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Re:	**IEEE 802.16m-09/0034r2: IEEE 802.16m System Description Document (SDD)**
Abstract	Proposal on the handover procedure that enables handover of mobile relay stations.
Purpose	For review and adoption into 802.16m
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Mobility support for mobile relay stations

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1. Objective

The objective of this contribution is to propose a handover mechanism that enables to perform handover of mobile relays. The proposal contains the description for intra as well as for inter ABS handover.

2. MAC support for Mobile ARS

If mobile ARSs are implemented into the WiMAX networks, two general scenarios for handover have to be considered similarly as in the case of simple MS in networks with RSs. The first scenario (Figure 1) corresponds to the handover in the area of one ABS, noted as intra ABS handover. It means that the moving ARS (ARS2 in Figure 1) proceeds handover from the ARS1 to ARS3. Note that both ARSs are served by the same ABS. In this case, the ABS1 manages the whole area and has all information required for handover of all served ARSs.
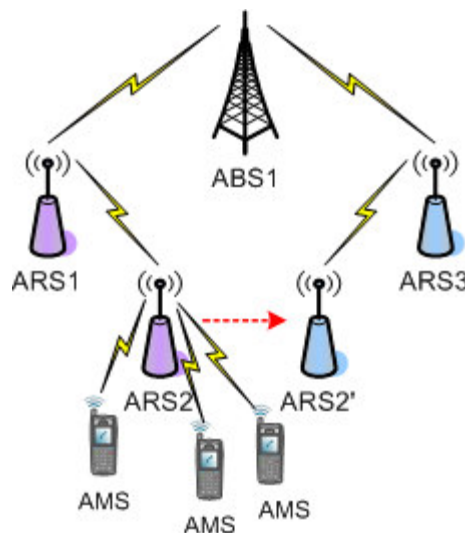

Figure 1. Scenario for *Intra ABS* handover of mobile ARS

The second scenario (Figure 2), *inter ABS* handover, defines the handover of the ARS from the area managed by one ABS (ABS1) to the area managed by another ABS (ABS2). Therefore, the current serving ABS (ABS1 in Figure 2) has no information regarding target access ARS/ABS (ARS3 in Figure 2). The ARS as well as the ABS can be current access station. Also the target access station can be either the ARS or ABS. The modifications of MAC management messages do not depend on the type of access and target station (it does not matter if it is ABS or ARS).
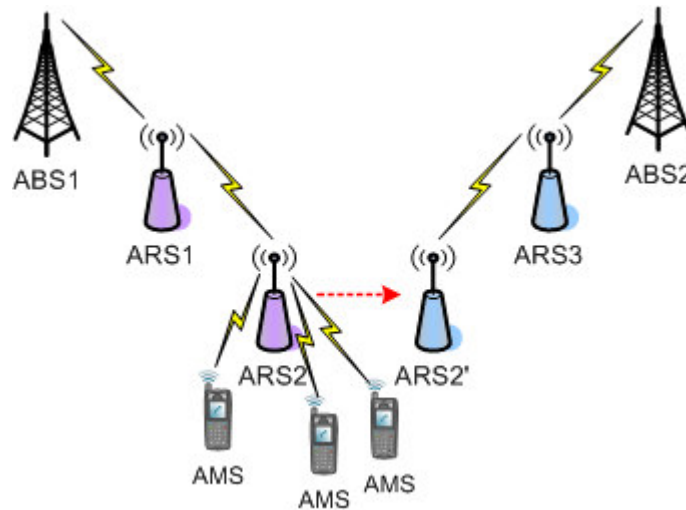
Figure 2. Scenario for *Inter ABS* handover of mobile ARS

When compare to the conventional handover, the MAC messages for support of ARS's handover have to consider some modifications related to the fact that the ARS proceeding handover has to ensure the connection of all attached AMSs.

Generally, the most often modification in MAC messages is a replacement of the MS/AMS identification (MS/AMS ID) by identification of ARS (ARS ID). Further, some new messages must be defined to enable the handover of ARS. The structure of new messages can be based on the messages for handover of AMS. The list of all modifications and new MAC messages is summarized in Table 1.

Handover stage	Final message	Source message	Description of modification (between source and final message)
Neighbourhood advertisement	MOB_NBR-ADV	Modification of *MOB_NBR-ADV* [1]	Add info about neighbor ARSs and
Scanning	MOB_SCN-CIR	Modification of *MOB_SCN-CIR* [2]	Replace MSID by ARSID
Scanning	MOB_SCN-ACI	Modification of *MOB_SCN-ACI* [2]	Replace MSID by ARSID
Scanning	MOB_RSSCN-REP	Modification of MOB_SCN-REP [1]	Add info about neighbor ARSs.
Handover initialization	MOB_BSHO-RSP	Modification of *MOB_BSHO-RSP* [1]	Add info about neighbor ARSs and include neighboring ARSs to the list of potential targets of handover
Handover initialization	HO_INFO-REQ	Modification of *HO_INFO-REQ* [3]	Replace MSID by ARSID
Handover initialization	HO_INFO-RSP	Modification of *HO_INFO-RSP* [3]	Replace MSID by ARSID
Handover initialization	MOB_RSHO-REQ	**New message**, based on *MOB-MSHO-REQ* [1]	Add RSIDs and all belonging parameters (such Preamble index, SLP or ARS channel characteristics – CINR/RSSI/RTD/relative delay) into list of potential targets of handover and a into list of ABS/ARS included in diversity set.
Ranging	RS_INFO-REQ	**New message**, based on *MS-INFO-REQ* [4]	Replace MSID by ARSID

Ranging	RS_INFO-RSP	**New message**, based on *MS-INFO-RSP* [4]	Replace MSID by ARSID
Ranging	RNG-REQ	Modification of *RNG-REQ* [1]	Add the list of fields required to appear in RNG-RSP related to ARS that performs handover and attached AMSs
Ranging	RNG-RSP	Modification of *RNG-RSP* [1]	Add ▪ AMSIDs of all AMSs attached to the ARS that performs handover ▪ CID info of all attached AMSs (Basic, Primary, Secondary, data connection SFID+CID)
Re-authorization	PKM-REQ	Modification of *PKM -REQ* [1]	Add TLV parameters for ARS and all attached AMSs
Re-authorization	PKM-RSP	Modification of *PKM -RSP* [1]	Add TLV parameters for ARS and all attached AMSs
Re-registration	REG-REQ	Modification of *REG -REQ* [1]	Add TLV parameters for ARS and all attached AMSs
Re-registration	REG-RSP	Modification of *REG -RSP* [1]	Add TLV parameters for ARS and all attached AMSs
Termination	HO_CLP	Modification of *HO_CLP* [5]	Replace MSID by ARSID Add IDs of all attached AMSs

Table 1. List of modified and new messages for handover of MRS

2.1 Intra ABS handover of mobile ARS

If the current access and target access ARS are deployed under the management of the same ABS, the handover is analogical to the handover of the AMS in the conventional handover of MS in networks with RSs. Assuming no update of the serving ABS within handover, the moving ARS does not have to execute network re-registration and re-authorization since the registration and authorization of ARS is done still to the same ABS. The process of intra ABS handover of ARS is depicted in Figure 3.
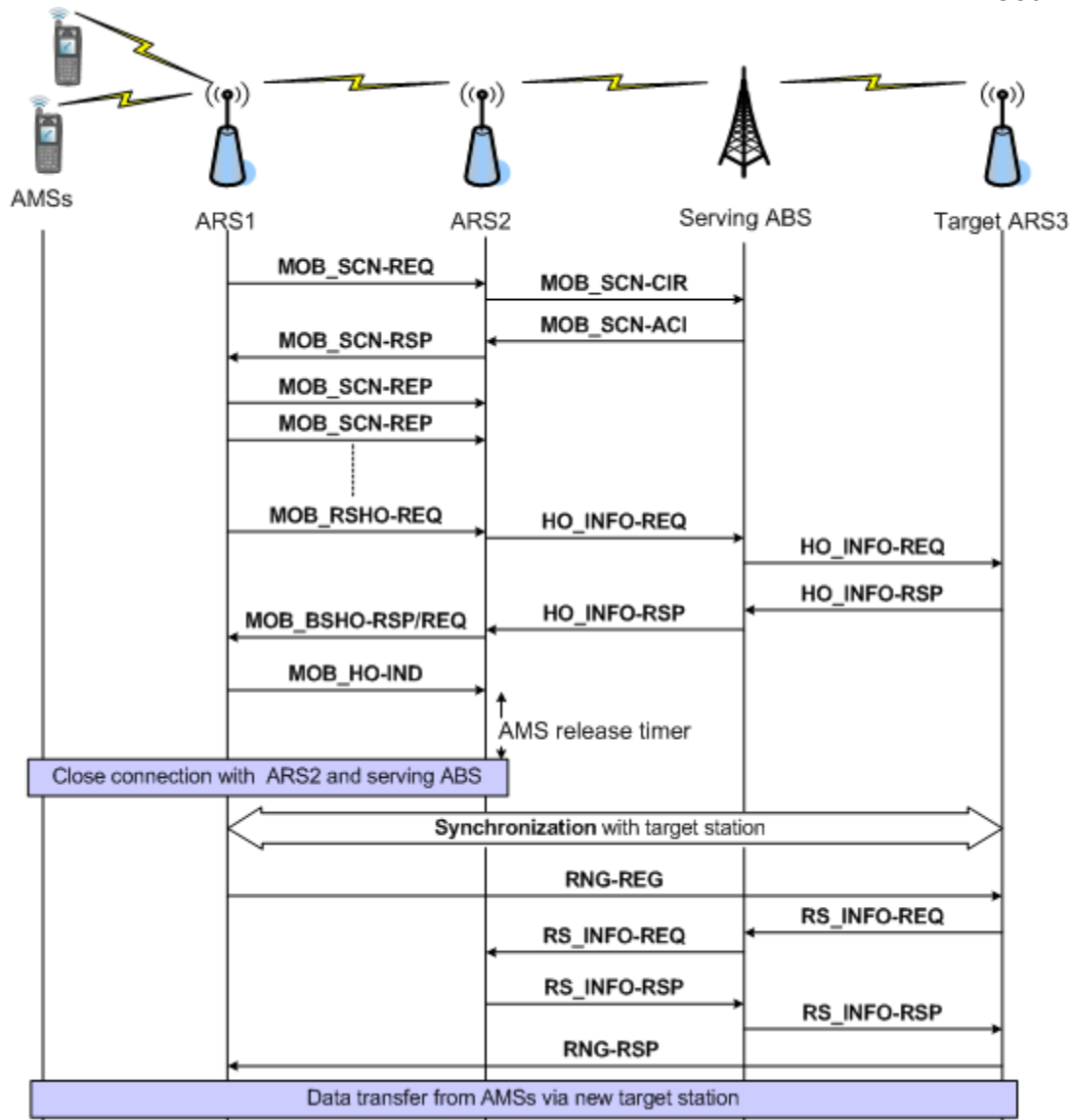
Figure 3. Handover stages for intra ABS handover of mobile ARS

When the ARS performs the handover to the target access ARS/ABS, all AMSs attached to this ARS will be attached to the target serving ABS via different route (e.g. in Figure 1 the AMS communicates via ARS2→ARS1→ABS1 before handover; however AMS uses the route ARS2→ARS3→ABS1 after the handover). Whereas the ABS manages all ARSs in its area including CIDs assignment, the AMSs does not have to perform the network re-entry procedure as the ranging, registration and authorization is done to the ARS and ARS is still registered and authorized to the same ABS.

2.2 Inter ABS handover of mobile ARS

The handover of the mobile ARS between areas served by two different ABSs is also based on the handover of AMS in the same scenario. However, in comparison to the intra ABS handover, the ARS must perform network re-registration and re-authorization to the new target serving ABS. The modification of the content of MAC management messages is similar as in the inter ABS handover. On the other hand, the flow of MAC management message is different (see Figure 4). The target ABS has no knowledge of the ARS that is trying to execute the handover. Thus, the ARS has to execute whole network re-entry process. The AMSs connected to the network via the ARS performing handover must be automatically re-connected to the new target serving ABS via the

same access ARS. The MAC management procedure differs for the scenario with centrally controlled ARSs and decentrally controlled ARSs. Both scenarios differ in the network re-entry procedure of attached AMSs.
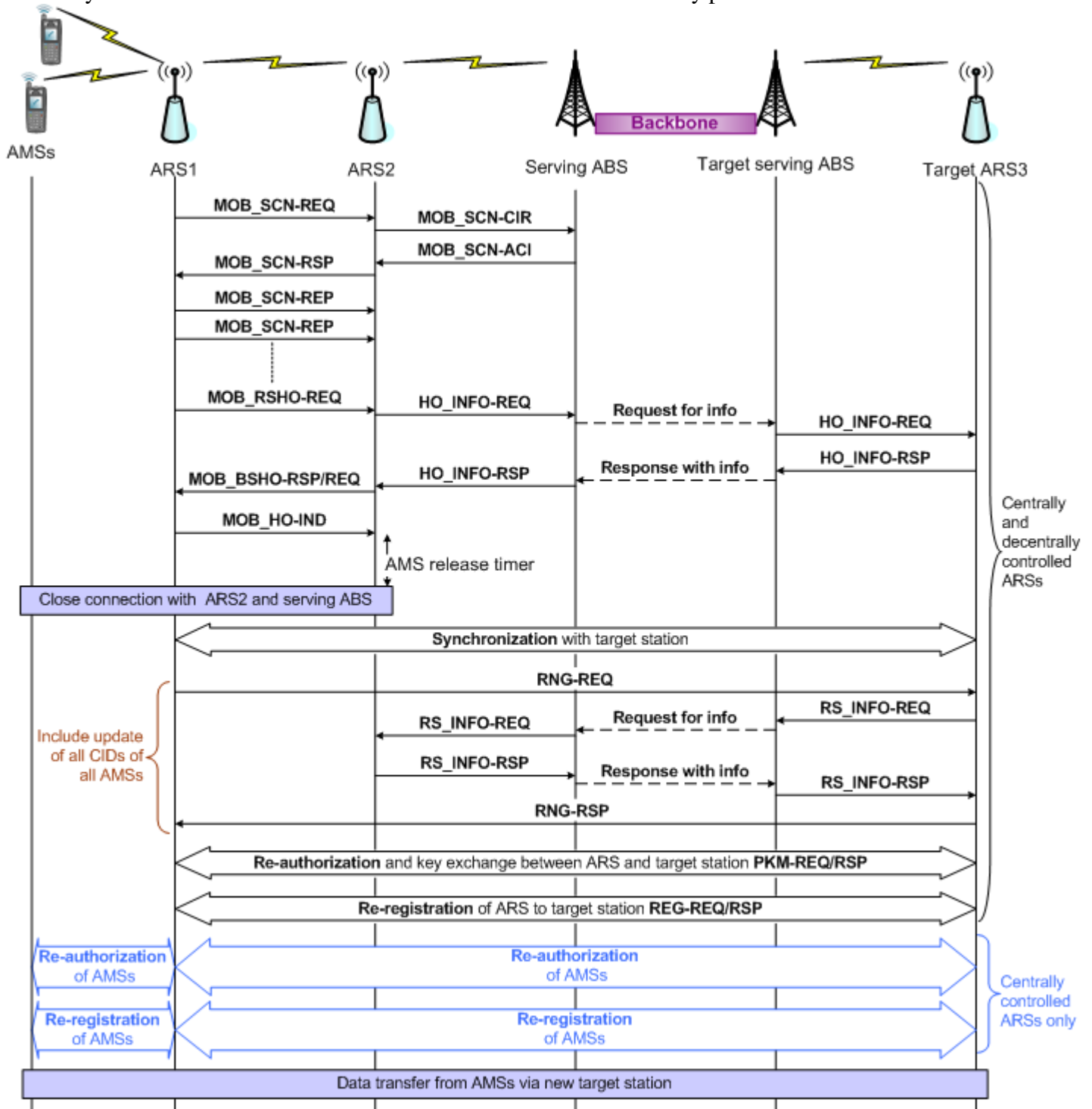

Figure 4. Handover MAC management message flow for inter ABS handover of the mobile ARS -black arrows are common for centrally and decentrally controlled ARSs, blue arrows belong to the scenario with centrally controlled ARSs

2.2.1 Inter ABS handover of mobile ARS in decentrally controlled system

The message flow for decentrally controlled ARSs is depicted in Figure 4 (only messages with arrows and text in

black color). The first part of handover (up to closing of the connections with the serving ABS) is analogical to the intra ABS handover procedure. Subsequently, the ranging of the ARS to the new target access station has to consider also an update of CIDs of all connections belonging to the attached AMSs for the CID is managed by an ABS in its area. Consequently, CIDs have to be updated together with change of serving ABS. After update of all CIDs, the ARS initiate re-authorization and re-registration procedures. The re-authorization and re-registration of only the ARS is required. The AMSs attached to the ARS proceeding handover do not proceed the re-authorization and re-registration since all AMSs have already performed the authorization and registration to the access ARS (ARS that processed handover). Hence, if the AMS is authorized and registered to the access ARS and simultaneously the access ARS is re-registered and re-authorized to the network, the AMS is also fully registered and authorized to the network.

2.2.2 Inter ABS handover of mobile ARS in centrally controlled system

The message flow for centrally controlled ARSs is depicted in Figure 4 (both, black and blue arrows). The procedure is similar with inter ABS handover in the system with decentrally controlled ARSs; however the re-authorization and re-registration of all AMSs must be done in centrally controlled system.

3. Proposed Text

On the IEEE 802.16m-09/0034r2, page 136, replace section 14.4.7 by the following text

--Start of the Text--

14.4.7 ARS mobility support

Two scenarios of mobile ARS handover should be considered. The first scenario (Figure 1) corresponds to the handover in the area of one ABS, called as intra ABS handover. It means that the moving ARS (ARS2 in Figure 1) proceeds handover from the ARS1 to ARS3. Note that both ARSs are served by the same ABS. In this case, the ABS1 manages the whole area and has all information required for handover regarding all served ARSs.
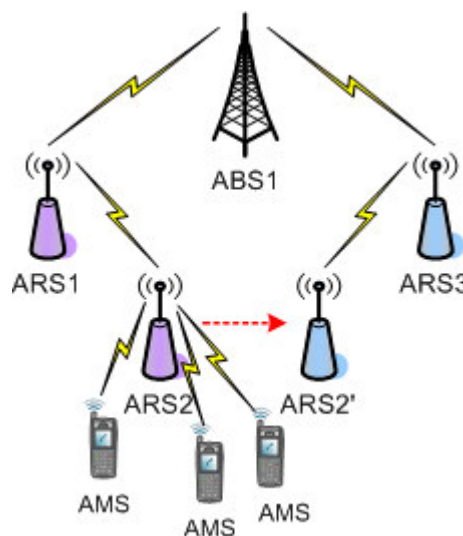

Figure 5. Scenario for Intra ABS handover of mobile ARS

The second scenario (Figure 2), *inter ABS* handover, defines the handover of the ARS from the area managed by one ABS (ABS1) to the area managed by another ABS (ABS2). Therefore, the current serving ABS (ABS1 in Figure 2) has no information concerning target access ARS/ABS (ARS3 in Figure 2). The ARS as well as the

ABS can be current access station. Also the target access station can be either the ARS or ABS. The modifications of MAC management messages do not depend on the type of access and target station (it does not matter if it is ABS or ARS).
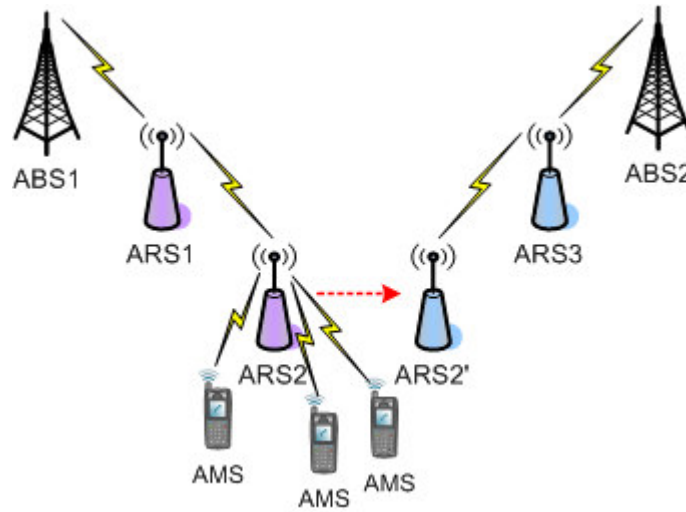

Figure 6. Scenario for Inter ABS handover of mobile ARS

When compare to the conventional AMS's handover, the MAC messages for support of ARS's handover have to consider some modification related to the fact that the ARS proceeding handover has to ensure the connection of all attached AMSs. The structure of new messages can be based on the messages for handover of AMS. The list of all modifications and new MAC messages is summarized in Table 1.

Handover stage	Final message	Source message	Description of modification (between source and final message)
Neighborhood advertisement	MOB_NBR-ADV	Modification of *MOB_NBR-ADV* [1]	Add info about neighbor ARSs and
Scanning	MOB_SCN-CIR	Modification of *MOB_SCN-CIR* [2]	Replace MSID by ARSID
Scanning	MOB_SCN-ACI	Modification of *MOB_SCN-ACI* [2]	Replace MSID by ARSID
Scanning	MOB_RSSCN-REP	Modification of MOB_SCN-REP [1]	Add info about neighbor ARSs.
Handover initialization	MOB_BSHO-RSP	Modification of *MOB_BSHO-RSP* [1]	Add info about neighbor ARSs and include neighboring ARSs to the list of potential targets of handover
Handover initialization	HO_INFO-REQ	Modification of *HO_INFO-REQ* [3]	Replace MSID by ARSID
Handover initialization	HO_INFO-RSP	Modification of *HO_INFO-RSP* [3]	Replace MSID by ARSID
Handover initialization	MOB_RSHO-REQ	**New message**, based on *MOB-MSHO-REQ* [1]	Add ARSIDs and all belonging parameters (such Preamble index, SLP or ARS channel characteristics – CINR/RSSI/RTD/relative delay) into list of potential targets of handover and a into list of ABS/ARS included in diversity set.
Ranging	RS_INFO-REQ	**New message**, based on *MS-INFO-REQ* [4]	Replace MSID by ARSID

Ranging	RS_INFO-RSP	**New message**, based on *MS-INFO-RSP* [4]	Replace MSID by ARSID
Ranging	RNG-REQ	Modification of *RNG-REQ* [1]	Add the list of fields required to appear in RNG-RSP related to ARS that performs handover and attached AMSs
Ranging	RNG-RSP	Modification of *RNG-RSP* [1]	Add ▪ AMSIDs of all AMSs attached to the ARS that performs handover ▪ CID info of all attached AMSs (Basic, Primary, Secondary, data connection SFID+CID)
Re-authorization	PKM-REQ	Modification of *PKM -REQ* [1]	Add TLV parameters for ARS and all attached AMSs
Re-authorization	PKM-RSP	Modification of *PKM -RSP* [1]	Add TLV parameters for ARS and all attached AMSs
Re-registration	REG-REQ	Modification of *REG -REQ* [1]	Add TLV parameters for ARS and all attached AMSs
Re-registration	REG-RSP	Modification of *REG -RSP* [1]	Add TLV parameters for ARS and all attached AMSs
Termination	HO_CLP	Modification of *HO_CLP* [5]	Replace MSID by ARSID Add IDs of all attached AMSs

Table 2. List of modified and new messages for handover of MRS

14.4.7.1 Intra ABS handover of mobile ARS

The moving ARS does not need to execute network re-registration and re-authorization since the registration and authorization of ARS is done still to the same ABS. The process of intra ABS handover of ARS is depicted in Figure 3.
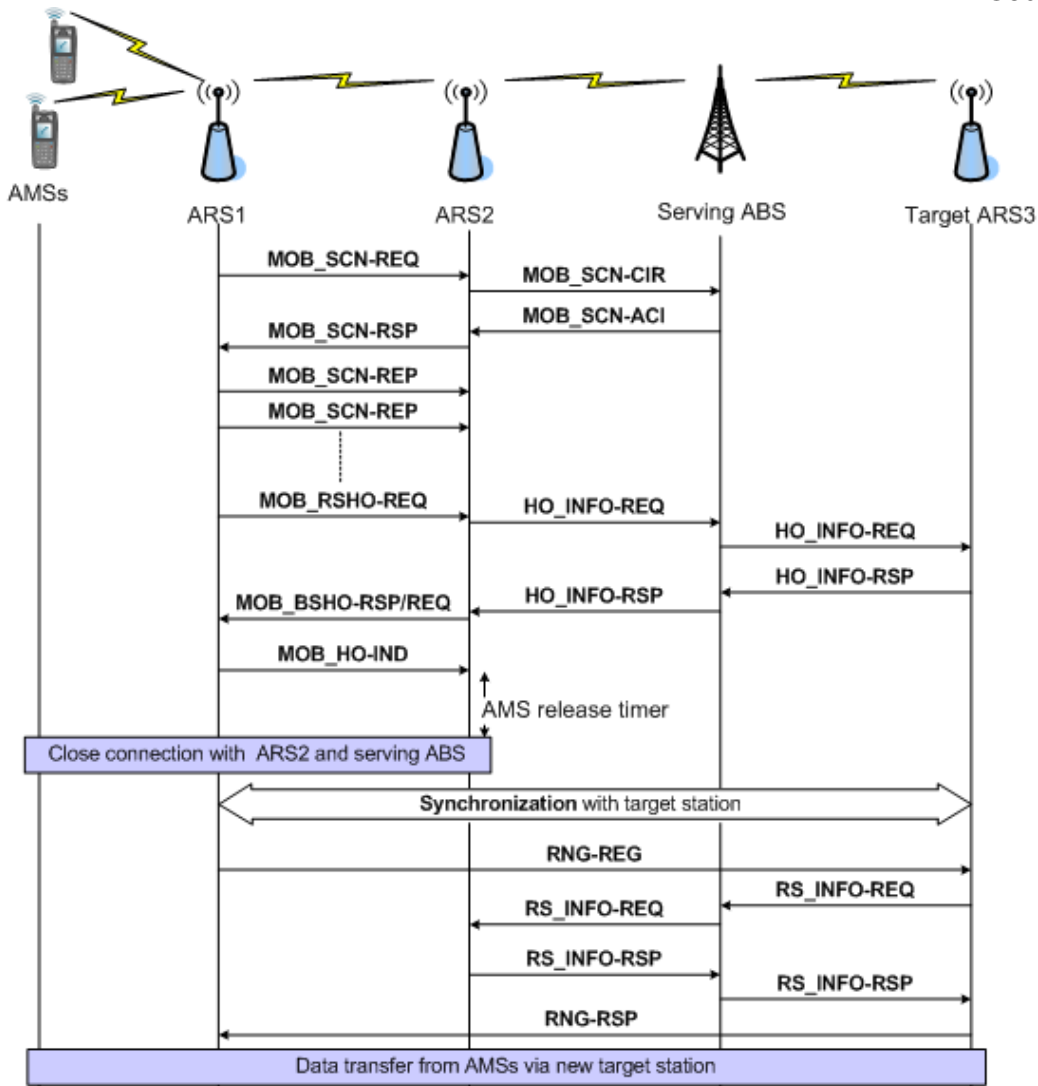
Figure 7. Handover stages for intra ABS handover of mobile ARS

Whereas the ABS manages all ARSs in its area including CIDs assignment, the AMSs do not need to perform the network re-entry procedure as the ranging, registration and authorization is done to the ARS and ARS is still registered and authorized to the same ABS.

14.4.7.2 Inter ABS handover of mobile ARS

The mobile ARS must perform network re-registration and re-authorization to the new target serving ABS. The modification of the content of MAC management messages is the same as in the inter ABS handover. On the other hand, the flow of MAC management message is different (see Figure 4). The target ABS has no knowledge of the ARS that is trying to execute the handover. Thus, the ARS has to execute whole network re-entry process. The AMSs connected to the network via the ARS performing handover must be automatically re-connected to the new target serving ABS via the same access ARS. The MAC management procedure differs for the scenario with centrally controlled ARSs and decentrally controlled ARSs. Both scenarios differ in the network re-entry procedure of attached AMSs.
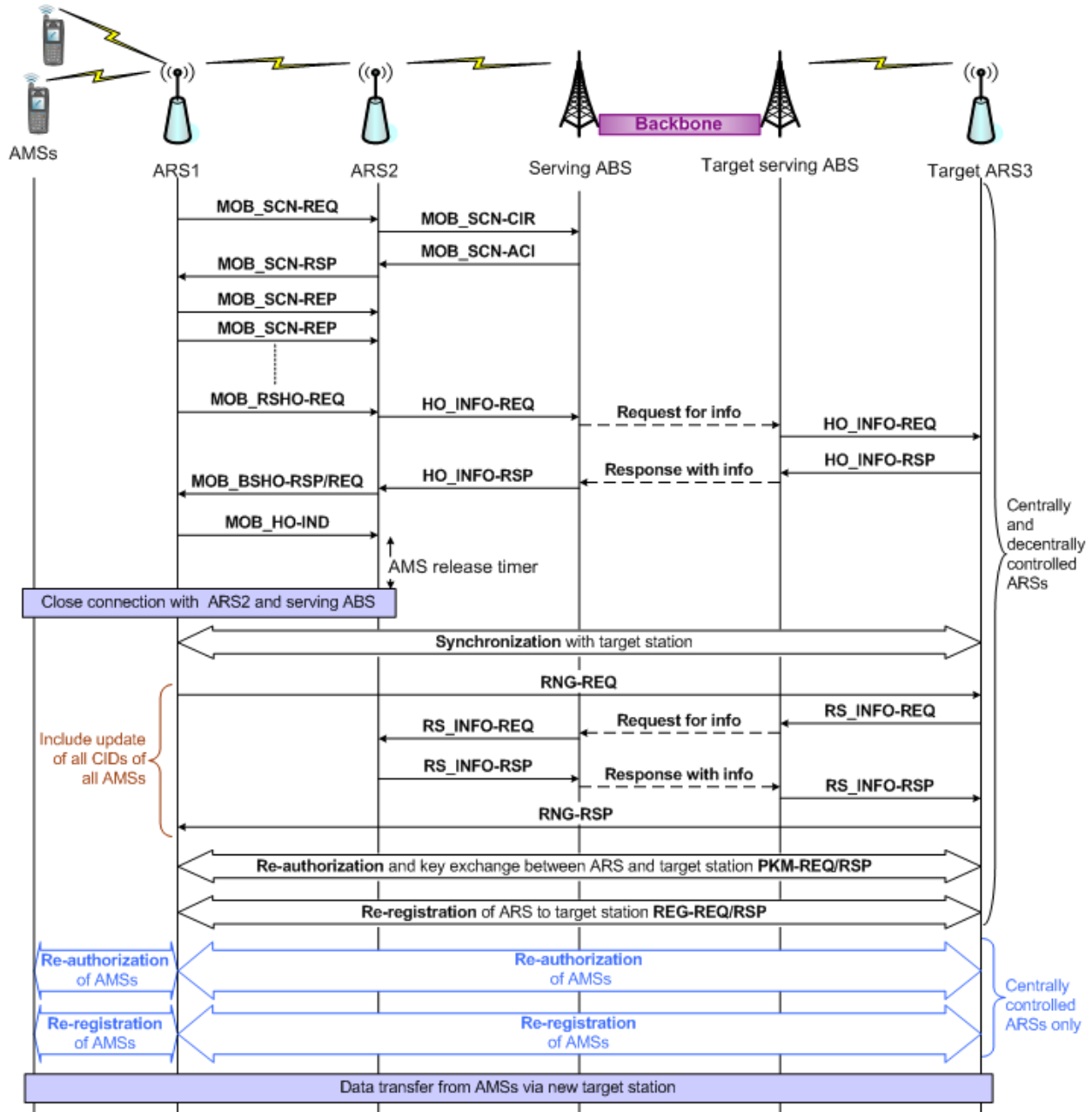
Figure 8. Handover MAC management message flow for inter ABS handover of the mobile ARS -black arrows are common for centrally and decentrally controlled ARSs, blue arrows belong to the scenario with centrally controlled ARSs

14.4.7.2.1 Inter ABS handover of mobile ARS in decentrally controlled system

The message flow for decentrally controlled ARSs is depicted in Figure 4 (only messages with arrows and text in black color). The first part of handover (up to closing of the connections with the serving ABS) is analogical to the intra ABS handover procedure. Subsequently, the ranging of the ARS to the new target access station has to consider also an update of CIDs of all connections belonging to the attached AMSs for the CID is managed by a ABS in its area. Consequently, CIDs have to be updated together with change of serving ABS. After update of all CIDs, the ARS initiate re-authorization and re-registration procedures. The re-authorization and re-registration of only the ARS is required. The AMSs attached to the ARS proceeding handover do not have to proceed the re-authorization and re-registration since all AMSs have already perform the authorization and

registration to the access ARS (ARS that processed handover). Hence, if the AMS is authorized and registered to the access ARS and simultaneously the access ARS is re-registered and re-authorized to the network, the AMS is also fully registered and authorized to the network.

14.4.7.2.2 Inter ABS handover of mobile ARS in centrally controlled system

The message flow for centrally controlled ARSs is depicted in Figure 4 (both, black and blue arrows). The procedure is similar with inter ABS handover in the system with decentrally controlled ARSs; however the re-authorization and re-registration of all AMSs must be done in centrally controlled system.

--End of the Text--

References

[1] IEEE 802.16e/D12, "Air Interface for Fixed and Mobile Broadband Wireless Access Systems: Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands", New York, February 2006.

[2] Z. Becvar, P. Mach, R. Bestak, "Optimization of Handover Scanning Procedure in WiMAX Networks with Relay Stations", In Proceeding of International Symposium on Wireless Pervasive Communication 2008 (ISWPC 2008), Santorini, Greece, May 2008.

[3] H. Lee, W.C. Wong, J. Sydir, K. Johnsson, S. Yang, M. Lee, "MS MAC Handover Procedure in an MR Network – Handover Decision and Initiation", Proposal paper on IEEE 802.16j, CTP 06/219, November 2006.

[4] H. Lee, W.C. Wong, J. Sydir, K. Johnsson, S. Yang, M. Lee, "MS MAC Handover Procedure in an MR Network – Handover Execution", Proposal paper on IEEE 802.16j, CTP 06/220, November 2006.

[5] H. Lee, W.C. Wong, J. Sydir, K. Johnsson, S. Yang, M. Lee, "MS MAC Handover Procedure in an MR Network – Handover Termination", Proposal paper on IEEE 802.16j, CTP 06/221, November 2006.