Implementation of mobile ad-hoc network using BATMAN routing protocol (better approach to mobile ad-hoc network) for salinity monitoring in Vaname shrimp farms

Fadila Larasati[1], Nugroho Suharto[2], Aad Hariyadi[3]

[1]Digital Telecommunication Network Study Program, [2,3]Telecommunication Engineering Study Program, Department of Electrical Engineering, State Polytechnic of Malang, Indonesia

[1]larasatifdla@gmail.com, [2]nugroho.suharto@polinema.ac.id, [3]aad.hariyadi@polinema.ac.id

***Abstract*—Salinity is one of the key parameters in the vannamei shrimp culture environment. Currently, the conventional method is still being used, by visiting each pond plot. However, due to the large number of pond plots and the large distance between the plots, this method is less effective because it takes time and effort. This ineffectiveness can lead to less than optimal yields. Therefore, manet is applied to increase the effectiveness of checking salt levels using the BATMAN routing protocol. In this study, 2 units of laptops were used that act as Node 1 (central) and Node 4, 2 units of Orange Pi Zero which functioned as Node 2, and 3. Each device is connected to a conductivity sensor to measure the salinity. The four devices are configured with an adhoc network using the BATMAN routing protocol as a bridge to connect wireless communication between nodes. This research was conducted to provide an alternative for monitoring salt levels in shrimp ponds to make it more effective and easier for pond farmers. Based on the results of testing and analysis of network quality, the average delay value is 22.285 ms with a jitter value below 0 ms. The low delay value affects the percentage of packet loss in the four test scenarios with an average percentage of 0.999759613 %. Memory and CPU usage in testing 4 transition scenarios resulted in an average memory usage of 0.225% and CPU usage of 0.725%. The BATMAN routing protocol does not use a lot of memory and CPU usage because it only forwards data packets without the need to process data. From these data, it can be concluded that manet with batman routing protocol can be used as an alternative communication to provide communication network services in areas where there is no fixed network infrastructure.**

Keywords*— *MANET, Routing BATMAN, Salinity

I. INTRODUCTION

In shrimp farming, there are several things that must be checked to maintain the stability of pond water, one of which is to maintain salt levels (salinity) in pond water. Salinity must be kept in the range of values of 20–30 ppm [1]. Pond water is generally brown-green, indicating the predominance of diatomous plankton [2]. Plankton Diatom is a type of plankton that is suitable for vaname shrimp farming This type of plankton is a natural source of feed for shrimp, so the growth and development rate of shrimp is relatively high [3]. However, seasonal conditions with high rainfall can reduce the level of diatomous plankton resistance, causing the plankton in the pond to die[4]. Currently, the manual (conventional) method is still being carried out, namely checking by visiting each pond plot carried out by pond farmers. However, due to the large number of pond plots and the distance between plots that are quite far, this method is considered ineffective because it requires a lot of time and energy to check each pond plot one by one. This ineffectiveness certainly takes a lot of time, which can cause less than optimal yields. In addition, the factor of location near the sea makes the location of the pond far from internet infrastructure, so that it does not get adequate telecommunications access coverage. A solution is needed that can overcome the problem of ineffective monitoring in locations with minimal network access, which occurs in vaname shrimp farms. BATMAN. (Better Approach To Mobile Ad-Hoc Network) is a type of proactive routing protocol for wireless ad-hoc mesh networks [5]. The BATMAN [6] protocol package contains only a very limited amount of information and is therefore very small. BATMAN chooses the most reliable route based on the next-hop routing decisions of each node. This method shows that this routing protocol is reliable and loop-free. According to [7] in his research entitled A Simple Pragmatic Approach to Mesh Routing using Batman, which compares the Batman protocol with OLSR, it was found that the Batman routing protocol has a good throughput of 1378.3 s, with a lower delay of 7.62 ms, a little CPU load of about 4%, and low power consumption.

Therefore, in this final project, a Mobile Ad Hoc Network (MANET) will be designed using the BATMAN (Better Approach To Mobile Ad-Hoc Network) Routing Protocol to increase the effectiveness of monitoring salt levels in vaname shrimp ponds. The MANET [8,9] network was chosen because in this network each node functions as a router that can build its own network topology so that it can be easily formed and there is no need for centralized infrastructure in its implementation to relieve pond farmers in maintaining the stability of pond water quickly and efficiently.

Based on the background of the problems that occur in the field as well as the research that has been carried out first, the differences and similarities between this research can be described with the research that has been carried out. The equation is that mobile ad-hoc network is a communication variable. Meanwhile, the difference between this study and existing studies is in the focus of this study, where researchers use the BATMAN routing protocol, which is applied to monitor salinity values in vaname shrimp farms using laptops and orange pi devices.

II. METHOD

A. Research Design

Stages of the research to be carried out are stated by the flow chart shown in Fig. 1.

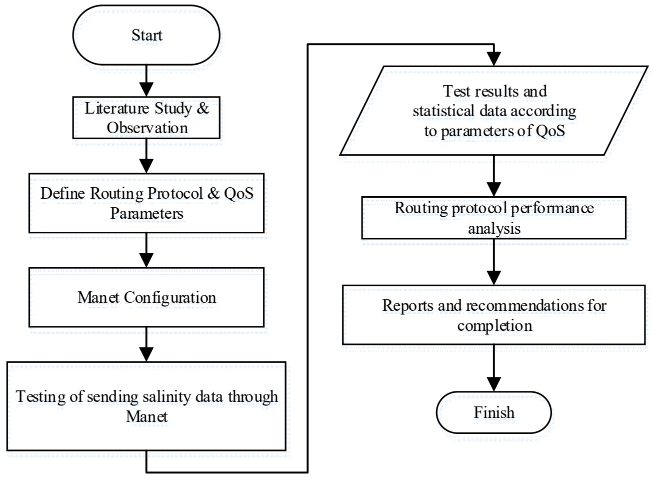

Figure 1. Flowchart of research stages

The explanation of the research design flow chart is as follows:

1. Literature Study & Observation

Literature studies and observations regarding the Manet network, the BATMAN routing protocol and QoS parameters [10] are useful for obtaining sources of information, especially about the routing protocol to be analyzed.

2. Determine the Routing Protocol and QoS Parameters

Determining the routing protocol to be used in this study is the BATMAN Routing Protocol on the Manet network, for the QoS parameter using the TIPHON standard as a comparison value to determine the performance of the protocol on the Manet network for communication of salinity data transmission.

3. MANET Network Configuration [11]

At this stage, manual network configuration is carried out using the BATMAN routing protocol using 4 PC/Laptop units according to the network scenario.

4. Testing

At this stage, a sensor data transmission test was carried out between nodes that had been connected to the Manet network and stamped the QoS parameters using Wireshark [12] software.

5. Test Outcomes

At this stage, the values of delay, jitter [13], throughput, packet loss [14], CPU and memory usage were obtained from testing salinity monitoring on the Manet network.

6. Analysis

Analyze the results of the BATMAN routing protocol performance data on the Manet network to monitor salinity and compare them with the standard QoS value according to TIPHON [15].

7. Report and Finishing Recommendations

At this stage, the preparation of the final report from the data that has been obtained is carried out, which then makes recommendations for improving the quality of the routing protocol to meet user needs.

This testing flowchart explains implementation flow in data retrieval quality of service protocol BATMAN for salinity data transmission that shown in the figure below:

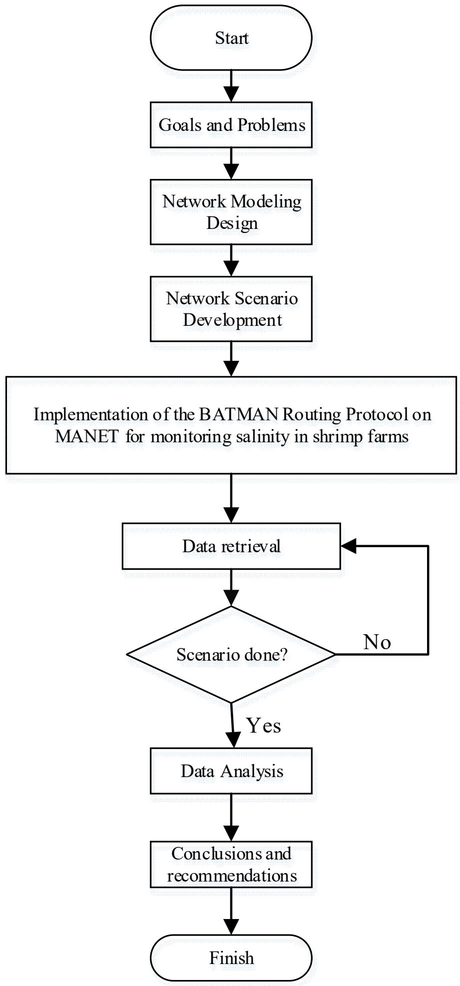

Figure 2. Flowchart of testing stages

The explanation of testing stages flowchart is as follows:

1. Identify Goals and Problems

Identify the goals and problems that occur in the shrimp farms environment. Information was obtained about the constraints of monitoring salt levels in shrimp ponds which took time and energy. Based on the problems that occur in the field, the author plans to create a manet network using the BATMAN routing protocol as an option to save time and effort in monitoring salt levels.

2. Network Modelling Design

Determine network modelling consisting of 4 device nodes connected to the manet network wirelessly, and each device placed in the pond plot is integrated with a salt content conductivity sensor.

3. Network Scenario Determination

At this stage 4 network scenarios for testing are determined. With the placement of each node at a certain distance which aims to test the connection and quality of the Manet network to send salt content data.

4. Implementation of BATMAN Routing Protocol on Manet for Salt Content Monitoring in Vaname Shrimp Ponds

At this stage, a sensor data transmission test was carried out between nodes that had been connected to the Manet network and stamped the QoS parameters using Wireshark software.

5. Data Retrieval

At this stage, the measurement values of garan content, delay value, throughput, packet loss, CPU and memory usage were obtained from testing salt content monitoring on the Manet network using the BATMAN. routing protocol.

6. Data Analysis

Analyze the results of the salt content sensor reading data compared to the refractometer sensor to determine the accuracy of the salt content conductivity sensor reading results, then analyze the performance of the BATMAN routing protocol on the Manet network which includes delay, packet loss, throughput, memory and CPU usage for salt content monitoring and compare it with the standard QoS value according to TIPHON.

7. Making Conclusions and Suggestions

After the analysis is carried out, at this stage conclusion can be made from a series of testing processes, for the subsequent preparation of the final report from the data that has been obtained.

B. System Design

Connection diagram of the network scenario system design is shown in Fig. 3.

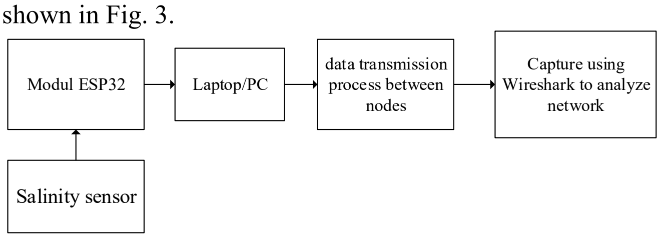

Figure 3. Connection diagram.

Explanation of the connection diagram is as follows:

1. Salinity sensors are used to read water salinity data in shrimp farms.
2. The salinity sensor is connected to the esp32 module as a microcontroller to run the sensor.
3. On laptop/pc performed sensor programming, network interface configuration and activation of BATMAN routing protocol.
4. Then the data transmission process is carried out to test the quality of service manet network and its captured using wireshark software.

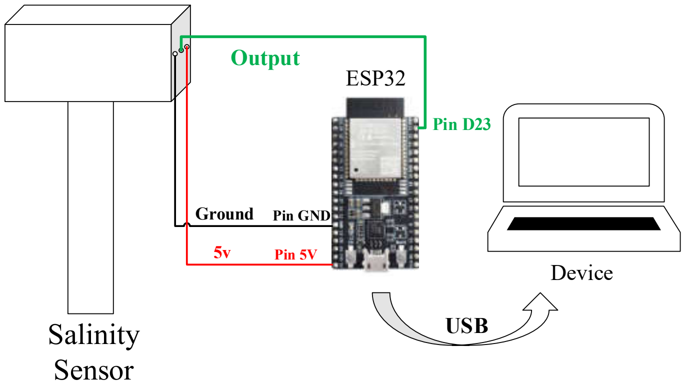

Figure 4. connection scheme diagram of the salinity sensor.

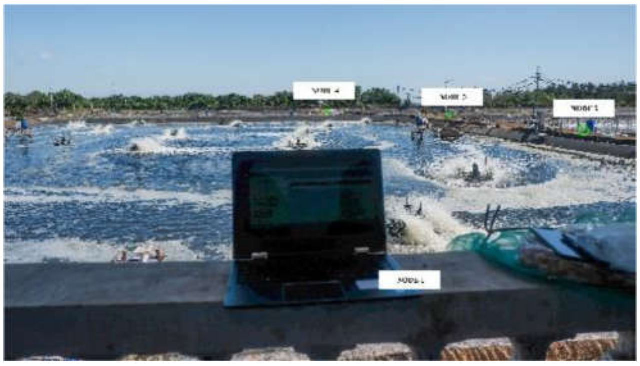

Figure 5. Network test design implementation

Fig. 4 shows connection scheme diagram of the salinity sensor, Fig. 5 shows the block diagram display of the system design, which shows the flow of the test to be carried out. The process of implementing salt level monitoring using a manet network with the BATMAN routing protocol is carried out at the PT. Kalimas Probolinggo. There are 4 devices that are configured using a manet network to connect to each other wirelessly. Then the process of sending salt content data from Node 4 to Node 1 through the manet network is carried out. In the process of exchanging data, the data obtained from the capture of data traffic and CPU & Memory usage.

C. Node Transition Network Scenarios

The design of the test transition scenario will be shown in Fig. 6-9.

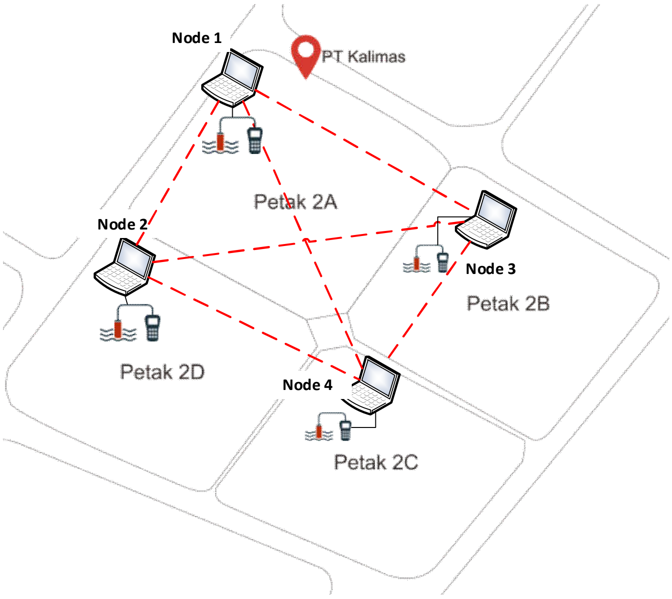

Figure 6. The 1st Scenario Node Transition

In this test, after the activation of the BATMAN routing protocol on the manet network, each pond plot is placed 1 device node. Between nodes are given a distance of 20 meters, then a test of sending salt content data is carried out from node 4 to node 1. The routing protocol BATMAN automatically determines the closest neighbor that has the highest OGM value will be the next hop to go to the next node point so that it is possible to pass.

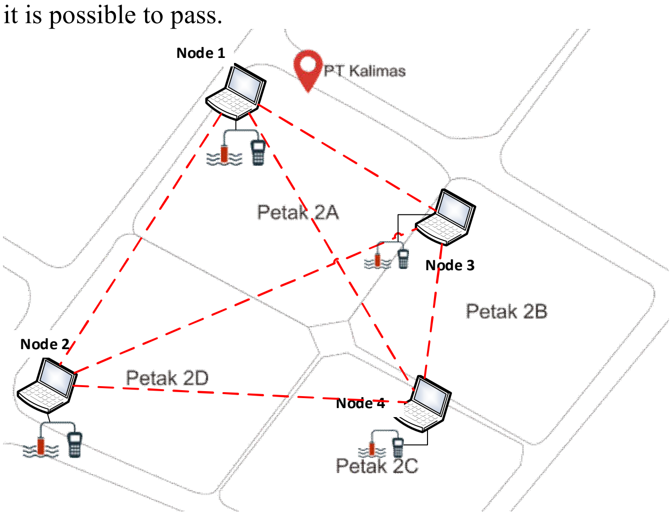

Figure 7. The 2nd Scenario Node Transition

In the transition 2 test scenario, node 2 is shifted 25 m from node 1, node 3 is shifted 16 meters from node 1, and node 4 is 22 meters away from node 1. Then the salt content data is sent from node 4 to node 1, capture the results of network traffic and memory and CPU usage for further analysis and comparison with other scenarios.

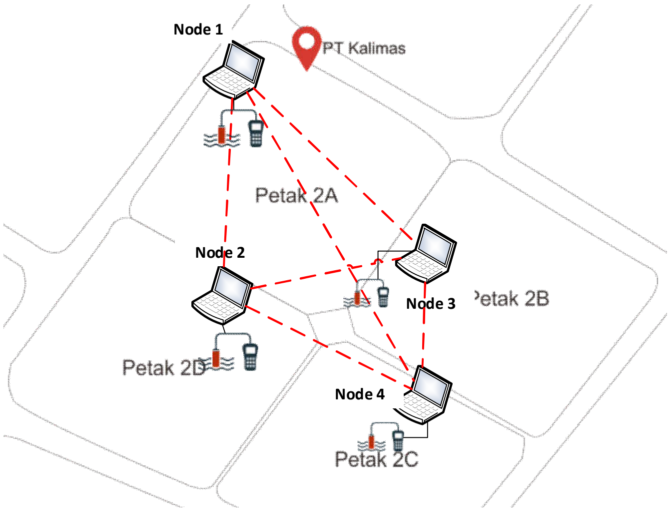

Figure 8. The 3rd Scenario Node Transition

In the transition test scenario 3, node 2 is shifted 14 m from node 1, node 3 is shifted 18 meters from node 1, and node 4 is 26 meters from node 1. Then the salt content data is sent from node 4 to node 1. capture the results of network traffic and memory and CPU usage for further analysis and comparison with other scenarios.

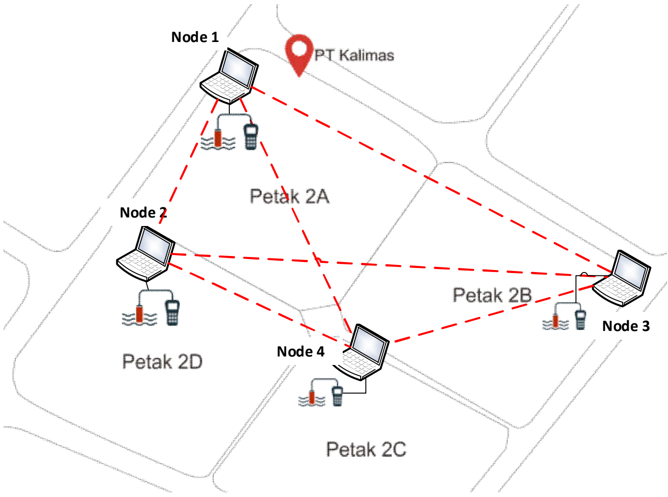

Figure 9. The 4th Scenario Node Transition

In the transition 3 scenario, node 2 is shifted 12 m from node 1, node 3 is shifted 34 meters from node 1, and node 4 is 22 meters away from node 1. Next, a test of sending salt content data from node 4 to node 1 is carried out. Capture the results of network traffic and memory and CPU usage for further analysis and comparison with other scenarios.

The test is done by placing each node in their respective positions according to the test scenario. Then the arduino and python programs are run to retrieve salinity data and store it in an excel file. After that, wireshark software is run to analyze network traffic. then a connection is made between node 1 to node 4 passing through the nearest node to carry out the process of sending salinity data through the manet network with the batman routing protocol. Batman routing protocol that run in each node will automatically select the nearest neighbor to forward the data packet to the destination.

III. RESULTS AND DISCUSSION

The results of manet network testing using batman routing protocol with 1st Scenario Node Transition is shown in Table 1.

TABLE I
RESULTS OF SALINITY MEASUREMENT 1ST SCENARIO

1st Scenario Node Transition			
No.	**Sensor TDS (ppm)**	**Refractometer (ppm)**	**Error percentage (%)**
1.	29	30	3,33%
2.	29	30	0,00%
3.	29	30	3,33%
4.	29	30	3,33%
5.	29	30	0,00%
6.	30	30	3,33%
7.	30	30	0,00%
8.	30	30	0,00%
9.	30	30	3,33%
10.	30	30	3,33%
Percentage of Error			1,67%

TABLE II
RESULTS OF SALINITY MEASUREMENT 2ND SCENARIO

2nd Scenario Node Transition			
No.	**Sensor TDS (ppm)**	**Refractometer (ppm)**	**Error percentage (%)**
1.	30	30	3,33%
2.	30	30	0,00%
3.	29	30	3,33%
4.	29	30	3,33%
5.	29	30	0,00%
6.	30	30	3,33%
7.	30	30	0,00%
8.	30	30	0,00%
9.	30	30	3,33%
10.	30	30	3,33%
Percentage of Error			1,33%

TABLE III
RESULTS OF SALINITY MEASUREMENT 3RD SCENARIO

3rd Scenario Node Transition			
No.	Sensor TDS (ppm)	Refractometer (ppm)	Error percentage (%)
1.	29	30	3,33%
2.	30	30	0,00%
3.	29	30	3,33%
4.	29	30	3,33%
5.	30	30	0,00%
6.	29	30	3,33%
7.	30	30	0,00%
8.	30	30	0,00%
9.	29	30	3,33%
10.	29	30	3,33%
Error percentage			2,00%

TABLE IV
RESULTS OF SALINITY MEASUREMENT 4TH SCENARIO

4th Scenario Node Transition			
No.	**Sensor TDS (ppm)**	**Refractometer (ppm)**	**error percentage (%)**
1.	30	30	3,33%
2.	30	30	0,00%
3.	30	30	3,33%
4.	30	30	3,33%
5.	30	30	0,00%
6.	30	30	3,33%
7.	30	30	0,00%
8.	29	30	0,00%
9.	29	30	3,33%
10.	29	30	3,33%
Percentage of Error			1,00%

Based on testing the data shows of salinity sensors with the four transition scenarios, results were obtained for salinity data at a value of 29-30 ppm, this value was then compared with the refractometer sensor on a display scale that showed a value of 30 ppm, with a value that did not differ much from the average percentage of errors in scenario 1 = 1.67%, scenario 2 = 1.33%, scenario 3 = 2%, and scenario 4=1%. These results show that the output of the salinity TDS sensor used in this study has a stable and accurate value and is close to the value of the calibrator sensor.

TABLE V
DELAY OF BATMAN ROUTING PROTOCOL ON MANET

No.	**Testing**	**Delay (ms)**
1.	1st Transition Scenario	25 ms
2.	2nd Transition Scenario	18.9 ms
3.	3rd Transition Scenario	18,39 ms
4.	4th Transition Scenario	26,85 ms
Average		22,285 ms

In testing with 4 node transition scenarios, the average magnitude of the delay of each scenario 1 was 25 ms, scenario 2 = 18.9 ms, scenario 3 = 18.39 ms, and scenario 4 = 26.85 ms. Delays or packet delays varied due to the process of sending sensor data, the distance between one node to another node was not fixed. However, the routing protocol is able to cover and route nodes well despite the varying distances. When compared to the TIPHON standard, the delay in all four scenarios is still categorized as very good because it is < 150 ms.

TABLE VI
PACKET LOSS OF BATMAN ROUTING PROTOCOL ON MANET

No.	Testing	Packet Loss (%)
1.	1st Transition Scenario	0,999869281 %
2.	2nd Transition Scenario	0,99963028 %
3.	3rd Transition Scenario	0,999725073 %
4.	4th Transition Scenario	0,999813815 %
	Average	0,999759613 %

Based on the results of the calculation of package loss in this test, the percentage of each scenario was 1 = 0.999869281 %, scenario 2 = 0.99963028 %, scenario 3 = 0.999725073 %, and scenario 4 = 0.999813815 % with an average below 3% where this is categorized as very good. The low percentage of packet loss even with varying distance testing is influenced by the relatively small size of the data packets sent and the low delay so that the percentage of packets lost is also low.

TABLE VII
THROUGHPUT OF BATMAN ROUTING PROTOCOL ON MANET NETWORK

No.	Testing	Throughput (%)
1.	1st Transition Scenario	11457,76 bps
2.	2nd Transition Scenario	5847,06 bps
3.	3rd Transition Scenario	4200,55 bps
4.	4th Transition Scenario	7881,70 bps
	Average	7346,76 bps

Based on the calculation of throughput values in tests that have been carried out, throughput analysis in 4 node transition scenarios was 11457.76 bps, 5847.06 bps, 4200.55 bps, and 7881.70 bps, respectively, with an average throughput of 7346.76 bps. This value is in the excellent category according to the TIPHON QoS standard, which is above 100 bps.

TABLE VIII
RESULT OF CPU & MEMORY USAGE OF BATMAN ROUTING PROTOCOL ON MANET (1ST NETWORK TRANSITION SCENARIO)

1st Scenario Node Transition		
No.	**CPU (%)**	**Memory (%)**
1.	0.7 %	0.2 %
2.	0.7 %	0.2 %
3.	0.7 %	0.2 %
4.	0.7 %	0.2 %
5.	0.7 %	0.2 %
6.	0.7 %	0.2 %
7.	0.7 %	0.2 %
8.	0.7 %	0.2 %
9.	0.7 %	0.2 %
10.	0.7 %	0.2 %
Average	0.7%	0.2 %

TABLE IX
RESULT OF CPU & MEMORY USAGE OF BATMAN ROUTING PROTOCOL ON MANET (2ND NETWORK TRANSITION SCENARIO)

2nd Scenario Node Transition		
No.	**CPU (%)**	**Memory (%)**
1.	0.5 %	0.2 %
2.	0.5 %	0.2 %
3.	0.5 %	0.2 %
4.	0.5 %	0.2 %
5.	0.5 %	0.2 %
6.	0.5 %	0.2 %
7.	0.5 %	0.2 %
8.	0.5 %	0.2 %
9.	0.5 %	0.2 %
10.	0.5 %	0.2 %
Average	0.5 %	0.2 %

TABLE X
RESULT OF CPU & MEMORY USAGE OF BATMAN ROUTING PROTOCOL ON MANET (3RD NETWORK TRANSITION SCENARIO)

3rd Scenario Node Transition		
No.	**CPU (%)**	**Memory (%)**
1.	1.0 %	0.3 %
2.	1.0 %	0.3 %
3.	1.0 %	0.3 %
4.	1.0 %	0.3 %
5.	1.0 %	0.3 %
6.	1.0 %	0.3 %
7.	1.0 %	0.3 %
8.	1.0 %	0.3 %
9.	1.0 %	0.3 %
10.	1.0 %	0.3 %
Average	1.0 %	0.3 %

TABLE XI
RESULT OF CPU & MEMORY USAGE OF BATMAN ROUTING PROTOCOL ON MANET (4TH NETWORK TRANSITION SCENARIO)

4th Scenario Node Transition		
No.	**CPU (%)**	**Memory (%)**
1.	0.7 %	0.3 %
2.	0.7 %	0.3 %
3.	0.7 %	0.3 %
4.	0.7 %	0.3 %
5.	0.7 %	0.3 %
6.	0.7 %	0.3 %
7.	0.7 %	0.3 %
8.	0.7 %	0.3 %
9.	0.7 %	0.3 %
10.	0.7 %	0.3 %
Average	0.7 %	0.3 %

The percentage of memory and CPU usage used when the routing protocol is running is relatively low, namely in scenario 1 the average memory usage is 0.2%, CPU usage is 0.7%. In scenario 2 the average memory usage is 0.1%, CPU usage is 0.5%. Scenario 3 with average memory usage of 0.3%, CPU usage of 1.0%. and scenario 4 average memory usage of 0.3%, with CPU usage of 0.7%. The overall average CPU usage is

0.725% and memory usage is 0.25%. Average memory usage is low because nodes do not process data packets but only forward packets.

IV. CONCLUSION

Based on the analysis of the results of the implementation of the Manet Network test using the BATMAN routing protocol for monitoring salt levels in Vaname shrimp ponds, it is known that the manet network can be applied as a means of communication for monitoring salt levels in vaname shrimp ponds. It can be seen from the results of the data readings of the salinity sensor obtained quite accurately with an average error percentage of 1%. Based on network quality analysis from 4 test scenarios obtained an average delay of 22.285 ms, jitter below 0 -5.144 ms, percentage of packet loss of 0.999759613%, throughput of 7346.76 bps, and average CPU and memory usage of 0.725% and 0.25%, respectively. This result belongs to the category of excellent according to TIPHON standards. So based on the tests and analysis that have been carried out, it was concluded that manet with the routing protocol can be used as an alternative communication to increase the effectiveness of salinity monitoring, as well as being able to provide communication network services in areas where there is no fixed network infrastructure. In future research, the number of nodes can be expanded to cover a wider pond area, and it can be developed using other newer types of routing protocols.

REFERENCES

[1] W. Soemardjati and A. Suriawan, "Petunjuk Teknis Budidaya Udang Vannamei Litopenaeus vannamei di Tambak," *Departemen Kelautan dan Perikanan, Direktorat Jenderal Perikanan Budidaya. Balai Budidaya Payau Situbondo,* pp. 12-16, 2007.

[2] C. E. Boyd, "Water Quality Management for Pond Fish Culture," *Department of Fisheries and Allied Aquacultures,* pp. 207-209, 1982.

[3] A. Sahrijanna and Sahabuddin, "KAJIAN KUALITAS AIR PADA BUDIDAYA UDANG VANAME (Litopenaeus vannamei) DENGAN SISTEM PERGILIRAN PAKAN DI TAMBAK INTENSIF," *Prosiding Forum Inovasi Teknologi Akuakultur,* pp. 313-320, 2014.

[4] L. A. Kurniawan, M. Arief, A. Manan and D. D. Nindarwi, "PENGARUH PEMBERIAN PROBIOTIK BERBEDA PADA PAKAN TERHADAP RETENSI PROTEIN DAN RETENSI LEMAK UDANG VANAME (Litopenaeus vannamei)," *Journal of Aquaculture and Fish Health,* vol. 6, pp. 32-40, 2016.

[5] A. Neumann, C. Aichele, M. Lindner and S. Wunderlich, "Better approach to mobile ad-hoc networking (BATMAN)," 30 March 2008. [Online]. Available: https://www.researchgate.net/publication/32017246.

[6] D. T. Nugrahadi, M. R. Faisal, L. Triyasmono and M. Janawi, "Dampak dari Parameter Variasi Koneksi, Node dan Kecepatan Node Terhadap Delay pada Routing Protocol AODV dan BATMAN Jaringan MANET," *Jurnal Komputasi ,* vol. Vol 8 No. 2, pp. 10-22, 2020.

[7] D. Johnson, N. Ntlatlapa and C. Aichele, "A simple pragmatic approach to mesh routing using BATMAN," pp. 1-10, 2008.

[8] O. B. Rhaiem, L. C. Fourati and A. Masmoudi, "Content-Centric-Network-based MANET for streaming video transmission," *IEEE International Conference on Computer and Information Technology; Ubiquitous Computing and Communications,* pp. 1022-1027, 2015.

[9] S. Basagni, M. Conti, S. Giordano and I. Stojmenovic, MOBILE AD HOC NETWORKING, Canada: IEEE Press, 2004.

[10] A. Kaur, "AN OVERVIEW OF QUALITY OF SERVICE COMPUTER NETWORK," *Indian Journal of Computer Science and Engineering (IJCSE),* vol. 2, pp. 470-475, 2011.

[11] E. E. Lawrence and L. Ramavel, Fundamentals of Mobile Ad hoc Network, Tamilnadu: Bonfring, 2016.

[12] "WIRESHARK," wireshark.org, [Online]. Available: https://www.wireshark.org/. [Accessed 26 March 2022].

[13] I. Media, "IR Jitter," [Online]. Available: https://www.ir.com/guides/what-is-network-jitter#:~:text=Jitter%20is%20the%20variation%20in,received%20over%20a%20network%20connection.. [Accessed 04 04 2022].

[14] I. Media, "IR Packet Loss," [Online]. Available: https://www.ir.com/guides/what-is-network-packet-loss#:~:text=Packet%20loss%20describes%20lost%20packets,dropped%20packets%20during%20data%20transmission.. [Accessed 03 04 2022].

[15] ETSI, "ETSI TR 101 329-7 V2.1.1 (2002-02)," ETSI, France, 2002.