International Journal of Analysis of Basic and Applied Science ISSN: 2457-0451

Vol. No.6, Issue I, Jan-Mar, 2022 http://bharatpublication.com/current-issue.php?jID=30/IJABAS

Evaluation of Performance of QoS based AODV Protocol with Simulation

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ABSTRACT

*Ad hoc mobile networking is a recent area of research. It could be used in agriculture as a wireless sensor network to monitor and manage environmental conditions. The purpose of this study is to assess the performance of the QoS-enabled AODV protocol, which is used in these Ad hoc networks. Quality of Service is abbreviated as QoS. Its performance is compared to the standard AODV protocol. The study suggested numerous changes to the AODV protocol to support QoS, including adding extensions to Route Discovery messages relating to bandwidth estimations. The metrics discussed in this article include traffic rate, node speed, and mobile node pause time. Packet delivery ratio, average end-to-end latency, throughput, and normalized overhead load are the performance measures used for assessment. These criteria are used to evaluate the performance of the AODV protocol in both QoS and non-QoS circumstances.****Keywords:*** *quality of service, Ad hoc networks, AODV, bandwidth estimation*

INTRODUCTION

In an ad hoc mobile network, each node has its own router, and all nodes collaborate to carry traffic. The overall idea of the Ad hoc networking model is a significant departure from the currently utilized highly organized and frequently hierarchical models used for both local area and wide area networking. Ad hoc networking may be utilized in a variety of situations[1], [2], and [3]. Only the connection performance, routing delays, and connectivity to the existing fixed network of the participating nodes limit the nearly global connectivity that mature and dependable ad hoc networking provides. Ad hoc networks are entirely practical with today's technology, as shown in Fig. 1, if proper Ad hoc routing protocols are available and deployed..

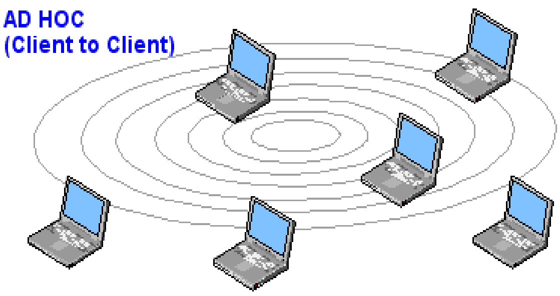


Figure 1. Ad-hoc Networking (From Computer Desktop Encyclopedia ©2007)

Although both the Distance Vector (DV) and Link State (LS) routing algorithms are widely utilized in static networks, none is well adapted to rapidly changing topologies. In a highly dynamic wireless network, such protocols face a variety of challenges:

• Topologies may be very redundant, with a few nodes connecting to a large number of neighbors while only seeing a tiny number of them. Bandwidth is limited and cannot be squandered.

• The battery power of portable devices is a limited resource that should not be wasted.

• When topology changes often, high update rates are required.

Routing Models

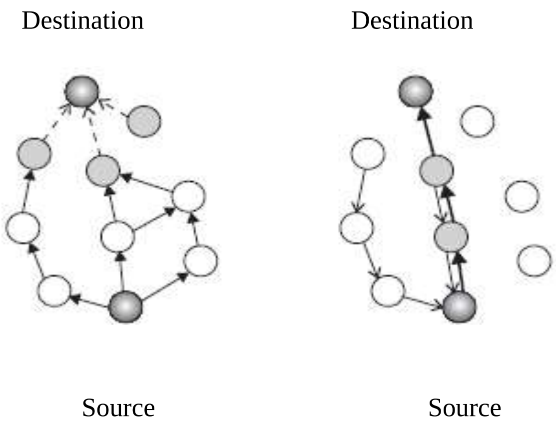
Routing models are of two types:

1) Proactive Routing
2) Reactive Routing
3) Hybrid Routing

This article focuses on three parameters: traffic rate, speed, and halt duration of mobile nodes. The performance indicators utilized for evaluation include average end-to-end latency, packet delivery rate, normalized overhead load, and throughput. Three parameters and four performance metrics are utilized to evaluate the AODV [4] protocol for both QoS and Non-QoS using a graphical depiction of their interrelationships.

AODV Protocol Overview

Routing tables with one entry for each destination are used by on-demand reactive routing protocols such as the AODV. When a sender node has to identify a route to the destination, it launches a route discovery operation based on flooding to find the destination node, as shown in Fig. 2..



(a) RREQ Broadcast (b) RREP Propagation and Subsequent Route

Figure 2. Route Discovery Cycle

After receiving a route request (RREQ) packet, the intermediate nodes continue to update their routing databases for a backward path to the source. Similarly, when a route reply (RREP) packet is received from the destination or any other intermediate node with a valid route to the destination, the destination's forward route is changed. The AODV protocol use sequence numbers to determine the chronology of each packet and avoid looping. Expiry timings are used to update the route entries. Route error (RERR) messages are used to propagate link failures by being delivered from a broken link to the source node of the relevant route. When the next hop link breaks, the beginning node of the link transmits RERR packets to a group of surrounding nodes, who interact with the destination across the broken link.

AODV and QoS-AODV

The purpose of this study has been to improve the performance of the conventional AODV protocol while simultaneously increasing QoS[6],[7]. Among the several QoS criteria are bandwidth, cost, end-to-end delay, delay alteration (jitter), throughput, packet loss probability, battery charge, processing power, and so on. Various performance measures must be investigated in order to evaluate the QoS-enabled AODV protocol's performance. Research is being conducted to increase performance by concentrating on any of these criteria. This study considers bandwidth characteristics in order to improve QoS.

BANDWIDTH ESTIMATION FOR QOS

A host's available bandwidth in a distributed Ad hoc network is controlled not only by the raw channel capacity but also by the bandwidth utilization of its neighbors and interference from external sources, both of which restrict a host's bandwidth that can be utilized for data transmission. As a result, apps cannot effectively optimize their coding rate unless they are aware of the condition of the whole network. As a result, bandwidth estimate is a critical procedure for QoS in MANETs. As seen in Figure 3, bandwidth estimate may be performed at several network tiers.

In this work, I aimed to improve QoS [8] by focusing on the bandwidth parameter [10].The RREQ message format in the AODV protocol is seen in Figures 4 and 5 before and after QoS is implemented. To increase the speed of the basic protocol, a new field named "Bandwidth Required" [9] [16] is added to the given RREQ format. This RREQ packet contains the bandwidth required field information, which is then compared to the existing demand. When there is adequate bandwidth, the packet is sent to the next intermediate node; otherwise, it is dropped and retransmitted when the circumstances are favorable.

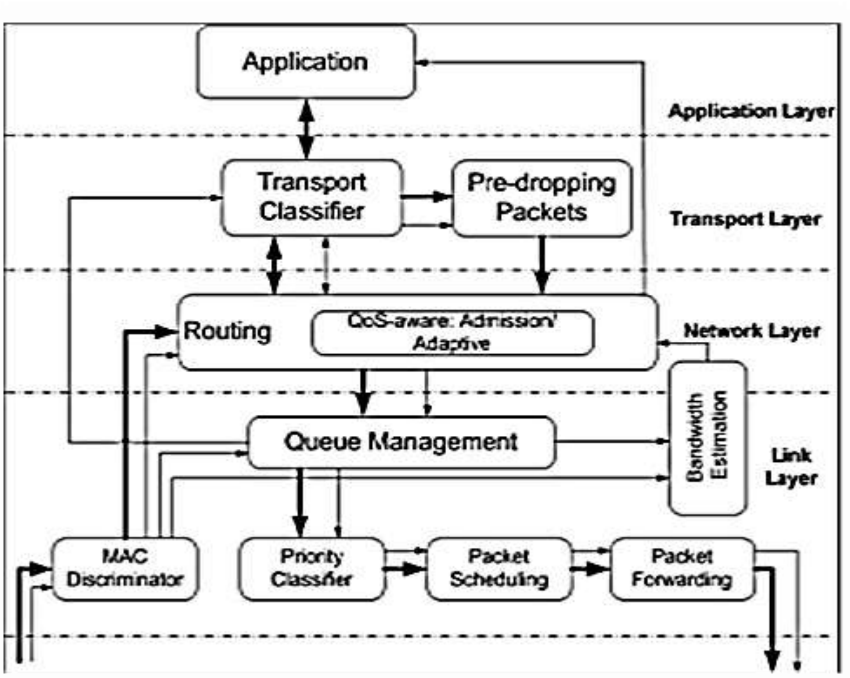


Figure 3. QoS Architecture [13]

.TYPE	RESERVED	HOP COUNT
Broadcast ID		
Destination IP Address		
Destination Sequence Number		
Source IP Address		
Source Sequence Number		
Request Time		

Figure 4. RREQ Message Format pre QoS-Enabling

TYPE	RESERVED	HOP COUNT
Bandwidth Required		
Broadcast ID		
Destination IP Address		
Destination Sequence Number		
Source IP Address		
Source Sequence Number		
Request Time		

Figure 5. RREQ Message Format post QoS-Enabling [15]

IMPLEMENTATION

The implementation section discusses the AODV protocol's implementation and comparative analysis [5]. This is true for both the operating system, Fedora, and the apps ns2 (Network Simulator version), NAM (Network Animator), and Gnuplot. Following that, the major implementation is discussed.

Need of Fedora

Linux was used for all simulation, implementation, and analysis work. Fedora was the version of Linux that was utilised for this. This particular operating system was chosen for research work because it is one of the most reliable and stable platforms available. Second, Linux systems offer greater security than other operating systems, and security is a crucial component in network environments. It is necessary to discuss some of the platform's key features because it serves as the foundation for everything.

Network Simulator ns-2

After the platform was set up, ns-2, a piece of software that was used in addition to other tools for all analysis and simulation work, was installed on it. The accepted protocol for network simulation is ns-2. The networking community highly respects its behaviour. It is being developed at ISI in California with funding from DARPA and NSF.

Core Implementation

a) Basic Protocol Simulation: The simulation and implementation of the AODV protocol are covered in this section. The platform, Fedora 8, was first set up in a virtual setting. The platform on which the aforementioned protocols were implemented was then configured for ns-2. A script file must be run on ns-2 for it to function. These script files were created using the TCL programming language (Tool Command Language). For the purpose of plotting graphs, we used Gnuplot and shell scripting.

b) QoS-Enabled Protocol Simulation: This study investigates a quality of service (QoS) architecture for real-time transmission of data in mobile ad hoc networks (MANETs). The QoS architecture consists of a priority MAC protocol, a QoS transport layer, QoS routing, and queue management. Simulations reveal that the QoS architecture significantly increases resource utilisation in MANETs and lowers packet loss.

c) QoS architecture: The proposed QoS architecture is shown in Fig. 3 and includes every networking layer, from application layer to MAC layer [11], [12]. The control packet flow is shown by the narrow lines, while the data packet flow is shown by the bold lines.

Performance Analysis

ns 2.34 was installed on the console for simulating the protocols, together with the necessary software like GnuPlot, which is a tool for plotting the graph from the trace files. Fedora 8 was used as the operating system for the performance analysis. The object-oriented, discrete event-driven network simulator ns (version 2) was created in C++ and Otcl.

Basic Protocol Simulation

This section discusses the simulation and implementation of the AODV protocol. Fedora 8 was initially installed in a virtual environment. The platform used to implement the aforementioned protocols was then setup using ns 2.34. To function, a script file must be executed on ns-2. The TCL programming language (Tool Command Language) was used to produce these script files. Gnuplot and shell scripting were used to create graphs.

Performance Metrics used for Analysis

The procedures were compared using the metrics listed below. [14]:

a) Throughput: This is the real network bandwidth consumed by the program.

b) Bandwidth: This is the real network bandwidth used by the program.

c) Average Packet Delay: A packet's transport time between its source and destination is average. For each source-destination pair, an average packet delivery delay is determined first. Following that, the average delay for all couples is computed.

d) Packet Delivery Ratio: It is the ratio of data packets transmitted from source to destination, or the number of delivered packets divided by the number of created packets. The total number of data packets received from all destinations equals the total number of data packets provided.

e) Network Overhead Load: When the share of wireless bandwidth needed to transmit packets that are discarded on many other links is compared to the total overhead caused by control routing packets, the overall overhead is reduced.

RESULTS & ANALYSIS

Traffic Environment

The tests were carried out using 50-node CBR traffic. Because it is impossible to manually produce traffic simulations for such a large number of nodes, the simulations were made using CMU traffic generated and the scenario was generated using setdest, both of which are utilities that come preloaded with the ns2. The packet size was set to 500, while the time interval between packet transfers was set at 0.005 ms. The field configuration had recently been adjusted to 500 by 500 meters, resulting in 12 graphs that were utilized to test the AODV protocol for both QoS and Non-QoS utilizing three parameters and four performance measures.

Figure 6 indicates that for high data rates exceeding 600 kbps, QAODV's average packet latency is much smaller than that of AODV. At low data rates, the degree of delay encountered by AODV and QAODV is nearly comparable. Because AODV rejects packets at the source as soon as QoS requirements in the path are broken, it reduces congestion in the common intermediate sub-paths utilized by multiple flows.

According to Fig. 7, QAODV has an average packet delay of 40 to 60 ms less than AODV during each Pause time. The minimal delay for both AODV and QAODV is attained when the nodes halt for 6 seconds. The average packet delay incurred by QAODV for each speed setting is much smaller than that encountered by AODV, as shown in Fig. 8. The minimal delay is attained for both AODV and QAODV when the nodes move at a speed of 4 m/s or less.

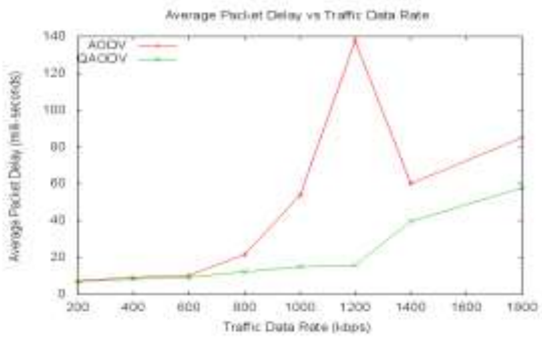


Fig. 6. Average Packet Delay versus CBR

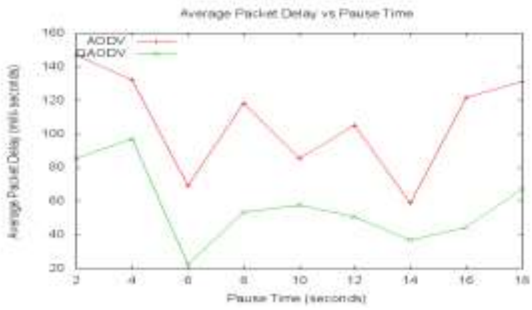


Fig. 7. Average Packet Delay versus Pause Time

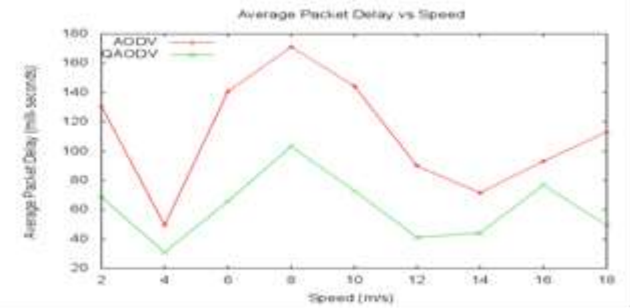


Fig. 8. Average Packet Delay versus Speed of Nodes

NOL and CBR are compared in Figure 9. QAODV has a larger overhead than AODV for each data rate. The overhead values of AODV and QAODV decrease as the traffic data rate increases. When the traffic data rate is 1200 kbps, the overhead value of QAODV increases significantly, which is difficult to explain.

In Fig. 10, NOL is plotted against Pause Time. For each pause time value, the overhead while utilizing QAODV is larger than when using AODV. The overhead values of AODV are practically the same for different pause time values. When the pause period is set to 12 seconds, the QODV overhead value climbs dramatically for unclear reasons.

Figure 11 depicts NOL vs Node Speed. QAODV has a greater overhead than AODV for each movement speed setting. The overhead scores of AODV are roughly the same for different speed settings.

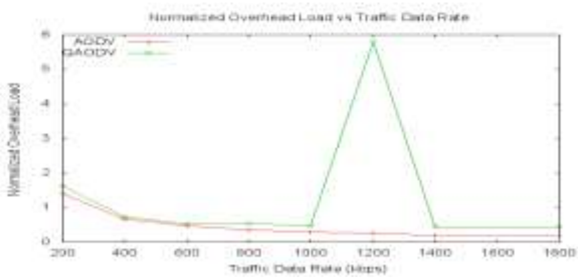


Fig. 9. NOL versus CBR

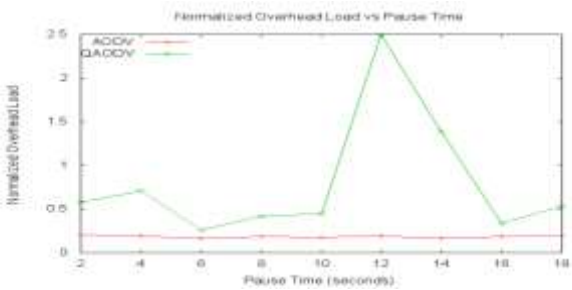


Fig. 10. NOL versus Pause Time

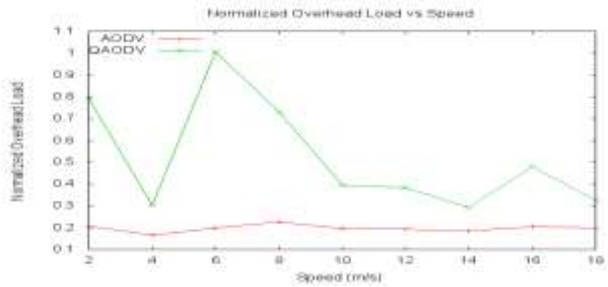


Fig. 11. NOL versus Speed of Nodes

Figure 12 depicts the Packet Delivery Ratio vs CBR. At all data rate values, the PDR achieved by AODV is larger than that produced by QAODV. The PDR value for AODV approximately remains constant as the traffic data rate increases, but the PDR value for QAODV falls. When QoS (bandwidth) demand is high, it is difficult to find a QoS-satisfying path for the flows. As a result, QAODV inhibits packets at the source, causing the PDR value to fall as the data rate rises. Figure 13 depicts the packet delivery ratio vs pause time. In this case, the data rate is set at 2000 kbps, and the PDR value of QAODV is smaller than that of AODV at each pause. Figure 14 depicts the Packet Delivery Ratio vs Node Speed. The data rate is 2000 kbps in this case, and QAODV's PDR value is lower than AODV's for all speed values.

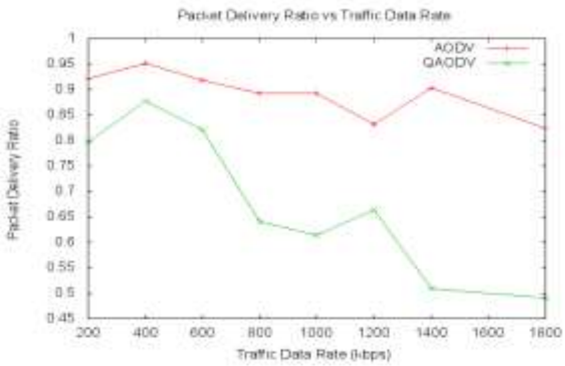


Fig. 12. Packet Delivery Ratio versus CBR

Fig. 13. Packet Delivery Ratio versus Pause Time

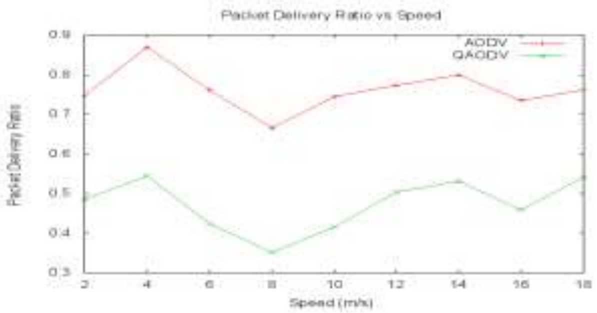


Fig. 14. Packet Delivery Ratio versus Speed of Nodes

Figure 15 depicts throughput versus CBR. At low data rates, QAODV achieves about equivalent throughput as AODV. When QoS (bandwidth) demand is high, it is difficult to find a QoS-satisfying path for the flows. As a result, QAODV stops packets at the source, lowering performance at data rates above 1200 kbps.

Figure 16 shows a plot of throughput vs pause time. The data rate in this example is 2000 kbps, and QAODV has a lesser throughput than AODV. When the pause length is 4 seconds, both AODV and QAODV have the highest throughput.

Figure 17 depicts the relationship between throughput and node speed. The data rate in this example is 2000 kbps, and QAODV has a lesser throughput than AODV. When the speed is 4 m/s, the AODV and QAODV achieve the greatest throughput. When the speed is reduced to 8 m/s, both AODV and QAODV see a sharp fall in throughput. There are little variations in the throughput that AODV and QAODV can accomplish at speeds greater than 12 m/s.

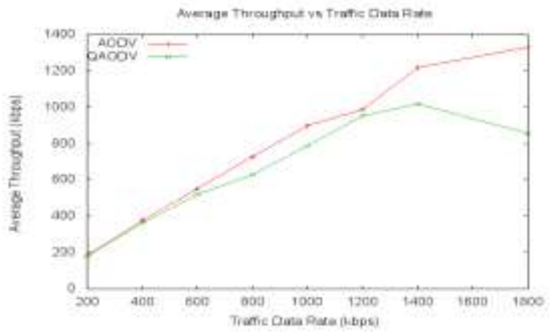


Fig. 15. Throughput versus CBR

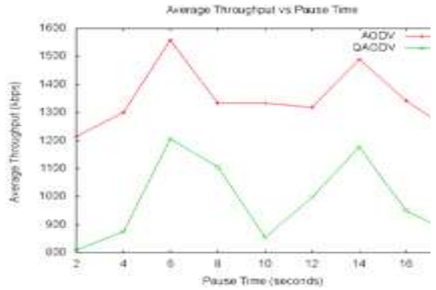


Fig. 16. Throughput versus Pause Time

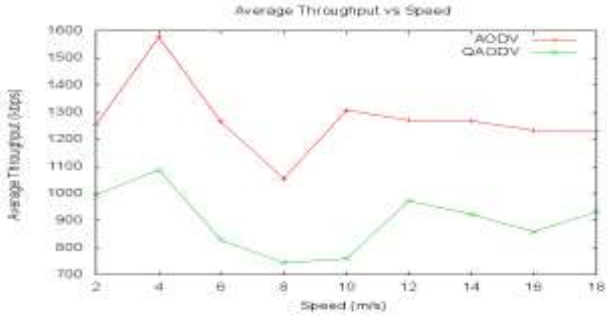


Fig. 17. Throughput versus Speed of Nodes

CONCLUSION

I introduced the AODV protocol with QoS (Quality of Service) support in this work. First, I used ns-2 to replicate the basic protocol. Gnuplot is then used to construct the twelve graphs with three distinct simulation scenarios: 1) Node speed, 2) Traffic Rate, 3) Pause Time or Mobility, and performance indicators such as PDR, NOL, Average packet delay, and Throughput. The fundamental protocol's QoS is then improved, and graphs are created once more. Finally, a comparison of QoS-enabled and non-QoS protocols is performed. The result shows an improvement in data routing from source to destination.The following conclusions can be drawn from the generated graphs:

1) The average packet latency of QAODV is lower than that of the original AODV protocol.

2) Because we are using Hello Messages to read the bandwidth, the Network Overhead Load in QAODV is somewhat higher than in AODV.

3) The average throughput and packet delivery ratio of QAODV are similar to those of the AODV Protocol.

Reduced Average Packet Delay for QAODV indicates that this method is suitable for current and future networks. When multimedia-based data, such as text, music, and video, is streamed, the network's traffic will grow. Network congestion is a typical source of packet loss, prolonged delays, and delay jitter in streaming video. The primary goal of a protocol is to make the network more helpful overall by prioritizing higher-value or more performance-sensitive traffic. although a modest increase in network overhead load, the QAODV protocol is proven to manage this circumstance better than AODV protocols, although having almost comparable average packet throughput and packet delivery ratio.

This QAODV's reduced packet delay is a significant accomplishment. This is because wireless networks will require an approach like this in the future to reduce transmission delays. This reduced latency will be critical for networks handling real-time traffic, such as video calling.

According to a Cisco research, the volume of mobile data in 2010 was three times that of all Internet traffic worldwide in 2000. The previous year's growth rate was 159%, which was 10% greater than expected in 2009.

Mobile data is predicted to rise at a 92% annual pace over the next five years, continuing the trend of fast expansion. A variety of reasons have contributed to the rapid rise in mobile traffic. For starters, it is expected that mobile video, which requires high bit rates, would boost mobile traffic. According to projections, mobile video accounted for up to 49.8% of all mobile traffic in 2010 and will account for two-thirds of all mobile traffic by 2015. Furthermore, Internet gaming, which used 63 PB per month on average in 2009, adds to a rise in mobile traffic, which is expected to expand by 37% each year over the next five years. Last but not least, Voice over IP (VoIP), which comprises phone-based VoIP services given directly to a service provider or by a third party, as well as software-based internet VoIP services such as Skype, increases mobile traffic. Many of the aforementioned applications are real-time, requiring certain assurances for performance measures such as average packet latency to work effectively. As a result, it is critical that this new QAODV delivers a lower average packet latency for ad hoc networks.

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