Machine-to-Machine Applications over Mobile Networks

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Abstract

M2M applications have been in existence for the past many years. However, its provisioning using mobile technologies is a recent and emerging phenomenon. In this paper, we discuss the concept of M2M in brief, the services and technologies involved, identify the key players required to provide these services and example tariff models. Recently, regulatory requirements have acted as drivers for the adoption of M2M solutions. Vattenfall, the Swedish utility provider's installation of automatic meter reading (AMR) systems at the consumer site is one such example. We discuss this case in the paper and provide some analysis on the present and future prospects for M2M solutions. The paper mainly considers M2M provisioning using mobile communications technology and hence an operator's point of view is emphasized.

Key Words

M2M, AMR, mobile operator, value network

1. Introduction

Today, mobile operators in developed markets are actively seeking new avenues for revenue generation since the traditional sources such as voice are getting saturated. M2M communication is considered as one such opportunity. M2M is defined differently in different literatures and contexts. A broader definition of M2M communication includes the remote control of machines (telematics) and monitoring/collecting data from machines (telemetry). Recently, from a mobile perspective, M2M is defined as communication between a machine and a mobile terminal (machine-to-mobile and mobile-to-machine) or between a machine and a back-end information system (machine-to-machine) (Nokia 2004).

M2M communication isn't a new phenomenon *per se*. For instance, in the United States, AT&T proposed an automatic meter reading (AMR) system in 1962 for utilities which didn't materialize due to economic reasons (Tamarkin 1992). In 1980s, many utilities in the US introduced such systems due to the availability of cost-effective solutions. However, it is only recently that M2M solutions have emerged as a significant revenue opportunity for mobile operators. The existence of increasing number of network-enabled devices is a major driver for this development. According to Frost& Sullivan, Europe has around 13 billion devices that can be M2M-enabled (Levi 2005). Forrester provides a comparison of the number of networking people vs. machines expected in the future (Figure 1) (Forrester 2001).

Other factors responsible for the emergence of M2M are regulatory requirements in markets such as electricity, pharmaceuticals etc, and a need for operational cost-efficiency.

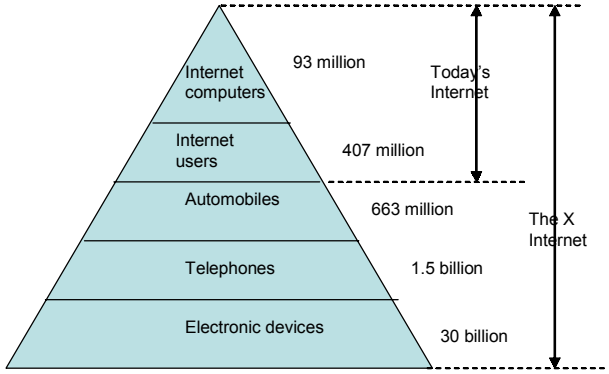

Figure 1 Networking people vs. machines comparison

The organization of this paper is as follows. Section 2 describes the technology blocks involved in an M2M communication solution. Section 3 lists some of the M2M application categories in practice today and their respective market segments. Section 4 gives an overview of an M2M application's value network. Section 5 provides some example tariff models. The paper discusses the Vattenfall-TeliaSonera case for AMR in section 6 followed by conclusions in section 7.

2. Technology

As mentioned before, M2M communications has been in existence for many years. The three technological building blocks necessary for the implementation of an end-to-end M2M solution such as an automatic reading meter (AMR) are as follows:

- *Meter interface module*: This module acts as an interface between the communications system and the meter unit (such as electric, gas or water). The interface is bi-directional, thus enabling the transmission and reception of data from the meter to the back-end information system and vice versa.

- *Communications system*: The system acts as a transport medium for the transmission of control and information data between the meter unit and the back-end information system. Fixed-line, mobile, powerline carrier (PLC), and cable are

some examples of communication systems. Unlicensed spectrum-based radio technologies can also play a major role in enabling communication.

- Back-end information system: This can either be a server that collects data for further processing and analysis or a handheld terminal.

While the earlier M2M systems have used fixed-line telephony as the communication system, the current trend shows a growing acceptance of GSM-based mobile technology. GSM-based systems with its availability in more than 200 countries and properties such as greater security, mobility and higher bandwidth in recent years have become a natural choice for many M2M applications. For instance, many Nordic utility providers such as Denmark's NESA and Sweden's Vattenfall have chosen mobile communication systems for their mass installation of AMR systems.

Often, the amount of data traffic generated by M2M communication is limited and not frequent. Considering the number of units to be deployed, especially in cases where the deployment is for millions of customers, the revenue generated for a mobile operator from the traffic may only be a small fraction. Hence, an operator needs to provide value-added services in addition to the basic data transmission to enhance the revenue prospects.

3. Services and market segments

M2M applications are of different types suitable for different market segments. The market segments are classified as business and consumer. Some of the recent implementations of M2M using mobile communications has been for the AMR system. An AMR system enables the remote collection and monitoring of end-user's consumption of utilities such as electricity, gas or water supply. Some of the other possible services are illustrated in Table 1 (Nokia 2004, Kviselius 2002).

Table 1 M2M services and market segments

Machines	Service	Market segment
Utility meter	Monitoring, maintenance, home and building automation	Business & Consumer
Household appliances	Monitoring, maintenance, home automation, infotainment	Consumer
Vending machines	Monitoring, maintenance, infotainment	Consumer
Security systems	Monitoring, maintenance, home and building automation, transportation and logistics	Business & Consumer
Elevators	Monitoring, maintenance, building automation	Business
Heating, ventilation and air conditioning	Monitoring, maintenance, home and building automation	Business & Consumer
Billboards	Maintenance, infotainment	Business
Amusement machines	Maintenance, infotainment	Business
Industrial machines	Monitoring, maintenance, transportation and logistics	Business
Photocopiers	Monitpring,maintenance	Business
Traffic signs	Monitoring, infotainment, transportation and logistics	Business
Trucks and other vehicles	Monitoring, maintenance, transportation and logistics	Business
Speed cameras	Monitoring, maintenance	Business
Medical equipment	Monitoring, maintenance	Business

4. M2M value network

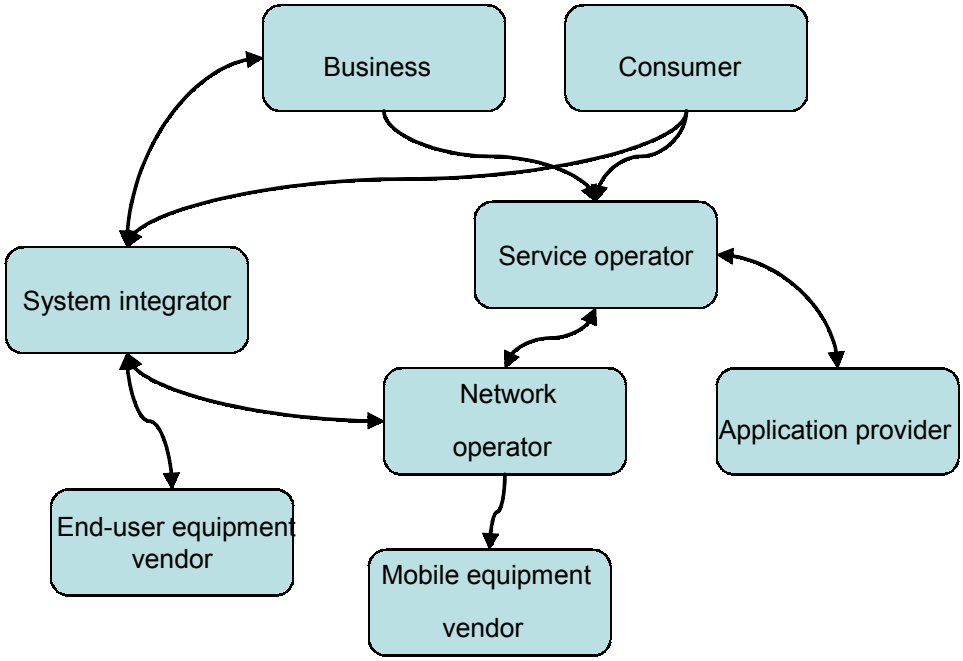

Figure 2 M2M value network

Based on Table 1, it is evident that value generation for an M2M solution is only possible with the confluence of multiple industries and their respective players. Hence, a value network approach would enable us to capture the reality in an M2M business. Figure 2 provides an overview of all the roles involved in an M2M business.

The roles are described as follows:

- The end-user for the M2M application can be either a *business firm* or a *consumer*. These roles don't have a major influence on the value network as they are mainly involved in the consumption of the service. However, one possible way of their influencing the net is in terms of the demand. Changes in demand would lead to different configurations among other players in the network, in order to generate economically viable business models.
- *Service operator* provides the basic M2M service to the end-user. The service operator works in tandem with the network operator to provide M2M services. The service operator has a direct relationship with the end-user
- *Network operator* provides the basic communications transport network service to the service operator.
- *Application provider* develops M2M value-added services for a service operator to be consumed by the end-user.
- *Equipment vendor:*
    - *End-user equipment vendor* provides M2M-enabled equipments. A player having this role would typically work with the systems integrator.
    - *Mobile equipment vendor* provides the necessary mobile infrastructure such as GSM-based modules for M2M communications. A player having this role works in cooperation with the network operator.
- *System integrator* plays a major role in providing an end-to-end M2M solution. A player with this role would work together with the network operator, end-user and equipment vendors.

A player can assume one or more of these roles according to the business model. Assuming more than one role could provide additional power in the value network. For instance, a network operator can act as a service operator and systems integrator in order to get greater control over the value network.

5. Tariff models

Applying appropriate tariff models is very important for encouraging usage and penetration of any service. M2M is no exception. M2M services typically generate constant-bit rate (CBR) traffic. In many cases, the transmission time can be set to suit the mobile operator. For instance, an application that requires monitoring once a day could be operated to generate traffic at night or off-peak hours, enabling an operator to increase the efficiency and usage of the network as well as generate greater revenue. The tariff models applicable in such

Table 2 Example tariff model for data M2M service

	Basic M2M	Optimum M2M	Expert M2M
Monthly fee	34,00 HRK	45,00 HRK	56,00 HRK
Inclusive bytes	0 MB	5 MB	15 MB
Not included in fee for 100 KB	1,34 HRK	1,34 HRK	1,34 HRK
SMS message	0,30 HRK	0,30 HRK	0,30 HRK
CSD/Fax in T-mobile HR network	0,98 HRK	0,98 HRK	0,98 HRK
CSD/Fax towards other network	1,46 HRK	1,46 HRK	1,46 HRK
CSD/Fax international	According to standard price list		
Voice calls	No	No	No
Data roaming (SMS, GPRS, CSD, Fax)	According to standard price list		

cases are in line with other data service provided today over mobile networks. An example of data M2M tariff offered by T-mobile for business users in Croatia is shown in Table 2 (T-mobile 2005). This tariff model is similar to the current data access tariffs provided by many service operators. Considering the volume of such M2M data to be lesser than the traffic generated by regular data traffic, operators may have to provide value-added services over their M2M system. We will discuss more on the tariff models in the next section.

6. Vattenfall case

In this section, we discuss the case of Vattenfall, one of the three major Swedish multinational energy group, which has recently installed the AMR system for its consumers in Sweden and Finland. We look at Vattenfall's implementation plans in Finland. In Finland, Vattenfall has 360,000 customers and a market share of approximately 12%. It had EUR 375 million in net sales and 550 employees in 2003. Vattenfall's core business includes production, sales and distribution of energy to about 6 million customers in Europe.

All the 25 European electricity markets are expected to complete the liberalization process by 2007. The deregulation of the electricity market in Sweden witnessed price rise, consolidation and confusion among the end-users in terms of the billing. This led the Swedish Energy Authority (STEM) in May 2002 to propose monthly electricity meter readings in order to enable economic benefits for the consumers and providers as well as reduced power consumption.

Vattenfall's decision to introduce M2M AMR systems in Finland seems to be the result of its requirement to install such systems in Sweden. Vattenfall had concluded an agreement with TeliaSonera to provide an end-to-end M2M solution for automatic metering of electricity consumption by Vattenfall's consumers. The total agreement is valued at EUR 100 million. The service offered by TeliaSonera includes delivery, installation and maintenance of the AMR which is a GSM-modem based solution. It also provides application services, secure connections and mobile/IP gateway services as part of its M2M solution.

TeliaSonera has teamed up with ELTEL Networks in order to install M2M-enabled meters at Vattenfall's 360,000 customer sites. The project is expected to start in spring 2005 and is expected to last for 2 years. ELTEL will take care of the management and installation work in cooperation with TeliaSonera. The new meters are expected to be installed at the rate of 5000-25000 households per month.

TeliaSonera has segmented its M2M tariff models into three as follows:

- *Control*: This subscription offers a low monthly charge and is suitable for low data traffic or non-frequent M2M services such as anti-theft alarm.

- Control Plus: This subscription offers a low volume-based data charge for higher data volumes of M2M services that generate continuous traffic such as credit card scanners.

- *Data subscription*: This subscription is suitable for M2M services which require high speed data transmission. Voice service is not included in this model.

So, based on the arrangements by TeliSonera, the value-network seems to be controlled by it since it assumes the role of network and service operator as well as systems integrator (refer Figure 2). ELTEL Network acts as the end-user equipment vendor in this case.

The AMR system is expected to provide accurate invoicing, even on a per-hour basis, and enable monitoring of power failures and state of the electricity network which would help to improve customer service and fault management. It would also reduce Vattenfall's operations cost. From a regulatory point of view, Vattenfall will be better prepared to face any such requirements for AMR by Finnish regulators in the future. From an organizational point of view, this is a step towards greater synchronization of processes among Vattenfall's European sub-groups.

7. Conclusions

Maturity in voice revenues and advancement in the mobile technologies have motivated operators to look at possibilities of providing value-added data services. In this regard, M2M services have attracted much attention recently from the mobile operators. The current implementations are concentrated towards business users. However, considering the number of network-enabled appliances in the future, operators will inevitably start providing services for the consumers as well. We identified such services in this paper. Key players were identified and example tariff models were mentioned. The Vattenfall case was discussed.

Based on the discussions thus far, we conclude this paper by indentifying some of key drivers for the success of M2M services from a mobile operator's perspective. They are as follows:

- Considering the data generated from M2M services to be lower in volume, operators should provide value-added services in order to boost the revenue prospects.
- Regulation in other sectors/industries can be a driving force to generate business in M2M as is evident in the case of Vattenfall and the European electricity market in general.
- Mobile operators need to interact and cooperate with industry players outside the mobile realm in order to provide innovative, cost-efficient and revenue generating M2M solutions. This would mean new relationships in the value network, which is no longer, same as visible in the mainstream mobile market.
- Major operators can gain greater control of the value network due to their financial power. However, smaller operators can also play a major role as service operators.

There are numerous forecasts predicting an enormous increase in the number of M2M-enabled devices and an increase in the M2M-related revenue generation. However, these reports must be considered with cautious optimism, as not all the M2M-enabled devices would automatically translate to business opportunities. Different players in the value network require greater cooperation among each other in order to maximize the benefits from M2M service market in the future.

References

Nokia 2004, White paper, "Machine-to-Machine: Let your machines talk.". http://www.nokia.com/BaseProject/Sites/NOKIA_MAIN_18022/CDA/Categories/Business/Machine-to-Machine/WhatisM2M/_Content/_Static_Files/m2m-wp_may04-final.pdf

Tamarkin T.D., 1992, "Automatic Meter Reading", Public Power magazine, Vol. 50, No. 5, Sept-Oct 1992, http://www.energycite.com/amr.htm

Levi N., 2005, "The rise of the machines", Telecommagazine, Feb 2005, http://www.telecommagazine.com/default.asp?journalid=2&func=articles&page=0502i13&year=2005&month=2

Forrester 2001, http://www.gii.co.jp/press/epr15863_en.shtml

T-mobile 2005, T-mobile Croatia's data M2M tariff model, http://www.t-mobile.hr/english/50/50-10-10-35-00.asp

Kviselius N.Z, 2002, "Swedish M2M Industry Case Study", Tokyo roundtable on seamless mobility, Akasaka, Tokyo, http://web.hhs.se/cic/emarkets/whoputthedoginthedoghouse/m2m_abstract.html