

Smart City: Issues and Research Challenges in Implementation

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Abstract—Smart City is one of the recent researches going on in India to make all the cities as Smart in the near future. This paper discusses about the requirements for smart city and the research challenges and issues in implementation. Machine-to-Machine (M2M) communications is a new type of communication which endows full automation and a promising research for the implementation of smart city. M2M have surmounted the machine to human communication. Recent researches in M2M say that network of 30 billion devices will be worldwide in 2020. Supporting these numbers of devices is a challenging task, thus attracting the researchers from both academia and industry in M2M communication in implementing smart city. The interconnection of Machine Type Devices (MTD) using 3G/ 4G to form a M2M Area Network (M2MAN) which facilitates the M2M applications like smart grid, eHealth, eEnvironmental monitoring, smart city, Smart Home, smart Water Quality, Smart Air Quality etc., integrated into a Single Application named Smart City/Village. Since the M2M uses wireless channel and MTD placed in unmanned environment invites security threats. In this paper, a survey is made on various applications using M2M communication. Also there are lot of challenging tasks in implementing Smart City, Here some of the applications like Smart Water, Structural Health monitoring, Air Quality Monitoring and issues related to implementation were discussed. Also the latest technologies for the implementations are also discussed. Without addressing the challenging issues like security, communication protocol, devices etc., M2M communications for smart city cannot be prophesied.

Keywords-smart city; M2M, monitoring; RF; M2MAN

I. INTRODUCTION

Smart city: There is no unique definition or Frame work for smart city. Based on the requirements, each country defines their own definition for smart city according to the geographical Location, their requirements and the economical conditions.

Schaffers H *et al.*[1], examined the smart cities as open and user driven innovation, and tried out with experiments in validating Future Internet-enabled services. Also shared the common resources to establish urban and regional innovation ecosystems for the stake holders (smart city implementers).

Chourab H *et al.*, suggested the directions for the researchers and government professionals in implementing the smart city [2].

Harrison *et al.* says that a smart city denotes an instrumented, interconnected, and intelligent city.

Instrumentation is capturing the data through the sensors and intelligence refers to the analysis and decision making [3].

Zanella A. *et al.*, analyzed the currently available solution in the implementation of urban IoT and addressed the technical solutions guidelines adopted in the Padova Smart City in collaboration with the city municipality [4].

Caragliu A. *et al.*, presented a definition for the smart city concept and reviewed some quantitative and graphical evidence. Also formulates a new strategic agenda for European cities that allowed them to achieve sustainable urban development and a better urban landscape [5]. Vito Albino *et al.*, identified and reviewed the performance metrics for few smart cities [6]. Coimbatore is one of the smart cities selected in Digital India Project, Our research focuses on providing a few solutions for the same [7].

A M2M communication is a novel technique which is useful in forming a network that can be utilized for smart city. M2M communication allows sensors as well as mobile devices, computers to communicate each other without human intervention. An M2M network uses the existing network like cellular networks (instead of building a new network) to transfer the data's in any part of the world. Typically Machine Type Devices (MTD) transmits/receives small amount of data. Security plays a vital role in any communications environment, and it is more critical in M2M communications. Recent Research interest in M2M is increasing but there is a lack of research contributions in identifying the main issues in security on M2M environments. Since huge number of devices connected in the M2MAN, there is no standard protocols define for M2M communication. Research also going in analyzing a new protocol to provide service for large number of devices.

II. SMART CITY- FEW APPLICATIONS

In this section some of the applications related to Smart city are discussed here.

A. Smart Metering

In Coimbatore, electricity is one of the main parameters which decide the business strategies. In 2015 many of the small scale industries and public suffered due to power paucity. Awareness is given to public to save electricity. Here using the technology, Smart meters are proposed to save energy. Smart meters are utility meters used to measure the utilized amount of gas, heaters, water, electricity thereby estimates the bill and provide the details like billed amount, meter readings etc., to customers, energy distributors and

suppliers. The intelligent meters are installed at client's residence, offices. The objective of this smart metering is to save the energy. Clients can make smart decisions by analyzing their usage. Figure 1 shows the smart home with smart metering. Here the client can get the details about the usage of above said parameter through smart phone. This system uses Mobile Network Operators (MNO), M2M gateway and M2Mserver.

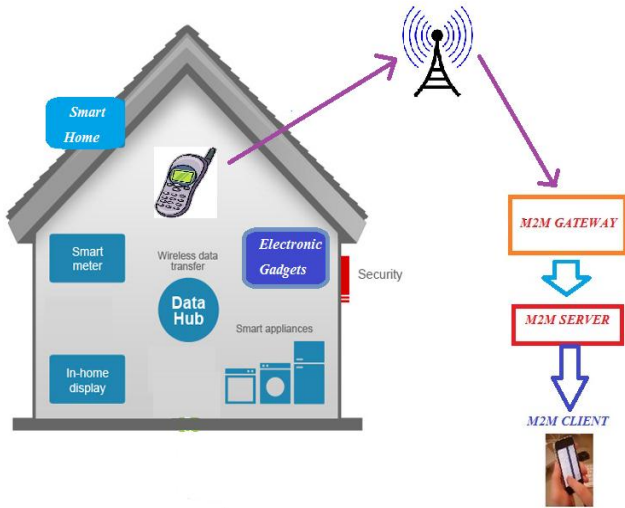


Figure 1. Smart home with smart metering

B. Smart Water

Without doubt, humans cannot exist without air, food and water. In recent years, due to climatic change, air pollution, scarcity of water and human power for agriculture has threatened for human life. Water Quality monitoring ensures the quality of surface water or underground water both for human being and plants/animals. Smart Water involves in water quality monitoring, water distribution and usage. M2M communication opens up completely for new possible applications in smart water quality monitoring system. In this research proposal, project idea is framed out to design and implement M2M area network (M2MAN) to monitor the turbidity, pH, Electrical Conductance(EC), Dissolved Oxygen(DO), Nitrate, Arsenic, Fluoride contents for finding the quality of water. Water quality monitoring involves analyzing water properties in rivers, dams, lakes and underground water reservoir as figure shows the WQM in Lakes. The module is tested at Perur Lake in Coimbatore.

- Water Quality: Turbidity, pH, Electrical conductance, Dissolved O2
- Water Distribution: Pressure Level, Detection in leakage (if any)
- Water Usage: Remote Monitoring of water meters (usage), control of irrigation in farms.

C. Air Quality Monitoring System

Recently in Coimbatore, the environment is polluted heavily due to automobiles, from large industries located

outside urban areas. Research says that increase of respiratory and other related diseases is due to air pollution. In order to protect humans and other living things like animals, plants, environment from damage by air pollution, it is of the utmost importance to measure the levels of air pollutants. M2M-based solutions for air quality monitoring both at industrial areas, institutes, hospitals, and inhabited areas, including the following capabilities:

- Monitoring gas levels: robust and certified wireless gas detectors in hazardous areas
- Odor detection in inhabited areas close to industrial parks: H₂S, NH₃, Volatile Organic Compounds (VOCs) measurement in one single monitoring station
- On-line real-time air pollution monitoring in cities: highly flexible wireless gas monitors to be deployed in an urban environment.
- Can monitor Temperature, Relative humidity, Carbon monoxide (CO), Nitrogen Dioxide (NO₂), O₃, Noise.

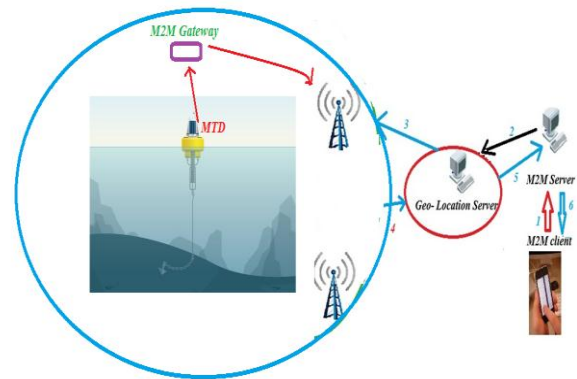


Figure 2. Monitoring system with Single Point Buoy Mooring containing Tmotes

D. Structural Health Monitoring

Now a days industrialized nation rely highly on civil infrastructure and invest huge resource too construct and maintain them. Civil structure immediately begins to deteriorate due to its continuous exposure to the elements. Manual inspection ensures the public safety but it's so costly in terms of human and financial capital. Structural health monitoring (SHM) system include network of MTD used to monitor the condition and safety of the structure. By installing SHM system could improve efficiency of inspection process ant increase the accuracy of evaluation and the safety level of the structure. Figure shows the structural Health Monitoring system. The efficiency of the system depend on the type of MTD network and the damage detection algorithm implemented. One of the fundamental part of SHM is data acquisition and it is purely based on MTD connected to a centralized data repository. All the MTD are connected to this repository where data processing take place and the information are extracted as shown in

Figure 3. The information collected from the MTD can be used to

- Find/Detect the damage on the structure.
- Locating and type of the damage
- Quantifying the severity



Figure 3. Structural health Monitoring

III. PROTOTYPE-IMPLEMENTATION USING M2M

These M2M communications in different environments and their applications requires attention to provide security aspects like confidentiality, data integrity, and authentication between M2M users and MTD. The requirements for the MTD to build a M2M network are

- Small size (physical)
- Small Processing unit
- Low memory
- Low data rate
- Low power (battery operated)

A battery operated MTD should have a lifetime of at least 20years. This can be achieved by making the devices to get automatically switched into sleep mode, if service is not required by MTD. The networked MTD are becoming more popular now, the security of the information exchanged between the MTD becomes an important parameter. Several short range and medium range wireless technologies used in M2MAN for networking MTDs are specified in the Table I.

The proposed system uses set of Machine Type Devices (MTD) placed in the appropriate places where the information is sent to the Server through Gateway. For example in WQM, MTD are placed in water canal/dams can transmit the information about the quality /status of the water to the M2M server through M2M gate way as shown in figure 2. Tmote (a wireless Sensor node) are used as MTD in this application. The MTD contains provisions for connecting sensors and RF transceiver module which can send/receive the information to/from the Main Control Unit (MCU), Ethernet gateway Advanticsys SG 1000 using M2M communication. In case of SHM, the MTD (sensors) have to be placed inside the concrete while construction and

provisions are made to interconnect with Tmotes. For Air Quality Monitoring system the MTD are placed in open environment. These MTD have to be provided with protection from rain, wind etc., Figure 4 shows an individual network for particular application. Figure 5 shows the complete setup for implementing the smart water, smart air quality and structural health monitoring project.

TABLE I. STANDARDS, DEVICES AND APPLICATIONS

Standards	Technology	Applications
IEEE 802.5.1	Bluetooth	Audio, Voice, data
IEEE 802.15.4	ZigBee	Home Control, Security, Asset Tracking
IEEE 802.15.3a	UWB	Television Transmission, Wireless Monitors.
IETF	6LowWPAN	Outdoor lightings, Smart Metering
IEEE802.15.4 6LoWPAN	Thread	Home Automation
ZAD12837 / ITU-T .9959	Zwave	Home Automation
Sigfox	SigFox	M2M Applications
LoRaWAN	LORA	Smart City Applications in Urban Environments upto 20KMs

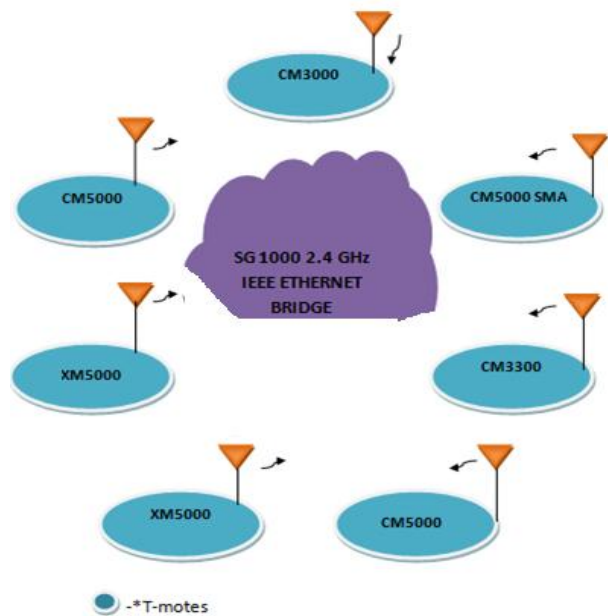


Figure 4. M2M Network using Tmotes and SG1000 Bridge.

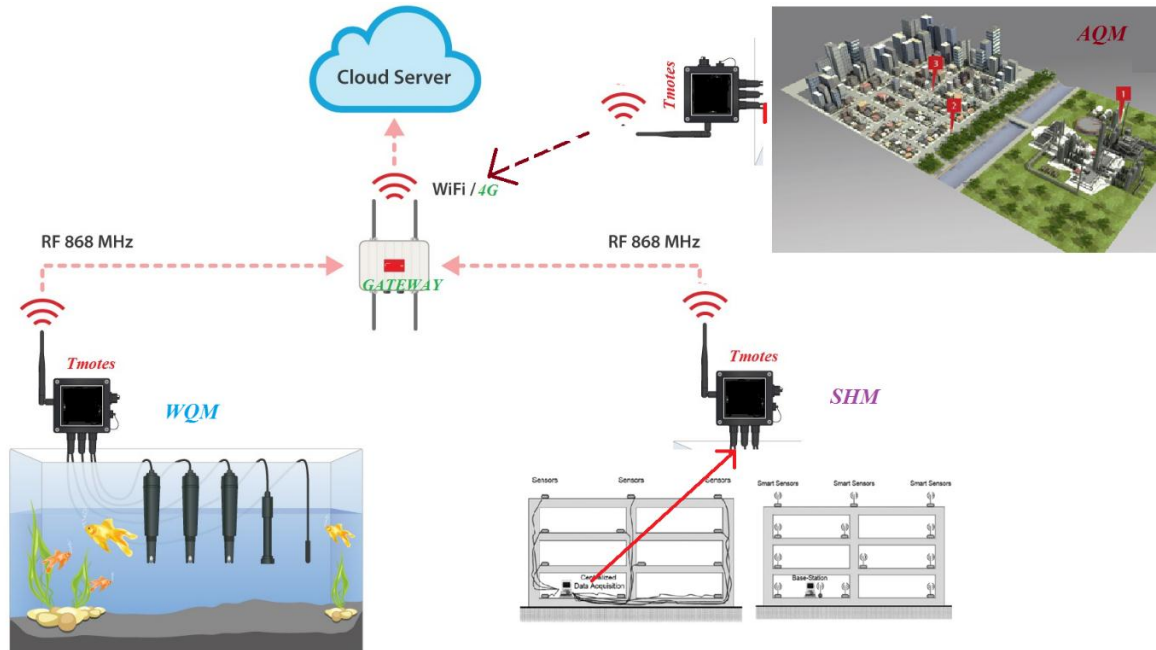


Figure 5. Deployment envisaged for smart water/Air using M2M

IV. CONCLUSION

Smart city is one of the recent applications where most of the countries are interested in implementing the same. M2M is one of the promising researches which provide solutions for implementing the smart city. Hence M2M has attracted academicians and Industries and it is clearly the most high profile of currently emerging technology trends, blending the physical and online worlds. By 2020, it is expected that nearly 70 percent of the India's population will be living in cities. As these areas expand, so will the demand for Structural health monitoring and Smart water, air quality monitoring i.e., smart world. This rapidly rising market is based on numerous factors, including increasing energy demand and buildings, water consumption etc. Security issues, Protocols, data storage, data analytics are some of the researches going on to provide solution for the smart city projects. Our research concentrates on security issues, power issues for devices and practical implementation issues in Coimbatore one of the city in India. The research proposed here are recent researches for Smart India in 2020, M2M is expected to offer tremendous opportunities for vendors in near future.

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