International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 7, Issue 9, September 2018, ISSN: 2278 -7798

Performance Analysis of On Demand Routing Protocols in Vehicular Ad Hoc Network (VANET)

May Zar Win, Khin Khat Khat Kyaw, Cho Cho Myint

***Abstract*—Vehicular ad-hoc network (VANET) is an intelligent network technology in wireless communication where the vehicles act as a mobile nodes to share data without any central point for a safety issue. VANET protocols are important for road-safety, traffic efficiency and management applications. In city, vehicles are very crowded in roads. When VANET communication on city map is performed, routing overhead is an essential point to reduce in VANET. Among the current routing protocols, reactive routing protocols are favoured in mobile ad-hoc network (MANET) because they help in reducing overheads by continuously sending the data for better communication. In order to design a suitable and efficient routing protocol in VANET, a comprehensive study on popular existing VANET routing protocols must be considered as a tangible need. In this paper AODV, AOMDV and DSR routing protocols on real traffic environments are tested and analyzed the packet delivery ratio, end-to-end delay, throughput and routing overhead of VANET. The Simulation studies are analyzed using NS2.**

***Index Terms*—VANET, MANET, AODV, AOMDV, DSR, NS2.**

1) Introduction

Vehicular Ad-Hoc Networks (VANETs) are special type of Mobile ad Hoc Networks (MANETs), where wireless-equipped vehicles form a network spontaneously while traveling along the road. VANET is uniquely differentiated based on two special & unique characteristics of wireless networks such as high dynamic connectivity in network and frequently change of network topology. These two properties separate the VANET from other networks such as MANET etc. the increased utilization of vehicles on roads, also increases the road accidents, unsafe journeys and polluted environment etc. and these things motivated us to initiate this work. To assure the safe journey of passengers, drivers and provide the comfortable and easy driving environment, different messages for different requirement are communicated to nearby vehicles called the inter-vehicle communications. Vehicular network have two main types of communications. One main type of communication is vehicle to vehicle or on-board unit (OBU) V2V and second is Vehicle to infrastructure or Road Side Unit (RSU) V2I communication as shown in Figure 1.

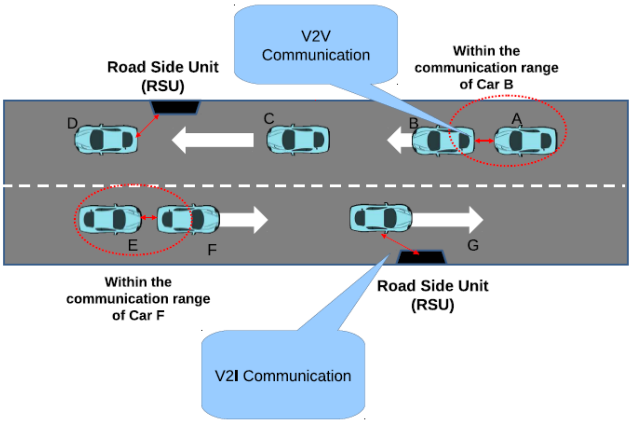

Figure 1. Vehicular Adhoc Network (V2V and V2I)

There are many routing protocols for ad hoc networks [1], [2], [3]. Here we are considering AODV, AOMDV and DSR routing protocol based on two parameters: vehicle velocity and vehicle density. Ad Hoc On-Demand Distance Vector (AODV) is one of the promising available reactive routing algorithms. AODV is an on demand routing protocol. This protocol finds routes for a node only when it has data packet for transmission. AODV routing consists of three phases: route discovery, data transmission and route maintenance. Ad Hoc On-Demand Multipath Distance Vector (AOMDV) [4] routing protocol is an extension to the AODV protocol for computing multiple loop-free and link disjoint paths. The Dynamic Source Routing (DSR) protocol is based on secure routing method. In this algorithm the mobile node whose want to send data in network knows the complete path of destination and store that in route cache.
The contents are organized as follows. The next section is a brief of Related Work and section 3 discusses about the overview of AODV, AOMDV and DSR routing protocol. Finally, the simulation results and conclusion are presented in section 4 and section 5.

2) Relaed Works

Several research studies have been carried out to enhance the routing on VANET. The performance analysis of the protocols is the major step before selecting a particular routing protocol. In fact, path routing and protocol selection are the primary strategies to design any vehicular ad-hoc

Manuscript received September, 2018.
May Zar Win, *is with the Department of Information Technology of West Technological University, Yangon, Myanmar (corresponding author to provide phone: 09443219566).*
Dr. Khin Khat Khat Kyaw*, is with the Department of Information Technology of West Technological University, Yangon, Myanmar.*
Dr. Cho Cho Myint*, is with the Department of Information Technology of West Technological University, Yangon, Myanmar.*

network considering data delivery, data integrity and especially time delivery.

Routing in VANET can be proactive, reactive and hybrid. Reactive schemes maintain routes to the nodes only when required, which reduces the routing overhead. A proactive routing scheme periodically finds the routes to all of the nodes within the network, which causes an increase in routing overhead [4]. Link state routing algorithms are usually used by proactive schemes. The delay encountered, when the packet needs to be sent to a particular node, is less for the proactive schemes as compared to the reactive schemes. However, the routing overhead of the proactive schemes are more as compared to reactive schemes. Moreover, the convergence time for proactive schemes is high as compared to the reactive schemes. Therefore, the efficiency of the proactive scheme decreases for a network where the topology changes frequently. A hybrid routing scheme - Zone Routing Protocol (ZRP) [5] combines the features of both the proactive and reactive schemes.

In [6], authors illustrate the differences between AODV, DSR and DSDV based on TCP and CBR connection with various network parameters. The performance of these three routing protocols shows some differences in low and high node density. Indeed, in low density with low pause time, the PDR of CBR connection for these routing protocols is low. While for TCP connection, the PDR is high for DSR and average for DSDV.

In [7], DSR is a reactive routing protocol in which the primary aspect is to store the whole path from source to destination in the routing table instead of having the next hop stored (AODV routing protocol). Therefore, the packet header must include all nodes through which the packet must travel to be delivered to the destination. Similar to AODV, the RREQ and RREP are used to perform the route discovery and delivering the reply message back to the source. DSDV is a proactive routing protocol which maintains the route to the destination before it is required to be established. Nodes exchange their routing tables periodically or when it is required to be exchanged.

3) Routing Protocols in VANET

Many routing protocols have been developed for VANETs, which are classified in the literature [8],[9] in different ways and according to many aspects. On Demand routing protocols work on the principle of creating routes as and when required between a source and destination node pair in a network topology. Our discussion is limited to three on-demand ad-hoc routing protocols AODV, AOMDV and DSR, as follows.

1) Ad-hoc On-demand Distance Vector (AODV)

AODV is a famous on-demand routing protocol for ad hoc network, which consists of route discovery and route maintenance processes. It uses three kinds control messages: Route Request (RREQ), Route Reply (RREP) and Route Error (RERR) [10].

When a source node wants to send data packets to destination, it needs to look for available routing information in route table. If no available route exits, route discovery is initiated. To handle this process, the source node broadcasts a route request (RREQ) for the destination. An intermediate node receiving RREQ first sets up a reverse route to the source node if needed, then rebroadcasts the RREQ. If an intermediate node is the destination or has a “newer” route to the destination, it may generate a RREP. When the RREP routes back to the source via the reverse path established previously, a forward path to the destination can be established by intermediate nodes based on the information carried by RREP. When the RREP arrives at the source, a route between the source and destination is built up. The source node uses expanding ring search when discovering new routes to limit flooding of the network wide and reduce the overhead.

In AODV, hello message, local repair, RREQ and RERR packet are used in route maintenance process. Nodes in the active routes periodically broadcast hello message to their neighbors to announce the connectedness. Its neighbors update their route table according to the information carried by hello message. If a node doesn’t receive hello message within fixed intervals, the corresponding node is considered to be unreachable, and this node initiates local repair mechanism by broadcasting RREQ downstream if its location is rather close to the destination. During local repair process, the initial node buffers data packets until receiving the corresponding RREP which means new route is reconstructed. However, if local repair is unsuccessful, this node sends RERR packet to the source node. As a result, the source node will try to reestablish a new route discovery process, and intermediate nodes may detect the link break.

2) Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV)

Ad hoc On-demand Multipath Distance Vector (AOMDV) [11, 12] is an extension to the AODV protocol for computing multiple loop-free and link-disjoint paths. AOMDV is a reactive hop-by-hop routing protocol which finds node/link-disjoint multiple paths. In AOMDV when a source has packets to send to a destination and finds no routes in its routing table, it invokes a route discovery by broadcasting RREQ packets. Route discovery in AOMDV is similar to AODV. A RREQ packet in AOMDV includes all fields as that in AODV. Besides, it includes an additional field called the last hop, i.e., the neighboring node of the source. This information and the next-hop information, i.e., the node from which to receive the RREQ, are used to achieve link-disjointness for reverse paths to the source. A node may receive multiple duplicate RREQ packets. For each packets received, it examines if an alternate reverse path to the source can be formed such that loop-freedom and link-disjointness are preserved. In an attempt to get multiple link-disjoint routes, the destination replies to duplicate RREQs, the destination only replies to RREQs arriving via unique neighbors. After the first hop, the RREPs follow the reverse paths, which are node disjoint and thus link-disjoint. The trajectories of each RREP may intersect at an intermediate node, but each takes a different reverse path to the source to ensure link disjointness. The advantage of using AOMDV is that it allows intermediate nodes to reply to RREQs, while still selecting disjoint paths. But, AOMDV has more message overheads during route discovery due to increased flooding and since it is a multipath routing protocol, the destination replies to the multiple RREQs those results are in longer overhead.

3) Dynamic Source Routing (DSR)

The Dynamic Source Routing (DSR) is an on demand source routing protocol [13] that employs route discovery and route maintenance procedures similar to AODV. In DSR, each node maintains a route cache with entries that are continuously updated as a node learns new routes. Similar to AODV, a node wishing to send a packet will first inspect its route cache to see whether it already has a route to the destination. If there is no valid route in the cache, the sender initiates a route discovery procedure by broadcasting a route request packet, which contains the address of the destination, the address of the source, and a unique request ID. As this request propagates through the network, each node inserts its own address into the request packet before rebroadcasting it. As a consequence, are quest packet records a route consisting of all nodes it has visited. When a node receives a request packet and finds its own address recorded in the packet, it discards this packet and does not rebroadcast it further. A node keeps a cache of recently forwarded request packets, recording their sender addresses and request IDs, and discards any duplicate request packets. Once a request packet arrives at the destination, it will have recorded the entire path from the source to the destination. In symmetric networks, the destination node can unicast a response packet, containing the collected route information, back to the source using the exact same path as taken by the request packet.

4) Simulation And Test Results

1) Simulation Tools

The performances of the protocols have been studied using simulation tools mainly Network Simulator 2 (NS2) and SUMO (Simulation of Urban Mobility).

- NS2: Network Simulator (Version 2), widely known as NS2, is simply an event driven simulation tool that has proved useful in studying the dynamic nature of communication networks. Simulation of wired as well as wireless network functions and protocols (e.g., routing algorithms, TCP, UDP) can be done using NS2 It consists of two simulation tools. The network simulator (ns) contains all commonly used IP protocols. The network animator (nam) is use to visualize the simulations. Ns-2 [14] fully simulates a layered network from the physical radio transmission channel to high-level applications. The simulator was originally developed by the University of California at Berkeley and VINT project the simulator was recently extended to provide simulation support for ad hoc network by Carnegie Mellon University (CMU Monarch Project homepage, 1999).

NS2 consists of two key languages: C++ and Object-oriented Tool Command Language (OTcl) while the C++ defines the internal mechanism (i.e., a backend) of the simulation objects, the OTcl sets up simulation by assembling and configuring the objects as well as scheduling discrete events (i.e., a frontend). As shown in figure The C++ and the OTcl are linked together using TclCL After simulation, NS2 outputs either text-based or animation-based simulation results.

- Real Traffic Generator (SUMO)

The SUMO simulator is an open source and real time traffic simulation package including net import and demand modeling components. To design and implementation of VANET in urban environment, we downloaded the Yangon city (Myanmar), OSM file from OpenStreetMap [15] and created a real time road traffic scenario using SUMO 0.26 simulator with a real traffic as shown in below figure 2 and detailed view of communication is shown figure 3. The mobility of traffic data is generated in SUMO trace exporter, which will be exported to NS2 simulator which is used as vehicular network simulator for analyzing the VANET performance.

Figure 2: Yangon City Map from OpenStreetMap

By using sumo commands such as netconvert and polyconvert, we are able to convert the open street map OSM data into configuration (cfg) file. These configuration files are used to store information and settings. We can also generate trace files which is a very important step in order to create a network scenario for the network simulator which is NS 2 in our case. The sumo package contains tools directory which contains exporter. We can use this either by using the newer command - Python Script or by using the traditional –jar file.

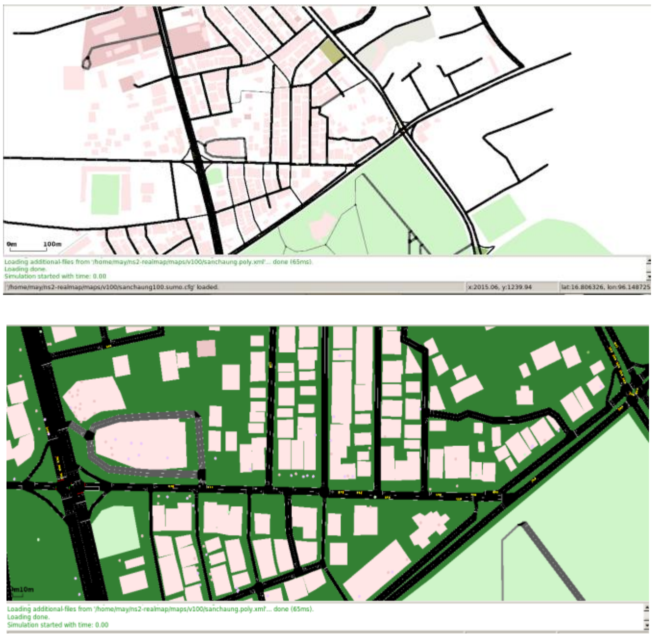

Figure 3: Yangon City Traffic Simulation in SUMO 0.26

2) Simulation Configuration

The main scope for this paper is to study the behaviors of the protocols in high dynamic and high offered load environments. Therefore, the number of vehicles and connections are varied. The simulation parameters used in experimental scenarios are shown in table1.

Parameters	Values
Network Simulator	NS2.35
Traffic Siulator	SUMO
Map Model	OSM (Yangon City)
Antenna Type	Omni Antenna
Routing Protocol	AODV,AOMDV, DSR
Simulation Time	200s
Number of Nodes	50, 100, 150,200
Number of connections	10, 20, 30, 40 TCP connections
Packet size	512 bytes

3) Network Performance Indicators

In order to analyze the simulation results, the following performance indicators were utilized in our study:

- Packet Delivery Ratio: the ratio between the number of packets received by the destination and the number of packets sent by the source.
- End-to-End Delay: the time taken for a packet to be transmitted across a network from source to destination.
- Throughput: refers to the number of packets successfully transmitted from sorce to destination. It has an important consideration in selecting a routing protocol for mobile networks.
- Routing Overhead: The number of control packets transmitted, with each hop-wise transmission of a control packet conted as one transmission.

4) Simulation Results

The simulation is aimed to analyze the impact of increasing the size of network on each Packet Delivery Ratio, End-to-End Delay, Throughput and Routing Overhead on different routing protocols (AODV, AOMDV, DSR) VANET environment using NS2 simulator. Two kinds of variable are considered in our simulation including the number of nodes (vehicles) and the number of simultaneous connections with various speeds of nodes.

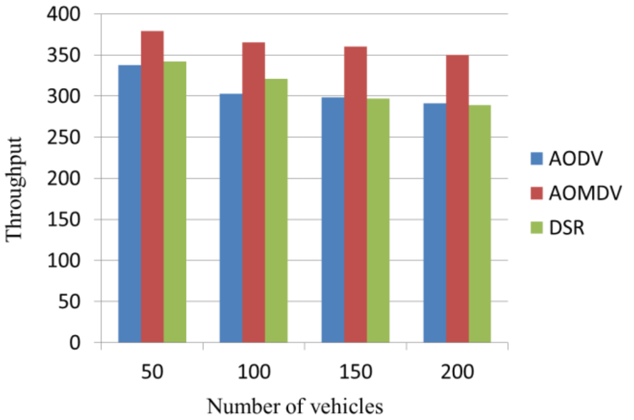

Figure 4: Throughput of AODV, AOMDV, DSR protocols

Figure 4 shows the throughput of our simulation of routing protocols. It indicates that AOMDV has best throughput and AODV and DSR have lower throughput than AOMDV. In the simulation of figure 4 and figure 5, the number of tcp connections is fixed to 10 simultaneous connections.

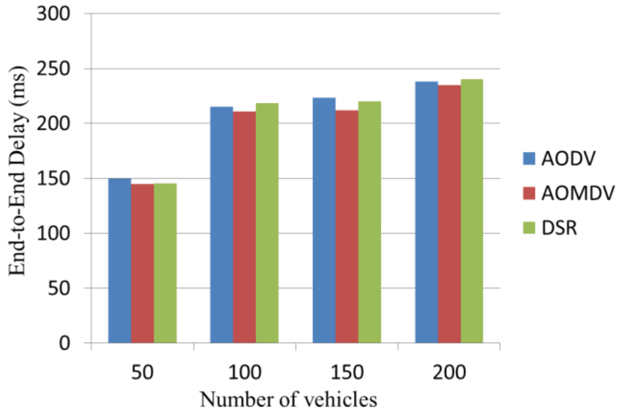

Figure 5: End-to-End Delay of AODV, AOMDV, DSR protocols

Figure 5 shows the delay time of our simulation of routing protocols. It indicates that AOMDV has lower delay than AODV and DSR. Indeed, switching directly to another alterative route gives in some cases some advantages than waiting for adjacent nodes to relay undelivery unicast packets. AODV and DSR slightly higher delay than AOMDV.

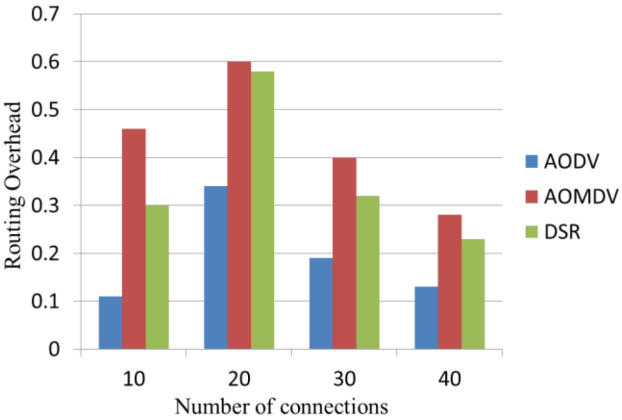

Figure 6: Routing Overhead of AODV, AOMDV, DSR protocols

Figure 6 shows the routing overhead of AODV, AOMDV, DSR protocols. It indicates AOMDV generates more routing overhead due to its multipath conception and maintenence than AODV and DSR. But AODV has best routing overhead value. In the simulation of figure 6 and figure7, the number of vehicles is fixed to 50 vehicles.

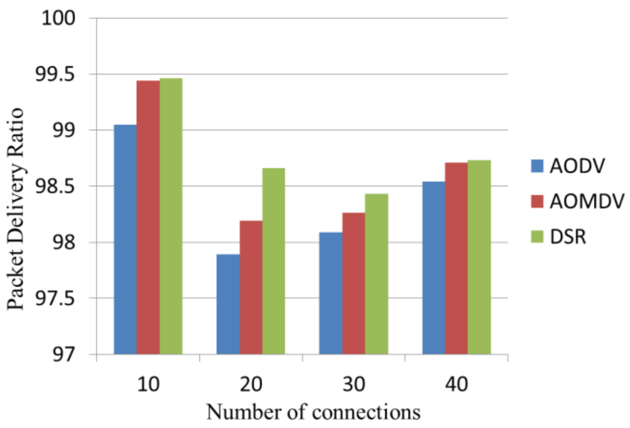

Figure 7: Packet Delivery Ratio of AODV, AOMDV, DSR protocols

Figure 7 shows packet delivery ratio (PDR) of AODV, AOMDV and DSR protocols. When the number of connections increases, DSR has highest PDR value than AODV and AOMDV protocols.

4) Conclusion

In summary, in this paper we analyze under realistic conditions different routing protocols namely AODV, AOMDV and DSR to evaluate their performance of answering the routing challenges in VANET context. Our results show that AOMDV gives better performance as compared to AODV and DSR in terms of throughput and end-to-end delay but worst in terms of routing overhead and packet delivey ratio. We have also seen that AODV routing protocol is best in terms of routing overhead and DSR routing protocol is best in terms of packet delivery ratio. Thus, we should take into account the connectivity problem caused by the various vehicles' velocity. Our task will be based on finding the relevant parameters that make us able to select the most reliable route duting the route selection process.

ACKNOWLEDGMENT

First of all, the author really thanks to Chairmen and Co-chairmen of Organization Committee for International Journal of Science, Engineering and Technology Research (IJSETR). She also likes to express her supervisor, her Head of Department, and all of her teacher from Department of Information Technology, West Yangon Technological University. She has provided not only helpful guidance but also a lot of inspiration, motivation and encouragement during my research work.

Finally, she is grateful to my parents and my family who specifically offered strong moral and physical support, care and kindness, during the year of my M.E study and anybody for overall supporting during my thesis.

REFERENCES

1) D. Johnson et al., "Dynamic Source Routing for Mobile Ad Hoc Networks", IEFT MANET Draft, April 2003.
2) S. Jaap, M. Bechler, L. Wolf. "Evaluation of routing protocols for vehicular ad hoc networks in city traffic scenarios", 11th EUNICE Open European Summer School on Networked Applications, Spain, July'05.
3) Royer et al., "A review of current routing protocols for ad hoc mobile wireless networks", IEEE Personal Communications, Apr'99. M. Zapata and N. Asokan, "Securing Ad-hoc Routing Protocols," in Proc. of ACM Workshop on Wireless Security (WiSe), Atlanta, GA, Sept. 2002.
4) H. Zafar, D. Harle, I. Andonovic, M. Ashraf, "Performance Evaluation of On-demand Multipath Routing Protocols for Mobile Ad Hoc Networks", Proc. Seventh IASTED International Conference of Wireless & Optical Communications, Montreal, Canada, pp. 325–329, May 2007.
5) S.R. Raju, K. Runkana, J. Mungara, "ZRP versus AODV and DSR: A Comprehensive Study on ZRP Performance on MANETs", Proc. International Conference on Computational Intelligence and Communication Networks, Bhopal, India, pp. 194-199, Nov. 2010.
6) H.D.Trung, W.Benjapolakul, P>M>Duc, "Performance evaluation and Comparison of different ad hoc routing protocols" , Department of Electrical Engineering , Chulalongkorn University, Bangkok, Thailand, May 2007.
7) B. Paul, A. Roy, and S. K. Paul. Comparison of DSR, AODV, and DSDV Routing Protocols with Varying Pause Time and Node Density over TCP and CBR Connections in VANET. IEEE, 2014.
8) N. H. Saeed, M. F. Abbod, and H. S. Al-Raweshidy.MANET routing protocols taxonomy.IEEE, 2012.
9) M. Altayeb and I. Mahgoub. A survey of vehicular ad hoc networks routing protocols. International Journal of Innovation and Applied Studies, 3(3):829–846, 2013.
10) C. Perkins, "Ad Hoc On-Demand Distance Vector (AODV) Routing," RFC3561, IETF MANET Working Group, July 2003.
11) M. Marina and S. Das, Ad hoc on-demand multipath distance vector routing, ACM Mobile Comput. Commun. Rev. 6 (2002) (3), pp. 92–93.
12) M. K. Marina and S.R. Das, On-demand multi path distance vector routing in ad hoc networks, Proceedings of the Ninth International Conference on Network Protocols, IEEE Computer Society, Washington, DC, USA (2001), pp. 14–23.]
13) D. B. Johnson and D. A. Maltz, ―Dynamic Source Routing in Ad Hoc Wireless Networks, Mobile Computing, Chapter 5, pp. 153-181, Kluwer Academic Publishers, 1996.
14) NS2, Network Simulator 2, http://www.nsnam.org.
15) OpenStreetMap, https://www.openstreetmap.org/

May Zar Win received her BE (Information Technology) degree from Technological University (Pathein), Ayeyarwady, Myanmar. She is doing postgraduate research for master degree at Information Technology Department, West Yangon Technological University. Her research is concerned Data Communication and Networking. She is also a Assistant lecturer at Technology University Pathein.

Dr. Khin Khat Khat Kyaw (Associate Professor), Department of Information Technology of West Yangon Technological University, Yangon, Myanmar.

Dr. Cho Cho Myint (Professor), Department of Information Technology of West Yangon Technological University, Yangon, Myanmar.