



QUALITY OF SERVICE ANALYSIS OF ROUTING PROTOCOLS BABEL AND BATMAN IN A RASPBERRY AD-HOC NETWORK

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ABSTRACT

An Ad-Hoc network with five nodes is implemented using SBC (Single Board Computer) to measure its quality of service (QoS) parameters, comparing the efficiency of the BABEL and BATMAN (Better Approach To Mobile Ad-hoc Networking) protocols in real applications, some scenarios are initially proposed, the five nodes will be in rest, then they will be separated at a distance greater than two meters, finally one will be in motion. Parameters such IPTD, IPLR, IPDV and IPER will be identified to be compared and the document finalized.

Keywords: routing protocols, quality of service, Ad-Hoc network.

INTRODUCTION

For International Mobile Telecommunications (IMT) access to different services and applications based on IP must be supported by the fixed-mobile convergence (FMC) that supports a wide range of data speeds, different quality of service requirements proportional to mobility, in an environment with multiple users [1]. Here the routing is one of the most important areas in the interconnection, it is essential for an Ad-Hoc network of multiple jumps. Not many studies or researches have compared the performance of routing protocols in real environments and using low cost hardware, those that have done are based on industrial devices which are difficult to access.

This study carries out the implementation and measurement of quality of service parameters of the BABEL and BATMAN protocols in low-cost cards, achieving a correct performance in the different nodes. In future technological generations, multi-hop wireless networks will have a fundamental role, since the Fifth Generation (5G) will take the best of past technologies and allow the evolution of decentralized networks as a different approach, where small cells will densify the diffusion of information and, as not always depend on the same access point, it will provide scenarios for Device to Device (D2D) communications. The above allows mobile devices to treat local traffic and then, relay this information to a base station, during this transition, the role of routing protocols will be fundamental [2].

For instance, the BABEL and BATMAN protocols have been compared in real scenarios as in [3] taking into account the performance of multi-hops and the capacity of each routing protocol to recover from link failures. The results showed that the BATMAN protocol achieves the highest level of stability and package delivery, while the BABEL protocol offers more bandwidth in multi-hops and the route repair time is faster.

In [4] traditional routing protocols proved to be inadequate in ad hoc wireless networks, which motivated

the necessity for specific ad hoc routing protocols. The results show that the BABEL protocol exceeds the BATMAN protocol. These have also been tested in simulation environments such as [5] where it was evidenced that the results obtained in a simulation environment, sometimes they are not valid in a real site.

The BABEL protocol has higher Throughput than the BATMAN protocol, therefore, it is a suitable protocol for a network that requires high data rates. In addition, these protocols have been used in a simulator as a protocol for disaster networks, in [6] the evaluation was carried out using a virtual environment in order to obtain results similar to the expectations of a real-world test bank. The results obtained showed that none of the protocols is appropriate for large networks, with the exception of the BABEL protocol, that can be modified to support a large number of clients and routers.

QoS PARAMETERS

The International Telecommunication Union on its recommendation Y1540 [7], Defines the parameters that can be used to evaluate the performance and, which are mentioned below:

- **IP packet transfer delay (IPTD):** Time between the arrivals of two IP packets at their destination.
- **IP Packet Loss Ratio (IPLR):** Relationship between the total of lost IP packets and total packets that were transmitted.
- **IP Packet Delay Variation (IPDV):** Difference of delay between the selected packets in a single direction of the way - one-way delay.
- **IP Packet Error Ratio or IPER:** Rate of packets with errors.

The ITU recommendation Y.1541 defines a number of QoS classes for the different services as shown in Table-1.

**Table-1.** QoS Classes [5].

QoS parameter	QoS Class					
	0	1	2	3	4	5
IPTD	100ms	400ms	100ms	400ms	1s	U
IPDV	50ms	50ms	U	U	U	U
IPLR	1x10 ⁻³	U				
IPER	1x10 ⁻⁴					U

BABEL PROTOCOL

Babel is a protocol that uses a technique based on distance vector, inspired by AODV protocols (Ad hoc On Demand Distance Vector), DSDV16 (Destination Sequenced Distance Vector) and EIGRP17 (Enhanced Interior Gateway Routing Protocol) Cisco to route packets in a mesh network. It works with IPv4 and IPv6 and was originally designed for ad-hoc wireless networks, so it is a very heavy protocol in the presence of mobile nodes, preventing the formation of endless loops and offering a fast convergence [8].

BATMAN PROTOCOL

BATMAN in none node has the complete information about the network topology. Instead, to build its routing table, store the best direction to reach each node. For each wireless link in a hop the arriving packets from each node are counted. The link through which more packets arrive from a specific node, will be the best link to send packets to that node [8].

IMPLEMENTATION OF PROTOCOLS

The configuration and addressing of the WLAN and Ethernet interfaces associated with the nodes are performed, then, the protocols in each one of the Raspberry are installed and started, when capturing traffic with the Wireshark software the protocols work correctly and the nodes send Streaming content to each other. Figure-1 shows the scenario used.

The used cards correspond to the following references:

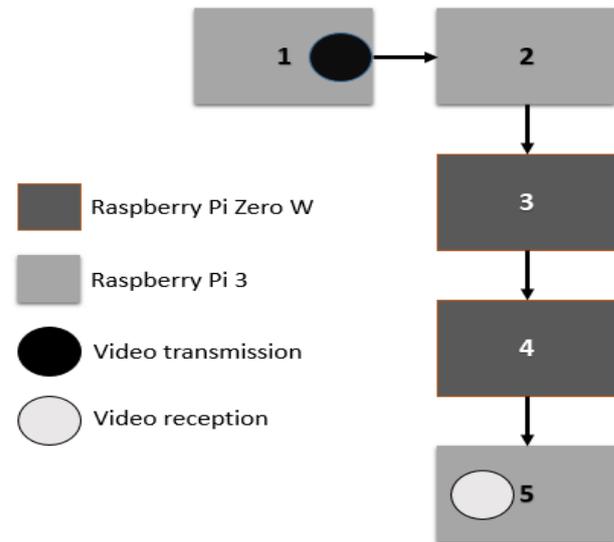
- Raspberry pi zero W (3 nodes).
- Raspberry Pi 3 (2 nodes).

Three scenarios were implemented as follows:

- Static nodes separated by less than one meter each one (scenario1).
- Static nodes two meters separated each one (scenario 2).
- One node in motion and four static nodes (scenario 3).

The aspects to evaluate in each one are:

- IPTD
- IPDV
- IPLR
- IPER

**Figure-1.** Block diagram.

RESULTS

When comparing the QoS results of the two protocols (BABEL, BATMAN) and despite being wireless networks, the results obtained in scenarios 1 and 2 (Figures 2 and 3) are appropriate for a stable operation in general, these protocols have an almost negligible IPER and for that reason, they are cataloged in class 2 of QoS [5]. The variations are observed until the result of scenario 3 (Figure-4), when a single node is in movement and when there is any change of route the network takes longer to transmit packets, affecting its QoS parameters directly without considering the protocol. It is clearly seen in the graphic that the BATMAN protocol has a delay (IPTD) that greatly exceeds BABEL (more than four times) so this negatively affects the performance of the protocol and, its QoS parameters.

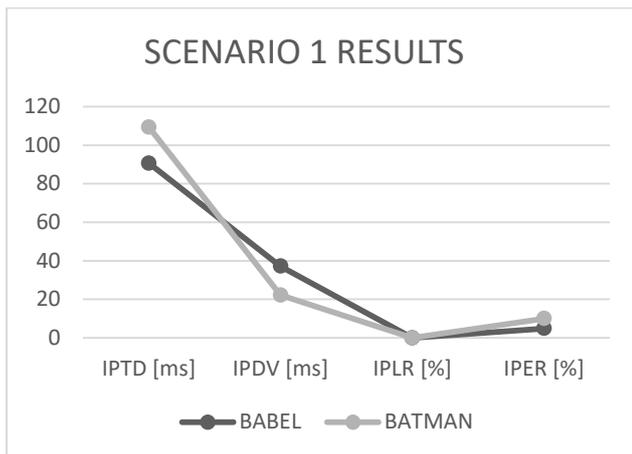


Figure-2. Results scenario 1.

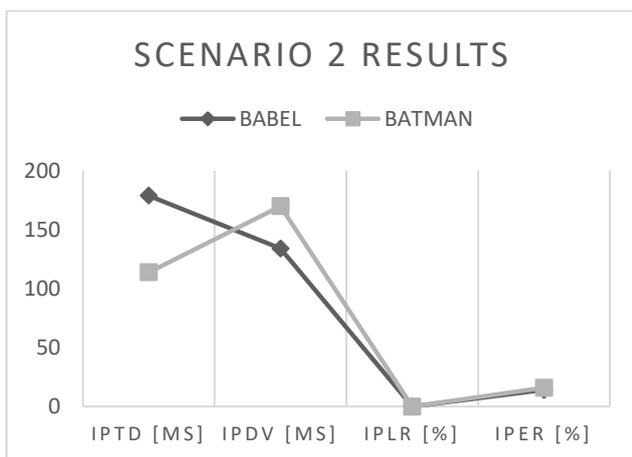


Figure-3. Results scenario 2.

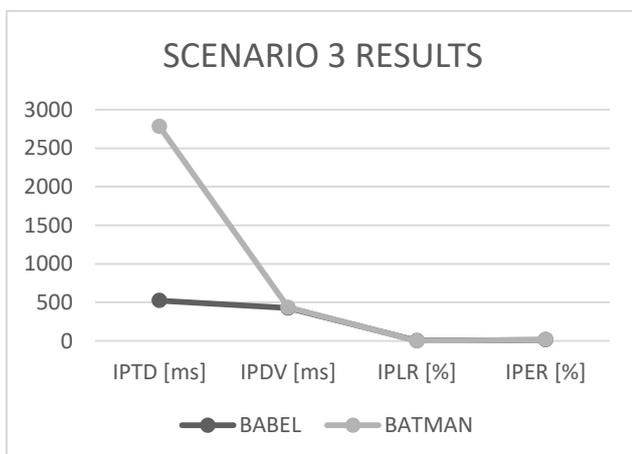


Figure-4. Results scenario 3.

CONCLUSIONS

Considering that the used Raspberry nodes are learning technologies to a large extent and, this type of devices cannot be compared with a real router because of they cannot be implemented to a Backbone network, due to the limitations of the network card, it could consider implementation for home networks, whose information management is not critical but rather informative,

providing the integration of this kind of technology in the future technological generations.

In general, BABEL and BATMAN protocols behave very similar in two of the three scenarios. The results of the protocols are acceptable, achieving classifying the second class of QoS parameters, therefore, the work cited in [6] whose conclusion is to combine different routing protocols to improve the performance of large-scale networks.

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