IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⪤ Peer-reviewed & Refereed journal ⪤ Vol. 11, Issue 4, April 2024

DOI: 10.17148/IARJSET.2024.11483

Multi-metric Geo-Routing Protocol for Tactical Ad Hoc Networks

Sushma K K[1],Thikshana M S[2], Noor Saba Banu[3], Darshini M S[4]

[1-3]UG student Department of CSE, GSSSIETW, Mysuru, VTU, Belagavi, India

[4]Assistant Professor, Department of CSE, GSSSIETW, Mysuru, VTU, Belagavi, India

Abstract: Mobile Ad hoc Networks (MANETs) are equipped with multiple radios, serving as the foundation for future force communication networks envisioned for application in war field network-centric scenarios. In this study, we introduce a novel geographical routing protocol tailored for the distinctive multi-radio, multi-band tactical MANET environment. The protocol is engineered to leverage various routing metrics across multiple radio interfaces, each operating on different frequency bands. Comparative analysis reveals superior quality of service offered by this protocol when contrasted with existing General Packet Radio Service (GPRS) technology. Simulation of the protocol's performance was conducted using the JProwler platform, implementing Java code with Swing, within the NetBeans IDE tool, and on the Windows operating system.

Keywords- Tactical ad hoc networks, Geographical routing

1. INTRODUCTION

We propose a new multi-metric geographical routing protocol with multi-radio capabilities for the next-gen Tactical Multi-Interface Multi-Frequency Radios (TMMR). Unlike single-radio location-based algorithms, our scheme assumes each node has multiple interfaces across frequencies, varying transmission ranges [1]. Nodes share location info via periodic hello messages, eliminating the need for control messages [2]. Existing algorithms struggle in multi-interface setups with different ranges. Our protocol addresses this and is tailored for TMMR environments. Tactical Information Communication Network is a fundamental system in Network-Centric Warfare [5]. See Figure (1) for the network structure. Military networks demand minimal data packet loss and delay, far surpassing commercial networks due to their critical missions. Thus, ensuring the right routing path aligns with tactical QoS needs is crucial. Additionally, as future tactical wireless networks must adapt to dynamic environments, selecting the optimal interface based on application demands becomes vital [3]. We introduce a novel multi-metric geographical routing protocol with multi-radio capabilities for next-generation TMMR. Unlike traditional location-based routing algorithms, which rely on a single radio, our approach assumes that each node has multiple interfaces across multiple frequency bands, resulting in varying transmission ranges. In our protocol, nodes share their location information with neighboring nodes through periodic hello messages, without the need for control messages. The core concept of our scheme is for nodes to select the most suitable radio interface and routing metric based on the specific data types they require on demand[4]. This approach enhances network efficiency by enabling nodes to dynamically adapt to changing environmental conditions and traffic demands. By selecting the optimal radio interface and routing metric based on real-time requirements, our protocol optimizes resource utilization and minimizes latency. Additionally, the exchange of location information among nodes facilitates more accurate route calculations, leading to improved overall network performance. This novel protocol represents a significant advancement in the design of tactical communication systems, offering enhanced flexibility and robustness in challenging operational environments.

2. PROBLEM STATEMENT

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. PROPOSED SYSTEM

We propose a new geographical routing protocol for such a **multi-radio, multi-band tactical ad hoc networking** environment for next generation TMMR(Tactical Multiband Multirole Radio). Our protocol is designed to use more than

DOI: 10.17148/IARJSET.2024.11483

a single routing metric with multiple radio interfaces, each of which runs on different frequency bands. The idea behind the proposed scheme is to choose the right metric and radio for QoS provisioning. 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. LITERATURE SURVEY

I. Recently, due to the advent of GPS, researchers have proposed several routing protocols that consider the location of a node. In [10], Location Aided Routing (LAR) is proposed; it estimates a route request zone based on destination location and forwards packets to that destination.

II. It uses the location information of a source and destination to reach to the destination. In [11], the authors proposed Greedy Perimeter Stateless Routing (GPSR) that derives a locally optimal choice of next hop, which is closer to the destination and intermediate nodes repeat the process until a packet reaches to the destination.

III. Both protocols significantly alleviate the broadcasting overhead that was a problem in DSDV [7], AODV [8], and DSR [9]. Ljubica et. al. [12], proposed a location based routing method for MANETs, which exploits a location and link state protocol. Wen-Hwa Liao et. al. [13], also suggested GRID based on location information.

IV. Another critical component of routing is the quality of a route from source to destination, which can be quantified through a measurement of metrics. Metrics are designed based on delay, hop count, bandwidth, type of data to exchange, path cost or energy consumed between source and destination.

V. Researchers took a single or multiple characteristics to develop one or multi metrics to verify the quality of paths, but in recent literatures the consideration of multiple characteristics or metrics has shown a better performance over the single one. In [14], the authors propose a general purpose metric called QoSMR.

VI. This metric combines multiple characteristics such as delay, jitter, bandwidth, and bit error rate, with an assumption that this combination assures route quality, since it has all the necessary recipes. Badis et. al. [15] proposed the use of two metrics for measuring delay and bandwidth, where they use OLSR and incorporate delay and bandwidth metrics for better routing.

VII. In another work [16], Cao et. al. provide an adaptive method using multiple metrics for integrating hop count, energy and traffic load into path cost calculation. This work is an extension of AODV, which could suffer from inherent problems of AODV. Although there are several routing metrics to guarantee data delivery, no consensus has been made especially for mission-oriented applications with a seamless flow of information and this is because most of the metrics are designed to guarantee only a certain data type.

VIII. The major difference of our proposed scheme is that previous approaches set various levels of priority different applications, users or data flows to guarantee certain performance requirement, while the latter makes sure that data are transmitted through a path and interface that is suitable for the application rather than giving priority to the application. Most of location based routing works have been designed for the single interface and restricted spectrum bands.

IX. Therefore, problems arise when they are deployed in the multi-interface with different communication range. In this environment, the location routing protocols basically does not support multi-radio environment, our contribution is to combine the most critical components of a routing protocol with multiple metrics to support QoS requirement. And the proposed scheme adopts GPSR in different transmission range multi-band to improve the performance of routing protocols in tactical MANETs.

5. SYSTEM REQUIREMENTS
6.

HARDWARE REQUIREMENTS

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

SOFTWARE REQUIREMENTS

Coding : Java
Platform : Jdk
Tool : Netbean ide

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

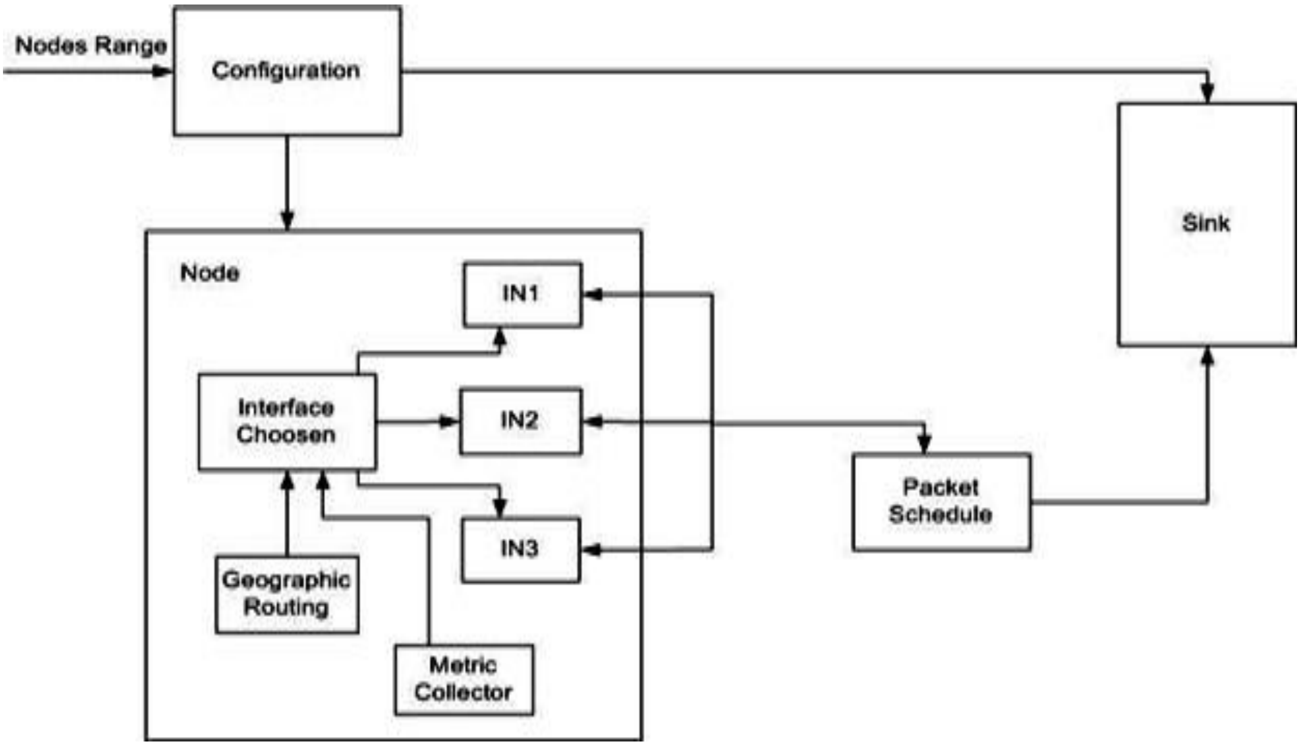
International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 11, Issue 4, April 2024

DOI: 10.17148/IARJSET.2024.11483

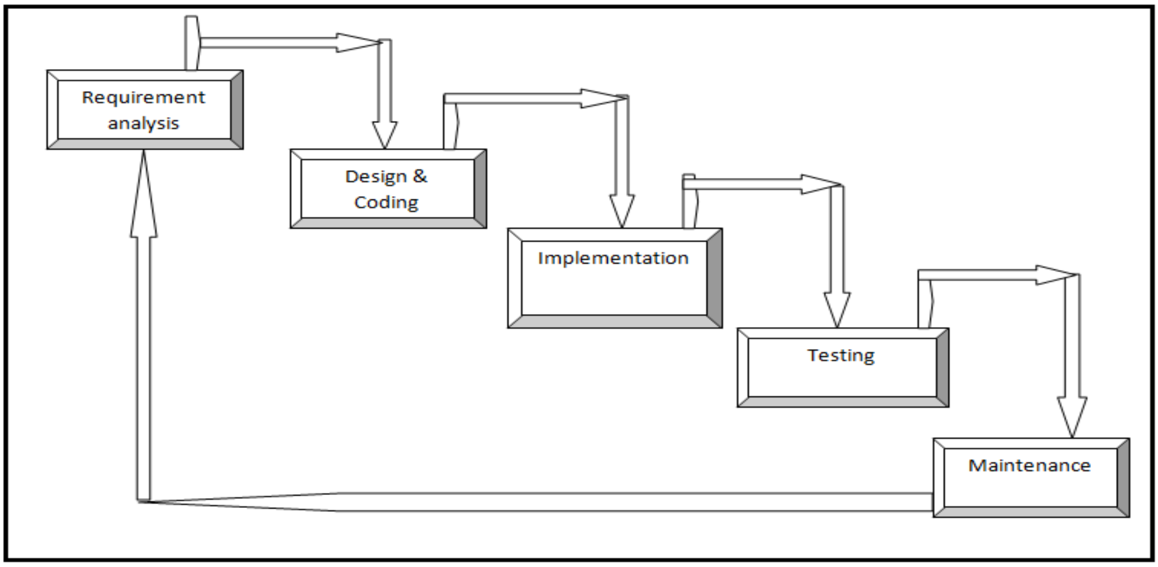
OS	:	Windows OS
Chart	:	JFreeChart
Simulator	:	Jprowler
Front end	:	Swings

6. SYSTEM ARCHITECTURE



System architecture serves as the blueprint that outlines both the structure and behavior of a system. An architecture description is a structured representation of the system, facilitating analysis of its structural properties. It delineates the system's components or building blocks and offers a roadmap for procuring products and guiding development efforts. The system architecture encompasses the collective arrangement of interconnected systems, each contributing to the implementation of the overarching system. The depicted System architecture can be visualized in Figure.

7. METHODOLOGY



IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ≋ Peer-reviewed & Refereed journal ≋ Vol. 11, Issue 4, April 2024

DOI: 10.17148/IARJSET.2024.11483

System development method is a process through which a product will get completed or a product gets rid from any problem. Software development process is described as a number of phases, procedures and steps that gives the complete software. It follows series of steps which is used for product progress. The development method followed in this project is waterfall model.

The waterfall model is a sequential software development process, in which progress is seen as flowing steadily downwards (like a waterfall) through the phases of Requirement initiation, Analysis, Design, Implementation, Testing and maintenance.

1. Requirement Analysis:

- This phase is concerned about collection of requirement of the system. This process involves generating document and requirement review.

2. System Design:

- Keeping the requirements in mind the system specifications are translated in to a software representation. In this phase the designer emphasizes on:-algorithm**,** data structure**,** software architecture etc.

3. Coding:

- In this phase programmer starts his coding in order to give a full sketch of product. In other words system specifications are only converted in to machine readable compute code.

4. Implementation:

- The implementation phase involves the actual coding or programming of the software. The output of this phase is typically the library, executables, user manuals and additional software documentation.

5. Testing:

- In this phase all programs (models) are integrated and tested to ensure that the complete system meets the software requirements. The testing is concerned with verification and validation.

7. Maintenance:

- The maintenance phase is the longest phase in which the software is updated to full fill the changing customer need, adapt to accommodate change in the external environment, correct errors and oversights previously undetected in the testing phase, enhance the efficiency of the software.

8. CONCLUSION

We introduce a novel multi-metric geographical routing protocol tailored for tactical ad hoc networks, catering to their distinct traffic requirements. By employing multiple routing metrics for voice, video, and short message data, we optimize interface selection based on computed metrics. Preliminary simulation results indicate superior performance over the conventional GPSR scheme, showcasing lower end-to-end delay, higher packet delivery ratio, and improved throughput, all achieved with minimal overhead. Multi-metric technology exhibits lower end-to-end delay, higher packet delivery ratio, and superior throughput compared to GPRS technology. These advantages highlight the high performance and utility of multi-metric technology relative to existing GPRS technology.

In future endeavors, we intend to conduct comprehensive simulations to delve into the trade-offs inherent in various metrics within the protocol. Additionally, we aim to adapt the protocol to prioritize energy efficiency and explore mobility prediction capabilities as part of our ongoing research.

9. FUTURE ENHANCEMENT

1. Dynamic Metric Adaptation: Implement algorithms to dynamically adjust routing metrics based on real-time network conditions and traffic demands, enhancing protocol responsiveness.
2. Cross-Layer Optimization: Explore techniques that leverage information from different protocol layers to optimize routing decisions and improve overall network performance.
3. Security and Resilience: Enhance the protocol's security mechanisms and develop resilient routing strategies to mitigate threats and maintain connectivity in challenging environments.
4. Edge Computing Integration: Integrate edge computing capabilities into the protocol to support distributed applications and offload processing tasks at the network edge.
5. QoS Support: Extend the protocol to provide Quality of Service (QoS) support for diverse application requirements, including prioritization of critical traffic and bandwidth guarantees.

DOI: 10.17148/IARJSET.2024.11483

REFERENCES

[1] M. S. Hasan, M. LaMacchia, L. Muzzelo, R. Gunsaulis, “Designing the joint tactical radio system (JTRS) Handheld, Manpack, and small Form Fit (HMS) Radios for interoperable networking and waveform applications,” in Proc. of IEEE MILCOM, 2007

[2] J. Redi, R. Ramanathan, “The DARPA WNaN network architecture,” in Proc. of IEEE MILCOM, 2011

[3] D. Kim, “Load Balancing with Mobile Base Stations in Tactical Information Communication Networks,” in Proc. of IEEE WCNC, 2011

[4] M.E.M. Campista, P.M. Esposito, I.M. Moraes, L.H.M. Costa, O.C.M. Duarte, D.G. Passos, C.V.N. de Albuquerque, D.C.M. Saade, M.G. Rubinstein, “Routing metrics and protocols for wireless mesh networks,” IEEE Network, vol. 22, 2008

[5] J.L. Burbank, P.F. Chimento, B.K. Haberman, W.T. Kasch, “Key Challenges of Military Tactical Networking and the Elusive Promise of MANET Technology”, IEEE Communications Magazine, vol. 44, Issue: 11 , 2006

[6] A. A. Sakr, A. M. Kozae, M. Elshafae, M. R. Ibraheem, “Optimizing Network Routing by Deducing a QoS Metric Using Rough Sets,” International Journal of Engineering Science and Technology, vol. 2(7), pp. 2101--3110, 2010

[7] D. Chen, P.K. Varshney, “A survey of void handling techniques for geographic routing in wireless networks,” IEEE Communication Survey & Tutorials, vol. 9, no. 1, 2007.

[8] B. N Cheng, J. Wheeler, L. Veytser, “Radio-to-Router interface technology and its applicabliity on the tactical edge”,IEEE communication Magazine, Vo. 50 , pp. 70--77 , 2012

[9] L. Cao, K. Sharif, Y. Wang, T. Dahlberg, “Adaptive Multiple Metrics Routing Protocols for Heterogeneous Multi-Hop Wireless Networks,” in Proc. of CCNC, 2008

[10] R. Kumar, M. Misra, A. K. Sarje, ”A Routing Protocol for Delay-Sensitive Applications in Mobile Ad Hoc Networks,” in Proc. Of ISAUHC, 2006

[11] A. Kumar , D. Manjunath , J. Kuri, “Wireless Networking,” Morgan Kaufmann Publishers Inc., 2008

[12] W. S. Jung, K.W. Lim, Y.B. Ko, Y. Song, S. Park, “A Practical Approach for Channel Problem Detection and Adaptation in Tactical Radio Systems,” in Proc. of IEEE MILCOM, 2011