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# Comparison and Analysis Study between AODV and DSR Routing Protocols in VANET with IEEE $802.11_b$

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## Abstract

Mobile Ad-Hoc networks (MANET) have become related to several aspects in human life while normal users uses the wireless mobile systems without prior knowledge about how such systems works. In order to support the mobility in MANETs, the routing protocols are needed to handle the data transmission between the wireless nodes from a source to destination. Ad-Hoc On demand Distance Vector (AODV) and Dynamic Source Routing (DSR) is a popular routing protocols used in MANET. Vehicular Ad-Hoc Networks (VANET) is a special type of MANET which is used to support the high mobility between moving cars on the roads. In this paper the AODV and DSR are applied on a VANET over two different scenarios, dense and sparse traffic based on cars density on the road, and then both protocols are evaluated based on different performance metrics.

***Keywords:*** *AODV, DSR, MANET, VANET*

## 1. Introduction

A computer network is an interconnected collection of autonomous computers. Recently, there has been tremendous growth in the sales of laptop and mobile computers. Moreover, many of these small computers operate for hours with battery power, users are free to move about at their convenience without being constrained by wires. MANET is a set of wireless nodes or devices that connects to each other as peer to peer without server devices and without any previous connection establishment processes. MANET has many characteristics to make it different than wired networks, the main characteristic in MANET that it does not have a fixed network topology because of its dynamically moving nodes, for that reason, MANET has a different routing protocols than any other networks types [6][7][8][9][10]. MANET have a different set of routing protocols in order to carry the packets from source to destination, the routing protocols in MANET are divided into two main categories: Proactive and Reactive. The Proactive routing protocols is table driven protocols while the Reactive is on demand protocols. VANET is a special type of MANET which have its own special characteristics such as the high mobility rate which leads to high topology changes. The goal of the research is to study the impact of AODV and DSR on VANET while using the well-known IEEE 802.11 WIFI standard. The analysis study will be done on four performance

metrics: Packet Delivery Ratio, End-to-End Delay and Throughput and total send-received packets [1].

## 2. Routing Protocols in MANET

Routing protocols is used to transfer the packets from source to destination node. In ad-hoc networks such protocols is different than routing protocols in LANs, because the nature of ad-hoc networks which have a mobile nodes that change the topology very frequently there are several types of routing protocols that proposed for such manner. In ad-hoc networks the routing protocols are classified into three main categories: Proactive, Reactive and Hybrid between proactive and reactive [1][8]. The proactive routing protocols is called also “Table Driven”, in proactive protocols such as the Destination Sequenced Distance Vector (DSDV) each node only needs to know the next hop to the destination, and how many hops away the destination, this information stored in each node and it is arranged in a table, hence the term “table driven routing”, while the reactive protocols such as AODV and DSR seek to set up routes on-demand, if a node wants to initiate communication with a node to which it has no route, the routing protocol will try to establish such a route.

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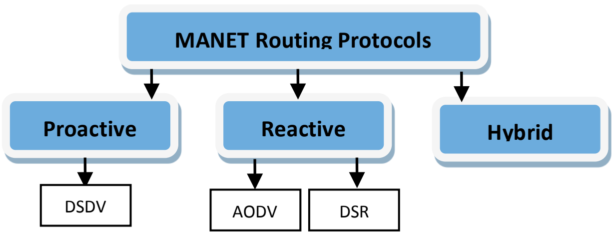


**Fig. 1. Routing Protocols Classifications in MANET**

### 2.1. AODV

Ad-Hoc on Demand Distance Vector (AODV) is a reactive routing protocol where the routes are formed only when needed. When the source has data to send to a destination, it broadcasts a Route Request message (RREQ) for that destination [4]. When a RREQ is received to each intermediate node, a route to the source is created. If the intermediate node has not received this RREQ before, means that it is not the destination and does not have a route to the destination, so, it rebroadcasts the RREQ. If the receiving node is the destination or has a current route to the destination, it generates a Route Reply message (RREP). The RREP is unicast in a hop-by hop to the source. When the RREP propagates, each node creates a route record to the destination. When the source get the RREP, it saves the route to the destination and then begin sending data [4]. The route with the shortest hop count is selected when multiple RREPs are received to the source. As data flows from the source to the destination, each node along the route updates the timers associated with the routes to the source and destination, maintaining the routes in the routing table. If a route is not used for some period of time, a node cannot be sure whether the route is still valid; consequently, the node removes the route from its routing table. If data is flowing and a link break is detected, a Route Error (RERR) is sent to the source of the data in a hop-by hop fashion. As the RERR propagates towards the source, each intermediate node invalidates routes to any unreachable destinations. When the source of the data receives the RERR, it invalidates the route and reinitiates route discovery [4].

### 2.2. DSR

The Dynamic Source Routing Protocol is an on-demand reactive routing protocol. In DSR a node maintains route cache which contains the source routes that it is aware of. The node updates records in the route cache when a new route is found [2]. Route Discovery and Route Maintenance are the two main parts of DSR. When a node wants to send a packet as a source to a specific destination, it searches in its route cache in order to determine if it already contains a route to the destination. If it finds a route to the destination exists, then it uses this route to send the packet. But if the node does not have a route to the destination, then it initiates the route discovery process by broadcasting a route request packet. Each intermediate node checks if there is a route to the destination in its cache. If there is no route, it appends its address to the route record of the packet and forwards the packet to its neighbors [2]. A route reply message is generated when the destination or an intermediate node that have current information about the destination receives the route request packet. A route request packet reaching such a node already contains, in its route record, the sequence of hops taken from the source to this node. For route maintenance DSR uses two types of packets: Route Error packet and Acknowledgements. When a node encounters a transmission problem, it generates a Route Error packet. When a node receives a route error packet, it removes the hop in error from its route cache. All routes that contain the hop in error are truncated at that point [2]. Acknowledgment packets are used to verify the correct operation of the route links. This also includes passive acknowledgments in which a node hears the next hop forwarding the packet along the route [2][11].

## 3. Vehicular Ad-Hoc Networks – VANET

Vehicular Ad-Hoc Network (VANET) is an Intelligent Transportation System (ITS) technology that provides many applications such as safety message dissemination, dynamic route planning, content distribution, gaming and entertainment and other applications [3]. VANET is self-organized network that can be formed by connecting vehicle aiming to improve driving safety and traffic management with internet access by drivers and programmers [5][10]. VANET is an application of MANET but it has its own distinct characteristics which can be summarized as [5]:

- **High Mobility:** The nodes in VANETs usually are moving at high speed. This makes harder to predict a node's position and making protection of node privacy
- **Rapidly changing network topology:** Due to high node mobility and random speed of vehicles, the position of node changes frequently. As a result of this, network topology in VANETs tends to change frequently.
- **Unbounded network size:** VANET can be implemented for one city, several cities or for countries. This means that network size in VANET is geographically unbounded.
- **Frequent exchange of information:** The ad hoc nature of VANET motivates the nodes to gather information from the other vehicles and road side units. Hence the information exchange among node becomes frequent.
- **Wireless Communication:** VANET is designed for the wireless environment. Nodes are connected and exchange their information via wireless. Therefore some security measure must be considered in communication.
- **Time Critical:** The information in VANET must be delivered to the nodes with in time limit so that a decision can be made by the node and perform action accordingly.
- **Sufficient Energy:** The VANET nodes have no issue of energy and computation resources.

## 4. Simulation

### 4.1. Simulation Setup

To establish a VANET, IEEE has defined the standard 802.11p. A Dedicated Short Range Communication (DSRC) is proposed which is operating on 5.9GHz band and uses 802.11 access methods [5]. But, in this simulation we used the 802.11b to test its impact on VANET while using both AODV and DSR routing protocols.

The main parameters for our simulation are as shown in table 1:

**Table 1. Simulation Parameters**

| Parameter | Value |
|---|---|
| Simulation Tool | OpNet |
| Simulation Start Time | 10 seconds |
| Packet Size | 1024 bits |
| Protocols | AODV , DSR |
| Pause Time | 0 – 20 seconds |
| Node Range | 80 M |
| Data Rate | 2 Mb/s |
| Nodes Speed | 80 , 100 , 120 Km/h |
| Number of Nodes | 25 , 50 Nodes |
| Wireless Standard | 802.11b |
| Simulation Area | 5 Km x 5 Km |
| Simulation Time | 60 Minuets |

### 4.2. Simulation Scenarios

In our study two main simulation scenarios were used, Sparse and dense nodes based on number of nodes. Figure 2 shows the simulation scenario for 25 nodes. The trajectory was fixed for all scenarios were in each simulation there was three rectangular paths, each one has fixed node speed 80, 100 and 120 Km/h respectively. Also, at the edge of each path there was a pause time between 0 – 20 seconds. The different scenarios that we used are:

- 25 nodes with AODV
- 50 nodes with AODV
- 25 nodes with DSR
- 50 nodes with DSR

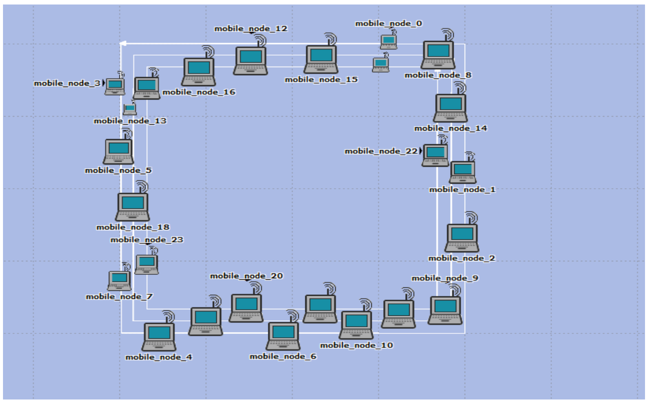


**Fig. 2. Simulation Scenario for 25 nodes**

## 5. Simulation Results and Discussion

- Total Traffic – Sent and Received

The total amount of traffic sent during the simulation for both 25 and 50 Nodes are respectively shown in figure 5 and figure 3. The total traffic sent for both AODV and DSR are almost the same for both scenarios which is in between of 45.000 bits and 55.000 bits for the dense mode which contains 50 nodes, while the total traffic sent in the sparse mode which contains of 25 nodes is between 24.000 and 28.000 bits for both AODV and DSR. On the other side, the total traffic received is shown in figures 4 and 6. For 50 nodes the total traffic received is between 10.000 and 20.000 bits, but as we see in figure 4 at the beginning of simulation the DSR got two high jumps of 30.000 and 55.000 bits respectively because DSR protocol is good when it initiates routes to small numbers of nodes, but when it comes to large number of nodes the number of bits received goes down. As we know DSR is source routing protocol and there are many routes are returned due to route discovery process, and when one of these routes fails it will just select another new route. This mechanism is strong when we deal with small number of nodes, but when we have heavy network it is going to be difficult to use this mechanism because of the huge overhead. In AODV protocol there is only one route returns when the discovery path phase is applied, which makes it difficult to find another route quickly. It has to use the sequence number again and another parameters to build a new route. We can notice this delay of picking a new route when we have small number of nodes (e.g. 25 nodes in our study). We can see that DSR can overcome AODV in light network, but AODV is better in terms of total traffic received for 50 nodes scenario as shown in figure 4 because it is table driven-based not source-routing based.

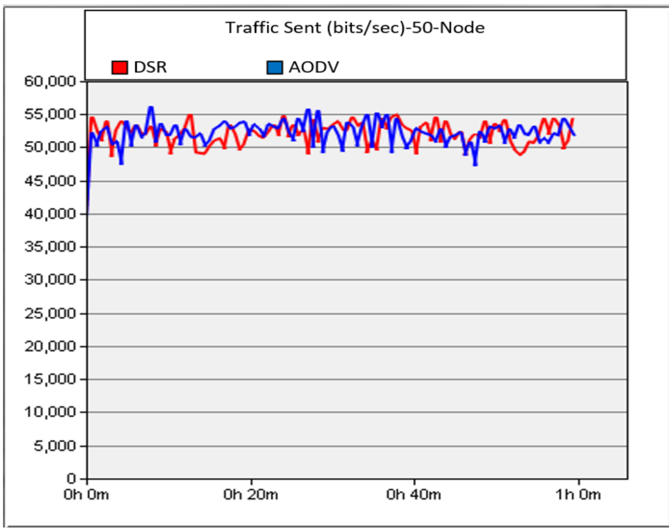


**Fig. 3. Total Traffic Sent – 50 Nodes**

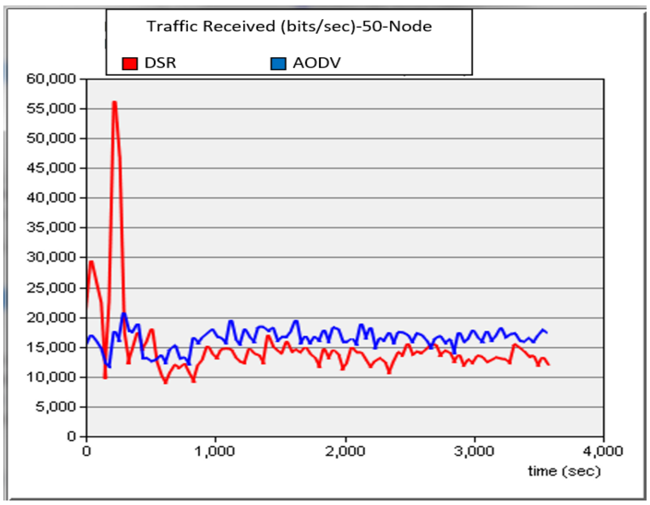


**Fig. 4. Total Traffic Received – 50 Nodes**

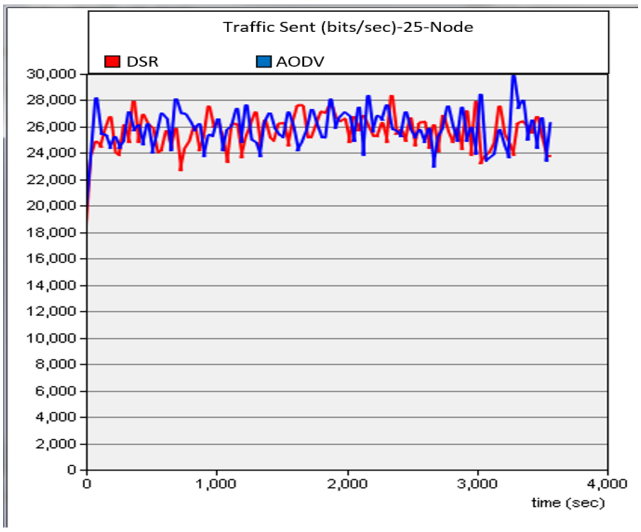


**Fig. 5. Total Traffic Sent – 25 Nodes**

But on the other hand, DSR gives much better results of the total received traffic in 25 nodes scenario, it hits 15.000 to 30.000 bits with a high jump to 35.000 bit, while the AODV got a total traffic received between 10.000 and 15.000 bits. The reason here as we have mentioned before because of discovery route phase used in DSR which gives good results with small number of nodes.

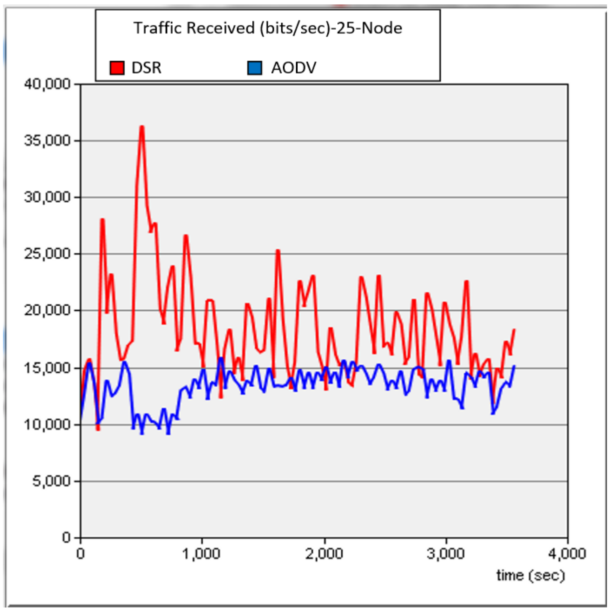


**Fig. 6. Total Traffic Received – 25 Nodes**

In terms of throughput, as shown in figure 7 for a 50 nodes scenario the AODV outperforms the DSR after a while of the beginning of the simulation, but in the sparse mode scenario where it's a 25 nodes we can see from figure 8 that the DSR have much better throughput than AODV. Regardless of the interval between 0 to 1000 seconds where the simulation is not stable at this time because the route discovery processes in both AODV and DSR, AODV gives very high throughput.

- Throughput

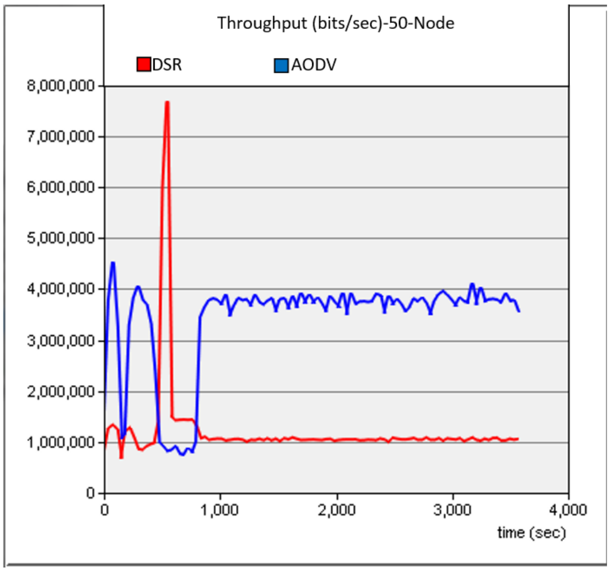


**Fig. 7. Throughput – 50 Nodes**

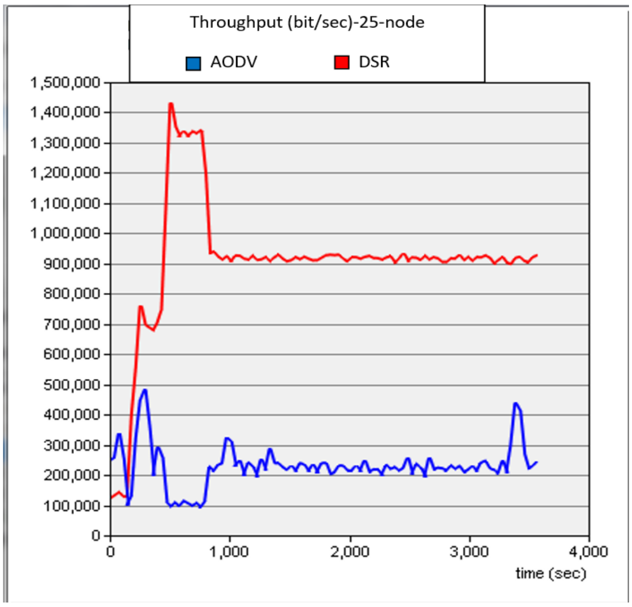


**Fig. 8. Throughput – 25 Nodes**

The total delivery delay in AODV in 50 Nodes scenario is higher than the delay in 25 nodes around by four times as shown in figure 9 because AODV takes much time to find another route if the previous one failed . Also, in DSR the delay in 50 nodes is much higher than in 25 nodes as shown in figure 10 and the reason here returns to the significant overhead generated when DSR built its tables. All in all, in both protocols, the higher number of nodes the much delay time we get, but AODV is still the best in a dense network.

- Delay

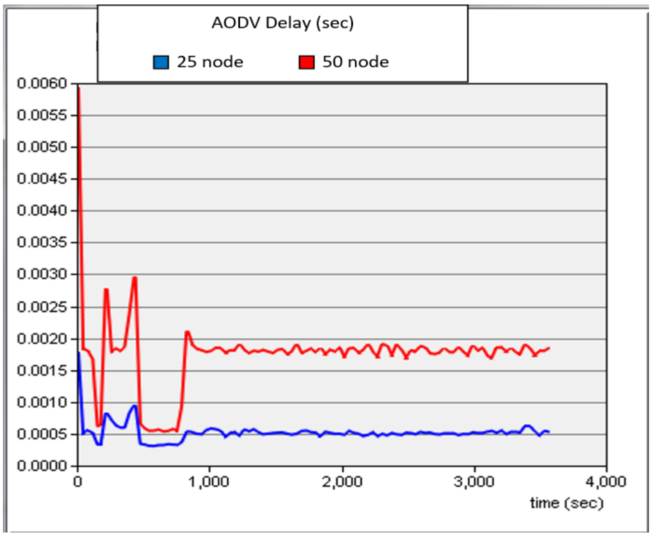


**Fig. 9. Delay – AODV**

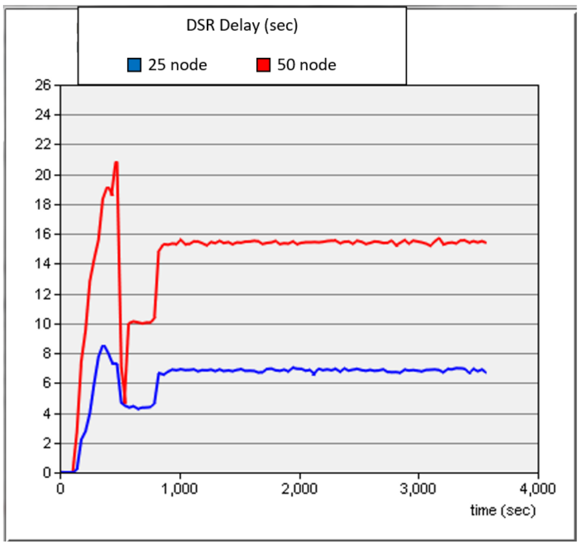


**Fig. 10. Delay – DSR**

- Packet Delivery Ratio

In terms of Packet Delivery Ratio, we can see in figure 11 that the delivery ratio in 50 nodes scenario the AODV is better than DSR. In general both protocols got a ratio between 20% and 40%, while at the beginning of simulation the DSR got a very high ratio which hits the 90% due to the multiple paths created by DSR which gives a high delivery ratio and less packet loss. Figure 12 shows the Packet Delivery ratio in 25 nodes scenario, as other metrics we found that in the sparse mode the DSR is better than AODV since the DSR got a delivery ratio between 60% and 95%, while the AODV got a delivery ratio between 40 and 60%. We conclude that the lower number of nodes we have the higher delivery ratio we get in both AODV and DSR, because in the large networks the paths are changes rapidly which needs a route maintenance and more packet loss.

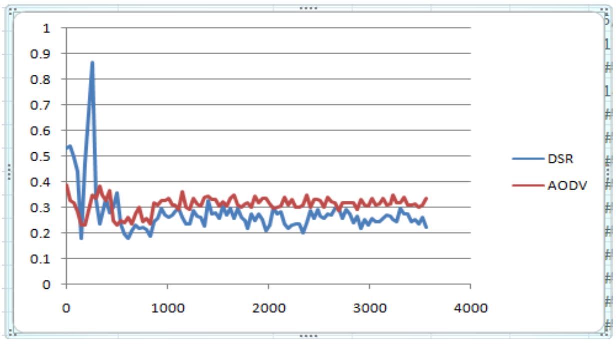


**Fig. 11. Packet Delivery Ratio – 50 Nodes**

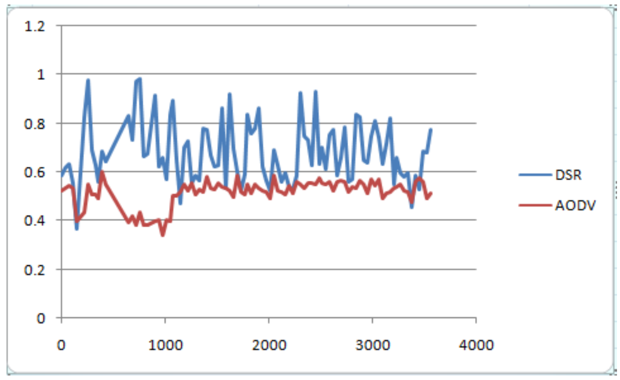


**Fig. 12. Packet Delivery Ratio – 25 Nodes**

## 6. Conclusion

In this study a simulation was done in order to see the impact of using the IEEE 802.11b WIFI protocol on VANET scenarios. This was measured on both MANET routing protocols AODV and DSR. As a result of this simulation we found that the AODV is better than DSR when we have dense mode scenario which means a large number of nodes, while the DSR protocol is better than AODV when the number of nodes is not that much. Both AODV and DSR have been measured using different metrics: Packet delivery ratio (PDR), Throughput, End-to-End Delay and total number of sent-received packets.

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