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Performance Analysis of Mobile Ad-Hoc Networks Based on TCP and UDP Traffic on AODV Protocol for Warship Communication

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Abstract

This research focuses on evaluating two key parameters in Mobile Ad-Hoc Networks (MANETs) that use the AODV protocol for warship communication, namely the packet delivery ratio (PDR) and end-to-end delay. PDR describes the percentage of data packets that successfully reach their destination without loss or damage during transmission. The study will analyze and compare PDR in MANETs with TCP and UDP traffic to understand the reliability and efficiency of the AODV protocol in data delivery. Furthermore, the research will also assess end-to-end delay, which measures the time it takes data packets to reach their final destination. Evaluating this delay will provide insights into the network's responsiveness in transmitting data between source and destination. The results of this research will offer valuable information about the performance of MANETs using the AODV protocol with TCP and UDP traffic. These findings can be used to optimize warship communication systems by selecting the most suitable protocol and traffic to achieve high PDR and minimal end-to-end delay; this study has the potential to serve as a critical foundation for developing reliable and efficient mobile ad hoc networks for military communication in dynamic and challenging environments.

Keywords: *Mobile Ad-Hoc Networks, Packet Delivery Ratio, End-to-End Delay, AODV, Warship Communication*

1. Introduction

Effective and reliable communication are crucial in warship communication systems, especially those operating in dynamic environments. Communications on warships often rely on ad hoc mobile networks (MANETs) to facilitate the exchange of data and information between units. MANET is a wireless network with a router that moves freely and does not have a fixed router. Routers act and are responsible for finding and handling routes to each node in the network. The Manet Network[1], The node that serves as a router is responsible for finding and handling routes to each node in the network. The movement of each node affects the network topology and transmission route, as well as failure of the route can lead to failures in communication between nodes and the quality of data transmission. In this context, the MANET routing protocol becomes a key element for ensuring good connectivity and data delivery efficiency.

In wartime communication, manets can be used as a replacement for physical weapons for modern communication. This allows communication with no delay and is also confidential. This situation requires an effective and uninterrupted communication system. One of the routing protocols widely used in MANET is the ad hoc on-demand distance vector. (AODV)[2]. AODV is a reactive routing protocol that works by finding routes on demand when there is a data delivery request. In the MANET environment on warship communication, where network conditions can change rapidly, AODV [3] offer some benefits. First, the protocol can adapt to changes in network topology efficiently, avoiding significant overhead.

Second, AODV can maintain a relatively small routing table, thus reducing the burden of using valuable network resources on the warships. However, in the context of dual-traffic warship communication systems, special challenges arise. Double traffic refers to situations in which MANET networks on warships must simultaneously handle data traffic of a tactical and administrative nature. Tactical traffic involves the exchange of critical data for missions and tactical information. Administrative traffic involves routine communication, such as reporting, message delivery, and synchronization [4].

In this case, the effectiveness of the AODV protocol is the main concern. Therefore, the analysis of the effectiveness of the AODV protocol in the mobile ad hoc network in the communications system of warships with dual traffic becomes of paramount importance. This research will provide information on the capabilities of this protocol to address unique challenges in this environment, as well as recommendations and developments to improve network performance and data delivery efficiency in the context. Simulation results show that the delay

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and ratio of package delivery on the AODV protocol can be influenced by several factors, such as the type of traffic source, the area width, and the mobility of the nodes.

2. Methods

In this study, we conducted simulations of war communication using an NS simulator to analyze the performance of the AODV protocol with two different types of traffic. Figure 1 shows the workflow of this study."

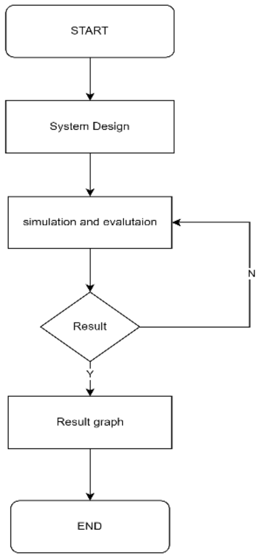

Figure 1. Planning of Research

In this study, we performed simulations in war communication using an NS simulator to analyze the performance of the AODV protocol using two different traffic. The workflow of this study was shown, as well as the mobility of the node as a representation of the formation of the warships. In this study we used the number of nodes of 10 and 21 nodes with an area area of 1000 m x 1000 m for 200 seconds. The experiment used two scenarios, a scenario with random waypoint mobility and a Manhattan mobility as a repersentation of the warship formations. We test the parameter ratio of the packages received and delayed. Table 1 shows the experimental scenarios for this study.

Table 1. Simulation Parameters of Simulation

Simulator	NS 2.34
MAC type	802.11
Time Simulation	200 detik
Protokol routing	AODV
Area Simulation	1000 m x 1000 m
Traffic Type	UDP/TCP
node	10/21
Model propagasi	Two-ray
Packet	200 bytes/packet

The source of traffic is the traffic used in the network that is created. Constant bit rate (CBR) and TCP traffic patterns [14]. This traffic pattern is created at ns 2 in the directory "~ns/indep-utils/cmu-scen-gen/" and generated at "cbrgen.tcl":

```
$ns cbrgen.tcl [-type cbr|tcp]
```

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To calculate the test parameters, namely packet delivery ratio (PDR) and end-to-end delay, use the following formulas: PDR is calculated by dividing the number of data packets successfully sent from source to destination by the total number of datasets initiated at the beginning of the experiment. The results of the PDR calculation will provide a percentage of the efficiency of data packet delivery in an ad hoc mobile network with the AODV protocol [10].

$$\text{PDR} = (\text{Number of successfully delivered packets} \;/\; \text{total number of Sent Packets}) < 100$$

The end-to-end delay is calculated as the time gap between the delivery of a data package from the source to the destination and the time when the data packet arrives at the destination. This end-to-end delay calculation provides information on the response time of the network when sending data from one point to another in a dynamic environment [15].

$$End - to - End\ Delay = (N\ L\ /\ R)\ P$$

N = link
L = packet length
R = transmission rate

3. Results and Discussion

Figure 2 shows the results of a simulation in which the number of nodes is placed in a random position. Next, we run the node with 2 mobility scenarios. Then we take the values in the trace file to analyze the packages that are confirmed according to Figure 3.

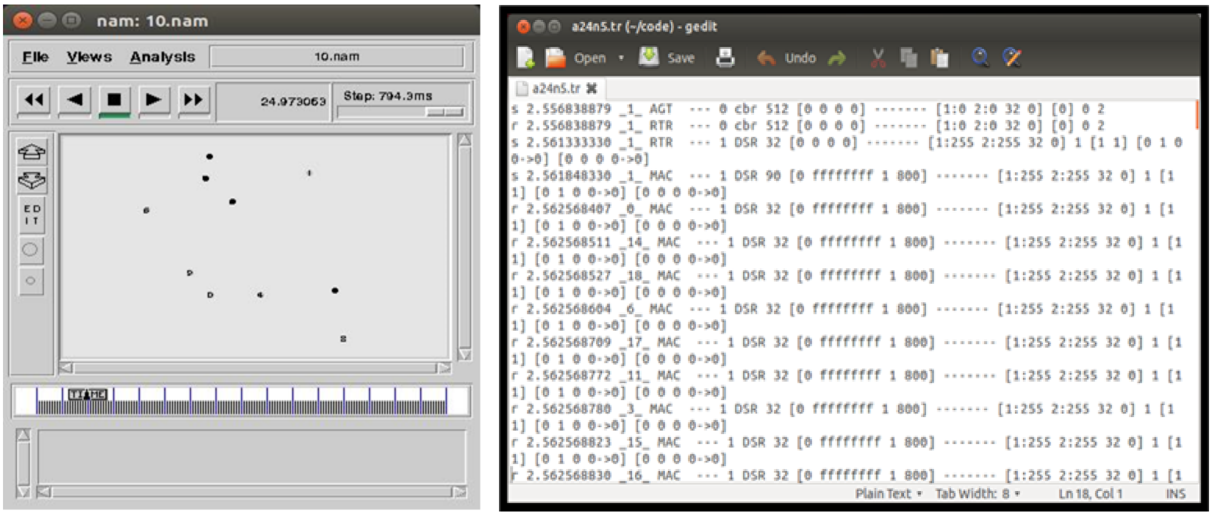

Figure 2. Simulation in the NS2 simulator and file trace

In the trace file in Figure 3, the output seen in the image is the event located in the first field of the trace file. There are four possibilities: s is sending, r is receiving, d is disposing and f is shipping. The second field is the time to show how long the event lasts. The third field is the node ID, which is the identity of the event node. The fourth field shows the type of trace that remains. The next field is the size of the package. By storing awk files and trace files, we can perform analysis of package delivery between nodes.

From the results of the simulation done using the randow way point node, where the value of end-to-end delay on UDP is very high from TCP and for the PDR value itself in the UDP tends to go down but on TCP PDR values tend to be stable. Manhattan's end-to-end delay value on Manhattan dropped significantly in TCP traffic. Similarly, with UDP traffic, the delay value decreases when the number of nodes is added. For the test results on random mobility waypoints shown in Figure 4, the results on TCP and UDP traffic for end-to-end delay parameters, while in Fig. 5, the results of simulations using the Manhattan mobility node.

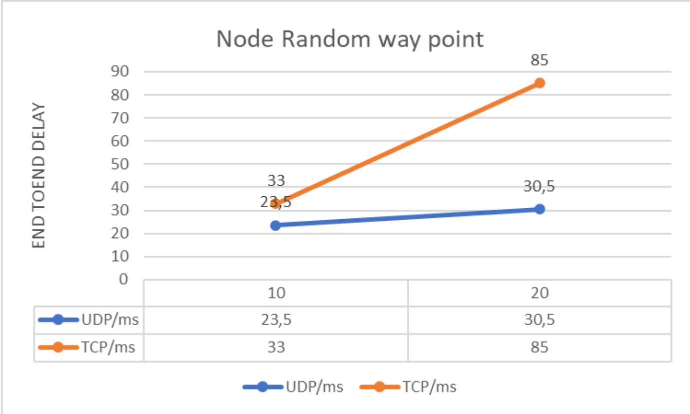

Figure 3. Random end-to-end delay point for TCP and UDP traffic

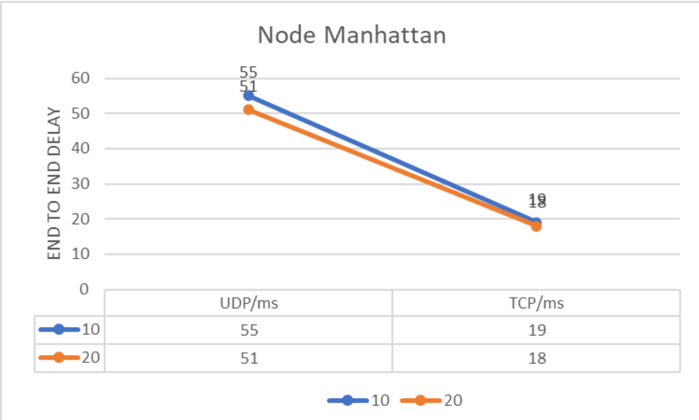

Figure 4. End-to-End Delay Manhattan for TCP and UDP traffic

In the first simulation with the type of TCP traffic and the area of 1000m2 x 1000m2, increased simulation time resulted in an increase in the end-to-end delay values when the type of traffic changes. However, the package delivery ratio remained stable, indicating consistent delivery success over a longer period of time. In the second simulation with the same UDP traffic type and area width, the Waypoint Random UDP model showed a stable overall package delivery ratio and end-to-end delay. However, there is an increase in delay values at nodes 10 and 21. Although the package delivery ratio remains stable, network adjustments or optimizations should be considered to address increased delays on certain affected nodes.

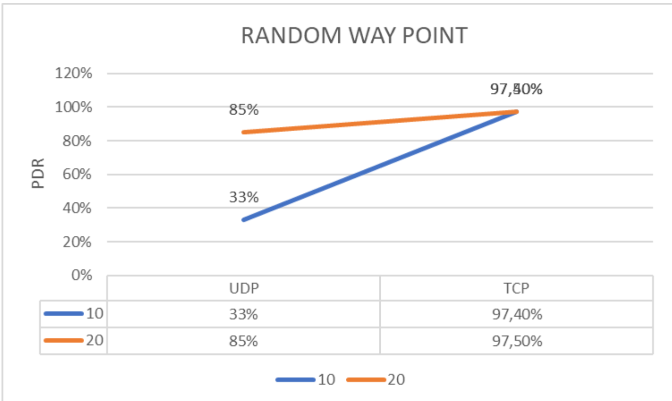

Figure 5. Random way point PDR for UDP and TCP traffic

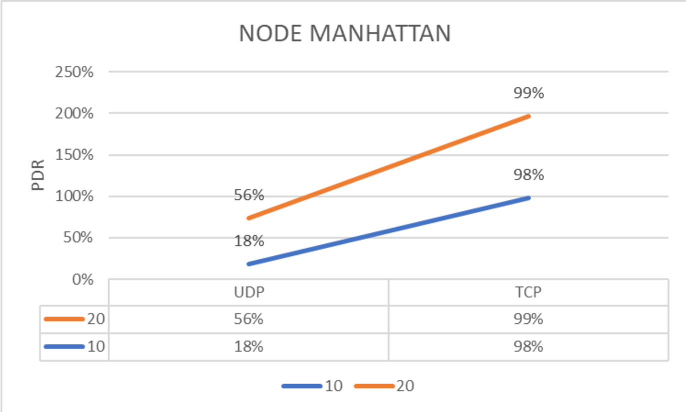

Figure 6. PDR Manhattan for UDP and TCP traffic

From the above image, you can observe differences in the PDR (Packet Delivery Ratio) simulation results with the same simulation time and area size. There was a fairly significant decrease in the number of nodes 21 using the type of TCP traffic. However, the PDR value remains stable along with the addition of nodes. Meanwhile, the end-to-end delay values with the same type of traffic and the same area width also experienced a decrease when nodes were added. However, for the PDR value, the result remains stable as in the previous simulation. These findings suggest that in the same scenario, the use of similar types of traffic and area widths could affect network performance in terms of PDR and end-to-end delays. Changes in the number of nodes can also affect end-to-end delay values, while PDRs tend to be more stable. These results can be used to understand how the network responds to changes in specific parameters and to help optimize and configure the network for better performance.

4. Conclusions

From the results of the simulations carried out, the type of traffic source and the size of the area, as well as the mobility of the node, can affect the result of the delay and the delivery ratio of the package on the AODV protocol. There are a few points that can be found from the results of this research. The AODV protocol shows better performance on node mobility with structured movement patterns, as in the Manhattan scenario. In the mobility of random waypoints, the delays in the AODV protocol tend to be greater, indicating challenges in the management of networks with unstructured mobility. The success rate of packet delivery on the TCP protocol is higher than that of the UDP protocol. This suggests that TCP is more suitable for use in communications that prioritize reliability and data transmission success. When designing communications systems for warships, it is necessary to consider the high mobility of the nodes, since the vessels tend to shift positions. The AODV protocol may be effective if the mobility of the node is structured, but it needs to be reconsidered if its mobility is unstructured. Furthermore, the choice of the type of traffic source and the size of the area also affects the performance of the AODV protocol. The use of the AODV protocol must be adapted to the specific conditions of the warship network. Taking into account the above factors, the communication network design for warships can be optimized, thus achieving better performance in terms of delay and the success ratio of package delivery.

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