Geographical Path for Multi-Radio Networks using MANETs

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Abstract
MANETs are provided with multiple radios which will be considered as the basis of future force communication networks envisioned for use in the war field applications. In this paper, we propose a new geographical path protocol for such a different multi-radio, multi-band tactical MANETS. This new protocol is designed to use many routing metric with different many radio interfaces such as IF0,IF1,IF2 each of which runs on different range of frequency bands. This protocol gives high quality of service comparing to the existing GPRS technology. Simulation of the protocol results using the JProwler platform, java coding with swings, Netbeans IDE tool and windows OS.

Keywords:
Tactical ad hoc networks, MANETS, Geographical routing

1. Introduction

We propose a new novel multi-metric geographical routing protocol with multi-radio for next generation TMMR. While location-based routing algorithms adopt a single radio, our scheme assumes that each node has multiple interfaces over multiple frequencies, resulting in different transmission ranges [1]. In this new protocol, a node is also assumed to share its own location information with neighboring nodes by exchanging periodic hello messages without control messages. [2].Problems arise when these existing algorithms are deployed in the multi-interface with different communication range. In this environment, the location routing protocols basically does not support multi-radio environment. Tactical Information Communication Network is one of the fundamental information communication systems which constitute the information mesh network of NCW [5].We proposes a novel multi-metric geographical routing protocol with different multi-radio TMMR.

The networking structure in tactican information communication network is as shown in the Figure 1. From the performance point of view, military networks are characterized by very strong requirements of data packet loss and delay compared to commercial networks, because it is more mission critical. Therefore, it is important to provide the appropriate routing path in accordance with tactical application requirement for Quality of Service (QoS). Also, since future tactical wireless networks should be able to coordinate services in dynamic network environments, how to make a selection of optimal interface depending on the type of demanding application is important [3].

We propose a novel multi-metric geographical routing protocol with multi-radio for next generation TMMR. While conventional location-based routing algorithms adopt a single radio, our scheme assumes that each node has multiple interfaces over multiple frequency bands, resulting in different transmission ranges. In our protocol, a node is also assumed to share its own location information with neighboring nodes by exchanging periodic hello messages without control messages. The main idea behind the proposed scheme is for node to select the most appropriate radio interface and hence routing metric corresponding to its on-demand data types [4].

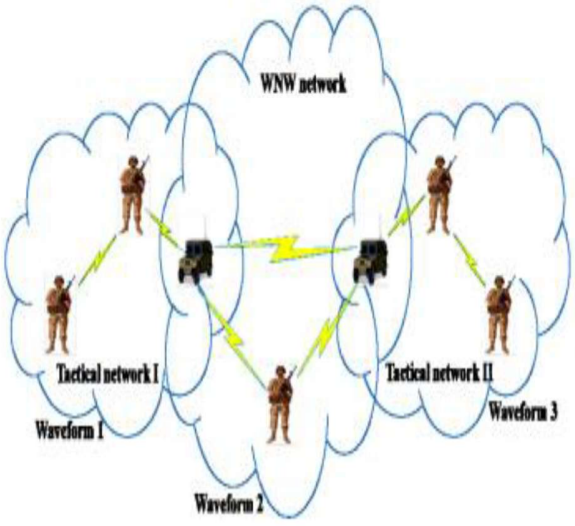

Figure 1 TMMR networking structure in tactical information communication network

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2. Hardware and Software Requirements

The Netbean SDK includes the Netbean java development tools (JDT), offering an IDE with a built-in incremental Java compiler and a full model of the Java source files. This allows for advanced refactoring techniques and code analysis.

Hardware Requirements

Processors	: Pentium IV
RAM	: 64 MB.
Storage	: 20GB.
Monitor	: 15 inch
Keyboard	: Standard 102 keys

Software Requirements

Coding	: Java Platform : Jdk
Tool	: Netbean ide
OS	: Windows OS
Chart	: JFreeChart
Simulator	: Jprowler
Front end	: Swings

3. System Design

Design is a creative process; a good design is the key to effective system. The system "Design" is defined as "The process of applying various techniques and principles for the purpose of defining a process or a system in sufficient detail to permit its physical realization". Various design features are followed to develop the system. The design specification describes the features of the system, the components or elements of the system and their appearance to end-users.

3.1 Fundamental Design Concepts

A set of fundamental design concepts has evolved over the past three decades. Although the degree of interest in each concept has varied over the years, each has stood the test of time. Each provides the software designer with a foundation from which more sophisticated design methods can be applied. The fundamental design concepts provide the necessary framework for "getting it right". The fundamental design concepts such as abstraction, refinement, modularity, software architecture, control hierarchy, structural partitioning, data structure, software procedure and information hiding are applied in this project to getting it right as per the specification.

3.1.1 Input Design

The input Design is the process of converting the user-oriented inputs in to the computer-based format. The goal of designing input data is to make the automation as easy and free from errors as possible. Providing a good input design for the application easy data input and selection features are adopted. The input design requirements such as user friendliness, consistent format and interactive dialogue for giving the right message and help for the user at right time are also considered for the development of the project. Input design is a part of overall system design which requires very careful attention. Often the collection of input data is the most expensive part of the system, which needs to be route through number of modules .It is the point where the user ready to send the data to the destination machine along with known IP address; if the IP address is unknown then it may prone to error.

3.1.2 Output Design

A quality output is one, which meets the requirements of the end user and presents the information clearly. In any system results of processing are communicated to the users and to other systems through outputs. It is most important and direct source information to the user. Efficient and intelligent output improves the systems relationship with source and destination machine. Outputs from computers are required primarily to get same packet that the user has send instead of corrupted packet and spoofed packets. They are also used to provide to permanent copy of these results for later consultation.

3.1.3 The MVC Design Method

Swing actually makes use of a simplified variant of the MVC design called the model-delegate. This design combines the view and the controller object into a single element that draws the component to the screen and handles GUI events known as the UI delegate. Communication between the model and the UI delegate becomes a two-way street. Each Swing component contains a model and a UI delegate. The model is responsible for maintaining information about the component's state. The UI delegate is responsible for maintaining information about how to draw

the component on the screen. The UI delegate (in conjunction with AWT) reacts to various events that propagate through the component.

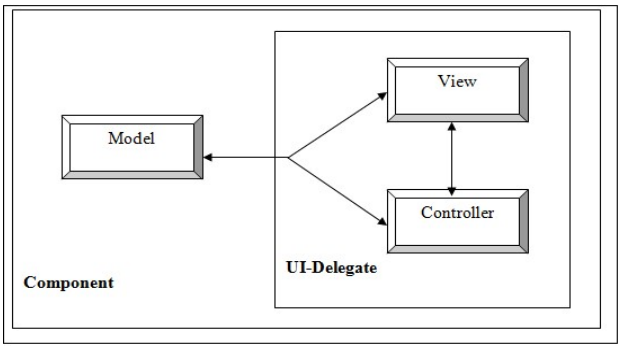

Figure 2 Combination of View & Controller into a UI delegate object

The design method that has been followed to design the architecture of the system is MVC design pattern. Swing uses the model-view-controller (MVC) architecture as the fundamental design behind each of its components. Essentially, MVC breaks GUI component into three elements. Each of these elements plays a crucial role in how the component behaves. The MVC design pattern separates a software component into three distinct pieces: a model, a view, and a controller.

4. System Analyses

Analysis is the process of finding the best solution to the problem. System analysis is the process by which we learn about the existing problems, define objects and requirements and evaluates the solutions. It is the way of thinking about the organization and the problem it involves, a set of technologies that helps in solving these problems. Feasibility study plays an important role in system analysis which gives the target for design and development.

4.1 Feasibility Study

All systems are feasible when provided with unlimited resource and infinite time. But unfortunately this condition does not prevail in practical world. So it is both necessary and prudent to evaluate the feasibility of the system at the earliest possible time. Months or years of effort, thousands of rupees and untold professional embarrassment can be averted if an ill-conceived system is recognized early in the definition phase. Feasibility & risk analysis are related in many ways. If project risk is great, the feasibility of producing quality software is reduced. In this case there are three primary areas of interest.

4.1.1 Performance Analysis

For the complete functionality of the project work, the project is run with the help of healthy networking environment. Normally, the OS is windows XP. The main theme of this project is to mitigate the black holes in the network by routing the packets in random paths Performance analysis is done to find out whether black holes are still able to intercept the packets .It is essential that the process of performance analysis and definition must be conducted in parallel. We measure the parameter called Packet Interception Probability (PIP) to measure the effectiveness of the approach.

4.1.2 Technical Analysis

System is only beneficial only if it can be turned into information systems that will meet the organization's technical requirement. Simply stated this test of feasibility asks whether the system will work or not when developed & installed, whether there are any major barriers to implementation. Regarding all these issues in technical analysis there are several points to focus on:-

Changes to bring in the system: All changes should be in positive direction, there will be increased level of efficiency and better customer service.

Required skills: Platforms & tools used in this project are widely used. So the skilled manpower is readily available in the industry.

Acceptability: The structure of the system is kept feasible enough so that there should not be any problem from the user's point of view.

5. Implementation

Implementation is the stage of the project where the theoretical design is turned into a working system. At this stage the main workload and the major impact on the existing system shifts to the user department. If the implementation is not carefully planned and controlled, it can cause chaos and confusion. The implementation stage requires the following tasks.

- Careful planning.
- Investigation of system and constraints.
- Design of methods to achieve the changeover.
- Evaluation of the changeover method.
- Correct decisions regarding selection of the platform
- Appropriate selection of the language for application development

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5.1 Language used for implementation

Implementation phase should perfectly map the design document in a suitable programming language in order to achieve the necessary final and correct product. Often the product contains flaws and gets ruined due to incorrect programming language chosen for implementation. In this project, for implementation purpose Java is chosen as the programming language. Few reasons for which Java is selected as a programming language can be outlined as follows:-

Platform Independence

Objects Orientation

Rich Standard Library

Applet Interface

Familiar C++-like Syntax

Garbage Collection

Swing support

5.2 Platform used for implementation

A platform is a crucial element in software development. A platform might be simply defined as "a place to launch software". In this project, for implementation purpose Windows XP platform is used & reasons for choosing this platform are Integrated Networking support, More stable and secure than previous version, Contain remote desktop connection and restore option, Enhanced device driver verifier, Dramatically reduced reboot scenarios, Improved code protection, Side-by-side DLL support, Windows File Protection, Preemptive multitasking architecture, Scalable memory and processor support, Encrypting File System (EFS) with multi-user support, IP Security (IPSec), Kerberos support, Smart card support, Internet Explorer Add-on Manager, Windows Firewall, Windows Security Center, Fresh visual design.

6. Testing

System testing is actually a series of different tests whose primary purpose is to fully exercise the computer-based system. Although each test has a different purpose, all work to verify that all the system elements have been properly integrated and perform allocated functions .The testing process is actually carried out to make sure that the product exactly does the same thing what is supposed to do. Testing is the final verification and validation activity within the organization itself. In the testing stage following goals are tried to achieve:-

- To affirm the quality of the project.
- To find and eliminate any residual errors from previous stages.
- To validate the software as a solution to the original problem.
- To provide operational reliability of the system.

During testing the major activities are concentrated on the examination and modification of the source code.

6.1 Unit Testing

Here each module that comprises the overall system is tested individually. Unit testing focuses verification efforts even in the smallest unit of software design in each module. This is also known as "Module Testing". The modules of the system are tested separately. This testing is carried out in the programming style itself. Unit testing exercises specific paths in a module's control structure to ensure complete coverage and maximum error detection. This test focuses on each module individually, ensuring that it functions properly as a unit. Hence, the naming is Unit Testing. In this step each module is found to work satisfactorily as regard to the expected output from the module. This testing is done to check for the individual block codes for their working. It is done so that when we carry out functional testing then the units which are part of these functionalities should have been tested for working.

6.2 Integration

After successful completion of unit testing or module testing, individual functions are integrated into classes. Again integration of different classes takes into

place and finally integration of front-end with back-end occurs.

Integration of functions into classes

At the start of coding phase only the functions required in different parts of the program are developed. Each of the functions is coded and tested independently. After verification of correctness of the different functions, they are integrated into their respective classes.

Integration of different classes

Here the different classes are tested independently for their functionality. After verification of correctness of outputs after testing each class, they are integrated together and tested again.

Integration of front-end with back-end

The front-end of the project is developed in Java Swing environment. The user interface is designed to facilitate the user to input various commands to the system and view the system's normal and faulty behavior and its outputs. The back-end code is then integrated with the GUI and tested.

6.3 Integration Testing

Data can be lost across interface. One module can have an adverse effect on another. Sub functions when combined, should not reduce the desired major function. Integration testing is a systematic technique for constructing the program structure. It addresses the issues associated with the dual problems of verification and program construction. The main objective in this testing process is to take unit tested modules and build a program structure that has been dictated by design.

After the software has been integrated, a set of high order tests are conducted. All the modules are combined and tested as a whole. Here correction is difficult, because the isolation of errors is complicated by the vast expanse of the entire program.

Top down Integration

This method is an incremental approach to the construction of program structure. Modules are integrated by moving downward, beginning with the main program module. Modules that subordinates to the main program module are incorporated into the structure in either a depth first or breadth first manner.

Bottom-up Integration

This method begins the construction and testing with the modules at the lowest level in the program structure. Since the modules are integrated from bottom to up, processing required for modules subordinate to a given level is always available. Therefore in this case the need for stubs is eliminated. The following integration testing table shows the functions that were combined into different classes and the class as a whole tested for its functionality. This is important to check for error-free interaction between various classes, and maintenance of data integrity.

7. Results

Following are the interpretation results getting in the simulation process.

7.1 End to End Delay :

As shown in the Figure 2 and Figure 3, the End to End delay is less in multi metric while comparing to the GPRS technology. Hence the performace of the multimetric technology is very high comparing to the existing GPRS technology.

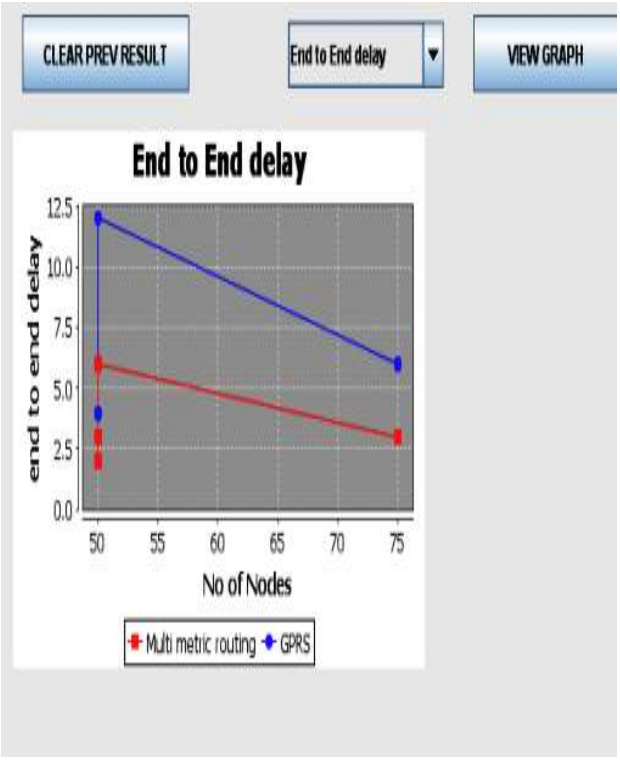

Figure 3. Illustration of the output End to End delay

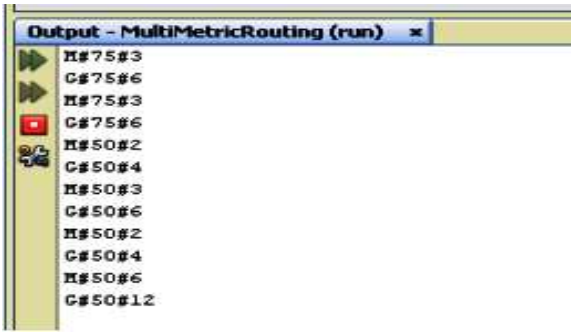

Figure 4. Output - multi metric routing of End to End delay

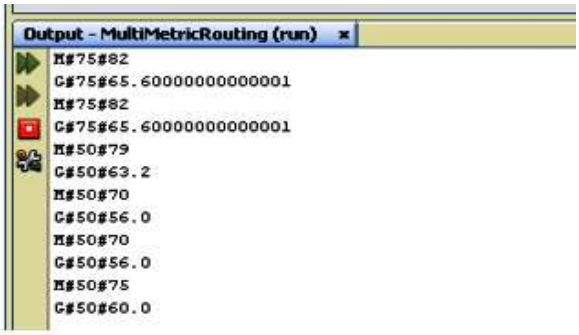

Figure 6. Output - multi metric routing of Packet Delivery Ratio

7.2 Packet Delivery Ratio :

As shown in the Figure 4 and Figure 5, the Ratio of the packet delivery is very high in multi metric while comparing to the GPRS technology. Hence the performace of this multimetric technology is very high comparing to the existing GPRS technology.

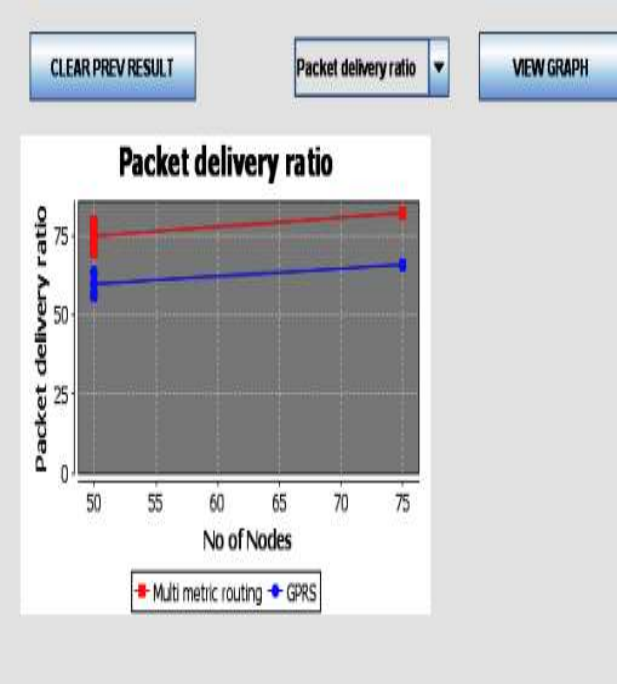

Figure 5. Illustration of the output Packet Delivery Ratio

7.3 Throughput :

As shown in the Figure 6 and Figure 7, the throughput is very high in multi metric while comparing to the GPRS technology. Hence the performace of this multimetric technology is very high comparing to the existing GPRS technology.

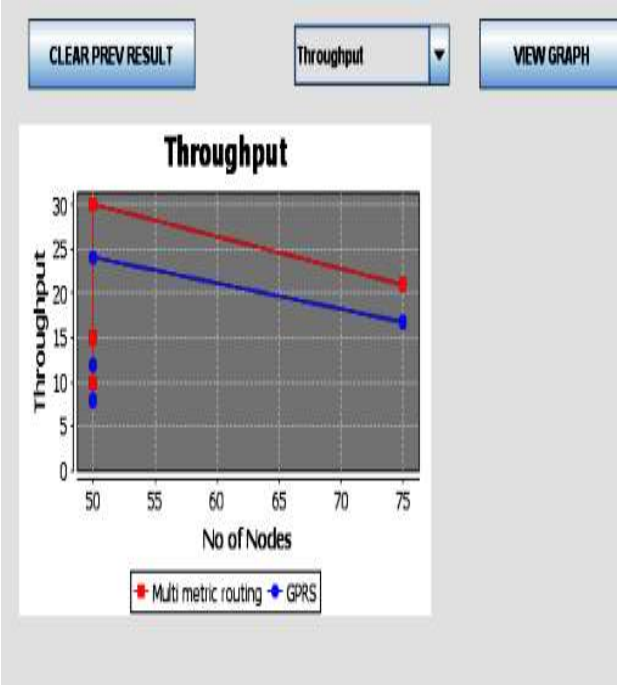

Figure 7. Illustration of the Throughput

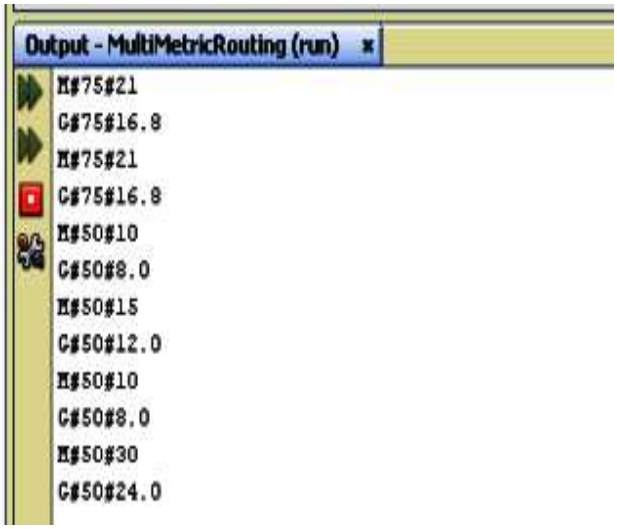

Figure 8. Output - multi metric routing of Throughput

8. Conclusion and Future Enhancement

We have presented a new multi-metric geographical routing protocol for tactical ad hoc networks. In order to support simple but unique traffic characteristics of tactical operations, we proposed to utilize multiple routing metrics for three different types of data, i.e., for voice, video and short message data. After computing metric of interfaces, one of interfaces in the set can be chosen. Since a source node knows location and distance of every node, data can be transmitted to the nearest node from the destination node. During this process, there are no additional routing control packets such as RREQ and RREP to be generated among nodes.

Simulation preliminary results show that the proposed scheme outperforms than simple GPSR scheme in terms of end-to-end delay, packet delivery ratio and throughput with low overhead.

The End to End delay is less in multi metric while comparing to the GPSR technology. The Ratio of the packet delivery and the throughput are very high in multi metric while comparing to the GPSR technology Hence the performace of the multimetric technology is very high and useful when comparing to the existing GPSR technology.

As a future work, we plan to perform extensive simulation to explore the trade-offs made by different metrics in the protocol. Adapting the protocol for energy efficiency and mobility prediction are also our future inquiry.

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