IJCSE International Journal of Computer Sciences and Engineering Open Access
Survey Paper Volume-5, Issue-1 E-ISSN: 2347-2693

Mobility support in Wireless Sensor Network in Healthcare-A Survey

Ritika Narang[1*], Amita Malik[2]

[1,2]*Department of Computer Science & Engineering, DCRUST MURTHAL, India*

Available online at: www.ijcseonline.org

Received:18/12/2016 Revised: 26/12/2016 Accepted: 20/01/2017 Published: 31/01/2017

***Abstract*—** Mobility in healthcare helps to promote clinical collaboration. By providing timely access to Patient Health Information, it helps doctors to take critical care decisions. Mobility in healthcare is enhancing the accessibility of critical firm and clinical systems. These days, condition devices are advancing closer to patient's point-of-care. Network based mobility protocols are suitable for 6LoWPAN because in these protocols network initiates the message signaling and reduces the load on low power sensor nodes by relieving them from participating in mobility procedure, result in enhancing lifetime of network. Proxy Mobile IPv6 (PMIPv6) is suitable mobility solution as it is Network based mobility protocol alongside it provides single hop communication but single hop communication is not sufficient for LoWPAN. Sensor Proxy Mobile IPv6 (SPMIPv6) is an optimization of PMIPv6 and appropriate for low power sensor nodes as it reduces message signaling overload ,optimize power consumption and minimize mobility cost compare to PMIPv6 and MIPv6.

***Keywords*—** Wireless sensor networks (WSN), Mobility Support, and MIPV6.

I. INTRODUCTION

Wireless Sensor Network is presently projected in countless areas: military, education, nature, healthcare, transportation or manufacturing automation etc are public targets for WSNs based on IEEE 802.15.4. IEEE 802.15.4 creates LoWPAN[1]. LoWPAN is described due to its extra manipulated skills than supplementary WLANs and WPANs. LoWPAN has constraints due to its tiny construction size, low data rate, less bandwidth of wireless links, so there arises need to minimize power consumption and decrease mobility cost[2].

Low-power Personal Area Network (LoWPANs) includes colossal number of nodes alongside power preserving capability. The IETF (Internet Engineering Task Force) defines IPv6 over Low-power Personal area Network (6LoWPAN) on the basis of IEEE 802.15.4.In 6LoWPAN low power sensor nodes are able to participate in IoT. Due to large address space in IPv6, 6LoWPAN allow globe connectivity and addressing amid a colossal numbers of IPv6 enabled LoWPAN nodes. The mobility protocol additionally allows the nodes to be self-organized i.e. they can do self-detection and self-configuring, lacking human intervention.

HWSN (Hospital Wireless Sensor Network) is vital 6LoWPAN request of the Internet of things [3], where it constantly monitors patients vital signals when they are mobile. Efficient mobility support protocol is demanded to have proper connectivity amid Hospital network and patient nodes to monitor their signals and precise locations during mobility. HWSN guarantees real time and continuous monitoring of patients in hospitals. Portable monitored devices provide freedom to the patients, and efficient medical service. During monitoring of patient mobility allow them to walk in corridors, change room for test without losing connection.

Emerging trends in healthcare have lessened the use of arrangements that permits monitoring of physiological parameters everywhere and anytime. It could be done by installing health sensors on body of patient. The mainly used sensors on patient body in healthcare are –heart rate, pulse rate, Blood pressure, body temperature, electrocardiogram (ECG), oxygen saturation (SPo2), electroencephalogram (EEG) and movement (with accelerometers) [4]. Wireless sensor Networks with mobility support protocols along with handover mechanism provides reliable solution in healthcare scenario, like hospitals, aging or disabled person's homes and nursing residences [5].

In supplement, Mobility Support Protocol in Healthcare is required to be reliable i.e reduce packet loss, no network failures and proper end-to-end connectivity, because of the criticalness of healthcare [6]. The main goal of portable monitoring system in healthcare is: first, manipulation and monitoring of the patients in each locale, and second, to store the data in the Knowledge Based Store (KBS) in order to forecast illness by discovering unusual symptoms.

In Host based mobility protocols such as HMIPv6, FMIPv6 and MIPv6 each node participates in message signaling during mobility procedure, and thus put extra load on each MN results increase in power consumption. The 6LoWPAN node design features like small packet size ,low power and manipulation capability and delays in messages reception restricts host based protocols [7] . In network based mobility protocols network initiates mobility signals after detecting

node mobility. Thus these protocols relieve MN from participating in exchanging message during mobility. Network based protocols such as Proxy MIPv6 are more suitable and appropriate to prop 6LoWPAN mobility than the host-based, but it has two shortcomings: first, it support single Hop Communication and don't support multi-hop and second it needs 64 bit address prefix to be allocated to every Mobile Node.

Mobility in Healthcare – Advantages

Mobility in healthcare helps update workflow and advances clinical collaboration. By providing timely access to Patient Health information (PHI), it helps doctors to take timely critical care decisions. Mobility in healthcare is enhancing the accessibility of critical/expensive company and clinical systems. These days, health monitoring devices are advancing closer to patient's point-of-care. Patient's health record retrieval has become hassle free alongside the advent of handheld devices such as tablets, intelligent phones and PDAs. Doctors are not dependent on bedside workstations or terminals for retrieval of the patient's record. Due to enhanced integration and coverage, mobility in healthcare has transformed how healthcare is conceptualized.

Rest of the paper is organized as follows: Section 2, presents challenges in mobility management, Section 3: discusses Mobile IP, Section 4 presents Hospital Information system. Section 5 presents various mobility support protocols, Section 6 presents comparative study of various mobility support protocols and lastly, Conclusion and future scope is discussed.

II. CHALLENGES IN MOBILITY MANAGEMENT

Mobility occurs when a node changes its access point due to change in topology of network. In WSN established on LoWPAN, change in the topology occurs due to various factors like movement of mobile node from one network to another, employing aggressive sleep. Various other probable factors can also be the frequent network disconnection, loss of packet, and the low network signal, increase delay in message signaling .

The access point change needs disconnection of mobile nodes. These disconnections results in handover and loss of data packets. Besides this WSN alongside 6LoWPAN knowledge imposes various constraints and necessities, it has become an urgent need to deal with these challenges as illustrated in Fig. 1. In WSN alongside 6LoWPAN knowledge, the major challenge is to provide "*Quality-of-Service*" (QoS) that is data transferred should be reliable with minimum delay [8]. Mobility mechanism should be effectual with denseness of nodes (i.e. safeguard "*scalability*"). The mobility prop protocols have to reduce the rate of data loss [9]. Data loss occurs when a node is disconnected from its access point during handover. Handover Delay must be minimized to have seamless connectivity.

Resources constraint is considered as major challenge that needs to consider while designing mobility protocol. Because of various network constraints design of mobility protocol is difficult. Wireless sensor network has various resource constraint issues usually in term of limited bandwidth of links, data aggregation and limited processing capability, memory and storage capacity. That's why, it is vital to minimize messages signaling, overhead link and processing capability results in order to enhance network lifetime[10].

Security is also an additional issue that requires special attention. Mobility allows nodes to change their point of attachment frequently while maintaining connectivity. Mobility of nodes and wireless network introduces various Security issues[11].

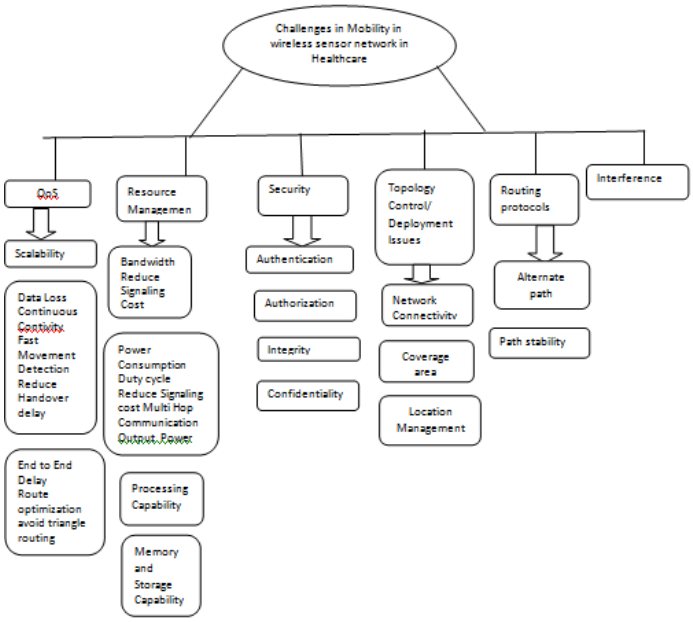


Figure 1 Challenges due to Mobility in Wireless Sensor Network

III. MOBILE IP

Mobile IP allow mobile node to move from one network to another network while maintaining fixed IP address. Mobile IP comprises of MIPv4 and MIPv6. IPv4 design did not anticipate with the development of internet and has number of limitation like scarcity of address, Security issues, Quality of Security, auto configuration related issues which proves that it needs to be changed [12]. MIPv6 is the successor of MIPv4 and solves all issues related to it. MIPv6 uses the continuing IPv6 protocol to enable seamless roaming.

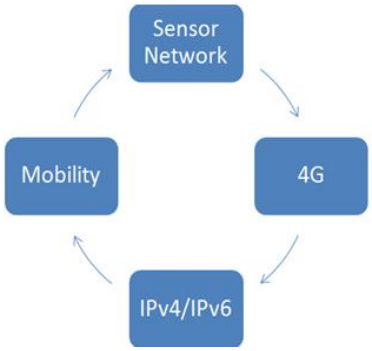


Figure 2: Mobile IPv6 and Sensor Networks

Migration from-IPv4 to IPv6

Internet protocol version 6 also known as Internet protocol next generation (IPng) is newest version of internet protocol designed to replace Internet protocol version 4 which is on the edge of depletion mainly due to address exhaustion and rapid growth of internet.IPv6 is designed to allow growth of internet both in terms of number of host connected, and amount of data traffic transmitted on the network[13]. IPv6 particularly provides:

- **Larger IP address space**: Internet protocol increases the address space size from 32 bits of IPv4 to 128 bits of IPv6. IPv6 provides large number of address to internet, allow them to expand further without any problem and prop automatic configuration of devices.
- **Simplified Header**: IPv4 contain all options within the IPv4 header.IPv6 simplified header structure by providing all options in the expansion header afterwards IPv6 header. In IPv6 header there is no restriction on maximum size of extension header, they can be expanded to accommodate any size of IPv6 Packet.
- **Enhanced support for Quality of Service**: IPv6 uses new flow label field in the header to provide Quality of Service. It also ensures how each packet can be identified and processed efficiently by routers. Ipv6 provides better Quality of Service, Mobility, IPSec Security, end to end connectivity.

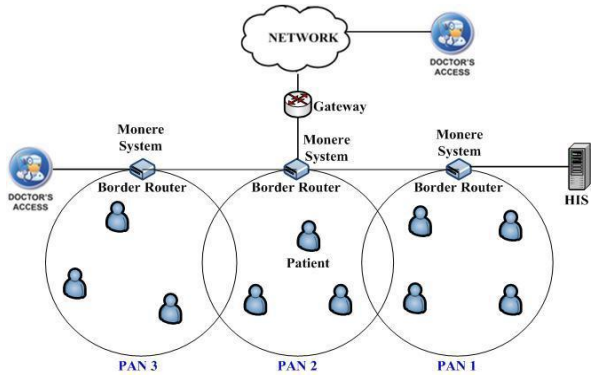
IV. HOSPITAL SYSTEM ARCHITECTURE

The hospital architecture consists of patient nodes, each room act as Menere System (local gateway) connected to internet, Hospital Information System and users (doctors, Nurses). Every area of hospital like wards, operation theatre, patient rooms, laboratory and observation room act as a PAN which is under network coverage to provide connectivity among all patient nodes with internet.

Hospital Information System

Hospital Information System (HIS) is an arrangement established on Open Services Gateway Initiative (OSGi). [10]Hospital Information saves all information belongs to a node, provides all information and following services to other networks. A little of these services are:

1. **Directory service:** IPv6 address of each patient node and Menere Systen can be obtained.
2. **Localization service:** Location of each patient in the hospital can be obtained from mobility information.
3. H**ealth status:** Patient healthcare information can be obtained from sensor installed on patient body.
4. **Electronic Health Record (EHR):** provides electronic version of patient medical history. Information from EHR of patient can be obtained.
5. **Management of alarms from the Monere Systems:** In cases of any alarm from the Menere System it sends signal to the Doctors about the health status (detection of unusual symptoms).



Monere arrangement: It is LoWPAN router installed in the hospital rooms or wards also known as mobile data collector (MDC) used to collect data from sensors installed on patient body similar to sink in PAN**.**

Patient node (mobile node)

Sensor installed on patient body transmitting data related to healthcare such as heart beat rate, SPo2, glucose level, ECG, Blood Pressure. Mobile patient node can move between personal area networks (PAN) in Hospital environment.

V. RELATED WORK

In WSNs, mobility occurs when a node tries to disconnect from its current access point and connect to new access point[9]. Mobility can be classified into two categories: macro-mobility (inter) and micro mobility (intra). Macro mobility occurs when a node moves between different networks, results in change of network address [14]. Movement of nodes between different access points within same network results in Micro mobility. Handover is the process of relocation of mobile node from one network to another (change of attachment point). Handover permits a node to disconnect from its current AP and then connect to one or more than one [15].

.

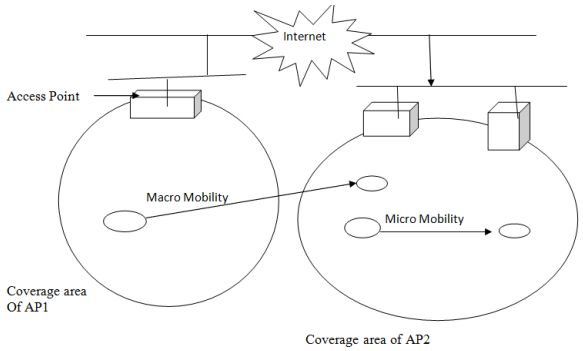
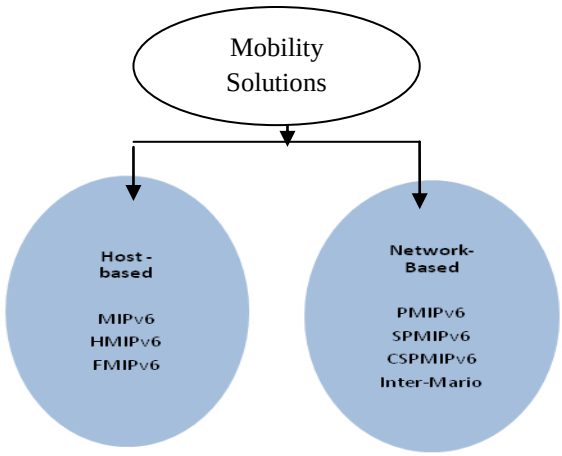


Figure 4: Indicating Micro Mobility and Macro Mobility



Figures 5: Various Mobility Management protocols

In **Host based Mobility Protocol** Mobile Node participates in the message signaling during the process of mobility and configures the IP address on the new link. Host based protocols due to its constraints are not considered suitable for 6LoWPAN[16].

In **MIPv6**, after a MN relocates to foreign network and changes its attachment point in the network, it will auto configure itself with a new CoA ought to notify its new Care of Address (CoA) to the Home Agent by sending Binding Update (BU).Every time mobile node moves from one access point to another it should update HA with its new CoA which results in increase in Handover Delay. Hierarchical Mobile IPv6 (HMIPv6), an extension to MIPv6 was proposed. HMIPv6 distinguish local mobility and global mobility.

Hierarchal MIPv6 (HMIPv6)

HMIPv6 refine the handover association of Mobile IPv6 by introducing the new conceptual entity called MAP. MAP separates the mobility management procedure into macro-mobility and micro-mobility. HMIPv6[17] extension of MIPv6 is noticed in the micro (intra) mobility when there is small coverage area and frequent handover occurs. In HMipv6 there is no need to notify its CoA to Home Agent in case of micro mobility. The relocation of MN from one MAP to another MAP that is located away results in **Macro mobility** and the relocation of MN from one access router to another within same MAP results in **Micro mobility**. In Micro mobility HMIPv6 minimizes Handover delay but in case of Macro mobility it suffers from long Handover latency.

Fast Handover for Mobile IPv6 (FMIPv6)

FMIPv6 improves the handover management of MIPv6.In FMIPv6 Mobile node is able to configure new care of address before it moves to new access router. This reduces considerably the handoff latency [13].FMIPv6 improves the performance of MIPv6 by limiting handover latency and establishing communication path from MN to New access router without any packet drop. Still some packet drop can be there if MN node move randomly from one access router to another without letting any handover mechanism to be completed. In the host-based mobility protocol, a MN participates in the signaling of messages during the mobility process and configures the IP address on new link. MIPv6, FMIPv6 and HMIPv6 are host-based mobility support protocol; due to their constraint these are not suitable for Low power personal area network.

Network-based mobility is recommended in low-power sensor nodes due to WSN constraints (power consumption, memory and storage capacity, and throughput) because message signaling relating to Binding update, movement detection during mobility is initiated by network, results in enhancing its network lifetime. Proxy Mobile IPv6 (PMIPv6) is suitable for mobility solution for IPv6 mechanisms as it relieve mobile node to participate in exchanging mobility related signals during handover. PMIPv6 helps to preserve power in IPv6 mechanisms but it suffers from single hop communication issues because each node has to communicate with its access point. Therefore, it is not appropriate for 6LoWPAN mechanisms[18]. Sensor Proxy Mobile IPv6 (SPMIPv6) is an optimization of PMIPv6 reduces energy consumption by minimizing message signaling and mobility cost. It is more suitable for energy deficient sensor nodes[19].

Inter Mario: is based on Make-Before-Break method. In this protocol neighboring node designated as an AP for the moving node configures the upcoming handover of the Mobile Node by providing Mobile Node information to the neighboring PAN and neighboring PAN information is sent to the Mobile Node[20]. When MN associates with the new PAN, Foreign Agent (FA) can send a binding update message to Home Agent for Mobile Node handover. By using the neighbor PAN information which mobile receive when previous link is disconnected Mobile Node can scan only that channel instead of scanning all other channel.

VI. Comparison Study various Mobility Support protocols

Difference between Host based and Network based Mobility Protocols is shown in Table 1. Difference between various Mobility Support Protocols is shown in Table 2:

VII. Conclusion and Future Works

Mobility in healthcare helps to enhance clinical collaboration. By providing timely admission to Patient Health Information (PHI), it helps doctors to take timely critical care decisions. Mobility in healthcare is enhancing the accessibility of critical/expensive firm and clinical systems. Mobility prop is vital for the accomplishment of Internet of things in Healthcare.

Mobility support protocols are needed to have network connectivity and allow transfer of data irrespective of location. In healthcare, major requirement of LoWPAN are for real-time monitoring of vital signals examples are ECG (electrocardiogram), heart rate, blood pressure, SPo2, respiration rate of patients. Mobility protocol needs to be reliable, that is, it has to reduce packet loss, end-to-end delay, and network failure in Healthcare due to its criticalness. Mobility leads to packet loss due to depreciation in the quality of link, consequently, erroneous data transfer, results in increasing the packet retransmission rate. Mobility leads to multiple path adjustments that result in increase in packet delay. Wireless Sensor network are resource constraint. Mobility of nodes increases power consumption so there is demand to discover effectual mobility association protocols. In future we will design, propose and simulate an improved Mobility Management Protocol and will perform comparative study between existing protocol and proposed protocol under different scenario.

REFERENCES

[1] S. Kumar, M. Dave, and S. Dahiya, "ACO Based QoS Aware Routing for Wireless Sensor Networks with Heterogeneous Nodes," Emerg. Trends Comput. Commun., vol. 298, pp. 157–168, 2014.

[2] A. J. Jara, M. A. Zamora, and A. F. G. Skarmeta, "Intra-mobility for hospital wireless sensor networks based on 6LoWPAN," Proc. - 6th Int. Conf. Wirel. Mob. Commun. ICWMC 2010, pp. 389–394, 2010.

[3] M. S. Shahamabadi, B. M. Ali, N. K. Noordin, M. F. B. A. Rasid, P. Varahram, and A. J. Jara, "A NEMO-HWSN solution to support 6LoWPAN network mobility in hospital wireless sensor network," Comput. Sci. Inf. Syst., vol. 11, no. 3, pp. 943–960, 2014.

[4] N. G. Arun, S. G. Surya, and M. Azath, "Survey on Mobile Healthcare," no. 5, pp. 261–263, 2015.

[5] C. R. Suryawanshi and Y. C. Bhute, "International Journal of Computer Sciences A WSN based System for Enhancing Intra Mobility Solution for Healthcare – A Review," no. 9, 2014.

[6] Vishakha Singhal and Shrutika Suri, "Comparative Study of Hierarchical Routing Protocols in Wireless Sensor Networks", International Journal of Computer Sciences and Engineering, Volume-02, Issue-05, Page No (142-147), May -2014

[7] J. M. L. P. Caldeira, J. J. P. C. Rodrigues, and P. Lorenz, "Toward ubiquitous mobility solutions for body sensor networks on healthcare," IEEE Commun. Mag., vol. 50, no. 5, pp. 108–115, 2012.

[8] S. Sharma, R. K. Bansal, and S. Bansal, "Issues and Challenges in Wireless Sensor Networks," 2013 Int. Conf. Mach. Intell. Res. Adv., no. August, pp. 58–62, 2013.

[9] D. Gurjar, I. Alam, P. B. B. Tiwari, and P. G. N. Pandey, "Wireless Sensor Network : an emerging entrant in Healthcare Wireless Sensor Network : an emerging entrant in Healthcare," no. June, 2016.

[10] M. Bouaziz and A. Rachedi, "A survey on mobility management protocols in Wireless Sensor Networks based on 6LoWPAN technology To cite this version : A Survey on Mobility Management Protocols in Wireless Sensor Networks based on 6LoWPAN Technology," 2015.

[11] S. Singh, "Security For Wireless Sensor Network," vol. 3, no. 6, pp. 2393–2399, 2011.

[12] R. A. Khan and C. Engineering, "Performance Analysis of Host Based and Network Based IP Mobility Management Schemes," vol. 6, pp. 1798–1803, 2008.

[13] J. Pieterse, R. Wolhuter, and N. Mitton, "Implementation and analysis of FMIPv6, an enhancement of MIPv6," Lect. Notes Inst. Comput. Sci. Soc. Telecommun. Eng. LNICST, vol. 111, pp. 351–364, 2013.

[14] F. T. Zohra, S. Azam, and M. Rahman, "Overview of IPv6 Mobility Management Protocols and their Handover Performances," no. 3, 2014.

[15] A. Achour, L. Deru, and J. C. Deprez, "Mobility Management for Wireless Sensor Networks A State-of-the-Art," Procedia Comput. Sci., vol. 52, no. Iupt, pp. 1101–1107, 2015.

[16] S. Salehian and R. Shamshiri, "A Survey on Mobility Management Protocols in Wireless Sensor Network-internet Protocol," Indian J. Sci. Technol., vol. 8, no. 52998, pp. 974–6846, 2015.

[17] M. H. Habaebi, "Macro/micro-mobility fast handover in hierarchical mobile IPv6," Comput. Commun., vol. 29, no. 5, pp. 611–617, 2006.

[18] J. Kim, R. Haw, S. Member, and E. J. Cho, "A 6LoWPAN Sensor Node Mobility Scheme Based on Proxy Mobile IPv6," vol. 11, no. 12, pp. 2060–2072, 2012.

[19] M. M. Islam and E. N. Huh, "Sensor proxy mobile IPv6 (SPMIPv6)-a novel scheme for mobility supported IP-WSNs," Sensors, vol. 11, no. 2, pp. 1865–1887, 2011.

[20] M. Ha, D. Kim, S. H. Kim, and S. Hong, "Inter-MARIO: A fast and seamless mobility protocol to support inter-PAN handover in 6LoWPAN," GLOBECOM - IEEE Glob. Telecommun. Conf., pp. 1–6, 2010.

Table 1: Comparison between Host based and Network based Mobility Support Protocols

	HOST BASED MOBILITY SUPPORT PROTOCOLS	NETWORK BASED MOBILITY SUPPORT PROTOCOLS
1	MN is involved in mobility support protocols	MN does not participates in mobility support protocols
2	Node movement detection is performed by rs/ra	Node movement detection is performed by network layer.
3	Home address is fixed but care of address changes	Only one address remains throughout entire domain
4	IP stack of MN needs to be change	No need to change IP stack of MN
5	Consumption of resources of MN is more	Consumption of resources of MN is less
6	Tunneling 1:1 relation is used	Tunneling 1:M is used
7	Macro mobility	Micro mobility
8	High handoff latency	Fast handoff/ low handoff latency
9	High signaling load	Reduction in mobility related signalling
10	More packet loss	Reduction in packet loss
11	Examples of host based mobility protocols:MIPv6,HMIPv6,FMIPv6	Examples of network based mobility protocols: PMIPv6,SPMIPv6, CSPMIPv6

Table 2: Comparison between various Mobility Support Protocols

PROTOCOLS	HOST/NETWORK BASED PROTOCOLS	MICRO/MACRO MOBILITY	REACTIVE/PROACTIVE MOBILITY	SOFT/HARD HANDOFF	NODE/NETWORK MOBILITY	ADDRESS	MOVEMENT DETECTION	DATA BUFFERED
MIPv6	HOST	MICRO	REACTIVE	SOFT/HARD	NODE	IPV6	RS/RA	HA
HMIPv6	HOST	MICRO/MACRO	REACTIVE	SOFT	NODE	RCOA/LCOA	RS/RA	MAP
FMIPv6	HOST	MICRO	PROACTIVE	SOFT	NODE	IPV6	RS/RA	HA
PMIPv6	NETWORK	MICRO	REACTIVE	HARD	NODE	FIXED IPV6	RS/RA	LMA
SPMIPv6	NETWORK	MICRO	REACTIVE	HARD	NODE	FIXED IPV6	RS/RA	SLMA
CSPMIP6	NETWORK	MICRO/MACRO	REACTIVE	HARD	NODE	FIXED IPV6	RS/RA	HMAG

