ARPU) as compared to retail consumer voice or data services, it has been difficult for MNOs to justify investment in direct M2M sales and services. Instead, MNOs have relied on Mobile Virtual Network Operators (MVNOs), who do not own their own network base stations, but buy wholesale airtime from multiple MNOs across multiple coverage areas. MVNOs sell wholesale airtime as a retail service to their M2M subscribers, and bulk provision and activate M2M devices in large, scalable batches for large enterprise clients.³

A Mobile Virtual Network Enabler (MVNE) is a company that provides infrastructure and services that enable M2M MVNOs to offer specialized shared infrastructure and value-added services, such as verification/validation of message receipts and GPS data, remote M2M device diagnostics, and bearer testing of different carriers' services through which a device may be expected to roam.⁴

Finally, the telematics industry exists as a specialized vertical market sector, tightly coupled to the auto industry, which was created to address extensive operational challenges. The telematics industry reduces the risk of bringing together wireless services and equipment, M2M applications and driver-oriented (non-M2M) services by integrating automotive systems together to provide a complete solution for consumer and enterprise mobility, safety and convenience applications.

The M2M value chain requires a number of development, manufacturing and operational processes, which vary by vertical sector. The manufacture, deployment and operation of M2M devices include such activities as design, certification, integration, manufacturing, approvals, distribution and installation, along with ongoing development and support of enterprise systems/platforms/software and network systems/platforms.

Some M2M applications have approval and certification processes which are peculiar to their industry, or vary based on the development life cycle. For example, automotive manufacturers have specific approval processes for quality and safety assurance, and healthcare regulatory approvals and certification can be particularly lengthy and complex. Industrial devices with long lifespans, such as utility sensors, often must rely upon widely accepted and understood long-term standards, while devices with short lifespans, such as consumer data centric appliances (such as a wirelessly connected personal navigation device) do not need long-term certification and can be more flexible.

The costs of development, manufacturing and deployment generally vary across M2M applications, but they nevertheless typically constitute the largest portion of the total cost. According to the GSM Association (GMSA), design and provisioning can account for more than 85 percent of the total cost for many low-traffic devices (e.g. automatic meter readers, automotive theft/e-call systems that have infrequent, low volume communications).⁵

Adaption of M2M to trends in Telecommunications Infrastructure

In the past, many M2M application service providers, and specifically telematics solution providers, have utilized SMS or 2G (GPRS) data services, mostly because data transfer needs were small and intermittent. Second generation wireless networks are also attractive for M2M use because of their nationwide and cross-border coverage footprints. Furthermore, the price of service and equipment for 2G has declined at a faster rate than 3G equipment and services. The lower cost of 2G was a critical feature for M2M given low financial breakeven points for many enterprise M2M projects, or depressed willingness-to-pay on the part of consumers who were unacquainted with the benefits of new telematics services.

Furthermore, automakers faced another unique challenge: choosing a wireless communications technology that must remain secure and useful for the entire design/build/service lifecycle of an automobile. Telematics Service Providers assumed that 2G coverage and SMS would remain a part

of the carriers' networks for years. It is estimated that nearly 90 percent of embedded modules currently deployed use 2G.⁶

For the most part, Mobile Network Operators are unaccustomed to taking into account legacy consumer equipment when making decisions regarding new network technology rollouts, because consumer handsets have a relatively short product life. Traffic is expected to explode on cellular networks, and all MNOs are committing to aggressive deployment of fourth generation (4G) technologies, with new handsets already becoming available.

For the most part, wireless carriers are uncertain what the impact of M2M will be on demand for their network services. In an environment where M2M applications are growing and "human" subscribers are a minority, network communications traffic will likely be bursty, based on either timely automated routines or events that may be unpredictable.⁷ Predicting the maximum capacity and provisioning networks to support that capacity will be a challenge, and will face some constraints. Some experts believe that even with faster 4G technology, such as Long Term Evolution (LTE) and WiMAX, we may be within a factor of three of the maximum efficiency that can be achieved within the current amount of spectrum, and that there are few options beyond aggressive and costly cell splitting and spectrum re-use. Conversion to 4G would mean re-farming 2G spectrum by decommissioning 2G base stations that support current M2M services and converting them to either third or fourth generation wireless technologies. The uncertainty of the MNOs infrastructure and service provisioning strategies may influence, and be influenced by the existence of a large number of legacy embedded 2G M2M modules.

Mobile Network Operators may try to entice MVNOs to purchase more expensive 3G or 4G M2M modules, with the assurance that even though upfront costs will be higher, use of 3G and 4G will result in lower on-going network tariffs that will lower total cost. According to Analysys Mason and the GSMA, the most likely scenario is that most operators will decommission their 2G networks in the next ten years, forcing an upgrade or replacement of thousands of modules to either 3G or 4G technology. Although decommissioning 2G may tarnish the reputation of the Mobile Network Operators in the eyes of the M2M application community, it is very necessary for MNOs given that the costs of acquiring new spectrum to support 4G are far greater than the expense to them if they were required to pay for a portion of obsolete M2M module replacement costs, or lose revenue from M2M application providers who may abandon them.⁸

Role of M2M in Transportation Applications

Theory and experience suggest that the success of any innovation hinges on two factors: the power of the core technology and its implications for business practice. Basic technology constraints on widespread deployment of M2M have been largely overcome for many applications, and the driving determinant is usually cost (specifically life cycle cost), which is driven by manufacturing and operational processes (provisioning, design, and certification driven by application needs such as security, reliability, etc.) and to some lesser extent, the cost of wireless telecommunications services.

In the transportation field, many opportunities exist to offset these costs, given that vehicle operators (the general driving public or fleet operators such as commercial freight, passenger or transit carriers) are often "in the loop." Many applications may be tied to a "human subscription" and be subsumed under a single data plan that wireless carriers may provide to cover all of their subscribers devices

(laptop, tablet, smartphone, car) under a flat rate scheme. Telematics service providers have also contemplated innovative pricing schemes to adapt to consumers' depressed willingness-to-pay for vehicle-only services. Wireless data service subscription models, such as per-session, per-device or device bundle, per-application, per-time (with peak/off peak), per-byte and –speed, or other flexible pricing schemes may help Telematics Service Providers' break-evens and counterbalance consumers' low willingness-to-pay for telematics services.⁹

Business process innovations are the keys to reducing costs and making M2M services more accessible to a wide variety of applications. A “managed service infrastructure” provides a hardware and software platform that can support the common needs across multiple sector applications (e.g. Transportation, Healthcare, Energy) such as device activation, monitoring and security among others. A managed service infrastructure operated by a Mobile Virtual Network Enabler could, for example, establish a middleware platform that can provide service level agreement monitoring and device profile reporting. Innovation in this area will depend on standardization, which can create interoperability and compatibility and focus firm innovation and competition in areas of higher value-added equipment and services. Standardization in M2M is occurring, but there are several disparate initiatives and no de-facto standard as of yet. Organizations include European Telecommunications Standards Institute (ETSI)/Third Generation Partnership Project (3GPP), International Telecommunications Union (ITU), Institute of Electrical and Electronics Engineers (IEEE), the International Standards Organization (ISO), and Global Standards collaboration M2M Standardization Task Force). The Telecommunications Industry Association (TIA) Smart Device Communications Engineering Committee (TR-50) is currently developing an M2M framework that can work over any type of communications framework, and this group intends to publish a well-defined application programming interface for the industry shortly. The automotive telematics industry has also developed standards, which include both M2M and Machine-to-Driver interaction with drivers and call centers. The Next Generation Telematics Pattern (NGTP) is an example of an approach for delivering over-the-air services to in-vehicle devices and handsets, with the focus on open interfaces across much of the service delivery chain.

With standards, it is more likely that a managed service infrastructure could be developed and shared across many independent applications. A new, open infrastructure, object-oriented approach could ultimately lead to services and features common to many applications, thereby reducing complexity, development effort and maintenance costs. There would also be significant operating cost savings since the resulting service infrastructure could be pooled across many independent applications. However, the biggest benefits would come from the ability to allow sensor information to be shared in a secure manner across any application and to allow any device to connect to any application. This means that new applications could be created and advertised on the basis of installed devices, not on the basis of exclusive use by a particular application service provider or mobile (or mobile virtual) network operator.¹⁰

Implications for New Vehicle-Based Technologies

In the future, as vehicles add new technology such as electric powertrains, drive-by-wire chassis systems, autonomous advanced driver assistance features and even future cooperative collision avoidance systems, these new advances may require new levels of maintenance, service and diagnostics.¹¹ Diagnostics for a safety system would be needed to ensure reliability (low mean time between failures), availability (readiness for service), maintainability (low mean time to repair), safety (no risk of catastrophic failure), and security (authorization of trusted users to operate and maintain the system, plus system resistance to malicious attacks). Diagnostics for these new vehicle technologies may need to be monitored and analyzed “off board” to improve safety, vehicle performance and future product quality.

In an age when “check engine light” includes an email from a Telematics Service Provider showing the driver what is malfunctioning, the severity of the problem, and how, when and where the vehicle may be repaired, it seems that M2M may usher forth new improved models of customer service and vehicle maintenance. M2M may improve the prospects of successfully implementing more complex systems such as electric powertrains and collision avoidance systems. These new levels of connectivity, service and maintainability may be made a reality by the expansion and growing affordability of machine-to-machine communications.

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- ⁶ Lee Sanders et. al, p.5
- ⁷ “Subscriber Data Management for Machine to Machine - M2M Applications Landscape,” Presentation, Frederic Bastien, Tecelek, November 11, 2010
- ⁸ Lee Sanders et al., p.5
- ⁹ Frederic Bastien, p.9
- ¹⁰ Emerson, p.22
- ¹¹ Autonomous ADAS uses navigation, radars or other object detection systems to alert drivers of potentially dangerous situations. Cooperative Safety Systems, such as being research by USDOT, will use navigation and short range communications with other vehicles and traffic controllers to alert drivers of potential crashes.

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