QOS Analysis of Routing Protocol Babel on Mobile Ad-Hoc Network (MANET)

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Abstract. The unequal access to internet communication infrastructure in most parts of Indonesia can cause difficulties for people in the area to communicate. As an alternative communication, the mobile ad-hoc network requires a reliable routing algorithm. Quality of service is vital to address the problem of communications in the mobile ad-hoc network. This study analyzes the quality of service routing protocol babel on a mobile ad-hoc network. Test carried out using 3 scenarios, namely testing feasibility condition, self-healing, and delay, jitter, packet loss, and throughput on multihop condition. Values delay and jitter generated by the scenario testing conducted according to the standards TIPHON into the category of a very good and good. In the packet loss data capture value generated by the scenario testing conducted according to the standards TIPHON into the category of good and bad, but most of the values obtained into the bad category. At throughput data capture value generated by the scenario testing conducted according to the standards TIPHON into the category of good, medium and bad but mostly the value obtained in the category of good.

1. Introduction

Based on a survey from the Indonesian Internet Service Providers Association (APJII), internet user penetration in Indonesia reached 64.8%, where the percentage includes 143.26 million users from 262 million Indonesians. However, the majority of internet user contributors are still found in Java (55%) and Sumatra (21%). Whereas for regions outside Java and Sumatra, they still have low penetration (<10%). The unequal access to internet communication infrastructure in most parts of Indonesia can cause difficulties for people in the area to communicate. On the other hand, disasters can also cripple or destroy communication infrastructure, be they earthquakes, floods, or tsunamis, where people exposed to such hazards will find it difficult to communicate outside the affected area. One solution that can overcome these communication problems is to create a wireless communication infrastructure that can be used in rural areas or extreme conditions such as natural disasters and war as alternative communication media. One alternative form of communication is the Mobile Ad-Hoc Network (MANET).

Development of wireless communication networks began since the discovery of Maxwell’s equation which shows that data transmission can occur without the need for cables. Signals emitted in the air can be a medium for delivering information, even being a cheaper medium than cable media[1]. In reality, the use of MANET can be assumed to be a “relationship anywhere and anytime”, which is why the implementation of MANET is beneficial in various fields of application such as disaster recovery, victim search and rescue, communication on the battlefield, educational needs, entertainment, robots, and sensor networks [2]. The rapid development of wireless technology, the smaller volume of batteries in
accommodating the electric current, and the development of wireless chips that are smaller but with
good signal strength, Mobile Ad-Hoc Network (MANET) emerged as a result of the development of the
superior technology. MANET is one of the infrastructures of the Internet OF Things[3]. By utilizing
a single board computer as a node in MANET, MANET can be built as a mobile network [4]. MANET
can be a collection of mobile communication devices running on inadequate infrastructure and the
absence of a predetermined liaison or router [5].

Even though MANET is flexible as secondary communication, the MANET network has some lack of
Routing, Security and Reliability, Quality of Service, Internetworking, and Power Consumption. Nodes
in MANET generally always move, existing wireless communication will often be disconnected and
then reconnected. Apart from that, most of the nodes in MANET have limitations in computational
capability and power source resources such as batteries. Therefore it is necessary to adjust the routing
protocol for nodes in MANET. For optimal utilization, MANET requires a reliable routing algorithm so
that the data packets sent by the source node can be received in full by the destination node. Adaptation
to network conditions that are not too fixed can be handled by reactive, proactive, or hybrid routing
methods. BABEL is included in the proactive routing protocol. Babel is a distance vector routing
protocol that has fast convergence and fast route repair time performance [6]. BABEL is designed to
make flexible route choices. Babel uses a feasibility condition that guarantees no routing loop. The
router will ignore the renewal of the route that does not meet the feasibility condition [7]. However,
despite its convergence speed, Babel has the most significant frequency of route changes than BATMAN
and OLSR routing[8].

Babel is designed to make flexible route choices. Babel uses a feasibility condition that guarantees
no routing loop. The router will ignore the renewal of the route that does not meet the feasibility
condition [9]. Babylon can also be called a hybrid routing protocol, in the sense that it can carry routes
for several network-layer protocols (IPv4 and IPv6) [6]. Quality of Service (QoS) is essential to
overcome communication problems in MANET. QoS refers to the ability of networks to provide better
services on specific network traffic through different technologies. The primary purpose of the QoS
parameters is to provide priorities including appropriate bandwidth, control jitter, latency and correct
loss characteristics [10]. Implementing QoS on an ever-changing network is a challenge. Resources
owned by MANET are limited. Therefore QoS is needed to measure the quality of communication with
these limited resources [11].

2. Research Method
In this study, we measure the Quality of Service in the MANET design using the Babel routing protocol
that is using raspberry as nodes in the MANET network. The general process of the proposed model
described in Figure 1.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Proposed model}
\end{figure}
3. Analysis software and hardware requirements for building MANET nodes

In this section, we will describe the analysis of software and hardware used in our research to build the MANET network. This section divided into three subsections, i.e., system planning, hardware design, and software design.

3.1. System Planning

In general, a system must have an input, process, and output. As shown in Figure 2, as input functions are data traffic, as the processing device is Single Board Computer (SBC) and Notebook with Babel routing protocol installed, and the output is Quality of Service analysis.

![Figure 2. System planning for building MANET nodes](image)

3.2. Hardware Design

As mentioned before, this section will describe the hardware design. The hardware used in this research are Notebooks, Single Board Computer, Micro SDHC Card, Wifi Dongle Ralink RT5370, and Power Bank. The notebook used to store data and operating systems, and the notebook also has a wireless interface that used as a transceiver, receiver, and router. Single Board Computer requires a Micro SDHC Card to store operating systems and data storage. Single Board Computer nodes are installed as a wireless device to build a MANET network that functions to connect with other nodes. Single Board Computer as a dynamic node in MANET requires resources that can take anywhere, Power Bank as resource storage has a flexible nature that can be taken anywhere so that it is suitable for use in this test.

3.3. Software Design

Software design section will describe the software used in this research, such as babel routing protocol.

3.3.1 Babel routing protocol

The process of installing the babel routing protocol requires packages that must be installed first. Babel routing protocol is suitable for use on Single Board Computers because it only requires a small CPU and memory requirements. The following algorithm from the Babel routing protocol:

- Detect all links that are connected inside the node
- Record all link information in the routing table
- The routing table owned by each router will contain the network address that is directly connected to the router.
- Periodically, each router exchanges information so that the contents of the routing table are entirely filled (converged)
- If there is a change in network topology, the router will immediately update the routing information.
- Periodically update every router.
- If the location of the router is far or remote, it will take a long time to receive information about network changes at a location.
- Tell each link connected in the node to the neighbour node.
4. Experiments and Results

4.1. Experimental Setup
After designing the MANET node, which consists of hardware and software design, then the formation of MANET, if the device was located in the wireless signal coverage area of the device, will be synchronized. This experiment conducted in three scenarios i.e., three nodes, four nodes and five nodes, which each scenario will send 2000, 2500, and 3000 bytes of data. The formation of each scenario can be seen in Figure 3.

![Scenario I](image1)
![Scenario II](image2)
![Scenario III](image3)

Figure 3. Block diagram of the formation of MANET

4.2. Experimental scenario
After the system is prepared, the next process is to test. Each node has a wifi dongle installed, and each node is connected to other nodes within the coverage signal range of 10 to 15 meters. Quality of Service parameters that will be observed is a delay, jitter, packet loss, and throughput. Delay is a time delay in the process of transferring packets from the source packet to its destination that passes through a series of nodes. Jitter is the variation of delay between packets that occur on an IP network. Packet loss can be defined as packet loss in the network[12]. Throughput is the rate (rate) of effective data transfer, measured in bps. This throughput can be measured after data transmission occurs[13]. Testing delay, jitter, packet loss, and throughput in a multihop condition where not all nodes are connected directly to all other nodes but must go through individual nodes that are considered as neighbours with the best link quality. In the testing of delay, jitter, packet loss, and multihop throughput conditions which is divided into three scenario, namely multihop testing with three nodes, four nodes, and five nodes. This test is essential because to see the ability of the Babel routing protocol in multihop conditions. The nodes for first scenario are node IP 192.168.10.12, node IP 192.168.50.16, and node IP 192.168.60.17, second scenario are IP node 192.168.10.12, IP node 192.168.30.14, and IP node 192.168.60.17, and the third scenario are IP node 192.168.10.12, IP node 192.168.30.14, and IP node 192.168.50.16.

4.3. Experiments results and Analysis
The results of this research based on the TIPHON standard is obtained from the analysis process on the results of the average UDP (User Datagram Protocol) data values that have been given varying network loads using predetermined network topology scenarios. It is known that the TIPHON (Telecommunications and Internet Protocol Harmonization Over Networks) standard has a standard with QoS parameters as a whole[14]. The results of the analysis are in Table 1, which has been obtained from the tests that have been carried out compared with the TIPHON standard provisions so that conclusions can be drawn from the tests that have been done. In Table 1, it can be seen that several parameters are included in the category of very good and good according to TIPHON standards.
Table 1. Quality of Service results with four-parameter (Delay, Jitter, Packet Loss, and Throughput).

| Parameter QoS | Scenario | Workload (byte) | Average results | TIPHON Standart |
|---------------|----------|-----------------|-----------------|-----------------|
|               | 1 (3 node) | 2000            | 3.53            | Very Good       |
|               |          | 2500            | 4.76            | Very Good       |
|               |          | 3000            | 4.49            | Very Good       |
| Delay (ms)    | 2 (4 node) | 2000            | 3.77            | Very Good       |
|               |          | 2500            | 4.63            | Very Good       |
|               |          | 3000            | 6.53            | Very Good       |
|               | 3 (5 node) | 2000            | 3.83            | Very Good       |
|               |          | 2500            | 4.93            | Very Good       |
|               |          | 3000            | 10.63           | Very Good       |
| Jitter (ms)   | 1 (3 node) | 2000            | 4.67            | Good            |
|               |          | 2500            | 5.06            | Good            |
|               |          | 3000            | 6.43            | Good            |
|               | 2 (4 node) | 2000            | 4.70            | Good            |
|               |          | 2500            | 5.06            | Good            |
|               |          | 3000            | 6.50            | Good            |
|               | 3 (5 node) | 2000            | 6.67            | Good            |
|               |          | 2500            | 13.10           | Good            |
|               |          | 3000            | 20.28           | Good            |
| Packet loss (%) | 1 (3 node) | 2000            | 3.85            | Good            |
|                |          | 2500            | 13.86           | Good            |
|                |          | 3000            | 25.39           | Bad             |
|                | 2 (4 node) | 2000            | 7.95            | Good            |
|                |          | 2500            | 35.14           | Bad             |
|                |          | 3000            | 45.40           | Bad             |
|                | 3 (5 node) | 2000            | 35.25           | Bad             |
|                |          | 2500            | 66.60           | Bad             |
|                |          | 3000            | 74.05           | Bad             |
| Throughput (%) | 1 (3 node) | 2000            | 80.58           | Good            |
|                |          | 2500            | 60.88           | Medium          |
|                |          | 3000            | 50.28           | Medium          |
|                | 2 (4 node) | 2000            | 47.66           | Bad             |
|                |          | 2500            | 59.16           | Good            |
|                |          | 3000            | 79.98           | Good            |
|                | 3 (5 node) | 2000            | 56.38           | Good            |
|                |          | 2500            | 39.28           | Bad             |
|                |          | 3000            | 35.32           | Bad             |

The comparison results shown in Table 1 is the Babel QoS routing protocol on the Mobile Ad-hoc Network with the TIPHON standard; the results are as follows:

- In scenarios 3, 4, and 5 nodes with a load of 2000 bytes, 2500 bytes, and 3000 bytes, the delay is included in the very good category.
- In scenarios 3, 4, and 5 nodes with a load of 2000 bytes, 2500 bytes, and 3000 bytes, jitter is included in the good category.
- In the scenario of 3 nodes with a load of 2000 bytes and 2500 bytes, packet loss is included in the good category. In the scenario of 3 nodes with a load of 3000 bytes, packet loss is included in the ugly category. In the scenario of 4 nodes with a load of 2000 bytes, packet loss is included in the good category. In the scenario of 4 nodes with a load of 2500 bytes and 3000 bytes, packet loss is included in the bad category.
loss is included in the ugly category. In the scenario of 5 nodes with a load of 2000 bytes, 2500 bytes, and 3000 bytes, packet loss is included in the ugly category.

- In the scenario of 3 nodes with a load of 2000 bytes, throughput is included in the good category. In the scenario of 3 nodes with a load of 2500 bytes and 3000 bytes, throughput is included in the medium category. In a scenario of 4 nodes with a load of 2000 bytes, throughput is included in the ugly category. In the scenario of 4 nodes with a load of 2500 bytes and 3000 bytes, throughput is included in the good category. In the scenario of 5 nodes with a load of 2000 bytes, throughput is included in the good category. In the scenario of 5 nodes with a load of 2500 bytes and 3000 bytes, throughput is included in the ugly category.

5. Conclusion
The results of the throughput, delay, jitter, and packet loss above are good because the loop-free characteristics of the babel also influence to avoid unnecessary waste of bandwidth. The characteristics of fast route repair also cause the results of good throughput, delay, jitter, and packet loss. Following the characteristics of MANET, i.e., bandwidth limitations, links on wireless networks tend to have low capacity when compared to wired networks. The effect that occurs on low capacity networks is congestion; variations will significantly influence the bad value of throughput, delay, jitter, and packet loss in traffic load and the amount of congestion in IP networks. The higher the traffic load on the network will cause, the higher the chance of congestion so that the value of throughput, delay, jitter, and packet loss will be increased. The characteristic of MANET, which has a dynamic topology, also causes the distance of connection points that are far away and requires other nodes to communicate or multihop, allowing the weak value of throughput, delay, jitter, and packet loss. Furthermore, in the MANET characteristic is autonomy, so that it burdens the node's performance. Even so, testing the actual conditions, of course, various other factors can affect the reduced throughput, delay, jitter, and packet loss obtained, especially concerning the tools and conditions of the test site.

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