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

Amendment 3: Optimized Single Radio Handovers

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, pre-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:

1. While the source radio is transmitting, the target radio cannot transmit.

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 so that the priority to transmit is given to the source radio. [CEP: what does this mean?]

1. 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..
2. It shall be possible that while the source radio is receiving, the target radio shall receive at a frequency not interfering with the frequency of the source radio receiver..
3. The mobile node (MN) and the target network may communicate with each other via the source network using the source link.

It is possible that the source point of attachment and the target point of attachment may: (a) belong to the same access network, (b) belong to different access networks connecting to the same backhaul network, or (c) belong to different access networks connecting to different backhaul networks. In (a) and (b), the capability to communicate between the source radio and the target network usually does not utilize internetwork interfaces. In (c), the two networks may require internetwork addresses in order to be able to communicate with each other.

1. Normative references

***Insert reference in appropriate order***

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

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 (including security establishment) which is accomplished before the handover actually occurs.

**Proxy function**: A function to bridge the mobility signaling between a mobile node and a target point of attachment via the source network. To the MN, the Proxy function appears to be a virtual point of attachment (PoA) to the target network. It enables such functions as preregistration and proactive authentication 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 handover MIHF (SR-MIHF)**: A media independent control function to enable MN and Target PoA to exchange the link-layer PDUs without depending on the existence of the target radio’s physical channel. It uses the available radio’s IP transport to deliver the deactivated target radio’s L2 PDUs. It interfaces with the transport layer (e.g., TCP or UDP) through the Media Independent Handover Service Access Point (MIH\_SAP) so that it may exchange SR-MIHF frames with remote SR-MIHF entities through IP transport. The exchanged SR-MIHF frames are processed by the SR-MIHF which has the assigned transport layer protocol’s port number [RFC 5677]. SR-MIHF also interfaces with the link-layer (L2) through the Media Independent Handover Link-layer Service Access Point (MIH\_LINK\_SAP) so that it may provide transport of L2 frames of a deactivated target radio to and from a remote SR-MIHF entity.

**Single radio MIH frame**: A packet which contains the target radio’s network PDUs in its payload. [CEP: note MIH\_Prereg\_Xfer commands can work even without containing link-layer PDUs]

**Source network PoA**: A Point of Attachment in the source network, to which a Mobile Node is attached after a handover has been completed

**SRHO-capable device:** A network node that implements one or more commands from this specification document. For instance, a mobile node MN is SRHO-capable if it implements at least MIH\_Prereg\_Xfer commands.

**Target network PoA**: A Point of Attachment in the target network,, to which a Mobile Node 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 selection functions

MIHF media independent handover function

MIH\_SAP media independent handover service access point

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

OPoS originating PoS

PoS point of serviceSPoA source PoA

SR-MIHF Single radio - media independent handover function

SRHO single radio handover

TPoA target PoA

TPoS target 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 the 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.

Security is indispensable to mobility management (see section 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. 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 (as above, the "source network") providing the current point of attachment for the MN. As a general rule, preregistration typically involves one or more of the following steps:

* pre-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, and
* 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 section 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. Since communication between the source 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 source and target networks as part of handover preregistration procedures (see subclause ). Improving the security model and reducing authentication delay enables crucial improvements in handover performance. [CEP: How is this related to 802.21c?]

* 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 SR-MIHF:**

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 SR-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
   5. Media independent handover reference framework

***Insert subclause 5.4.4 and subclause 5.4.5 and subclause 5.4.6***

* + 1. Information Repository

The network service information and the location information, such as the availability of candidate target network etc., are needed to make handover decisions. For example, the Information Repository may be implemented as part of a media independent information server (MIIS). Alternatively, as another example, IR may be implemented in conjunction with 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 in the mobility management protocol depends on the mobility management protocol being used. For example, when mobile IP is used for the inter-network management protocol, 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.

The distributed database of the Information Repository 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 Information Repository, organized so that each server knows which data belongs to which component of the Repository.

* + 1. General MIHF reference model and SAPs / Single Radio handover Control Function

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

In figure 4 (in subclause 5.5.2) the Single Radio MIHF in a multiple interface node is implemented using the media independent control function (MIHF) in the control plane.

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

* + 1. SR-MIHF and Proxy function at Home Network, Source Network, and Target Network



**Figure 3a An architecture of distributed mobility management.**

This distributed mobility management architecture also works for single radio management. Because the logical functions for distributed mobility management must already reside in some physical network elements, new physical network elements are not necessarily needed with this single radio handover reference model.[CEP: note that this does not mandate use of Proxy for distributed mobility mgmt.]

* 1. MIHF reference models for link-layer technologies

***Insert subclause 5.5.8***

* + 1. Single radio handover reference model and signaling process

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



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

The functions in originating network are: OPoS and the proxy function. The functions in target network are: TPoS and the proxy function.

The proxy functions enable signaling between the MN and the target PoA: MN signals with target PoA via OPoS/proxy function, which in turn signals with target PoA via TPoS/proxy function. Target PoA signals with MN (possibly via TPoS proxy function), which in turn signals with MN via OPoS or OPoS proxy function. [CEP: must allow for MIH functions that are NOT necessarily proxy functions]

The signaling process for single radio handover is shown in Figure 10b and is described in the following.



**Figure 10b Signaling process for Single radio handover via proxy functions**

1. MN sends a MIH\_PreReg\_Xfer.request message to the OPoS which may have a payload of a target network L2 handover frame.
2. Upon receiving this message from MN,
   1. OPoS queries the Information Repository to discover a suitable target network if not already known.
   2. OPoS signals with the TPoA via the TPoS proxy function, that is, OPoS proxy function sends the message to TPoS.
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).
   1. If the target PoA supports SR-MIHF messages, TPoS function sends the MIH\_PreReg\_Xfer.request to the target PoA .
   2. Else, TPoS performs proxy TPoA function by signaling with this target PoA using other message(s) out of scope of this specification. If the MIH\_PreReg\_Xfer.request fails because of failure in such signaling between TPoS and the TPoA, the MIH\_PreReg\_Xfer.response will include the indication to show that the fail is owing to TPoA not supporting MIH.