A Glimpse on Key Applications of Smart City under M2M Communication

Ms. Sonam Kaushik¹, Dr. Gaurav Aggarwal², Dr. Sanjay Tejasvee³
¹Asst. Professor/Research Scholar, Dept. of Engineering & Technology, Gurugram Univ., Gurugram -122001-India
²Professor, Dept. of Computer Science, JIMS, Bahadurgarh-124507-India
³Asst. Professor, Computer Application Dept., Govt. Engineering College Bikaner 334004-India
Email: ¹ksonamkaushik3@gmail.com, ²gaurav.aggarwal@jagannathuniversityncr.ac.in, ³drsanjaytejasvee@gmail.com

Abstract—In India, it is very necessary to make normal cities as smart cities near future. So, Develop a smart city is one of the most recent fields in today’s digital era to researches. Machine to Machine (M2M) communication is the latest innovative-fangled type of communiqué that enables full automation with the help of integrated applications to make a normal city to a smart city. Many devices are connected in a smart city to monitoring many tasks and it is a very challenging task to integrate and manage these connected devices. Interconnection of several devices and machines using the internet to form an M2M Area Network (M2MAN) provides controlling and monitoring smart applications like smart-metering, weather, environment, home, air quality, water supply with quality management, power supply with bill monitoring, traffic, and healthcare, etc. under M2M communication and integrated single level umbrella structured applications. Out of several M2M monitoring and controlling applications towards smart cities, few key applications are presented in this paper with their basic approach, workflow, and concerning issues and used technologies for the implementation with the brief growth analysis.

Keywords—M2M Communication, Interconnection, M2MAN, smart applications

1. Introduction

The Definition of smart is dependent upon requirements, geographical location, and economic condition. So, there is no exclusive definition and platform of a smart city. Smart city is user driven modernism with open access features that tries experiments for validation of future Internet enabled services through sharing common resources to develop urban innovation eco-systems [1] whereas Harrison etl [2] define the smart city as an interconnected instrumented and intellectual city. Instrumentation is data capturing by intelligent sensors to make decisions and analysis. [3] Smart cities mainly focus on enabling information and sources of communication technologies towards next-generation to all levels of life by implanting network actuators and sensors to power grids, hospitals, tunnels, roads, water systems, buildings, vehicles, gas pipelines, and oil pipelines, and other things in each corner of the particular and figure out the Internet of things (IoT) via many different types of networks. [4] Currently, smart city has gradually increased but at a slow speed instead of expansion of smartcities at a rapid rate. However, this M2M communication is recently in demanding numerous ways, consisting of a reduction of prices, connections of quality, and easy to use. The current advancement in the sector of Wifi communications has demonstrated a well-built intelligence and inclination on humanizing in each aspect. [5][6]
M2M is an autonomous communication of a big number of devices to sense, process, and actuate the actions without any human being intervention or supervision which the main feature apart from other technologies. [10-15] The main motto of M2M is to establish a communiqué between various intelligent/smart or elegant-devices. [16] M2M is a fast emerging technology consisting of billions of interconnected devices for several different kinds of applications. [17] M2M communication refers to the self-governing communications surrounded by computers, smart sensors, embedded processors, actuators, and devices of mobile with partial/no human being involvement. [18] Impacts of M2M communication technology will gradually be increasing in these days as per several predictions. [19] M2M is a new communicational method that assists in developing a network that can be used in a smart city. This novel technique allows sensors, devices, computers to transmit data to each other without any intervention of humans. This technology uses already established networks like cellular networks rather than to build up a new network system. However, a large number of devices/machines are connected in this paradigm but no standard protocols are defined. Hence, security is the main issue in this communication system. Many researchers are researching to develop a unified protocol design for analyzing a new protocol to deliver services for a big number of machines.

2. Key Applications of Smart City

Many applications of M2M communication wrap most every sector like security, tracking, tracing, payment, health, metering, productions, facility management, specific triggering, online data transmissions, and monitoring, etc. It gives a chance to the utility division also, for the most part through keen metering arrangements and distributing resource utilization in an optimization and control manner. With eminent latest upgrades in Internet connectivity and speed, M2M innovation is successfully giving buyers telecom arrangements, and also answerable for the advancement of the market is significant value drops because of the improved remote network. And in the case of the industry of transportation, the capacity of associated trucks to speak to one another operate installed sensors, RFID (Radio Frequency Identification), and a remote network makes brilliant armada and resource following conceivable. Further, organizations get accessibility and improve their activities then constrain customer promise via empowering the object’s services for example in the case of vehicle communication car producers and vendors may say to their customers when motors segments need substitution. M2M permits organizations to see insights concerning the area of benefit that possesses, fabricates, or oversees. With these new headways and advancement, several organizations are seeing numerous advantages to adopt M2M advancements. The following figure is showing the key M2M applications towards the modern era.

![Figure 1. M2M Applications](Source: internetofthingsagenda.techtarget.com)
In this section, out of many applications, few major and basic monitoring applications toward smart cities under M2M are discussed with their working flow as following:

2.1 Elegant Water Quality Monitoring Application

Water is one of the significant resources for life and its appropriate management is a major challenge in today’s environment. Water management is at present interoperability difficulty because of less support to standard parameters to control/monitor the pieces of equipment. This issue affects several procedures of inappropriate water management like distribution, consumption of water, identification of structure, and maintenance of pieces of equipment. Management of Water is a method of planning, distributing, and good use of available water resources. This impacts on many areas such as water consumption, food production, curing, purification, irrigation, the invention of energy, and their uses. Smart water consists of water quality monitoring, usage, and water distribution. M2M communication unlocks this for new potential applications in a smart water quality monitoring system which framed out a structure and implement M2MAN to monitor turbidity, Electrical conductance (EC), pH, Nitrate, Dissolved Oxygen (DO), Fluoride, Arsenic contents for the outcome the quality of water. Water quality monitoring consists of analyzing the properties of water in a dam, rivers, lakes, reservoir, and underground water.

2.2 Intelligent Metering Application

Out of many key parameters of the development of any country, electricity is one of them which also decides the business prospectus and planning. Many small scale industries highly suffered due to inappropriate supply of electricity. Smart meters are utility meters used to measure estimates of the bill. At the customer’s home or office, these smart meters are installed. Customers can make smart decisions by analyzing the use of consumption. Smart meter consent with a perceptive of habits of spending, enhance the network effectiveness, and causative to electrical energy, water, or gas saving. Some energy and saving optimization methods should be used because the lifetime of the battery can limit the frequency and quantity of data transmission.[21] High occurrence enables a new scale of possibilities to utility services and for the management of services.[22] Following figure 2 shows the smart home with a smart meter system. Customers can receive details of uses through the smart-mobile, here Mobile Network Operators (MNO), the gateway of M2M, and M2M server are used.

![Figure 2. Smart Metering at Smart Home](image)
Following figure 3 deals with features and indicators required in the smart electric energy meters to communicate, data processing, calculate the cost, real-time alarm, and maintenance, etc. [23]

2.3 Air Quality Monitoring Application

Today, the environment is highly polluted due to industries and automobiles mostly in urban areas. It increases respiratory and other diseases. In sequence to protect living things, it is very important to measure the levels of pollution and use techniques to reduce air pollution rapidly. M2M based resolution for monitoring of air quality includes robust wireless gas detectors, H2S, Volatile Organic Compounds (VOCs), NH3 measurement at a single monitor station. It is a very flexible wireless gas monitor to be deployed in urban areas. It can monitor temperature, humidity, Nitrogen Dioxide (NO2), Carbon monoxide (CO), O3, and Noise.

Figure 3. Features of Smart Meters

Figure 4. Air Monitoring with Single Point Buoy Mooring Containing Totes
This M2M based system observes air-quality via a web-server. Whenever the quality of air goes down by
determined point brink and whenever dangerous gases like CO2, smoke, alcohol, benzene, NH3, LPG, and
NOx comes in the air, it will trigger an alarm and show PPM.

2.4 Healthcare Monitoring Application
From the perspective of health care, the M2M communication network includes the use of proper devices
of sensors to facilitate monitor from remote of essential signals, early recognition of serious conditions,
and remote certain medical treatments from remote [24]. In a healthcare monitoring system, the
physiological data of the patient is access at remote and diagnose as soon. It can be executed in a wearable
alarm concept by WBAN (Wireless Body Area Network) which is a wireless network sensor, associated
with a wearable gadget of computing. These devices situated inside and/or outside of the body. This
network connects wearable machines on the human body with the help of a global network by WPAN
gateway devices so that patient’s data could be accessed online through the internet even from remote
locations.

![Figure 5. Illustration e-Health Application under M2M Communication](image)

2.5 Smart Traffic Monitoring
The rising of the clogging level in open street systems is a developing issue in numerous nations. Traffic
issues have deteriorated alongside the economy; a yearly investigation [26] recommends that a small
enhancement is being made in the direction of guaranteeing the country's framework of transportation
which will have the option to continue with work development. Inductive circles [27] with attractive
sensors [28] have been ordinarily utilized intended for traffic the executives and manage the nonetheless,
applications, obliteration, and constrained spatial detecting are two significant confines. Different
strategies, for example, Traffic [29], which comprise of the sensor at remote and access point, have
additionally been tried. Be that as it may, due to the critical props in the field of PC vision as of late,
traffic signal, what's more, observing utilizing vision sensors has drawn expanding consideration.
Numerous business and exploration frameworks [30] and [31] use video handling, intending to take care
of explicit issues in street traffic checking. Gridlock brings about direct monetary misfortune and worsens
the air contamination of urban communities since vehicles discharge more carbon dioxide and other
harmful materials when they are at a lower speed. This paper means to lighten this circumstance by
directing the vehicles to the unblocked streets utilizing ongoing traffic state observing. The traffic
checking framework is made out of two stations; sub streets and principal street. The sub street station
comprises of a camcorder and a PC associated with the web (Arduino 3G module can likewise be utilized as a modem for web availability), while the primary street involves a 3G Arduino mega 2560, and a showcase. The traffic stream rate information is then sent to the Arduino 3G at the principal street station through an email. The information got is then controlled and traffic stream rate is shown. The proposed framework engineering is depicted in figure 6.

![Figure 6. Traffic Monitoring Architecture](image)

### 2.6 Intelligent Weather Monitoring

The shrewd climate station is information obtaining platform distantly ready to gather data dependent on meteorological/surrounding boundaries and reside at the cloud/then again database on the web-server [32]. Non-shrewd climate position utilize just wired associated media to store estimation results, for example, Security computerized SD (Secure Digital) memory card, streak memory, EEPROM(Electrically erasable Programmable Read-Only Memory), and so on [33]. The regions of utilization call attention to integrating, e.g., the shrewd industry, wherever the advancement of canny creation platform and coupled creation destination is frequently examined [34]. Primary components of keen climate station are:

- a) Correspondence System – Link (Local Area Network (LAN)), Wire, remote.
- b) Smart Control – Microcontroller to Deal with the framework.
- c) Inserted Sensors- items which can be used to measure meteorological/encompassing boundaries.

A large part of the users utilizes remote advances for correspondence between the sensor part and the fundamental item. The improvement of this framework expects to address the issues of the client by utilizing arranged low power sensors delicate to the earth, so it very well may be applied to make life simpler. Acknowledged gadget expects DC power flexibly and batteries offer the chance of sun oriented force, which is a preferred position in the need of estimating barometrical boundaries in troublesome available areas. As per the utilization of sunlight based force, the quantity of estimating focuses, for instance as the outside of the sun-powered board increments, and the number of estimation focuses will increase longer than sixty minutes such as Temperature [°C] or [°F], Humidity [%], Altitude [m], Speed of wind[m/s] (Anemometer), Lighting[lx], Estimation and Gas Detection (LPG)[%]. Data of date and time are available during the capacity of information on the worker and are accessible while downloading the outcomes. There is an enormous number of particular gadgets for estimating and obtaining air boundaries available, however, there are no gadgets that consolidate all modules for estimating/watching both surrounding and barometrical boundaries. data to the client about the entered API key of the direction in which the consequences of the estimation will be put away so that toward the finish of the arrangement the
commencement starts before the beginning of the estimation. Each assignment in estimation is characterized as appeared in Figure 7, as an algorithmic method of showing programming.

**Figure 7.** Smart Weather Station Algorithm for Integrated System
3. M2M Communication Growth

Many companies are finding an opportunity to increase their use of M2M innovation due to continuous new developments in the IoT programming area. M2M is now being used to improve profitability with productivity in different fields. The solution drivers for this advancement are consolidating the related conditions, such as homes, vehicles and workplaces.

M2M affiliations are seeking implementations in a set of forms and have progressed over the last few decades with the emergence of global Online and IP orchestration systems, enabling improved and capable trades over remarkable separations and between colossal amounts of contraptions. Developing countries like India have perceived the criticality of M2M and are, as such, fully focused on the extended invasion of M2M. Indian Government has seen the meaning and has launched a Digital India and Make campaign in India. The achievement of these fights will be driven by the growth of the M2 M in India. The M2M relationship in India is expected to grow to 429 million by 2021 according to FICCI, which in itself is crucial to the need for a successful market upturn over the guessing period. The Media Interchanges (DoT) part declared that it will include a methodology record detailing the principles to engage a colleague of M2M organizations in India in 2018, thereby allowing the IoT to emerge in the same way. [37] The increasing determination of 5G advancement and the creation of movement in far-off correspondence will result in M2M. In either case, privacy and security concerns and the dynamic advancement of software are a crucial part of the problem that prevents the growth of market thought. [38][39] In the same way, the high cost of transport with forced versatility also has an adverse effect on the promotion of advancement.

4. Conclusion

Machine-to-machine correspondence, or M2M, is really as it sounds: two machines "bestowing," or exchanging data, without human interfacing or affiliation. This fuses successive affiliation, powerline affiliation (PLC), or distant trades in the mechanical IoT. At present, the vast majority of the nations are extremely intrigued to actualize brilliant city is applications. One of the most suitable answers for this course is M2M correspondence innovation. Subsequently, M2M innovation has focused on ventures and specialists with late rising mechanical patterns. The establishment of the quickly developing business sector relies upon different elements like expanding interest for vitality, water, building, streets, and
wellbeing true to form roughly 70% of India's populace will be living in urban areas by 2020. M2M correspondence is empowered to offer amazing open doors towards sellers in the close to ongoing possibility years. Convention related, security issues, information stockpiles, and examination identified with some continuous investigates are giving a superior answer for the keen city mission. A continuous watching structure expected to screen the traffic stream rate and vehicle speeds improves the situation of gridlock and air tainting on involved urban lanes. The system is also furnished with security meddle with, which can be used to pass on information, for instance, road end due to incident or fix works, about a particular sub road to the vehicle drivers. This prompts vehicles encountering the least blockage going at higher speeds and henceforth speaks to less fuel usage. Further improvement of the gadget is arranged, as concurrent sending of information from a few keen climate stations simultaneously to a similar channel. Thus, the client would have an understanding of the difference in estimated boundaries in numerous areas together for the client to know the difference in estimated boundaries in a few areas. It is likewise conceivable to add new sensors to gauge other meteorological/encompassing boundaries. A portion of the sensor can be included as a sensor for downpour measure, wind heading, Geiger counter radiation locator, and so forth. One of the gadgets that assemble its work on Cloud figuring innovation is the shrewd climate station portrayed in this paper. The savvy climate station separated from the chance of putting away information on the Cloud or database on the webserver, offer the chance of the framework to be sun based controlled. Along these lines, it is conceivable to quantify climatic boundaries in troublesome available areas. There is likewise the chance of working this gadget in four unique dialects. Organizations shouldn't consider IoT or M2M for IoT or M2M. Rather, they should concentrate on streamlining their plans of action or giving new an incentive to their clients. The business enthusiasm for more significant accessibility and M2M correspondence keeps creating, incited by the two key examples driving this expansive choice: falling costs of sensors and the all-inclusiveness of straightforwardness far off frameworks, which makes machine-to-machine development more sensible. Those associations who compensate for some recent setbacks and use M2M now will be the first to see epic points of interest from it, and transition is reliably here to help with ace level directing and use.

5. References
[1] Schaffers H. Komninos N., Pallot M. Trousse et. Al  (2011) smart cities and the future internet: towards cooperation frameworks for open innovation. In Domingue j.et al (eds) the Future Internet. FIA 2011. Lecture Notes in computer science, vol 6656. Springer, Berlin, Heidelberg.J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
[2] H. Chourabi et al., Understanding smart cities: An Integrative Framework, 2012, 45th Hawaii International conference on system sciences, Maui, Hi, 2012, pp. 2289-2297
[3] Harrison, C., Eckman, B.hamilton, R.Harswick, et. Al, (2010), a foundation for smarter cities, IBM Journal of research and development 54, (4)
[4] K. Su, J. Li, and H. Fu, “Smart city and the applications,” in Proc. of 2011 Int. Conf. on Electronics, Communications, and Control, Wuhan, China, Sept. 2011,pp.1028-1031.
[5] J. Shi, J. Wan, H. Yan, and H. Suo, “A survey of cyber-physical systems,” in Proc. of the Int. Conf. on Wireless Communications and Signal Processing, Nanjing, China, Nov.2011,pp.1-6.
[6] H. Suo, J. Wan, L. Huang, and C. Zou, “Issues and challenges of wireless sensor networks localization in emerging applications,” in Proc. of 2012 Int. Conf. on Computer Science and Electronic Engineering, Hangzhou, China, Mar.2012,pp.447-451.
[7] D. Zhang, J. Wan, X. Liang, X. Guan, Q. Liu, and G. Ji, “A taxonomy of agent technologies for ubiquitous computing environments,” KSII Trans. on Internet and Info. Syst., vol. 6, no. 2, pp. 547-565, Feb. 2012.

[8] J. Wan, H. Yan, H. Suo, and F. Li, “Advances in cyber-physical systems research,” KSII Trans. on Internet and Info. Syst., vol. 5, no. 11, pp. 1891-1908, Nov. 2011.

[9] B. M. Michelson, “Event-driven architecture overview,” Technical Report, Patricia Seybold Group, Boston, USA, Feb. 2006.

[10] M. Doher, J. Swetina, A. Alexiou, C. Wang, P. Martigny, K. Zheng, Editorial: IEEE Communications Surveys & Tutorials; Machine-to-machine Technologies & Architectures, IEEE Communications Surveys & Tutorials 16 (1) (2014) 1–3. DOI: 10.1109/SURV.2014.012114.00000.

[11] R. Lu, X. Li, X. Liang, X. Shen, X. Lin, GRS: The green, reliability, and security of emerging machine to machine communications, IEEE Communications Magazine 49 (4) (2011) 28–35. DOI: 10.1109/MCOM.2011.5741143.

[12] P. Jain, P. Hedman, H. Zisimopoulos, Machine type communications in 3GPP systems, IEEE Communications Magazine 50 (11) (2012) 28–35. DOI: 10.1109/MCOM.2012.6353679

[13] K.-C. Chen, S.-Y. Lien, Machine-to-machine communications: Technologies and challenges, Ad Hoc Networks 18 (2014) 3 – 23. DOI: 10.1016/j.adhoc.2013.03.007.

[14] M. T. Islam, A. e. M. Taha, S. Akl, A survey of access management techniques in machine-type communications, IEEE Communications Magazine 52 (4) (2014) 74–81. DOI: 10.1109/MCOM.2014.6807949.

[15] S. Y. Lien, K. C. Chen, Y. Lin, Toward ubiquitous massive accesses in 3GPP machine-to-machine communications, IEEE Communications Magazine 49 (4) (2011) 66–74. DOI: 10.1109/MCOM.2011.5741148.

[16] P. K. Verma, R. Verma, A. Prakash, A. Agrawal, K. Naik, R. Tripathi, M. Alsabaan, T. Khalifa, T. Abdelkader, A. Abogharaf, Machine-to-machine (M2M) communications: A survey, Journal of Network and Computer Applications 66 (2016) 83 – 105. DOI: 10.1016/j.jnca.2016.

[17] M. Chen, J. Wan, and F. Li, “Machine-to-machine communications: architectures, standards, and applications,” KSII Trans. on Internet and Info. Syst., vol. 6, no. 2, pp. 480-497, Feb. 2012.

[18] M. Chen, “Towards smart city: M2M communications with software agent intelligence,” Multimed Tools Appl., DOI: 10.1007/s11042-0121013-4.

[19] Z. M. Fadlullah, M. M. Fouda, N. Kato, A. Takeuchi, N. Lwaski, and Y. Nozaki, “Toward intelligent machine-to-machine communications in smart grid,” IEEE Communications Magazine, vol. 49, no. 4, pp. 60-65, Apr. 2011.

[20] United Nations. Global Sustainable Development Report – Executive Summary: Building the Common Future We Want. New York: United Nations Department of Economic and Social Affairs, Division for Sustainable Development. 2013. http://sustainabledevelopment.un.orgglobalsreport/ last viewed in November 2014.

[21] S. Sendra, J. Lloret, M. Garcia, J. F. Toledo, Power saving and energy optimization techniques for wireless sensor networks, Journal of communications, 6 (6), 439-459. 2011

[22] A. Khamis, S. Rashed, A. Abou-Elnour, M. Tarique, ZigBee Based Optimal Scheduling System for Home Appliances in the United Arab Emirates, Network Protocols and Algorithms, Vol 7, No 2 (2015). Pp. 60-80

[23] Jaime Lloret, Jesus Tomas, Alejandro Canovas, Lorena Parra; "An Integrated IoT Architecture for Smart Metering "; IEEE Communications Magazine-December-2016

[24] ETSI. Machine to Machine Communications (M2M): Use Cases of M2M Applications for eHealth. Draft TR 102732 v0.4.1, 2011
[25] E. Kawasaki, A.S. Lalos, A. Antonopoulos, et al., ‘Machine-to-machine (M2M) communications for e-health applications’ http://dx.doi.org/10.1016/B978-1-78242-102-3.00020-4 (2015)
[26] Urban Mobility Report, http://mobility.tamu.edu/ums/mediainformation/pressrelease/ (2011)
[27] Cherrett, T., et. al., “Remote Automatic Incident Detection Using Inductive Loop Detectors”. Proceedings of the Institution of Civil Engineers: Transport, . pp149-155, 2005.
[28] Zhang, L., et. al., “Real-time Traffic Monitoring with Magnetic Sensor Network”. Journal of Information Science and Engineering 27, . pp1473-1486, 2011.
[29] Color, S., et. al., “Sensor Networks for Monitoring Traffic”. Proceedings of Allerton Conference on Communication, Control and Computing, 2004.
[30] Chitnis, M., et. al., “Wireless Line Sensor Network for Distributed Visual Surveillance”. Proceedings of Conference ACM 09, Canary Islands, Spain, October 26-30, 2009.
[31] Wen, W., “A Dynamic and Automatic traffic light control expert system for solving the road congestion problem”. Journal of Expert System and Applications, 2008.
[32] B. Mihai, “About The Smart Weather Station”, Acta Universitatis Cibiniensis – Technical Series, vol. LXVIII, no.3, pp. 26–29, 2016.
[33] M. B. Waghmare and P. N. Chatur, “Temperature and Humidity Analysis using Data Logger of Data Acquisition System: An Approach”, International Journal of Emerging Technology and Advanced Engineering, vol. 2, no. 1, pp. 102–106, January 2012.
[34] F. Wortmann and K. Flütcher, "Internet of Things – Technology and Value Added", Springer Fachmedien Wiesbaden, Bus Inf Syst Eng, vol. 57, no. 3, pp. 221–224, March 2015.
[35] https://www.link-labs.com/blog/what-is-m2m [Retrieved as on 10-08-2020 ]
[36] https://www.itransition.com/blog/m2mtechnology [Retrieved as on 13-08-2020 ]
[37] https://internetofthingsagenda.techtarget.com/ [Retrieved as on 14-08-2020 ]
[38] M2M Connections Market - Growth, Trends, and Forecast (2020 - 2025) https://www.mordorintelligence.com/industry-reports/m2m-connections-market [Retrieved as on 15-08-2020]
[39] M2M Satellite Communication Market by Technology (Satellite Telemetry, VSAT, AIS), Communication Network Device (Satellite IP Terminals, Satellite Modems, Gateways), Service (Managed Service, Data), Vertical, Region - Global Forecast to 2020; https://www.marketsandmarkets.com/Market-Reports/m2m-satellite-communication-market-33741729.htm