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M2M TECHNOLOGY: A LITERATURE REVIEW

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Abstract

Machine-to-Machine (M2M) communications technology facilitates devices to share information and execute actions without human intervention. M2M communication offers various services and it is a key enabler of the Internet of Things (IoT) technology which provides an opportunity to build powerful Industrial systems. This paper addresses M2M concepts through a review of various research papers and online database so the development of M2M technology can be understood. This paper will provide an insightful review of M2M technology, key enabling technologies and their applications..

Keywords:
IoT;
M2M;
Automation;
ETSI;
RFID;
Cellular.

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1. INTRODUCTION

M2M Communication technology was firstly adopted by manufacturing industries but later found equally useful in many more industries including business, healthcare, communication, automation etc. This technology is building block IoT technology which allows different devices like sensors, smartphones, computers, PDAs and many more devices to connect with each other to communicate and share data using various network technologies. Both IoT and M2M technologies are among the fastest growing technologies. According to MarketAndMarket research report, M2M connection market is expected to be worth USD 27.62 billion by 2023, growing at a CAGR 4.6% from 2017 to 2023 [1]. While global M2M service market is expected to grow at a CAGR of 29% during 2017-21 as per a report by Technavio [2].

2. DEFINITIONS

There are many different groups including academicians, researchers and organizations who have defined M2M technology, some of the definitions are discussed here. Telecom Engineering Centre (TEC) has defined M2M communication as, data communication between two or more entities, without the mandatory involvement of humans [3]. According to ETSI, M2M communication happens between two or more devices without direct human interference [4]. IoTAgenda refers to M2M communication term as a broad tag, which describes any networking technology which is used by network devices for data communication and executes actions without human assistance [5]. There is no unique definition of M2M present, still every definition summaries M2M communication as, communication between devices with no or minimal intervention of humans.

3. ARCHITECTURE

As M2M communication is a broad concept, there is no unique architecture is available, some of the M2M architectures given by several researchers, authors and organizations are discussed here.

3.1 Concept

The M2M communication system conceptually is a 3 Layered system as shown in Figure 1 below. It consists of Application, M2M and Network service providers [3].

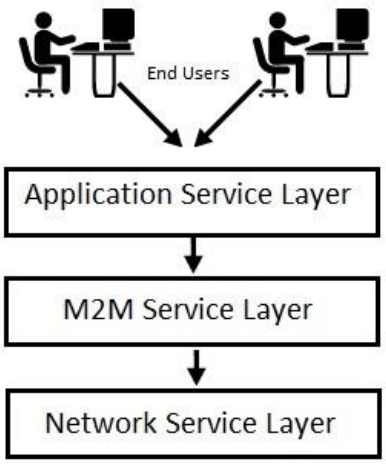

Fig.-1 M2M Conceptual Model

Source – Redrawn from M2M Gateway & Architecture report by Telecommunication Engineering Centre, 2015

3.2 ETSI Architecture

ETSI divided the M2M communication system into 3 domains as following-

1) Application Domain- defines business specific application services.

2) Network Domain-define transmission between M2M applications and M2M gateway.

3) M2M area domain-define devices that are capable of transmitting data without human intervention, also define connectivity between M2M devices and gateway.

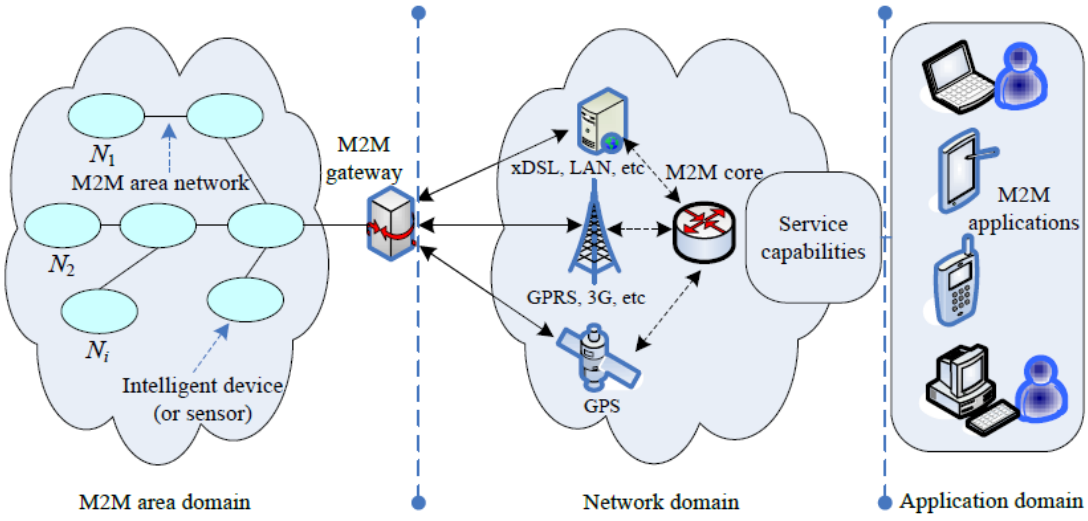

Fig.-2 M2M Architecture by ETSI

Source – Machine-to-machine communications: architectures, standards and applications, pp-480–497 (2012).

3.3 oneM2M Architecture

This architecture model has 4 entities and reference points:-

Entities-

1) Application Entity (AE):- It contains the logic of M2M application.

2) Common Service Functions (CSF):- Contains sub-functions those are optional to include in common service entity.

3) Common Service Entity (CSE):- It contains common service function; those are common to a vast range of M2M environment.

4) Network Service Entity (NSE):- Provides network services to common service entities.

Reference Point-

1) Mca reference point: - An interconnection between AE and CSE.

2) Mcc reference point: - An interconnection point between to CSEs.

3) Mcn reference point: - An interconnection point between CSE and Network service entity.

4) Mcc‘ reference point: - An interconnection point between two M2M service providers. Here Mc(-) is mnemonic for “M2M communication”.

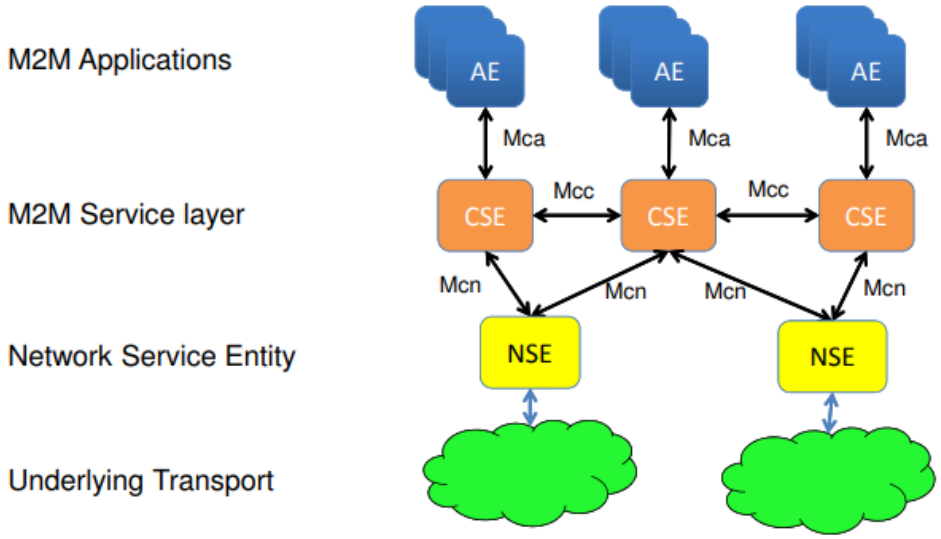

Fig.-3 oneM2M Architecture

Source – http://www.itvarnews.com/2018/08/06/what-makes-a-good-m2m-service-provider/ retrieved on February 11, 2019

4. TECHNOLOGIES

M2M communication technology is a group of several intelligent technologies; among them, some are discussed here.

4.1 IP (Internet Protocol) – It is the primary network protocol developed in the 1970s, currently has two versions in use IPv4 and IPv6. As day by day networked devices like sensors, CCTV, smartphones etc are increasing, there was a need of a new system which can provide each of them a unique IP address, hence IPv6 developed and it allows 2128 unique addresses. In M2M technology each device is given a unique IP address through which these devices can communicate with each other and/or send data to a central server, based on what technology has been used by implementers.

4.2 Wi-Fi (Wireless Fidelity) – It is a networking technology that allows wireless communication between networking devices. This technology was invented by Vic Hayes. It is based on IEEE 802.11 standards. It supports two bands 2.4 and 5 GHz. generally accepted as a high-speed default connectivity option for M2M devices including a sensor, CCTV, smart home, notebooks, hand-held devices and other consumer electronics.

4.3 RFID (Radio Frequency Identification) – RFID technology is used in objects monitoring. This system has two parts mainly, RFID reader and the RFID tag. RFID reader sends a query to the RFID tag to identify it. The RFID tag has an antenna with a unique id associated with it. This tag can be bind to any object which needs to be tracked. There are two types of RFID tags are available tags with and without battery. Without the battery, RFID tags are called passive RFID while battery RFID tags are called active RFID [8]. In M2M technology these tags are used by many devices, especially in inventory type applications.

4.4 Medical Devices – There are some implants are used in medical science to monitor patient condition like cardiac monitoring; these devices are operated in 402-405 MHz range and are known as medical implant communication services (MICS). These implants are normally stayed in the human body in sleep mode and needs a "wake-up" signal to get activated. These devices are designed to consume ultra-low power, thus allowing them to work for years (5-10 years) [9].

4.5 Bluetooth – It is a short-range wireless communication technology invented by Ericson Mobile Communication in 1994. It is mostly used in Personal Area Networking (PAN) for data sharing. It was initially standardized by IEEE as IEEE802.15.1, but this standard is now no longer maintained. Latest Bluetooth standard is v.4.0 which consumes very less power compared to its ancestors. In M2M technology it is mainly used in wireless sensors, healthcare, industrial atomization and sports.

4.6 ZigBee – ZigBee standard was developed ZigBee Alliance to enhance features of wireless sensor networks. It is a low-cost short-range reliable protocol. It is based on IEEE 802.15.4 standard with a range of 100 meters with 250 kbps speed. It is mostly used in home/industry automation, power systems, agriculture and medical industry.

4.7 2G Cellular (GPRS) – The General packet radio service (GPRS) is a part of the 2G standard, which provides practically data transmission speed of 56 kbps. This technology is mostly used standard for M2M applications. It has advantages of greater geographic coverage, low battery consumption and lower device cost. Although GPRS data rate is low, still it is suitable for M2M applications those required speed less than 16 kbps. The power consumption of a GPRS terminal can be reduced by configuring the device in such a way that they transmit data only when it is required. GPRS requires active subscribed identification module (SIM) card, so each device on the network can be identified.

4.8 3G Cellular – As M2M modules are increasing, there is a need for a faster way of communication to support a wide range of M2M applications. Although 3G is older technology compare to currently available technologies, it has own advantages like wider application

support, reliability and speed which is very attractive for automobile and multimedia sectors. This technology also required SIM card for its working.

4.9 4G Cellular (LTE) – Long-Term Evolution is the latest and high-speed wireless communication standard for data terminals. This technology is really promising for mobile industries, automotive and multimedia industries. However this is latest and fasted technology, still it is not supported by many M2M terminals as older M2M devices are based on 2G technologies, so currently 2G/3G technology is will continue to serve mostly M2M device, till all the M2M devices get a replacement with new one devices.

4.10 Cloud Computing – Cloud computing is a demand service consisting of a shared group of computer resources. It provides platforms, software and infrastructure as a service [10]. Cloud computing allows M2M devices to sense the environment and send data to the cloud so it can analyze and extract the required information from that data. Cloud computing has many advantages over conventional computing as it provides scalability, faster implementation, globally accessible with security.

5. APPLICATIONS

This technology is being used in various sectors like industries, healthcare, logistic, smart grid, metering, payments, security, home/office/industry automation, transportation and traffic management etc. from last many years. In this section, some important applications of M2M technology are discussed briefly.

5.1 Traffic Management – M2M devices including sensors, GPRS, RFID tags and others play a significant role in traffic management, they can collectively offer smart traffic management for the cities. GPRS can navigate vehicles to their destination with the shortest path by calculating distance and traffic on the road. RFID tags can be used for cashless tolling to reduced waiting and traffic jam on the roads. Sensors can communicate with other vehicles and infrastructures for vehicle telemetry

5.2 Security Management – M2M devices are an integral part of security devices such as surveillance, vehicle security, theft alarms and access control. Nowadays CCTV cameras are everywhere to monitor activities. These types of device can work as an access control system for vehicles, safe, chest, home or for any premises which need to take care of trespassing. They are very useful in crime forensic also.

5.3 Healthcare System – M2M devices can be used to understand the patient's condition by doctors, resulting in a better prognosis. These devices can be categorized in many forms based on their uses like implants, external devices, supportive devices, life support systems etc. Heart rate monitor, Sugar monitor, fitness band, pacemaker, implants are some examples of M2M healthcare devices.

5.4 Payment System – Modern payment system is completely based on M2M devices. Whether it is an automatic teller machine (ATM), a point of sale (POS) mobile payment or automated fuel station, all are based on M2M devices. These devices are used widely for automated vending machines to sold tickets, water, milk etc. POS is becoming a popular method of cashless payments in shopping malls, stores and stalls.

5.5 Remote Controlling – There are so many valves, motors, pumps, belts, lights, hoist etc. even in a small industry, each cannot be operated by human or in time by humans, here M2M technology takes the lead. Industries devices can be controlled through M2M technology when required. This also ensures human safety where operation includes hazardous chemicals, flammable chemicals etc.

5.6 Tracking and Tracing – The Best example of M2M communication is Global Positioning System (GPS), it is satellite-based navigation system which is currently being used on very large scale in cars, bikes, mobile phones etc. to pinpoint users/device location. Google map, Ola cab etc. is completely based on this technique. M2M devices are being used in traffic control systems, road tolling and asset tracking.

5.7 Manufacturing – M2M device plays a vital role in manufacturing industries, whether it is an automobile industry or a small soap making factory, M2M device somehow finds its place. This technology is being used by industry in the production chain, supply chain, inventory management etc. It is being used in process control for controlling various analyzers, valves, pumps, flow meters, temperature controller etc. This technology can save maintenance time by sending logs, issues related to any device to control unit for better management. This technology has significantly improved production with a reduction in the cost of production.

5.8 Home Automation – The Best example of M2M communication is Global Positioning System (GPS), it is satellite-based navigation system which is currently being used on very large scale in cars, bikes, mobile phones etc. to pinpoint users/device location. Google map, Ola cab etc. is completely based on this technique. M2M devices are being used in traffic control systems, road tolling and asset tracking.

6. CONCLUSION

M2M communication technology seems very beneficial for manufacturers, suppliers and consumers. This technology adding functionality, automation to older system day by day and now this technology can be found in almost each and every system. As it is going to occupy every system in future, it is necessary for us to understand this technology and its uses. Though this technology is in demand, still it is facing some basic issues like safety, cost, privacy, applicability etc., which need to be looked upon. This paper tries to give some insight into this technology including definitions and applications after reviewing various research papers and online database.

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