Mobile Ad-hoc Networks in the Battlefield With 4G Support

ViswasriSravya.M[#1], NagaSaiKeerthi.J[#2], M.S.S.Dasarsh Rajarao[*3]
[#]IV/IV B.Tech Student's Dept of CSE, K L University
Guntur, India
[1]viswasrisravya@gmail.com
[2]keerthijavaji@gmail.com
[*] I/IV Student, VIT University
Vellore, Tamil Nadu
[3]dasarshmanikonda@gmail.com

Abstract: Information is power, nowhere be this truer than on the battlefield, where the ability to talk clearly and rapidly pass on information spells the difference between survival and death? This technology adopts Wireless technology on the platform of permanent networks, advanced antennae technologies and more advanced wireless security technologies. Next thing is about the gear for the opportunity warrior. Our system provides an enhanced power of hallucination, which provides Ground Guidance, Unit recognition, Soldier position, and Target Hand-Off and provides the Soldier Rescue during the battle. In this paper, we explore future wireless network especially in the hostile military surroundings. By combining two hottest wireless network topics, 4G (the fourth generation of cellular communication systems) and MANET (the Mobile Ad-hoc Network), we explore potentials as well as predictable challenges to the wireless communications in the future battlefield.

Keywords: 4G, Mobile Ad-hoc Network, Military Wireless Network, MIMO

I. INTRODUCTION

The fourth generation of cellular communication systems, generally known as 4G, is the emerging technology of future wireless networks. For the past years, many researchers and scientists from all over the world have been working on projects funded by governments and business institutions whose goals are efficient wireless networks by merging all current technologies and adapting new solutions for the enhanced telecommunication[4] which provides superior quality, efficiency, and opportunities where wireless communications were not feasible. Some researchers define 4G as a significant improvement of 3G [7] where current cellular networks' issues will be solved and data transfer will play more significant role. For others, 4G unifies cellular and wireless local area networks and introduces new routing techniques, efficient solutions for sharing dedicated frequency band, and increases mobility and bandwidth capacity.

A. 4G OVERVIEW AND POTENTIALS:

4G stands for the fourth-generation cellular network. Although it is generally agreed that 4G is going to offer better communication technology than 3G, it is still undefined as to which areas should be really improved upon, and in which ways, from 3G. Researchers are often pointing towards integration whereas business institutions are working on upcoming technologies that will make 4G more attractive to the business community by implementing it more customer-friendly. This section presents different perspectives on how 4G is defined. Later, we will investigate how the fourth generation of mobile wireless networks (4GM) can be implemented in the modern military environment known as the fourth generation on warfare (4GW). We introduce term 4GM@4GW to discuss issues of implementing presented technology in the military mobile environment.

II. EXISTING SYSTEM

Integration is the key concept in defining 4G capabilities since we should support all kinds of multimedia by offering single access to all wireless networks. Understanding the significance of unifying Wi-Fi, WiMax and Cellular networks into one

product,Woerner and Howlader proposed that the most important factor of 4G will be "seamless integration of wireless networks" based on flexibility of the software radio technology, with improved bandwidth capacity, and improved routing techniques allowing multi-hop peer-to-peer networks. Due to the lack of single military scenario where and how 4G will be used, it is critical that future wireless technology will be capable of effortlessly access all kind of radio interactions.

Bauer addressed that enhanced cellular range and capacity, supported by Wi-Fi [3] and WiMAX networks is the vision of 4G .However, considering the fast development of WiMAX networks, and the increasing range of Wi-Fi standards, they argue that these new wireless networks can in the future substitute cellular networks such as the current 3G. They also addressed that it is "misleading" calling the evolution of cellular technology in terms of generations because this would "suggest a linear progression" which is not the case. Finally, they moreover evaluated business opportunities of 4G pointing out on establishing a global standard, along with open architecture, and supporting multiple interfaces all over the world, as the keys to economical success.

DVB is the "global standard for the global delivery of digital television and data services." Researchers see DVB-H (Digital Video Broadcasting - Handheld) and DMB (Digital Multimedia Broadcasting) as additional component of 4G providing video transmission to mobile devices. Understanding technical requirements of soldiers fighting on the battle-field, we believe that DVB can become a considerable utility for army by providing necessary information such as soldiers' view and access to maps and immediate satellite pictures.

In number present be two paths leading toward each other whose goal is 4G. One path defines the evolution of 3G cellular systems into more advanced 4G technology that will be acquainted with and be supported by Wi-Fi principles and upcoming wireless networks technologies. The other path successfully deploys high bandwidth and introduces high-speed mobility emerging from currently popular Wi-Fi technology and upcoming standards such as WiMax 802.16 [4] supported by mobility amendment 802.16e and additional projects like 802.20 considering mobile broadband wireless networks. Designed for the second group of people leading Toward 4G, cellular networks are additional supporting component offering complete integrity with all available wireless connections.

Steer addressed 4G is officially designated by IEEE as "Beyond 3G."Characterized by wireless broadband with over 100Mbps mobile capacity and 1Gbps stationary bandwidth supported by OFDM, MIMO, and software defined radio, Steer presents new 3G's components that will upgrade it up to 4G. The idea of upgrading 4G is shared by two other groups working on the next generation technology 3GPP and 3GPP2 developing new versions of UMTS and CDMA2000 cellular systems respectively.

After introduce 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 release8, the UMTS (Universal Mobile Telecommunications System) Revision 8 LTE(Long Term Evolution) that will introduce 4G on UMTS foundations . The 3GPP plans presented in Technical Report (TR) 25.913 that are going to be concluded expects cell coverage flanked by 5 to 30 km, latency below 100ms, 100 Mbps/50Mbps downlink/uplink data rate within 20MHz spectrum allocation, high performance mobility up to 120km/h that between networks can be increased as much as up to 500km/h. The same report signifies the importance of IP based networks with support of MIMO and OFDMA. Currently Ericsson's antenna permits 144Mbps transmission.

Based on IS-95 (Interim Standard 95), CDMA2000 is third generation telecommunication standard that became foundation for 3GPP2 (Third Generation Partnership Project 2) project introducing 4G known as UMB (Ultra Mobile Broadband). Like UMTS 8 LTE, UMB will be supported by MIMO and OFDMA. With full mobility, UMB offers over 100 Mbps transfer using beam-forming signal processing technique from smart antennas , which although highly complex and still significantly costly after integration with MIMO allow high data rates particularly in scattered environment.

Whereas 3GPP and 3GPP2 are upgrading 3G technology up to 4G, the groups like the WiMAX Forum are developing solutions that increase capabilities of wireless local networks. An

organization of over 400 most important operators called WiMAX Forum is working on technology offering wireless alternative to DSL and cable providers based on IEEE 802.16 and HiperMAN standards called WiMAX (Worldwide Interoperability for Microwave Access).

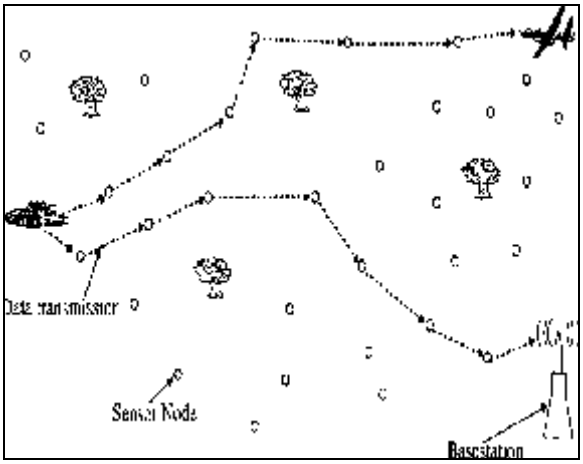


Fig 1: Battle field forces without any fixed infrastructure

WiBro (Wireless Broadband) is the Korean alternative to WiMAX. Offering mobility of up to 60 km/h, with service coverage up to 1 km, handoff less than 150 ms, maximum download 3 Mbps and maximum upload 1Mbps, WiBro is an important support to mobile wireless research projects . Cooperating together, IEEE 802.16, WiBro, and HIPERMAN, will create single version of WiMAX based on American, Korean, and European developments of broadband mobile wireless networks.

Considering mobility of future 4G technology, two additional working groups IEEE 802.16e (Mobile WiMAX), which is the amendment to IEEE 802.16a [6], and IEEE 802.20 (Mobile Broadband Wireless Access) provide new wireless broadband services. Even if similar because both goal at low latency on packet architecture with at least 1 Mbps transfer, 802.16e and 802.20 target on different speeds of nodes. The 'e' amendment maintains the 802.16 achievements adding vehicular mobility. The networks' access from trains traveling with speeds up to 250 km/h will be possible using mobile broadband wireless access defined by IEEE 802.20.

Looking back on different paths leading toward next generation communication system, 4G emerges as a puzzle of many components that when connected together properly, complement each other's technological holes such as mobility, range, or bandwidth creating the 4G picture that provides global, single, and a simple standardized way of access it such as puzzles have one, by everybody known, way of putting them together. The Pioneer and Inventor of 3G/Wi-Fi Convergence Systems and Technologies, Top Global USA, Inc. created the first such 4G picture, the first mobile router that links 3G/4G Cellular and Wi-Fi networks. Providing seamless routing and secure connectivity, Top Global's router maintains connection in moving vehicles with 802.11n, HSDPA, and WiMAX [1] wireless access points simultaneously.

In this section, we observed how 4G technology will simplify implementation of wireless networks and at the same time increase mobility, bandwidth and range on the radio signal in the civil environment. As we will investigate in the later sections, it might be more difficult to achieve same successful results from 4G in the military environment compared to the civil environment in a metropolitan area.

III. PROPOSED SYSTEM

A. MANET WITH 4G

There are special ideas most important toward 4G, some concept and network components frequently come up as a supporting and significant solution that help achieve progress toward 4G. In this section we are departing to investigate and explain technical innovations such as MIMO (Multiple-Input Multiple-Output), OFDMA (Orthogonal Frequency Division Multiple Access) and HIP (Host Id Protocol) that could significantly increase security, mobility and throughput of 4G.see in your mind's eye that you can hear better come again? you want to pay attention, and don't hear what did you say? bothers you, just by pointing out where message and noises are coming from. Beam forming that is the significant concept of MIMO (Multiple-Input Multiple-Output) allows you do just that by means of smart antennas system. But that's not every one of what MIMO has to offer. Spatial multiplexing, achieved as a result of self-determining at the same time operational antennas, increase bandwidth capacity by modulating and transmitting signal throughout many path. Using

space-time coding, reliability is enhanced. MIMO achieves great success thanks to multiple antennas that allows simultaneous directional transmission of two otherwise more unique data streams sharing the same channel. Increasing speed and range, MIMO is already accepted by researchers as one of the main apparatus of projects such as WiBro, WiMAX, WLAN, 802.11n, UMTS R8 LTE, along with UMB.

Data Research Company proposed the simplest way near implement MIMO is by sharing frequency using OFDM, with the purpose of collectively significantly can increase performance by extend assortment, boosting speed and improving reliability. Together with MIMO, OFDMA is an added component of 4G that as the unconventional in the bearing of CDMA, promise high data capacity and spectral efficiency. OFDM (Orthogonal Frequency-Division Multiplexing) is the modulation scheme which divides allocated frequency channel into many narrow bands assurance mutual independency connecting subcarriers such that there is no interference flanked by them; signal are orthogonal.

To split bandwidth flanked by many user, the obtained subcarriers have to be distributed between users using miscellany in frequency, time, space or code. Lawrey [5] anticipated new technique by allocate subcarriers between compound users through one of the five methods:

- distribution by fixed frequency
- randomly hopped subcarriers
- distribution using TDMA
- by spreading subcarriers in a comb pattern
- by adaptive user allocation

B. POWER CHALLENGES OF 4G MANET

When processing speed doubles every 2 years (Moore's Law), another significant component of wireless devices limits their usage in the military environment - a battery. The fourth generation of wireless technology offers increased bandwidth, mobility and the signal's range. Increasing the signal power, a device requires more electrical power that will be consumed during signal transmission. The amount of energy currently stored in batteries needs to be increased to utterly benefit from the fourth generation of mobile wireless network implementation. More sophisticated, with additional routing protocols and security enhanced, wireless nodes require also a lot of computational power. Although the processors speed increases and its they turn into lower power consumption by introducing nanometer processor technology, the software requirements turn out to be more and supplementary complicated require faster hardware (Wirth's Law), and more electrical energy.

Today two kinds of batteries are available for mobile devices: rechargeable along with non-rechargeable batteries. Rechargeable batteries, such as nickel-cadmium, nickel iron, nickel metal hydride, lithium ion polymer, lithium ion, and lead-acid, are characterized by ability to restore their energy through application of electrical energy. Disposable batteries: alkaline, thermal, lithium, are used once and discarded. However, when disposable batteries be unused they can lose less than 5% of their energy during one year, whereas rechargeable may lose over 90% of stored energy just after 100 days. While a military action becomes organized and prepared, technical equipment, stored in magazines, awaits its usage. During this time, it is critical to ensure that once military equipment get prepared and stored, it will keep its ability to rapid usage for long period of time. To allow rapid ready just before mission state of all mobile devices, it is important to ensure that batteries will after everything else for more than 100 days while stored on a shelf.

We present a single military scenario to show the importance of considering the power constraints of 4G MANET. The important aspect of 4G MANET [5] in military environment is the fact that soldiers will become independent units where everybody will be able to communicate between themselves as well as with the headquarter using all possible means of wireless low infrastructure communication. Increased soldiers' mobility as well as quality of communication increase the total weight of equipment's that soldiers have in the direction of carry with them on battlefield. The increased amount of technology increases the smallest amount amount of electrical power that has in the direction of be provided during military action for every soldier. Whereas 4G mobile devices implemented for military environment should not significantly increase the soldier's weight, the batteries weight might do consequently.

Imagining that 4G MANET [5] implementations, as well as all necessary military technical equipment's were provided during a military action we present in the Figure 3 two situations that might take a place. In one situation, a soldier will be required to transmit overwhelming amount of batteries that will significantly decrease his mobility. On the other hand, deplorable weight of batteries was solved through introducing rechargeable batteries. However, in this container, the soldiers' mobility becomes limited as healthy.

The presented two scenarios show two extremes that determination never be acceptable as real life implementations of 4G MANET technology in

military surroundings. However, the increased quality of communication and mobility, achieved by the fourth generation of wireless technology, can paradoxically be abandon in military environment because of overwhelming enormous amount of electrical energy that will be supplied either by rechargeable or non-rechargeable batteries, which in result will decrease soldiers' mobility. The solution for this problem can be new batteries designs and wireless technology that will lower power consumption.

The accessible two scenarios show two extremes that will never be acceptable as real life implementations of 4G MANET technology in military environment. However, the increased quality of communication and mobility, achieved by the fourth generation of wireless technology, can paradoxically be abandon in military environment because of consuming enormous amount of electrical energy that will be abounding either by rechargeable or non-rechargeable batteries, which in result will decrease soldiers' mobility. The solution for this problem can be new batteries designs and wireless technology that will lower power consumption. Power aware microarchitecture, maximization of power efficiency, and management of heat, that is produced as a result of increased computational power, are issues that current chip leaders, like Intel, have to consider while designing their products . Another solution for power constraints of mobile devices in military environment are coming up technologies such as designed by emphases Nano batteries, which are disposable batteries. Nano batteries' revolutionary design uses "super hydrophobic characteristics of Nano touch circuses to control battery's internal reaction" and preserves energy for over 15 years by separating electrolyte from reactive metal when are stored . Its small and flexible size supports Nano batteries candidacy for the military scenario implementation battery that will power up transportable 4G.

IV. IMPLEMENTATION

Beginning earlier sections, we investigated many faces of the fourth generation of cellular network. Its final definition as well as main concepts influencing the progress of wireless network technology toward 4G portrays the future society living in utopia of constant access to all kinds of information through wireless communication. Someone may think that such technology is already accessible while walking on the streets of New York. New Yorkers, with all kind of procedural equipment's that they are carrying, such as cell phone, PDAs, and laptops, be able to access information through cellular networks or local wireless networks beginning the free public hotspots installed by NYC Wireless community [3] or networks in homes, offices, or restaurants and bars. New York needs single terminal allowing access to all kinds of wireless technologies and business support that will take a profit, to step up into 4G. However, unlike commercial environment, 4G implementation and secure constant connectivity may require tremendous work in a military environment.

The next generation of wireless technology requires understanding the future of warfare: the 4GW. 4GM@4GW is the idea of implementing the fourth generation of wireless technology hooked on mobile ad-hoc network in the next generation military environment. To understand this concept better, we will fist explain the 4GW term defined by William Lind, an American expert on military affairs, as the theory of the Fourth Generation War.

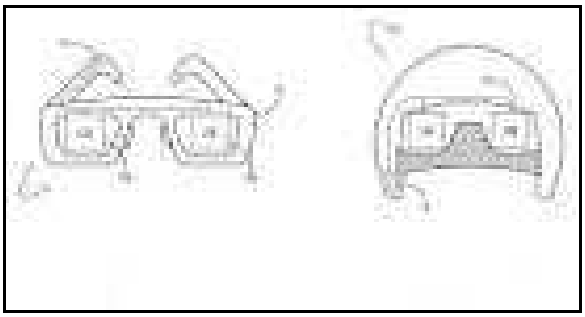


Fig 2: Eyewear with Helmet

Additional technological key components of 4GW question the success of 4G MANET in military environment. 4GW is not only the new way of moving army armed forces using new artillery, but also the worldwide real-time information revolution, supported by all kinds of new technology, with cyber and net wars. In the world of priceless information, the transmission medium of data becomes a target of attack during any kind of conflict. It is a misconception that addition of efficient and unbreakable cryptography to 4G supported by MANET's [8] routing protocols will be enough to create professional wireless communication for army. The first significant point of the 4GM@4GW is too aware about the wide spectrum of terrorist technological activity by an enemy and to indicate the possible actions done by the enemy that can prevent successful implementation of future wireless networks in military environment.

4GM@4GW will be supported by 4G using increased mobility, range and bandwidth, single terminal connectivity with all already existing military equipment, possibility of using any present technology maintaining communications on the

territory of action, and supported by MANET's mobile mesh routing in case of lack infrastructure. At the same time, 4G(M@W) will be twisted by technical limitations, natural-geographical constraints, possible breakings of encryption code, and DoS (Denial of Service) attack.

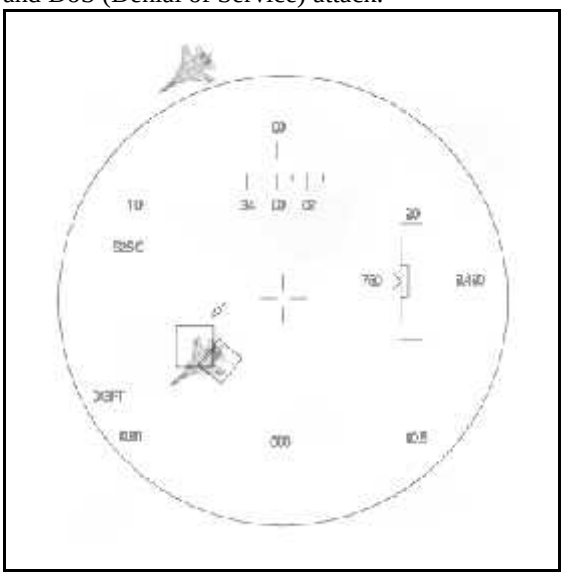


Fig3: Unit Detection

Technical restrictions defined as physical constraints in terms of bandwidth, memory, and power, are the primary significant point on the list of issue in 4GM@4GW. This paper defines the potential of escalating bandwidth by means of the fourth generation of wireless communication. Currently easily reached happening market different kinds of memory allow us to take for granted that satisfactory and low cost memories, such as flash drives, should fit keen on military environment. Conversely, the important number arises from supplying military mobile electronic devices by sufficient amount of power that is dependent on: how 4G is going to be implemented, what routing protocol will be practical, in what urban geographical environment missions will capture a place, and finally the duration of missions.

Technological limitations defined as physical constraints in fundamentals of bandwidth, memory, in addition toward power, are the first significant point on the list of issue in 4GM@4GW [7]. This paper defines the possibilities of increasing bandwidth using the fourth generation of wireless communication. Currently accessible taking place market dissimilar kinds of memory allow us to assume that sufficient and low cost memories, such as blaze drive, should fit into military environment. However, the important question arises from supplying military mobile electronic devices through sufficient quantity of influence that is dependent on: how 4G is disappearing to be implemented, what routing protocol will be present functional, in what urban geographical environment missions will take a place, and finally the duration of missions. Natural geographical

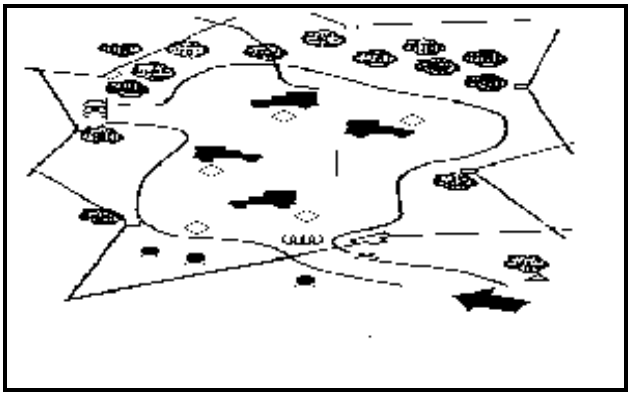


Fig 4: Ground Guidance

Constrains are another issue that can influence 4G(M@W).

Through greater than ever range in addition to bandwidth, 4G lowers the possibility of existence of routing problems between nodes in MANET network, such as hidden terminal interference and signal's departure. But at the same, the shape of the land may limit the benefits of using 4G. For instance, 4G in military environment will achieve different results what time second-hand on the deserts of Iraq, in Afghanistan Mountains, or during some very urban city with metal-concrete with electric barriers. This bring to the problem if a single implementation of 4G (M@W) cans success in all geographical environments? In 4GW everywhere army forces have to be ready to combat in any time and in any place all over the world it would be critical to use one single model of a device that determination be able to provide sufficient communication during military action devoid of major dependencies happening the shape of land

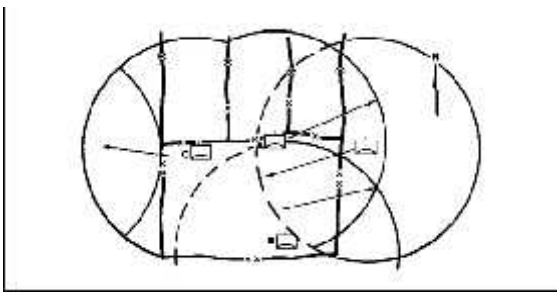
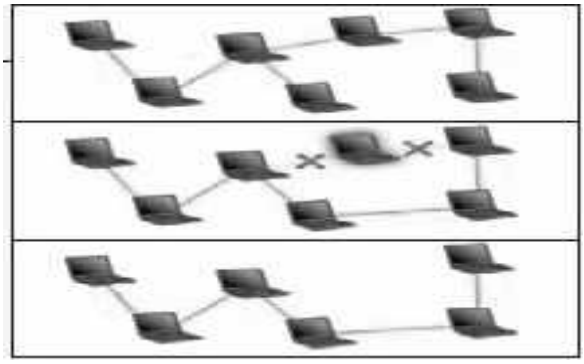


Fig5: Target Hand-Off

Comparing to the implementation of 4G in the civil environment, 4GM@4GW is also constrained by enemy's action preventing successful community of crowd forces and technological devices left on the battle field by enemies for the purpose of disrupting the wireless communication. Such an activity does not have to focus on decrypting information that is sent through air, but simply on preventing information to reach the soldiers by using DoS attacks. In many cases, successful DoS be able to be more important that decrypting information because of its immediate manipulate on the army's condition.

V. SECURITY

The device security must address both communications security (COMSEC) and a way to protect the network from unauthorized use if the



device is captured. Communications are more secure when mesh networks allow for route diversity. Meshed architectures also allow devices to transmit at lower output power on the way to neighbors rather than _Shouting_ at a cell tower.

Fig 6: Self-healing and routing of traffic around downed links

This lowers the probability of detection and increases battery life. Should a device be captured, the 4G Warrior be able to blacklist that device toward maintain the integrity of the network

VI. CONCLUSION

The fourth generation of cellular system will provide single interface to all kinds of wireless networks allowing participating nodes in the direction of access to the network through cellular, wireless LAN networks, and new protocol such as IEEE 802.20 and WiMAX. But, successful in addition to safe implementation of the fourth generation of wireless knowledge keen on the mobile ad-hoc network for the next generation military environment might face strong challenges. It also can be interrupted payable to the significant differences between the civil and military atmosphere. Physical and technological constraints, geographical limitations and DoS attack are some of the foreseeable challenge. By putting all possible technological advances together from 4G and MANET, we try to set an example for future battle-field in this paper. The period of new wireless communications be upon us. Eventually it will penetrate into our daily life just like many technical breakthroughs whose original research came from the military needs. Automatic highway traffic control system where vehicle equipped with sophisticated embedded communication chips can enter and leave from the infrastructure dynamically will be alive one example among many potential applications from 4G and MANET combined scenario. The future work includes: define physical constraints meant for military mobile devices, suggest the effectiveness of MANET's routing protocols in 4G environment to find the most optimal protocol intended for the 4GM@4GW.

REFERENCES

[1] IETF. "Mobile Ad-hoc Networks (MANET)." The Internet Engineering Task Force, http://www.ietf.org/html.charters/manet-harter.html

[2] Perkins C., Belding-Royer E., Das S., "Ad hoc On- Demand Distance Vector (AODV) Routing.". http://www.ietf.org/rfc/rfc3561.txt

[3] Clausen T., Jacquet P., "Optimized Link State Routing Protocol (OLSR)." Network Working Group Request for Comments: 3626. http://www.ietf.org/rfc/rfc3626.txt

[4] Kurose J., Ross K., "Wireless Links and Network Characteristics." Computer Networking pg. 508-513. Pearson Education, Inc.

[5] Woerner B., Howlader M., "Research Directions for Fourth Generation Wireless."

[6] Hussian S., Hamid Z., and Khattak N., " Mobility Management Challenges and Issues in 4G Heterogeneous Networks."

[7] 3GPP. http://www.3gpp.org/

[8] 3GPP2. http://www.3gpp2.org