

Factors Influencing Implementation of 4G with Mobile Ad-hoc Networks in m-Governance Environment

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ABSTRACT

Mobile Governance is at implementation stage in various countries including India. The m-Governance can be a whole range of government services and applications, available via various mobile networks which are designed for a broad range of devices. The m-Governance environment need low cost infrastructure which must also provide high quality transmission and constant connectivity. Mobile Ad-hoc Networks (MANETS) are self-creating, self-organizing, and self-administrating. MANET offer unique benefits and versatility if the environment and application is appropriate and m-governance is one such application. Due to this reason MANETS can be easily adapted to m-Governance. The Fourth Generation (4G) of communication systems, which also combines wireless local networks and cellular networks, are expected to significantly influence the design and implementation of MANETS in m-Governance environment.

In this paper, an attempt is made to provide an understanding of 4G concepts and identify its potential in design and implementation in m-Governance environment of wireless networks such as MANETS. This paper will also discuss factors influencing the commercial deployment into MANET.

General Terms

This paper is about application of MANET in m-Governance and factors influencing its implementation with future 4G networks.

Keywords

MANET, m-Governance, 4G.

1. INTRODUCTION

4G is emerging wireless technology. 4G will have a profound impact on entire wireless landscape. 4G offers a highly focused solution to the problems of multiple heterogeneous networks. 4G will fundamentally advance the way we use mobile and existing network and repair the problems of 3G. This technology can take us from radio technologies and concept of the 1920s into the next era of radio communication using "open spectrum" and 4G may be able to answer many cost and technical problems of earlier mobile systems (Kaur, B., Prasad, M.S., 2009).

Like 4G project, MANET (Mobile Ad-hoc Network) is also in developing stage. Internet Engineering Task Force is working on routing techniques for MANET. Due to infrastructure less and self organizing nature of MANET, this network can be used in m-Governance. We introduce the term MANET@MGOV to

describe the possible situations where MANET can be used in m-Governance.

Emerging wireless technologies are expected to significantly influence design and implementation of MANET in m-Governance environment. As 4G provides the concept of convergence, the future wireless networks will take help of each other to provide anywhere, any time, anyhow connectivity. Thus many networks can overcome their loopholes by converging and using the services of other networks to solve the constraints of MANET@MGOV. 4G can be implemented with MANET which results in 4GMANET@MGOV concept. (Kaur, B. Feb 2010)

This paper is organized in following way: Section 1 introduces the paper. Section 2 presents the different dimensions of 4G and describes different paths leading to 4G. How MANETs are useful in m-Governance is presented in section 3. This section will discuss the concept of m-Governance and it will also define Mobile Ad-hoc Network. Here the scope of MANET in m-Governance is discussed. Section 4 discusses constraints for implementation of MANET in m-Governance. Section 5 details how 4G can be implemented into MANET. Section 6 highlights implementation issues of 4G into MANET in m-Governance. Section 7 discusses factors influencing the commercial deployment of MANET. Finally section 8 concludes the findings.

2. DIMENSIONS OF 4G

4 G stands for fourth Generation cellular network. Nowadays, network technology plays a significant role on science and business area. Everyday new technologies are emerging. Fourth Generation (4G) is the next generation of wireless networks that will replace third Generation (3G) networks sometimes in future. 4G is intended to provide

- High speed
- High capacity
- Low cost per bit
- IP based services for video, data and voice (VoIP).

4G is all about integrated, global network that is based on an open system approach. At the moment we have several technologies each capable of performing some of functions like broadband data access in mobile or nomadic environment, supporting voice traffic using voice over IP etc. But what we really need is a deployment of new technologies that allow merging, bridging and integrating all these repeated system into an information delivery system of the twenty first century. There are two paths which are leading us to one destination of 4G[Fig.1], One path consider the up gradation of 3G cellular

system that will be recognized and supported by Wi-Fi standards and up coming wireless technologies. The other path that is leading to 4G is successful deployment of high bandwidth, high speed mobility emerging from currently popular Wi-Fi and additional project like 802.20.

Researcher are often pointing towards integration whereas business institutions are working on upcoming technologies that will make 4G more interactive to the business community by implementing it more customer friendly (Szcodrak,M, Kim,J and Baek,Y.,2007).4G is officially designated by IEEE as a "beyond 3G".Groups like 3GPP and 3GPP2 and WiMax Forum are working on developing new technologies taking us to 4G.

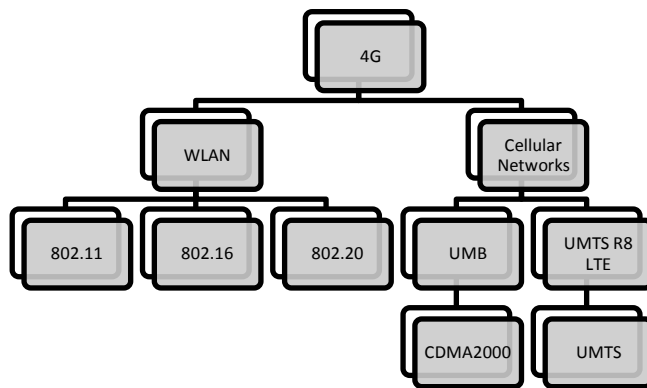


Figure 1: Different paths leading to 4G

3GPP and 3GPP2 are developing new versions of UMTS and CDMA2000 cellular system respectively. After introducing HSDPA (High-speed Downlink Packet Access) in release 5, HSUPA(High-speed Uplink Packet Access) in release 6, and HSOPA(High –speed OFDM Packet Access) in release 7, the 3GPP group project is working on release 8-the UMTS(Universal mobile Telecommunication System) revision 8 LTE (Long Term Evolution) that will introduce 4G on UMTS foundations.

Based on IS-95 (Interim standard 95), CDMA 2000 is third generation telecommunication standard that become foundation for 3GPP2 project introducing 4G known as UMB (Ultra Mobile Broadband).

Like UMTS 8 LTE, UMB will be supported by MIMO and OFDMA. Whereas 3GPP and 3GPP2 are upgrading 3G technology up to 4G, the groups like WiMAX Forum are developing solutions that increase capabilities of wireless local networks. WiMAX Forum is an organization of over 400 leading operators working on technology offering wireless alternative to DSL and cable provides based on IEEE 802.16. WiMAX forum certified TM systems also use MIMO and OFDMA to improve performance and HiperMAN standards called WiMAX.

WiBro (Wireless Broadband) is the Korean alternative to WiMAX. Cooperating together, IEEE 802.16, WiBro, and HIPERMAN, will create single version of WiMAX based on American, Korean and European development of broadband mobile wireless networks.

Considering mobility of future 4G technology, two additional working groups IEEE 802.16e (Mobile WiMAX), which is

amendment to IEEE 802.16a, and IEEE 802.20(Mobile Broadband Wireless Access) provide new wireless broadband services.

If we look back, there are number of different paths leading toward next generation communication system, 4G emerges as a Puzzle of many components that when connected together properly, compliments each others technological holes such as mobility, range or bandwidth .

Therefore general concepts of 4G can be presented as following:

- Improved Capacity.
- Increased number of users in a cell
- Lower transmission costs.
- Connection with already existing system
- Lower latency.
- Based on IPV6 protocol, with packet switching.
- Single interface for all wireless connections.
- Increased mobility.
- Support for media applications.
- Seamless connectivity.
- Improved security.
- Improved and guaranteed quality of service.
- Global examining of networks.
- Standardized open interface.
- Self Organizing networks.
- Fast response.

3. MANET in m-Governance:

MANETS@MGOV

The idea of implementing MANET in m-Governance is termed as MANET@MGOV. Mobile government is relatively a new phenomenon for developing countries whose potential is largely unknown and unexplored. After moving towards e-governance, now world is expanding m-Governance. Mobile government can be a whole range of government services and applications, available via various mobile networks and designed for a broad range of devices. Governments, at various levels , have noticed the spread of the Internet and Web and interest in using the latest technologies to improve the services they provide to their citizens. The field of study that develop technologies and support their proper use in interaction between governments and its citizens is known as e-Governance. A natural extension of the concept of e-Governance is the concept of m-Governance, which means, mobile Governance. Mobile Governance is defined as the strategies and their implementation involving the tilization of all kinds of wireless and mobile technologies, services, applications, and devices for improving benefits to citizens, business, and all government units. Transparency and accountability are the key mantras of a successful government. With growing number of mobile subscriber base, m-Governance has become a powerful tool in the delivery of public services. It's a well known that information and communication technology (ICT) is very critical for processing, storing, organizing, and presenting data and information. The new growth driver now is the mobile phone. It has emerged as an effective tool for good governance in not only facilitating openness and transparency, but also in creating a flow of information between departments, institutions, and various layers of the government. There are still areas where even

newspapers do not have a reach, while the mobile technology is becoming all pervasive.

Mobile and wireless network technologies are now the main channels of communication for hundreds and millions of users worldwide. Agendas for better performance of local authorities should prioritize the creation of mobile extensions to well-established programs of e-Governance. Sustained enhancements to the functionality of mobile devices and the growing deployment of wireless broadband networks are a major factor in expanding the scope of m-Governance. The pursuit of seamless interoperability across the range of mobile and wireless network systems is a priority across the industry. For commercial service providers, it promises high-speed broadband downloads of data and heavy audio-visual content. In m-Governance, seamless broadband interoperability will allow marked enrichment of online resources and heightened levels of user interaction. Given the extent of global interest in utilizing mobile and wireless technologies for local government, the business opportunities that arise in the markets for devices, systems hardware and software, and outsourced services, and staffing are considerable. The use of mobile technology in the government sector not only provides an alternative channel of communication and public service delivery, but more importantly, it can transcend the traditional government service delivery model. The road ahead for m-governance is a challenging one, but it has a sure shot opportunity to enhance delivery of government services. M-Governance will surely steer the government to a 'service oriented' mindset and make it more agile, responsive, accountable, and action-oriented (Singh, A., 2010). Current m-Governance applications do not exploit the full potential of available technology. In current stage m-Governance is concentrating on following service domains: m – Administration, m – Democracy, m – Education, m – Health, m – Transport, m – Payment [Figure 2].

Thus, mobile devices are presently used by governments and public only for the purpose of information sharing. Different m-governance Services are identified for pilot level implementation to deliver services through mobile phones and make it accessible to the citizens in the field, in the street, at home or other convenient locations on a 24 X 7 basis, rather than the users having to visit government offices or log on to the internet portals to access services.

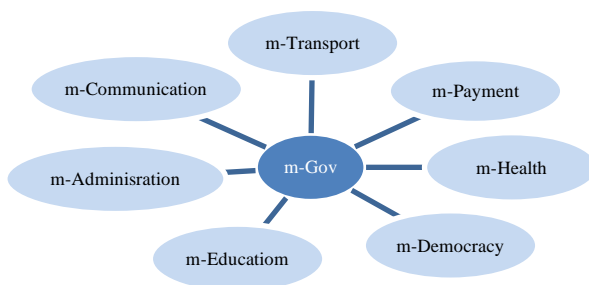


Figure 2: m-Governance service domains

But, the services such as

- m-disaster relief/rescue operations (Flood, tsunami, earthquake)
- m-Education(Virtual classrooms, Conferences)
- m-monitoring system (Police raids)
- m-excavations
- m-intelligent transport system

should also be included in m-Governance. These service domains can be included in a m-Governance project to exploit its full potential by making use of mobile networks like Mobile Ad hoc Networks (MANET). In fact, Mobile Ad hoc Networks (MANET) were proposed for applications like: Military maneuvers, Mobile robotics, Disaster relief, Home networking, Conferences, and for any instant infrastructure (Kaur,B.Feb , 2010).

A "mobile ad hoc network" (MANET) is an autonomous system of mobile routers (and associated hosts) connected by wireless links --the union of which form an arbitrary graph. The routers are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet. Sensor nodes consist of sensing, data processing, and communication components and typically form ad hoc networks. Due to a lack of infrastructure support, each node acts as a router, forwarding data packets for other nodes [Figure 3].

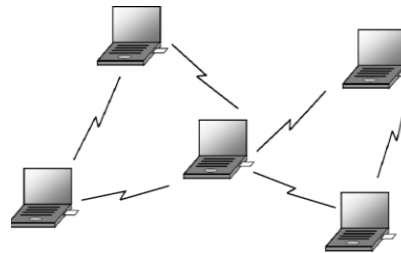


Figure 3: Mobile Ad - hoc Network

3.1 MANET can be efficiently used in situation like 26/11 at TAJ HOTEL in MUMBAI.

MANET provides an extremely flexible method for establishing communications for fire/safety/rescue operations or other scenarios requiring rapidly-deployable communications with survivable, efficient dynamic networking. Rescue workers engaged in disaster relief investigate the extent of the damage around them and collaboratively work by sharing the information on their locations and findings. In a situation like 26/11, commandos inside the TAJ could communicate with the rest of world by using satellite network [Figure 4]. But at that time we were not aware about what was happening inside the building.



Figure 4: Smoke Engulf Hotel TAJ

In view of the above discussion, there are different characteristics of MANET that can be mapped to m-government applications. Using self-organizing mobile nodes, MANET can be deployed in any environment, such as a gallery, a theatre, a shopping mall and even a street. The mobile nodes within the network can be any moving or fixed-position objects equipped with antennas. They can be either humans moving in a mall or gallery, or insects and animals in a natural environment. These networks use unlicensed frequency spectrum. Due to these characteristics of MANETS, these networks can be used in uncertain situations like disaster relief/rescue operations (Flood, tsunami, earthquake), Education (Virtual classrooms, Conferences), monitoring system (Police raids), excavations, intelligent transport system. At the time of disaster when no resources are available, these self organized network help in communication among the rescue rangers and help them to work efficiently in uncertain situation. Many times when police or custom department have to raid a location where cellular networks are not reachable like Godawns (warehousing rooms), in this situations MANET can help the officers at different locations to maintain a network working on local frequency and enable them to share the information. There are number of uncertain and unorganized situations where these networks can help.

4. CONSTRAINTS FOR MANET@MGOV

Like 4G project, the MANET (Mobile Ad-hoc Network) is also in a developing stage. Currently, 802.11 a/b/g/n wireless networks defined by the IEEE standards are being used at homes, offices, and also could be found in the initial MANET infrastructure. Thus, the factors which are limiting cellular network and WLANs will also limit MANET as well. On the other hand any solution that can increase capabilities of wireless network can influence capabilities of MANET as well and further more could solve serious issues like hidden terminal problems and fading (Kurose J. & Ross K.). In the previous section we have observed that how MANETS can help the government in uncertain situations like Disaster, Monitoring System, and Excavations etc.

M-Governance need low infrastructure and at the same time it also demands for constant connectivity, high quality transmission.

MANETS provide low infrastructure in m-Governance environment as it is self organizing and self maintained network. But it is an isolated network, to share information on MANET with other, it is necessary to connect it to other network as well. It is also required that while connecting MANET with other network the quality of transmission must also be maintained. 4G could be an answer to offer significant solution for mobile MANET to achieve high quality transmission and constant connectivity.

5. 4G as a resolution: Introduction of 4GMANET@MGOV concept

In the earlier sections, we investigated many dimensions of 4G of cellular network. With such technology it is possible to walk on the street with all kind of technical equipment that you are carrying such as cell phones, PDAs and Laptops are able to access the information through cellular network or local wireless network from the free public hotspot installed by Municipal Corporations or networks in homes, offices, or restaurants and bars.

The next generation of wireless technology requires understanding the future Government (m-Governance). 4GMANET@MGOV is the idea of implementing the Fourth Generation of wireless technology into Mobile Ad-hoc Network in m-Governance environment. To understand this concept better, we will first explain the future m-Governance.

The status of government can be defined in 3 steps. At first step government acted in traditional way and used man power for providing services to citizens. At next step, e-Governance initiatives were there to help government to serve citizens in better way. Currently at 3rd step government is implementing m-Governance. The 4th step in growth of government could be to join different technologies under one umbrella to serve people anytime, anywhere, anyhow.

As we have discussed how MANETS can be used in m-Governance environment in uncertain and unorganized scenarios, the problem of constant connectivity and high transmission quality can be solved by 4G concept. This concept can be explained with help of an example of (26/11) Taj Hotel. In the earlier section, we discussed how MANET can be used in 26/11 Taj Hotel situation. The situation can be further improved if the following improvements can be implemented:

- **Situation 1-** The MANET developed in such a situation can also interact with outer world, So that cops outside the Taj Hotel can get idea of situation inside Hotel and help them in better way.
- **Situation 2-** As nodes can move arbitrarily, there could be a situation when an isolate network can break up in group of two or more networks. Communication between different groups is not possible if there is no connecting help between groups. The situation will become better if different groups can also connect to outer network and communicate with each other using services of external network.

The scenarios represented in situation 1 and 2 can be resolved with use of 4G concept. As 4G gives the concept of convergence, it is possible to connect MANET to outer world with 4G and also communication between different isolated MANET subgroups can be established using concept of 4G [Fig. 5].

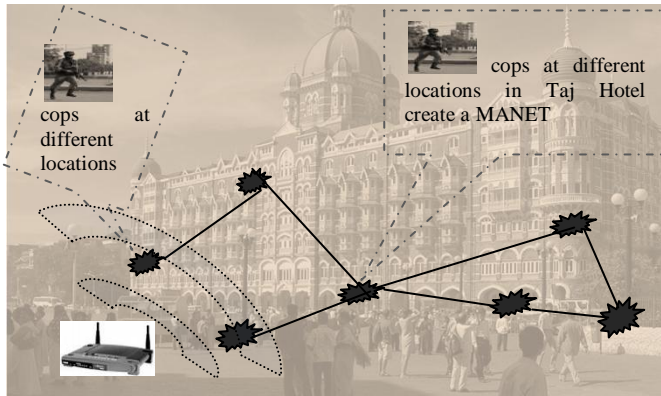


Figure 5: 4GMANET@MGOV scenario in (26/11) Taj Hotel Situation. Convergence of MANET inside Taj with wi-fi network outside.

6. 4GMANET@MGOV constraints:

The implementation of 4G into MANET for m-Governance environmental will not only improve the Government service towards citizens in a uncertain situations but also it will give rise to real time information revolution, supported by all kinds of new technology. In the world of priceless information, the transmission of data becomes a target attack during any kind of conflict. The current security provision provided by unbreakable cryptography to 4G supported by MANET routing protocols will not be enough for creating professional wireless communication for m-Governance. Therefore 4GMANET@MGOV should be aware of intruder activity and should be able to indicate possible action done by intruder that can prevent successful implementation of future wireless network in m-Governance environment.

Technical constraints in term of bandwidth, and power are significant issues for implementation of 4G MANET @MGOV. Bandwidth can be improved by using algorithms for efficient bandwidth utilizations and using 4G.Power is also can important issue that depend on how 4G is going to be implemented, what routing protocol will be applied ,geographical environment and duration of mission. Routing problems between the nodes of MANET in 4G can be solved by increasing Range and bandwidth. But irrespective of that 4GMANET in m-Governance will achieve different results when used in different environments.

7. Factors influencing implementation of MANET in commercial environment:

Next generation of mobile communications will include both infrastructure based wireless network and infrastructure less Mobile Ad- hoc Networks. The special failures of MANET bring this technology great opportunity together with severe challenges. In this section we will discuss some of the technical challenges MANET poses and based on which the paper points out some of the key research issues for ad-hoc networking technology that are expected to promote the development and accelerate the commercial applications of MANET technology.

Ad hoc networking is not a new concept. It has been deployed in military since 1970s. Due to advances in wireless communication, interest in commercial application of MANET has increased. Ad-hoc networking can be applied anywhere, where there is little or no communication infrastructure or the existing infrastructure is expensive or inconvenient to use. In ad-hoc environment nodes

can be easily removed or added in network. Applications supported by MANET are diverse, mobile in nature, highly dynamic networks, networks constrained by power sources.

Regardless of attractive applications provided by MANET, its features introduce several challenges that must be taken care before a wide commercial deployment is expected. The influencing factors are:

Routing: In mobile ad-hoc network, topology is constantly changing; therefore communication between pair of nodes is a challenging task. Proactive routing protocols serve less due to mobile nature of network; therefore hard work on reactive protocols is required. Routes between nodes may have multiple hops which are also mobile; this creates a more complex situation than single hop.

QoS: Providing different quality of services levels in a constantly changing environment is challenging. Due to mobile nature of nodes, it is difficult to guarantee the service provided by device.

Internetworking: In addition to communication within an ad-hoc network, internetworking between MANET and fixed network is often required in many cases as we discussed in 4GMANET @ MGOV concept. The consistence of routing protocols in such a heterogeneous environment is challenging.

Security and Reliability: Ad-hoc environment has particular security problems due to multi-hop routing procedures. This distribution operation requires different schemes of authentication. The problem like hidden terminal, mobility – induced packet losses, data transmission errors, limited wireless transmission range , broadcast nature of wireless medium makes MANET less reliable.

Power constraints: Future mobile terminals are going to be light – weighted and therefore communication between the terminals must be optimized to use minimum power. Conservation of power and power aware routing must be taken into consideration.

It has been recognized that routing is most important research problem among others. Many routing protocols have been proposed by IETF, there are still many relative aspects to be deeply researched before the wide deployment of commercial ad-hoc system like MANET@MGOV. Therefore based on above discussion, key research issues are:

- Reactive routing algorithms
- QoS supporting Model
- Security and Reliability schemes
- Internetworking mechanism
- Power aware routing protocols

8. Conclusion

The popularity of Mobile Networks, in the world, is on the rise in turn creating more opportunity for m-services. There is clear potential from MANETS to m-Governance services and governments must consider more wireless applications in parallel with current m-Governance project involving mobile phone only. The MANETS provide infrastructure less architecture to m-Governance concept, resulting in low cost infrastructure results in MANET @MGOV concept. This kind of network can achieve constant connectivity and high transmission quality by

implementing this concept with 4G, results in the concept of 4GMANET@MGOV. These kinds of networks will result in real-time information delivery revolution to serve highly mobile service user in m-Governance. But successful and safe implementation of fourth generation of wireless technology into mobile ad-hoc network for future m-Governance might face tough challenges. By putting all possible technological advances from 4G and MANET, I tried to set an example for future m-Governance environment. The 4GMANET@MANET must face various technical challenges before its adoption; therefore factors influencing the adoption of MANET in commercial environment must be given proper attention.

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