

## Performance Comparison between WiMAX and WLAN and Construction of Tactical/Strategic Communication Network Using OPNET

제승모\*, \*\*한상훈, 허준호\*\*\*  
\*전자부품연구원 위축연구원  
\*\*부산가톨릭대학교 응용과학대학 소프트웨어학과  
\*\*\*부산가톨릭대학교 응용과학대학 소프트웨어학과 조교수  
\*\*\*교신저자 e-mail : 72networks@cup.ac.kr

## Performance Comparison between WiMAX and WLAN and Construction of Tactical/Strategic Communication Network Using OPNET

Seung-Mo Je\*, Sang-Hoon Han\*\*, Jun-Ho Huh\*\*\*  
\*KETI (Korea Electronics Technology Institute), Republic of Korea.  
\*\*Dept. of Software, Dept. of Software, Catholic University of Pusan.  
\*\*\*Assistant Professor of Dept. of Software, Dept. of Software, Catholic University of Pusan.  
\*\*\*Corresponding Author e-mail : 72networks@cup.ac.kr

### Abstract

As part of overseas defense program of the US's Trump administration, the military allies were asked to cover partial operation costs for the weaponry deployed at the US bases in their countries. This raised the Korean government's, as well as defense industry's interest in constructing a tactical/strategic communication network and investments are being made actively. Thus, in this study, the performances of WiMAX and WLAN have been compared and a tactical/strategic communication network has been constructed for simulation by using OPNET. As a result, the simulation for the network using combat tanks was successful. An average communication distance that can be achieved by WLAN in open terrain is about 200m as it has been designed on the premise of short-range wireless communications. When the distance was increased to 1km, the tanks could not receive data. By contrast, it was able to confirm that the WiMAX-based network has allowed smooth communications at the same distance. Based on this result, it can be concluded that using WiMAX for tactical operations will have much more merit than adopting WLAN as far as the distance is concerned.

### 1. Introduction

Recently, US's Trump administration requested their allies to share the operation costs for the US weapons or weapon systems deployed at in respective allied nations. Thus, the government of ROK and military defense industry have started to pay their attention to constructing a Korean-model tactical/strategic communication network and investments for the relevant projects are being made actively.

### 2. Related Study

#### 2.1. WLAN

WLAN is one of wireless near field communication networks that uses OFDM frequency or spread spectrum method to link two or more equipments. Most of WLANs are referred as WiFi systems that correspond to the IEEE 802.11 standard which has been designed to be compatible with 802.x such that they are quite flexible when configuring a communication network and require much less costs. However, at the same time, their standardization process can

be very slow and they show some vulnerabilities in security. Other major demerit of WLAN is that they can use a limited range of frequencies.

Basically, WLAN is usually configured assuming that the subjects within it are mobile and supports existing wired LAN(s). If there is any wired LAN in close proximity, even a non-specialist will be able to easily configure a wireless network environment. Also, as WLAN supports the Ad-hoc networks, a communication network can be configured autonomously without any central control. Multi-hop routing is also supported so that communication can be restored through self-healing process even if a certain part of network fails. Finally, it has a merit of not having any constraints in node participation or departure.

In this study, the simulations were carried out under the condition of 11Mbit/s at 2.4GHz following the IEEE 802.11 standard. OFDM was used as a method for the frequency modulation while CSMA/CA technology was used to allow the network to be configured with multiple nodes for simulations.

## 2.2. WiMAX

WiMAX is a communication standard based on the IEEE 802.16 set of standards and aims to provide data wirelessly from a long distance. It includes both physical and MAC layers. Although WiMAX originally provided a data transfer rate between 30 to 40Mbps, the rate reached to 1Gbps for the fixed nodes through the update in 2011.

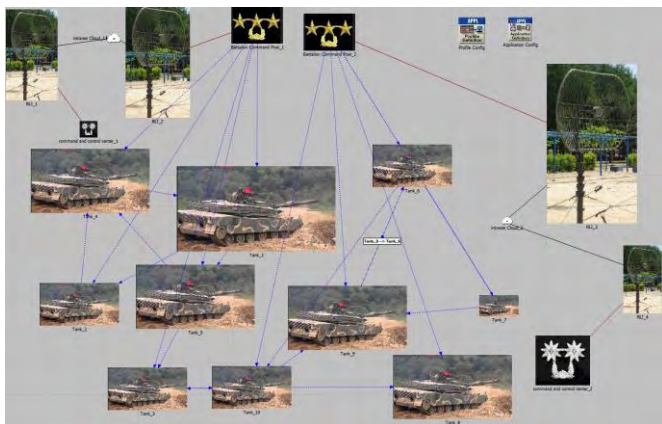
To extend the internet service radius to allow communications even from the outside of the building, the IEEE 802.11a/b/c standards have been complemented as the new definition is being defined in IEEE 802.11d. This technology guarantees an average data transfer rate of 70MB/s within the range of 48km but the demerit is that it has some weaknesses in mobile environment. Mobile WiMAX was developed to complement such a problem and Korean term for this is Wibro which has been developed by Samsung Electronics and Electronics and Telecommunications Research Institute (ETRI) together to allow high-speed data exchanges with portable wireless devices while moving at the speed of 60km/h or slower. OFDMA was used to compensate the problem of limited data transfer rate (e.g., Mobile Phones) when CDMA was used, offering an average of 25Mbps speed at the bandwidth of 2.3GHz, maximum communication distance of 1km, and maximum allowable mobility up to 120km.

Simulations in this study were performed under the condition of 11Mbit/s at 2.3GHz following the IEEE 802.16 standard. At the same time, OFDMA was used for frequency modulation while setting MCS with QPSK 1/2.

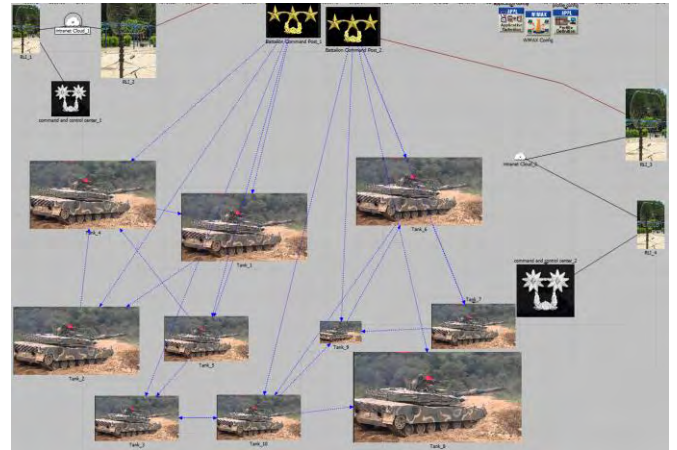
## 3. WiMAX and WLAN and Construction of Tactical/Strategic Communication Network

The performances of both WLAN and WiMAX were analyzed and compared.

As shown in (Fig. 1 & 2), this scenario consists of 10 terminal nodes, four RLIs currently used for the army communication network, an intranet where accesses are made to the army tactical communication network through RLIs and a server which has been represented as a higher command who issues orders following the army rank system.



(Fig. 1) Formation of a Communication System between army Armored Tanks Using the WLAN-based Network.

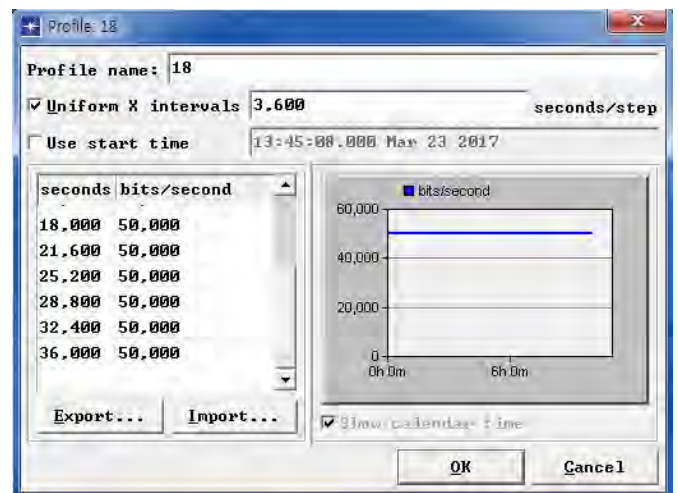


(Fig. 2) Formation of a Communication System between Army Armored Tanks Using the WiMAX-based Network.

## 4. Performance Evaluation

### 4.1. Traffic

As shown in (Fig. 3), an environment similar to actual communication environments has been established through multiple traffic connections.



(Fig. 3) Traffic Setting

The ip\_traffic\_flow provided by OPNET is used as the traffic in this scenario where the traffic is transmitted from Battalion Command Post node to Command and Control Center (CCC) of a lower command and then to a tank node(s) to execute commands from the higher command efficiently. The simulation time is 10 hours during which 500,000bit traffics are delivered (50,000bit/h).

- Link speed: 11Mbps
- Simulation time: 10 hours
- Performance index: Traffic transmission/reception rate

The setting is shown in (Fig. 4 & 5).

Wireless LAN	
Wireless LAN MAC Add...	1
Wireless LAN Parameters (...)	
BSS Identifier	Auto Assigned
Access Point Functi...	Disabled
Physical Characteri...	Direct Sequence
Data Rate (bps)	11 Mbps
Channel Settings	
Transmit Power (W)	0.005
Packet Reception-Po...	-95
Rts Threshold (bytes)	None
Fragmentation Thres...	None
CTS-to-self Option	Enabled
Short Retry Limit	7
Long Retry Limit	4
AP Beacon Interval ...	0.02
Max Receive Lifetim...	0.5
Buffer Size (bits)	256000
Roaming Capability	Disabled
Large Packet Proces...	Drop

(Fig. 4) WLAN Setting

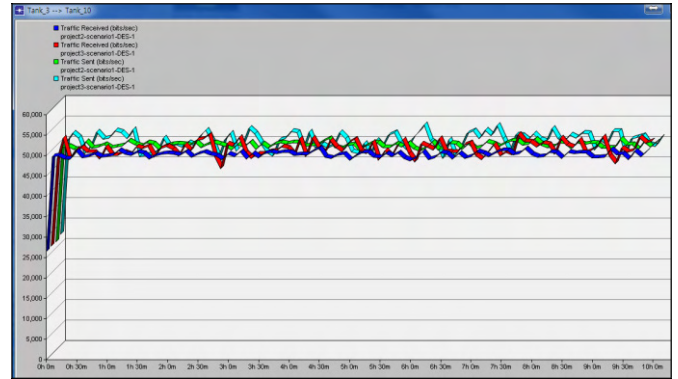
OFDM PHY Profiles (...)	
Number of Rows	2
Row 0	
Profile Name	WirelessOFDMA 8.75 MHz
Frame Duration (mil...	5
Symbol Duration (mi...	115.2
Number of Subcarriers	1024
Frame Structure (...)	
Frame Preambles (...)	1
TIG (microseconds)	106
RTG (microseconds)	60
UL/DL Boundary	Fixed
DL-MAP Repetition...	Repetition Coding of 4
DL Information EL...	32
Contention Area	<...>
Fast Feedback Area	Two Slots (1x6)
Duplexing Technique	TDD
TC Sublayer Overhea...	<...>
Frequency Band (...)	
Base Frequency (GHz)	5 GHz
Bandwidth (MHz)	20
Frequency Division (...)	
UL Zones (...)	
Zone Extent (x)	100
Number of Null ...	184
Number of Null ...	183
Number of Data ...	1120
Number of Subch...	70
Usage Mode	PUSC
DL Zones (...)	
Zone Extent (x)	100
Number of Null ...	184
Number of Null ...	183
Number of Data ...	1440
Number of Subch...	60
Usage Mode	PUSC

(Fig. 5) WiMAX setting

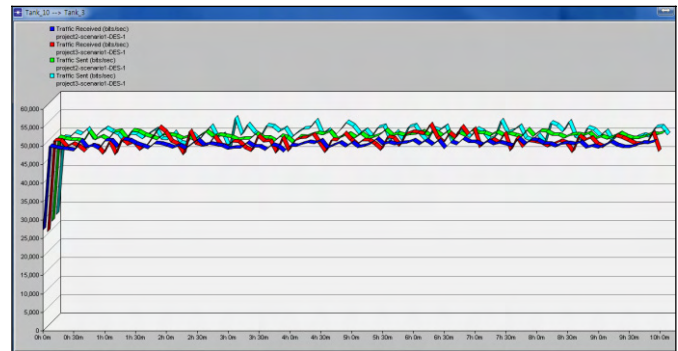
#### 4.2. Analysis Result

Both average traffic generations in (Fig. 6 & 7) are consistent at 50,000bph, when comparing their transmission/reception rates, there were no message losses.

The messages were received 100% as all the traffics in both WLAN and WiMAX networks were generated within the limit of 11Mbps. Although some losses were expected due to the characteristics involved in the wireless environments, they were avoided with their CSMA-CA and ARQ functions.

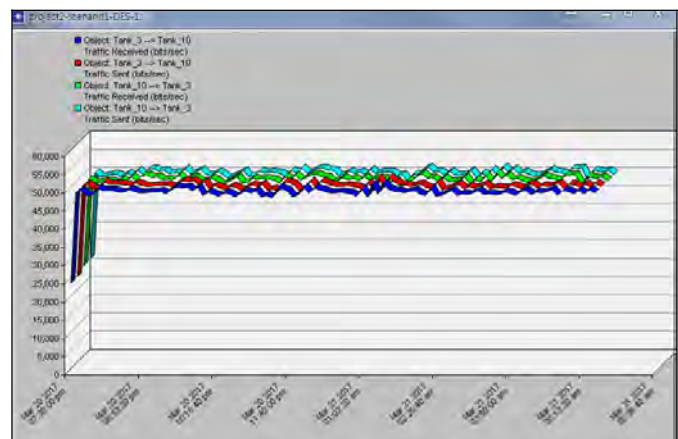


(Fig. 6) Tank 3 -> Tank 10 in a Logical Environment.

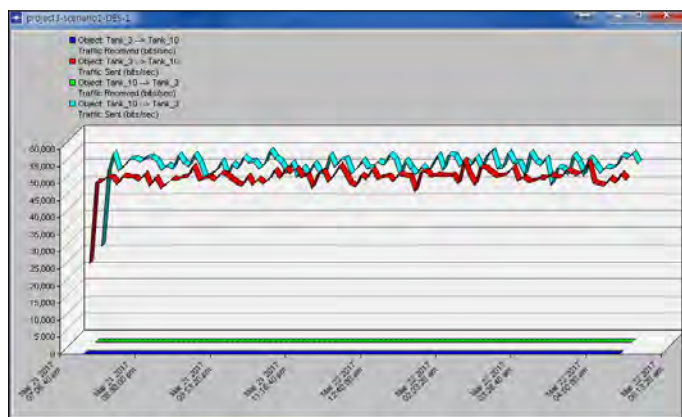


(Fig. 7) Tank 10 -> Tank 3 in a Logical Environment.

As for (Fig. 8 & 9), there may have been some losses in a micro level due to the characteristics of wireless networks but in a macro level, it can be considered that the communications were completed without any losses. The results of the simulations in a logical environment showed that both WLAN and WiMAX had successfully achieved communications. The wireless MAC used for the simulations are IEEE 802.11 WLAN MAC and IEEE 802.16 WiMAX MAC respectively and the speed was consistent at 11Mbps.



(Fig. 8) WiMAX Communication at the Distance of 1km.



(Fig. 9) WLAN Communication at the Distance of 1km.

## 5. Conclusion and Future Work

The performances of WLAN and WiMAX have been compared and a tactical/strategic communication network has been constructed by using OPNET.

Since WLAN has been designed on the premise of near field communications, its effective range of communication in an open terrain is about 200m and we were able to confirm that the data were not be received properly at the distance of 1km. By contrast, WiMAX carried out communications adequately at the same distance. These results shows that the WiMAX is more suitable for the tactical/strategic network which is vital for executing tactical military operations when considering the communication capability in terms of distance. WLAN can be directly connected to existing wired LAN and has the merits of being able to guarantee mobility, support Ad-hoc networks that are useful for the field operations where it is difficult to establish a wired network or the network should be operated/maintained for a short period of time. However, its biggest demerit is that communications are possible only within the small areas such as schools, homes or buildings.

By contrast, WiMAX is a communication protocol developed to complement the problem of distance. Wibro, a Korean model WiMAX developed by Samsung Electronics and ETRI together, provides communication distance up to 1km and 60km mobility. Based on the results obtained via simulations, it is definite that WiMAX is much more preferable than WLAN when the army operation requires their forces to be dispersed over a wide area or needs higher mobility.

## Acknowledgments

The 4D Health Care Project Group of Catholic University of Pusan aims to cultivate the creative talent who have capabilities in developing 4D contents required for rehabilitation and health care of modern people. Both Department of Physical Therapy and Department of Software of this university are participating and operating the group jointly to perform the task.

The 4D Health Care refers to an advance health care technology which is used for the operation in a 4D-based mixed reality where human senses, cognition and experiences (1D) have been converged with both real and virtual information (3D) and the project group runs various

curricular and extracurricular programs to train every participating student to acquire a 4D technology-based health care contents development skills.

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