

Research Article

Hierarchical Model of IEEE 802.21 Media Independent Information Service (MIIS)

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Abstract: In this era of emerging technologies, the main issue is to discover the appropriate neighbor access network during handoff mechanism for a mobile node. We require handover because in this heterogeneous environment, there can be several networks (Wi-Fi, WIMAX and UMTS) in a geographical area which are not so interoperable. For abiding the services we use Media Independent Information Service (MIIS) provided by IEEE 802.21 MIH standards (Buiati *et al.*, 2010) to select the most suitable network. This study provides a brief overview of how the challenges associated with the handoff are solved by several proposed schemes. In the introduction, role of MIIS is comprehensively defined to represent its importance followed by issues associated with handoff. Then, it gives an overview of the latest research activities in this field, including all the problems faced during handoff process. The study concludes by giving a new hierarchical scheme presenting implementation of MIIS servers to significantly improve the mobility.

Keywords: Handoff delay, IEEE 802.21 MIH, Inter-zone Handoff, neighbor discovery time, query response, two-level hierarchy

INTRODUCTION

When a mobile node moves from one network point of attachment to another, the process is called Handoff. Handovers can be classified as either horizontal or vertical. Horizontal are homogeneous handovers which occurs when a mobile node moves within the same network changing the point of attachment i.e., intra-network and inter-cellular. Vertical handovers are heterogeneous which maybe inter-technology or inter-domain specifying handoff between different access points. As the variety of available networks increases, mobile nodes can support multiple interfaces at a time. To do so, the Mobile Node (MN) will need information about the neighboring networks, such as the link quality, transmission rate, security, cost and address of the target network before the mobile moves into the target network. A process is required in which a mobile discovers information about its neighboring networks as network neighborhood discovery. An important problem in network discovery process is the discovery database construction in an automated, dynamic and efficient way.

The IEEE 802.21 standard (Buiati *et al.*, 2010) solves this problem by giving us a facility to handle

handover procedures in heterogeneous access networks by providing information, events and commands services. Media Independent Information Service (MIIS) server supports various Information Elements (IEs) that provide network information within a geographical area. Based on the information from several access networks and operators, a Mobile Node (MN) gets the neighborhood information by requesting IEs from the Information Server (IS). The IS can provide both static and dynamic information.

Static information: Represent a general review of the networks covering a specific area such as network type, operator identifier, QoS, security, cost and roaming partners. The names of service providers, Medium Access Control (MAC) addresses and channel information of the MN's current network neighborhood are examples of static information.

Dynamic information: Includes link-layer parameters such as data rate, throughput and other higher layer service information. It also represents overview of the Points of Attachment (PoA) for each available access network and categorizes aspects such as channel configuration to make an intelligent handover.

HANDOFF CHALLENGES

- **Handoff Latency:** The delays and delay variations during handoff should be minimized to guarantee the QoS.
- **Scalability:** The handoff procedure should support seamless handoff between APs in different private and/or public networks.
- **Quality of Service (QoS):** Refers to the capability of a network to provide better service to selected network traffic over various technologies.
- **Signaling Traffic:** Handoff signaling traffic should be kept to a minimum in order to reduce the load on the wired network and the air interface.
- **Resource consumption efficiency:** Handoff procedure should aim at low buffer consumption to reduce latency and minimize the consumption of bandwidth.
- **Data Integrity:** It includes minimization of cell loss, avoiding of cell duplication and maintaining cell-sequence for each connection.
- **Registration and Authentication:** The handoff requires that the MN should switch to trustworthy Point of Attachment.
- **Wastage of channel resources:** Due to too late or too early handoff, the channel resources are wasted as handoff occurs when not required.
- **Power saving:** The MN should prevent excessive scanning of channels or networks to save the power.
- **Packet loss:** Handoff delay or handoff to inappropriate PoA can cause the MN to drop packets containing data.
- **Cost:** The MN should switch to the affordable network having less cost.

LITERATURE REVIEW

We discuss various proposed schemes in this section for improving handover performance using the Media Independent Information Service (MIIS). In conventional handoff schemes, L2 triggers were generated after the threshold was reached. The inefficiency was that there were too late or too early triggers. For instance, in the case of too late Link Going Down (LGD) trigger, when the MN sends the L2 trigger of LGD, the mobility manager still keeps on scanning the channel for horizontal and vertical handoff to connect to new interface. Meanwhile, the connection is lost with the current interface before the completion of the handover procedure.

Similarly, for too early LGD Trigger, as soon the L2 LGD trigger is generated, the handoff initiation starts and the scanning is simultaneously performed. The handover procedures in such case completes before

the need of actual handoff as the signal strength of current interface is still strong to support the MN connection.

The proposed scheme (Yoo *et al.*, 2010) reduces the service disruption time by using the neighbor network information to decide the desired handover policy and required handover procedure. This scheme initially measures the QoS and RSSI parameters of the current interface. Then, a trigger named *initAction* trigger is generated to use the MIIS server to obtain the network information. The list of candidate network is created and the type of handoff is selected by the MN. Later the *LGD* trigger is generated and the MN again scans the network for candidate list for the target decision. Finally, the handoff procedures are completed before the *LD* trigger is generated.

The proposed scheme MPA (Dutta *et al.*, 2008) performs pre-authentication by generating MN-CA and MN-AR keys which are securely delivered to the configuration agent and access router, respectively. In the pre-configuration phase, the MN creates a tunnel containing the IP address and other configuration parameters using the keys identified in the previous phase. Before switching, the MN starts secure proactive handover by executing the binding update operation of a mobility management protocol and transmitting data traffic over the tunnel. After the MN attaches to the target network, the proactive handover tunnel needs to be deleted or disabled using a tunnel management protocol.

This provides access authentication and security association between the authentication agents in neighboring networks. To use the MIH Services, a MN enabled with MIHF with an additional entity named Connection Manager CM (Wan-Seon *et al.*, 2009) is integrated in the MN. The performance of vertical handover is evaluated and the packet loss, AP discovery time and power consumption are reduced by this method. A MN runs on the Linux 2.6.16 by applying a kernel patch for MIPL.

The proposed scheme reduces the AP discovery time by sending a POA-specific IE in the *MIH_Get_Information_Response* which contains the type of POA located nearby the MN. The MN then gets the information of the location of AP to which handoff is required. This approach reduces the overhead of scanning, saving the power consumption of MN significantly. The experiments in the proposed scheme show that before the old link is disconnected, the MN locates another network and initiates the handover process. Hence the handover latency and packet loss is reduced.

An Enhanced Information Server (EIS) (Kim *et al.*, 2011) is introduced where the channel state can be estimated by exploiting temporal and spatial localities in the channel state. The MN does not need to perform

time-consuming scanning procedures which save the power of mobile node. Moreover, the proposed vertical handover eliminates the scanning delay by estimating the wireless channel condition through the EIS.

In a typical 802.11 handoff procedure, a station switches to a new channel, sends a probe frame and dwells on the channel for a certain amount of time waiting for responses from the APs (if any) operating on the channel. The channel dwell time contributes to overall handoff delay. HaND (Xi and Qiao, 2010) is based on a novel zero-channel-dwell-time architecture which is different from existing handoff schemes. A hand station switches back to its current channel immediately after sending out a probe frame on the new channel. Instead, the current AP of the station is responsible for collecting the responses from nearby APs and forwarding them to the station over its current channel.

To achieve secure proactive pre-authentication with a target neighboring network, network parameters should be discovered for fast handoff to reduce delay and transient data loss for real time communication. The method used for network discovery is Application-layer mechanisms for Information Service (AIS) (Dutta *et al.*, 2006) to solve the discovery database construction problem and methods for mobiles to discover information regarding neighboring networks. Comparison results (Lopez and Robert, 2010) of TLV and RDF query base information element retrieval methods specified in IEEE 802.21 standard show advantages and disadvantages of each of these methods:

TLV: Preferred method when size and processing power is vital for a mobile station. Disadvantage is the time and testing needed for implementing a TLV encoding for increasingly more complex structural data.

RDF: Preferred method of implementation for physically larger, more powerful and more user application inclined mobile stations, where development time is critical.

Information service is used to discover the available networks and their parameters for the selection of best network and to minimize scanning mechanism to save power for MN. The use of Cost function provides flexibility to balance different factors in the decision making and improving both seamlessness and energy efficiency of the device and handovers. The approach (Liu *et al.*, 2009) is based on usage scenarios over Wi-Fi, WiMAX and 3G networks using captured signal strength traces as a trigger.

Open MIH (Cezar, 2009) is an open source architecture for Media Independent Handover Service that gives pre-proactive pre-authentication. To enable the authentication process, it uses off the shelf

components. The proposed scheme is according to the approved MIH standard and partially implements MIHF conformant with the standard. Its main feature was to perform handover in a secure wireless environment. The drawback of Open MIH was that it was implemented only for the horizontal handover and was not much in conformance with the standard due to lack of testing.

Yuan (2010), the idea was to potentially reduce the packet loss and to enhance the performance between different interfaces in the multiservice environment. It is proved more efficient than FMIPv6 scheme thorough numerical analysis especially with an imperfect decision algorithm and bad wireless environment.

To discover the available neighbor access networks and it's characteristics as the user move, the letter (IEEE STD 802.21, 2008) proposes a new neighbor network discovery mechanism, considering a hierarchical view of the network information which enhances the performance of the MN in terms of experienced throughput and discovery response time. MIIS is used in three hierarchical levels to give information for network discovery.

PROPOSED MODEL

In the IEEE 802.21 MIH standard (Buiati *et al.*, 2010) only one information server is proposed to provide information about the neighboring network. However, the growing number of networks, users and supported communication technologies directly affect the amount of MIIS information sent from the network to the MN, causing handover performance delay. The Hierarchical Neighbor Discovery Scheme for Handover Optimization provides three levels of hierarchy to handle the neighbor network information. These levels cause handover delay when a MN moves from one zone to another as MS has to wait for the query response when query is transferred to upper level causing inefficient handoff.

Our proposed model of MIIS contains two level of hierarchy. First level contains Zone level server (ZMIIS) that contains BTS belonging to its specified geographical area. Second level contains Local level server (LMIIS) that contains the information of all of the Zone level servers and facilitate inter-zone handoff. The evaluation parameters are neighbor discovery time and handoff delay.

Local level information server contains the necessary data of all the available networks belonging to the same operator. When MN sends a request for network map to Zone Level MIIS, then that IS sends a reply containing the network map. When MN starts moving, it travels to another zone, now if the MN sends

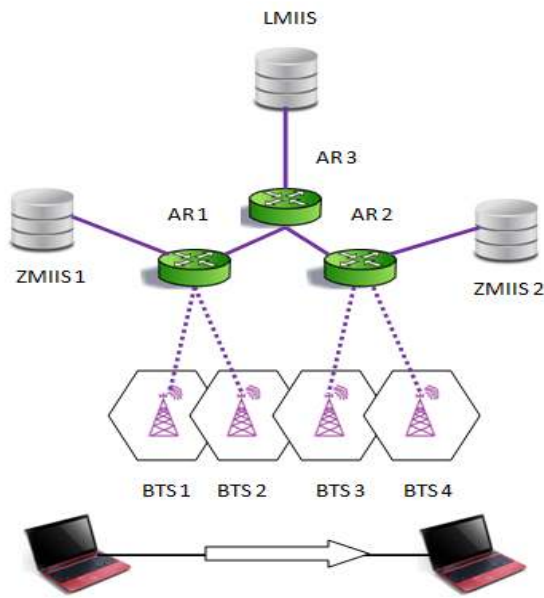


Fig. 1: Proposed two level hierarchical model for MIIS

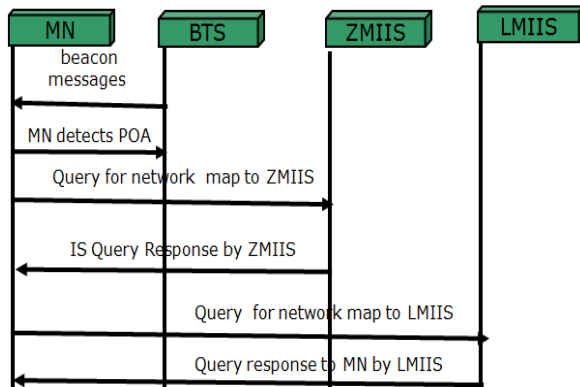


Fig. 2: Simulated hierarchical model flow diagram

a request for network map to Zone Level MIIS, then that IS in turn requests it from the Local Level MIIS. The Local Level MIIS (LMIIS) returns it to Zone Level MIIS and the Zone Level MIIS (ZMIIS) sends it to MN.

We used Network Simulator NS-2.34 for creating the simulated scenario. The results are interpreted to show the performance of our proposed scheme. We have used the network map as a query and respected response message is generated. The MN sends request to the ZMIIS to obtain the network map of its surrounding networks in the vicinity of that zone level server. Now if the ZMIIS contains the network map it replaces the query message into response by filling the information necessary for network map. MN receives

this network map as a response from ZMIIS and checks whether the information in the network map is fulfilling its requirements for handoff to a specified PoA or not. The mobile node receives this request at its multiple interfaces and then checks all the parameters e.g., cost of the detected PoA, Received Signal Strength (RSS), power consumption and battery usage, security issues etc for an optimized handoff to the detected PoA.

If the MN successfully scans all these parameters and finds the most appropriate network, it starts handoff. Our proposed scheme also minimizes over-scanning as MN does not have to scan the information; it just sends a request to IS for all the relevant information. So this aspect reduces the power consumption of MN and hence saves the battery usage.

We use two levels of hierarchy as illustrated in Fig. 1 to provide the required information by the MN. Previously, one MIIS server was used containing all the data, but the Max Response Size parameter set by the IEEE 802.21 restricts the message size of the response due to which some information is lost. This is not acceptable by the MN; therefore, different level servers can serve the purpose of replying back with accurate amount of information so that MN receives all the required information without causing delay hence improving the quality of MIIS response. We propose a two-level hierarchical neighbor discovery scheme in which the network coverage area is divided into mobility zones, managed by different MIIS servers.

Neighbor discovery scheme: For a large variety of multiple networks and different operators there should be a solution considering a hierarchical division of the existing information. The fact behind that is the detail information of the particular PoAs of a single access network and the collection of all these details for a large number of access networks.

When MN requires handoff, it starts discovering neighbor PoA. When a particular BTS is detected, the MN sends a request message to obtain the network map for that particular BTS. The ZMIIS receives the request and checks whether it contains the information regarding that particular BTS. If the BTS is known, the response is sent by the ZMIIS to the MN containing network map. On the other hand, if the BTS is not known by the ZMIIS, it forwards the request to LMIIS. The LMIIS receives the request and checks whether the BTS is known. If a known BTS request is received, it forwards the reply to the ZMIIS which in turn sends the reply to MN. Otherwise, a No Response message is generated as illustrated in Fig. 2 and 3.

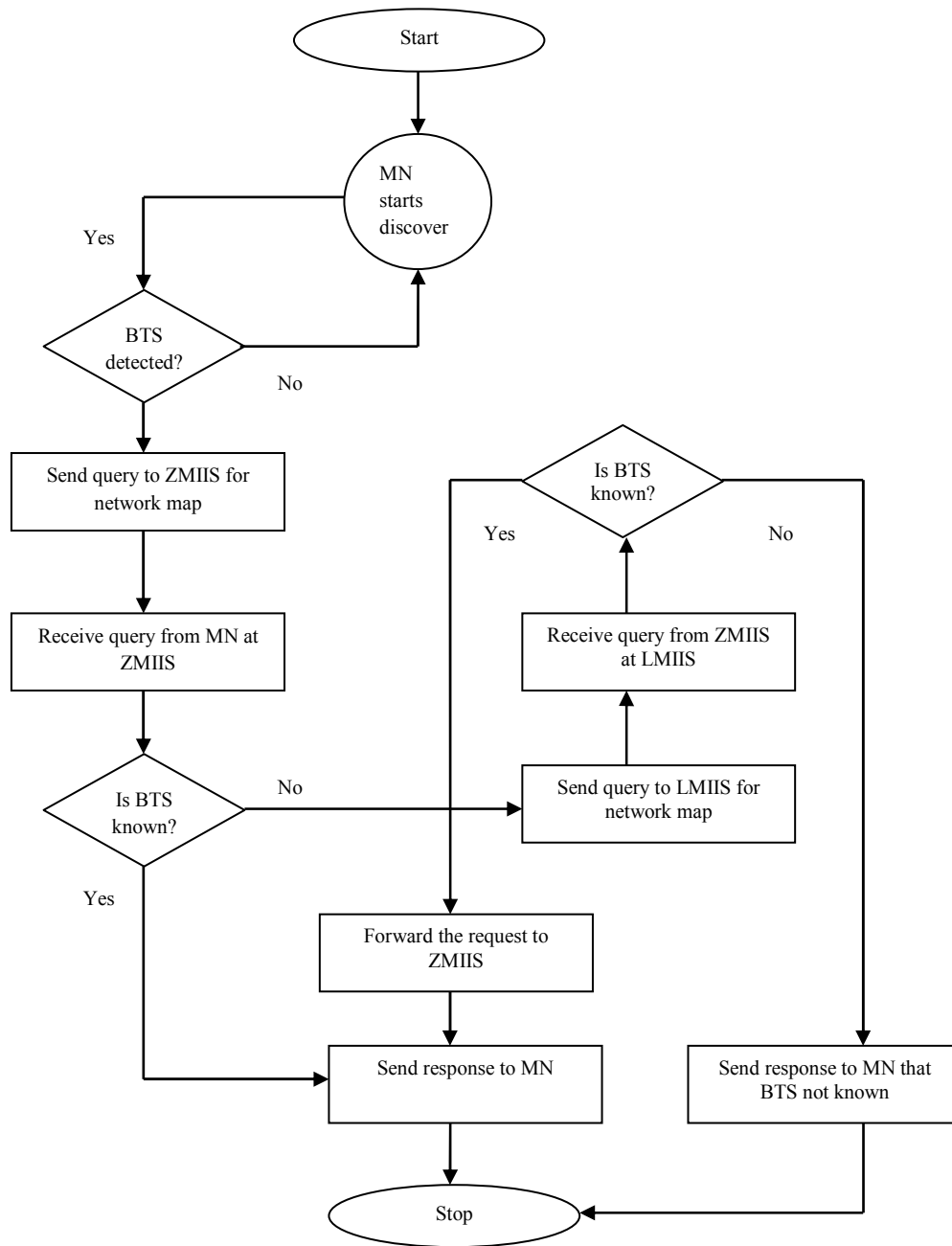


Fig. 3: Two-level hierarchical neighbor discovery algorithm

Results evaluation and comparison: Figure 4 shows the graph of Time at which the packet was sent vs. the delay. i.e., the time required to receive the response. Delay is scaled on y-axis and represented in number of seconds. It is plotted against time at which the packets sent are measured in seconds. The delay is checked at several seconds and the results are displayed in the graph. As shown, the average delay occurred in

proposed Hierarchical scheme is 0.024 sec which is quite less than the standard MIIS. Neighbour discovery time parameter is used to evaluate the results against the simulation time. Total Neighbour Discovery time (TND) is equal to time of receiving the Response Message (RM) minus time of sending the query message (QM) i.e., $TND = RM - QM$.

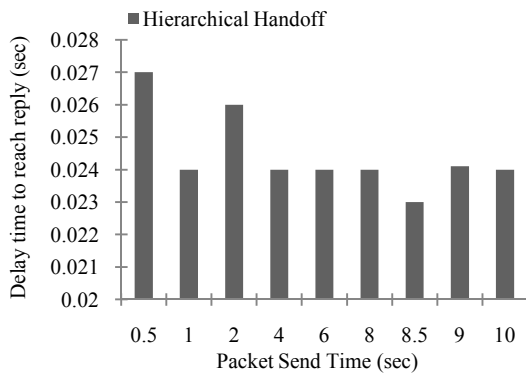


Fig. 4: Packets sent vs. the delay

CONCLUSION

This study presents a review of the main research activities which show the importance of media independent information service to make the handoff performance optimized. The proposed model of the two level hierarchical implementation of media independent information service gives better result than the previous proposed scheme. The evaluation parameters are neighbor discovery time and handoff delay. Through the ns 2.34 simulations, results are interpreted and compared with the proposed three level hierarchical model. The results shows that by reducing hierarchy from three levels to two level, handoff delay and neighbor discovery time is reduced which enhances the handoff performance. The security parameter is not handled by our proposed scheme.

REFERENCES

Buiati, F., J. Luis, G. Villalba, D. Corujo, J. Soares, S. Sargento and R.L. Aguiar, 2010. Hierarchical neighbor discovery scheme for handover optimization. *IEEE Commun. Lett.*, 14(11): 1020-1022.

Cezar, A., 2009. Practical approach of implementing media independent information service from IEEE 802.21 standard. *Proceeding of Wireless Communication, Vehicular Technology, Information Theory and Aerospace and Electronic Systems Technology*, pp: 92-96.

Dutta, A., D. Famolari, S. Das, Y. Ohba, V. Fajardo, K. Taniuchi, R. Lopez and H. Schulzrinne, 2008. Media-independent pre-authentication supporting secure interdomain handover optimization. *IEEE Wirel. Commun.*, 15(2): 55-64.

Dutta, A., S. Madhani and T. Zhang, 2006. Network discovery mechanisms for fast-handoff. *Proceeding of 3rd International Conference on Broadband Communications, Networks and Systems*. San Jose, CA, pp: 1-11.

IEEE STD 802.21, 2008. *IEEE Standard for Local and Metropolitan Area Networks, Part 21: Media Independent Handover Services*. IEEE 3 Park Avenue, New York, NY 10016-5997, USA.

Kim, Y., S. Pack, C.G. Kang and S. Park, 2011. An enhanced information server for seamless vertical handover in IEEE 802.21 MIH networks. *Comput. Netw.*, 55(1): 147-158.

Liu, H., C. Maciocco, V. Kesavan and L.Y. Low, 2009. Energy efficient network selection and seamless handovers in mixed networks. *Proceedings of International Symposium on a World of Wireless, Mobile and Multimedia Networks and Workshops (WoWMoM, 2009)*, pp: 1-9.

Lopez, Y. and E. Robert, 2010. Open MIH, an open-source media-independent handover implementation and its application to proactive pre-authentication. *Soc. Inform. Telecommun. Eng.*, 32: 14-25.

Wan-Seon, L., K. Dong-Wook, S. Young-Joo and W. Jeong-Jae, 2009. Implementation and performance study of IEEE 802.21 in integrated IEEE 802.11/802.16e networks. *Comp. Commun.*, 32(1): 134-143.

Xi, C. and D. Qiao, 2010. HaND: Fast handoff with null dwell time for IEEE 802.11 networks. *Proceeding of IEEE Conference on Computer Communications*, pp: 1604-1612.

Yoo, S.J., D. Cypher and N. Golmie, 2010. Timely effective handover mechanism in heterogeneous wireless networks. *Wireless Pers. Commun. Int. J.*, 52(3): 449-475.

Yuan, J., 2010. Optimized handover scheme using IEEE 802.2 MIH service in multi-service environment. *Proceeding of IEEE Vehicular Technology Conference*, pp: 1-5.