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Mobility Management Schemes in Wireless Sensor Networks - Open Issues and Challenges: A Survey

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Abstract: Mobility Management scheme plays a significant role in the Wireless Sensor Networks to provide seamless connectivity to the mobile users on the move. When the MNs/MHs (Mobile Nodes/Mobile Hosts) is communicating with other node, the network has to follow the MNs/MHs and allocate required resource to provide uninterrupted service without user awareness that in fact the network facility (base station) is changing. Mobility Management is used to track the mobile users they move from place to place in the coverage of wireless mobile networks to ensure ubiquitous communications. Thus, mobility management is a key component for the effective operations of wireless networks to deliver wireless Internet services. Wireless Sensor Networks consist of base stations, each of which is responsible for relaying communication services for the mobiles travelling in its coverage known as cells. When MNs/MHs are in communication and moving from one cell to another, the base station in the new cell will allocate a channel to continue to provide the service to the mobile user without any interruption. The switch from one channel to another (from one base station to another base station) is known as handoff. The importance of mobility management is the handoff management (how to achieve a smooth handoff between base stations without degrading the service). When users do not engage any communications and move around, the system has to track them in order to deliver possible services to them. This can be done by Location management/Mobility management. In Internet of Things(IoT)[23], Sensor nodes are being deployed/installed on many objects and some of them are mobile (moving) including mobile gadgets, physical objects (living or non-living) etc. in order to get and transmit information over the internet and handoffs are major issues. These mobile objects require sufficient Mobility Management schemes to take care of data transmission. Existing research has made many improvements in terms of Handoff Latency (H.O.) but less attention has paid towards signaling cost and packet loss particularly in time critical areas. The study provides the complete survey of Host based and Network based mobility management schemes including 6LoWPAN (Low Power Wireless Personal Area Network), PMIPV6 (Proxy Mobile IPv6), challenges associated with them and solution to meet these challenges.

Keywords: IP Mobility, MIPv6, PMIPv6, 6LoWPAN and WSN.

1. INTRODUCTION

In IOT, most of the objects is MNs/MHs connected to the network, every connected device requires address. Since there is high demand of addresses and current version of IP version 4(IPv4) can support at most 232 address which leads to scarcity of addresses, so there is a newer version of IP i.e. IP version 6 (IPv6) [57] which provides sufficient address space to meet the expected increase of network devices. In IOT, the users carrying mobile gadgets like cell phones, laptops or smartphones etc. wish to remain connected to the network services all the time even they are on the move (i.e. moving from one network to another). So as to provide the flexible clients persistent organizations or to take after the motioning from moving things, there's require of mobility schemes.

In IOT (machine to machine (M2M) communication) [58], IPv6 addressed Sensor Nodes (SNs) are being used for making the objects to communicate. IPv6 over Low-Power Personal Area Networks (6LoWPAN)[11] and Proxy Mobile IPv6 (PMIPv6) [11,60] standard allows these heavily resource constrained SNs to connect to IPv6 networks. Different researchers have used 6LoWPAN and PMIPv6 mobility with different perspective and application areas like military surveillance, environmental monitoring, healthcare monitoring, vehicular networks etc. where time criticality of data is most important. Versatility administration plans have come over time with the development of versatile devices. A few employments portable has to carry versatility whereas others utilize network components for the same.

Therefore these are classified into two different categories: Host Based Mobility Management schemes and Network Based Mobility Management Schemes. In view of the above, this further presents a recent survey for the same.

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1.1 Survey Scope

1.1 Host Based Mobility Management Schemes: In such Mobility Management Scheme, the Mobile host/Mobile Node (MH/MN) which experiences the mobility from one network to another is involved in all signaling related process which requires protocol stack modification and IP address changes on the MN for the session continuity during handover. In this, signaling process includes movement detection, Router Solicitation request (RtSolReq), Duplicate address detection (dad) and Binding updates (BUs) etc. The well-known Host Based Mobility Schemes which have been used for different applications including real time services and these are: Mobile IPv6, Hierarchical MIPv6 (HMIPv6) and Fast Handovers for MIPv6 (FMIPv6) [4, 5, 7].

1.1.1 Mobile IPv6: Mobile IPv6 (MIPv6) [1, 2, 6, 7, 9, 13] permits MN to move across subnets, while retaining reachability and on-going connections between MN and Correspondent Node (CN). To achieve this, MN moves across subnets at all the time, it sends Binding Updates (BU) to its Home Agent (HA) and to all Correspondent Nodes (CN) to enable them about new IP address, i.e. the Care Of Address (CoA). MIPv6 also makes use of the Route Optimization mechanism as a default to remove the Triangle Routing problem. With the help of Route Optimization, the MN and CN can communicate directly without passing packets with the guide of the HA (See Fig 1).

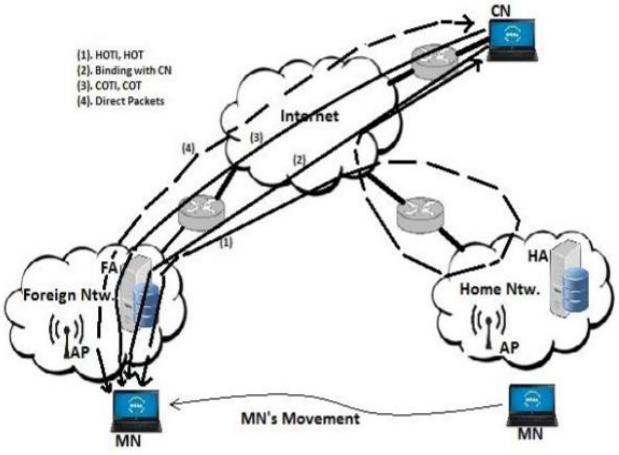

Fig. 1: MIPv6 Basic Scenario with route optimization

1.1.2 Hierarchical MIPv6 (HMIPv6): HMIPv6 [3, 4] introduces the Mobility management model majorly depends on Hierarchical mobility which is shown in the figure 2. HMIPv6 also works on MN movement detection in the region (that is, Micro-Mobile or Local Mobility) and Inter Domain Mobile (Macro mobile or Global mobility). HMIPv6 [2], movement detection in the region and inter-domain region can be separated by using Mobility Anchor Point (MAP). Mobile Node (MN) receives registered with MAP by sending Binding Updates (BU) to the MAP; So MAP acts as Home Agent (HA) for MN. All the packets for MN are intercepted by MAP and re-transmitted to MN. MN Is associated with two addresses when it is in the domain of MAP': the Regional Care-of Address (RCoA) and Local/Link Care of Address (LCoA). The BU which is dispatched by MN to MAP consists of RCoA and LCoA., which makes MN's registration of RCoA with the HA and CN. Whenever MN only moves in the MAP region, it only wants to register to acquire new LCoA to MAP and need not to send any BU to HA and CN because there is no exchange in RCoA, as a result it reduces the signaling overload on the network, packet loss and also handover delays (See figure 2).

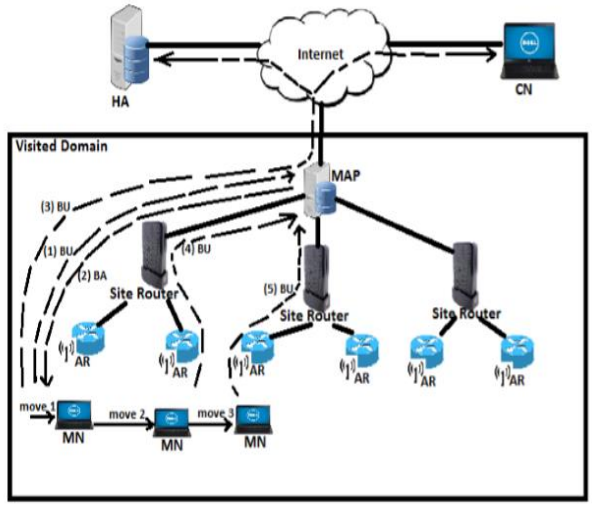

Fig. 2: HMIPv6

1.1.3 Fast Handovers for Mobile IPv6: Fast Handovers for Mobile IPv6 (FMIPv6) [5, 3, 7, 8] is based on the MIPv6. The goal of FMIPv6 is to minimize the handover latency. The primary principle is establishment of MN connection with New Access Router (NAR) in advance before breaking connection with the Previous Access Router. Once the connection is set up then MN obtains new temporary address by NAR. For implementation of FMIPv6 over IEEE 802.11 wireless network, RFC4260 divides FMIPv6 mechanism into two major modes: Predictive mode and Reactive mode.

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1.1.3.1 Predictive Fast Handover Mode: As illustrated in Figure 3, when the MN realizes that the handoff is necessary, it performs the scan in advance to the handover, and sends a Router Solicitation for Proxy (RtSolPr) message to group the list of Neighbor Access Routers (NAR). The current Default Access Router(DAR) or Previous Access Router (PAR) responds to MN with a Proxy Router Advertisement (PrRtAdv) resolving the particular Access Point (AP) identifiers. Therefore, it is capable to send the Fast Binding Update (FBU) and Handover Initiate (HI) prior to the New Access Router (NAR) through PAR.

NAR confirms the message by sending Handover Acknowledge (HAck) and then Fast Binding Update Acknowledgement (FBack) consists of CoA will be dispatched from PAR to each MN and NAR. The Packets which are sending to the MN will be buffered at NAR during its handover. After completion of handover process Fast Neighbor Advertisement (FNA) is sent; and the buffered packet will be delivered to the MN.

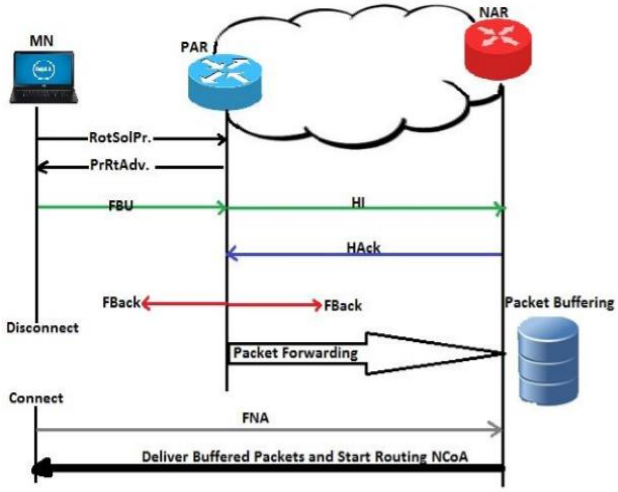

Fig. 3: Predictive Fast HO operations

1.1.3.2 Reactive Fast Handover Mode: As illustrated in Figure 4 Reactive Fast Handover Mode is opposite to predictive mode, the MN can't send FBU prior to the handover, instead of that packets which are pushed to wireless node will be buffered at the PAR during the handover process. Finally, FBU is dispatched to the PAR after the handover and inform the PAR to forward packets to the MN below NAR (see figure 4).

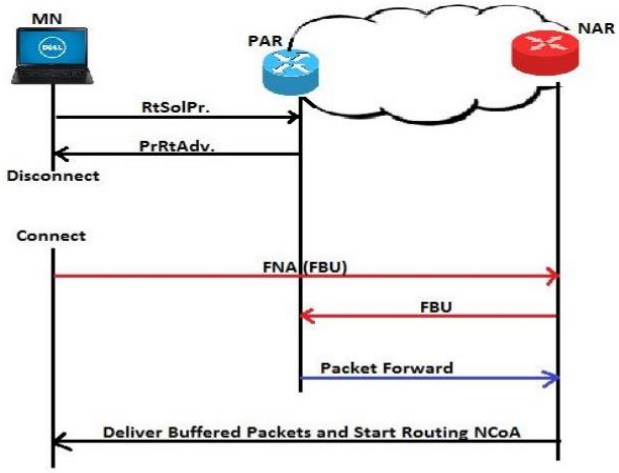

Fig. 4: Reactive Fast HO operations

After the survey about of Host based mobility schemes, it is clear that all the above protocols requires modification in MN's protocol stack and change of its IP address in order to continue the session even in roaming inside or across network domains. Furthermore, MNs are basically resource reservation based (e.g., memory, power) especially sensor nodes, their involvement in the mobility signaling technique (Movement detection, Router Solicitation Request (RtSolReq), Duplicate Address Detection (DAD) and Binding Updates (BUs)) may increase node complexity, consumption of energy, and wastage of resources.

Hence these protocols are not been considerably used in real time because of the above problems and its drawbacks such as excessive handover latency, packet loss and signaling overhead cost. Kong et al., [32], said that due to their lack of ability to fulfill the Quality of Service (QoS) requirements for real-time, non-real-time and streaming sensitive services, such as VoIP, video conferencing, audio/video streaming.

1.2 Network Based Mobility Management Schemes: In such protocols, there is no involvement or less involvement of MN in signaling process (Network elements are involved in Signaling). The Following belongs to Network Based Mobility Management Protocols.

1.2.1 NEMO-BS: The NEMO Basic Support Protocol is standardized for IPv6 but drafted for IPv4 . NEMO is an extension of Mobile IP that facilitates the network to

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exchange its attachment point to the Internet. In NEMO, The function of MN takes over by the Mobile Router (MR) in carrying out mobility functions. Nodes which are connected to a MR are referred to as Mobile Network Nodes (MNNs) and these MNNs are no way concern to the network's mobility and do not embed any mobility functions. MRs in addition sends binding updates to their HAs. However, Binding Updates from MRs also incorporate the Mobile Network's Prefix (MNP). HAs binds network prefix to the MR's CoA and forward all packets for that network (prefix) to the MR. Figure 9, shows the route of packets using NEMO. IP packets are delivered from CN to HA of that MN through preferred routing on the Internet and then HA tunnels packets to the MR for delivery to the MNN. Reverse packets takes the same route in the opposite direction; the MNN send packets to the MR to be tunneled to the HA and then sent out to the CN by well-known routing on the Internet.

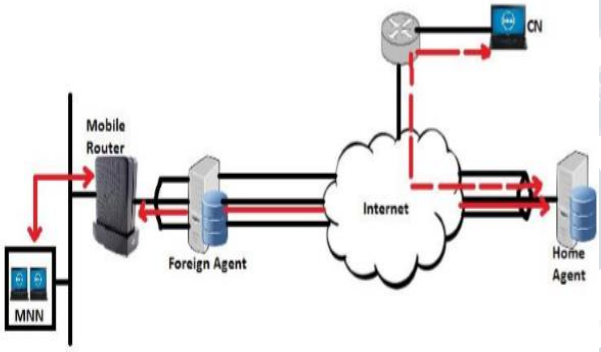
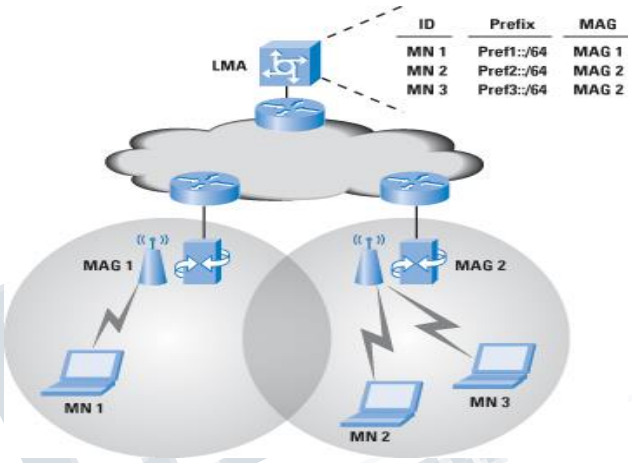


Fig. 9: IP traffic between a Mobile Network Node and a Correspondent Node using NEMO

1.2.2 PMIPv6: Proxy Mobile IPv6 (PMIPv6) [11, 60] could be a Network-based quality management protocol, the sole standardized network based mostly quality protocol by IETF, per RFC 5213 [11].This protocol is used to construct common access technology, independent of mobile core networks, accommodating various access technologies such as Wi-MAX, 3GPP, 3GPP2 and WLAN based access architectures.

Operation of Proxy Mobile IPv6 : The objective of PMIPv6 is MN is not concerned in any IP layer mobility-related signaling. The MN is a traditional IP device (that is, it runs the general protocol stack). The basic purpose of PMIPv6 is to furnish mobility to IP devices without involvement of MN. This provision is performed by way of relocating relevant functions for mobility management from the Mobile node to the network. PMIPv6 presents mobility assist within a localized area, the Localized Mobility Domain (LMD) or PMIPv6 domain. While moving within the LMD, the Mobile Node retains its IP address, and network is accountable of monitoring its location. PMIPv6 is primarily based on Mobile IPv6 (MIPv6) which re-uses the concept of Home Agent that need to signal the changes in the region of a Mobile Node on its behalf.



The functional components in the PMIPv6 network architecture is as follows:

- Mobile Access Gateway (MAG): It does the mobility-related signaling on behalf of the MNs attached to its access links. The MAG acts as the access router for the Mobile Node, that is, the first-hop router in the Localized Mobility Management infrastructure. Its responsibility is monitoring the movements of the Mobile Node in the LMD. An LMD can be with multiple MAGs.
- Local Mobility Anchor (LMA): This is used to keep a collection of routes for each Mobile Node which are linked to the LMD within the core network. The routes point to MAGs managing the links where the Mobile Nodes are presently located. Packets can be dispatched or received to or from the Mobile Node are routed through tunnels between the LMA and the corresponding MAG. The LMA is a centralized anchor point for the addresses assigned to Mobile Nodes in the LMD, means that packets with those addresses which are destined are routed to the LMA. The simple operation of PMIPv6 is as follows: When a Mobile Node enters a PMIPv6 domain, it attaches to an access link provided by a MAG. The MAG proceeds to identify the Mobile Node, and tests whether it is authorized to use the network-based mobility management service. If so, the MAG performs mobility signaling on behalf of the Mobile Node (see in Figure 2 the signaling when the Mobile Node enters the

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PMIPv6 domain). The MAG sends to the LMA a Proxy Binding Update (PBU) associating its own address with the identity of the Mobile Node (for example, its Media Access Control [MAC] address related to its authentication in the network). After receiving this request, the LMA allocates a prefix to the Mobile Node after that LMA sends to the MAG a Proxy Binding Acknowledgment (PBA) which includes the prefix which is allocated to the Mobile Node. It further creates a Binding Cache entry and establishes a bidirectional tunnel to the MAG. The MAG sends Router Advertisement messages to the Mobile Node, including the prefix allotted to the Mobile Node, therefore the Mobile Node can configure an address (stateless auto configuration). The MN can alternatively use stateful address auto configuration mechanisms.

1.2.3 6LoWPAN: Wireless sensors are widely used in critical applications such as natural disaster forecasting, medical assistance and battle field control. Sensors have limited resources like (memory and processing) and autonomous with limited power supply. ZigBee 802.15.4 protocol stack is non-IP based protocol used for Wireless Sensor Networks. Zigbee has found incompatible with IP and introduces many other constraints like resource usage, limited bandwidth, energy consumption etc. To overcome the above issues, a new IETF 6LoWPAN was introduced.

The 6LoWPAN protocol stack is given in the figure

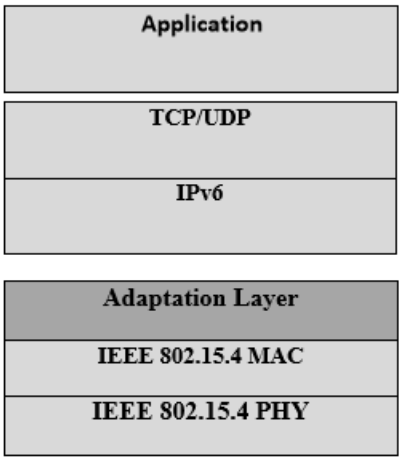

Fig. 8: 6LoWPAN protocol stack

6LoWPAN embraces the PHY and MAC layer conventions of IEEE 802.15.4 and alongside IPv6 convention; it is utilized in 6LoWPAN as system layer convention. The Adaption layer gives consistent transmission among MAC and network layer. Adaption layer is in charge of fragmentation, Re-fragmentation, and IPv6 header compression.

2. Open Issues and Challenges

From the above survey, IP mobility management schemes provide seamless handover to MN. As discussed in the above, some of the existing methods are based on Host and some are based on Network. Network based mobility schemes terribly helpful in 6LoWPAN mobility; such networks are composed of devices with restricted energy resources, memory and computational power.

An adaptation layer [22, 27] is also introduced in those networks to provide IPv6 connectivity. Lot of research has been carried out on 6LoWPAN WSN mobility (see figures (6) and (7)) and main objective is to reduce signaling cost, packet loss and particularly HO latency. Layer2, Layer3 (L2 and L3) handoffs causes HO latency. The delays caused by L2 are Channel scanning, authentication and association. However, Movement Detection (MDD), CoA, Duplicate Address Detection Delay (DAD) and Registration Delays are caused by L3 [65]. The more often than not devouring postponement is happened in light of examining of channel and [66, 67, 68, 69] make a few enhancements to decrease L2 delay. [68] Used Pre-enrollment procedure to diminish HO delay while [67] utilized reserving AP system for lessening the equivalent. While conveying restricting data by recently connected nodes in Wireless Body Area Networks(WBAN) at that point there might be possibility of flagging cost, the group based conventions in [18,42] is accomplished the objective in lessening flagging expense for the equivalent, however sensors in WBAN joined to new connection in the meantime. Thusly in [41], one control message (RA and RS) to convey the entire body sensor's data was utilized to diminish the flagging expense. In [70], Fast Handover for PMIPv6 (FHPMIPv6) was additionally used to diminish the flagging expense in sensor systems. In this manner Healthcare is one of the quickly developing exploration territories based on 6LoWPAN WSN. Anyway numerous medicinal services applications utilize the current portability the board conventions and these conventions are producing worthy outcomes yet at the same time there are few shortcomings:[29]

In this article, the contextual investigation depends on the Hospital Wireless Sensor Network (HWSN) and consistent Patient's health monitoring in HWSN is exceptionally fundamental. The patients are autonomous and portable. The flagging messages (RA and multicast

messages) utilized for enrollment procedure ought to be few to upgrade the SN's life so as to help versatility in HWSN. Since HWSN is controlled system and Mobile Node (SN/MN) is very much aware of the current framework, so hubs need to check the flag quality dependably, to accomplish this there is prerequisite of consistent trade of messages between portable SN and AP. This must be maintained a strategic distance from to spare existence of battery of worked gadgets and furthermore to improve their portability. The flagging overhead among SN and AP is high as nearly to Single-trust correspondence which likewise prompts channel of SN's hitter. Single-bounce correspondence can be accomplished by conveying additional APs, in spite of the fact that it is costly however gives flagging financially savvy and consistent versatility. In HWSN, sensors which are put on patient's body often produces basic information including patient's body parameters like heartbeat rate, ECG, sugar levels, temperature of body, circulatory strain and so on. This information is time basic and ought to be transmitted to Hospital Monitoring Station without out loss of any bundle. The got information can be deciphered and quick counsel can be given to tolerant. On the off chance that there is misfortune to basic information, at that point patient's life would be in peril. The loss of bundle is because of the end of association amid HO. Existing portability plans experiences information misfortune amid HO in HWSN. To control or decrease the parcel misfortune amid HO by buffering the bundles either at past AP (The present home of MN) or at new AP (where the MN means to move) and convey the cradled parcels to the MN after the HO is finished. Thusly the basic information can be spared from being lost and Quality of Service (QOS) is additionally improved in HWSN versatility conspire.

3. CONCLUSION

The contextual investigation comprises of Host based, Network based, 6LoWPAN and PMIPv6 mobility management schemes. Further likewise introduced a portion of the testing regions in versatility the board where upgrades are as yet required. One such area featured in this is medicinal services (HWSN), where patient's versatility is ceaselessly observed. Amid patient's portability (HO), basic information (wellbeing parameters) need to transmit to the checking station with no loss of information. Effectively existing versatility approaches [63, 74, 75] are tunnel based where sensor nodes need to send many of flagging messages, in this way they are not appropriate for 6LoWPAN portability. [41] Used PMIPv6 based versatility approach for sensor's gathering portability which gives better outcomes in contrast with unique convention yet it likewise still experiences parcel misfortune and there is further extension for lessening flagging expense.

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