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Analysis of Wireless Network Security in WLAN

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Abstract: This paper examines those protocols and identifies the parameters needed to implement a tactical MANET routing scheme. The findings of this research advance understanding of MANETs and the elements necessary to enable their use in support of tactical communications to achieve goal of lightweight and efficient tactical communications. Mobile Ad Hoc Network's (MANETs) areinfrastructure less, highly mobile communications and their multi-hop routing capabilitieshave the potential to reliably and robustly extend existing networks to the tactical edge. To manage challenges of MANET in dynamic physical topology and efficient use of limited spectral and energy resources TDMA platform is needed.

Key words: TDMA, Routing, Deviation, Manet, Tactical networks, Adhoc network.

I. INTRODUCTION

The Mobile Ad- Hoc Networking (MANET) is an emerging technology whose potential presents anopportunity to greatly improve warfighting capabilitiesMANET is one technology that is capable of contributing to the accomplishment of those goals. Mobile Ad Hoc Networking is beneficial in many applications where an underlying communications infrastructure is not present, or the establishment of one is not advantageous. There are many challenges in the design and implementation of MANETs. One of the unique challenges to MANETs is network management. Due to the dynamic physical topology and decentralized architecture, fault detection and performance monitoring is difficult. There are two main categories of information routing techniques used in current MANET systems: the barrage relay scheme, and the intelligent routing scheme. The barrage relay schemeemploys every node other than the source and destination node as a relay. The intelligent routing scheme determines the best path between the source and destination before sending a message. Routing is the process of directing data in a network. Routing is conducted either statically or dynamically. In static routing, an administrator directs the path of information from a source to a destination in or among networks. In dynamic routing, a connectivity device determines the best route between a source and destination.

MANETs are uniquely identified by five characteristics: wireless, ad-hoc based, autonomous and infrastructure-less, multi-hop routing, and mobility. There are many challenges associated with managing and implementingMANETs. Due to the lack of infrastructure and a central management entity, faultdetection and management, is difficult. The dynamic nature of the network topology canlead to network splits and packet loss. An example of a situation where a network splitoccurs is shown in Figure 1.

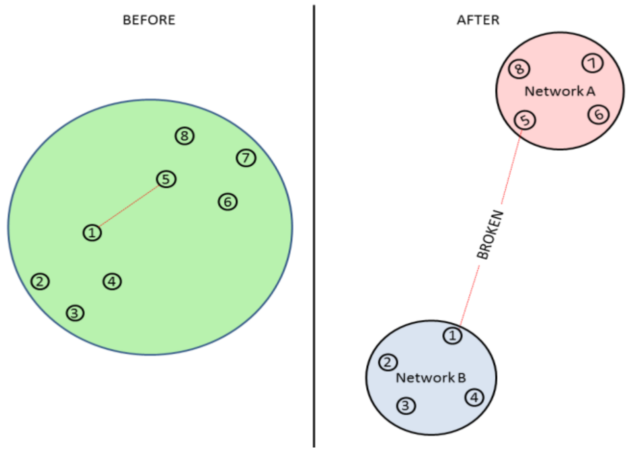

Figure 1.Network splitsment

II. THEORETICAL CONSIDERATIONS

Proactive protocols are derived from traditional distance vector and linkstate protocols, where each node always maintains an up to date route to every other nodein the network. Route creation and maintenance occurs periodically or after an event istriggered (e.g., when a link is added or removed). A key difference in proactive protocolsas opposed to traditional routing protocols is the rate of updates. Updates occur at different rates based on the speed of nodes.

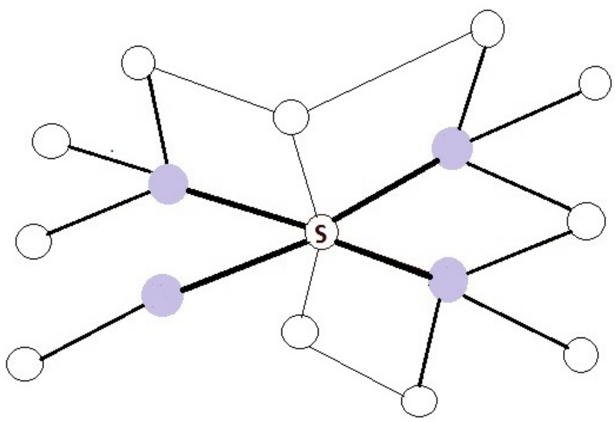

Figure 2. Multipoint Relays

The advantage of proactive protocols is that a route is immediately available when needed. Optimized link state routing improves on traditional link state routing byadding multipoint relays (MPRs) to reduce network overhead.Each node chooses its own MPR according to which nodes will retransmit a message toeach of the original node's two hop neighbors. Only the MPRs rebroadcast the original node's messages. (Figure 2)

Dynamic Source Routing is similar to AODV with a couple of notabledifferences. DSR is a source routing protocol where data packets contain the full route tothe destination and the next hop is not determined at each intermediate hop. During the route request process, each intermediate node that does nothave a route to the destination appends its own address to the original RREQ and thenforwards the message. When a node that does have a route to the destination receives the route request packet, it appends the known route from its routing cache to the route travelled by the route request packet, creating a full route from source to destination. An example of the DSR RREQ / RREP process is demonstrated in Figure 3. In the example, the source node, marked "S", sends a routerequest, attempting to find a viable route to the destination, marked "D". The RREQmessage arrives at the destination because none of the intermediate nodes has a viableroute in their caches. The destination node upon receiving the request sends the routinginformation already in the RREQ message back to the source in a RREP message.

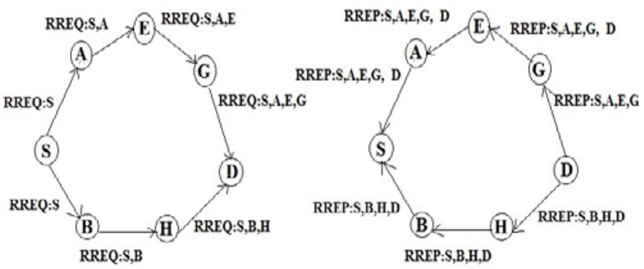

Figure 3. DSR Route Request and Route Response

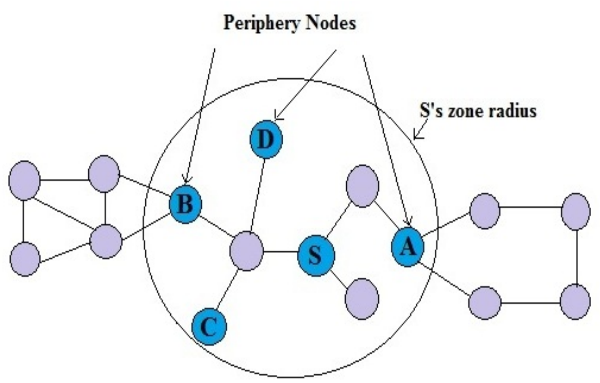

Figure 4. ZRP 2-Hop Zone with Periphery Nodes

Hybrid Protocols exhibit a combination of proactive and reactive protocolcharacteristics based on specific circumstances. An example of a hybrid protocol is theZone Routing Protocol (ZRP). In the Zone Routing Protocol, a zone is established based

on a predetermined number of hops extending out from each node. Figure 4 shows the zones for node "S" with azone size of two hops, and peripheral nodes (i.e., A, B, C, and D).

Rule based reasoning breaks problems into "if...then" statements. There are threebasic components to expert systems: the working memory, the rule base, and theinference engine. The working memory is a repository of dynamically changing factsabout the environment. The rule base is the repository of "if-then" rules that are used for problem solving. The inference engine compares the facts in theworking memory to the rule based to determine which actions need to be taken. The Rulebased Reasoning components with their interactions are depicted in Figure 5.

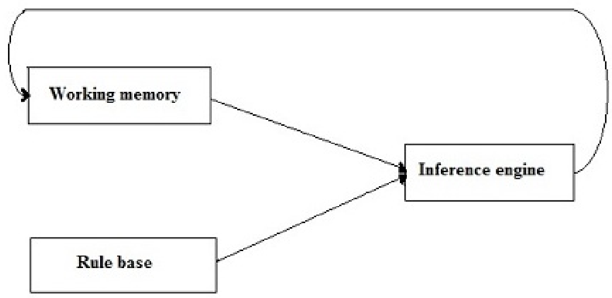

Figure 5. Rule Based Reasoning Model components and interactions

Case execution is the implementationof the solution and the evaluation of the success of the case. Case organization is how thenew case is stored in the case library after case execution. The key variables under consideration include the network statusof nodes and the environment. The CBR model with component interactions is depictedin Figure 6.

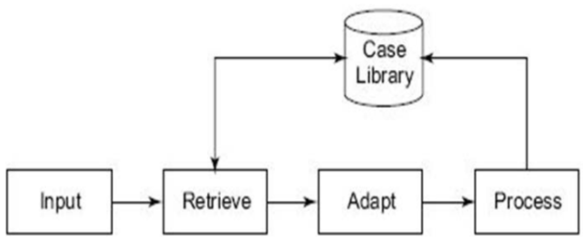

Figure 6. CBR Model components and interactions

III. RESULTS

To quantify the qualitative link color data, an integer was assigned to each color (as depicted in Figure 7). The red link color was assigned the value "1", yellow was assigned "5", green was assigned "10", and blue was assigned the value of "15". That refined data with numerical equivalents was imported into MATLAB and sortedaccording to link quality, from lowest to highest. After sorting, the link quality numericalvalue (independent variable) was plotted versus the link color value (dependent variable).It is evident from the resultant plot in Figure 8 that there is a direct correlation betweenlink quality (SNR in dB) and link color. It is also apparent from the data that there areclear link quality thresholds between each color. The data shows that the steep inclines inFigure 8 should actually be vertical lines because the link color value (andcorresponding link color), upon reaching a certain link quality threshold level, "jumped"to the next higher link color level.

Link Quality (dB)	Link Color	Link Color Value
3	Red	1
42	Blue	15
5	Yellow	5
39	Blue	15
13	Blue	15
12	Blue	15
8	Yellow	5
7	Yellow	5
30	Blue	15
18	Blue	15
15	Blue	15
26	Blue	15
21	Blue	15
10	Green	10

Figure 7. Sample of Refined Data Showing Link Quality and Link Color

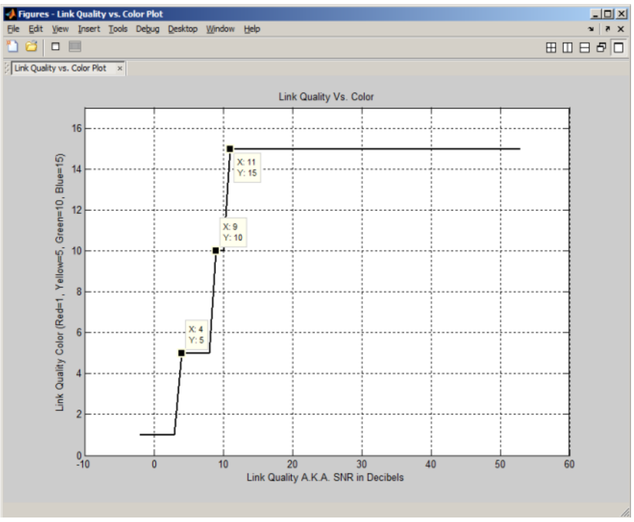

Figure 8. Link Quality vs. Link Color Value Plotted using MATLAB

The thresholds between link colors are as follows (format: "lower color – higher color" according to SNR): green-blue, 11 dB; yellowgreen,9dB, red-yellow, 4dB. Any SNR less than 4dB corresponded to the red link color,and an SNR that was 11 dB or greater corresponded to the blue link color. The highestSNR observed was 53 dB; the lowest was -2 dB. The most important threshold observed is the red-yellow SNR (4dB). This SNR represents the critical minimum threshold SNR(i.e., SNRt) needed in the link cost routing metric; without it, themetric would not be feasible because there would be no way to ensure robust datacommunications using the routing metric.

To convert multimeter readings into percentages, the formula for interpolation was used, with the maximum value being the first voltage reading (12.34 Volts), and the minimum reading used was the highest of the voltage readings that corresponded to "0%" on the radio display (10.88 Volts). After conversion of the voltmeter readings to percentage values, the calculatedbattery percentage was compared to the displayed battery percentage using the deviation formula-

% Deviation = 100*(Observed- Actual)/Actual

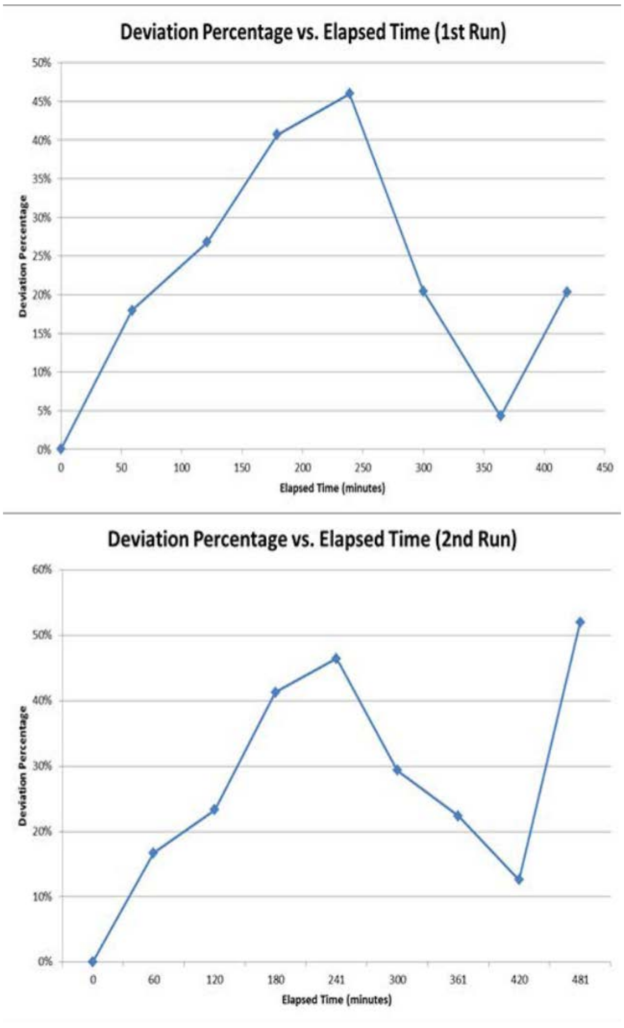

Figure9. Deviation vs elapsed time

It is important to note what was considered the "observed" and "actual" values.The observed values were values read from the radio display, and the actual values werevalues taken with the multimeter. The reason these values were deemed as such and not vice versa is because the zero percent reading on the radio display did not really mean thebattery was fully discharged. In actuality there was still a large amount of charge left onthe battery when the display read “0%.” Discounting the negative percentage deviationvalues that correspond to battery voltmeter readings less than the highest recorded “0%”value of 11.88V, the average percent deviation was 22%, with the highest deviation being46% (241 minutes elapsed). On the second run, the maximum and minimum voltagesrecorded were 12.36V (start) and 10.84V (497 minutes elapsed). The highest deviationrecorded was 52% (at 481 minutes elapsed). The plots of time elapsed versus percentagedeviation are shown in figure 9. Although the two plots show consistent deviationcurves, the maximum deviation percentage occurs at different points on each curve; the highest deviation for the first run occurs toward the middle of the test, whereas thehighest deviation for the second run occurs towards the end of the test.

IV. CONCLUSIONS

It was determined that there is a direct correlation betweenthe SNR and link quality associated with a given link between nodes. The informationcould be easily obtained fromnetwork management software tools.The battery life, in percentage levels, could also be obtained fromnetwork management system. The SNR and the Battery life of the nodes is a veryimportant finding; with those two metrics, the routing metric could be used to determinethe cost of a given route, and the costs of each route could be compared to determine themost efficient route. Of the two factors deemed necessary to the structure of a CBR case(i.e., node density and aggregate node mobility) only node density could be obtained.Node mobility levels based on node speeds is definitely a recommendation for futureresearch when the functionality is added. This research started out with a couple of goals in mind that were centered on thenecessary management tools to ensure that MANETs are able to support tactical communications.The main goal was developing a routing metric to evaluate alternate MANETrouting schemes. That metric was developed through a review of tactical communication requirements. This researchattempted to collect the necessary information needed to demonstrate that the routingmetric data was available. The routing metric is important for determining the cost of anygiven route between the source and destination in a MANET, hence a vital piece ofinformation for using the most efficient route—a key element to mitigate the constraintsimposed by mobile, battery operated tactical radios. With that information, a discussionof the benefit of different Ad-Hoc intelligent routing approaches was presented. A casebased reasoning approach was then put forth to exploit the potential that hyper nodesportend to the management of MANETs.

An analysis that simulates the transmission ofa message in one of the Ad-Hoc protocols versus the Barrage Relay / TDMAtransmission scheme would also be beneficial in its quest for a nextgeneration communications system. In addition, the SNRs collected were obtained by thesystem itself; an independent analysis evaluating the accuracy of SNR levels at thereceiving antenna would be beneficial as well.

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