

## Development of Mobile Ad-Hoc Network (MANET) Gateway for Future Soldier Communications Using Internet of Things (IoT) Technology

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**Abstract:** The study investigates and develops components for implementing an effective and efficient military knowledge/information/communication in closed network architecture. Since, military personnel are always on the move, the dissemination of knowledge/information/communication needs a mobile platform to accommodate mobility of people. The mobile and wireless network platform should be able to sustain the remoteness and seclusion of military operation areas. Communication is one of key problems of a military operation, especially due to environmental constraints. This study proposes on development of Mobile Ad-Hoc Network (MANET) gateway communications for military operation using Internet of Things (IoT) technology. The operational areas are considered to restricted and challenging locations. Mobile Ad-Hoc Network (MANET) gateway communications using IoT technology will become inexpensive and common over the next decade. Thus, a thorough study is vital to develop the most suitable Mobile Ad-Hoc Network (MANET) gateway equipment and network requirements for Malaysia's military eco-system.

**Key words:** Mobile Ad-Hoc Network (MANET), military, knowledge, mobile, prototype, Search and Rescue (SAR), gateway

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### INTRODUCTION

Cutting edge computer network technologies facilitates sharing knowledge and information among personnel in many organizations. Knowledge and information must now be treated as a critical resource to the organization in addition to land and raw materials. In military, initiatives labeled as Knowledge Management (KM), the focus is on learning and the sharing of tacit knowledge, particularly in the many areas of military operations (Wong, 2012; Nohuddin *et al.*, 2012). Since, military personnel are always on the move, the dissemination of knowledge and information needs a mobile platform to accommodate mobility of people. The mobile and wireless network platform should be able to sustain the remoteness and seclusion of military operation areas.

Future soldier is a concept of how the future soldier might be equipped. The future soldier shall be tailored with design considerations for each technology area name below with special emphasis on cognitive performance to improve soldier effectiveness and an increase in operational tempo. There are seven major areas within future soldier (Casey, 2009) human performance training) soldier protection) lethality) mobility and logistics) soldier

network) soldier sensors) soldier power and energy. The gateway device using Mobile Ad-Hoc Network (MANET) approach able to support four areas) Lethality) Imobility) soldier network and) soldier sensors. This approach is not focusing on military information but it is also can be applied to SAR (Search and Rescue) team unit.

Communication is one of key problems of a military operation especiall) there is no death notification status mechanism) unable to track the movement and location of soldier in real time) unable to monitor injured soldier from base station. Hence, this study proposes on development of Mobile Ad-Hoc Network (MANET) gateway for future soldier communications using Internet of Things (IoT) technology to suit the military operations in the jungle. Thus, a thorough study is vital to develop the suitable gateway equipment and network requirements for Malaysia's military eco system. Thus, the objectives of this research are as follows:

- To develop a Mobile Ad-Hoc Network (MANET) gateway using IoT technology and link to soldiers unit communication and base station for monitoring
- Create future gateway device operations and support future capability identification and analysis
- To provide low cost device, small size, mobility and weightless

- Innovators in the research community to better understand how future science and technology can enable future soldier

**literature review:** Infantry have always been inspired to the ideal of ‘one shot, one kill’ in the military training, but this study proves that, especially in complex terrains such as the jungle area, infantry usually applies the ‘volume of fire’ psychological approach to dominate their enemy. Only then the significant challenges of poor visibility and fleeting engagement opportunities are successfully overcome and maneuver restored to the light infantryman (Ross and Hall, 2009).

Communication is the key aspect in military operations (Maseng *et al.*, 2013). Throughout the ages, man have used many different modes of communication. Be it as pictography, sign languages, lights, smokes and many other symbolic ways in such that some even encrypted to hide the actual data that is being relayed. With the creativity of man to come up with many different ways of communicating, come challenges of making it much more effective. But in terms of military operations, communications have to be brief, precise and relayed to the target at pin point accuracy. The common mode of communicating has always been through voice radio. Soldiers of the world are much more dependent on current electronic warfare technology to win the war. These new emerging technology comes with a price, other than the value of money, the sum is weight is a major factor. Compared to soldiers of the First World War, soldiers of today have to carry almost double the weight. There are other methods being used in the history of military communication other than radio waves which are mainly in electronic signals and optical signals. Examples for electronic signals are telephone where the telephone converts the voice into electronic signal through the circuits in the telephone. Whereas for optical signals, it will receive the converted signals in a form of lights to be transmitted into the fibre optic cable that will then will be converted into electronic signals that will be convert into data via. electronic devices such as computers (Hecht, 2015).

A mesh network is a perfect fit for military operations because it is wireless and mobile rather than the traditional hub-and-spoke networking model which requires a physical connectivity and a centralized router. Instead, mesh networks transmits a relay system that lets each node act independently to receive and disseminate information and then forward them to the other nodes. It does not only works with the forward-operating units to collect data such as visual and sound on the surroundings of the required area that does not facilitate

with the networking infrastructure but it can also be configured accordingly with a much more efficient and quickly and considered as a much more reliable because it can bypass nodes that are operating sub optimally automatically in favor of the much more quickest and most robust pathway. Example of organization that has been using the mesh network is the United States Marines (Weintrit, 2009).

Based on the reviews, we can deduce that it is feasible to establish a wireless sensor network for infantry personnel during military operations (Kassim *et al.*, 2010; Ismail *et al.*, 2016; Ismail, 2012; Yahaya *et al.*, 2010). The following sections describes further on the research issues, objectives and the proposed network structure.

**The proposed wireless sensor network structure:** The approach of this research will be conducted according to the objectives that have been stated as above. Initial study would be concentrated in understanding the mechanics and characteristics of a Wireless Sensor Network (WSN) and Mobile Ad-Hoc Network (MANET). A handful of papers related to the research and development of the wireless network will be studied (Raniwala and Chiueh, 2005; Aguayo *et al.*, 2004; Bicket *et al.*, 2005). A wireless sensor network/ mobile ad-hoc network is a group of network which usually uses wireless or cabled network where each of the devices is connected from one to many. It needs to be configured to allow connections to be rerouted by avoiding obstacle objects that may be block the signals from being transmitted by hoping the nodes from one device to another until it reaches its destination. Wireless sensor networks are self-healing and very reliable (Karrer *et al.*, 2008; Russel, 2009; Ghani *et al.*, 2016), Fig. 1 illustrates the proposed framework of wireless sensor network structure for infantry operations (Ghani *et al.*, 2016; Wesenten *et al.*, 2005).

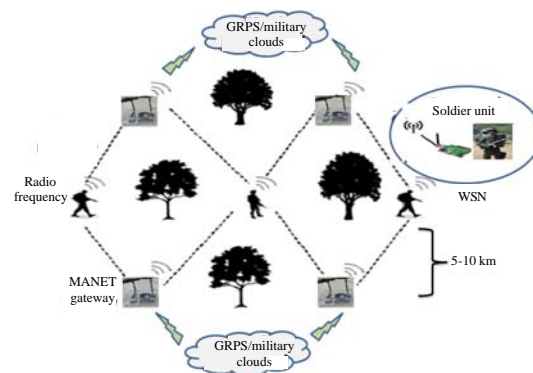


Fig. 1: Fundamental of WSN and MANET for military unit

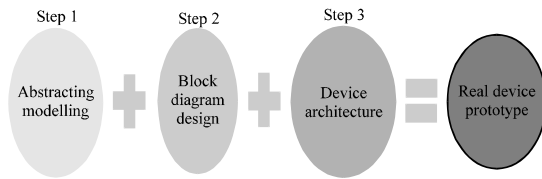


Fig. 2: Research methodology

## MATERIALS AND METHODS

The following methods would be applied to complete the project objectives (Fig. 2).

**Abstraction modelling:** In the first step, it is required to design the Mobile Ad-Hoc Network (MANET) gateway device which has a communication component. The layout of MANET device with its components is designed on the drawing paper (Abstraction modelling).

**Block diagram design:** Next, from abstraction modelling the Mobile Ad-Hoc Network (MANET) gateway will transform to the Block diagram design. In this stage, the communication components need to arrange and link each other's. The Radio Frequency (RF) sensor, GPRS sensor and controller unit are used as communication unit.

**Device architecture:** The next step, the block diagram design would be to transform into device architecture. The Mobile Ad-Hoc Network (MANET) gateway device will then be integrated with activation programming communication system. The Mobile Ad-Hoc Network (MANET) device prototype will be tested and the best performance will be used on Mobile Ad-Hoc Network (MANET) device communication for military/SAR unit team.

**Real Mobile Ad-Hoc Network (MANET) gateway communication:** In the final stage of the project, it is expected to have a successful communication on real network between smart device, Mobile Ad-Hoc Network (MANET) gateway and HQ base station. It helps to enhance the driving experience to be safer by having an effective communication between them. After that, the performance will be test and analyse in real operation monitoring and tracking situation.

## RESULTS AND DISCUSSION

### Design and result

**Abstraction model-mobile ad-hoc network gateway:** In the first phase, the overview of the Mobile Ad-Hoc Network (MANET) gateway has been sketch properly.

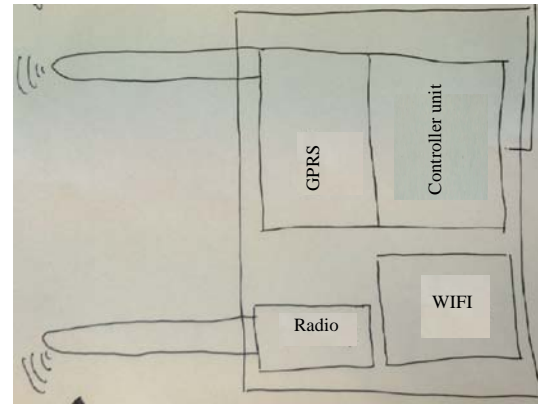


Fig. 3: Illustration of Mobile Ad-Hoc Network (MANET) gateway

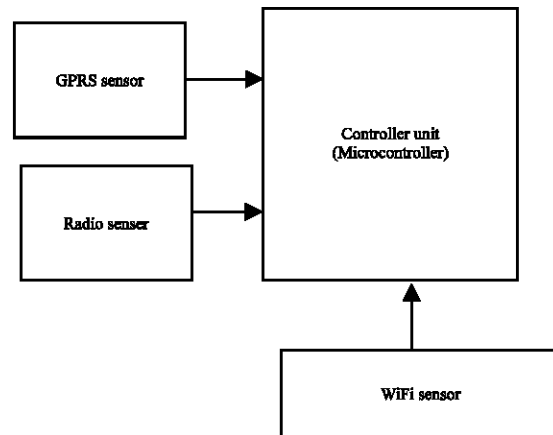


Fig. 4: Mobile Ad-Hoc Network (MANET) gateway-block diagram design for military unit

Figure 3 shows the illustration layout of Mobile Ad-Hoc Network (MANET) gateway embedded with sensor elements.

### Block diagram design of mobile ad-hoc network gateway:

The second phases, all the sensor components have been assembled and connected to block diagram design (Fig. 4). There are four components have been used in development of Ad-Hoc Network (MANET) gateway device for military operation such as: GPRS sensor, Radio Sensor (RF) and WiFi sensor. Three these sensors have connected/linked to the Micro Controller Unit.

### Device architecture layout

**GPRS sensors:** The GPRS is the central part of the General Packet Radio Service (GPRS) which allows 2G, 3G and WCDMA mobile networks to transmit IP packets to external networks such as the internet. The GPRS system

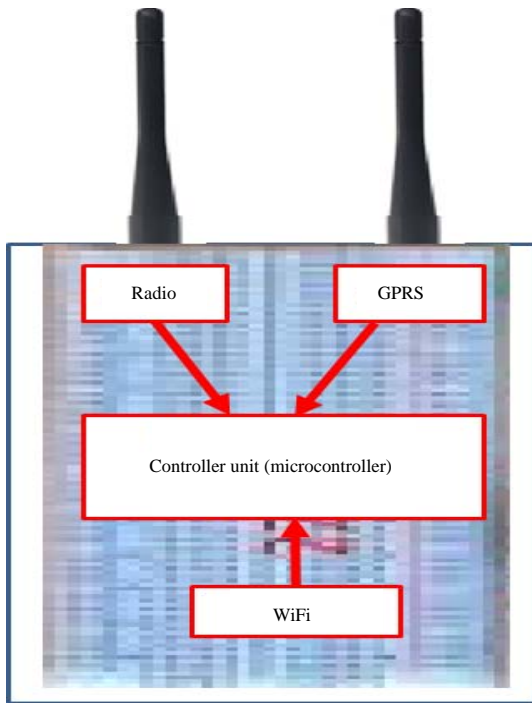


Fig. 5: Mobile Ad-Hoc Network (MANET) gateway layout

is an integrated part of the GSM network switching subsystem (Fig. 5). The GPRS is used to communicate with mobile service provider/internet. It used for wireless services on cellular phones and mobile Internet devices. With GPRS, data transfers at a much faster rate than with mobile communication services. GPRS services enable MP3 downloads, videos, games, wallpapers, animations and more. The information can be accessed anywhere, anyplace and anytime.

**Radio Frequency (RF) sensor:** This RF sensor is used for communication between military team to Mobile Ad-Hoc Network (MANET) gateway, then Mobile Ad-Hoc Network (MANET) gateway will be linked to the Base station (HQ) for real time monitoring (Fig. 5).

**Real mobile ad-hoc network gateway prototype:** At the end of the research, we are finally successfully developed real Mobile Ad-Hoc Network (MANET) Gateway device. Figure 6 shows the top view and side view of real Mobile Ad-Hoc Network (MANET) Gateway device. Table 1 shows the specification of the Radio Frequency (RF) (Alliance, 2015) used in Mobile Ad-Hoc Network (MANET) Gateway device development.

**Significant contribution:** Finally, this study has successfully developed new gateway device prototype

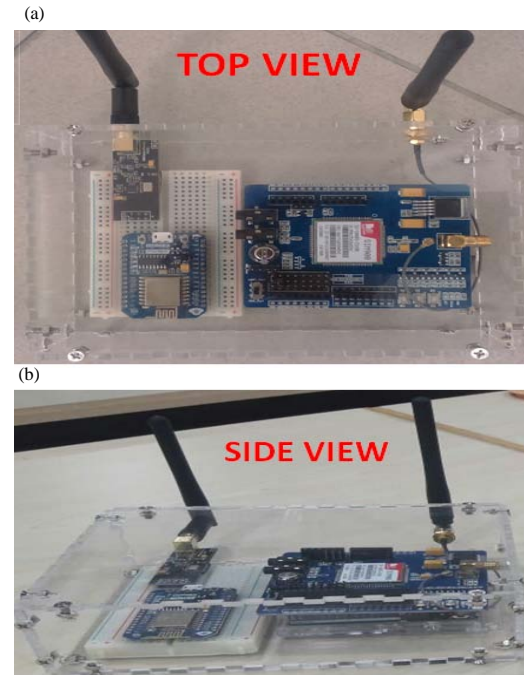


Fig. 6: Real Mobile Ad-Hoc Network (MANET) gateway; a) Top view and b) Side view

Table 1: Specification, feature and support

Specification/feature	Support
Radio Frequency (RF) bands	433 MHz, 868 MHz
Output power	+14 dBm (max.), adjustable
Modulation	FSK, GFSK, Lora supported modulation
receiver sensitivity	supports till -148 dBm
distance coverage	>15 km (sub-urban), >5 km (urban)
Applications	IoT, M2M, etc.
Supply voltage	2.1-3.6 V
Temperature range	-40°C to +85°C

using Mobile Ad-Hoc Network (MANET) approach based on IoT technology for Military operation. In addition, this prototype can be used as a gateway communication in Search and Rescue (SAR) operation. This prototype is able to flow death and location status, movement location status, health monitoring and status to the base station. In general, the contribution of this research would benefit the university and the military. At the university level, a broad field of study could emerge from this research.

The further enhancement of the wearable eco system that consists of a smart glass/goggles and also smart clothing could be included into the eco system. With a smart glass, a heads up display could be provided to the user thus saving precious time and could be coupled with augmented reality for further enhancement of situational awareness. By having heads up display, mad and field can be integrated into augmented reality. Clothes that collects physical parameters such as heart rate and perspiration rate would mean a whole new level on the term of smart

soldiers. Base situation could monitor infantry physical and mental condition, stress level and provide the appropriate remedy or re-group if retreat is imminent.

### RECOMMENDATIONS

Also, next future work needs to be focused on consumption of power energy and distance. The architecture of this Mobile Ad-Hoc Network (MANET) gateway can further extend to add Ethernet port, WiFi unit, Bluetooth port, USB port and micro SD.

### CONCLUSION

Finally, this study has successfully developed new Mobile Ad-Hoc Network (MANET) gateway device prototype for Military operation. In addition, this prototype can be used as a gateway communication for Search and Rescue (SAR) operation. This prototype is able to serve as gateway communication and flow the information between soldiers the base station.

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