IEEE P™/D  
Draft for Local and Metropolitan Area Networks- Part 21: Media Independent Handover Services

Amendment 3: Optimized Single Radio Handovers

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Sponsor

**Committee**of the **IEEE Computer Society**

NOTE: This amendment is to be applied to the result of original 802.21-2008, 802.21a-2012, and 802.21b-2012.

Approved <XX MONTH 20XX>

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Abstract: This standard specifies additional IEEE 802® media access independent mechanisms that optimize handovers between possibly heterogeneous IEEE 802 systems and between IEEE 802 systems and cellular systems, to enable improved handover performance for single-radio devices.

Keywords: management, media independent handover, mobile node, mobility, seamless, point of attachment, point of service, single-radio, preregistration, proactive authentication

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Introduction

This introduction is not part of IEEE P/D, Draft for Local and Metropolitan Area Networks- Part 21: Media Independent Handover Services

Amendment 3: Optimized Single Radio Handovers

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This standard extends the media access independent mechanisms that enable the optimization of handovers between possibly heterogeneous IEEE 802 systems and may facilitate handovers between IEEE 802 systems and cellular systems. The extensions enable mobile devices with single-radio designs to improve handover latencies and avoid packet loss.

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1. Overview



   4. Assumptions

***Insert at end of subclause 1.4***



The following assumptions apply during the single radio handover for a device that has two or more radios:

1. While the source radio is transmitting, the target radio cannot transmit.
2. It shall be possible that while the source radio is receiving, the target radio shall not transmit at a frequency interfering with the frequency of the source radio receiver..
3. The mobile device can transmit on only one radio at a time. Prior to handover completion, the source radio link is used to support data transfer..
4. Normative references

***Insert reference in appropriate order***

IETF RFC 5677 (2009-12) IEEE 802.21 Mobility Services Framework Design (MSFD)

IEEE 802.21a Media Independent Handover Services Amendment 1: Security Extensions to Media Independent Handover Services and Protocol

1. Definitions

*Insert these definitions in appropriate order*

**Originating network PoS**: The Point of Service in the network of the Mobile Node’s current Point of Attachment

**Preregistration:** preparatory handover signaling (possibly including security establishment) which is accomplished before the handover actually occurs.

**Proxy information repository (Proxy IR):** A service available for mobility signaling between a mobile node and an information repository via the originating network. To the MN, the Proxy IR appears to be a virtual information repository (IR) of the originating network.

**Proxy PoA**: A service available for mobility signaling between a mobile node and a target point of attachment via the originating network. To the MN, the Proxy PoA appears to be a virtual point of attachment (PoA) to the target network. It enables such services as preregistration of the MN.

**Single radio handover (SRHO)**: A handover among (possibly heterogeneous) radio access technologies during which a mobile node can transmit on only one radio at a time.

**Single radio MIH frame**: A packet which may contain the target radio’s PDUs in its payload.

**SRHO-capable device:** A node that implements one or more commands from clauses 7.4.30 through 7.4.33. For instance, a mobile node (MN) is SRHO-capable if it implements MIH\_Prereg\_Xfer commands.

**Target network PoA**: A Point of Attachment in the target network, to which a MN will be attached after a handover has been completed

**Target network PoS**: A Point of Service in the target network of the target Point of Attachment, to which a Mobile Node will be attached after a handover has been completed

1. Abbreviations and Acronymns

*Insert these definitions in appropriate order*

ANDSF Access network discovery and selection functions

ANQP Access Network Query Protocol

HPoS Home Network Point of Service

MIHF media independent handover function

MIH\_SAP media independent handover service access point

MIH\_LINK\_SAP media independent handover link-layer service access point

MN mobile node

OPoS originating network PoS

PoS point of service

SRHO single radio handover

TPoA target network PoA

TPoS target network PoS

1. General architecture
   1. Introduction

***Insert subclauses 5.1.10 and 5.1.11***

* + 1. Media independent single radio handover

The concept of media independence applies to single radio handover just as it does to multi-radio handover. A media independent handover may be accomplished in a media independent way, but the signaling messages for a single radio handover may differ from that for a multi-radio handover.

For the single radio handover design using media independent messages, the same transport possibilities as MIHF may apply. For single-radio performance improvement, it is important to accomplish as much of the handover signaling (including security establishment) before the handover actually occurs; this preparatory signaling is called preregistration. The exact signaling steps included in the preregistration process naturally depend on the requirements of the target network, and can be quite independent of the nature of the network ( e.g., the "originating network") providing the current point of attachment for the MN. As a general rule, preregistration typically involves one or more of the following steps:

* proactive authentication -- that is, authenticating the MN before it arrives in the target network,
* address allocation -- one or more IP addresses to be used by the MN after it arrives in the target network.
* data path setup -- establishing tunnels and forwarding entries for the MN in the target network
* context establishment -- building all necessary state information such as QoS parameters and access permissions within target core network entities.

Each of these operations can be time-consuming, and if they had to be carried out after the MN had returned to the target network radio access, smooth handover might be impossible because of the dead time before packets could start flowing again (break-before-make). Moreover, each of the operations must be carried out securely to prevent hijacking attempts or mismanagement of target network resources. As long as handovers occur only between access points within the same operator network, it is often possible to guarantee that signaling packets are never exposed to attack. On the other hand, for access networks belonging to different operators, the data path between neighboring access points of originating and target access networks are more likely to traverse the Internet, potentially exposing preregistration signaling to attack. See clause 5.1.11.

* + 1. Securing Single-Radio messages using PoS

Enabling movement between the networks of roaming partners for single-radio smartphones and Internet enabled wireless devices can be facilitated by enabling preregistration via the Point of Service (PoS) and making use of certain functions as developed in the WiMAX Forum, 3GPP2, and 3GPP . Using the PoS along with some signaling to transmit security information between roaming partners enables a low-latency, optimized handover for even the single-radio devices. Security is indispensable to mobility management (see clause 10.2), but it has been typically quite time consuming because of reliance on distant authentication agents. Improving the security model and reducing authentication delay enables crucial improvements in handover performance. Since communication between the originating and target networks may traverse the Internet, these communications must be secured; but this can be quite time consuming because of reliance on distant authentication agents. A method is defined to establish a secure communication channel between originating and target networks as part of handover preregistration procedures (see clause 11). Improving the security model and reducing authentication delay enables crucial improvements in handover performance, because single-radio systems cannot take advantage of parallel authentication operations during data plane operations in the originating network.

* 1. General design principles

***Insert subclause 5.2.3***

* + 1. Single Radio Handover MIHF Design Principles

The following requirements facilitate single radio handover between different radio access technology networks.

**Functional Requirements for MIHF to handle single radio messaging:**

1. tunneling mechanism to deliver the pre-registration messages
2. control for pre-registered states and delivery for pre-registered contexts.
3. capabilities exchange between mobile station and MIHF at the network.
   1. Supported radio access technology (RAT) types (3GPP, WiMAX, WiFi, 3GPP2, etc.)
   2. Supported target network capabilities
   3. Any required layer-2 parameters

***Insert two paragraphs at the end of clause 5.3.4***

MIIS may be enabled to obtain information from other services (e.g., the Access Network Discovery and Selection Function (ANDSF) defined in 3GPP standard [3GPP TS23.402]), using methods outside the scope of this document. The type of information needed for mobility management depends on the mobility management protocol being used. For example, when mobile IP is used, the location of the MN in the network is the care-of-address (CoA) and the identity of the MN is the home address in the home network of the MN. The location management information for mobile IP may then be the binding of the home address to the care-of-address. Furthermore, in accordance with existing procedures for subscriber management, mobility management may also require access to policy information controlling the allowable behavior of the mobile devices.

MIIS allows flexibility for different owners to manage their data separately. For example each network will typically host the master copy of the data that is most convenient to be managed by that network. The servers in the different networks constitute a distributed database of the MIIS, organized so that each server knows which data belongs to which component of the MIIS.

* 1. Media independent handover reference framework

***Insert subclause 5.4.4 and subclause 5.4.5***

* + 1. Single Radio MIHF relationship to Reference Model

To prepare for handover, the MN exchanges link-layer PDUs with the target PoA at the target network. These PDUs contain the same information as in the PDUs that would be exchanged if the target links were active. There is no guarantee that the target link is available during a single radio handover. A Proxy PoA can be used to enable the MN and the target PoA to exchange link-layer PDUs without depending on the existence of the target PoA’s physical radio channel but with the help of the active source radio.

The MIHF may use MIH\_SAP for communication via TCP/IP or UDP/IP. The MIHF may similarly communicate with the target PoA using MIH\_LINK\_SAP. During a single radio handover, an L2 frame may be encapsulated in an MIH message to constitute a SRC frame, which is then exchanged via an active link between the MIHFs of a local and a remote node using MIH protocol over L3 transport (TCP or UDP).

* 1. MIHF reference models for link-layer technologies

***Insert subclause 5.5.8***

* + 1. Single radio handover functional model and signaling flow

The functional model for single radio handover is shown in Figure 10a.



**Figure 10a Single radio handover functional model.**

The services in originating network are: OPoS (the Originating PoS) and the Proxy IR. The services in target network are: TPoS and the proxy PoA.

The proxy services (see clause 12) are available to enable signaling between the MN and the target PoA: MN signals with target PoA via OPoS/or Proxy PoA, which in turn signals with target PoA via TPoS or Proxy PoA. Target PoA signals with MN via TPoS or Proxy PoA, which in turn signals with MN via OPoS.

The signal flow for single radio handover is shown in Figure 10b, and described in the following.

**Figure 10b HO signal flow via proxy**

1. Upon receiving a Query message from MN to discover a candidate target network:
   1. If the Query message from the MN is the MIH message, the SRHO-Capable PoA communicates with Information Repository by using MIH\_Get\_Information (see clause 7.4.25).
   2. If the Query message from the MN is not the MIH message, the SRHO-Capable PoA can use the MIH\_CTRL\_Transfer message to encapsulate other control messages. The Proxy IR behaves like the Information Repository to the MN. The control messages between Proxy IR and Information Repository are out of scope.
2. MN sends a message to the OPoS with a payload containing a target network L2 handover frame.
3. Upon receiving this message from MN (either directly or via the OPoS: if the message is received directly from the MN, the OPoS is bypassed), TPoS or target Proxy PoA helps to discover a suitable PoA if not already known, and the TPoS or Proxy PoA communicates the link-layer frames to the target PoA using a mechanism that is outside the scope of this specification.
   1. TPoS or Proxy PoA signals with this target PoA using MIH message if the target PoA supports MIH messaging.
   2. Otherwise, Proxy PoA may signal with the candidate target PoA using other L2-specific protocol messages. OPoS will relay the reply messages to MN, indicating whether the L2 handover is successful. Also, the reply will include an indication that Proxy PoA signals with the target PoA using message(s) outside the scope of this document. L2 frames can be passed to TPoA either by way of proxy PoA or by MIH\_Prereg\_Xfer commands.

As shown above, MN and Target Network can exchange link-layer PDUs without using the target PoA’s physical radio channel. The exchanged Single-Radio Control frames are processed by the MIHF which has the assigned transport layer protocol’s port number [RFC 5677].

***Insert clauses 5.8 and 5.9***

* 1. Major single radio handover processes

A single radio handover following the reference model in subclause 5.4 may consist of different handover processes and involve different information elements (clause 7) and messages (clause 8). Examples of handover are described in Annex N. Figure 50 shows the single radio handover procedures consisting of 5 processes as described below.

**Figure 50 –Single radio handover procedures.**

1. **Network discovery**: determine whether or not there is a candidate target network available for handover. In network discovery, the MN queries the Information Repository to discover candidate networks and their handover policies. Such information includes whether candidate networks and MN support SRHO or not, and the availability of proxy services on the candidate network. Network discovery also allows the MN to acquire the corresponding system information blocks for candidate PoAs to perform the radio measurements. Alternatively, the MN may request that the Originating PoS identify one or more candidate target networks.
2. The **handover decision** may involve the following
   1. A handover trigger, which may be a command.
   2. Target network selection
   3. Proxy services discovery.
   4. Evaluating the handover benefit: the evaluation can be made by the MN or the network, e.g., based on parameters such as signal strength, target QoE, cost, and operator policy.
3. **Preregistration** includes pro-active authentication and establishing context (user identity, security, resource information) at the target network. Possibly with the help of Proxy services, the MN can perform preregistration procedures within the target network while still retaining its data connection with the originating network. Optionally, the preregistration process may occur before the network selection process as in the case of WiMAX target networks.
4. **Target link preparation**: the MN and target network prepare the establishment of the target link. This process ascertains whether the target network has enough resources to accommodate the new link and may include performing resource reservation or admission control as well as confirming that the signal conditions are favorable enough to establish the target link.
5. **SRHO execution**. Finally, the source link is disconnected, the target radio is activated, and the target link is established. The association of the network layer address to the link layer address will change from the source link layer address to the target link layer address for IP-based mobility management, and future incoming packets are then routed to the target radio.
   1. Proxy operations
      1. Introduction

Proxy services bridge the signaling between the MN and the target network via the originating network. In single radio handover, the MN may signal to the Proxy PoA as if signaling to the target point of attachment, and the target PoA may respond by signaling to the Proxy service as if signaling to the MN.

The Proxy PoA may also behave like a virtual PoA to signal with the target PoA. The control frames from the MN tunneled via the originating network to the target network are consumed at the Proxy PoA, which processes these control frames. Before replying to the control frames, the Proxy PoA may communicate with the appropriate network entities in the target network to enable conducting any needed functions requested in the control frame. This proxy in the control plane may therefore proxy any control functions in general, including but not limited to preregistration and proactive authentication of the MN.

Moreover, the Proxy Information Retrieval (IR) may behave like a virtual IR to signal with the target IR. The control frames from the MN tunneled via the OPoS to the IR that is not the MIH information server are consumed at the Proxy IR. If the MN requests target network discovery to Proxy IR, the Proxy IR signals with the IR and then responds to the MN’s request. Through the Proxy IR, even though the MN cannot communicate with the IR directly, the MN can discover target network by using Proxy IR.

Proxy services may be located at a border router of the network.

In a WiMAX network, the proxy services may be implemented in as an extension of the Signal Forwarding Function (SFF) [B5] and may reside at the ASN-GW.

In a 3GPP network, the proxy services may be implemented as an extension of the Mobility Management Entity (MME).

In a 3GPP2 network, the proxy services may be implemented in the HRPD-SFF and the existing functions of the Packet Control Function (PCF).

Control signals between the MN and the proxy service are implemented in a media independent manner using the functions of, respectively, the originating network PoS and target PoS and the signaling messages defined in this specification.

In a distributed mobility management design, each network has a mobility routing function. The mobility routing function enables a router to forward packets towards a mobile node according to the new location of a mobile node. The logical functions of mobility routing and of the Proxy may be co-located. The distributed mobility management architecture is then shown in Figure 10a in which the Information Repository contains the logical function of location management information only and the proxy contains the logical function of mobility routing only.

If the control message for IR that is not the MIH information server may transfer control messages to Proxy IR, then Proxy IR can exchange control messages with the IR for example as described in Annex T.

* + 1. Communication between the MN and the target PoA

The MN needs to communicate eventually with the target PoA to prepare for handover by performing network access procedure with the target access network. The first part of this communication is the transport of TCP or UDP / IP packets to the Proxy PoA. The second part of this communication depends on whether the target PoA supports MIHF in the 802-architecture or whether it is a legacy PoA lacking such support.

If the target PoA supports MIHF, the L2 frame is encapsulated into an MIH frame to forward to the target radio. Figure 51 shows the transport of the target radio L2 control frame as a payload of a MIH frame between the MN and the Proxy PoA via the source radio interface, in the absence of the target link. In Figure 51, the MN has 2 interfaces (1) and (2). It uses the wireless interface PHY(1), L2(1) to communicate with the PHY(1), L2(1) at the AP or Base Station. After that, the AP / BS uses some other L2, e.g., Ethernet to get to the Proxy. The Proxy is usually not using wireless interface. Therefore, the Proxy simply shows PHY and L2 and not PHY(1) and L2(1).



**Figure 51: Transport of L2 frame of target interface via MIH using the logical connection at the Target PoS to SRHO-capable target PoA, showing the resulting protocol stack.**

Figure 52 shows the transport of the target radio L2 control frame as a payload of a MIH frame between the MN and the Proxy PoA via the source radio in the absence the target link. The PPoA communicates with the target PoA using other control messages in order to proxy between the MN and the target PoA.

L2(2)

control

frame

L2(2)

control

frame

Control

message

Control

message

MI H

MIH

TCP or

UDP

/ IP

TCP or

UDP

/ IP

TCP or

UDP

/ IP

TCP or

UDP

/ IP

L2(1)

L2

L2

L2

PHY(1)

PHY

PHY

PHY

MN

Proxy

PoA

WiMAX

BS

**Figure 52. Transport of L2 frame via the proxy PoA, showing the resulting protocol stack.**

* + 1. Proxy Service for Information Repository

As extension of L2 message transfer in Figure 51, Proxy IR for Information Repository that is not MIH information server, as shown in Figure 53, can be considered. If the SRHO-Capable PoA receives the control message for the Information Repository, the SRHO-Capable PoA can only encapsulate control messages with the MIHF header using MIH\_CTRL\_Transfer messages. The SRHO-Capable PoA uses the encapsulated messages to communicate with the Proxy IR. The SRHO-Capable PoA only encapsulates the control messages but does not need every function of the MIH. It means the implementation of the PoA for single radio handover can be simplified. Use cases and extension of the Proxy IR are included in Annex T.



**Figure 53. Proxy IR for Information Repository.**

1. MIH Services



   4. Media independent command service


      3. Command List
         1. Link commands

***Insert following row at end of Table 6 in subclause 6.4.3.1***

1. –Link commands

|  |  |  |
| --- | --- | --- |
| Link\_IF\_PreReg\_Ready | Request a preregistration on a target link | 7.3.15 |

* + - 1. MIH commands
         1. General

***Insert following rows at the end of Table 7 in subclause 6.4.3.2.1:***

**Table 7–MIH commands**

|  |  |  |
| --- | --- | --- |
| MIH\_Prereg\_Xfer | Transport parameters and link layer frames | 7.4.30 |
| MIH\_N2N\_Prereg\_Xfer | Transport link layer frames between OPoS and TPoS | 7.4.31 |
| MIH\_IF\_PreReg\_Ready | Check readiness of preregistration on a target link | 7.4.32 |
| MIH\_CTRL\_Transfer | Delivers control messages encapsulated by MIH header | 7.4.33 |

* 1. Media independent information service

     2. IE Containers

In the binary representation method, the Information Element Containers are defined. The containers are used in the type-length-value (TLV) based query method. A new Information Element, namely the IE\_CONTAINER\_PoS, is defined for SRHO.

IE\_CONTAINER\_PoS – contains all the information depicting a PoS as shown in Table 11.

*Table 11 will use a new Table Number after Table 10*

1. —IE\_CONTAINER\_PoS definition

|  |  |
| --- | --- |
| Information element ID = (see Table B.1) | Length = *variable* |
| IE\_PoS\_IP\_ADDR | |
| IE\_PoS\_TUNN\_MGMT\_PRTO | |
| IE\_PoS\_NAI | |

* + 2. Information elements

***Change ordered list element item (c) as follows:***

1. The Information Server provides access to the Point of Service information, the Mobile Node information and the capability for supporting SRHO for each of the available access networks. The PoS information includes PoS addressing information and tunnel management protocol information. The MN information includes location information of the MN.
2. ~~c)~~ Other information that is access network specific, service specific, or vendor/network specific

***Insert information elements in Table 10 as follows:***

1. –Information elements

|  |  |  |
| --- | --- | --- |
| Name of information element | Description | Data type |
| 802.21 Point of Service information elements | | |
| IE\_PoS\_TUNN\_MGMT\_PRTO | Type of tunnel management protocol supported. | IP\_TUNN\_MGMT |
| IE\_PoS\_NAI | NAI of PoS. | NAI |

1. Service Access Point (SAP) and primitives

   2. SAPs
      1. General
      2. Media dependent SAPs
         1. MIH\_LINK\_SAP primitives

***Insert primitives in Table 15 as follows:***

1. – MIH\_LINK\_SAP primitives *(continued)*

|  |  |  |  |
| --- | --- | --- | --- |
| Primitives | Service  category | Description | Defined  in |
| Link\_IF\_PreReg\_Ready | Command | Used by MIHFs at MN and PoS to prepare for preregistration | 7.3.15 |

* + - 1. MIH\_NET\_SAP primitives

1. – MIH\_NET\_SAP primitives *(continued)*

|  |  |  |  |
| --- | --- | --- | --- |
| Primitives | Service  category | Description | Defined  in |
| MIH\_N2N\_Prereg\_Xfer | Command | Used by MIHFs at OPoS and TPoS for cross-network preregistration operations | 7.4.31 |
|  |  |  |  |

* + 1. MIH\_SAP primitives

***Insert primitives in Table 17 as follows:***

1. – MIH\_SAP primitives *(continued)*

|  |  |  |  |
| --- | --- | --- | --- |
| Primitives | Service  category | Description | Defined  in |
| MIH\_Prereg\_Xfer | Command | Used by MIHFs at MN and PoS for preregistration operations | 7.4.30 |
| MIH\_IF\_PreReg\_Ready | Command | Used by MIHFs at MN and PoS to prepare for preregistration | 7.4.32 |
| MIH\_CTRL\_Transfer | Command | Used by MIHF to deliver control messages | 7.4.33 |

* 1. MIH\_LINK\_SAP primitives

***Insert following clause 7.3.15***

* + 1. Link\_IF\_PreReg\_Ready
       1. Link\_IF\_PreReg\_Ready.request
          1. Function

The primitives defined here are used by MIH functions running on MN and PoS to prepare for preregistration for MN on a target Point of Attachment.  See Annex S for examples.

* + - * 1. Semantics of service primitive

Link\_IF\_PreReg\_Ready.request (

ExecutionDelay

)

|  |  |  |
| --- | --- | --- |
| **Name** | Data type | Description |
| ExecutionDelay | UNSIGNED\_INT(2) | Time (in ms) to elapse before the action SHOULD be taken. A value of 0 indicates that the action is taken immediately. Time elapsed is calculated from the instance the request arrives until the time when the execution of the action is carried out. |

* + - * 1. When generated

This primitive is generated by the MIHF to prepare preregistration of the target link.

* + - * 1. Effect on receipt

Upon receipt of this primitive, the target link interface prepares preregistration at the time specified by the ExecutionDelay parameter. The L2 messages for preregistration are transmitted to the MIHF on behalf of PHY of the target link.

* + - 1. Link\_IF\_PreReg\_Ready.confirm
         1. Function

This primitive is used by link-layer technologies to provide an indication of the result of the preregistration preparation on the target link layer.

* + - * 1. Semantics of service primitive

Link\_IF\_PreReg\_Ready.confirm (

Status

)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| Status | STATUS | Status of the operation. Code 3 (Authorization Failure) is not applicable. (See Table F.3.2) |

* + - * 1. When generated

This primitive is generated in response to Link\_IF\_PreReg\_Ready.request operation.

* + - * 1. Effect on receipt

Upon reception of this primitive, the MIHF can know the status of the preregistration on the target link.

* 1. MIH\_SAP primitives

***Insert following clauses 7.4.30 – 7.4.33***

* + 1. MIH\_Prereg\_Xfer

The primitives defined in this clause are used by MIH applications running on MN and OPoS during preregistration for MN at a target Point of Attachment.  See Annex N for examples.

* + - 1. MIH\_Prereg\_Xfer.request
         1. Function

This primitive is used to transport parameters and link layer frames from the MN’s MIH application to the MIHF running on the MN’s local PoS (i.e., OPoS) for preregistration signaling, including the establishment of a secure tunnel, between the MN and a target PoS (TPoS) in an appropriate target network.

* + - * 1. Semantics of service primitive

MIH\_Prereg\_Xfer.request (

DestinationIdentifier,

TargetLinkIdentifier,

LLInformation,

TPoSIdentifier,

CandidateLinkList,

Ciphersuite,

)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| DestinationIdentifier | MIHF\_ID | Identifies a MIHF as the destination of this request. |
| TargetLinkIdentifier | LINK\_TUPLE\_ID | (Optional: may be included if the target link is known) Identifies the remote PoA as the corresponding peer of the L2 exchange.[[2]](#footnote-2) |
| LLInformation | LL\_FRAMES | (Optional: included if the target link is known) Carries link layer frames. |
| TPoSIdentifier | MIHF\_ID | (Optional) This identifies the target PoS (TPoS) that will be the destination of the link-layer frames. |
| CandidateLinkList | LIST (LINK\_PoA\_LIST) | (Optional) A list of PoAs, identifying candidate networks to which handover SHOULD be initiated. The list is sorted from most preferred first to least preferred last. The link information can include values and IEs from tables F.10, F.11, F.14, and G.1. |
| Ciphersuite | Ciphersuite TLV | (Optional) Ciphersuite is included when MN wishes to request use of a particular algorithm during the establishment of a security association with TPoS for the purposes of preregistration in the target network. |

* + - * 1. When generated

This primitive is generated by an MIH application to preregister with a target PoS. The MN can send this primitive to instruct its serving PoS (i.e., the OPoS) to generate a Security Association with an appropriate TPoS when the OPoS and the TPoS reside on different nodes, for instance so that the MN and the TPoS are able to carry out additional preregistration commands before handover to TPoA. The MN can include whatever information it has about candidate TPoAs, to help OPoS to identify the proper TPoS. If the MN has sufficient information about TPoA to include link-layer frames, those frames can also be supplied for secure delivery to TPoA. In this way, the number of round trips for preregistration may be minimized.

* + - * 1. Effect on receipt

If the TargetLinkIdentifier is not included, the OPoS shall use the CandidateLinkList (if included) to identify the appropriate TPoS that can initiate pre-registration activities with an appropriate TPoA. In the absence of other information, the OPoS can use available link-type information and location information for the MN to identify an appropriate TPoS. Some location information about the MN may be available by other means, such as associating geographical coordinates with the MN’s current Point of Attachment (i.e., SPoA). After reception of this primitive, the MIHF must generate a MIH\_N2N\_Prereg\_Xfer request message destined to the TPoS (or MIH\_Prereg\_Xfer, for TPoS on the same network as OPoS), which is expected to relay the link-layer frames transported in this message to the TPoA..

* + - 1. MIH\_Prereg\_Xfer.indication
         1. Function

This primitive is used by the OPoS’s MIHF to notify OPoS’s MIH application about the reception of an MIH\_Prereg\_Xfer request message.

* + - * 1. Semantics of service primitive

MIH\_Prereg\_Xfer.indication (

SourceIdentifier,

TargetLinkIdentifier,

LLInformation,

TPoSIdentifier,

CandidateLinkList,

Ciphersuite,

)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| SourceIdentifier | MIHF\_ID | Identifies the invoker, a MN in the same network as OPoS. |
| TargetLinkIdentifier | LINK\_TUPLE\_ID | (Optional: may be included if the target link is known) Identifies the remote PoA as the corresponding peer of the L2 exchange [[3]](#footnote-3). |
| LLInformation | LL\_FRAMES | (Optional) This carries link layer frames. This attribute may be included if the target link is known. |
| TPoSIdentifier | MIHF\_ID | (Optional) This identifies the target PoS |
| CandidateLinkList | LIST(LINK\_PoA\_LIST) | (Optional) A list of PoAs, identifying candidate networks to which handover SHOULD be initiated. The list is sorted from most preferred first to least preferred last. The link information can include values and IEs from tables F.10, F.11, F.14, and G.1. |
| Ciphersuite | CIPHERSUITE TLV | (Optional) Ciphersuite is included when MN wishes to request use of a particular algorithm during the establishment of a security association with TPoS for the purposes of preregistration in the target network. |

* + - * 1. When generated

This primitive is generated by a MIHF after receiving a MIH\_Prereg\_Xfer Request protocol message.

* + - * 1. Effect on receipt

If TPoSIdentifier is not provided, the MIH application on the OPoS uses the information provided by the MN to identify an appropriate target PoS (TPoS). If the TPoS is hosted remotely (e.g., in a separate target network), the MIH application on the OPoS must generate a MIH\_N2N\_Prereg\_Xfer.request primitive for TPoS. Otherwise, the MIH application must generate a MIH\_Prereg\_Xfer.response primitive and transmit that response to the MIHF specified by the SourceIdentifier.

* + - 1. MIH\_Prereg\_Xfer.response
         1. Function

OPoS’s MIH application uses this primitive to relay preregistration frames to MN via OPoS’s local MIHF.

* + - * 1. Semantics of service primitive

MIH\_Prereg\_Xfer.response (

DestinationIdentifier,

TargetLinkIdentifier,

LLInformation,

MN\_NAI,

TPoSIdentifier,

SALifeTime,

Status)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| DestinationIdentifier | MIHF\_ID | This identifies a MIHF that will be the destination of this response. |
| TargetLinkIdentifier | LINK\_TUPLE\_ID | (Optional: may be included if the target link is known) Identifies the remote PoA as the corresponding peer of the L2 exchange. [[4]](#footnote-4) |
| LLInformation | LL\_FRAMES | (Optional) Carries link layer frames; included if and only if the corresponding MIH\_Prereg\_Xfer.indication contained LLInformation. |
| MN\_NAI | MIHF\_ID | (Optional) Carries the MN’s Network Access Identifier in the case optimized pull key distribution is used. |
| TPoSIdentifier | MIHF\_ID | (Optional) This identifies the target PoS |
| SALifeTime | Lifetime TLV | (Optional) Lifetime of the Security Association |
| Status | STATUS | Status of the preregistration transfer with TPoS. Code 3 (Authorization Failure) is not applicable. (See Table F.3.2) |

* + - * 1. When generated

This primitive is generated by OPoS either (i) after receiving a MIH\_Prereg\_Xfer.indication primitive if the MIH application that received the corresponding MIH\_Prereg\_Xfer.request primitive did not invoke a MIH\_N2N\_Prereg\_Xfer.request primitive, or (ii) after receiving a MIH\_N2N\_Prereg\_Xfer.confirm primitive. If the OPoS has received a positive confirmation that the TPoS has accepted the Security Association, this will enable MN to complete the establishment of the secure tunnel.

* + - * 1. Effect on receipt

The local MIHF generates a MIH\_Prereg\_Xfer Response protocol message in order to provide the MN with the information previously requested in MIH\_N2N\_Prereg\_Xfer Request.

* + - 1. MIH\_Prereg\_Xfer.confirm
         1. Function

This primitive is used to notify the MN’s MIH application about the reception of a MIH\_Prereg\_Xfer Response message.

* + - * 1. Semantics of service primitive

MIH\_Prereg\_Xfer.confirm (

SourceIdentifier,

TargetLinkIdentifier,

LLInformation,

MN\_NAI,

TPoSIdentifier,

*K*,

SALifeTime,

Status)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| SourceIdentifier | MIHF\_ID | This identifies the invoker, which is a MIHF. |
| TargetLinkIdentifier | LINK\_TUPLE\_ID | This identifies the remote PoA that is the corresponding peer of the L2 exchange. [[5]](#footnote-5) |
| LLInformation | LL\_FRAMES | (Optional) Carries link layer frames |
| MN\_NAI | MIHF\_ID | (Optional) Carries the MN’s Network Access Identifier |
| TPoSIdentifier | MIHF\_ID | (Optional) Identifies the target PoS |
| *K* | ENCR\_BLOCK | A key derivation key encrypted in a way recoverable by TPoS |
| SALifeTime | Lifetime | (Optional) Lifetime of the Security Association |
| Status | STATUS | Status of the preregistration transfer with TPoS. Code 3 (Authorization Failure) is not applicable. (See Table F.3.2) |

* + - * 1. When generated

The MN’s MIHF generates this primitive after receiving a MIH\_Prereg\_Xfer Response protocol message.

* + - * 1. Effect on receipt

The MIH application on the MN may generate another MIH\_Prereg\_Xfer.request primitive -- for example if preregistration processes are not completed. If *K* is present, the MN derives the key hierarchy according to clause 9.2.2 and Figure 47.

* + 1. MIH\_N2N\_Prereg\_Xfer

The primitives defined in 7.4.31 are used by MIH functions running on OPoS and TPoS to enable preregistration for MN on a target Point of Attachment.  See Annex N for examples. The primitives provide the ability to transport link-layer frames for the target link over the MIH protocol between the originating PoS and the target PoS. Preregistration is conducted between the MN and the target PoA. As part of preregistration, media-specific authentication may be conducted with an authenticator deployed in the target PoA.

* + - 1. MIH\_N2N\_Prereg\_Xfer.request
         1. Function

OPoS generates this primitive to deliver link layer frames to the target PoS.

* + - * 1. Semantics of Service Primitive

MIH\_N2N\_Prereg\_Xfer.request (

DestinationIdentifier,

TargetLinkIdentifier,

LLInformation,

MNID,

CandidateLinkList,

Ciphersuite,

)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| DestinationIdentifier | MIHF\_ID | This identifies a remote MIHF that will be the destination of this request. |
| TargetLinkIdentifier | LINK\_TUPLE\_ID | (Optional) Identifies the remote PoA as the corresponding peer of the L2 exchange; [[6]](#footnote-6) shall be included if the target link is known. |
| LLInformation | LL\_FRAMES | (Optional) Carries link layer frames; shall be included if the target link is known. |
| MNID | MIHF\_ID | (Optional) MIHF\_ID of the MN to identify the MN’s Media Independent Root Key to be transferred to the target PoS. |
| CandidateLinkList | LIST (LINK\_PoA\_LIST) | (Optional) A list of PoAs, identifying candidate networks to which handover SHOULD be initiated. The list is sorted from most preferred first to least preferred last. This attribute shall not be included if the target link is known. |
| Ciphersuite | CIPHERSUITE TLV | (Optional) Ciphersuite is included when MN wishes to request use of a particular algorithm during the establishment of a security association with TPoS for the purposes of preregistration in the target network. |

* + - * 1. When generated

OPoS’s MIH application generates this primitive after receiving an MIH\_Prereg\_Xfer.indication primitive, to relay preregistration signaling to the target PoS, possibly to relay link-layer frames as well as possibly to establish a security association derived from key derivation key *K*.. In order to allow OPoS and TPoS to exchange the key derivation key *K*,, MIHF first produces *K*, and another random number Nonce-N. Then OPoS’s MIHF encrypts *K* using the mechanism specified in clause 10, and transmits the result to TPoS along with Nonce-N and Nonce-T, where Nonce-T is the value received from MN in the MIH\_Prereg\_Xfer protocol message.

* + - * 1. Effect on receipt

The local MIHF shall generate a MIH\_N2N\_Prereg\_Xfer request message to the remote MIHF.

* + - 1. MIH\_N2N\_Prereg\_Xfer.indication
         1. Function

This primitive is used by the MIHF of the TPoS to notify its MIH application of the reception of a MIH\_N2N\_Prereg\_Xfer request message.

* + - * 1. Semantics of service primitive

MIH\_N2N\_Prereg\_Xfer.indication (

SourceIdentifier,

TargetLinkIdentifier,

MNID,

*K*,

LLInformation,

)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| SourceIdentifier | MIHF\_ID | This identifies the invoker, which is a remote MIHF. |
| TargetLinkIdentifier | LINK\_TUPLE\_ID | (Optional)This identifies the remote PoA that is the corresponding peer of the L2 exchange. [[7]](#footnote-7) This attribute shall be included if the target link is known. |
| LLInformation | LL\_FRAMES | (Optional) carries link layer frames. This attribute shall be included only the target link is known. |
| MNID | MIHF\_ID | ID of the MN, used to index and compute the MN’s Media Independent Root Key to be established the target PoS |
| *K* | ENCR\_BLOCK | A key derivation key encrypted in a way recoverable by TPoS |

* + - * 1. When generated

TPoS’s MIHF generates this primitive upon receiving a MIH\_N2N\_Prereg\_Xfer Request protocol message.

* + - * 1. Effect on receipt

The TPoS MIHF recovers *K* according to the formula in subclause 10.3.1. MIHF then passes *K* to the MIH application, which then derives the key hierarchy, installing keys as necessary in the target AAA. The TPoS also must generate appropriate messages to the TPoA to install a media-specific pair-wise master key (MSPMK, defined in 10.2.1.2) also derived from *K*, which will be used by MN as necessary when MN connects to the target network.

The MIH application must generate a MN\_NAI associated with the MNID provided; the two IDs are allowed to be the same.

The MIH application must subsequently generate a MIH\_N2N\_Prereg\_Xfer.response primitive and include MN\_NAI.

***Subclauses 10.2.1.2 and 10.2.2 are defined in IEEE 802.21a-2012.***

* + - 1. MIH\_N2N\_Prereg\_Xfer.response
         1. Function

This primitive is used by TPoS’s MIH application to supply preregistration frames to TPoS’s MIHF.

* + - * 1. Semantics of service primitive

MIH\_N2N\_Prereg\_Xfer.response (

DestinationIdentifier,

TargetLinkIdentifier,

LLInformation,

MN\_NAI,

SALifeTime,

Status

)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| DestinationIdentifier | MIHF\_ID | This identifies a remote MIHF that will be the destination of this response. |
| TargetLinkIdentifier | LINK\_TUPLE\_ID | This identifies the remote PoA that is the corresponding peer of the L2 exchange. [[8]](#footnote-8) |
| LLInformation | LL\_FRAMES | (Optional) Carries link layer frames |
| MN\_NAI | MIHF\_ID | (Optional) Carries the MN’s Network Access Identifier. |
| SALifeTime | Lifetime TLV | (Optional) Lifetime of the Security Association |
| Status | STATUS | Status of the preregistration transfer with TPoS. Code 3 (Authorization Failure) is not applicable. (See Table F.3.2) |

* + - * 1. When generated

This primitive is generated after receiving a MIH\_N2N\_Prereg\_Xfer.indication primitive.

* + - * 1. Effect on receipt

The MIHF at the TPoS shall generate a MIH\_N2N\_Prereg\_Xfer Response protocol message in order to provide the required information until the authentication is finished.

* + - 1. MIH\_N2N\_Prereg\_Xfer.confirm
         1. Function

This primitive is used to notify OPoS’s MIH application about the reception of a MIH\_N2N\_Prereg\_Xfer Response protocol message.

* + - * 1. Semantics of service primitive

MIH\_N2N\_Prereg\_Xfer.confirm (

SourceIdentifier,

TargetLinkIdentifier,

LLInformation,

MN\_NAI,

SALifeTime,

Status)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| SourceIdentifier | MIHF\_ID | This identifies the invoker, which is a remote MIHF. |
| TargetLinkIdentifier | LINK\_TUPLE\_ID | This identifies the remote PoA that is the corresponding peer of the L2 exchange. [[9]](#footnote-9) |
| LLInformation | LL\_FRAMES | (Optional) This carries link layer frames. |
| MN\_NAI | MIHF\_ID | (Optional) This carries the MN’s Network Access Identifier |
| SALifeTime | Lifetime TLV | (Optional) Lifetime of the Security Association |
| Status | STATUS | Status of the preregistration transfer with TPoS. Code 3 (Authorization Failure) is not applicable. Code 6 (TPoS is identical to OPoS), is not applicable. (See Table F.3.2) |

* + - * 1. When generated

This primitive is generated by the remote MIH application after receiving a MIH\_N2N\_Prereg\_Xfer response message.

* + - * 1. Effect on receipt

The OPoS MIH application generates a MIH\_Prereg\_Xfer.response primitive with the information obtained from this primitive. The OPoS also retrieves its stored value for *K* which had previously been sent to TPoS, encrypts it according to clause 10.4 for use in the MIH\_ Prereg\_Xfer Response protocol message.

* + 1. MIH\_IF\_PreReg\_Ready

The primitives defined in 7.4.32 are used by the MIHF at MN to select a target network interface for preregistration. After the target network interface receives MIH\_IF\_PreReg\_Ready.request, the target network interface responds with MIH\_IF\_PreReg\_Ready.response. See Annex S for examples.

* + - 1. MIH\_IF\_PreReg\_Ready.request
         1. Function

This primitive is used by an MIH application of MN MIHF to request preparation for preregistration on a target link interface of the MN.

* + - * 1. Semantics of service primitive

MIH\_IF\_PreReg\_Ready.request (

DestinationIdentifier,

ExecutionDelay

)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| DestinationIdentifier | MIHF\_ID | This identifies the MIHF that will be the destination of this request. |
| ExecutionDelay | UNSIGNED\_INT(2) | Time (in ms) to elapse before the action SHOULD be taken. A value of 0 indicates that the action is taken immediately. Time elapsed is calculated from the instance the request arrives until the time when the execution of the action is carried out. |

* + - * 1. When generated

This primitive is generated by the MIHF user to prepare preregistration of the target link.

* + - * 1. Effect on receipt

If the Destination Identifier is the MIHF-ID of the local MIHF, the local MIHF invokes an IF\_PreReg\_Ready.request primitive to the specified lower layer link(s). Otherwise, the local MIHF generates and sends a MIH\_IF\_PreReg\_Ready request message to the remote MIHF identified by the Destination Identifier. The remote MIHF issues Link\_IF\_PreReg\_Ready.request(s) to the specified lower layer link(s).

* + - 1. MIH\_IF\_PreReg\_Ready.confirm
         1. Function

This primitive is used by the MIHF to confirm that the target link is ready for preregistration signaling.

* + - * 1. Semantics of service primitive

MIH\_IF\_PreReg\_Ready.confirm (

SourceIdentifier,

Status

)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| SourceIdentifier | MIHF\_ID | This identifies the MIHF invoking of this primitive. |
| Status | STATUS | Status of the preregistration transfer with TPoS. Code 3 (Authorization Failure) is not applicable. (See Table F.3.2) |

* + - * 1. When generated

This primitive is generated by the MIHF on receiving a MIH\_IF\_PreReg\_Ready response message from a peer MIHF.

* + - * 1. Effect on receipt

Upon receipt of this primitive, the MIHF user can know success of preregistration preparation on the target link. If Status does not indicate “Success,” the recipient performs appropriate error handling.

* + 1. MIH\_CTRL\_Transfer

The primitives defined in 7.4.33 are used by the MIHF of MN or PoS to transfer control messages encapsulated by MIH header. See Annex T for examples

* + - 1. MIH\_CTRL\_Transfer.request
         1. Function

This primitive delivers control messages encapsulated by MIH header. The control messages are not only network specific control messages but also messages, such as ANQP and ANDSF messages, for interworking heterogeneous networks.

* + - * 1. Semantics of service primitive

MIH\_CTRL\_Transfer.request (

DestinationIdentifier,

CTRLmessage,

)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| DestinationIdentifier | MIHF\_ID | Identifies a MIHF as the destination of this request. |
| CTRLmessage | CTRL\_PROT\_MSGS | Delivers control messages. |

* + - * 1. When generated

This primitive is generated by an MIH application to deliver control messages such as ANQP and ANDSF messages.

* + - * 1. Effect on receipt

After reception of this primitive, the MIHF of MN at PoSmust generate a MIH\_CTRL\_Transfer request message destined to the MIHF of Proxy IR.

* + - 1. MIH\_CTRL\_Transfer.indication
         1. Function

This primitive is used by the MIHF to notify the local MIH application about the reception of a MIH\_CTRL\_Transfer request message.

* + - * 1. Semantics of service primitive

MIH\_CTRL\_Transfer.indication (

SourceIdentifier,

CTRLmessage,

)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| SourceIdentifier | MIHF\_ID | Identifies the invoker, typically a remote MIHF. |
| CTRLmessage | CTRL\_PROT\_MSGS | This delivers control messages. |

* + - * 1. When generated

This primitive is generated by a MIHF after receiving a MIH\_CTRL\_Transfer request message.

* + - * 1. Effect on receipt

The MIH application must generate a MIH\_CTRL\_Transfer.response primitive.

* + - 1. MIH\_CTRL\_Transfer.response
         1. Function

This primitive is used by an MIH application to provide control messages to the local MIHF.

* + - * 1. Semantics of service primitive

MIH\_CTRL\_Transfer.response (

DestinationIdentifier,

CTRLmessage,

Status

)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| DestinationIdentifier | MIHF\_ID | This identifies a remote MIHF that will be the destination of this response. |
| CTRLmessage | CTRL\_PROT\_MSGS | Delivers control messages. |
| Status | STATUS | Status of the preregistration transfer with TPoS. Code 3 (Authorization Failure) is not applicable. (See Table F.3.2) |

* + - * 1. When generated

This primitive is generated by the local MIHF after receiving a MIH\_CTRL\_Transfer.indication primitive.

* + - * 1. Effect on receipt

The local MIHF may generate a MIH\_CTRL\_Transfer response message.

* + - 1. MIH\_CTRL\_Transfer.confirm
         1. Function

This primitive is used to notify the local MIH application about the reception of a MIH\_CTRL\_Transfer response message.

* + - * 1. Semantics of service primitive

MIH\_CTRL\_Transfer.confirm (

SourceIdentifier,

CTRLmessage,

Status

)

|  |  |  |
| --- | --- | --- |
| Parameter Name | Data type | Description |
| SourceIdentifier | MIHF\_ID | This identifies the invoker, which is a remote MIHF. |
| CTRLmessage | CTRL\_PROT\_MSGS | Delivers control messages. |
| Status | STATUS | Status of the preregistration transfer with TPoS. Code 3 (Authorization Failure) is not applicable. (See Table F.3.2) |

* + - * 1. When generated

This primitive is generated by the local MIHF after receiving a MIH\_CTRL\_Transfer response message.

* + - * 1. Effect on receipt

The MIH application on the MN may generate a MIH\_CTRL\_Transfer.request primitive.



1. Media independent handover protocols














   15. MIH protocol messages






       7. MIH messages for command service

***Insert subclauses 8.6.3.24 through 8.l6.3.31***

* + - 1. MIH\_Prereg\_Xfer Request

MN’s MIHF sends this message so that OPoS transmits link layer frames to expedite preregistration with an appropriate TPoS, particularly to initiate proactive authentication for the establishment of a security association. The corresponding primitive is defined in subclause 7.4.30.1. Nonce-T is included if MN is requesting OPoS to establish a security association with TPoS. CandidateLinkList is included if MN has information available about the desired target link.

|  |
| --- |
| MIH Header Fields (SID=3, Opcode=1, AID=13) |
| **Source Identifier** = sending MIHF ID  (Source MIHF ID TLV) |
| **Destination Identifier** = receiving MIHF ID  (Destination MIHF ID TLV) |
| TargetLinkIdentifier (optional)  (Link Identifier TLV) |
| LLInformation (optional)  (Link Layer Information TLV) |
| TPoSIdentifier (optional)  (TPoS Identifier TLV) |
| CandidateLinkList (optional)  (Link identifier list TLV) |
| Ciphersuite (optional) (Ciphersuite TLV) |
| Nonce-T (optional) (Nonce TLV) |

*(Note to editor: Nonce TLV is defined in IEEE 802.21a-2012.)*

* + - 1. MIH\_Prereg\_Xfer Response

This message is used by the MIHF running on OPoS to complete the establishment of a security association between an MN and an appropriate TPoS. The corresponding primitive is defined in subclause 7.4.30.3. SALifetime, *K*, and Nonce-N are not sent unless MN sent Nonce-T in the MIH\_Prereg\_Xfer Request. *K* is encrypted as described in subclause 10.4.

|  |
| --- |
| MIH Header Fields (SID=3, Opcode=2, AID=13) |
| **Source Identifier** = sending MIHF ID  (Source MIHF ID TLV) |
| **Destination Identifier** = receiving MIHF ID  (Destination MIHF ID TLV) |
| TargetLinkIdentifier (optional) (Link Identifier TLV) |
| LLInformation (optional) (Link Layer Information TLV) |
| MN\_NAI (optional) (Network Access Identifier TLV) |
| TPoSIdentifier (optional) (TPoS Identifier TLV) |
| Encrypted *K* (optional) (ENCR\_BLOCK TLV) |
| Nonce-N (optional) (Nonce TLV) |
| SALifeTime (optional) (Lifetime TLV) |
| Status (Status TLV) |

*(Note to editor: Lifetime TLV is defined in IEEE 802.21a-2012.)*

* + - 1. MIH\_N2N\_Prereg\_Xfer Request

An MIHF sends this message to relay link layer frames during preregistration. The corresponding primitive is defined in subclause 7.4.31.1. Nonce-T, Nonce-N, and the encrypted key derivation key *K* must all be present, or must all be absent; MIHF generates Nonce-N and the encrypted key derivation key *K* as specified in subclause 9.2.2. The method for encrypting *K* is specified in subclause 10.4.

*Note to editor: Clause 9.2.2 is defined in IEEE 802.21a-2012.*

|  |
| --- |
| MIH Header Fields (SID=3, Opcode=1, AID=14) |
| **Source Identifier** = sending MIHF ID (Source MIHF ID TLV) |
| **Destination Identifier** = receiving MIHF ID (Destination MIHF ID TLV) |
| TargetLinkIdentifier (optional) (Link Identifier TLV) |
| LLInformation (optional) (Link Layer Information TLV) |
| MNID (optional) (Mobile node MIHF ID TLV) |
| Ciphersuite (optional) (Ciphersuite TLV) |
| Encrypted K (optional) (ENCR\_BLOCK TLV) |
| Nonce-T (optional) (Nonce TLV) |
| Nonce-N (optional) (Nonce TLV) |
| SALifeTime (optional) (Lifetime TLV) |

* + - 1. MIH\_N2N\_Prereg\_Xfer Response

An MIHF sends this message to complete the establishment of a security association between itself and the preregistering MN, or to accomplish other layer-2 signaling. The corresponding primitive is defined in subclause 7.4.31.3. The SALifeTime may be included if specified by the TPoS for the requested security association. The TPoS may also include the MN\_NAI parameter if the MNID parameter of the MIH\_N2N\_Prereg\_Xfer Request message is not appropriate for use in the target network.

|  |
| --- |
| MIH Header Fields (SID=3, Opcode=2, AID=14) |
| **Source Identifier** = sending MIHF ID (Source MIHF ID TLV) |
| **Destination Identifier** = receiving MIHF ID (Destination MIHF ID TLV) |
| TargetLinkIdentifier (Link Identifier TLV) |
| LLInformation (optional) (Link Layer Information TLV) |
| MN\_NAI (Network Access Identifier TLV)(optional) |
| SALifeTime (optional) (Lifetime TLV) |
| Status (Status TLV) |

* + - 1. MIH\_IF\_PreReg\_Ready request

The corresponding MIH primitive of this message is defined in 7.4.32.1.

This message is transmitted to the MIHF to perform preparation of preregistration.

|  |
| --- |
| MIH Header Fields (SID=3, Opcode=1, AID=15) |
| **Source Identifier** = sending MIHF ID  (Source MIHF ID TLV) |
| **Destination Identifier** = receiving MIHF ID  (Destination MIHF ID TLV) |
| ExecutionDelay  (Link Identifier TLV) |

* + - 1. MIH\_IF\_PreReg\_Ready response

The corresponding MIH primitive of this message is defined in 7.4.32.2.

This message returns the result of a MIH\_IF\_PreReg\_Ready request.

|  |
| --- |
| MIH Header Fields (SID=3, Opcode=2, AID=15) |
| **Source Identifier** = sending MIHF ID  (Source MIHF ID TLV) |
| **Destination Identifier** = receiving MIHF ID  (Destination MIHF ID TLV) |
| Status ( Status TLV) |

* + - 1. MIH\_CTRL\_Transfer request

This message is used to deliver control messages such as ANQP and ANDSF message. The delivery of control messages is described in subclause 12.3. The corresponding MIH primitive of this message is defined in 7.4.33.1.

|  |
| --- |
| MIH Header Fields (SID=3, Opcode=1, AID=16) |
| **Source Identifier** = sending MIHF ID  (Source MIHF ID TLV) |
| **Destination Identifier** = receiving MIHF ID  (Destination MIHF ID TLV) |
| CTRLmessage  (Control Information TLV) |

* + - 1. MIH\_CTRL\_Transfer response

This message is used to respond to MIH\_CTRL\_Transfer request message. Moreover, this message can deliver control messages such as ANQP and ANDSF message. The delivery of control messages is described in subclause 12.3. The corresponding MIH primitive of this message is defined in 7.4.33.3.

|  |
| --- |
| MIH Header Fields (SID=3, Opcode=2, AID=16) |
| **Source Identifier** = sending MIHF ID  (Source MIHF ID TLV) |
| **Destination Identifier** = receiving MIHF ID  (Destination MIHF ID TLV) |
| CTRLmessage  (Control Information TLV) (optional) |

1. MIH protocol protection


   3. Key establishment through an MIH service access authentication

***Replace text in the first paragraph of subclause 9.2.2 with the following:***

* + 1. Key derivation and key hierarchy

Upon a successful MIH service access authentication, the authenticator (i.e., the serving PoS) obtains a master session key (MSK), a re-authentication master session key (rMSK) via EAP to generate a root key *K* shared between the MN and the serving PoS. Alternatively, the root key *K* may be securely exchanged with the serving PoS from another trusted PoS (e.g., OPoS) using the transfer mechanism specified in 10.3.1. In the latter case, the MIHF identifier of the MN, Nonce-T, generated by the MN and Nonce-N, generated by the OPoS are also transferred together with *K*. Nonce-T is generated as follows: Nonce-T = PRF(Nonce-T’ || MN\_MIHF\_ID), where Nonce-T’ is provided by the MN and MN\_MIHF\_ID is the MN’s MIHF identity. Similarly, PoS generates Nonce-N by first generating a random number Nonce-N’. Then Nonce-N = PRF(Nonce-N’ || POS\_MIHF\_ID), where POS\_MIHF\_ID is the PoS’s MIHF identity.

The keys derived from *K* include a 128 bit authentication key (MIAK) used to generate a value AUTH, the session keys determined by the ciphersuite *c* agreed upon between the MN and the serving PoS. If no ciphersuite is specified by the MN, the default ciphersuite is used as specified in Table 25. The session keys used for MIH message protection consist of an encryption key (MIEK) only, an integrity key (MIIK) only, or both an encryption key (MIEK) and an integrity key (MIIK). The concatenation of MIAK, MIEK and MIIK is called the media independent session key (MISK). The length, *L*, of the MISK is specified in 9.2.3. When (D)TLS is not used to establish the MIH security association between MN and TPoS, the default SALifeTime for MISK and derived keys is 65,536 seconds (slightly over 18 hours). This value may be overridden by passing a preferred value as the SALifeTime parameter in relevant MIH primitives.

***Replace the definition of the key derivation key K, in subclause 9.2.2 of 802.21a, with the following:***

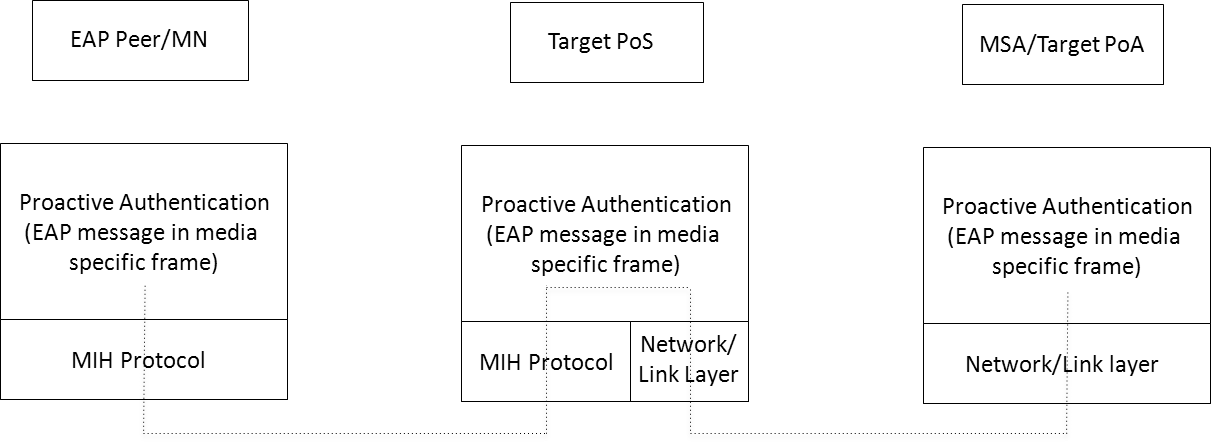
*K* - key derivation key. It is truncated from a master session key (MSK) or re-authentication MSK (rMSK), or obtained by key exchange with another trusted PoS (e.g see subclause 10.3). The length of *K* is determined by the pseudorandom function (PRF) used for key derivation. If HMAC-SHA-1 or HMAC-SHA-256 is used as a PRF, then the full MSK or rMSK is used as the key derivation key *K*. If CMAC-AES is used as a PRF, then the first 128 bits of MSK or rMSK are used as the key derivation key *K*.

1. Proactive Authentication
   1. Media specific proactive authentication

***Change first paragraph of 10.1 as follows:***

In a media access proactive authentication, a Target PoS passes authentication messages between the mobile node and a media specific authenticator (MSA). The protocol stacks in each interface are illustrated in Figure 46 and Figure 47. In scenarios where MSA/Target PoA is reachable via same media as MN and TPoS, EAP messages received at TPoS are directly forwarded to the target PoA. In an optimized pull key distribution, OPoS passes authentication messages between the mobile node, the target PoS and a media specific authenticator (MSA).

***Replace Figure 46 as follows:***



***Insert figure, renumber existing figure 47 to Figure 48***

Figure 47—Protocol Stack for MIH Supported optimized pull key distribution with two Points of Service

***Insert second paragraph of 10.1 below Figure 47 as follows:***

Figure 47 illustrates the protocol stacks and message passing when the Originating PoS is in a different network than the TPoS.



***Change Figure number 47 in subclause 10.2.1.2 to Figure number 48***

Figure ~~47~~ 48 —Key Hierarchy for Bundle Case

***Insert subclause 10.3 and subclause 10.4 and subclause 10.5***

* 1. Establishing MIH Security Association between roaming partners

The PoS is a convenient and natural place to locate security services, and roaming partners have in place agreements that can be used to beneficially establish the needed security agreements between different PoS modules in partner networks. It is expected that the PoS functions in partner networks must often communicate by data paths that traverse the external Internet; in such cases, a secure communication channel must exist or must be established between the partners. It is out of scope for this document to specify exactly how the secure communication channel should be established, but this can be done by configuration when the partners enter into their roaming agreement. It can also be done on demand by using IKEv2 [IETF RFC 5996]. The following overview describes in more detail the circumstances enabling dynamic establishment of security association between OPoS and TPoS.



**Figure 49: MN handover signaling for preregistration using OPoS**

MIH\_Prereg\_Xfer and MIH\_N2N\_Prereg\_Xfer messages exchanged between OPoS and TPoS may require security protection. Furthermore, TPoS may reject these messages from an unauthorized originating PoS. To protect the link between OPoS and TPoS, several approaches are possible.

An MIH SA (Security Association) (see clause 3)[IEEE 802.21a] can be used for protecting the communications between OPoS and TPoS. In this case, OPoS acts as the initiating end-point of an MIH SA and TPoS as the other end-point of the MIH SA. The MIH SA can be established using (D)TLS over MIH or EAP over MIH (see clause 9.2) [IEEE 802.21a].

Other mechanisms such as IPSec and TLS over TCP can also be used for protecting the communications between OPoS and TPoS. Details on such mechanisms are outside the scope of this standard.

* 1. Key generation and distribution by OPoS

Except for the initial network attach, by the time a MN enters a network, it can also have a security relationship with the PoS in that network by using MIH\_Prereg\_Xfer commands. For each newly visited network, this security relationship can be created on demand, enabled by signaling from another PoS. The PoS creating the visited security relationship can either be the MN's home PoS (HPoS, a PoS in MN's home network), or the PoS in the network previously visited by the MN. When the MN first attaches to one of the partner networks of the roaming partners, it is either the MN's home network, or a visited network. If the first attachment is to the MN's home network, then the MN is expected to already have a security association with HPoS; otherwise, the MN can bootstrap this security association with the assistance of HPoS, IKEv2 or standard AAA mechanisms or other proprietary means.

After initial attachment, there is signaling defined so that at all times the MN has a security association with the PoS in the network at its current point of attachment, i.e. OPoS. As the MN moves from one partner network to the next target network, the MN establishes or renews a security association with the PoS in the target network, TPoS. When handover is completed, TPoS naturally begins to play the role of the MN’s local PoS, and subsequently when a handover is required, TPoS plays the role of OPoS.

In order to enable wider application of high-performance handovers and in particular preregistration signaling, security must be guaranteed for the control traffic. As described above, this signaling traffic is mediated by the PoS in each target network, which may be unknown to the MN until the need for handover has been determined. In such cases, for secure signaling, the MN needs to establish a security association with TPoS. The process of establishing such a security association can be quite time consuming and often expensive in processor cycles as well. This clause specifies a fast, straightforward method for providing security associations as needed between the MN and TPoS in any target network within the networks covered by the roaming partners.

This subclause specifies one algorithm to allow OPoS to distribute a key derivation key *K* to the MN and to its desired TPoS. The key derivation key is then used to derive other keys that are used as the basis for a secure communications channel between the MN and the TPoS, enabling further secure preregistration activities. The notation used in this clause for PoS-based handover keys is listed in Table 26.

Table 26 — Notation for OPoS-based exchange of key derivation key *K*

|  |  |
| --- | --- |
| *K* | Key derivation key |
| *K*opos | Encryption key (i.e., MIAK (MN, OPoS)) between MN and OPoS |
| *K*otpos | Encryption key between OPoS and TPoS |
| PRFopos | pseudo-random function between MN and OPoS |
| PRFotpos | pseudo-random function between OPoS and TPoS |

Because of previous protocol operations (e.g., derivation of MIAK upon arrival in the originating network), the MN has a current security association with OPoS. This security association is bidirectional and based on a shared key *K*opos.

Suppose the MN determines to move to a new network, the target network; for preregistration, the MN needs to use the PoS in target network, i.e., TPoS. Before it can do this, it needs to discover the address of TPoS and establish a security association with TPoS by exchanging MISK as described in clause 9.2.2.

For this purpose, MN can make use of its existing security association with OPoS, because OPoS either already has, or can readily establish, a security association with TPoS; suppose OPoS already has the required security association with TPoS. Then, when MN begins forwarding preregistration traffic to TPoS via OPoS, OPoS will provide MN and TPoS with a key derivation key, *K*, for use to derive MIAK which can be used to protect the remainder of the MN's signaling traffic with TPoS. OPoS thus forwards the initial traffic to TPoS on behalf of the MN; the OPoS uses its own security relationship with TPoS to protect this initial preregistration signaling, and it also supplies the value of *K* to TPoS by adding a new extension to the preregistration traffic.

To send *K* to TPoS, OPoS provides the following payload within the TLVs of MIH\_N2N\_Prereg\_Xfer Request (see clause 7.4.31.1):

Payload = MNID, Nonce-T, Nonce-N, [*K* ⊕ PRFotpos (MNID, Nonce-T, Nonce-N)]

Upon receiving this payload, TPoS calculates PRFotpos (MNID, Nonce-T, Nonce-N) and XORs the result to the third parameter of the payload to recover *K*.

Similarly, to send *K* to MN, OPoS provides the following payload as a parameter to MIH\_Prereg\_Xfer Response (see clause 7.4.30.3):

Payload = TPoSIdentifier, Nonce-N, [*K* ⊕ PRFopos (TPoSIdentifier, Nonce-N)]

Upon receiving the payload, MN calculates PRFopos (TPoSIdentifier, Nonce-T, Nonce-N) and XORs the result to the third parameter of the payload to recover *K*.

Alternatively, for either of these messages, OPoS could encrypt the entire contents by using *K*otpos or *K*opos, the keys OPoS has available with TPoS and MN respectively. MN is allowed to send more signaling information to TPoS via OPoS even after OPoS distributes the keys; OPoS continues to forward traffic back and forth between MN and TPoS as needed until both endpoints have used *K* to derive the required security associations. For best performance and least likelihood of congestion at OPoS, MN and TPoS should begin to use direct signaling as soon as possible and thus bypass OPoS. Other structures for the message payloads are also possible, depending on requirements.

Once the handover is completed, TPoS "becomes" OPoS and the handover cycle can begin anew whenever MN determines the need for the next handover.

* 1. TPoS selection by OPoS

It is possible for OPoS to take a more active role to promote smooth handover. When the MN determines the need for handover, but does not already know the address of the TPoS for the intended target network, the MN can start the preregistration sequence by sending all the known information to the OPoS. If OPoS has access to information about each surrounding networks, and information about the MIH PoS in each such surrounding network, OPoS can make a determination about which target network may best be able to provide connectivity and service to the MN. This also depends on OPoS having access to location and configuration information about the MN – for example which radio access technologies (RATs) are configured for operation on the MN. When the candidate TPoS is in another operator’s network, it may be also important the OPoS should have a security relationship with a candidate TPoS, in order to avoid interference from malicious nodes. This would typically mean that the operators are also roaming partners.

Subsequently, the OPoS will provide the address of the TPoS to the MN along with *K*, as described above. The exact nature of the information about TPoS provided by the MN is dependent on the radio access technology type (RAT) of the target network, and may be specified in detail in later revisions of this document. Other alternatives for identifying the target network access point are also envisioned. For MNs configured with ANDSF software, detailed information about TPoS, and the other entities within the target network can easily be made available. Note, however, that discovery and secure communication with TPoS via OPoS may be easier than discovery and secure communication with ANDSF.

# Bibliography

(informative)

***Insert these normative references in appropriate order.***

1. IEEE 802 standard, “IEEE Draft Standard for Local and metropolitan Area Networks: overview and Architecture”, P802-D1.4, June 2012.
2. 3GPP, “3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access,” TS23.401.
3. 3GPP, “3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Architecture enhancements for non-3GPP accesses,” TS23.402
4. WiMAX Forum Network Architecture: Stage 3 Detailed Protocols and Procedures T33-001-R015
5. WiMAX Forum, “Single radio interworking between Non-WiMAX and WiMAX Access Networks,” WMF-T37-011-R016v01, Nov 30, 2011.
6. WiMAX Forum, “WiFi-WiMAX Interworking,” WMF-T37-010-R016v01.
7. 3GPP2, “WiMAX-HRPD Interworking: Core network aspects,” X.S0058.
8. IETF RFC 6153 (2011-02), DHCPv4 and DHCPv6 Options for Access Network Discovery and Selection Function (ANDSF) Discovery
9. IEEE 802 standard, “Part 21: Media Independent Handover Services Amendment 1: Security Extensions to Media Independent Handover Services and Protocol”, 802.21a, May 2012.

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***Insert following Data Type to Table E.1.***

|  |  |  |  |
| --- | --- | --- | --- |
| MIH\_LINK\_SAP\_primitive | | IEEE Std 802.16 C\_SAP | IEEE Std 802.16 M\_SAP |
| Link\_Action | Link\_RX\_ON | N/A | N/A |

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## 

## 

## Derived data types

### 

### *Change the following row in Table F.2:*

|  |  |  |
| --- | --- | --- |
| STATUS | ENUMERATED | The status of a primitive execution.  0: Success  1: Unspecified Failure  2: Rejected  3: Authorization Failure  4: Network Error  5: Authentication Failure  6:TPoS is identical to OPoS, use  *K*opos  7: Requested Ciphersuite Not Available |

### 

### Data types for link identification and manipulation

(normative)

***Insert number 5 in the description of LINK\_PARAM\_GEN in Table F.4 in F3.4***

|  |  |  |
| --- | --- | --- |
| Data type name | Derived form | Description |
| LINK\_PARAM\_GEN | UNSIGNED\_INT(1) | 5: Average power consumption in active state- the parameter value is represented as an UNSIGNED\_INT(2). Its measure is mW. See Annex S.3 for examples.  Value Range: 0 – 216-1 mW  6-255: (Reserved) |

***Insert Following Data Type to Table F.5 in F3.5***

|  |  |
| --- | --- |
| Action name | Description |
| Link\_RX\_ON | Turn on only the receiver of the radio |

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### Data types for information elements

***Change Table F.13 in F3.8 as follows:***

**Table F.13 – Data types for information elements**

|  |  |  |
| --- | --- | --- |
| Data type name | Derived from | Definition |
| NET\_CAPS | BITMAP(32) | These bits provide high level capabilities supported on a network.  Bitmap Values:  Bit 0: Security – Indicates that some level of security is supported when set.  Bit 1: QoS Class 0 – Indicates that QoS for class 0 is supported when set  Bit 2: QoS Class 1 – Indicates that QoS for class 1 is supported when set  Bit 3: QoS Class 2 – Indicates that QoS for class 2 is supported when set; Otherwise, no QoS for class 2 support is available.  Bit 4: QoS Class 3 – Indicates that QoS for class 3 is supported when set; Otherwise, no QoS for class 3 support is available.  Bit 5: QoS Class 4 – Indicates that QoS for class 4 is supported when set; Otherwise, no QoS for class 4 support is available.  Bit 6: QoS Class 5 – Indicates that QoS for class 5 is supported when set; Otherwise, no QoS for class 5 support is available.  Bit 7: Internet Access – Indicates that Internet access is supported when set; Otherwise, no Internet access support is available.  Bit 8: Emergency Services – Indicates that some level of emergency services is supported when set; Otherwise, no emergency service support is available.  Bit 9: MIH Capability – Indicates that MIH is supported when set; Otherwise, no MIH support is available.  Bit 10: SRHO Capability – Indicates that SRHO is supported when set; Otherwise, no SRHO support is available.  Bit ~~10~~ 11–31: (Reserved) |
| IP\_TUNN\_MGMT | BITMAP(16) | Indicates the supported tunnel management protocol on PoS.  Bitmap Values:  Bit 0: IPSec  Bit 1–15: (Reserved) |

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### Data type for security



***Change following Data Types into Table F.24 in F.3.16 [802.21a]***

|  |  |  |
| --- | --- | --- |
| Data | Derived from | Definition |
| LL\_FRAMES | OCTET\_STRING | ~~Represents the information needed to carry out a key installation.~~ One or more link-layer frame(s). |

***Insert F.3.17 after F.3.16:***

### Data types for delivery of control messages

***Insert Table F.25 as follows:***

**Table F.25- Data types for delivery of control messages**

|  |  |  |
| --- | --- | --- |
| Data type name | Derived form | Definition |
| CTRL\_PROT\_MSGS | SEQUENCE(  CTRL\_TYPE,  CTRL\_MSGS  ) | Represent which control messages are delivered. CTRL\_TYPE represents a type of control messages. CTRL\_MSGS represents control messages to be delivered. |
| CTRL\_TYPE | UNSIGNED\_INT(1) | Indicates the type of the control message.  0: Reserved  1: ANQP  2: ANDSF  3..127: Reserved for other control message types  128..255: Reserved for vendor-specific message types |
| CTRL\_MSGS | OCTET\_STRING | Represents control messages to be delivered. |

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(normative)

***Insert following Information element identifiers values into Table G.1***

**Table G.1—Information element identifier values**

|  |  |
| --- | --- |
| Name of information element or container | IE Identifier |
|  |  |
| IE\_PoS\_TUNN\_MGMT\_PRTO | 0x10000209 |
| IE\_PoS\_NAI | 0x1000020A |
| IE\_CONTAINER\_PoS | 0x10000303 |

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(normative)

***Insert the following rows to Table L.1***

|  |  |
| --- | --- |
| MIH messages | AID |
| MIH messages for Command Service | |
| MIH\_Prereg\_Xfer | 13 |
| MIH\_N2N\_Prereg\_Xfer | 14 |
| MIH\_IF\_PreReg\_Ready | 15 |
| MIH\_CTRL\_Transfer | 16 |

***Insert the following TLVs to Table L.2***

|  |  |  |
| --- | --- | --- |
| TLV type Name | TLV type value | Data type |
| TPoS Identifier TLV | 78 | MIHF\_ID |

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***Insert the following row to Table M.3***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| M.8.3.10 | Is Key Generation supported? | 9.2.2 | O | Yes [ ] No [ ] | MC10 |

***Insert the following rows to Table M.4***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| M.8.4.43 | MIH\_Prereg\_Xfer request | 8.6.3.24 | O | Yes [ ] No [ ] | PDU43 |
| M.8.4.44 | MIH\_Prereg\_Xfer response | 8.6.3.25 | O | Yes [ ] No [ ] | PDU44 |
| M.8.4.45 | MIH\_N2N\_Prereg\_Xfer request | 8.6.3.26 | O | Yes [ ] No [ ] | PDU45 |
| M.8.4.46 | MIH\_N2N\_Prereg\_Xfer response | 8.6.3.27 | O | Yes [ ] No [ ] | PDU46 |
| M.8.4.47 | MIH\_IF\_PreReg\_Ready request | 8.6.3.28 | O | Yes [ ] No [ ] | PDU47 |
| M.8.4.48 | MIH\_IF\_PreReg\_Ready response | 8.6.3.29 | O | Yes [ ] No [ ] | PDU48 |
| M.8.4.49 | MIH\_CTRL\_Transfer request | 8.6.3.30 | O | Yes [ ] No [ ] | PDU49 |
| M.8.4.50 | MIH\_CTRL\_Transfer response | 8.6.3.31 | O | Yes [ ] No [ ] | PDU50 |

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(informative)

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***Change the Annex subclause number N.6[802.21a] to N.5***

## ~~N.6~~ Terminating Phase

***Insert new Annex subclause N.6***

## MIH\_Prereg\_Xfer messages for Optimized SA Establishment

### OPoS distributing key derivation key *K* to TPoS and MN



Figure N‑1 -- OPoS distributing key derivation key *K* to TPoS and MN

The signaling diagram illustrated in Figure N.6 1 shows the following steps

1. MIH\_Prereg\_Xfer.request: the MN user application asks to initiate preregistration to a suitable target PoA (TPoA)
2. MIH\_Prereg\_Xfer Request: MN’s MIHF transmits request to Originating PoS (OPoS)
3. MIH\_Prereg\_Xfer.indication: OPoS presents MN’s Request to OPoS MIH application.
4. MIH\_N2N\_Prereg\_Xfer.request: issued by OPoS MIH application containing information to enable TPoS to compute *K*
5. MIH\_N2N\_Prereg\_Xfer Request: relayed by OPoS to TPoS, possibly encapsulated with IPSec
6. MIH\_ N2N\_Prereg\_Xfer.indication: presented to TPoS MIH application for extraction of *K* and computation of MNmsrk (i.e., MSPMK between MN and TPoA).
7. TPoS MIH application provides MIAK and any other appropriate keys to AAA for future authentication purposes
8. TPoS MIH application computes MNmsrk from *K* and sends appropriate LL frames to TPoA for key distribution and any other preregistration tasks.
9. MIH\_N2N\_Prereg\_Xfer.response: TPoS MIH application initiates message for OPoS MIH application containing MN\_NAI.
10. MIH\_N2N\_Prereg\_Xfer Response: TPoS relays message to OPoS containing MN\_NAI.
11. MIH\_N2N\_Prereg\_Xfer.confirm: OPoS presents message to OPoS MIH application containing MN\_NAI.
12. MIH\_Prereg\_Xfer.response: OPoS MIH application initiates message to MN user application via OPoS containing MN\_NAI, *K*.
13. MIH\_Prereg\_Xfer Response: OPoS relays message to MIHF running on MN containing MN\_NAI, *K*.
14. MIH\_Prereg\_Xfer. confirm: MIHF running on MN relays message to MN user application containing MN\_NAI, *K*.
15. MN user application extracts *K*, computes MNmsrk, continues any necessary preregistration activities
16. MN continues with additional preregistration signaling

The call flow illustrated in Figure N-1 shows how the identity is bootstrapped by TPoS, how *K* is sent by OPoS to TPoS and how the MSPMK is installed into the TPoA (AAA). Notice that the PoA in the originating network does not conceptually play any role in the signal handling, even though signals exchanged between the MN and the OPoS are transmitted by way of the originating PoA.

### OPoS relays additional Preregistration signaling



Figure N.6‑2 -- OPoS relays additional Preregistration signaling

The signaling diagram illustrated in Figure N.6-2 shows the following steps

1. MIH\_Prereg\_Xfer.request: the MN user application asks to continue preregistration to a suitable target PoA (TPoA)
2. MIH\_Prereg\_Xfer Request: MN’s MIHF transmits request to Originating PoS
3. MIH\_Prereg\_Xfer.indication: OPoS presents MN’s Request to OPoS MIH application.
4. MIH\_N2N\_Prereg\_Xfer.request: issued by OPoS MIH application relaying MN additional preregistration signaling to TPoS
5. MIH\_N2N\_Prereg\_Xfer Request: relayed by OPoS to TPoS, possibly encapsulated with IPSec
6. MIH\_ N2N\_Prereg\_Xfer.indication: presented to TPoS MIH application for continuation of preregistration signaling
7. TPoS relays preregistration signaling to TPoA
8. TPoA contacts AAA for authentication
9. TPoA responds with additional preregistration signaling for MN
10. TPoS MIH application relays preregistration signaling from TPoA, possibly including LL frames, to be transmitted to OPoS.
11. MIH\_N2N\_Prereg\_Xfer.response: TPoS MIH application transmits message for OPoS MIH application.
12. MIH\_N2N\_Prereg\_Xfer.confirm: OPoS presents message to OPoS MIH application.
13. MIH\_Prereg\_Xfer.response: OPoS MIH application transmits message to MN user application.
14. MIH\_Prereg\_Xfer Response: OPoS relays message to MIHF running on MN.
15. MIH\_Prereg\_Xfer. confirm: MIHF running on MN relays message to MN user application.
16. MN user application continues any necessary preregistration activities based on signaling received from TPoA.

In Figure N-2, the authentication between the MN and the TPoA is depicted. MNmsrk is as previously installed on the TPoS, shown in the bootstrap process in the first figure; TPoA holds the MNmsrk and uses it for media-specific authentication. Therefore, another MNmsrk transfer is not needed.

### OPoS key distribution when OPoS is same as TPoS



Figure N.6‑3 OPoS key distribution when OPoS is same as TPoS

The signaling diagram illustrated in Figure N.6-3 shows the following steps.

1. MIH\_Prereg\_Xfer.request: the MN user application asks to initiate preregistration to a suitable target PoA (TPoA)
2. MIH\_Prereg\_Xfer Request: MN’s MIHF relays request to Originating PoS (OPoS)
3. MIH\_Prereg\_Xfer.indication: OPoS presents MN’s request to OPoS MIH application.
4. OPoS MIH application provides MIAK and any other appropriate keys to AAA for future authentication purposes at TPoA
5. OPoS MIH application computes MNmsrk from *K* and sends appropriate LL frames to TPoA for key distribution and any other preregistration tasks.
6. MIH\_Prereg\_Xfer.response: OPoS MIH application initiates message to MN user application via OPoS containing MN\_NAI, *K*. The response message informs MN that TPoS is the same as OPoS.
7. MIH\_Prereg\_Xfer Response: OPoS relays message to MIHF running on MN containing MN\_NAI, *K*.
8. MIH\_Prereg\_Xfer. confirm: MIHF running on MN relays message to MN user application containing MN\_NAI, *K*.
9. MN user application extracts *K*, computes MNmsrk, continues any necessary preregistration activities

When the MN can directly contact the TPoS (this case is the same as when OPoS and TPoS are the same entity), Figure N.6-3 and the numbered steps apply for authentication at the TPoA.

### OPoS relay preregistration when OPoS is same as TPoS



Figure N.6‑4 OPoS relay preregistration when OPoS is same as TPoS

Finally when the OPoS and TPoS are the same entity and the MIH\_Prereg\_Xfer is used to exchange L2 frames, but no authentication messaging is required, the diagram shown in Figure N.6-4 can be applied. The signaling diagram illustrated in Figure N.6-4 shows the following steps.

1. MIH\_Prereg\_Xfer.request: the MN user application asks to initiate preregistration to a suitable target PoA (TPoA)
2. MIH\_Prereg\_Xfer Request: MN’s MIHF relays request to Originating PoS (OPoS)
3. MIH\_Prereg\_Xfer.indication: OPoS presents MN’s request to OPoS MIH application.
4. OPoS MIH application sends appropriate LL frames to TPoA for preregistration tasks such as datapath setup, context transfer, etc.
5. OPoS MIH application receives corresponding LL frames from TPoA to complete preregistration tasks initiated in the previous step.
6. MIH\_Prereg\_Xfer.response: OPoS MIH application initiates message to MN user application via OPoS containing MN\_NAI, *K*. The response message informs MN that TPoS is the same as OPoS.
7. MIH\_Prereg\_Xfer Response: OPoS relays message to MIHF running on MN containing MN\_NAI, *K*.
8. MIH\_Prereg\_Xfer. confirm: MIHF running on MN relays message to MN user application containing MN\_NAI.

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***Insert Annex P and Annex Q and Annex R and Annex S and Annex T***

# MN’s Network Access Identifier Format

(Informative)

An MN\_NAI attribute (of type MIHF\_ID), which is optionally contained in MIH\_Prereg\_Xfer.response, MIH\_Prereg\_Xfer.confirm, MIH\_N2N\_Prereg\_Xfer.response, and MIH\_N2N\_Prereg\_Xfer.confirm primitives, is assigned by the target PoS to the MN such that the MN can use the value of this attribute as the EAP peer identity for subsequent reactive pull key distribution or optimized pull key distribution from the target PoS. The username part of the MIHF\_ID carried in this attribute may contain the identifier of the MSRK used between the MN and the target PoS, and the realm part of the MIHF\_ID may contain a Fully Qualified Domain Name of the target PoS.

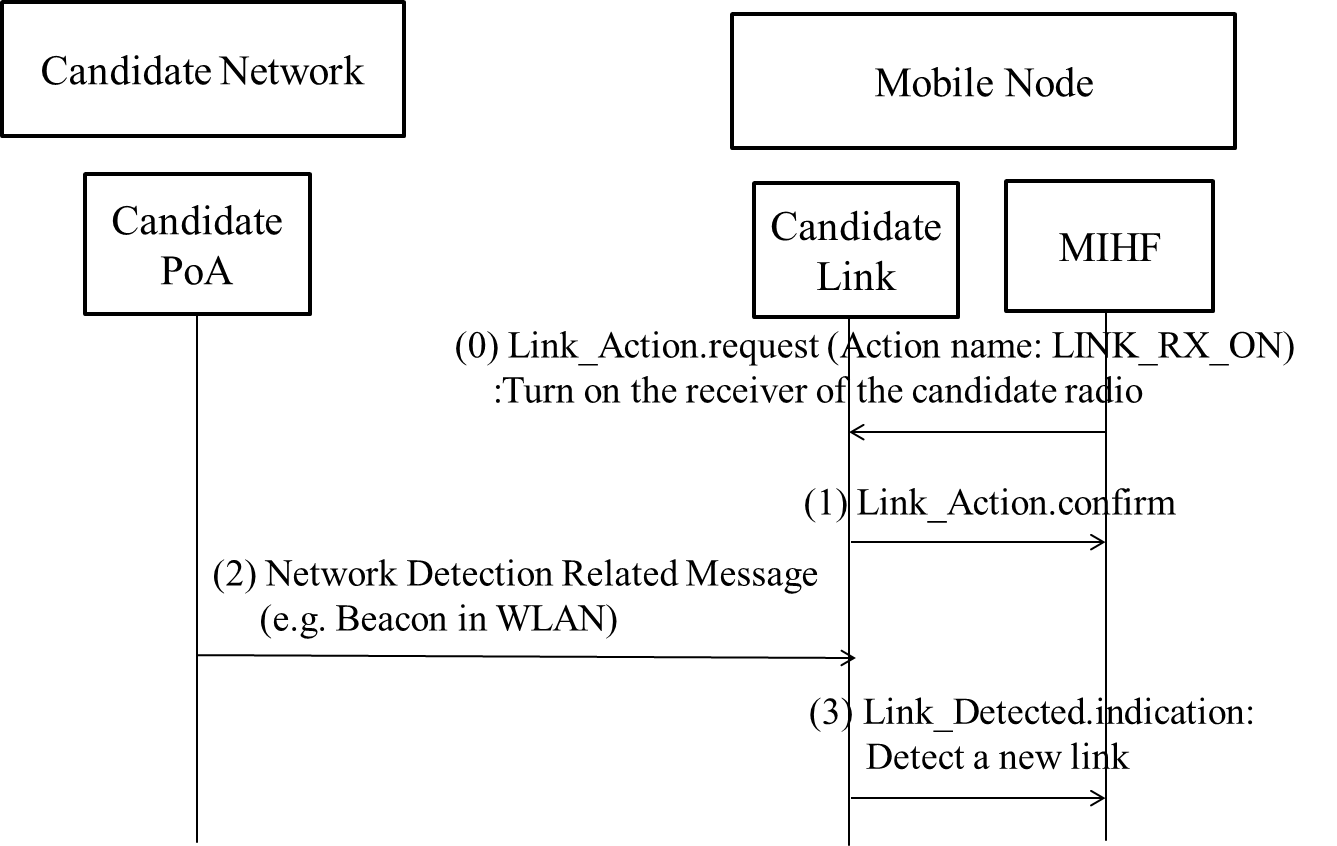
# Network discovery for single radio handover

(Informative)

The purpose of Annex Q is to introduce network discovery for single radio handover (SRHO). As shown in clause 1.4, the SRHO has restrictions on the use of radio interfaces to reduce interference between source and target radio interfaces and power consumption of mobile nodes. A mobile node is not free to use the target radio when the source radio is operating. Annex Q shows methods of network discovery under the restrictions of SRHO.

## Network discovery: listening to the target link

The first method is listening to the target link. When the mobile node can listen to the target link and signal strength of the source link decrease, the mobile node can scan candidate links and then can find the target link. Moreover, periodic scanning for the target link can support network discovery. This method serves the accurate detection of the target links, but the mobile node may follow the assumptions in subclause 1.4.

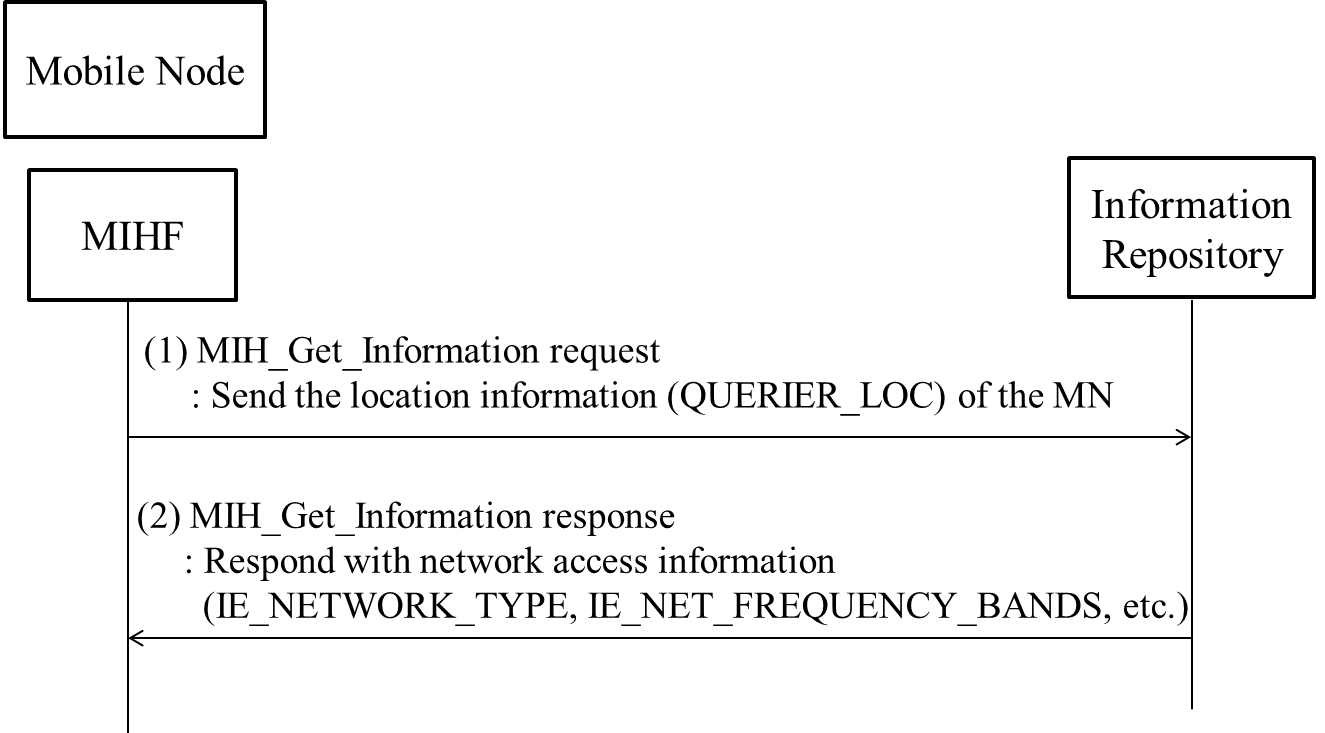


**Figure Q.1- Network discovery listening to the target link**

Figure Q.1 shows the case for network discovery listening to the target link with extended Link\_Action. In (0) and (1), MIHF turns on only the receiver of the candidate radio using Link\_Action message with newly defined action name which is LINK\_RX\_ON. In (2), the candidate link listens to network detection related messages, such as beacon of IEEE 802.11 network. In (3), candidate link informs detection of a new link using Link\_Detected message. This method serves the accurate detection of the target links, but the mobile node may follow the assumptions in subclause 1.4.

## Network discovery: using location information

The second method is network discovery based on the location information of the mobile node. This mechanism finds the target network using GPS (Global Positioning System) location information and interacting with the IR (Information Repository) explained in subclause 5.4.4. This mechanism will avoid the interference explained above. Although location information from global positioning system (GPS) can enhance network detection, the GPS also dissipates power in the mobile node which is often limited by the power capability of its battery. Also, the GPS systems performance is often degraded with the weak signals in an indoor environment. In the event of GPS signal loss, such as when entering a building, the last known location could be used. Moreover, it can be a huge load to the network to invoke a network information repository to support network discovery for the mobile nodes which are equipped with the GPS.



**Figure Q.2- Network discovery using location information**

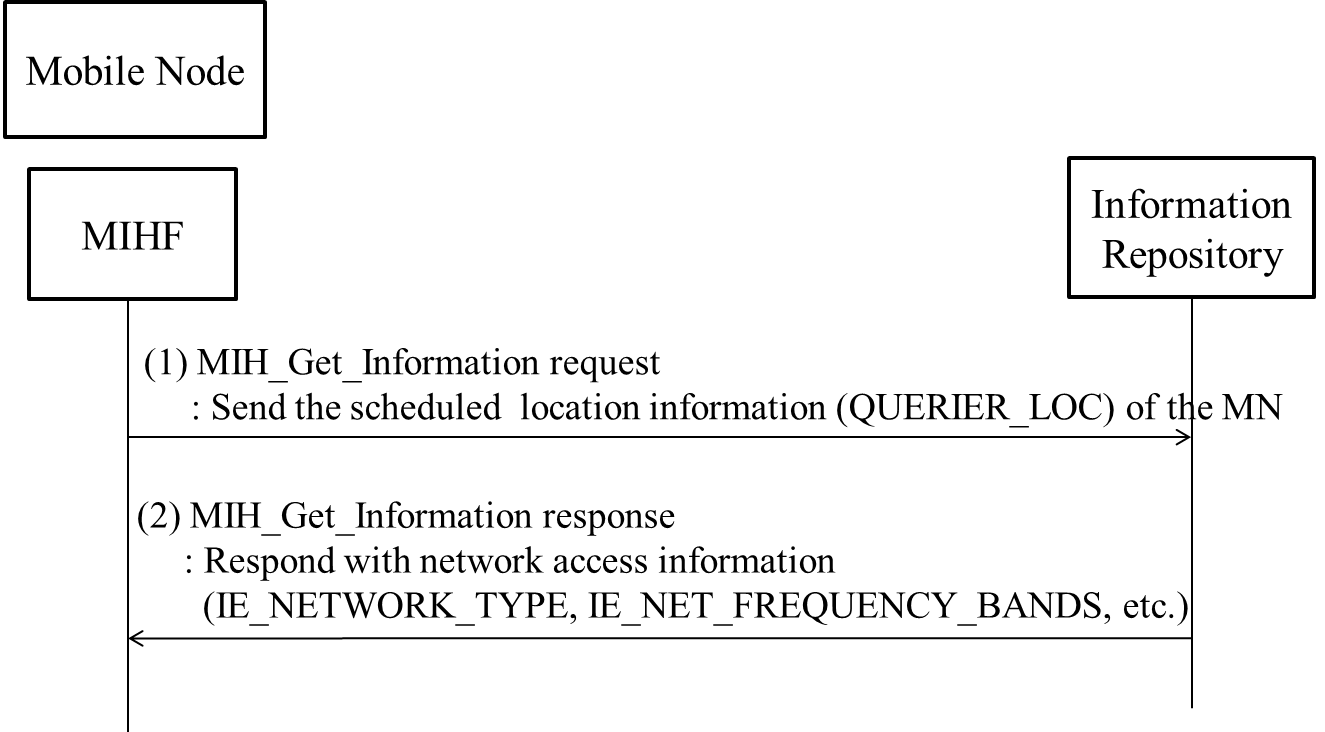
Figure Q.2 shows the case for network discovery using location information of the MN with QUERIER\_LOC. In (1), the MN MIHF sends the location information (QUERIER\_LOC) of the MN through MIH\_Get\_Information request message. In (2), the IR MIHF responds with network access information elements, such as IE\_NETWORK\_TYPE and IE\_NET\_FREQUENCY\_BANDS.

Moreover, scheduled location information can be used for network discovery. The multi-radio MN can possess a lightweight software that includes schedule program, e.g., Google calendar, and many users are already managing their schedule through the use of a schedule program such as Google calendar. The schedule program usually shows the user’s location at the dedicated time. Based on user’s location information, the multi-radio MN can determine its available networks and the target radio.

The network discovery using scheduled location information can improve network discovery in indoor environments and reduce the network load. The GPS does not work correctly in indoor. The network discovery using the MN’s geo-location information using GPS is not appropriate in indoor. Moreover, periodical update of location information results in network load. The scheduled location information is not affected by indoor environment and does not need periodical update of location information. Thus, the network discovery using scheduled location information can be more efficient at indoor and network load than the conventional location information.

A usage of network discovery with the scheduled information is the same as follows. If Mr. Sam is scheduled to stay meeting room from 9AM to 11AM, the Mr. Sam’s multi-radio MN can discover a WLAN AP at the meeting room. In order to enhance this network discovery mechanism, the scheduled information can include the network information including information about link type, link identifier, link availability, link quality as defined in this standard. Using the network information, the mobile node can perform network discovery. If the MN knows the network information, it can try to connect to the network using that information.

In addition, records of user’s network access can enhance network discovery with or without the Information Repository. For example, if Mr. Sam had visited “Room #1” and accessed WLAN at some time. When Mr. Sam is scheduled to visit “Room #1” again, the recorded network information will show that Mr. Sam’s MN can connect the WLAN using the recorded WLAN access information.



**Figure Q.3- Network discovery using user schedule information**

Figure Q.3 shows the case for network discovery using location information of the MN with QUERIER\_LOC. In (1), the MN MIHF sends the scheduled location information (QUERIER\_LOC) of the MN through MIH\_Get\_Information request message. In (2), the IR MIHF responds with network access information elements, such as IE\_NETWORK\_TYPE and IE\_NET\_FREQUENCY\_BANDS.

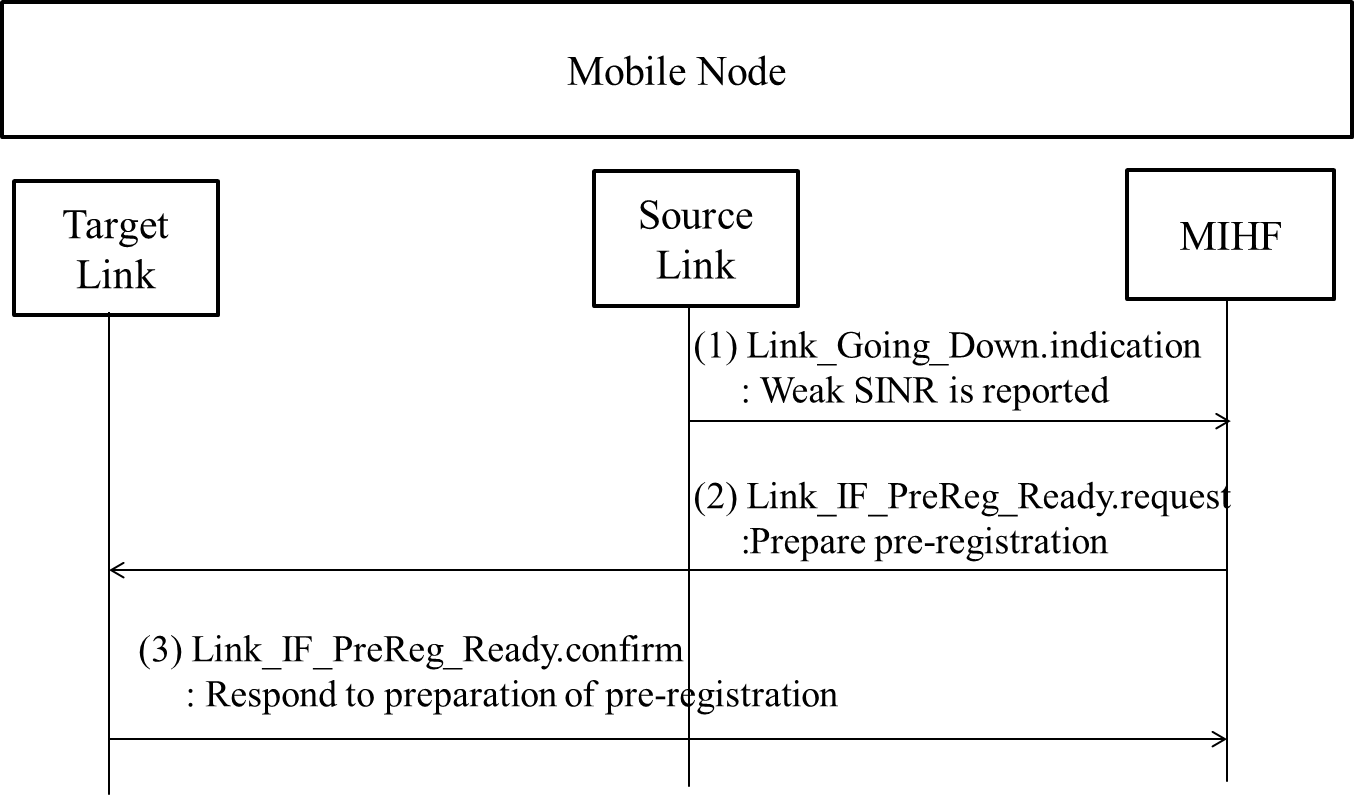
# (VOID)

# Handover Decision

(Informative)

To decide handover, three representative criteria are considerable for handover decision. Criteria to decide handover can be weak SINR (Signal to Interference plus Noise Ratio), QoS and/or cost, and the power consumption of the source link.

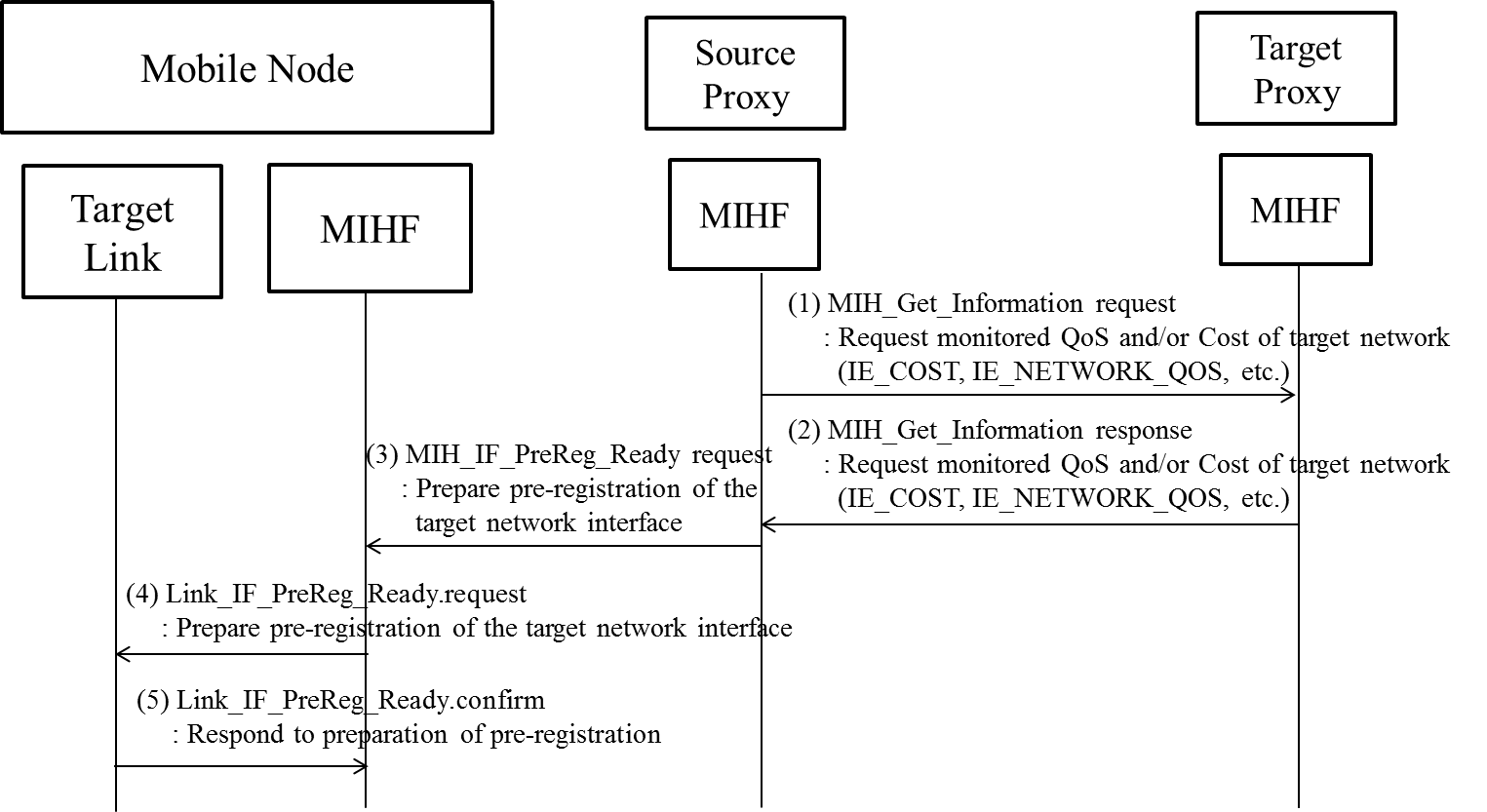
## Weak SINR of the source link



**Figure S.1- HO decision caused by weak SINR of the source link**

Figure S.1 shows the case for weak SINR of the source link. Through Link\_Going\_Down.indication, the source link interface reports its weak SINR. Afterwards, the MIHF orders the target link interface to initiate preregistration through Link\_IF\_PreReg\_Ready.req. Link\_IF\_PreReg\_Ready is needed, because preregistration is different from regular registration. While the L2 messages for regular registration are transmitted through the target link, the L2 messages for preregistration are transmitted through higher layer (TCP or UDP/IP) and the source link. After the target link interface prepares preregistration, the target link interface responds with Link\_IF\_PreReg\_Ready.confirm.

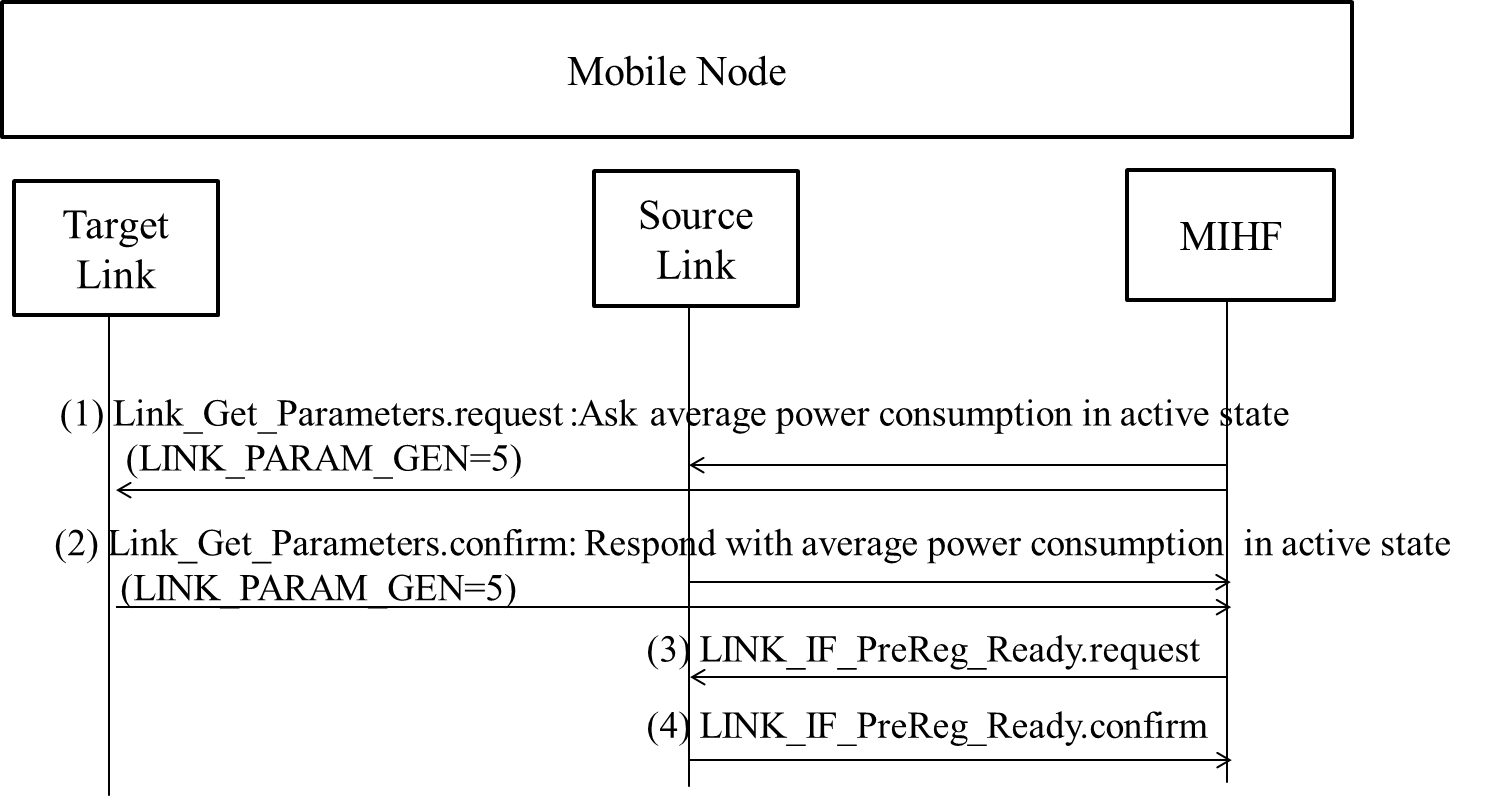
## QoS and/or cost check



**Figure S.2- HO decision caused by QoS and/or cost**

Figure S.2 shows the case of QoS and/or cost check for HO decision. The source Proxy GW consults the QoS and/or cost with target Proxy GW through MIH\_Get\_Information. After source Proxy GW recommends the MN to perform handover, the source Proxy GW transmits MIH\_IF\_PreReg\_Ready request message. The MIHF of the MN orders the target link to pre-register through Link\_IF\_PregReg\_Ready.

## Power consumption comparison of the link interfaces



**Figure S.3- HO decision caused by power consumption comparison**

Figure S.3 shows the HO decision to reduce power consumption of the MN. The MIHF of the MN asks power consumption of each link interface through Link\_Get\_Parameters.request with new LINK\_PARAM\_GEN value, which is 5, and thus the source link interface and the target link interface answers its average power consumption through Link\_Get\_Parameters.confirm. Afterwards, the MIHF of the MN decides to perform handover through Link\_IF\_PreReg\_Ready.request, and then the target link interface responds with Link\_IF\_PreReg\_Ready.confirm.

# 

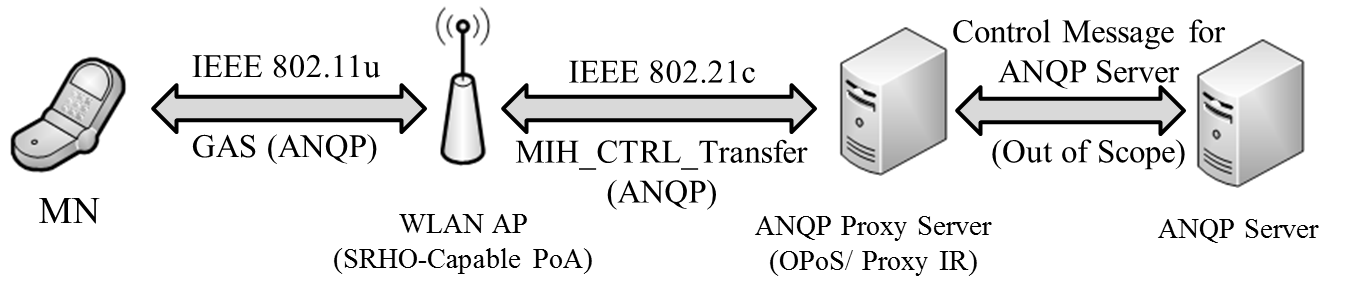
*(Informative)*

**Practical Uses of Proxy IR for Information Repository**

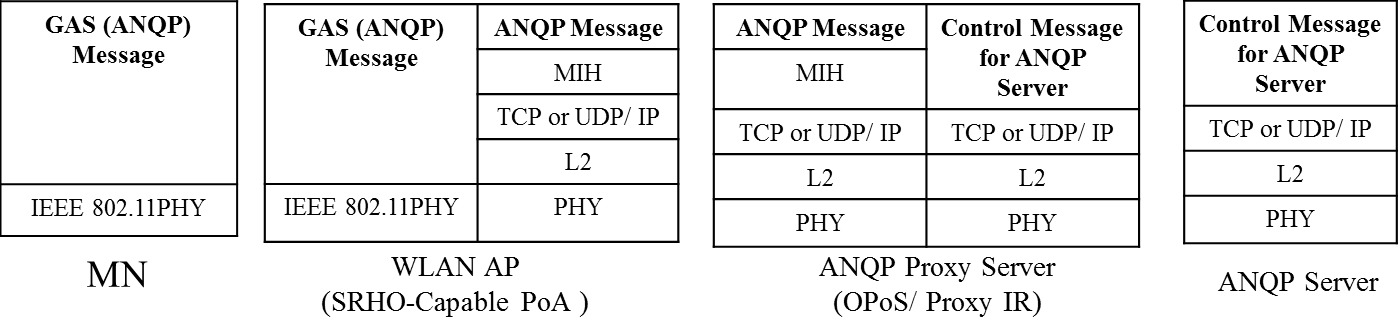
Since ANQP (Access Network Query Protocol) messages are defined between an MN and a WLAN AP, the WLAN AP needs translation function for the ANQP server that provides network information of WLAN to the MN. This translation function requires high complexity of the WLAN AP. To reduce the complexity of WLAN AP, Proxy IR for ANQP transfer can be used.

When the MN wants to receive ANQP messages, which include access network information, from the ANQP server, the MN can exchange with the ANQP server by using MIH\_CTRL\_Transfer messages as shown in Figure T.1 (a). As explained in Figure 53, if the MN wants to know WLAN access information by using ANQP messages, the WLAN AP as the SRHO-Capable PoA can only encapsulate ANQP messages with the MIH header using MIH\_CTRL\_Transfer messages. The WLAN AP exchanges MIH\_CTRL\_Transfer messages that encapsulate ANQP messages with the ANQP Proxy Server. Afterwards, the ANQP Proxy Server as the Proxy IR can signal with ANQP server through control messages for the ANQP server. The control messages between the ANQP Proxy Server and the ANQP server are out of scope in this standard.

The WLAN AP only encapsulates ANQP messages of the MN into MIH\_CTRL\_Transfer messages and decapsulates MIH\_CTRL\_Transfer message of ANQP Proxy Server, as shown in Figure T.1 (b). The encapsulation and decapsulation functions are simpler than the translation function for the original ANQP transfer. Therefore, complexity of the WLAN AP can be reduced by using Proxy IR for ANQP transfer



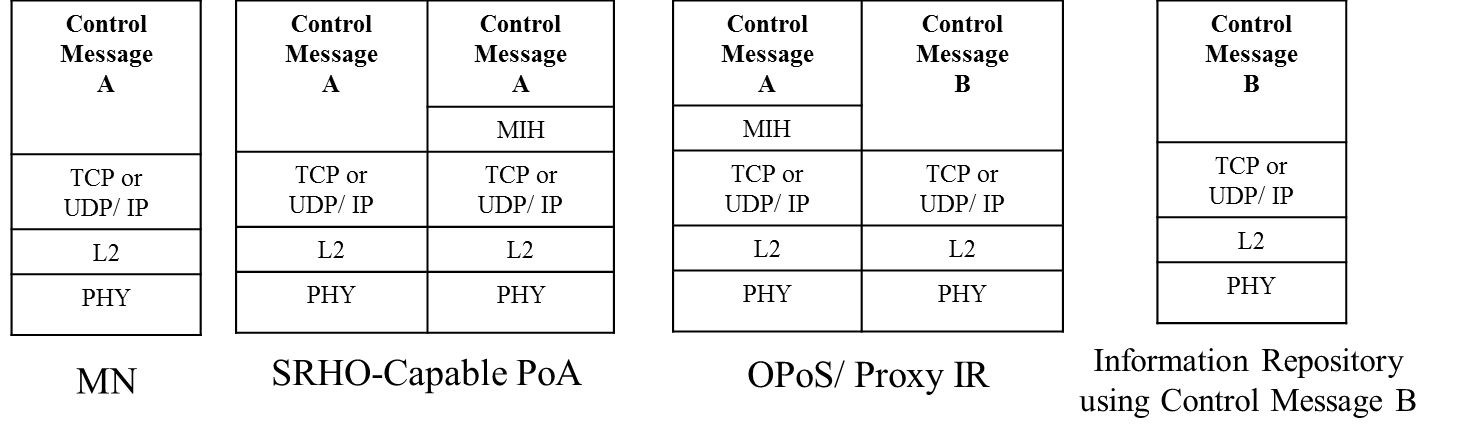
**(a) ANQP Message Transfer using Proxy IR**



**(b) Protocol Stacks for ANQP Transfer**

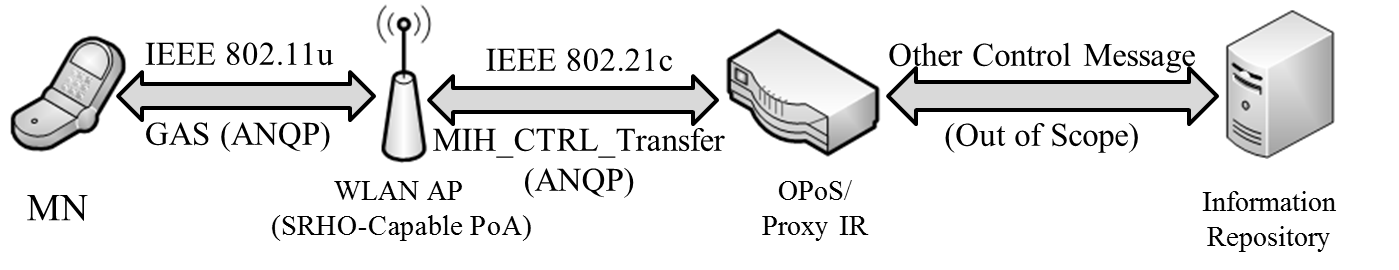
**Figure T. 1 Proxy IR for ANQP Transfer.**

Figure T.2 shows Control Message Conversion for Information Repository. If the Information Repository does not support control messages that the MN can use, the Proxy IR converts the control message (Control Message A) for the MAN into other control message (Control Message B) for the Information Repository. The Proxy IR operates as a proxy of the Information Repository to the MN. To the Information Repository, the Proxy IR behaves like the MN that can communicate with the IR.

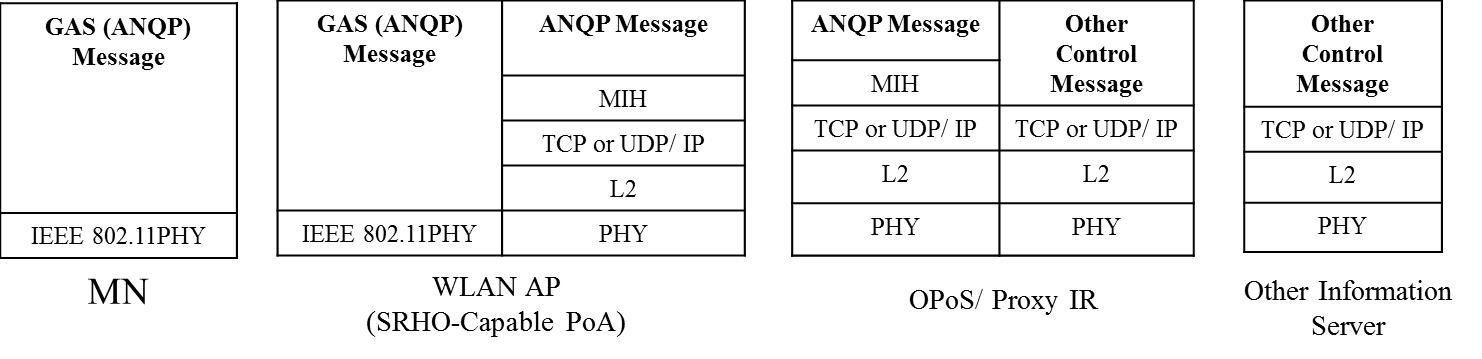


**Figure T.2 Control Message Conversion for Information Repository.**

If the MN uses ANQP messages but the Information Repository uses the other control messages such as ANDSF messages, the Proxy IR needs to convert ANQP messages to the other control messages. For this case, the WLAN AP as the SRHO-Capable PoA only encapsulates ANQP messages of the MN into MIH\_CTRL\_Transfer messages and decapsulates MIH\_CTRL\_Transfer messages of information server, as shown in Figure T.3 (a). Proxy IR converts the ANQP messages from the WLAN AP to the other control messages and vice versa. Hence, the MN can communicate with Information Repository by using the WLAN AP and the Proxy IR. To explain the ANQP conversion, the protocol stacks for MN, WLAN AP, Proxy, and Information Repository are shown in Figure T.3 (b).



**(a) ANQP Message Conversion using the Proxy IR**



**(b) Protocol Stacks for ANQP Conversion**

**Figure T.3 Proxy IR for ANQP Conversion**

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2. Note that LINK\_TUPLE\_ID includes the LINK\_ID of both sides of the link, the MN and the PoA. [↑](#footnote-ref-2)
3. Note that LINK\_TUPLE\_ID includes the LINK\_ID of both sides of the link, the MN and the PoA. [↑](#footnote-ref-3)
4. Note that LINK\_TUPLE\_ID includes the LINK\_ID of both sides of the link, the MN and the PoA. [↑](#footnote-ref-4)
5. Note that LINK\_TUPLE\_ID includes the LINK\_ID of both sides of the link, the MN and the PoA. [↑](#footnote-ref-5)
6. Note that LINK\_TUPLE\_ID includes the LINK\_ID of both sides of the link, the MN and the PoA. [↑](#footnote-ref-6)
7. Note that LINK\_TUPLE\_ID includes the LINK\_ID of both sides of the link, the MN and the PoA. [↑](#footnote-ref-7)
8. Note that LINK\_TUPLE\_ID includes the LINK\_ID of both sides of the link, the MN and the PoA. [↑](#footnote-ref-8)
9. Note that LINK\_TUPLE\_ID includes the LINK\_ID of both sides of the link, the MN and the PoA. [↑](#footnote-ref-9)