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Session Initiated Quadratic Lyapunov Multi Access Router for Seamless Mobility Communication in Pans

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Abstract

Mobility management is significant issues to be solved in Personal area networks (PANs) for providing seamless connectivity. Few research works have been designed for seamless mobility communication. However, the performance of existing method was not sufficient for reducing handover delay and mobility handover cost in PAN. To study the mobility handover when a mobile node moves between PANs, a framework called, Session Initiated Quadratic Lyapunov Multi Access Router (SI-QLMAR) scheme is proposed. The SI-QLMAR scheme is Heterogeneous Multi Access Router architecture for achieving seamless communications in PAN. In SI-QLMAR scheme, a unique IP address is assigned through Session Initiation Model for each mobile node when connected to different access routers. Besides, SI-QLMAR scheme used Quadratic Lyapunov function to switch the mobile node into intra access router communication or inter access router communication when mobile node moves out of its communication area of access routers. The inter access router communications is performed by a network of pivot nodes. On the other hand, intra access router communications is carried out through access routers using their unique IP address. Therefore, SI-QLMAR scheme reduces the handover delay and mobility handover cost in an efficient manner. The SI-QLMAR scheme also provides policy based management to securely access seamless communication among nodes of different access routers within PAN or different PANs. This helps to decrease the packet loss rate. The performance of SI-QLMAR scheme is measured in terms of mobility handover cost, handover delay and packet loss rate. The simulation results show that the SI-QLMAR scheme is able to reduce the handover delay and mobility handover cost for achieving seamless communication in PAN when compared to state-of-the-art works.

Keywords: mobile node, handover, access routers, Session Initiation Model, Quadratic Lyapunov function, inter access router communication, intra access router communication.

1. INTRODUCTION

Personal Area Network (PAN) consists of many mobile nodes. The growth of mobile communications requires seamless connectivity for improving the quality of services. When the mobile node moves away from its associate area of access router, handover is invoked to choose another suitable access router for seamless communication. In such a network, handover delay and mobility changes produce a major issue for the provision of efficient handover. Therefore, there is a need for new model to reduce the handover delay and mobility handover cost in PAN.

Recently, many research works have been designed for seamless mobility communication. An enhanced fast handover protocol with seamless mobility known as enhanced Seamless MIPv6 (e-SMIPv6) was presented in [1] to decrease the mobility signaling overhead and handover delay. Though, analyzing handover latency and packet loss for roaming users with ongoing multi- media applications was not considered. Seamless mobility handover (SMH) method was designed in [2] for IPv6 over minimum power. In SMH, the routing of the control messages for the mobility handover was accomplished in the link layer through the IPv6-access-node trees, therefore the mobility handover cost and the delay was reduced. However, mobility handover is not considered when the mobile node transmits among PANs that associates different access routers.

A Multi-Path TCP (MPTCP) was presented in [3] for solving handoff- and mobility-related service continuity issue and reduces the handoff induced defects and disruptions in service continuity. But, In Handoff, the connection achieves minimum throughput rate. A novel network mobility management system was intended in [4] for improving the communication quality during handover by considerably minimizing the latency and packet loss. However, maintaining high quality communication was difficult.

A Radio Frequency Identification (RFID)-based seamless personal communication system was designed in [5] with cloud computing that construct a VoIP connection for a mobile telephone communication device through monitoring its position. But, maintaining communication quality was complex while a VoIP account switches to a new IP address. An LTE femtocell-based network mobility system was introduced in [6] to maintain seamless handover for high-speed rail systems. This scheme lessens the handover latency and transmission overhead of handover signaling significantly.

Seamless Streaming Data Delivery (SSDD) Protocol was designed in [7] for improving the scalability and energy efficiency of inter cluster communication in hierarchical WSNs. In SSDD, a cross-cluster handover method and a path redirection approach supports the mobility of mobile elements. But, it creates several issues for data delivery in WSNs with mobile elements. A handover method was presented in [8] with the aid of a local anchor-based architecture for managed minimum cells in which the Local mobility anchor to minimize total handover costs, handover interruption time and core network load. However, handover mechanism does not focus on handover failure.

Seamless Mobility management system (SeaMoX) was designed in [9] to fulfill the QoS requirements of mobile real-time multimedia applications over cellular networks. The SeaMoX enhances data reliability and reduces the end-to-end delays. An effective application-layer handover scheme was introduced in [10] for mobile P2P live streaming systems for enhancing the playback continuity ratio while the handover occurs. But data loss caused due to the handover.

In order to solve the above mentioned existing issues, Session Initiated Quadratic Lyapunov Multi Access Router (SI-QLMAR) scheme is developed. The main objective of SI-QLMAR scheme is to study the mobility handover while a mobile node moves between PANs.

The research contribution of SI-QLMAR scheme is formulated as,

- To achieve the seamless mobility communication in PAN, Session Initiated Quadratic Lyapunov Multi Access Router (SI-QLMAR) scheme is designed.
- To reduce the handover delay and mobility handover cost while providing the seamless communication between PANs, Quadratic Lyapunov function is used in SI-QLMAR scheme.

The rest of this paper is organized as follows. Section 2 explains the Session Initiated Quadratic Lyapunov Multi Access Router scheme for achieving seamless mobility communication in PAN. Section 3 and Section 4 provides the experimental section with details performance analysis. Section 5 presents the related works. Finally, Section 6 concludes this paper.

2. Session Initiated Quadratic Lyapunov Multi Access Router

In personal area network, a mobile node moves in the random walk mobility in which the mobile angle ranges from 0 to 2π. If a mobile node is within the associate area of its access router, then it indicates that the relationship between the mobile node and its access router is relatively stable. If a mobile node is not within the associate area of its access router but within the transmission area of its PAN, then the signal strength of the frame transmitted between the mobile node and its access router weakens and the distance between them is considered to be more than the threshold. In that situation, the mobile node begins to determine its next an access router and therefore mobility handover process starts. To provide seamless communication when a mobile node moves between PANS, Session Initiated Quadratic Lyapunov Multi Access Router (SI-QLMAR) scheme is designed. The overall architecture diagram of Session Initiated Quadratic Lyapunov Multi Access (SI-QLMAR) Router scheme for providing seamless mobility communications in PAN is shown in below Figure 1.

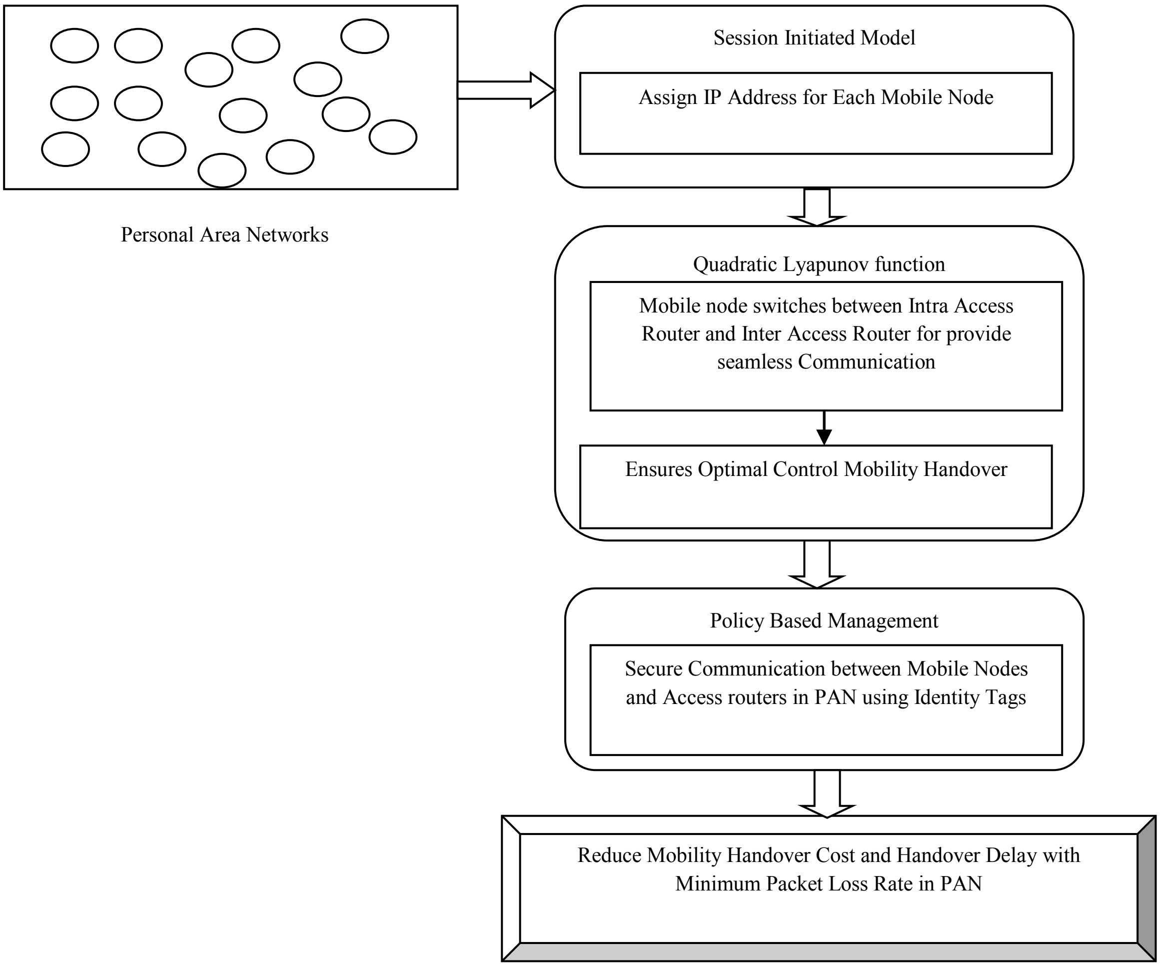

Figure 1. Architecture Diagram of Session Initiated Quadratic Lyapunov Multi Access Router Scheme

As shown in Figure 1, SI-QLMAR scheme used session initiated model for assigning the IP address for each mobile nodes in PAN. Then, SI-QLMAR scheme employed Quadratic Lyapunov function to switch the mobile node into an intra and inter access routers in within PAN or another PAN for seamless communication while moving. Therefore, SI-QLMAR scheme achieves optimal control mobility handover in PAN. Besides, SI-QLMAR scheme performs Policy Based Management to secure communication between mobile nodes and access routers using identity tags. The detailed explanation about SI-QLMAR scheme is described in forthcoming sections.

2.1 Session Initiation Model

The PAN network is formed by a group of mobile nodes coming together. The mobile nodes can connect and disconnect the network any time and are free to move around. In PAN, each mobile node is allocated with a separate IP address when connected to access routers (ARs) through Session Initiation Model (SIM). The Session Initiation Model assigns IP address for mobile nodes which communicate with access routers for providing the seamless connectivity in PAN. The Session Initiation Model allocates permanent IP address which is a home address for identification of mobile node in network. This IP address is unchanged where the mobile node is moved.Let consider a mobile node requesting an IP address is a client node. The PAN network which actually allocates the IP address is a server node. The process of session initiation model for allocating the IP address is shown in below.

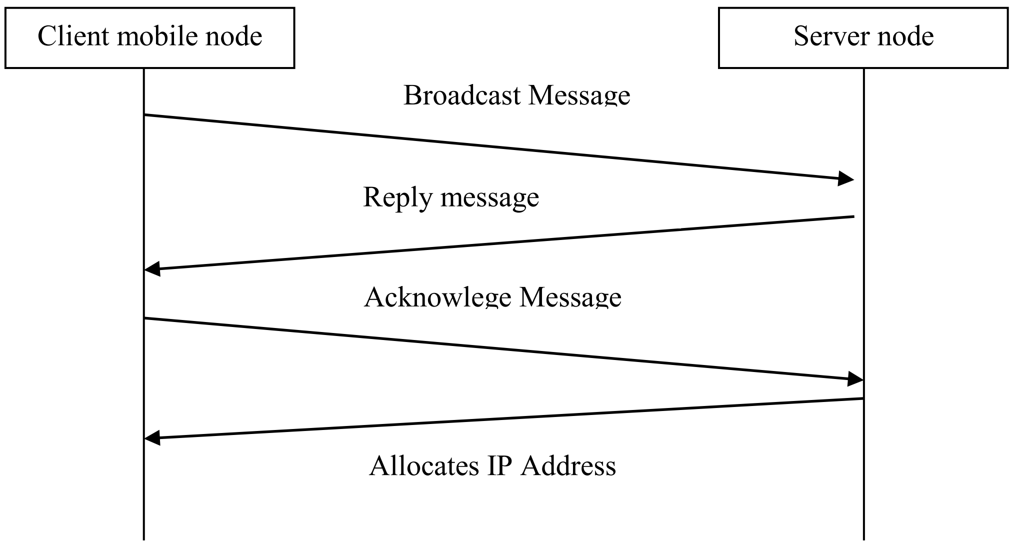

Figure 2. Session Initiation Model for Allocating IP Address

As shown in Figure 2, the client node periodically transmits broadcast messages using its hardware address. When a server node obtains this broadcast message, it transmits a reply message using its IP address and the client's hardware address. It is potential that two or more servers reply to the same broadcast message. The client mobile node transmits an acknowledgment message back to the server. If the client has obtained more than one reply messages from dissimilar servers, it transmits the acknowledgment message only to the first server and disregards the rest. Whenever the server receives this acknowledgment message, allocates an IP address to the mobile node. If server contains many blocks of IP addresses, then allocates one of these blocks to the requesting mobile node. Otherwise, server node segments the available set of IP addresses into two subsets and allocates one subset to client node and preserves the other subset with itself. The server transmits the latest version of IP address table to the client. When client receives IP addresses, it assigns itself and then transmits a confirm message to the server. When the server receives this confirm message, the IP address allocation process is finished.

2. QUADRATIC LYAPUNOV FUNCTION

The mobile nodes in PAN move randomly at different directions. When a mobile node moves outs of its communication area of access routers in within PAN or another PAN, Quadratic Lyapunov function is used to provide seamless connection. It is assumed that the probability of mobile node remaining in its current PAN of access routers is t and the probability of the mobile node moving into another PAN of access routers is $t + 1$. Then, the Quadratic Lyapunov function can be used to describe the state change. The Quadratic Lyapunov function switches the mobile node into a inter or intra access router communication which is mathematically formulated as,

$$\Delta L(t) = L(t + 1) - L(t) \tag{1}$$

From the equation (1), $L(t)$ refers the intra access router communication of mobile node within PAN whereas $L(t + 1)$ denotes inter access router communication of mobile node between different PANs. Besides, considered that π_0 is the long-term steady-state probability of a mobile node retaining in the current PAN and π_1 is the long-term steady-state probability of a mobile node moving to another PAN, therefore above said formula can formulated as,

$$\pi_0 + \pi_1 = 1 \tag{2}$$

$$\pi_0 = t\pi_0 + (t + 1)\pi_1 \tag{3}$$

$$\pi_1 = (t + 1)\pi_0 + t\pi_1 \tag{4}$$

Thus, mobility handover cost $MH_C$is determined by using following mathematical representation,

$$MH_C = \frac{\pi_0 . C_{intra} + \pi_1 . C_{inter}}{T} \quad (5)$$

From the equation (5), C_{intra} indicates the mobility handover cost when a mobile sensor node moves within one PAN and C_{inter} denotes the mobility handover cost when a mobile sensor node moves between PANs. Here, T is a mobile node's average residence time. The inter access router communications are carried out through a network of pivot nodes. On the other hand intra router communications are accomplished through access routers using their unique IP address. The detailed explanation about intra and inter access router communication is shown in below sections.

2.1.1 Intra Access Router Communication

The intra access router communications are performed through access routers using their unique IP address. There are two kinds of IP addresses namely local and external. The local IP address of mobile node is changed when connecting the different access routers in network. The external IP address refers the permanent IP address of mobile node is allocated by the session initiation model. When a mobile node moves from one access router to another, a handover event takes place between the two routers in PAN using their local IP address. The intra access router communication in PAN is shown in below,

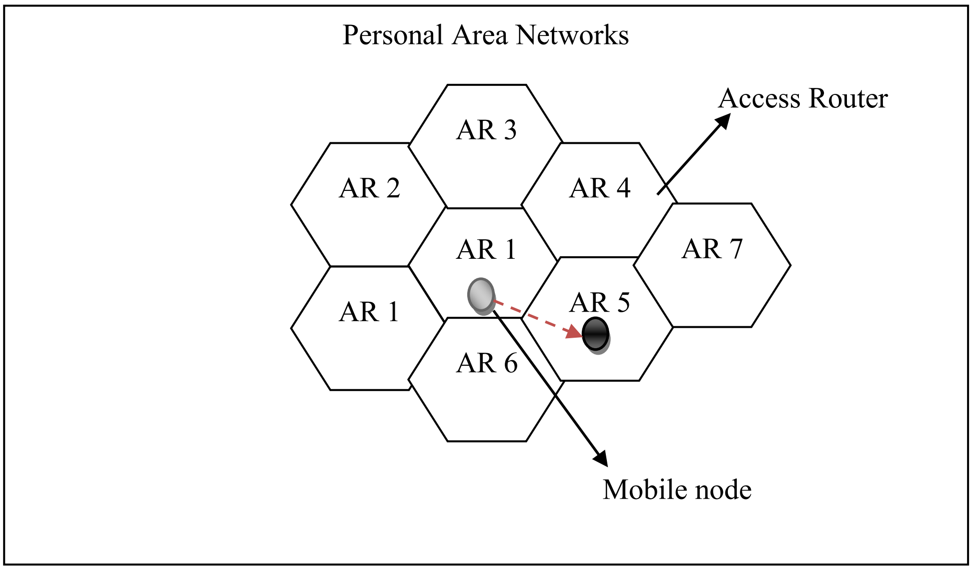

Figure 3. Structures of Intra Access Router Communications in PAN

The process of intra access router communication is shown in below Figure 4.

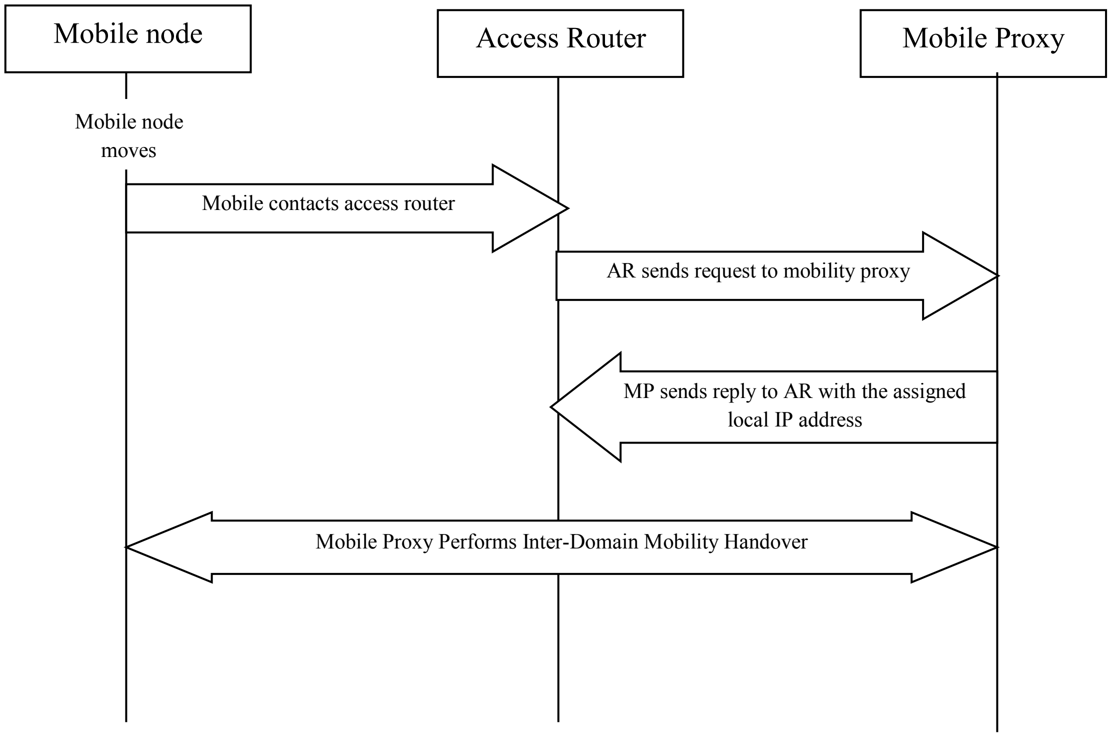

Figure 4. Process of intra access router communications in PAN

As shown in Figure 4, when a mobile node travels into a new domain, it contacts its access router (AR). The AR then transmits a request message to the mobility proxy to obtain an IP address for communication. Consequently, mobility proxy sends reply to AR with the assigned local IP address and therefore performs intra domain mobility handover. Thus, mobile node is communicated with different access router in within PAN or another PAN by using local IP address.

2.1.2 Inter Access Router Communication

The inter access router communications are performed by a network of pivot nodes. The pivot node serves as an access point for a mobile node and pre-configures the future handover of the mobile node through transmitting mobile node's information to candidate neighbour PANs and providing neighbour PAN information such as channel information to the mobile node. By using the pre-configuration scheme, the foreign agent transmits binding update messages to home agent for inter access router communications when a mobile node associates with new PAN.

When a mobile node moves out of its PAN and moves into a new PAN, the inter access router communications is performed. An inter access router communications of PAN includes of a gateway, a PAN coordinator, and mobile nodes, pivot node. The gateway presents a connection between the PAN networks and the Internet. Besides, the gateway plays a role as a local Home Agent for mobile nodes and a foreign agent for visiting nodes. The PAN coordinator is a representative of a PAN that responsible for creating the PAN network. While a mobile node moves out of its PAN and it is attached to a new PAN, therefore mobile node carry outs handover process. This movement of the mobile node called inter access router communications. The inter access router PAN Handover of mobile node is shown in below Figure 5.

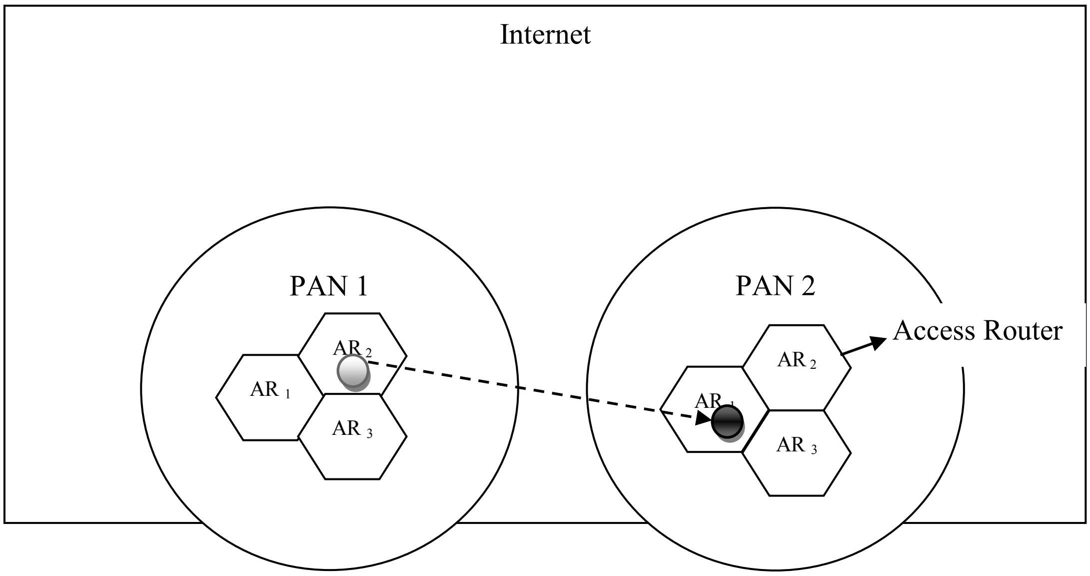

Figure 5. Structures of Intra Access Router Communications in PAN

The SI-QLMAR scheme pre-configures inter access router communications between PAN by means of transmitting mobile nodes information to candidate neighbour PANs and providing neighbour PAN information to the mobile node. This pre-configuration is accomplished by the pivot node that serves as an access point for the mobile node. The pivot node is familiar with which neighbours PANs exist nearby itself i.e. neighbour PAN information. In SI-QLMAR, consider that the pivot node can discover the movement of mobile nodes with the help of existing movement detection algorithms such as signal strength indicator, periodic hello packets, and link quality estimation. The process of inter access router communications between PANs is shown in below Figure 6.

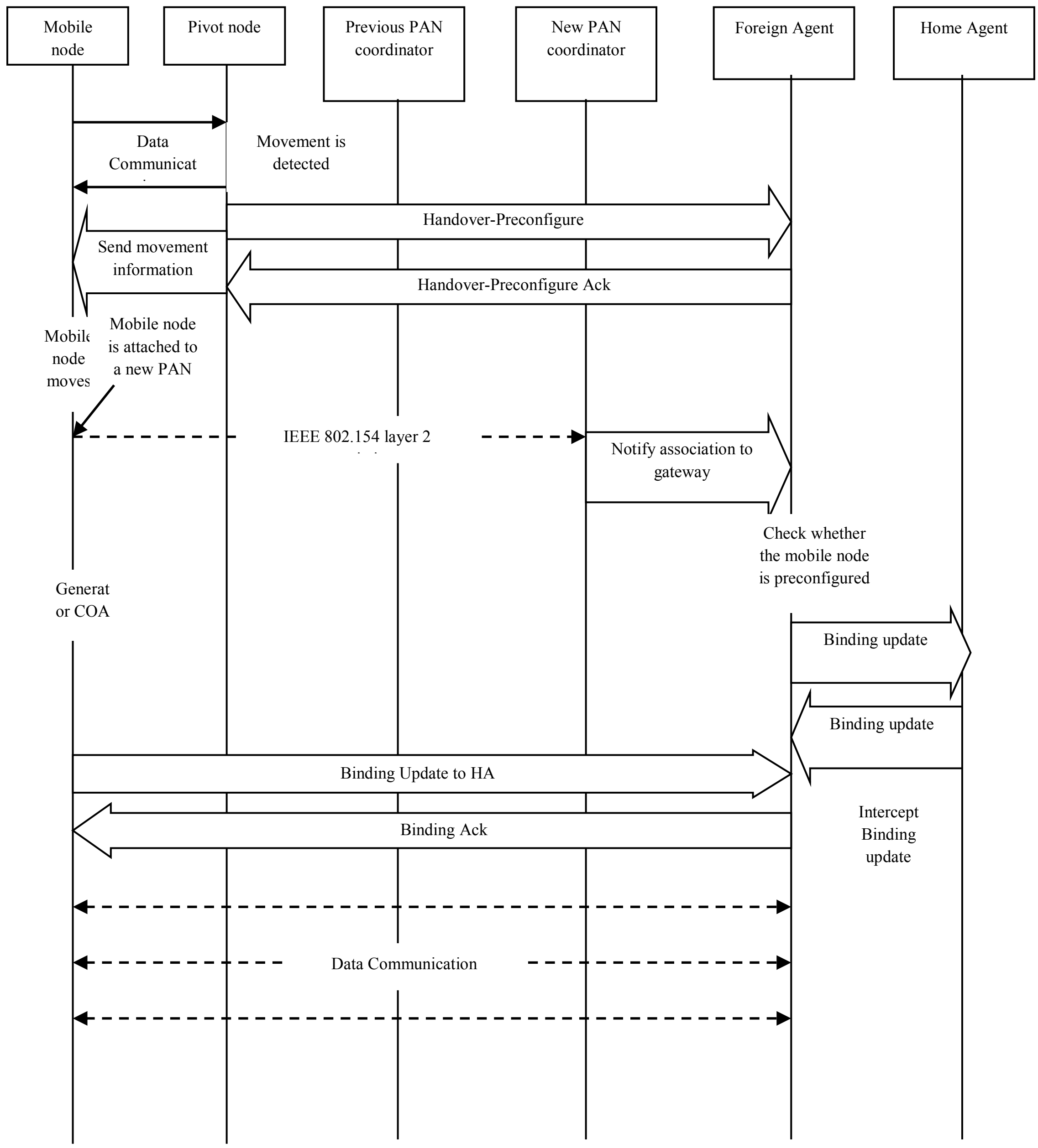

Figure 6. Process of inter access router communications in PAN

As shown in Figure 6, if a pivot node discovers mobile nodes movement and has neighbor PAN information, it is possible that inter access router communications occurs. Thus, the pivot node regards that the mobile node will perform inter access router communications. Then, the pivot node begins pre-configuration procedure through broadcasting Handover-Preconfigure message (that contains mobile node identifier, HoA, and the address of the home agent,) to the gateway of the neighbor PAN. This gateway will perform as the foreign agent of the mobile node. After mobile nodes physical movement, when the mobile node carried outs L2 layer association with a new PANs, the new PAN coordinator notifies it to the foreign agent with identifier of the new comer. The foreign agent verifies whether or not the new comer is a preconfigured mobile node through comparing the identifier with preconfigured mobile node identifiers obtained from Handover-Preconfigure message. If the new comer is a preconfigured mobile node, the foreign agent accomplishes surrogate binding update with a binding [mobile nodes Home-of Address (HoA) -> foreign agent] to the foreign agent of the mobile node. After that, the mobile node transmits binding update message with a binding [mobile nodes HoA -> mobile nodes CoA] to its home agent. However, since the surrogate binding update for the mobile node is already performed through foreign agent, it is not essential to deliver binding message to home agent. In inter access router communication, the foreign agent which is a current gateway of mobile nodes new PAN ensures whether or not a source of the binding message is already updated. If preconfigured, the foreign agent intercepts it and makes the binding in its binding cache. Then, the foreign agent responds to the mobile node by means of broadcasting binding acknowledge message to the mobile node. Otherwise, the foreign agent just forwards it to the home agent without any operation. By performing theses operations, the inter access router communications of the mobile node is completed.

2.2 Policy Based Management

In SI-QLMAR scheme, policy based management is performed to secured seamless communication among mobile nodes of different access routers in PAN. The policy based management provides security decided by access router administrators without losing ongoing connections and without disruptions in the communication. The security aspects of access router administrators are ensured through Mobile Node Identity tag. In policy based management, access router administrator defines set of rules for authenticating the each mobile node when providing the communication service using Mobile Node Identity tag. The mobile node is verified through Mobile Node Identity tag for securing the communication in PAN.

Let consider all the mobile nodes in PAN consisting of identity tag. The identity tag is the identity of a mobile node for authentication. In SI-QLMAR scheme, an identity tag consists of home address of the mobile node. The home address represents the permanent IP address given to a mobile node. The home address is unchanged no matter where the mobile node is positioned. When a mobile node requests connection to the access routers, access router administrator checks its IP address with aid of identity tag to provide a secured communication in PAN.

When a mobile node requests connection to the access routers, access routers matches the IP address of mobile node (IP_{MN_i}) with pre-stored IP addresses (IP_{PS}) in PAN using policy based management system. If IP address of connection requesting mobile node (IP_{MN_i}) matches with pre-stored IP addresses (IP_{PS}), then access router provides communication to mobile users otherwise communication is declined which is mathematically represented as,

$$\begin{cases} if\ IP_{MN_i} = IP_{PS} & communication\ is\ provided \\ otherwise & communication\ is\ declined \end{cases} \tag{6}$$

The equation (6) specifies the set of rule defined by access router administrators for secured communication between the mobile node and access routers. The algorithmic process of policy based management is shown in below,

// Policy Based Management Algorithm

Input: Mobile Nodes $MN_i = MN_1, MN_2, \dots MN_n$

Output: Secured Communication between the mobile node and access router

Step 1:Begin

Step 2: **For** each Mobile Node MN_irequesting the connection to access routers

Step 3: Access routers matches the IP address of mobile node (IP_{MN_i}) with pre-stored IP addresses (IP_{PS}) in PAN

Step 4: **If** ($IP_{MN_i} = IP_{PS}$) then

Step 5: Communication is provided to the mobile node

Step 6: **else**

Step 7: Communication is declined

Step 8: **End**

Step 9: **End for**

Step 10: End

Algorithm 1 Policy Based Management Algorithm for secured Communication in PAN

By using the above algorithmic process of Policy Based Management system, SI-QLMAR scheme provides security decided by access router administrators without losing ongoing connections and without disruptions in communication between the mobile node and access routers within PAN or different PAN. Therefore, SI-QLMAR scheme significantly reduces the packet loss rate in an effective manner.

3. SIMULATION SETTINGS

The proposed Session Initiated Quadratic Lyapunov Multi Access Router (SI-QLMAR) is implemented in NS-2 simulator with the network ranges of 100X100 m^2. The number of mobile nodes selected for experimental purpose is 100.The simulation parameters are used for conducting the experimental works is shown in below Table 1.

Table 1. Simulation Parameters

Parameter Description	Parameter Value
Simulation area	100X100 m
Number of mobile nodes	100
Number of data Packets	10,20,30,40,50,60,70,80,90,100
Mobility model	Random Walk Mobility Model
Mobile angle	[0,2π]
Communication range of a node	30m
Transmission power	3 dBm
MAC protocol	IEEE 802.154
Simulation time	100 s
Rounds	10

The results of simulation are obtained from several configurations and multiple runs and the results shown are averaged of 10 simulation runs. The performance of SI-QLMAR is compared against with existing two methods namely enhanced Seamless MIPv6 (e-SMIPv6) [1] and Seamless mobility handover (SMH) scheme [2]. The efficiency of SI-QLMAR is measured in terms of mobility handover cost, handover delay and packet loss rate.

4.1 Measurement of Handover delay

In SI-QLMAR scheme, handover delay measures time differentiation between when a mobile node is last able to send and/or receive an data packet by way of the old access router, until when the mobile host is able to send and/or receive an data packet through the new access router. The handover delay is measured in terms of milliseconds (ms) and mathematically formulated as,

$handover\ delay = time\ (data\ packet_{old\ access\ router} - data\ packet_{new\ access\ router})$ (7)

From the equation (7), $data\ packet_{old\ access\ router}$ refers the time of data packet send or receive by mobile node using old access router whereas $data\ packet_{new\ access\ router}$ represents time of data packet send or receive by mobile node using new access router. By using equation (7), handover delay of mobile node is measured. While handover delay is lower, the method is said to be more efficient.

Table 2. Tabulation for Handover delay

Speed (m/s)	**Handover delay (ms)**		
	e-SMIPv6	**SMH scheme**	**SI-QLMAR scheme**
2	25.8	22.5	16.2
4	27.3	23.8	17.6
6	28.9	24.7	19.5
8	31.2	25.2	20.8
10	32.6	26.9	21.7
12	33.5	27.6	23.1
14	35.1	28.1	24.9
16	36.6	30.3	25.5
18	37.4	31.8	28.2
20	38.2	33.5	29.4

The comparative result analysis of handover delay based on different speed in the range of 2-20 m/s is demonstrated in Table 2. From the table, it is expressive that the handover delay using proposed SI-QLMAR scheme is lower while compared to existing e-SMIPv6 [1] and SMH scheme [2].

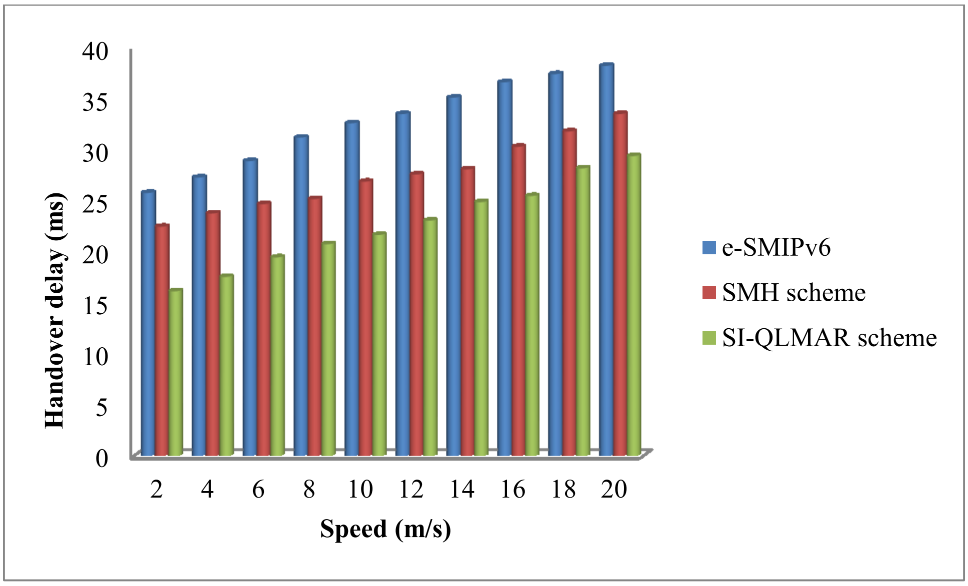

Figure 7. Measure of Handover delay

Figure 7 depicts the impact of handover delay versus diverse number of speed in the range of 2-20 m/s using three methods. As revealed in figure 5, proposed SI-QLMAR scheme provides better handover delay for attaining seamless mobility communication in PAN when compared to existing e-SMIPv6 [1] and SMH scheme [2]. Additionally, while increasing the speed, the handover delay is also increased using all the three methods. But comparatively handover delay using proposed SI-QLMAR scheme is lower. This is due to the application of Quadratic Lyapunov function in SI-QLMAR scheme. When the mobile node moves out of its communication area of access router within PAN or different PAN, Quadratic Lyapunov function is used. The Quadratic Lyapunov function switches the mobile node into an intra to inter and vice versa for providing seamless mobility communication. This in turn helps for reducing the handover delay in an effectual manner. Therefore, SI-QLMAR scheme reduces the handover delay by 31% when compared to e-SMIPv6 [1] and 18 % when compared to SMH scheme [2] respectively.

4.2 Measurement of Mobility Handover cost

In SI-QLMAR scheme, mobility handover cost measured based on bandwidth utilization. Therefore, mobility handover cost measures the amount of data that can be transmitted in a fixed amount of time. It is measured in terms of bits per second (bps) and mathematically formulated as,

$$Bandwidth\ utilization\ = Data_T\ (bits)/Time(sec) \qquad (8)$$

From the equation (8), the mobility handover cost measured based on data is being transmitted '$Data_T$' and the time taken to transmit '$Time$'. While the mobility handover is lower, the method is said to be more efficient.

Table 3. Tabulation for Mobility Handover Cost

Speed (m/s)	**Mobility Handover Cost (bps)**		
	e-SMIPv6	**SMH scheme**	**SI-QLMAR scheme**
2	265	200	160
4	279	225	178
6	291	238	191
8	305	246	212
10	320	252	225
12	338	267	240
14	346	288	259
16	360	295	270
18	378	302	281
20	390	315	293

Table 3 portrays the result analysis of mobility handover cost with respect to different speed in the range of 2-20 m/s using three methods. From the table, it is descriptive that the mobility handover cost using proposed SI-QLMAR scheme is lower while compared to existing e-SMIPv6 [1] and SMH scheme [2].

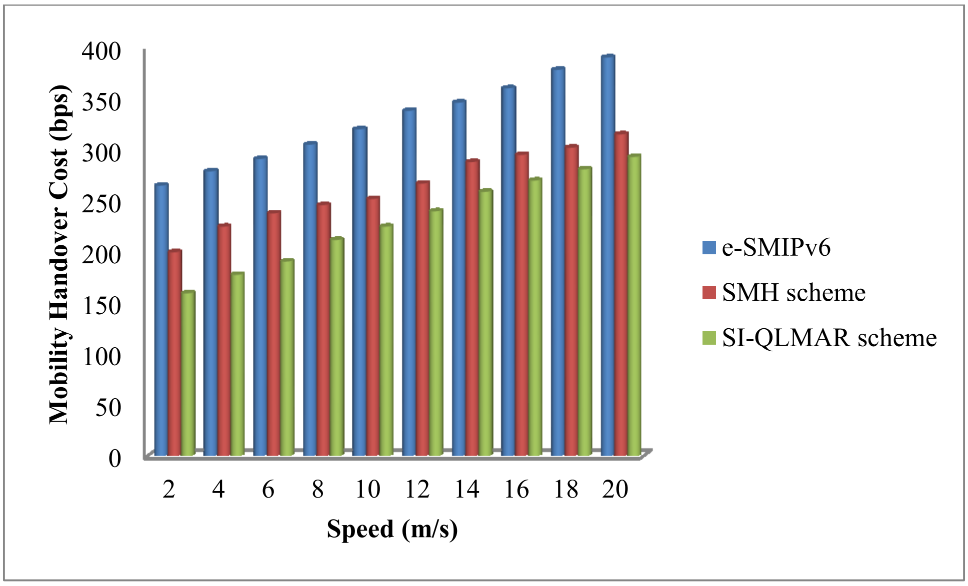

Figure 8. Measure of Mobility Handover Cost

Figure 8 represents the impact of mobility handover cost versus different number of speed in the range of 2-20 m/s using three methods. As exposed in figure 6, proposed SI-QLMAR scheme provides mobility handover cost for attaining seamless mobility communication in PAN when compared to existing e-SMIPv6 [1] and SMH scheme [2]. As well, while increasing the speed, the mobility handover cost is also increased using all the three methods. But comparatively mobility handover cost using SI-QLMAR scheme is lower. This is because of the application of Quadratic Lyapunov function in SI-QLMAR scheme. With the aid of Quadratic Lyapunov function, SI-QLMAR scheme provides seamless communication for mobile nodes while its moves out of its communication area of access router within PAN or different PAN. This in turn assists for reducing the mobility handover cost in a significant manner. As a result, SI-QLMAR scheme reduces the mobility handover cost by 30% when compared to e-SMIPv6 [1] and 13 % when compared to SMH scheme [2] respectively.

4.3 Measurement of Packet Loss rate

In SI-QLMAR scheme, packet loss rate is defined as the ratio of number of packets dropped to the total number of packets send. The packet loss rate is measured in terms of percentages (%) and mathematically formulated as,

$$Packet\ Loss\ Rate\ = \frac{number\ of\ packets\ dropped}{total\ number\ of\ packets\ send} * 100 \qquad (9)$$

From the equation (9), packet loss rate is measured. While the packet loss rate is lower, more efficient the method is said to be.

Table 4. Tabulation for Packet Loss Rate

Number Of Data Packets	Packet Loss Rate (%)		
	e-SMIPv6	SMH scheme	SI-QLMAR scheme
10	45.56	32.18	20.47
20	47.16	36.54	23.56
30	51.08	41.25	28.14
40	55.16	43.68	30.19
50	59.28	49.87	35.16
60	63.17	55.16	38.25
70	68.91	57.09	42.19
80	72.18	61.18	44.05
90	76.68	65.18	47.92
100	80.45	71.36	51.06

The result analysis of packet loss rate with respect to different data packet size in the range of 15-150 KB using three methods is presented in Table 4. From the table, it is clear that the packet loss rate using proposed SI-QLMAR scheme is lower while compared to existing e-SMIPv6 [1] and SMH scheme [2].

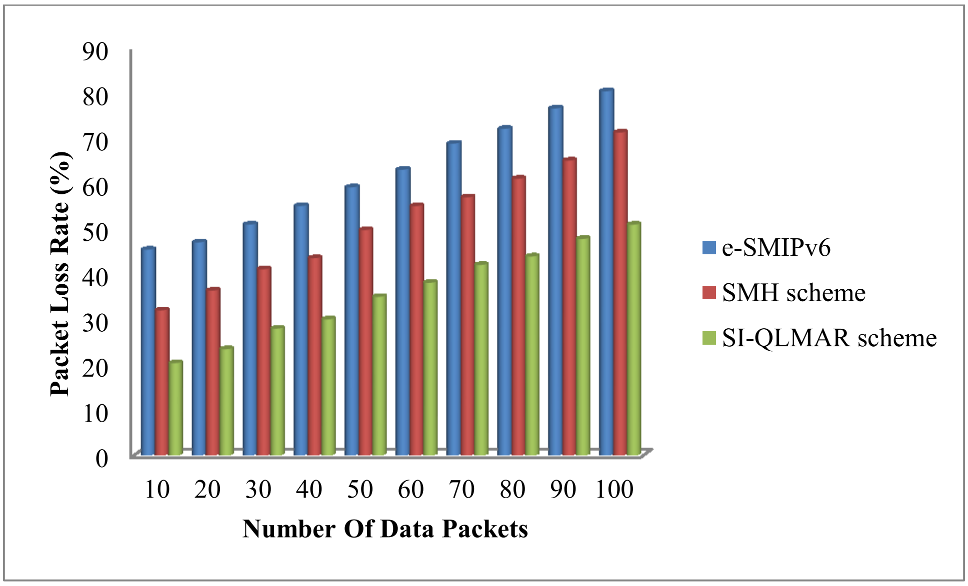

Figure 9. Measure of Packet Loss rate

Figure 9 shows the impact of packet loss rate versus diverse data packet size in the range of 15-150 KB using three methods. As demonstrated in figure 9, proposed SI-QLMAR scheme provides packet loss rate while performing seamless mobility communication in PAN as compared to existing e-SMIPv6 [1] and SMH scheme [2]. Besides, while increasing the data packet size, the packet loss rate is also increased using all the three methods. But comparatively packet loss rate using SI-QLMAR scheme is lower. This is owing to the application of policy based management system in proposed SI-QLMAR scheme. The policy based management system defines the set of rules for authenticating the mobile nodes which communicates to the access routers within PAN or another PAN for providing secured communication. Therefore, SI-QLMAR scheme affords security defined by access router administrators without losing ongoing connections and without disruptions in communication. This in turn supports for reducing the packet loss rate in an efficient manner. Thus, SI-QLMAR scheme reduces the packet loss rate by 43% when compared to e-SMIPv6 [1] and 30 % when compared to SMH scheme [2] respectively.

5. RELATED WORKS

An adaptive handover prediction (AHP) approach was designed in [11] for seamless mobility based wireless networks that combine fuzzy logic with AP prediction model provides cognitive ability to handover decision making. A mobility management approach was developed in [12] to minimize the system signaling cost and handover delay through the link layer information. This strategy reduces the handoff packet losses during the handover process. But, improving seamless mobility performance was not efficient.

A coordinator selection algorithm was developed in [13] for predicting the nodes direction of movement with respect to the coordinator and chooses that coordinator which has maximum available bandwidth and towards which the node is moving and early identification of future link breakage and handover decision. However, the Node connectivity at different Beacon order was not at required level. Inter-Domain Handoff Scheme was presented in [14] to diminish the packet loss and latency by means of avoiding the handoff among LMAs.

An inter-domain Proposed Fast Handover Scheme P-FMIPv6 was designed in [15] to lessen the handover latency and a handover disruption time. But, intra-domain handover analysis was remained unsolved. A comprehensive description of issues are solved in [16] to achieve seamless mobility in a heterogeneous wireless networks. However, handover delay remained unaddressed. Advanced Mobility Handover scheme (AMH) was intend in [17] for seamless mobility in MIPv6-based wireless networks. Though, reducing the handover latency in heterogeneous wireless networks was not sufficient. A Markov decision process approach was designed in [18] for performing seamless handoff in Heterogeneous Networks.

A cross layer based dynamic handover decision algorithm was employed in [19] to improve resource utilization and to achieve high QoS in Heterogeneous wireless networks. However, end to end latency, signaling load was not considered. Fuzzy Logic Based Decision Making Algorithm was designed in [20] to improve the Handover Performance in HetNets and to decrease handover latency with less packet loss.

6. CONCLUSION

An effective Session Initiated Quadratic Lyapunov Multi Access Router (SI-QLMAR) scheme is designed to improve the mobility handover performance when a mobile node moves between PANs. The main objective of SI-QLMAR scheme is to minimize the handover delay and mobility handover cost in PAN. The SI-QLMAR scheme is used Session Initiation Model to allocate the separate IP address for each of the mobile nodes when connected to different access routers. When a mobile node moves outs of its communication area, SI-QLMAR scheme employed Quadratic Lyapunov function to switch the mobile node into intra or inter access router communication and therefore ensures optimal control mobility handover. The inter access router communications are accomplished with the aid of pivot node in network. On the other hand intra access router communications are carried out through access routers using their local IP address. As a result, SI-QLMAR scheme reduces the handover delay and mobility handover cost for affording seamless connectivity. In addition, SI-QLMAR scheme designs policy based management system to securely access seamless communication among nodes of different access routers within PAN or different PANs which resulting in reduced packet loss rate. The effectiveness of SI-QLMAR scheme is test with the metrics such as handover delay, mobility handover cost and packet loss rate. The simulation results demonstrate that SI-QLMAR scheme is provides better performance with a reduction of handover delay and mobility handover cost when compared to the state-of-the-art works.

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