# Performance Comparison of Proactive and Reactive Routing Protocol in Mobile Ad Hoc Network

*by* Bekti Maryuni Susanto

# Performance Comparison of Proactive and Reactive Routing Protocol in Mobile Ad Hoc Network

Bekti Maryuni Susanto, Agus Hariyanto, and Surateno
Departement of Computer Engineering, State Polytechnic of Jember
Jl. Mastrip Kotak Pos 164 Jember East Java Indonesia
Email: bekti@polije.ac.id; agus_hariyanto@polije.ac.id; ratno@polije.ac.id

***Abstract*** —Today, the use of Mobile Ad Hoc Network (MANET) is becoming increasingly popular due to its flexibility and ease of use wherever and whenever. MANET is able to adapt to many applications, such as disaster management and military operations. The MANET routing protocol consists of two types, namely Proactive Routing Protocols and On Demand Routing Protocols. Destination-Sequence Distance-Vector (DSDV) is an example of a protocol that includes Proactive Routing Protocols. Meanwhile, Ad Hoc on-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) are examples of protocols that include On Demand Routing Protocols or Reactive Routing Protocols. Because routing protocols greatly affect MANET performance significantly, it is necessary to study the performance of routing protocols. This paper discusses the performance comparison of MANET routing protocol based on RandomWaypoint mobility model. The experiment was carried out by applying the MANET routing protocol to the RandomWaypoint mobility model. Routing protocols used are AODV, DSDV and DSR. The simulation is done using NS-2 software. The total of nodes used in simulations is 100, 150, 200 and 250 nodes respectively. Length of simulation time 900s. The simulation area take place in urban residential areas. Performance evaluation is performed on variable packet delivery ratio (PDR), throughput, average end to end delay, packet loss and Normalized Routing Load (NRL).

***Index Terms***— MANET; AODV; DSDV; DSR

## I. Introduction

In general, wireless networks are divided into two types, namely infrastructure-based and infrastructure-less. In infrastructure-based wireless network required a device that serves to connect between nodes in the network, the access point. This infrastructure-based wireless network is adapted from cellular networks. In an infrastructure-less network, each node establishes the network itself without any other fixed devices. All nodes on the infrastructure-less network work together with each other to forward packets [1], which are limited to the coverage of the wireless network interface transmission of each node. Mobile Ad Hoc Network is one type of infrastructure-less wireless network.

Today, the use of Mobile Ad Hoc Network (MANET) is becoming increasingly popular due to its flexibility and ease of use wherever and whenever. MANET is able to adapt to many applications, such as disaster management and military operations. MANET enables end-to-end connectivity [2]. Communications lines can be established instantaneously requiring minimal human intervention during path establishment. In general, data is transmitted over a mobile node-based pathway that works together, carrying packets through multi-hop networking. Each node can forward packets unrelated to its use, therefore nodes become routers for other nodes [3]. Each node on the MANET is independent to move in any way and hence the node can change the connection to other devices frequently.

Mobile Ad Hoc Network is differed by dynamic topologies, limited wireless bandwidth, no fixed infrastructure, rapid network forming and creation [4]. The development of routing protocols became one of the main challenges to ad hoc networks. Unpredictable topologies have a significant impact on MANET performance. Therefore, routing protocols play an important role in mobile ad hoc network (MANET). A protocol consists of a set of communicable, formal messages and how to react to these messages [5].

The MANET routing protocol consists of two types, namely Proactive Routing Protocols and On Demand Routing Protocols. Destination-Sequence Distance-Vector (DSDV) is an example of a protocol that includes Proactive Routing Protocols. Meanwhile, Ad Hoc on-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) are examples of protocols that include On Demand Routing Protocols or Reactive Routing Protocols. In general, the difference of all types of protocols is how protocols mapped the network [5]. Some protocols store all destination routes completely, while others store only partial information.

Because routing protocols greatly affect MANET performance significantly, it is necessary to study the performance of routing protocols. This paper comparing of MANET routing protocol based on RandomWaypoint mobility model. Routing protocols used in this experiment are DSDV, AODV, and DSR. The comparison parameters include Packet Delivery Ratio (PDR), Throughput, Average End to End Delay, Packet Loss and Normalize Routing Load.

The paper is structured as follows, section 2 discusses MANET. Section 3 deals with the MANET routing

Manuscript received November 24, 2017; revised May 2, 2018.
Corresponding author email: bekti@pilije.ac.id.
doi:10.12720/jcm.13.5.218-224

protocol. Section 4 deals with experimental methods. Section 5 Discusses experimental results and discussion. And section 6 deals with conclusions.

## II. MANET

MANET is dynamically built by mobile nodes connected via a wireless link without the utilize of existing network infrastructure or centralized administration [6]. MANET is decentralized where there is no single main station or access point that governs the flow of network traffic [7]. MANET is governed by the rule of the 802.11a/b/g/n physical layer protocol, all nodes in the same time send and receive wireless data and forward the traffic to other nodes. Every node acts as a node and as a router at the same time and make a multi-hop wireless network.

Nodes that are within range of other nodes, can exchange packets between devices without the help of other entities. To send a remote packet, the node between the source and the destination forwards the packet from one to another, as in the conventional router until it reaches the destination, shown in Fig. 1.

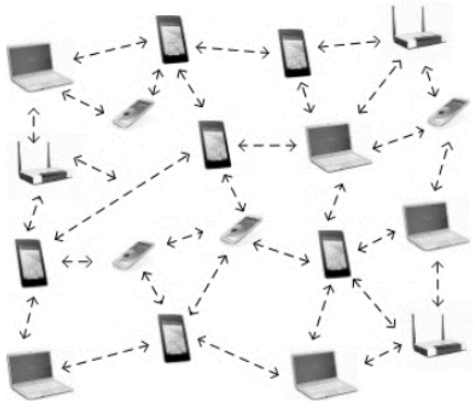

Fig. 1. MANET topology [2]

MANET's main advantage over wireless infrastructure-based networks is decentralized, which means afford to self-manage. Another advantage, does not need the installation of special infrastructure and flexibility as a mobile network. MANET is widely used in disaster management, military operations, instant infrastructure, remote areas and cost-effectiveness in an area with no wireless infrastructure-based network.

MANET is marked with the following criteria:

- Dynamic topology; node is independent to move anywhere, network topology can change randomly and quickly at unpredictable times [8].
- Limited bandwidth and fluctuating relationship capacity; wireless networks have lower capacity compared with cable networks.
- Low resources; Mobile nodes typically use batteries as power sources that have limited capacity.
- Limited physical security;compared with cable network, MANET more susceptible to physical security threats. For example, there is an increased likelihood of spoofing, denial of service and eavesdropping attacks that need to be carefully calculated.
- Decentralized network control; each node requires extra resistance compared to a centralized network.

## III. Routing Protocol in MANET

There are several different routing protocols developed for ad hoc networks over the years. This protocol is basically divided into 2 categories [7]. There are several protocols that combine these two categories and benefit from both categories.

Proactive or Table Driven Routing Protocols - In this category, the routing protocol maintains some neighboring tables or routing information on each node for all nodes in the network. Each at the specified time sends a small packet and through this small packet keeps neighbor records. When the network topology changes, the node propagate the update messages to the entire network and has the latest network topology information.

When the routing information becomes worthless quickly, there are many short-lived routes that are being determined and not used before they turn invalid. Therefore, another drawback resulting from the increased mobility is the amount of traffic overhead generated when evaluating these unnecessary routes. This is especially altered when the network size increases. The portion of the total control traffic that consists of actual practical data is further decreased. Lastly, if the nodes transmit infrequently, most of the routing information is considered redundant. The nodes, however, continue to expend energy by continually updating these unused entries in their routing tables as mentioned, energy conservation is very important in a MANET system design. Therefore, this exclusive expenditure of energy is not desired. Thus, proactive MANET protocols work best in networks that have low node mobility or where the nodes transmit data frequently [9]. DSDV is one of these routing protocol types.

Reactive or On Demand Routing Protocols - Unlike Proactive Routing Protocols, each node does not store the current route of the entire network. Route created when package needs to be sent. When the source wants to send packets to the destination, the routing protocol initiates the route discovery process to get the path to destination. The route remains valid when the new packet is created for the purpose and removed from routing table if it is not used after a certain period of time.

Portable nodes- Notebooks, palmtops or even mobile phones usually compose wireless ad-oc networks. This portability also brings a significant issue of mobility. This is a key issue in ad-hoc networks. The mobility of the nodes causes the topology of the network to change constantly.Reactive routing protocols were intended for

these types of environments. Paths will be constantly changing. Instead, whenever a node needs a route to a given target, it initiates a route discovery process on the fly, for discovering out a pathway.

Reactive protocols start to set up routes on-demand. The routing protocol will try to establish such a route, whenever any node wants to initiate communication with another node to which it has no route. This kind of protocols is usually based on flooding the network with Route Request (RREQ) and Route reply (RERP) messages .By the help of Route request message the route is discovered from source to target node; and as the target node gets a RREQ message it send RERP message for the confirmation that the route has been established. This kind of protocol is usually very effective on single-rate networks. It usually minimizes the number of hops of the selected path. However, on multi-rate networks, the number of hops is not as important as the throughput that can be obtained on a given path. AODV and DSR are the types of routing protocols.

### A. AODV

AODV uses a conventional routing table, one record on every destination. Differ with DSR, which maintain the several route cache for every destination. AODV depend on routing table records to distribute RREP back to source, hereafter, to forward packets to destination. AODV utilize the serial number keept at every destination to decide the freshness of routing information and to avoid routing loops. Entire routing packet carry this serial number. Preservation of a timer-based condition in every node is a necessary attribute of AODV, in connection with the use of individual routing table records. The routing table record expired when it was not used lately. Predecessor nodes is conserved for every routing table record, which indicate the neighboring nodes that utilize the record to route the data packets. This node is informed with the RERR packet if the subsequent hop link stops. Every precursor node, in its turn, through RERR to its own predecessor circuit, successfully removing entire routes by using broken links. Differ with the DSR, the RERR package in AODV is meant to advise entire sources utilizing links if a failure happen. AODV error distribution route could be conceptually visualized as a tree whose a node at the point of failure is root and all as a leaves is sources that utilized failed link.

The main advantage of this protocol is that routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The connection setup delay is lower. One of the disadvantages of this protocol is that intermediate nodes can lead to inconsistent routes if the source sequence number is very old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries. Also multiple RREP packets in response to a single RREQ packet can lead to heavy control overhead. Another disadvantage of AODV is that the periodic beaconing leads to unnecessary bandwidth consumption[10].

Advantages of AODV:

- Very powerful on highly dynamic networks
- Require less storage space compared to other reactive routing protocols
- Supports multicasting

Weakness of AODV:

- Has no efficient route maintenance techniques because routing information is always obtained on request.
- Suffer from high route discovery latency
- Large overhead is imposed on the routing protocol because of the overhead of control. This is required to send route reply messages for single route requests

### B. DSDV

Distance-Vector Destination-Sequenced Distance (VDS) routing algorithm is a classic Bellman-Ford routing algorithm advancement. The principal think is that every mobile node keep a routing table comprising all available destinations, the number of hops convenient to that goal and the series number specified by the destination node. Serial numbers are utilized to differentiate stale routes from new ones and thus prevent loop establishment. Thus, updates are done both time-based and event-driven. The routing table can be renewed either by a full dump or by conventional updates. A full dump transmits the whole routing table to a neighbor. Accordingly, many packages may be exposed in such an update mode. On the other hand, only records that have metric changes since the latest update are announce. So, the update must match the package. The record can be included in which the series number changed when space in the incremental update available. Incremental updates are transmitted to prevent additional traffic and full dumps are comparatively rare when the network comparatively stable. Incremental packets can get larger in a fastchanging network so that full dumps will be more frequent.

DSDV is one of the early algorithms available and the main advantage of this protocol is that it is quite suitable for creating ad hoc networks with a small number of nodes. One of the disadvantages of this protocol is that it requires a regular update of its routing tables, which uses up battery power and some amount of bandwidth, even when the network is idle. Secondly, whenever the topology of the network changes, a new sequence number is necessary before the network re-converges. Thus, DSDV is not suitable for highly dynamic networks [10].

Routing information is advertised by broadcasting or multicasting. Packets are transmitted periodically and incrementally as changes are detected. In a wireless medium broadcasts are limited by the physical characteristic of medium. If a node invalidates its entry to a destination due to loss of next hop node, it increments its sequence number and uses new sequence number in its

next advertisement of the route. Data broadcast by each mobile computer will contain new sequence number and

1) Destination IP address
2) Number of hops required to reach the destination
3) Sequence number of the information received regarding that destination

Advantages of DSDV:

- No loops guarantee
- Ensure the freshness of routing information in the routing table by using serial numbers.
- Avoid extra traffic by using extra updates.
- Keep the best paths for just about each destination. Therefore, the routing table space is reduced.

Weakness of DSDV:

- Periodic update messages require large bandwidts.
- Does not support multipath routing.
- Waste bandwidth because advertising does not require routing information even though there is no change in the network topology.

### C. DSR

Dynamic Source Routing (DSR) is a routing protocol for Ad Hoc network primary source-based routing theory and not table-based. Its a initiated resource. It is especially designed for utilize in ad hoc networks of multi-hop wireless networks. DSR does not require existing network infrastructure. This protocol allows the network to fully self-organize and configure itself. Route finging and route keeping are two necessary parts to this protocol. Every node keep a cache to save the recently discovered path. If a node needs to transmit a packet to another, it verify its record in the cache. Then he utilizes the path to send the packet if available. Additionally, it append the source address to the package. If the record is not cached, or expired (because it has been idle for a long time), the sender sends a route request packet to all the neighbors request for a way to the destination. The sender will await until the route is found. During the awaiting time, the sender can execute other job such as send/forward other packets.

Once the route request packets achieve one of the neighboring nodes, the latter search destinations in the appropriate cache. When the route to destination information is known, the neighboring node sends back the route reply packet to the sender node; If the same route request packet is not broadcast. When a route is found, the sender starts the delivery on the found route. Also, records are make in the corresponding cache. Furthermore, the node keep the age-entry information to decide cache line is new or not. Intermediate node first examine the packet, whether the packet is for its or not. If the data packet for itself, the packet is received (intermediate node is the destination). Alternatively, the same packet is forwarded utilizing the path added to the data packet. Any links may collaps at any time on the Ad hoc network.

Therefore, the route preservation process continues to monitor network status. A notification is sent to the relevant node in case of a failure on the road. Thus, nodes change their route cache entries.

The main difference between DSR and AODV is in the way they keep the information about the routes: in DSR it is stored in the source while in AODV it is stored in the intermediate nodes. However, the route discovery phase of both is based on flooding. This means that all nodes in the network must participate in every discovery process, regardless of their potential in actually contributing to set up the route or not, thus increasing the network load[10].

Advantages of DSR:

- With use cache, route discovery overhead decrease.
- Support multipath routing
- No need periodic beaconing or hello message exchange.

Weakness of DSR:

- Not effective for large networks
- In consequence of source routing, package size continues to increase along with route length.
- Suffer from high route discovery latency

## IV. Experiment Method

In this experiment use ns-2 as software simulator. Three MANET routing protocols are implemented in simulations, ie AODV, DSDV and DSR. MANET simulation using RandomWaypoint mobility model that generated using Bonnmotion software [11]. The simulation parameters are shown in Table I. The distance coverage of simulation activity is 1.000 $m^2$.

Table I. Simulation Parameter

| Simulation parameter | Value/description |
|---|---|
| Chanel type | Channel/Wireless Channel |
| MAC type | MAC/802_11 |
| Number of node | 100/150/200/250 |
| Traffic Pattern | Constant Bit Rate (CBR) |
| Network size | 1000 x 1000 |
| Simulation time | 900 s |
| Protocol routing | AODV, DSDV, DSR |
| Mobility model | RandomWaypoint |

After the simulation perform, then evaluated the performance of each routing protocol. The evaluation is done on variable packet delivery ratio (PDR), throughput, average end to end delay, packet loss and normalized routing load (NRL).

Packet Delivery Ratio (PDR) is the ratio between packets sent to destination and the total number of packets.

Throughput is the ratio between the number of successfully transmitted and the total simulation time.

Average End to End Delay is the average time required by packets to move from source to destination.

Packet Loss is the total of packets dropped in the router.

Normalized Routing Load is the ratio of the total packet routing that was successfully sent and the number of data packets.

## V. Result and Discussion

The experiment was carried out by applying the MANET routing protocol to the Random Waypoint mobility model. Routing protocols used are AODV, DSDV and DSR. The simulation was performed using NS-2 software which stands for Network Simulator Version 2. NS-2 was chosen because it provides simulation and research support for wired and wireless networks using TCP, UDP, IP and CBR communication patterns [12]. The number of nodes used in the simulation is successive, 100, 150, 200 and 250 nodes respectively. Length of simulation time 900 s.

The packet delivery ratio (PDR) measurement results are shown in Fig. 2. As the number of node 100 AODV protocols has the highest PDR while DSDV has the lowest PDR value. The greater the number of nodes of PDR values in the AODV and DSR protocols tend to be constant, whereas the DSDV fluctuates at the number of nodes 200. The DSDV protocols PDR value is the lowest when the number of nodes 200, but again increases as the number of nodes 250.

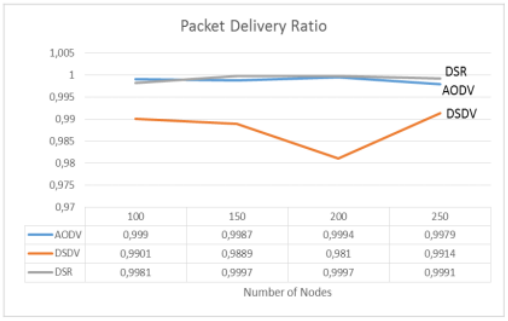


Fig. 2. Packet Delivery Ratio (PDR) measurement

As shown in Fig. 2, the difference between PDR values between routing protocols is not so far. DSDV has the lowest PDR value compared to the other two routing protocols, AODV and DSR. This indicates that the reactive routing protocol has a better PDR value compared to the proactive routing protocol.

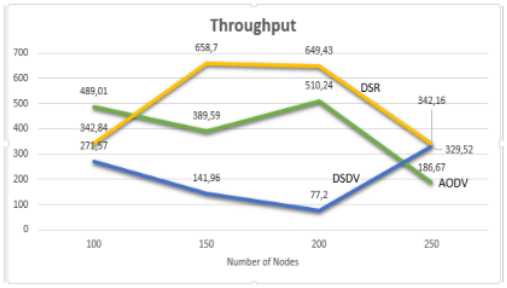


Fig. 3. Throughput Measurement

The throughput measurement results are shown in Fig. 3. As the number of nodes 100, the largest throughput value is achieved by the AODV protocol. The largest throughput value is achieved by the DSR protocol at the number of nodes 150. Of the three routing protocols, the DSDV has the lowest througput value at the node number 100, 150 and 200. But at the node number 250, the DSDV througput value is better than the AODV throughput value. Overall reactive routing protocol throughput value is better than proactive routing protocol. This is because in reactive routing protocol, the route is established when the packet need to be forwarded. So, this action can improve the throughput.

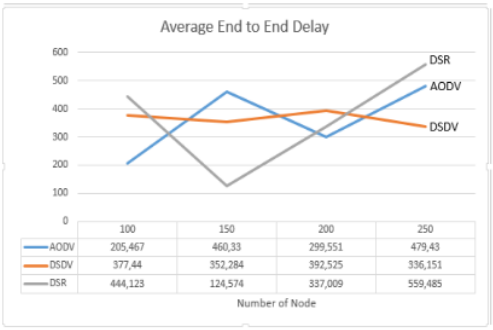


Fig. 4. Average end to end delay

The average end to end delay values for the three protocols are shown in Fig. 4. The average end to end delay DSDV tends to be constant when there are additional nodes, whereas for AODV and DSR fluctuates. This is because on DSDV each node will maintain the overall routing table. While on AODV and DSR routing lines are determined when needed to forward packets. The addition of number of nodes resulted in the average value of end to end delay of AODV and DSR increase. This is indicated when the number of nodes increases to 250 nodes. From the average end to end delay the proactive routing protocol is better than the reactive routing protocol. This is because in proactive routing protocol, every node update routing table through the network at certain time. While in reactive routing protocol, the route is established when packet need to be forwarded. It is caused delay on packet delivery.

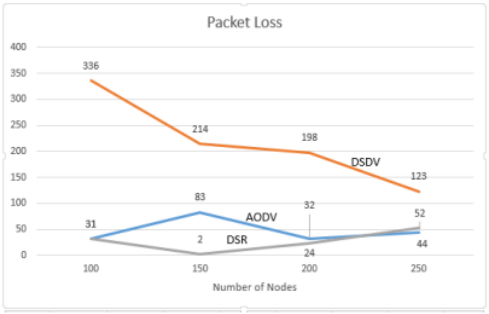


Fig. 5. Packet loss

Packet loss measurements are shown in Fig. 5. Based on these images the largest packet loss is owned by DSDV for all nodes. At the node number 100, 150 and 200, the lowest packet loss is achieved by DSR. But at the time of the node 250 the lowest number of packet loss was achieved by AODV. The value of the packet loss recipes routing protocol is better than the proactive routing protocol.

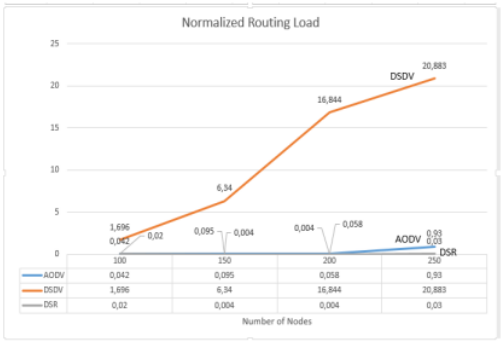


Fig. 6. Normalized routing load

The Normalized Routing Load (NRL) values for the three routing protocols are shown in Fig. 6. Based on those images the lowest NRL is achieved by DSR followed by AODV and DSDV. This indicates that the rective routing protocol has NRL better than the proactive routing protocol.

The simulation results are in line with [1] that shows that the DSR protocol has the best performance compared to other protocols.

## VI. Conclusion

This paper discusses the comparison of the performance proactive and reactive routing protocol based on RandomWaypoint mobility model. Proactive routing protocol represented by DSDV and reactive routing protocol represented by AODV and DSR. Routing protocol performance is measured by Packet Delivery Ratio (PDR), throughput, average end to end delay, packet loss and Normalized Routing Load (NRL). Based on experimental results obtained that DSDV protocol has the best value for average end to end delay, while for PDR value, throughput, packet loss and NRL, DSR protocol is best followed by AODV. Overall it can be concluded that reactive routing protocol is better than proactive routing protocol. In this case the reactive routing protocol is represented by AODV and DSR while the proactive routing protocol is represented by DSDV. Further research can apply the MANET routing protocol to specific activities, such as post-disaster handling. In this scenario, each node have some hierarchy that cause redundant traffic. Next study will apply routing protocol that differ hierarchy between node called hierarchy routing protocol.

## References

[1] M. N. Alslaim, H. A. Alaqel, and S. S. Zaghloul, "A comparative study of MANET routing protocols," *Beirut*, Lebanon, 2014.

[2] A. Azizan, M. F. Zuhairi, H. M. Salleh, and M. N. Ismail, "Optimised link state routing protocol testbed and performance evaluation," *International Journal of Computer Science and Network Security*, vol. 16, no. 10, pp. 32-37, October 2016.

[3] G. A. Kioumourtzis, *Simulation and Evaluation of Routing Protocols for Mobile Ad Hoc Networks (MANETs)*. Washington DC: Naval Postgraduate School, 2005.

[4] T. Linjun and W. Hanxing, "Performance analysis of route maintenance of MANET," Shanghai, China, 2009.

[5] R. K. Jradi and L. S. Reedtz, *Ad-hoc Network on Android*, Kongens Lyngby: Technical University of Denmark, 2010.

[6] O. Younes, *Modelling and Performance Analysis of Mobile Ad Hoc Networks*. Newcastle Upon Tyne, UK: Newcastle University, 2013.

[7] N. Chowdhury, *Olsr in Android Operating System*, Toronto: Program of Electrical and Computer Engineering Toronto, Ontario, Canada, 2013.

[8] S. Karthik, S. Kannan, V. P. Arunachalam, T. Ravichandran, and M. L. Valarmathi, "An investigation about performance comparison of multi-hop wireless ad-hoc network routing protocols in MANET," *International Journal of Computer Scie*, vol. 7, no. 3, pp. 35-41, May 2010.

[9] N. Kumar, V. Kumar, and N. Kumar, "Comparative study of reactive routing protocols AODV and DSR for mobile ad hoc networks," *International Journal of Computer Science and Information Technologies*, vol. 5, no. 5, pp. 6888-6891, October 2014

[10] A. Aggarwal, S. Gandhi, and N. Chaubey, "Performance analysis of AODV, DSDV, and DSR in manets," *International Journal of Distributed and Parallel System*, vol. 2, no. 6, pp. 167-177, November 2011.

[11] N. Aschenbruck, R. Ernst, E. Gerhards-Padilla, and M. Schwamborn, "BonnMotion - a mobility scenario generation and analysis tool," *Torremolinos*, Malaga, Spain, 2010.

[12] S. S. Jadhav, A. V. Kulkarni, and R. Menon, "Mobile Ad Hoc Network (MANET) for disaster management," Vijayawada, India, 2014.

**Bekti Maryuni Susanto** was born in Yogyakarta Province, Indonesia, in 1984. He received the Bachelor degree from the Yogyakarta State University, Indonesia in 2010 in Electrical Engineering Education and the Master degree from the STMIK Nusa Mandiri Jakarta, Indonesia, in 2012, in Computer Science. His research interests include computer network, internet of things and machine learning.

**Agus Hariyanto** was born in Jember, East Java Province, Indonesia, in 1978. He received the Bachelor degree from the Institut Teknologi Sepuluh November, Surabaya, Indonesia in 2003 in Informatic Engineering the Master degree from the Institut Teknologi Sepuluh November, Surabaya, Indonesia, in 2011. His research interests include computer network, internet of things and machine learning.

**Surateno** was born in Jember, East Java Province, Indonesia, in 1979. He received the Bachelor degree from the Institut Teknologi Sepuluh November, Surabaya, Indonesia in 2003 in Informatic Engineering the Master degree from the Institut Teknologi Sepuluh November, Surabaya, Indonesia, in 2010. His research interests include computer network, internet of things and machine learning.

# Performance Comparison of Proactive and Reactive Routing Protocol in Mobile Ad Hoc Network

ORIGINALITY REPORT

| 20% | 21% | 8% | 17% |
|---|---|---|---|
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
|---|---|---|
| 1 | pdfs.semanticscholar.org<br>Internet Source | 5% |
| 2 | airccse.org<br>Internet Source | 5% |
| 3 | www.ijsret.org<br>Internet Source | 3% |
| 4 | Submitted to Higher Education Commission Pakistan<br>Student Paper | 2% |
| 5 | ijarcsse.com<br>Internet Source | 2% |
| 6 | baadalsg.inflibnet.ac.in<br>Internet Source | 2% |
| 7 | www.ijcit.com<br>Internet Source | 2% |

| | | | |
|---|---|---|---|
| Exclude quotes | On | Exclude matches | < 2% |

Exclude bibliography On