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**MIF API extension for combining IEEE 802.2
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Abstract

The Application Program Interface (API) of MIF, specified in the MIFAPI consideration, must rely on lower layer functionalities when handover between homogeneous or heterogeneous networks is necessary. To improve the connectivity performance, the existing MIF API needs to be extended. IEEE is also aimed at the similar issue from different way. A kind of logical entities over the link layer protocol for handling the seamless handover has been defined in IEEE802.21. This document proposes a mechanism via integrating MIF API and IEEE 802.21 to support application service better.

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1. Introduction

In MIF context, the improvement of connectivity experiences SHOULD be produced. Enhancing the performance of horizontal and vertical switches between networks is the main target. The aforementioned situation is quite similar with Media Independent Handover (MIH) described in [IEEE 802.21]. Even though the MIF Application Program Interface (API) specified in the MIF API consideration [I-D.ietf-mif-api-extension] illustrates a series of message in multiple interface scenarios, this draft only provides a minimal set of message calls REQUIRED to implement the API. Hence, new functions could be added.

In terms of [IEEE 802.21], the Media Independent Handover Function (MIHF) is a logical entity, which can facilitate MIH decision making based on inputs from the MIHF. Abstracted services can be provided for higher layers by MIHF. Also, it can communicate with the lower layer of the mobility-management protocol stack through technology-specific interfaces in MIHF.

As two mechanisms, MIF API and MIHF, are working in different layers and defined by different organizations, the requirements of compatibility are distinct. Connection manager (i.e. the MIHF) SHOULD support some of the functions of MIF API, and vice versa. The functions of MIHF could be utilized in MIF API in order to handover issues according to the advantages of both MIHF and its Service Access Points (SAPs). Message calls of MIF API is extended by this document to support the MIH. Similar with [I-D.ietf-mif-api-extension], because they are left up to the implementation, there are no bindings for programming languages being provided. This document only illustrates the messages sending and receiving, which can be read as a checklist for operating system vendors.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC-2119](#) [[RFC2119](#)].

3. The Relationship between IEEE MIHF and MIF API

The purpose of IEEE 802.21 is to further the user experience of mobile devices through facilitating handover among all IEEE.802 networks despite of whether they are of different media types or not, including both wired and wireless. Also, the target is to make it possible for mobile devices to perform seamless handover between IEEE 802 and non IEEE networks. This standard defines:

1. A framework that enables service continuity while a Mobile Node (MN) transitions between heterogeneous link-layer technologies.
2. MIHF.
3. MIH_SAP and associated primitives for users to get services of MIHF.
4. The definitions of new link-layer SAPs and associated primitives for each link-layer technology. They help MIHF to collect link information and control link behaviors during handovers.

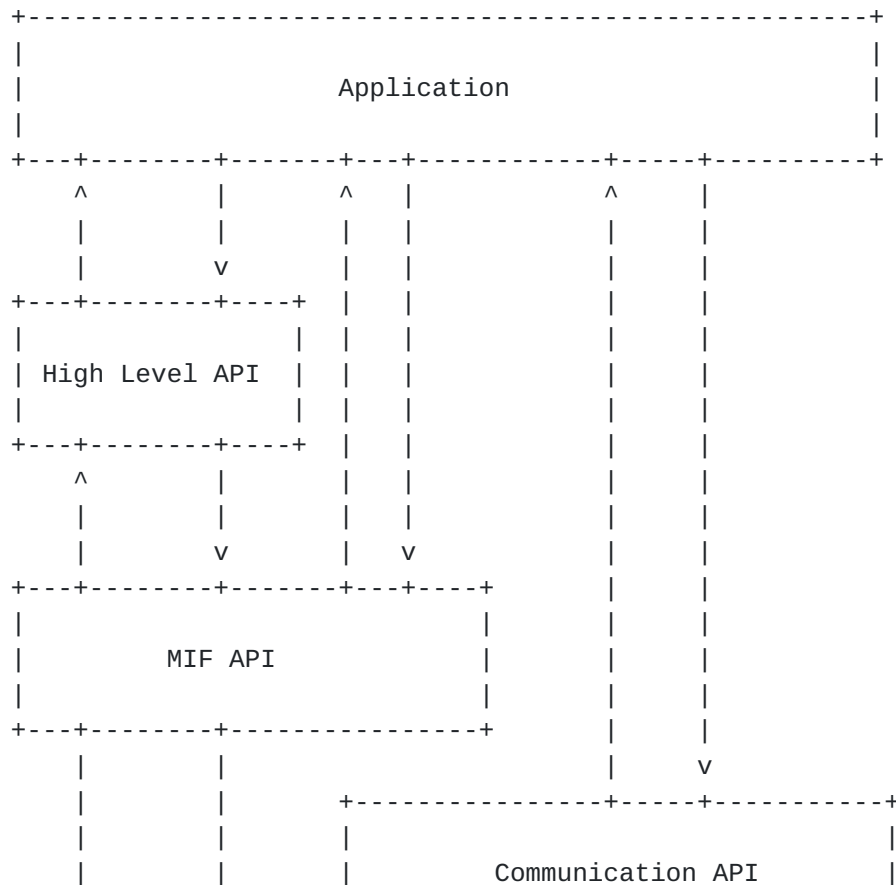
MIHF is a functional entity to fulfill the high- performance handovers. The fundamental advantage of MIHF is that it provides media-specific technology of lower layer is being used, such as IEEE Std.802.3, IEEE Std.802.11, IEEE Std.802.16, 3GPP and 3GPP2. Besides, three kinds of SAPs (will be detailed later) of MIHF are also defined and their primitives that interact between different layers.

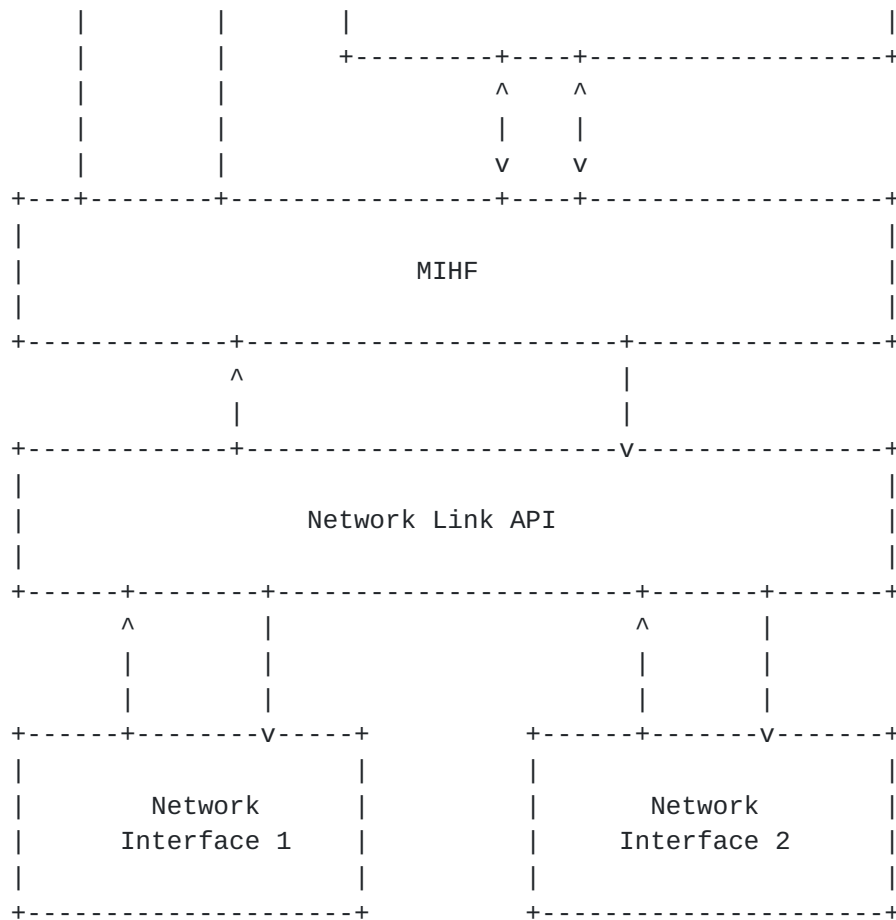
The MIHF can also act as a filter: the messages received from link layer SHOULD be processed and submitted to higher layer for meeting the subscribers' need. Therefore, MIHF should work under MIF API. In fact, MIF API SHOULD be served as a user of MIHF, as shown in Figure 1. The subscribers can then only interact with the MIHF via one kind of SAPs (i.e. MIH_SAP) without knowing the lower things. The MIH protocol is not in the scope of this document.

Three kinds of MIHF services are defined in the standard: Media Independent Event Service (MIES), Media Independent Command Service (MICS) and Media Independent Information Service (MIIS).

MIES provides event's degree, for event filtering and event reporting corresponding to dynamic changes in link characteristics, link status and link quality. It originates from lower layers and can be passed to MIHF or upper layers for the detection of handover requirement. MTH users manage and control link behavior relevant to handover and mobility by MICS. It is invoked by users or MIHF and makes effect on MIHF or lower layers.

For example, in MN-initiated handover scenario, MICS is adopted for MN switching between different links. MIIS makes it possible for MN and network entities discovering information which has influence on the selection of appropriate networks during handovers. Figure 2 [IEEE 802.21] shows MIH services and their initiation.





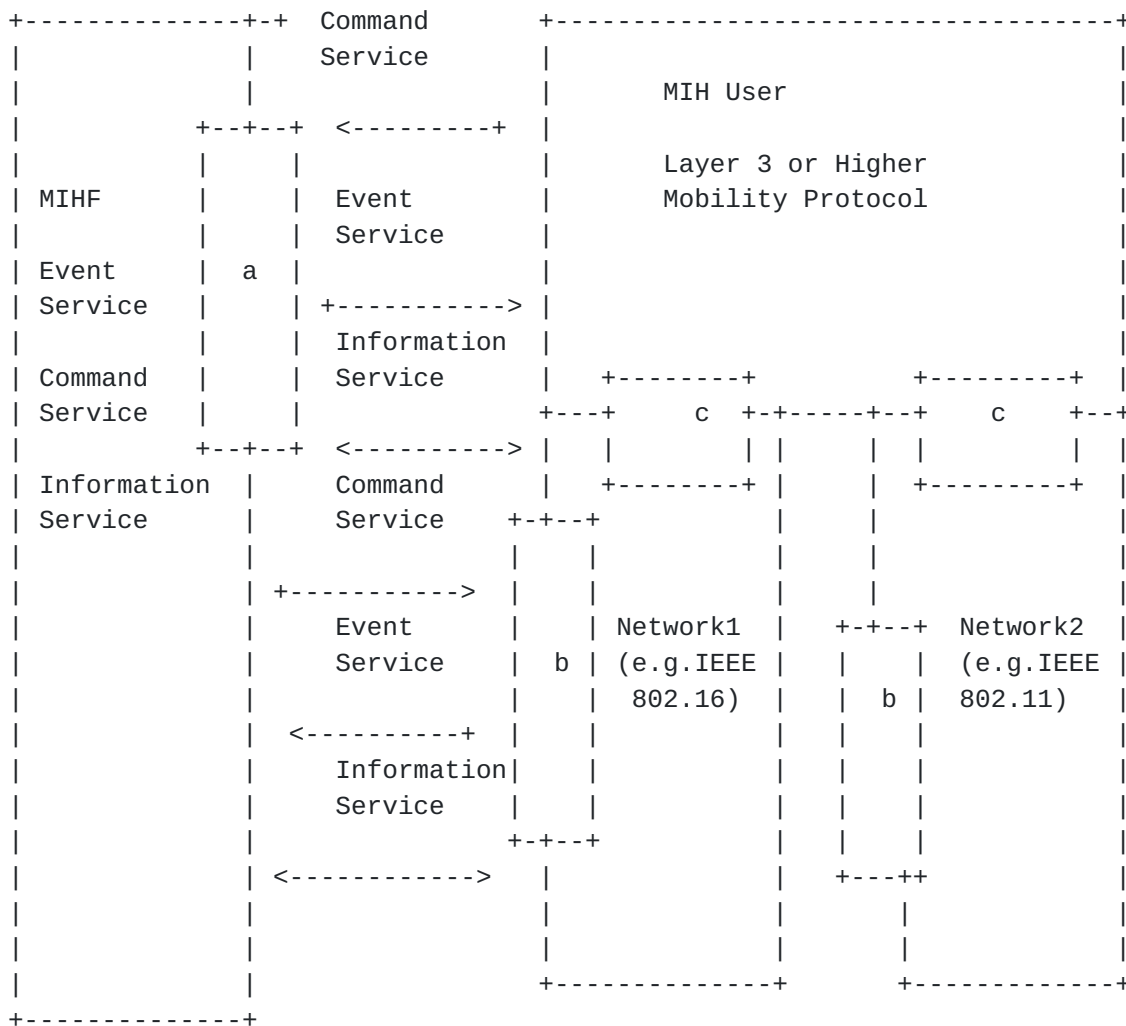
The relationship of the MIHF & MIF API

The letters a, b, c in Figure 2 respectively represent:

- a. MIH_SAP
- b. MIH_LINK_SAP
- c. LLC_SAP

The SAPs are divided into two categories:

- 1) Media dependent SAP (including MIH_LINK_SAP and LLC_SAP).
- 2) Media independent SAP (MIH_SAP).



MIH services and their initiation

SAP of the MIHF (i.e. MIH_SAP) is media independent. The interface between the MIHF and MIH users is defined by the MIH_SAP such as an upper layer mobility protocol or a handover function (e.g., MIF API) that might reside at higher layer transport entity as well. MIHF is allowed by MIH_SAP to provide services to the upper layers, the network management plane and the data bearer plane. Upper layers need to subscribe with the MIHF as users to receive MIHF events. In MIF case, the MIF API can directly send commands to the local MIHF via messages which use the service primitives of the MIH_SAP.

All the messages REQUIRED for communicating successfully in MIF environment that described in the [[I-D.ietf-mif-api-extension](#)] MUST also be used here. These messages define the way that MIF API interacts with the higher layers or applications and need to be added into this set for handover process. These new messages SHOULD be exchanged between MIHF and MIF API. The service of MIHF is used by some of them.

4. The Extension of MIF API for Handover: A Case Study

This section introduces the extension of message calls of MIF API in two parts based on the classification of handovers (MN-initiated handover and the network-initiated handover). In order to handle these two kinds of handovers successfully, MIF API SHOULD be extended respectively based on the characteristics of process.

4.1. The MN-initiated Handover

The handover initiated by MN includes the following seven steps:

- 1)Information query. The MN collects network information from the MIIS server which the MN is connected to.
- 2)Resource availability check. The MIF API sends request to find candidates and then receives a list of candidate networks in response message.
- 3)Resource preparation. The MN SHOULD determine which target network is suitable and request it for resource preparation.
- 4)Establish new L2 connection. The MIF API initiates a new link connection.
- 5)Link up indication. The MIHF of MN notifies the MIF API that the link is up.
- 6)Higher layer handover execution.

7)Resource release. The original serving network resources must be released in the end.

The following messages need to be added, which describe interactions between a MIHF and MIF APIs.

4.1.1. Get Information

This message is sent by the MIF API for the inquiry of the neighboring networks information. In MIH, the MIH_Get_Information. is use to request for the same purpose. After receiving this message, the MIHF inquires the MIIS server for the information, which will return a list of network information for MIF API.

4.1.2. Information Post

This message is sent to the MIF API by the MIIS server as a response to the Get Information message. MIH_Get_Information. confirm can be used to convey such information.

4.1.3. Parameter Report

The lower layers link status needs to be sent to the MIF API to better control the whole connection when connecting to a specific network. Reports can be sent to the MIHF from the link layers and then submit to the higher layers. If the link is going down, the MIF API must notify its subscribers using "Interface is going away" message. The application or higher API SHOULD establish new connections by sending "Wants to connect" to MIHF and the connection process will restart from step 2 (i.e. Resource availability check).

Another situation is when the MIF API receives a "Wants to connect" message from its subscriber, it SHOULD trigger a whole connection process to a new network accordingly. This can also begin from step 2.

4.1.4. Check Resources MN

In the connection starts period, the resource availability SHOULD be checked by the MN at the candidate networks. This message is sent to the MIHF by the MIF API. Then each candidate SHOULD be requested by

the serving network. The higher layer can receive the final result. The MIH_MN_HO_Candidate_Query. request can be used in the MIH case.

4.1.5. Resource Availability

When receiving the resource availability of the candidates from the serving network, the MIHF SHOULD submit these messages to the MIF API. The MIH_MN_HO_Candidate_Query. confirm can be used in the MIH case.

4.1.6. Connect to Interface

This message is sent to the MIF API by the upper applications. When the MIF API receives the Resource Availability, it could post the message to the higher layer. The upper application use "Connect to Interface" to choose a better network interface. More about the choosing methods need further discussion.

4.1.7. Resource Preparation Messages

The MIF API can use the MIH_MN_HO_Commit. request, which includes the target network information to request the network chose for resource preparation. The MIHF receives the response from the target network when the preparation is done. In order to inform the status of the previously issued target notification request, it sends a MIH_MN_HO_Commit. confirm message to the MIF API.

4.1.8. Establish Link Messages

The connection establishment problem can be solved by MIF API using the MIH_Link_Action. request. This message primitively defined by the [IEEE 802.21] is to control the local or remote lower link layers. It includes a MIHF ID and a Link Actions List, which can realize many controlling functions. The MIF API should receive a MIH_Link_Action. confirm to indicate the result, after the action has been executed.

4.1.9. Link Up

After the new link is established, a Link_Up. indication is delivered by MAC layers to MIHF. The MIHF then passes the MIH_Link_Up.

indication message to the MIF API. The MIF API can notify the upper applications using the "Link is going up" message. Then the higher layer handover execution might be triggered and the traffic flow can be re-established.

4.1.10. Handover Completed

This message is sent to the MIF API by the MIHF, which indicates that the resource of the previous network is successfully released.

4.1.11. Handover Completion Confirmation

This message is sent to the MIF API by the MIHF indicating that the resource of the previous network is successfully released.

4.2. The Network-initiated Handover

There are also seven steps in an intact network-initiated handover, like the MN-initiated handover:

- 1)Information query.
- 2)Resource availability check.
- 3)Resource preparation.
- 4)Establish a L2 connection using MIH_Link_Action. request.
- 5)Sent link indications to the MIF API.
- 6)Higher layer handover execution.
- 7)Resource release.

The differences between Network-initiated case and MN-initiated case are in step 1 and step 2. The MIH user of the serving network can initiate the Get Information Request and Information Query respectively. Such MIH user will send requests to the MN for a response message containing the MN's handover acknowledgement for MN's preferring link and PoS lists, when it obtains the information from the MIIS server.

In step 3, the commitment of target network is also initiated by the MIH user of a serving network. After the resource is prepared, the PoS of serving network SHOULD notify the MN for the establishment of L2 connection in step 4.

The following messages should be added in MIF API.

4.2.1. Candidate Query Notification

MN's MIHF receives this message from the PoS of the serving network with a list of PoAs of each candidate network link. Such message suggests the MN SHOULD consider new access network. This message can use the MIH_Net_HO_Candidate_Query. Indication.

4.2.2. Candidate Query Result

This message is sent to the local serving network's MIHF from MN's MIF API, specifying whether the request of handover is permitted or not. MIH_Net_HO_Candidate_Query. response can be used here. A new access network SHOULD be considered at the handover initiation stage, when the handover is permitted.

4.2.3. Check Resources Net

This message is sent to the MN's MIF API by the PoS of serving network with a list of target network information and a set of resource parameters assigned to the MN for handover.

MIH_Net_HO_Commit. indication can be used. TThen the establishment of L2 can be triggered by the MIF API using Link_Action. request. After the link connection is done, MIF API needs inform the serving network. Link_Action. request might also have a list of actions for handover control during the link connection period.

4.2.4. Confirm Chosen Target

The MN's MIF API sent this message as a response to the MIH_HO_Commit. indication, revealing that the indication is received. MIH_Net_HO_Commit. response can be used. Also such message might include a list of the results of previous actions.

4.2.5. Establish Link Messages

This message is exactly the same as that of the MN-initiated process, for establishing a new L2 link connection.

4.2.6. Link Up

This message is exactly the same as that of the MN-initiated process, for informing the MIF API that the L2 link is completed.

4.2.7. Handover Completed

This message is exactly the same as that of the MN-initiated process, for releasing the resources that have already attained by the MN.

4.2.8. Handover Completion Confirmation

This message is exactly the same as that of the MN-initiated process, for confirming that the resources of the previous network are successful.

5. Discussions for New Messages from MIF Perspective

New messages described in this document are critical for information exchanging and function achievement between MIHF and MIF API. Since both "upper layer requirements gathering" and "lower layer command delivering" (or reverse) can be achieved via messages, the logical relationship should be discussed in-depth. The messages below are only the examples. Further updating is needed.

5.1. Get Information

According to [IEEE 802 21] this information query is related to a specific interface. It has the flexibility to query either a specific data within a network interface or an extended schema of a given network. As "Announce Interface", "Announce PVD" and "Announce IE (Information Elements)" are sent by an advanced application or upper APIs, the MIF API could obtain the information via the Get_information. request in MIH.

5.2. Release the Ongoing Connection

The [[I-D.ietf-mif-api-extension](#)] defines a message "Connection can be broken", which means that the MN can tolerate the connection being broken, e.g. for power conservation. When the subscribers of MIF API delivers this message, the MIF API SHOULD send "Release the ongoing connection" to the MIHF so that directly releasing the current resources of network to cut off this connection, which will not weaken the application function.

5.3. Establish New L2 Connection

According to [IEEE 802.21], a L2 link connection can be triggered by the MIH_Link_Actions. The MIF API will receive "Connect to Address" or "Connect to Address from Address" messages, when MN wants to build a TCP connection with an IP host. Then the MIF API can use the MIH_Link_Actions. request to ask MIHF for new L2 link connection.

6. Discussions for New Messages from IEEE Perspective

The following tables, table1, 2, 3 and 4, are from the [IEEE 802.21]. These messages might be used in the MIF API because they are exchanged between the MIHF and its MIH users. Even though some of them have been discussed above, the specific usage of the rest is not represented. This section presents only a direct list of their category and brief descriptions. Further discussion is needed.

Messages (Information)	Description
MIH_Get_Information	Request to get information from repository
MIH_Push_Information	Notify the MN of operator policies or other information

Table 1 Information Messages of MIHF

Messages (Event)	Description
MIH_Link_Detected	Link of a new access network has been detected. This event is typically on the MN when the first PoA of an access network is detected
Track_timeout	This event is not generated when subsequent PoAs of the same access network are discovered
MIH_Link_Up	L2 connection is established and link is available for use
MIH_Link_Down	L2 connection is broken and link is not available for use
MIH_Link_Paremetrics_Report	Link parameters have crossed a specified threshold and need to be reported
MIH_Link_Going_Down	Link conditions are degrading and connection loss is imminent
MIH_Link_Handover_Imminent	L2 handover is imminent based on either the changes in the link condition or additional information available in the network
MIH_Link_Handover_Complete	L2 handover to a new PoA has been completed
MIH_Link_PDU_Transmit_Status	Indicate transmission status of a PDU

Table 2 Event Messages of MIHF

Messages (Command)	Description
MIH_Link_Get _Parameters	Get the status of a link
MIH_Net_HO _Candidate_Query	Network initiates handover and sends a list of suggested networks and associated points of attachment
MIH_Link_Configure Thresholds	Configure link parameter thresholds
MIH_Link_Actions	Control the behavior of a set of links
MIH_MN_HO_ _Candidate_Query	Command used by MN to query and obtain handover related information about possible candidate networks
MIH_N2N_HO_Query _Resources	command sent by the serving MIHF entity to the target MIHF entity for resource query
MIH_MN_HO_Commit	Command used by MN to notify the serving network of the decided target network information
MIH_Net_HO_Commit	Command used by the network to notify the MN of the decided target network information
MIH_N2N_HO_Commit	Command used by a serving network to inform a target network that an MN is about to move toward that network, initiate context transfer and perform handover preparation
MIH_MN_HO_Complete	Notification from MIHF of the MN to the target or source MIHF indicating the status of handover completion
MIH_N2N_HO_ Complete	Notification from MIHF of the MN to the target or source MIHF indicating the status of handover completion
MIH_N2N_HO Complete	Notification from either source or target MIHF to the peer MIHF indicating the status of the handover completion

Table 3 Command Messages of MIHF

Messages (Service management)	Description
MIH_Capability _Discover	Discover list of Events and Commands supported by MIHF
MIH_Register	Register with a remote MIHF
MIH_DeRegister	Deregister with a remote MIHF
MIH_Event_Subscribe	Subscribe for MIH event notification
MIH_Event_Unsubscribe	Unsubscribe from MIH event notification

Table 4 Service Management of MIHF

7. Security Considerations

This document does not contain any security considerations.

8. IANA Considerations

There are presently no IANA considerations with this document.

9. References

9.1. Normative References

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