PAPER Special Section on Parallel and Distributed Computing and Networking

Location-Based Routing Scheme with Adaptive Request Zone in Mobile Ad Hoc Networks

Putthiphong KIRDPIPAT[†a)], ***Student Member and*** **Sakchai THIPCHAKSURAT**[†b)], ***Nonmember***

SUMMARY Route discovery process is a major mechanism in the most routing protocols in Mobile Ad Hoc Network (MANET). Routing overhead is one of the problems caused by broadcasting the route discovery packet. To reduce the routing overhead, the location-based routing schemes have been proposed. In this paper, we propose our scheme called Location-based Routing scheme with Adaptive Request Zone (LoRAReZ). In LoRAReZ scheme, the size of expected zone is set adaptively depending on the distance between source and destination nodes. Computer simulation has been conducted to show the effectiveness of our propose scheme. We evaluate the performances of LoRAReZ scheme in the terms of packet delivery fraction (PDF), routing overhead, average end-to-end delay, throughput, packet collision, average hop count, average route setup time, and power consumption. We compare those performance metrics with those of Location Aided Routing (LAR) and Location Aware Routing Protocol with Dynamic Adaptation of Request Zone (LARDAR) protocols. The simulation results show that LoRAReZ can provide all the better performances among those of LAR and LARDAR schemes.

key words: *MANET, expected zone, request zone, LARDAR, LoRAReZ*

1. Introduction

Mobile Ad Hoc Network (MANET) is an infrastructure-less networking. Mobile node in MANET communicates with each other by sharing the limited radio channel in peer to peer fashion. Mobile node operates as a router by forwarding packet to other nodes in order to establish the communication path between source node and destination node.

Routing protocol is one of the major topics in MANET. Several routing protocols have been proposed to improve the network performance [1]–[3]. These protocols are reactive protocols in which the source node will broadcast the route request packet to entire network for discovering the route to the destination node. However, some nodes may not locate in the path between the source and destination nodes have to process those packets thereby increasing the routing overhead and power consumption. To reduce the routing overhead, the location-based routing schemes have been proposed [4]–[8]. Those schemes use the concept of setting the expected zone and request zone for limiting the route searching area thereby decreasing route discovery packet. The authors in [4] and [5] propose the request zones by using the rectangular shapes. The request zone in [6]–[8] is proposed by considering the triangular request zone that smaller size than those of [4] and [5]. In [6], the author proposes the mechanism of expanding the request zone size when the first of route discovery process is failed. The greedy algorithm is proposed in [7]. This algorithm selects the node in request zone for sending the data packet until reach the destination node without broadcasting the route discovery packet but the node selection may error if the node position is not correct. The adaptive request zone was proposed in [8]. In this scheme, the request zone can be explained in case of the source node could not found the route to the destination node during broadcasting the first route discovery packet.

In this paper, we propose Location-based Routing Scheme with Adaptive Request Zone called LoRAReZ scheme. In LoRAReZ scheme, the size of expected zone and request zone may not be fixed. They can be set adaptively depending on the distance between the source and destination nodes. The necessary information of node such as the node position and time stamp are used to set the size of expected zone and request zone adaptively. Using the techniques of adaptive expected zone and request zone, the routing overhead may be decreased. The network may be able to support more packets. As the result, the performance of MANET may be improved.

The rest of this paper is organized as follows. Section 2 describes the related work. Section 3 presents Location-based Routing with Adaptive Request Zone (LoRAReZ). The performances of LoRAReZ are shown in Sect. 4. Finally, the conclusion of this paper is given in Sect. 5.

2. Related Work

In location-based routing protocol, the several schemes have been proposed to decrease the size of request zone to small size and adjust the direction of request zone adaptively for tracking the mobility of the destination node.

Y.-B. Ko and N.H. Vaidya [4] propose a Location Aided Routing (LAR). LAR scheme assumes that the current location is precise and the mobile node can move in two dimensional planes. In this scheme, the expected zone is first determined as the expected location of the destination node at the time of route discovery process. Depending on the size of expected zone, the request zone can be set for limiting the route searching area. The necessary information such as node position and time stamp of the destination node used to define the both zones. These information may be obtained through Global Positioning System (GPS)

Manuscript received January 2, 2013.

Manuscript revised May 7, 2013.

[†]The authors are with the Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang, Bangkok, 10520, Thailand.

a) E-mail: s2610139@kmitl.ac.th

b) E-mail: ktsakcha@kmitl.ac.th

DOI: 10.1587/transinf.E96.D.2565

and exchanged among the nodes in the network by using hello message for maintaining in the Position Information Table (PIT). In the route discovery process, the source node S knows the position of the destination node D which locates at the position X_0, Y_0, and time stamp t_0. Then, at the time of route discovery process (t_1), the source node S will determine the expected zone by creating a circular area around the destination node with the radius of $R = V.\ (t_1 - t_0)$ where V is the speed of node, as shown in Fig. 1. Then, the request zone can be defined for limiting the route searching area. If any nodes are not located in the request zone, those nodes will not consider the route discovery packet.

LAR scheme is not appropriate to support a large scale of network due to the routing overhead depends on the size of request zone. If the source node and destination node locate far away, the size of request zone must be set to the larger size.

S. Basagni et al. [7] propose A Distance Routing Effect Algorithm for Mobility (DREAM). DREAM scheme is a location-based routing protocol that uses the triangular shape for request zone which is smaller than that of LAR scheme. This scheme uses a greedy algorithm to select node in the triangular request zone for sending the data packet to destination node without broadcasting the route discovery packet. The frequent update of node position and time stamp in the network for each node depends on the distance effect and mobility rate. For example, if the two nodes move separately far away or they move slowly. The both information in the database will be updated less frequently than the nodes which move close to each other or with the higher speed. This scheme is shown in Fig. 2. In DREAM scheme, if the source node S has to send the data packet to the destination node D, it will define the expected zone based on LAR concept by using the location of the destination node D which locates at X_0, Y_0, and time stamp t_0. The triangular request zone is defined between the source node S to the destination node D that related to the expected zone for selecting the sending node based on the greedy algorithm.

DREAM scheme has some restriction as follows: Firstly, suppose, the source node S selects the node I_1 for sending the data packet based on the greedy algorithm. Suppose, the node I_2 moves to the position I'_2 but the node I_1 may not know. The node I_1 selects and sends the data packet to the node I'_2. As the result, the node I_1 will send the data packet out of the triangular request zone. This event may occur to the several nodes including the destination node D. However, DREAM scheme doesn't have the mechanism to adapt the triangular request zone when the destination node moves during the source node S selects one neighbor node in the triangular request zone for sending the data packet to the destination node D [8]. Secondly, the positions of nodes must be known exactly.

T.-F. Shih and H.-C Yen [8] propose Location-Aware Routing Protocol with Dynamic Adaptation of Request Zone for Mobile Ad Hoc Networks (LARDAR). In this scheme, the expected zone and triangular request zone are set as same as DREAM scheme. The restriction of DREAM has been improved by adapting the triangular request zone when the destination node D changes the position. LARDAR improves the searching area by expanding the triangular request zone in case of the previous route discovery process is fail by expanding the request zone for 10 degrees until to 90 degrees. As shown in Fig. 3, the source node S broadcasts the route discovery packet, if the node I_1 cannot forward the route discovery packet to the other nodes. The searching area of triangular request zone is expanded

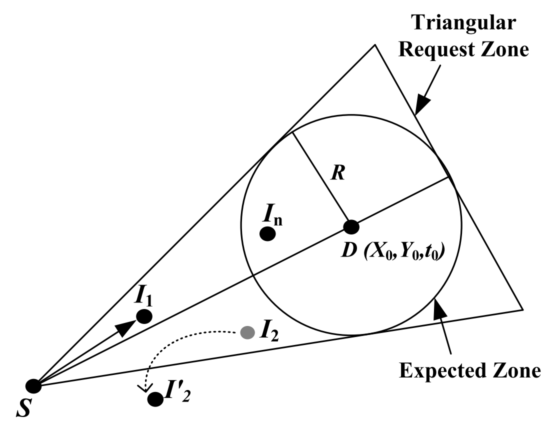

Fig. 2 Expected zone and triangular request zone in DREAM scheme.

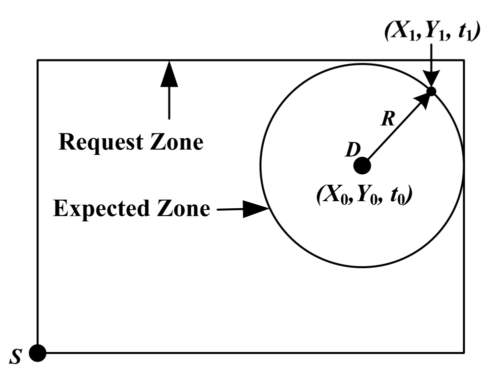

Fig. 1 Expected zone and request zone in LAR scheme.

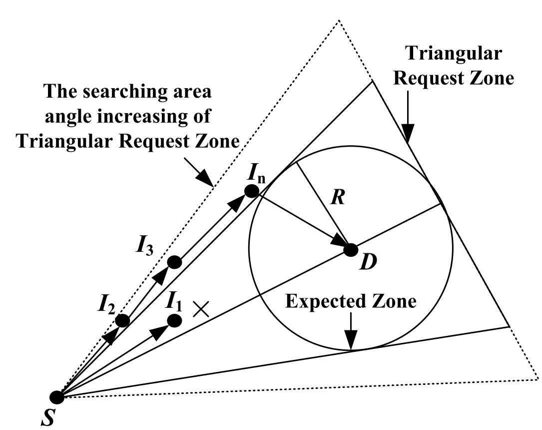

Fig. 3 Expected zone and triangular request zone in LARDAR scheme.

for 10 degrees. The mobile nodes who are located in the previous triangular request zone will not be considered as the intermediate node on the route any more such as node I_1. Thus, the node I_2, I_3, and I_n will forward the route discovery packet to the other nodes until reach the destination node D. The routing overhead and packet collision in the network may be decreased.

However, LARDAR scheme has also restrictive as the follows: 1) LARDAR scheme has not consider for the real time service. 2) LARDAR scheme did not consider the relation between the routing overhead and the wasting of power consumption during route discovery process. 3) The selected route from source node and destination node may not be shortest due to the expanding of the searching area of the triangular request zone. This may cause the longer route with longer end-to-end delay.

3. Location-Based Routing Scheme with Adaptive Request Zone

Several proposed location-based routing schemes [4]–[9] have confirmed that by utilizing the location information of node. We can limit the area of searching a new route in MANET to a smaller request zone resulting in reducing the routing overhead thereby improving the network performance. Those related works have encourage us to carefully consider for further improving the performances of MANET. In this section, we explain the detail of our proposed scheme called Location-based Routing with Adaptive Request Zone (LoRAReZ). The mechanisms of LoRAReZ can be divided into two mechanisms, as shown in Fig. 4:

- The expected zone selection mechanism : This mechanism is the first step of the LoRAReZ scheme process or initialization process for determining the size of expected zone (R_i) before any nodes in the network can communicate each other. The objective of this mechanism is to select the size of expected zone for each range of the distance between the source node and destination node which will be used for setting the expected zone in the request zone setting mechanism.
- The request zone setting mechanism : In this mechanism, the request zone is set by using the size of expected zone which is obtained from the expected zone selection mechanism in order to set the request zone accordingly.

The objective of these mechanisms is to reduce the routing overhead. The detail of both mechanisms will be explained clearly in the following sections.

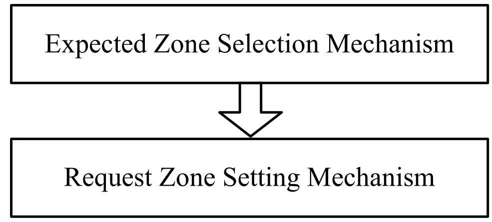

Fig. 4 Mechanism of LoRAReZ scheme.

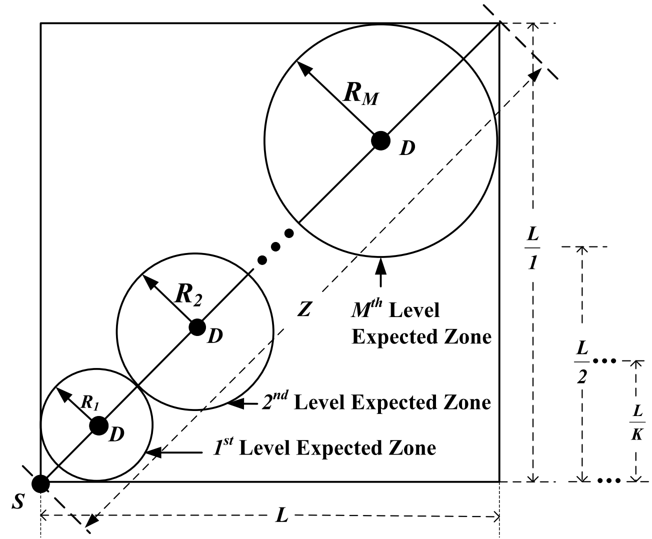

Fig. 5 The size of expected zone for various distance between the source node and destination node.

3.1 Expected Zone Selection Mechanism

In LoRAReZ scheme, the size of expected zone can be set to various sizes depending on the distance between the source node and destination node as shown in Fig. 5. As we have explained in the previous section, the expected zone mechanism is initialization process for selecting the size of expected zone which is done before the communication in the network will occur. The various size of expected zone can be obtained by assuming that the source node is placed at the lowest-left point and using the diagonal length of network area for determined the size of expected zone. The detail of the expected zone mechanism will be explained in this section. We assume that the network area has size of L meters x L meters. The network size (L) in real world can be considered depending on the application of MANET in the real environment such as MANET in university, MANET in airport, or MANET in sports stadiums, and MANET in shopping malls. In those environments, the network size (L) can be considered from the area of university, airport, sports stadiums and shopping malls, respectively. Within the network area, the diagonal length of network area is Z meters. We can divide Z into M expected zone size where M is the maximum number of expected zone sizes. Size of each expected zone has its own radius (R_i) where i is the level of the expected zone (i = 1,2,...,M) depending on the distance between the source node and destination node. The size of expected zone is set to small size if the source node and destination node are located close to each other. The size of expected zone becomes larger if the distance becomes larger. As we can see in Fig. 5, the 1^{st} level expected zone is smallest expected zone and the M^{th} level expected zone is a largest expected zone. The radius of i^{th} expected zone (R_i)

can be obtained by

$$R_i = \begin{cases} \frac{L}{K}, & if\ i = M, \\ R_{i-1} - \frac{L}{KM}, & for\ 1 < i < M,\ K = 1, 2 \ldots \end{cases} \quad (1)$$

Where $i = 1,2,\ldots,M$, M is the maximum number of expected levels, L is the size of network area, and K is the constant value which is denoted the number of partitions of L. The size of expected zone decreases with parameter L/KM.

The mechanism of selecting the expected zone is shown in Fig. 6. The distance between the source node and destination node and the range of each expected zone are considered for selecting the size of expected zone. The flowchart of expected zone selection mechanism is shown in Fig. 7.

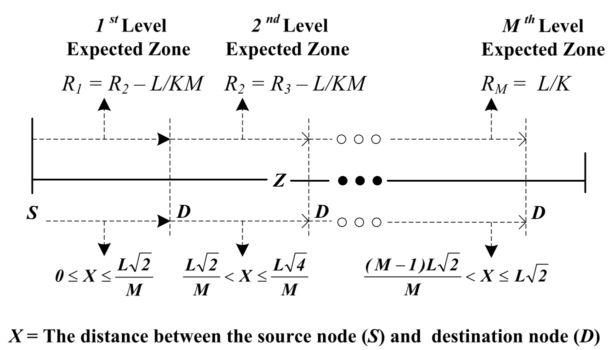

Fig. 6 Expected zone selection mechanism.

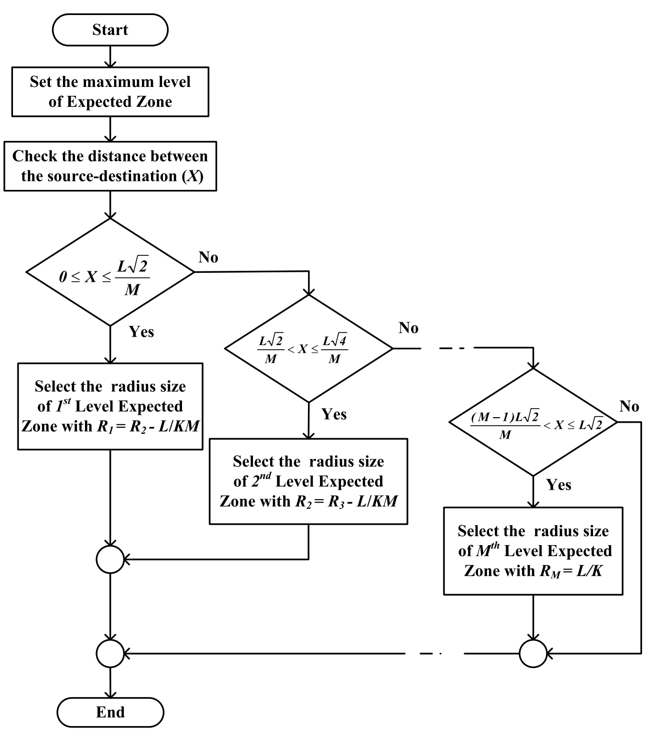

Fig. 7 Flowchart of selection mechanism.

3.2 Request Zone Setting Mechanism

From the expected zone selection mechanism, we obtain the selected level of expected zone which is releated to the distance between the source node and destination node as we have explained in the previous section. The request zone setting mechanisim will set the request zone according to the level of the expected zone as we can see in the Fig. 8. The size of request zone depending on the size of expected zone.

3.3 The algorithm of Location-based Routing with Adaptive Request Zone

In order to implement LoRAReZ scheme to MANET. We need to modify the algorithms for source node, intermediate node and destination node as we explain in the following sections.

3.3.1 Algorithm for Source Node

Whenever the source node needs to communicate with the destination node. The source node has to get the information such as destination node position, time stamp which are contained in the Position Information Table (PIT). Those information will be included in the route request packet. The route request packet is broadcast to the request zone. However, if the information of destination node could not be found, the route request packet will be broadcasted to the entire network. The algorithm of the source node is shown in Fig. 9.

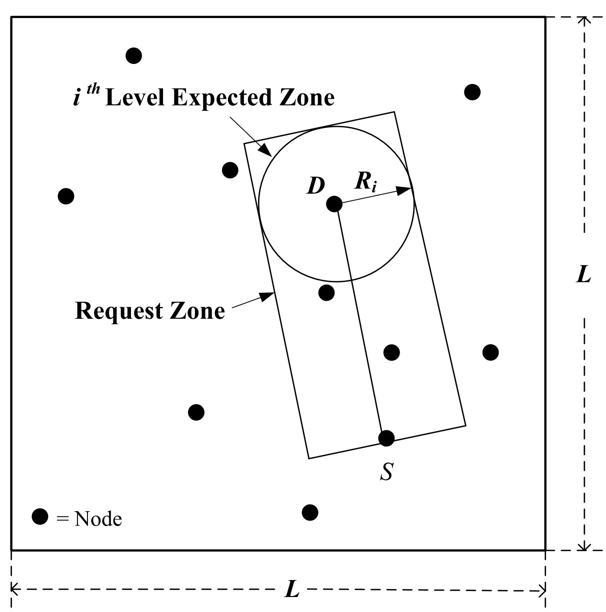

Fig. 8 Request zone setting mechanism.

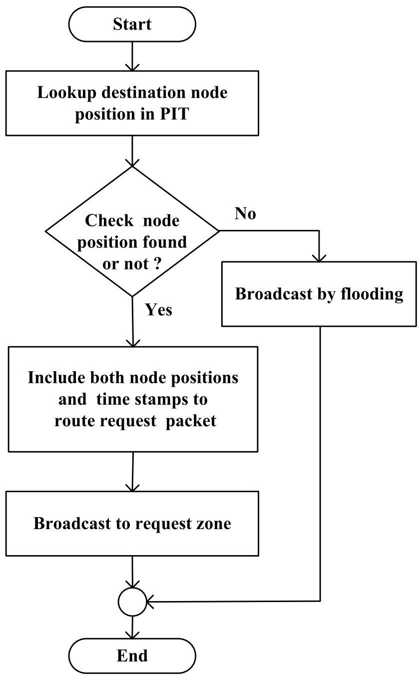

Fig. 9 Algorithm of the source node.

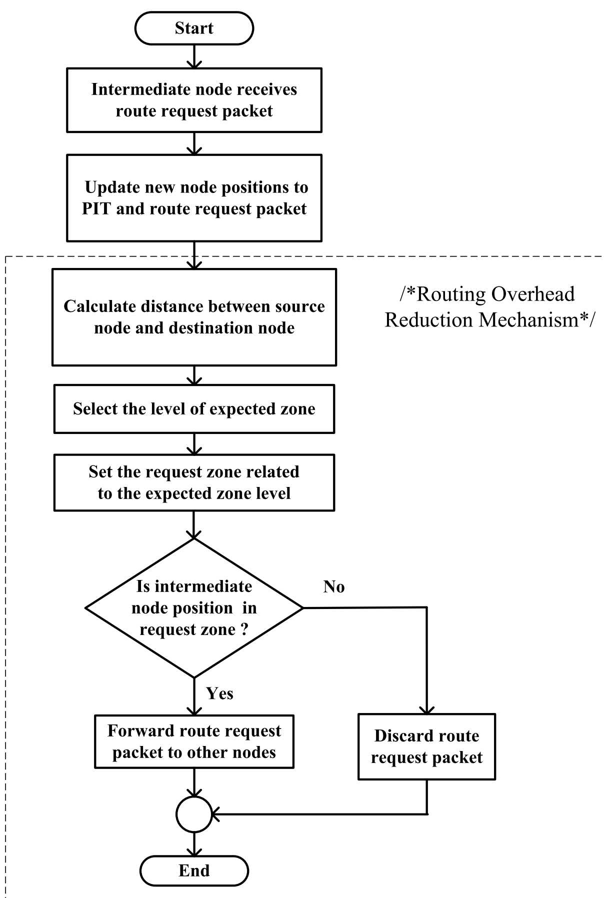

Fig. 10 Algorithm of the intermediate node.

3.3.2 Algorithm for Intemediate Node

In the intermediate node, after receiving the route request packet, it will update PIT if the node position and time stamp in the packet are up to date. Then, the adaptive request zone is considered based on the distance between the source node and destination node by selecting the level of expected zone. The intermediate node considers its position whether the position is in the request zone or not. The intermediate node will consider the route request packet if its position is in the request zone. Otherwise, the route request packet will be discarded. The algorithm of the intermediate node is shown in Fig. 10.

3.3.3 Algorithm for Destination Node

At the destination node, it may receive several route request packets. The destination node will first check whether the position of the source node changes or not. If it changes, the destination node will update the new position of the source node to PIT. The destination node selects only one route and then creates the route reply packet which is included the destination node position and time stamp. The route reply packet will be returned to the source node. The algorithm of

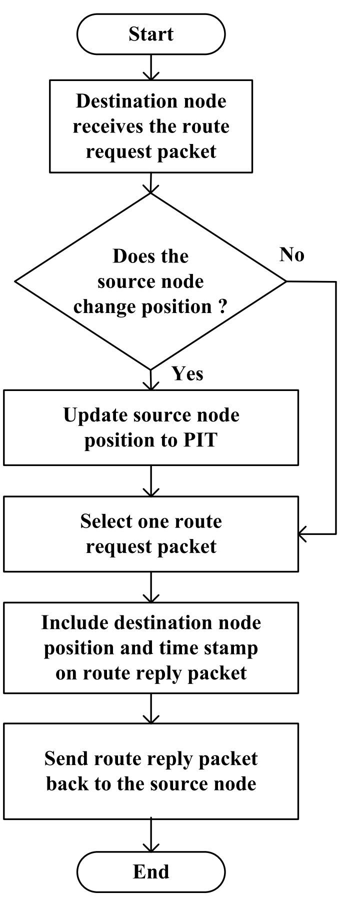

Fig. 11 Algorithm of the destination node.

the destination node is shown in Fig. 11.

4. Performance Evaluation

We evaluate the performance of LoRAReZ by means of simulation using NS-2. The performance metrics are packet delivery fraction (PDF), routing overhead, average end-to-end delay, throughput, packet collision, average hop count, average route setup time, and power consumption.

4.1 Simulation and Parameters

In simulation, we assume 50 nodes which are placed randomly within 1,000 meters x 1,000 meters network area. The size of network are (L) is set to 1,000 meters. The simulation is carried out for 1,500 seconds. The IEEE 802.11 MAC protocol is used in the simulation model. The transmission range of each node is 250 meters and link bandwidth is 1 Mbps. We focus our simulation on some applications of MANET such as MANET in university, MANET in airport, MANET in sports stadiums, and MANET in shopping malls. In those applications, the node moving with a speed of 1-5 m/s is chosen. The random waypoint model is selected as the moving pattern model with the pause time of 5 seconds. We focus on the non-realtime traffic with the data rate of 16 Kbps. The packet is generated at a constant bit rate (CBR) which is encapsulated into fixed 512 bytes packet. Thus, the sending rate of 4 packets/second is considered to investigate the performance of LoRAReZ. For the power consumption, we consider that with the principle of LoRAReZ scheme. LoRAReZ scheme can limit the area of searching a new route in the network. The nodes and the number of packets involved in the route discovery process may be decreased. The overall power consumption may be preserved thereby increasing the entire network lifetime. With this reason, we consider that the power consumption needs to be investigated. The power consumption can be obtained from the transmission power (txPower), the reception power (rxPower), and the idle power. The initial power of node is 1,000 Joules. The txPower, rxPower and idle power are set to 1 watt [10]. The generated traffic in the network is called the traffic connection that means the connection between the source node and destination node on the route establishment. The simulation results are obtained by varying the number of traffic connections from 2 to 20 in steps of 2. The simulation parameters can be summarized in Table 1.

Table 1 Simulation Parameters

Parameter Name	Value
Number of Mobile Nodes	50 Nodes
Simulation Area	1,000 m × 1,000 m
Moving Pattern	Random Waypoint
Random Speed	1-5 m/s
Simulation Time	1,500 s
Interface Queue	64 packets
Number of Traffic Connections	2-20 connections
CBR Sending Rate	4 packets/second
The Size of Packet	512 bytes
Transmission Range	250 m
The maximum number of expected zone levels (M)	2,4,8,10,12
The constant values (K)	2,4,8,10,12,14
The size of network area (L)	1,000 m
Pause Time	5 s
Link Bandwidth	1 Mbps
Initial Power	1,000 joules
Idle Power	1 watt
rxPower	1 watt
txPower	1 watt

4.2 Simulation Results

We demonstrate the simulation results into two parts. Part I is to investigate the appropriate value of K and the expected zone level (M) of LoRAReZ scheme. We first investigate to consider the appropriate value of K by considering the result of routing overhead. Then, we investigate the appropriate expected zone level with five the performance metrics such as packet delivery fraction (PDF), routing overhead, average end-to-end delay, throughput, and power consumption.

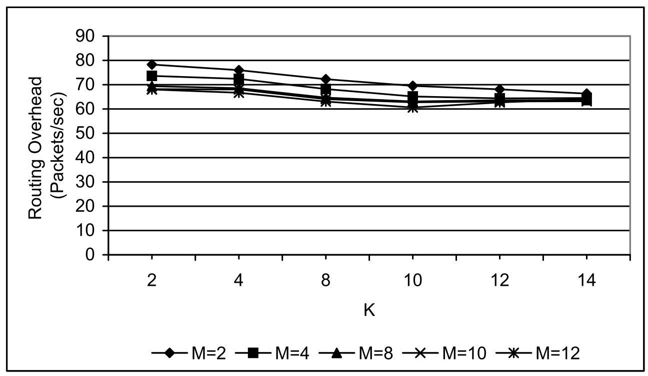

Fig. 12 Routing overhead versus various the constant values.

For Part II, we compare all the performance metrics as we have mentioned as above including the performance metrics of packet collision, average hop count, and average route set up time of LoRAReZ with those of LAR and LARDAR schemes.

4.2.1 Investigating the appropriate Request Zone Level

The objective of this subsection is to investigate influence of the constant value (K) and the expected zone level (M) on the routing overhead in order to consider the appropriate value of K and M for setting the request zone. Then, we will show that the appropriate K and M can provide the better performance comparing with those of the values of K and M in the terms of packet delivery fraction (PDF), routing overhead, average end-to-end delay, throughput, and power consumption. In Fig. 12, we show the routing overhead versus the value of K (K = 2,4,8,10,12, and 14) for various value of the expected zone level (M = 2,4,8,10, and 12). We aim to consider the appropriate value of K and the expected zone level. We can see that the routing overhead can be decreased as the increasing of K and M. Where M is greater than 8 the

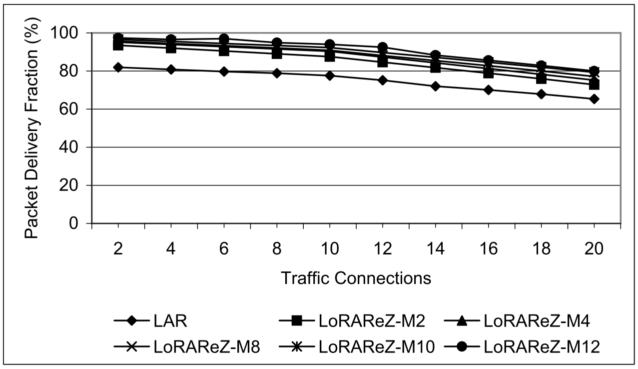

Fig. 13 Packet delivery fraction versus various traffic connections. (for K=10)

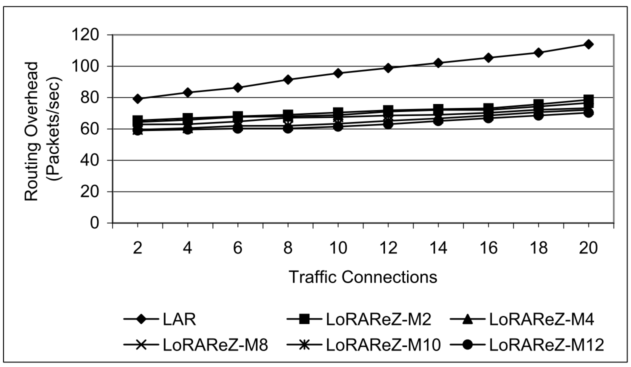

Fig. 14 Routing overhead versus various traffic connections. (for K=10)

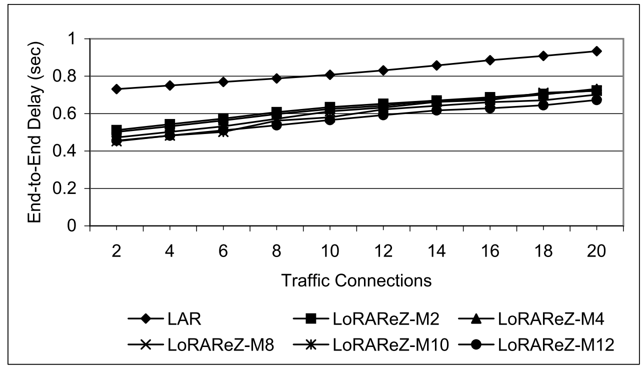

Fig. 15 Average-end-to-end-delay versus various traffic connections. (for K=10)

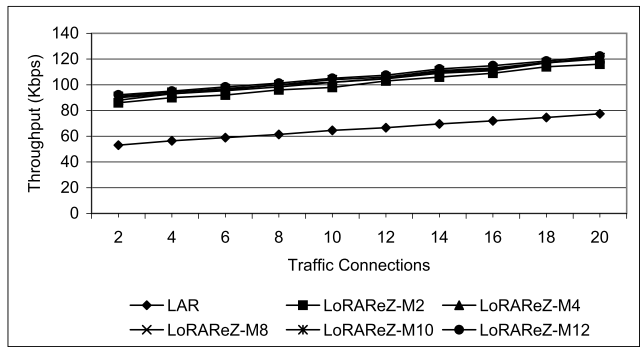

Fig. 16 Throughput versus various traffic connections. (for K=10)

routing overhead approaching to the same value and value of K also approaches to the same value when the value of K is greater than 10. According to those results, we consider that the appropriate value of K and the expectedd zone level (M) should be 10 and 12, respectively. From Fig. 13 to Fig. 17, we would like to show the comparison of the performance between LoRAReZ for K =10 with various of M (M = 2,4,8,10, and 12) and LAR scheme.

Figure 13 shows the packet delivery fraction (PDF) versus various traffic connections for the expected zone level of 2, 4, 8, 10, and 12 levels, respectively. The results show that PDF decreased when the traffic connections increase. LoRAReZ scheme can provide the higher PDF comparing with that of LAR scheme. We can see that LoRAReZ can provide the better PDF when M is greater than 10 because with this value of M, LoRAReZ scheme can provide the lowest routing overhead as we can see in Fig. 14.

The routing overhead versus various traffic connections depicts in Fig. 14. The routing overhead increases as the increasing of traffic connections. The LoRAReZ scheme with the various of M provides the smaller routing overhead all the range of traffic connections than those of LAR scheme. LoRAReZ with M=12 can provide the smallest routing overhead. This may be confirmed that the appropriate value of K and M derived from Fig. 12 is applicable.

In Fig. 15. We show the end-to-end delay versus traffic connections. We can see that end-to-end delay increases as the increasing of the traffic connections. All M values of LoRAReZ provides the lower end-to-end delay than LAR scheme. LoRAReZ with M=12 provides the lowest end-to-end delay. This is because the decreasing of routing overhead resulting in the decreasing of the nodes and the number of packets in the network. The lower end-to-end delay may be achieved.

The throughput result is shown in Fig. 16. We can see that LoRAReZ scheme can provide the higher throughput than that of LAR scheme as the increasing of traffic connections. We observe that the LoRAReZ scheme with M =12 can provide the highest throughput.The decreasing of end-to-end delay allows the more packets can be transmitted to the destination node resulting in the increasing of throughput.

We show the energy consumption in Fig. 17, LoRAReZ with all value of M can provide the lower power comsumption all the range of traffic connections than that of LAR scheme. We can see clearly that the network consumes more power when the traffic connections increase. LoRAReZ with M= 12 also provides the lowest power consumption. This is because the number of nodes and packets involved in route discovery process may be decreased. The power consumption may be preserved.

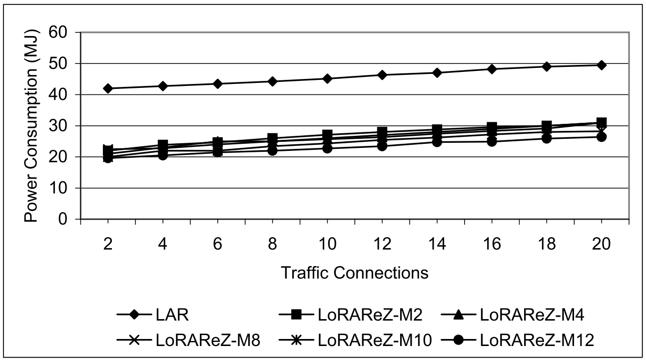

Fig. 17 Power consumption versus various traffic connections. (for K=10)

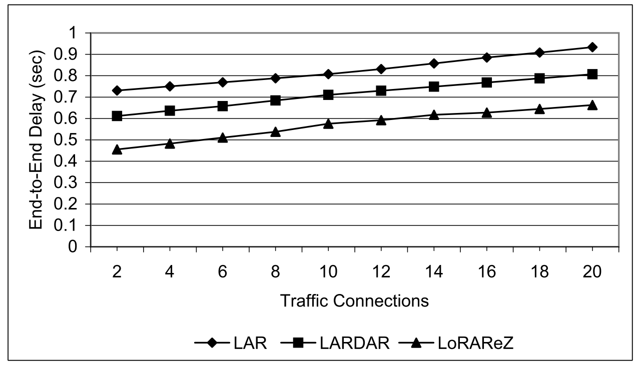

Fig. 19 Average end-to-end-delay versus various traffic connections. (for K=10, M=12)

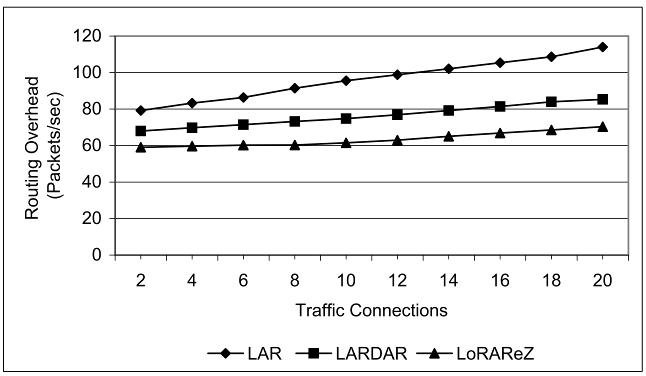

Fig. 18 Routing overhead versus various traffic connections. (for K=10, M=12)

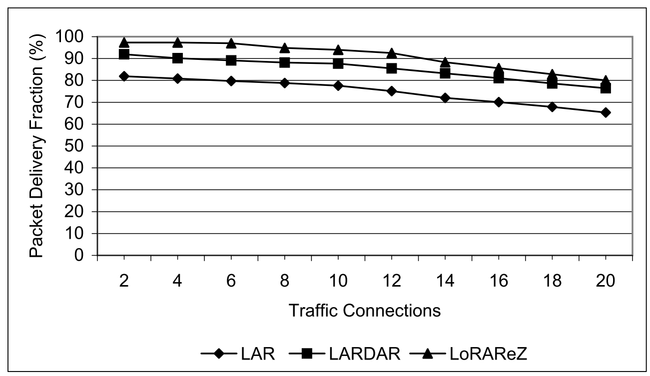

Fig. 20 Packet delivery fraction versus various traffic connections. (for K=10, M=12)

4.2.2 Comparing with LAR and LARDAR Schemes

We have shown that LoRAReZ may provide the better performance when we set the value of K and M as 10 and 12, respectively. In this section, we will apply those values to compare the performances with LAR and LARDAR schemes as shown in Fig. 18 to Fig. 25, respectively.

Figure 18 illustrates the routing overhead versus various traffic connections. The result shows that LoLAReZ has the lowest routing overhead compared with those of LAR and LARDAR schemes. The routing overhead increases with the increasing of traffic connections. The average routing overhead improvement may be 34.10 percent and 16.89 percent lower than those of LAR and LARDAR schemes. This is because LoRAReZ scheme considers the size of expected zone depending on the distance between the source and destination nodes. The smaller expected zone may be selected resulting in the smaller request zone.

The end-to-end delay versus various traffic connections is shown in Fig. 19. We can see that the end-to-end delay increases as the increasing of traffic connections. The result shows that LoLAReZ scheme has the lowest end-to-end-delay among those of LAR and LARDAR schemes with the average end-to-end delay of 30.92 percent, and 20.09 percent, respectively. This result confirms that the end-to-end delay can be improved if we can decrease the routing overhead.

The packet delivery fraction (PDF) versus various the traffic connections is shown in Fig. 20. We can see that as the traffic connections increase, the PDF of all schemes also slightly decrease. LoRAReZ scheme can provide the highest PDF among those of LAR and LARDAR schemes. The average PDF improvement can be 21.41 percent and 6.80 percent higher than those of LAR and LARDAR schemes. The decrease in routing overhead in LoRAReZ scheme can provide the improvement of end-to-end delay. The more packets may be transmitted in the network.

The packet collision is illustrated in Fig. 21. The packet collision increases as the increasing of the traffic connections. LoLAReZ has the lowest packet collision among those of LAR and LARDAR schemes as the increasing of traffic connections. The average of packet collision of LoRAReZ scheme can be approximately 36.60 percent and 22.23 percent lower than those of both schemes. By decreasing the routing overhead, the transmitting nodes and packets may be decreased. Thus, the packet collision may be improved.

Figure 22 demonstrates the throughput versus various traffic connections. The result shows that all schemes have increased the throughput as the traffic connections are increased. By contrast, LoRAReZ scheme has the highest

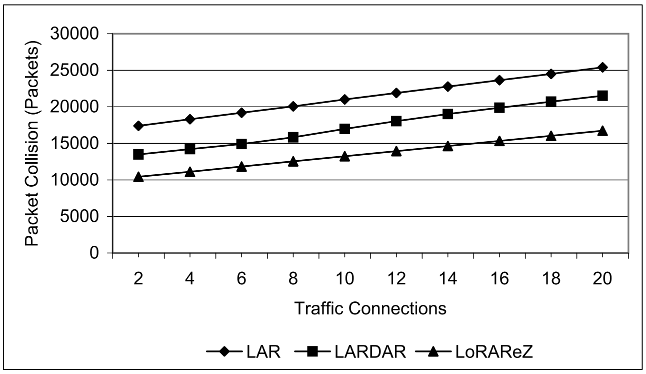

Fig. 21 Packet collision versus various traffic connections. (for K=10, M=12)

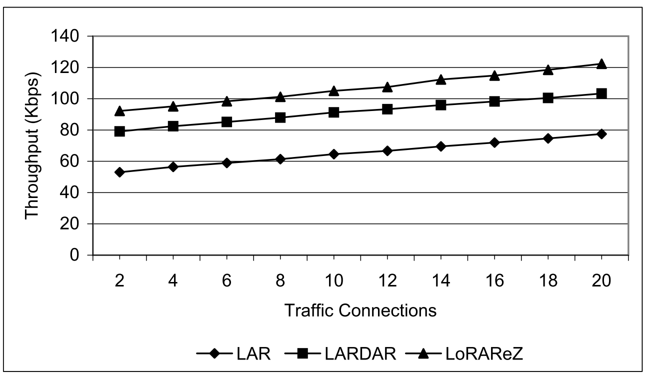

Fig. 22 Throughput versus various traffic connections. (for K=10, M=12)

throughput among those of LAR and LARDAR schemes. The result shows that the throughput increases as the increasing of traffic connections. LoRAReZ scheme can show the highest throughut among those of LAR and LARDAR schemes. The average throughput improvements are 63.05 percent and 16.39 percent higher than those of LAR and LARDAR. This result is caused by the decreasing of packet collision. The more packets can reach to the destination nodes successfully resulting in the increasing of throughput.

Average hop count is one of the performance metric that can show the number of hops between the source node to destination node. We compare the average hop count of LAR, LARDAR and LoRAReZ schemes as shown in Fig. 23. The result shows that LoRAReZ scheme has the lower average hop count than those of both schemes. The reason is that the size of expected zone in LoRAReZ scheme is set adaptively depending on the distance between source and destination nodes. The expected zone and request zone may be smaller than those of LAR and LARDAR scheme resulting in the lower average hop count.

Route setup time is a performance metric that shows the time required to construct a path of communication between the source node to destination node as shown in Fig. 24. We compare the average of route setup time of LAR, LARDAR, and LoRAReZ schemes. The result shows that LoRAReZ scheme has the lowest average route setup time among those of both schemes. This may be caused by the decreasing of the routing overhead.

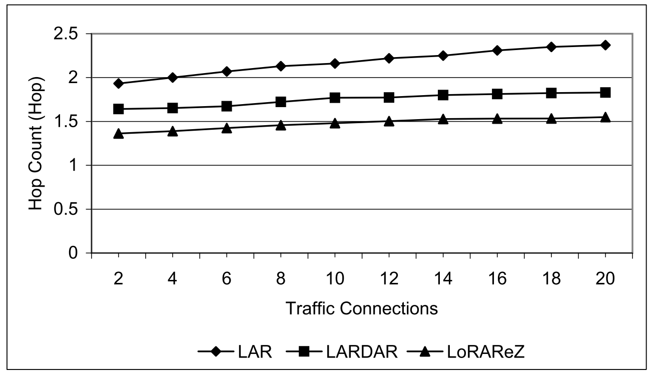

Fig. 23 Average hop count versus various traffic connections. (for K=10, M=12)

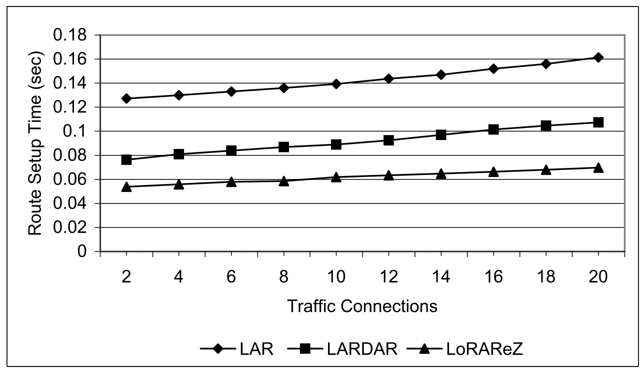

Fig. 24 Average route setup time versus various traffic connections. (for K=10, M=12)

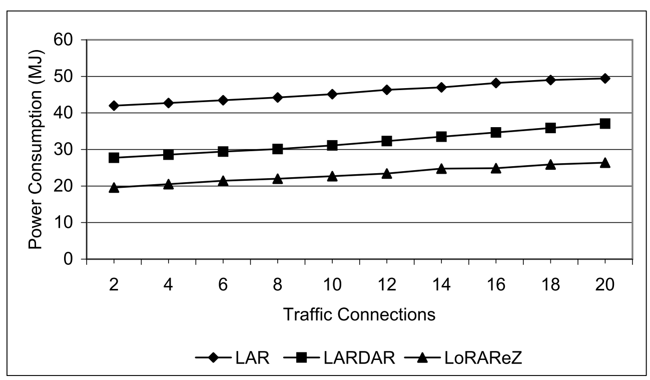

Fig. 25 Power consumption versus various traffic connections. (for K=10, M=12)

Power consumption versus traffic connections is shown in Fig. 25. The power consumption is depended on the routing overheads and traffic connections. Based on the simulation result, the power consumption of LoRAReZ scheme has lower than those of LAR and LARDAR schemes. LoRAReZ scheme shows the average power consumption improvement approximately 49.39 percent and 27.71 percent lower than those of LAR and LARDAR. The reason is that the number of nodes and packets involved in route discovery may be decreased which is caused by the decreasing of routing overhead. The power consumption may be preserved.

5. Conclusions

We have proposed Location-based Routing with Adaptive Request Zone in mobile ad hoc network called LoRAReZ scheme. The main objective of LoRAReZ scheme is to reduce the routing overhead. LoRAReZ considers the request zone based on the expected zone level which is derived by considering the distance between source node and destination node. By using LoRAReZ scheme, we can achieve the improvement of routing overhead that may influence the performance of MANET. We have shown the effectiveness of LoRAReZ scheme by means of computer simulation using NS-2. The simulation results have shown that the performance metrics such as routing overhead, end-to-end delay, Packet Delivery Fraction (PDF), packet collision, throughput, average hop count, average route setup time and power consumption may be improved. LoRAReZ scheme has shown the better performances comparing with those of LAR and LARDAR schemes.

References

[1] C.E. Perkins, E. belding Royer, and S. Das, "Ad hoc on-demand distance vector (aodv) routing," RFC 3561, July 2003.
[2] D. Johnson, Y. Hu, and D. Maltz, "The dynamic source routing protocol (DSR) for mobile ad hoc networks IPv4," RFC 4728, Feb. 2007.
[3] C.K. Toh, "Associativity-based routing for ad-hoc network," Wireless Pers. Commun., vol.4, pp.103–139, March 1997.
[4] Y.B. Ko and N.H. Vaidya, "Location-aided routing in mobile ad hoc networks," ACM Wireless Networks, vol.6, no.4, pp.307–321, July 2000.
[5] N.C. Wang and S.M. Wang, "An efficient location-aided routing protocol for mobile ad hoc networks," Proc. International Conference on Parallel and Distributed System (ICPADS'05), 2005.
[6] H. Asenov and V. Hnatyshin, "Gps-enhanced aodv routing," Department of Computer Science, Rowan University, Glassboro, New Jersey.
[7] S. Basagni, I. Chlamtac, and V.R. Syrotiuk, "A distance routing effect algorithm for mobility (DREAM)," MOBICOM 98, Dallas, Texas, USA, 1998.
[8] T.F. Shih and H.C. Yen, "Location-aware routing protocol with dynamic adaptation of request zone for mobile ad hoc networks," Wireless Network, pp.321–333, 2008.
[9] M. Bakhouya and N. Cottin, "Performance evaluation of the location-based protocal dream for large mobile ad hoc networks," University of Technology of Belfort-Montbeliard, France.
[10] H. Nishat and S. Rao, "Energy aware qos on-demand routing protocols for manets," Int. J. Comput. Appl., vol.23, no.8, pp.12–17, June 2011.

Putthiphong Kirdpipat received the B.Eng. degree and M.Eng. degree in Instrumentation Engineering and Computer Engineering from King Mongkut's Institute of Technology Ladkrabang, Thailand, in 1994, and 2006, respectively. He is currently working toward the D.Eng. degree at the Department of Computer Engineering, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand. His current interests are in the area of mobile ad hoc network, and wireless communications.

Sakchai Thipchaksurat received the B.Sc. degree in Statistics from Srinakaritwirot Prasarnmitr University in 1988, the M.Eng. degree in Electrical Engineering from King Mongkut's Institute of Technology Ladkrabang, Thailand, in 1996, and Ph.D. degree in Electronics and Computer Engineering from Gunma University, Japan in 2002. He is now an assistant professor in the Department of Computer Engineering, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand. His current research interests are in the area of performance evaluation of communication networks, wireless and mobile communications.