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| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Services and System Aspects;  Study on architecture enhancements for  vehicle-mounted relays - Phase 2  (Release 19) | |
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| ***3GPP***  Postal address  3GPP support office address  650 Route des Lucioles - Sophia Antipolis  Valbonne - FRANCE  Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16  Internet  http://www.3gpp.org |
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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

The scope of this Technical Report is to study and identify potential architecture and system level enhancements for the 5G system to support the operation of a mobile gNB mounted on vehicles, using NR for wireless access toward the UE and for wireless backhaul access toward the 5GC. The study addresses the service requirements documented in TS 22.261 [3] for the mobile base station relays, and focuses on the following aspects:

- architecture enhancements for the support of the wireless backhauling of the mobile gNB and its CN/OAM (e.g. N2/N3) interfaces, including e.g. UE access control, mobility aspects;

- the architecture to enable authorization and configuration of the mobile gNB;

- support of UE location services and emergency services via the mobile gNB.

The wireless backhauling of mobile gNB and CN/OAM (e.g. N2/N3) interfaces may use the existing TN or NTN technology.

NOTE 1: The mobile gNB configuration aspect needs synchronization with RAN working group.

NOTE 2: No enhancement is aimed to the existing QoS mechanisms for the wireless backhaul.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[3] 3GPP TS 22.261: "Service requirements for the 5G system; Stage 1".

[4] 3GPP TS 38.300: "NR; NR and NG-RAN Overall Description".

[5] 3GPP TS 38.401: "NG-RAN Architecture description".

[6] 3GPP TS 23.273: "5G System (5GS) Location Services (LCS); Stage 2".

[7] 3GPP TS 23.502: "Procedures for the 5G System (5GS); Stage 2".

[8] 3GPP TS 38.413: "NG-RAN; NG Application Protocol (NGAP)".

[9] 3GPP TS 23.122: "Non-Access-Stratum (NAS) functions related to Mobile Station (MS) in idle mode".

[10] 3GPP TS 23.503: "Policy and charging control framework for the 5G System (5GS); Stage 2".

[11] 3GPP TS 38.305: "Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN".

[12] 3GPP TS 37.355: "LTE Positioning Protocol (LPP)".

[13] 3GPP TS 38.455: "NR Positioning Protocol A (NRPPa)".

[14] 3GPP TS 24.501: "Non-Access-Stratum (NAS) protocol for 5G System (5GS)".

# 3 Definitions of terms and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1], TS 23.501 [2] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

**mobile gNB with wireless access backhaul:** A mobile base station acts as a gNB for other UEs and provide access to the 5G networks, i.e. providing a NR access link to UEs and connected wirelessly to the 5GC (using NR) through an IP connectivity provided by a PDU sessions established via a NG-RAN cell that the mobile gNB can camp on. The PDU session is provided either by a Terrestrial Network or by a Non-Terrestrial Network. Such mobile gNB may be mounted on a moving vehicle and serve UEs that can be located inside or outside the vehicle (or entering/leaving the vehicle).

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1] and TS 23.501 [2].

MWAB Mobile gNB with wireless access backhauling

MWAB-gNB gNB component of the MWAB

MWAB-UE UE component of the MWAB

NTN Non-Terrestrial Network

TN Terrestrial Network

# 4 Architecture assumptions and requirements

## 4.1 Architecture assumptions

The study should be based on the following architecture assumptions:

- the MWAB consists of a gNB component (MWAB-gNB) and a UE component (MWAB-UE);

- the MWAB-gNB is based on the gNB functionality specified in TS 38.300 [4] and TS 38.401 [5];

NOTE 1: Architecture impact on MWAB-gNB may depend on the RAN study output and needs to be coordinated with RAN WGs.

NOTE 2: In this release CU/DU split of the MWAB-gNB is not supported.

- the MWAB-gNB's N2/N3 and OAM access are over the IP connectivity provided by the PDU sessions(s) of the MWAB-UE;

- the interface between MWAB-UE and MWAB-gNB is not in scope of SA WG2 if it needs to be standardized;

- the MWAB-UE has a single NR Uu hop to the NG-RAN (i.e. MWAB-UE access a gNB via NR Uu interface which may use either TN or NTN technology);

- the MWAB may serve UEs located inside or outside the vehicle mounted with the relay;

- NR Uu is used for the radio link between a MWAB-gNB and served UEs. The NR Uu radio link between the MWAB-gNB and served UE does not use NTN technology;

- LCS framework as defined in TS 23.273 [6] is used for providing the location service to the served UEs;

- the MWAB may connect to an NG-RAN of a PLMN or an SNPN;

- the MWAB-gNB may broadcast a PLMN ID that is different to the PLMN ID of the PLMN that the MWAB-UE is connected to;

- the UE's serving PLMN is the one broadcast by the MWAB-gNB it is camped on/connected to. This may be a different PLMN ID to that of the PLMN serving the MWAB-UE;

- the MWAB-UE supports emergency services.

Figure 4.1-1 illustrates an example architecture for non-roaming scenarios.

MWAB operation can also support roaming scenario.



Figure 4.1-1: Non-Roaming MWAB architecture for 5GS

## 4.2 Architecture requirements

Solutions of the study should provide architecture and system level enhancements to the 5G system to support the operation of MWAB to satisfy the normative requirements of a mobile base station relay specified in TS 22.261 [3]. Specifically:

- a MWAB shall be capable to serve legacy UE(s) to connect via MWAB;

- support end-to-end service continuity for the UEs served by a MWAB upon MWAB mobility should be specified;

- support the mobile network operator to configure, provision and control the operation of a MWAB;

NOTE 1: Configuration of the MWAB needs to be coordinated with RAN WGs.

NOTE 2: Charging support will be coordinated with SA5 if there is such need.

- support of regulatory requirements (e.g. for support of emergency services, priority services) when UEs access 5GS via a MWAB;

- support roaming of the MWAB-UE from its HPLMN into a VPLMN.

# 5 Key Issues

## 5.1 Key Issue #1: Architectural enhancements for the support of a MWAB

This Key issue addresses architectural enhancements required to support the MWAB connects to the 5GC with the use of wireless backhauling (for the N2/N3 interfaces) via IP connectivity provided by a PDU session.

This will include:

- Whether and how the MWAB provides service for UEs from the HPLMN and UEs from other PLMN when the MWAB roaming nationally/internationally to another PLMN.

- How to provide the backhaul link using a PDU sessions for a MWAB, to support the N2/N3 interfaces and connectivity to an OAM server.

- How to discover and determine the AMF for the MWAB-gNB to connect to.

NOTE: The AMF discovery and determination need to be coordinated with RAN WGs.

## 5.2 Key Issue #2: Authorization of a MWAB and configuration of MWAB

A MWAB that operates in a PLMN by using the wireless access backhaul and serving UEs in proximity, is subject to authorization, with the additional support of the HPLMN of the MWAB in case of roaming. In addition, configuration of the MWAB (both the MWAB-gNB and MWAB-UE) for the MWAB operation needs to be studied.

This Key issue will study:

- How to authorize a MWAB to serve UEs and how to update and handle the MWAB authorization status (including de-authorize or authorize a previously not authorized MWAB and RAN-CN interface handling).

- How to support the configuration and update of the configuration of the MWAB with information related to MWAB operation, including the RAN-CN interface handling.

NOTE: Coordination with RAN WGs is needed due to the dependency on RAN.

## 5.3 Key Issue #3: Control of UE's access to 5GS via a wireless access backhaul

This key issue is to investigate efficient control of UE access to MWAB. In particular, the following aspects should be addressed:

- Whether and how to enhance the existing CAG mechanism to control and manage the access of a UE via MWAB.

NOTE 1: Support of legacy UE(s) shall be considered.

NOTE 2: Aspects related to RAN need to be coordinated with RAN WGs.

## 5.4 Key Issue #4: Efficient mobility and service continuity when served by MWAB

### 5.4.1 General description

When the moving vehicles are equipped with MWAB, the MWAB-gNB can provide 5G coverage and communication to UEs (inside the vehicle and/or in its vicinity), and connected wirelessly to the 5G network via a macro NG-RAN node. When one or a group of UEs are already served by the MWAB, there are two mobility scenarios to be studied as the following:

- Scenario A (mobility within the same 5GC node): When the UEs are continuously served by a MWAB (e.g. inside the vehicle and/or in its vicinity), and this MWAB-gNB is moving around within a limited geographical area while keeping connecting with the same 5GC nodes (e.g. AMF and UPF). In this case, the UE keeps the connection with the MWAB, and there is no change of the connections as in figure 5.4.1-1. However, the change of the NG-RAN nodes serving the MWAB-UE and the MWAB location may have impact on the mobility or service restrictions to the UE served by the MWAB.

- Scenario B (mobility between different 5GC nodes): When the UEs are continuously served by a MWAB (e.g. inside the vehicle and/or in its vicinity), and this MWAB is moving around over a long distance. To continue to provide services to the UEs, the MWAB needs to change the 5GC nodes it connects to. In this case, the UE keeps the connection with the MWAB-gNB, but there is a possible change of the AMF and UPF.

NOTE 1: For the above scenarios, whether the cell information in the System Information Broadcast (e.g. Cell ID, TAC) changes has RAN dependency.



Figure 5.4.1-1: Scenarios for efficient mobility and service continuity

The following aspects need to be studied for UEs served by the MWAB in the case of mobility in the scenarios A and B:

- Whether and how to enhance current procedures of mobility and service continuity for a UE. The following aspects need to be considered in potential solutions:

- how to reflect the change of MWAB serving cell or location in the mobility management of the UEs served by the MWAB.

- how to efficiently manage the mobility of the UEs served by the MWAB, when 5GC node change is necessary.

- how to manage the RAN-CN interfaces.

NOTE 2: Mechanisms related to mobility management and service continuity have RAN dependency and should align with the progress of RAN WGs.

## 5.5 Key Issue #5: Support of location services for UEs when MWAB(s) is involved

Based on the requirements of TS 22.261 [3], the 5G system shall be able to support location services for the UEs accessing 5GS via a mobile base station relay. When a UE is served by a MWAB, the MWAB's movement may affect not only positioning procedures but also regulatory services needing UE location. MWAB(s) not serving a UE may also be involved to determine the location of the UE. Therefore, this key issue needs to address:

- How to support location services for the UEs served by a MWAB that moves, including the cases when the MWAB roams to a VPLMN.

- Whether and how to support the involvement of other MWAB(s) not serving the UE in the location measurement.

NOTE: For this key issue, this study should as a baseline attempt to reuse the functionality supporting location service involving MBSR as specified in TS 23.273 [6].

## 5.6 Key Issue #6: Support of Emergency services for UEs via a MWAB

Based on the requirements of TS 22.261 [3], the 5G system shall be able to support emergency service for the UEs accessing 5GS via a mobile base station relay. Therefore, this key issue needs to address:

- Whether any enhancements are needed to support emergency service (including graceful release) for the UEs accessing 5GS via a MWAB. MWAB mobility and roaming scenarios shall be considered.

- Whether and how to handle the case when MWAB-UE initiates or has an ongoing emergency session already.

# 6 Solutions

## 6.0 Mapping of solutions to key issues

Editor's note: This clause describes the mapping between solutions and key issues.

Table 6.0-1: Mapping of solutions to key issues

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Key Issues | | | | | |
| Solutions | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | X | X | X |  | X | X |
| 2 | X |  |  |  |  |  |
| 3 | X |  |  |  |  |  |
| 4 |  | X |  |  |  |  |
| 5 |  | X |  |  |  |  |
| 6 |  |  | X |  |  |  |
| 7 | X |  | X |  |  |  |
| 8 |  |  |  | X |  |  |
| 9 |  |  |  | X |  |  |
| 10 |  |  |  | X |  |  |
| 11 |  |  |  |  | X |  |
| 12 |  |  |  |  |  | X |
| 13 |  |  |  |  |  | X |
| 14 |  |  |  |  |  | X |
| 15 | X |  |  |  |  |  |
| 16 | X |  |  |  |  |  |

## 6.1 Solution #1: Architecture enhancements to support MWAB operations

### 6.1.1 General

Figure 6.1.1-1 presents an example architecture for the MWAB operation when no roaming was involved for the MWAB-UE. In this case, there may be two PLMNs involved, i.e. the PLMN 1 that serves the MWAB-UE, and the PLMN 2 that serves the UE connected to the MWAB.

In this case, the MWAB-gNB logically belongs to PLMN 2, and establishes N2 and N3 connection with the UE AMF and UE UPF via the PDU session of the MWAB-UE established with PLMN 1. MWAB-gNB announces PLMN IDs of PLMN 2.

If the UE served by the MWAB is roaming, there is another PLMN (not shown in the figure), i.e. the HPLMN of the UE served by the MWAB, involved. The interactions of the HPLMN of the UE and PLMN 2 are the same as that described in clause 4.2.4 of TS 23.501 [2] for the roaming case.

The MWAB UPF in PLMN 1 serves the MWAB-UE and provides the connection via a N6 interface towards PLMN 2, to carry the N2 and N3 traffic from MWAB-gNB. The MWAB-UPF also supports the access to the OAM system in PLMN 2 by the MWAB-gNB.

NOTE: Depending on deployment requirement, a security gateway may be required between the MWAB-UPF and the PLMN 2 core network. In that case, the MWAB-gNB need to connect to the security gateway based on pre-configured security credentials. In that case, the traffic between MWAB-gNB and the PLMN 2 goes inside the security tunnel established via the security gateway.

Editor's note: Details of such operation with the security gateway will be coordinated with RAN WG3 and SA WG3.

UE connected to the MWAB-gNB can access the 5GS services offered by PLMN 2 as normal. No enhancement to the UE is required. The UE connected to the MWAB-gNB is not aware of PLMN 1, and thus does not need any roaming agreement between its HPLMN and the PLMN 1.

In some cases, the PLMN 1 and PLMN 2 can be the same PLMN.



Figure 6.1.1-1: Architecture for MWAB operation support - non-roaming

Figure 6.1.1-2 presents an example architecture for the MWAB operation when MWAB-UE is roaming with a Local Breakout PDU session for its operation. In this case, there may be three PLMNs involved, i.e. the PLMN 1 that serves the MWAB-UE, and the PLMN 2 that serves the UE connected to the MWAB, and the HPLMN of the MWAB-UE. The use of the Local Breakout PDU session by the MWAB can be configured by the HPLMN, e.g. with some VPLMN specific URSP rules.

In this case, the PLMN-1 may access the MWAB's HPLMN UDM for the subscription information. The rest of the operation are similar to that shown in Figure 6.1.1-1.

If the UE served by the MWAB is roaming, there is another PLMN (not shown in the figure), i.e. the HPLMN of the UE served by the MWAB, involved. In that case, the interaction of the HPLMN of the UE and PLMN 2 is the same as that described in TS 23.501 [2] for the roaming case.

The UE served by the MWAB-gNB is not aware of PLMN 1, and thus does not need any roaming agreement between its HPLMN and the PLMN 1.



Figure 6.1.1-2: Architecture for MWAB operation support - roaming with Local Breakout

Figure 6.1.1-3 presents an example architecture for the MWAB operation when MWAB-UE is roaming with a Home Routed PDU session for its operation. In this case, PDU session of the MWAB-UE is routed by PLMN 1 to the HPLMN of the MWAB.

In this case, the PLMN-1 may access the MWAB's HPLMN UDM for the subscription information. The rest of the operation are similar to that shown in Figure 6.1.1-1.

If the UE served by the MWAB is roaming, there is another PLMN (not shown in the figure), i.e. the HPLMN of the UE served by the MWAB, involved. In that case, the interaction of the HPLMN of the UE and PLMN 2 is the same as that described in TS 23.501 [2] for the roaming case.

The UE served by the MWAB-gNB (of PLMN-2) is not aware of PLMN 1, and thus does not need any roaming agreement between its HPLMN and the PLMN 1.

Editor's note: It is FFS how to ensure that the S-NSSAI used by MWAB-UE allows access to PLMN 2's slice serving the UE.



Figure 6.1.1-3: Architecture for MWAB operation support - roaming with Home Routed

### 6.1.2 Functional descriptions

The MWAB operates as follows to provide service to a UE:

1. To operate as a MWAB, the MWAB-UE needs to first register to a serving network that is allowed by its subscription, and that is PLMN 1 in the architecture shown in clause 6.1.1. The serving PLMN authorizes the MWAB based on its subscription and provides the authorization result indication to the MWAB-UE.

2. MWAB-UE provides the authorization result indication to the MWAB-gNB, which may trigger the MWAB-gNB to attempt the connection with the PLMN it serves, i.e. PLMN 2 in the architectures shown in clause 6.1.1.

3. The attempt from the MWAB-gNB triggers the MWAB-UE to establishes a PDU session(s) for the MWAB operation, based on the configuration of the MWAB-UE, e.g. with the proper DNN, S-NSSAI, and the SSC Mode. Only IP based of PDU sessions are used for the MWAB operations support. The configuration of the MWAB-UE can be Local Configuration, or URSP rules.

4. The serving PLMN of MWAB-UE selects the proper MWAB UPF according to the DNN and S-NSSAI for the PDU session and ensures that the selected MWAB UPF provides the connection to the PLMN 2's AMF and UPF.

5. The MWAB-gNB establishes the connection to the OAM system of the PLMN 2 and obtains the corresponding configurations to operate as a gNB for PLMN 2. This includes for example the configuration on the AS layer operation, and also the information to be sent in the SIB, e.g. PLMN ID(s). Details of the configuration information are out of scope of SA2.

6. The MWAB starts to operate based on the OAM control as a gNB for PLMN 2, and serves the UE in proximity for PLMN 2. The MWAB-gNB may also be instructed by the OAM system to establish N2 interface using the NG setup procedure defined in TS 38.413 [8] with some AMFs in PLMN 2 over the PDU session provided by MWAB-UE.

Editor's note: It is FFS how to support MOCN RAN sharing.

7. When a UE camps on the MWAB-gNB and requests a connection, e.g. initiates a registration or service request procedure, the MWAB-gNB performs usual operation as specified in TS 23.501 [2] and route the message to a suitable UE AMF in PLMN 2. The AMF may be aware of that the UE is served by a MWAB based on the ULI information.

8. When the UE establishes a PDU session, the UE SMF selects a proper UE UPF. The MWAB-gNB may establish the N3 interface with the UPF over the PDU session of the MWAB-UE, if it is not yet established.

9. The UE served by the MWAB-gNB (of PLMN-2) is not aware of the serving PLMN of the MWAB-UE, and thus does not need a roaming agreement with the serving PLMN of the MWAB-UE.

The efficient mobility and service continuity support for UE when the serving MWAB moves (KI#4) will be addressed in a separate solution compatible with this solution.

### 6.1.3 Procedures

#### 6.1.3.1 MWAB-UE registration and authorization

The MWAB-UE performs PLMN selection based on existing procedures in TS 23.122 [9].

MWAB-UE also follows existing procedures in TS 23.501 [2], for network slice configuration. The serving PLMN accesses the HPLMN of the MWAB-UE for the subscription data.

The MWAB-UE may be triggered by the MWAB-gNB to establish the PDU session(s) for MWAB operation. This can be based on an interface out of scope of SA2.

The MWAB-UE uses Local Configuration or the URSP to identify the PDU session parameters to use, e.g. the S-NSSAI, DNN, and SSC modes derived from the Route Selection Descriptor.

There may be VPLMN specific URSP rules configured on the MWAB-UE, and in that case the PDU session parameters may be different in different VPLMNs.

The requested S-NSSAI and DNN will be authorized based on the subscription of the MWAB based on existing procedures in TS 23.501 [2] and TS 23.502 [7].

No procedure enhancement to those defined in TS 23.501 [2] and TS 23.502 [7] is necessary.

#### 6.1.3.2 Control of UE's access to MWAB

Legacy UE can access the MWAB-gNB as a normal gNB.

For CAG capable UEs, the enhancement as described in clause 5.35A.7 of TS 23.501 [2] can be reused for control the access to the MWAB, if the MWAB is configured by OAM of PLMN 2 to broadcast CAGs.

Editor's note: It is FFS whether enhancements is needed to prevent the MWAB-UE from selecting the MWAB-gNB cell (including the case of MWAB-UE and MWAB-gNB belonging to same MWAB).

#### 6.1.3.3 Support of Location Service for UEs when MWAB(s) is involved

A separate solution compatible with the architecture introduced in this solution will be used to support the Location Service, based on the principles defined in clause 5.35A.5 of TS 23.501 [2].

Editor's note: It is FFS if further enhancements is needed to use the NRPPa procedures with MWAB in the roaming cases.

#### 6.1.3.4 UE mobility to and from a MWAB cell

Existing UE mobility procedure can be reused. No enhancement is required, based on the same considerations as described in clauses 5.35A.3.1 and 5.35A.3.2 of TS 23.501 [2].

### 6.1.4 Impacts on services, entities, and interfaces

None.

Editor's note: Related procedures can be eventually documented in an informative annex of TS 23.501 [2].

## 6.2 Solution #2: MWAB architecture and procedures

### 6.2.1 General

The solution provides methods for architectural enhancements for the support of a MWAB, which is based on the support of MWAB architecture as specified in clause 4.1 with the following high-level descriptions according to the different usages of PDU sessions(s) of the MWAB-UE:

- Connection with OAM server over IP connectivity provided by the PDU session of MWAB-UE.

- N2 interface with AMF over the IP connectivity provided by the PDU session of MWAB-UE.

- N3 interface with UPF over the IP connectivity provided by the PDU session of MWAB-UE.

### 6.2.2 Functional descriptions

#### 6.2.2.1 Connection with OAM server over PDU session

When a PDU session is used for the MWAB to access the OAM server, the MWAB-UE establishes a dedicated PDU session for the OAM traffic. Additionally, the OAM server address can be configured per PLMN ID, the MWAB selects the OAM server address of the respective PLMN ID for which it wants to act as NG-RAN.

The MWAB-UE is configured dedicated DNN/S-NSSAI for the PDU session for backhaul link to the OAM server, or the AMF provides it when the MWAB-UE attempts to establish the PDU session in the slice where the OAM service is (e.g. a default DNN/S-NSSAI can be used).

The MWAB-gNB accesses the OAM server and the OAM server can then configure the MWAB-gNB additional information for N2 or N3 connectivity. The MWAB-gNB requests the establishment of the N2 or N3 based on the configuration, which may trigger establishment of additional BH PDU sessions by the MWAB-UE, e.g. based on Local Configuration or URSP rules. The N2 connection is established on a BH PDU sessions as per the received configuration.

#### 6.2.2.2 N2 connection over BH PDU session

The N2 connection with AMF for the MWAB-gNB:

- The BH PDU session's PSA routes the N2 message between the MWAB-gNB and AMF based on the IP address.

- The N2 connection with AMF set over BH PDU session is described in the Figure 6.2.2.2-1.

- The MWAB-UE is configured with dedicated DNN/S-NSSAI for the PDU session for backhaul link to be used by the MWAB-gNB. When MWAB-UE establishes the PDU session to access the OAM server, the address of the AMF(s) for the MWAB-gNB to connect to can be configured by the OAM based on MWAB's location.

NOTE: Considering the mobility of MWAB-gNB, the AMF change may happen because of the regional deployment of AMF. the N2 connection change during MWAB-gNB mobility will be co-ordinated with the mobility aspects of key issue#4.



Figure 6.2.2.2-1: N2 connection over BH PDU session

#### 6.2.2.3 N3 over BH PDU session

Editor's note: Detailed description is FFS.

#### 6.2.2.4 Xn over BH PDU session

The MWAB-gNB's Xn, if enabled based on configuration by OAM, may share the same PDU session of N2/N3 or different PDU session. When the respective PDU session providing IP connectivity is established, IP connectivity is also used to connect with another NG-RAN (using the Xn interface).

Editor's note: It is FFS whether or not to support Xn connection over BH PDU Session and need the coordination with RAN WG3.

#### 6.2.2.5 Handling of NG establishment with respect to the topic of multi-hop handling

Editor's note: Whether and how to avoid multi-hop handing needs to coordination with RAN WG3.

The MWAB need to avoid multi-hop (until RAN WGs agree otherwise). A solution is provided to ensure this is possible without requiring new impacts on MWAB-UE and the deployed NG-RAN (except in the event of Xn handover).

The MWAB-gNB includes in the NG SETUP REQUEST message to the AMFs that it is configured to establish NG with an indication that it is a MWAB-gNB. The AMF stores this information.

If a MWAB-UE attempts to register at another MWAB cell, the AMFs that receives the registration request from the MWAB-UE can based on the received information and not accept the registration.

Editor's note: It is FFS how to avoid the multi-hop during the N2 and Xn handover.

When there is a N2 handover of a MWAB-UE, the AMF can indicate in the Handover Request that it is handing over a MWAB-UE. If the target gNB is a MWAB-gNB, the MWAB-gNB can reject the handover based on its policy and the information received.

Editor's note: The feasibility of this N2 handover solution will be evaluated later in the evaluation phase.

When there is a Xn handover of a MWAB-UE, the Source RAN node can indicate in the handover request the MWAB-UE. If the target gNB is an MWAB-gNB the MWAB-gNB can reject the handover based on its policy and the information received.

NOTE: It is assumed that the support of this in Xn case, will require the AMF to provide this information to NG-RAN in the MWAB-UE context and also a new Xn IE to be included by a gNB. Hence, for example, in a PLMN where no NG-RAN upgrade is desired to support MWABs, the MWABs can be configured to not establish Xn to other gNBs.

Editor's note: The feasibility of this Xn handover solution will be evaluated later in the evaluation phase.

### 6.2.3 Procedures

#### 6.2.3.1 Connection with OAM server over PDU session

The MWAB-UE may be configured dedicated DNN/S-NSSAI for the PDU session for backhaul link to the OAM server (e.g. Local Configuration or URSP rules) or network serving the MWAB-UE may determine a default DNN/S-NSSAI for it based on subscription.

#### 6.2.3.2 N2 connection over BH PDU session

The N2 message routing over BH PDU session is described in the Figure 6.2.3.2-1.



Figure 6.2.3.2-1: N2 message routing over BH PDU session

1 When MWAB-UE establishes the PDU session to access the OAM server, the address(es) of the AMF(s) for the MWAB-gNB to connect to can be configured by the OAM based on MWAB's location.

Editor's note: Details of the OAM configuration, e.g. whether one configuring the operation as a gNB in the BH-PLMN and one for getting configuration for N2/N3, is FFS.

2 The MWAB-gNB requests the connection towards the AMF(s) for N2 backhaul link via the interface with the MWAB-UE, and this triggers the establishment of a PDU session with a dedicated DNN/S-NSSAI based on Local Configuration or URSP rules of the MWAB-UE.

3 The MWAB generates the UL N2 message (e.g. NG SETUP REQUEST message) whose source IP address is the IP address associated with the N2 connection provided by the MWAB-UE and destination IP address is the AMF address.

4 The UL N2 message as the UL traffic is routed to the PSA of the BH PDU session.

5 The PSA of the BH PDU session routes the N2 message to the AMF.

6 The AMF generates the DL N2 message (e.g. NG SETUP RESPONSE message) whose source IP address is the AMF address and destination IP address is the IP address of MWAB-UE.

7 The DL N2 message is routed to the PSA of the BH PDU session.

8 The PSA of the BH PDU session routes the DL N2 message to the MWAB.

#### 6.2.3.3 N3 connection over BH PDU session

Editor's note: Detailed description is FFS.

#### 6.2.3.4 Xn connection over BH PDU session

Similar to the N3 connection over BH PDU session, the Xn connection is the user plane which routes the traffic from MWAB-gNB to another NG-RAN. The Xn message routing over BH PDU session is similar as the Figure 6.2.3.2-1.

#### 6.2.3.5 Alternative handling of N2 transmission by using dedicated IP address for MWAB-gNB

Editor's note: The additions proposed by this clause need further discussion.

There might be following additional treatment for MWAB-gNB IP address on top of the procedure in clause 6.2.3.2:

- Step 1: OAM may also configure MWAB with MWAB-gNB IP address, which is used to establish N2 interface with the AMF. MWAB-gNB may use the configured IP address to interact with AMF regarding N2.

Editor's note: The IP packet routing used in this procedure is FFS.

#### 6.2.3.6 MWAB NG-establishment

Editor's note: The procedure is only for information, and details need to be further coordinated with RAN WGs.



Figure 6.2.3.6-1: MWAB NG connection establishment including additional information for MWAB

The MWAB NG establishment is augmented with additional information the AMF stores to later decide what to do for MWAB UEs that attempt to register.

#### 6.2.3.7 MWAB-UE registration over other MWAB-gNB



Figure 6.2.3.7-1: MWAB-UE registration and multi-hop handling

The MWAB-UE of MWAB 2 attempts to register over a MWAB-gNB of MWAB 1. The AMF rejects the Registration or accepts the registration without authorizing the MWAB-UE to operate as MWAB.

#### 6.2.3.8 MWAB-UE N2 handover and multi-hop handling

Editor's note: The detailed procedures of N2 handover is FFS.

Editor's note: The procedure is only for information, and details need to be further coordinated with RAN WGs.



Figure 6.2.3.8-1: MWAB-UE N2 handover successful

In figure 6.2.3.8-1 the AMF indicates that the UE being handed over is a MWAB UE. The target RAN node is not a MWAB so it does not interpret any of this information, so the handover is successful (there is no multi-hop).



Figure 6.2.3.8-2: MWAB-UE N2 handover successful

In figure 6.2.3.8-2 the AMF indicates that the UE being handed over is a MWAB UE. The target RAN node is a MWAB and rejects the handover.

#### 6.2.3.9 MWAB-UE Xn handover and multi-hop handling

Editor's note: The detailed procedures of Xn handover is FFS.

Editor's note: The procedure is only for information, and details need to be further coordinated with RAN WGs.



Figure 6.2.3.9-1: MWAB-UE N2 handover successful

In figure 6.2.3.9-1 the source NG-RAN node indicates that the UE being handed over is a MWAB UE. The target RAN node is not a MWAB, so it does not interpret any of this information, so the handover is successful (there is no multi-hop).



Figure 6.2.3.9-2: MWAB-UE Xn handover successful

In figure 6.2.3.9-2 the source NG-RAN node indicates that the UE being handed over is a MWAB UE. The target RAN node is an MWAB and rejects the handover. Note there is impact on the source NG-RAN. If a PLMN does not desire to upgrade the NG-RAN, it can e.g. disable the Xn establishment for MWABs to prevent Xn handovers to an MWAB.

### 6.2.4 Impacts on services, entities, and interfaces

**MWAB:**

- May be configured with dedicated DNN/S-NSSAI for the PDU session for backhaul link.

- OAM configures MWAB-gNB with the PDUs session information to be used for the N2/N3.

- MWAB-gNB triggers PDU sessions establishment for the BH link based on obtained configuration and uses related address(es) for N2/N3, OAM interactions.

- The address of the AMF for the MWAB-gNB to connect to can be configured by the OAM based on MWAB's location.

- Support Multi-hop prevention feature as detailed above.

**AMF:**

- Support identification of an NG connection as related to a MWAB and the multi-hop prevention procedures as outlined above.

**OAM:**

- Configuration of MWAB with BH PDU sessions information and AMF address information (and other information related to MWAB-gNB operation.

## 6.3 Solution #3: N3 backhaul PDU session management

### 6.3.1 General

This solution is to address KI#1 about how to provide the backhaul link using a PDU sessions for a MWAB to support the N3 interfaces.

MWAB provides wireless connection to the 5GC through an IP connectivity provided by a PDU session; hence, both N2 interface and N3 interface are carried over the PDU session(s) between MWAB-UE and 5GC.

At least one PDU session is established between MWAB-UE and 5GC for both N2 interface and N3 interface depending on the configuration of the MWAB:

- Single BH PDU session for both N2 and N3.

- Multiple BH PDU session(s) for N2 and PDU session(s) for N3.

The PDU sessions of the UEs served by a MWAB are carried over BH PDU session(s) for N3 backhaul.

### 6.3.2 Functional descriptions

This solution assumes that:

- BH PDU session for N2 backhaul is already established.

- One or multiple BH PDU session(s) for N3 backhaul is already established or has not been established. Each BH PDU session is associated with the default 5QI and ARP of the QoS Flow associated with the default QoS rule as defined in clause 6.4 of TS 23.503 [10].

For the UL/DL UE traffic, the UE PDU session QoS received at MWAB-gNB (i.e. the UE QoS flow) is bound to the BH QoS flow (and/or BH PDU session). The MWAB binds the UE QoS flow to BH PDU session based on the UE requested PDU session and the QoS flow characteristics:

- If there is an existing BH PDU session which is suitable to support the UE PDU session and its QoS flows characteristics, this BH PDU session is selected, and the UE PDU session is bound to this BH PDU session.

- If no existing BH PDU session suitable, a new PDU session is established based on the UE PDU session and its QoS flow characteristics. Alternatively, an existing BH PDU session is modified to accommodate the new PDU session or QoS flow.

NOTE: It is the MWAB-gNB to trigger MWAB-UE to establish/modify the BH PDU session as defined in clause 4.3 of TS 23.502 [7].



Figure 6.3.2-1: Mapping of QoS flows at MWAB and at BH UPF

Figure 6.3.2-1 shows that the UE traffic for a specific QoS flow of a UE PDU sessions is carried in GTP-U tunnels for UL and DL that are associated with DSCP values and IP@ of theUPF(for UL) of the UE and IP address of MWAB-gNB (for DL). The DSCP value can be identified at the MWAB-gNB based on policy related to information the MWAB-gNB has in the SM context for the PDU session. The MWAB gNB then requests the MWAB-UE to perform a modification of the BH PDU session with a specific 5QI/ARP and other QoS parameters that are suitable to handle the new DL QoS flow of the UE served by the MWAB. The SDF included in the PDU session modification is identified by the IP@ of the MWAB-gNB and the DSCP value. This provides the BH UPF with the packet classification rules it needs to map the DL traffic from the UE UPF to the right QoS flow on the BH PDU session.

### 6.3.3 Procedures

#### 6.3.3.1 Handling of a UE PDU session establishment or modification



Figure 6.3.3.1-1: Handling of a UE PDU session establishment or modification

1. A PDU session is established or modified for a UE as defined in clause 4.3 of TS 23.502 [7], and this causes the MWAB-gNB to receive from SMF a new SM context for a PDU session including at least a QoS flow.

2. For each QoS flow the MWAB-gNB determines the required 5QI/ARP and other QoS parameters in the BH PDU session and TNL to be used to signal to the BH SMF the SDF for the QoS rules related to this SDF for DL. For UL the QoS rules are also determined by MWAB and the TNL information determined at the MWAB-gNB is used to classify in UL.

3. The MWAB-UE modifies the BH PDU session as instructed.

4. The UPF of the BH PDU session is now ready to correctly process DL traffic from the UE UPF.

5. The MWAB-UE acks the correct modification of the BH PDU session.

6. The MWAB-gNB can complete the establishment of the PDU session.

7. The data for the UE PDU session can be sent/received with the right QoS.

### 6.3.4 Impacts on services, entities, and interfaces

MWAB:

- The MWAB binds the UE QoS flow to a BH PDU session based on the UE requested PDU session and the QoS flow characteristics

## 6.4 Solution #4: MWAB authorization handling

### 6.4.1 Introduction

This solution addresses issues related to KI#2. It provides methods to support MWAB operation authorization in different roaming scenarios. It also provides means to handle authorization status change handling for both MWAB-gNB logic and MWAB-UE logic.

### 6.4.2 Functional Description

When MWAB node includes MWAB-gNB function and MWAB-UE function as described in clause 4, the authorization of the MWAB operation is based on subscription information linked to the MWAB-UE and the authorization status can depend on the location and/or time.

The MWAB-gNB and MWAB-UE may be connected to the same network/5GC, or they may be connected to different network/5GC. The UDM which holds the subscription information for MWAB-UE can be in the BH-5GC (i.e. where the MWAB-UE is registered) or in a different 5GC (which has roaming agreement with the network serving the MWAB-UE).



Figure 6.4.2-1: MWAB-gNB and MWAB-UE connect to the same 5GC



Figure 6.4.2-2: MWAB-gNB and MWAB-UE connect to different 5GCs

The BH-AMF, where the MWAB-UE is registered, is responsible for the authorization of the MWAB operation during the NAS registration procedure in all scenarios (i.e. non-roaming as well as roaming) based on the subscription information linked to the MWAB-UE.

The BH-AMF provides the MWAB node authorization information to the MWAB-UE via NAS registration related message and to the BH-gNB via NGAP message.

The MWAB-UE provides the authorization information to MWAB-gNB. The communication between MWAB-UE and MWAB-gNB is based on implementation.

The MWAB-gNB initiates the gNB operations (e.g. it requests MWAB-UE to setup IP connections for needed backhaul communication and sets up the RAN-CN connection towards AMF), if authorization information indicates that the MWAB is allowed to operate as MWAB node.

### 6.4.3 Procedures

#### 6.4.3.1 MWAB node authorization and operation initiation

This procedure describes the MWAB node authorization steps and the operations with focus on the 5GC aspects.



Figure 6.4.3.1-1: MWAB node authorization and operation initiation

MWAB-UE registration and authorization phase:

1. The MWAB-UE triggers registration towards the selected PLMN in NR cell. The MWAB-UE provides the MWAB Indication via RRC and NGAP message to BH-AMF.

2. The BH-AMF retrieves MWAB-UE subscription data from UDM and authorizes the MWAB operation.

3. The BH-AMF accepts the MWAB-UE registration request and provides the MWAB authorization status to MWAB-UE and BH-gNB.

Editor's note: The need of the indications on RRC and NGAP is FFS.

MWAB-gNB operation initiation:

4. Based on authorization allowed information provided, the MWAB establishes the IP connectivity for backhaul usage. Or the MWAB-UE may establish PDU Session to provide the IP connectivity for backhaul usage based on the MWAB authorization status (i.e. authorized) provided by the AMF.

NOTE 1: The detailed communication between MWAB-gNB and MWAB-UE is implementation based and not in SA2 scope.

5. The MWAB-gNB connects to the AMF via the backhaul IP connectivity provided by the MWAB-UE.

6. The MWAB-gNB initiates the service towards UE.

NOTE 2: How the MWAB-gNB receives the parameters needed for operation (e.g. PLMN ID, TAC, Cell information with CAG IDs, AMF information for connection) is addressed by other solutions.

UE registration via MWAB-gNB cell:

7. The UEs allowed to access the MWAB cell selects the cell and trigger Registration Request.

#### 6.4.3.2 MWAB authorization status change for Registered MWAB

This procedure is used when MWAB authorization status changes for a registered MWAB-UE .



Figure 6.4.3.2-1: MWAB authorization status change handling

Registered MWAB-UE authorization status change:

1. BH-AMF triggers NAS UE configuration update procedure to inform the MWAB-UE with the MWAB authorization status change.

When MWAB-UE authorization status is changed from allowed to not-allowed, the BH-AMF may provide one of the following additional information in the UE Configuration Update Command message:

a) Indication that the MWAB-UE needs to be deregistered.

b) Indication that the BH PDU Session(s) need to be released.

NOTE 1: The triggering for this may be different (e.g. subscription data change, location restriction, time restriction, local policy in BH-AMF).

MWAB-UE authorization status change from allowed to not-allowed:

2. Based on authorization allowed information provided by the MWAB-UE, the MWAB-gNB triggers the move of connected UEs to other cells.

3. After all the UEs are moved, the MWAB-gNB may remove the TNLA and NGAP connection towards the AMF.

4. The MWAB releases the IP connectivity or the MWAB-UE may release the BH PDU Session(s) based on the additional information received in step 1.

The MWAB-UE may deregister based on the additional information received in step 1. Or the BH-AMF may deregister the MWAB-gNB from the network based on local policy, after the BH PDU Sessions(s) have been released or a timer that started at step 1 expires.

Editor's note: The needs and usage of the additional indications from step 1 is FFS.

The MWAB-gNB shuts down the air interface.

NOTE 2: Deregistration of MWAB-UE can be performed without performing BH PDU Session(s) release separately.

NOTE 3: The detailed communication between MWAB-gNB and MWAB-UE is implementation based and not in SA WG2 scope.

MWAB-UE authorization status change from not-allowed to allowed:

5-8. Same to steps 4-7 in Figure 6.4.3.1-1.

### 6.4.4 Impacts on services, entities, and interfaces

**AMF:**

- Support MWAB authorization handling based on subscription data and local policy.

- Support NGAP removal procedure.

**MWAB-UE:**

- Support Authorization status handling.

- Support the IP connectivity establishment for the backhaul usage request from MWAB-gNB.

**MWAB-gNB:**

- Support NGAP removal procedure.

- Support the handling of UE move to other cells when authorization status changes.

## 6.5 Solution #5: Authorization and Change of Authorization of a MWAB and configuration of a MWAB

### 6.5.1 General

This is a Solution addressing Key Issue #2: Authorization of a MWAB and configuration of MWAB.

### 6.5.2 Functional descriptions

The solution is based on this outline:

- The MWAB-UE optionally includes a MWAB indication in the Registration request, in the UE MM Core Network Capability defined in clause 5.3.4 of TS 23.501 [2]. Alternatively, or in addition, the MWAB-UE may be configured by the HPLMN a specific (set of) S-NSSAI(s) associated with the MWAB operation, and the MWAB-UE includes the S-NSSAI in the Registration Request.

- During registration, the AMF retrieves subscription data and the UDM provides to the AMF in subscription data, the MWAB authorized indication with optional location and time availability if the SUPI is authorized for MWAB operation.

- The MWAB-UE is either accepted or rejected, if it is rejected it shall only register if the cause code and received information from AMF allows. If it is accepted, then if establishes a PDU session to obtain connectivity to an OAM server.

- At any time the AMF can change authorization status for the MWAB by means of UE configuration update. If a MWAB is changing to not authorized from authorized the MWAB-gNB triggers handover of the UEs it serves to other cells of other gNBs. Then MWAB-UE may release the NG related PDU sessions. The AMF may also release the PDU sessions of the MWAB-UE if it is configured to do so after a certain amount of time. The MWAB then stops service (which may cause any remaining UEs that could not be handed over to experience RLF, unless the MWAB had released their RRC connection before going out of service).

### 6.5.3 Procedures

#### 6.5.3.1 MWAB service authorization and MWAB gNB configuration



Figure 6.5.3.1-1: MWAB service authorization and initial MWAB-gNB configuration

1. The MWAB-UE registers and optionally includes in the UE MM Core network capability defined in clause 5.3.4 of TS 23.501 [2] an indication it is intending to act as MWAB, optionally also indicate the PLMN(s) for which it may want to act as MWAB-gNB to network. It is assumed the MWAB-UE is configured with a list of PLMNs it is not allowed to register with and any Preferred PLMNs list as usual for a UE. Alternatively, or in addition, the MWAB-UE may be configured by the HPLMN with a (set of) S-NSSAI(s) associated with the MWAB operation and requests it in the registration procedure.

Editor's note: Whether the MWAB-UE optionally also indicates the PLMN(s) for which it may want to act as MWAB-gNB to the network is FFS

Editor's note: The need of the indication on NAS MM capability is FFS.

2. The AMF retrieves the subscription data and checks whether the UE is authorized to act as MWAB by checking presence of MWAB Operation Allowed and any related location and time information. The AMF provides a default S-NSSAI for MWAB-UE if no S-NSSAI was requested by the MWAB-UE. The MWAB-UE also obtains any Configured NSSAI as applicable.

3. If the MWAB-UE subscription allows, the MWAB-UE is accepted and an indication that MWAB operation is allowed along with MWAB information is sent to the MWAB-UE, and the Allowed NSSAI including the S-NSSAI(s) for MWAB operation as applicable. The MWAB information includes:

a) MWAB-Authorized. Additionally, the area and time the UE is authorized optionally for per PLMN; or

b) MWAB-Unauthorized, additionally the area and time the UE is not authorized optionally per PLMN for.

The AMF may also send registration reject (if the UE is not allowed to remain registered in PLMN) to the MWAB-UE and indicate the MWAB information as MWAB-Unauthorized, additionally the area and time the UE is not authorized optionally for the PLMN.

Editor's note: Whether per PLMN MWAB information has to be provided to UE is FFS.

4. If UE is authorized for MWAB, then it can start MWAB operations as MWAB in the area or time the UE is authorized to act as MWAB. If the UE enters a location or time the UE is not authorized to act as MWAB it will stop operating as MWAB. To start MWAB operation, the MWAB- UE establishes a PDU session to get initial configuration information for the MWAB-gNB from the OAM server. The PDU session establishment Request may include S-NSSAI and DNN depending on the MWAB-UE configuration. If no DNN is included, the AMF determines the correct one to use for the MWAB.

5. The MWAB-UE provides to the MWAB gNB the IP address it can use to contact the OAM server.

6. The MWAB-gNB contact the OAM server and obtains configuration.

7. The MWAB-gNB establishes, based on how it has been configured by the OAM server, any additional PDU sessions to then use the for N2 and N3 connections as necessary.

8. If UE is not authorized for MWAB in the area or time (indicated by network) the UE will not start the MWAB operations. The UE can again attempt to act as MWAB i.e. execute from step 1 in the area or time where the UE is allowed to act as MWAB.

The MWAB-UE may maintain a list of authorized area and time per PLMN.

#### 6.5.3.2 MWAB change of service authorization



Figure 6.5.3.2-1: MWAB change of service authorization

1. The UDM may provide updated subscription data changing the MWAB authorization status to (not) authorized.

2. The AMF determines whether the MWAB authorization status has changed to Allowed or Not Allowed, and if so, the AMF updates the MWAB-UE with the new MWAB authorization status by a UE configuration update procedure. Additionally AMF may indicate below MWAB information:

a) MWAB-Authorization status, additionally the area and time the UE is (not) authorized for.

3. The MWAB-UE acknowledges the reception of the message.

4a. If the authorization state was changed to MWAB Operation Allowed, the MWAB continues from step 4 of Figure 6.5.3.1-1. And all other steps are skipped.

4b. If the authorization state was changed to MWAB Operation Not Allowed, then the MWAB-gNB hands over to other gNBs the UEs it serves.

5. The MWAB-gNB stops serving any UE and informs OAM it is out of service. The MWAB-gNB also releases all the NG connections to the AMFs if is connected to over the B/H PDU sessions.

6. The MWAB-gNB informs the MWAB-UE it has to release the b/h sessions it had requested earlier to establish.

7. The MWAB-UE releases all the b/h PDU sessions.

8. The AMF of the MWAB-UE or the MWAB-UE may initiate deregistration procedure when there are no more b/h PDU sessions based on policy. If so, the AMF may provide a suitable cause code and location/time information to the UE.

Editor's note: Whether and how the acknowledgement from the MWAB-UE after the graceful release will be provided to the network is FFS.

### 6.5.4 Impacts on services, entities, and interfaces

**AMF:**

- ability to authorize and update authorization state and support MWABs as per message flows above.

**MWAB (new):**

- support the interactions with the OAM and 5GS as outlined above for authorization and change of authorization state.

**OAM:**

- configuration of MWAB.

## 6.6 Solution #6: Reusing CAG mechanism for managing UE's access to MWAB-gNB

### 6.6.1 Key Issue mapping

This solution addresses Key Issue #3.

### 6.6.2 Functional Description

This solution proposes to reuse the existing CAG mechanism defined by NPN for managing UE's access to MWAB-gNB.

NOTE 1: In the case the UE does not support CAG functionality, or PNI-NPN is not deployed by the network, the NG-RAN and 5GC are allowed to use not only CAG mechanism but also other existing mechanisms e.g. forbidden Tracking Area, to manage its access control to MWAB-gNB.

CAG Identifier is used to control the access of UE via MWAB-gNB with the following considerations:

- When the MWAB is allowed to operate as an MWAB-gNB for a PLMN, the MWAB is configured either during the communication with the OAM of MWAB-gNB or (pre-)configuration mechanism, with a one or more CAG identifiers which are unique within the scope of this PLMN. If the MWAB is (pre-)configured with the PLMN list in which the MWAB is allowed to operate as MWAB-gNB, the corresponding CAG Identifiers per PLMN is also configured in the MWAB.

NOTE 2: The CAG for MWAB-gNB is supported as part of the PNI-NPN concept described in clause 5.30.3 of TS 23.501 [2].

- NG-RAN and 5GC support the UE access control based on the CAG identifier associated with the MWAB-gNB cell and the allowed CAG identifiers for the UE that supports CAG functionality.

- For the UE that does not support CAG functionality, NG-RAN and 5GC are allowed to use not only CAG mechanism but also other existing mechanisms e.g. forbidden Tracking Area, to manage its access control to MWAB-gNB.

- Time duration restriction may be provided to the UE together with the CAG Identifier(s) for the MWAB-gNB(s) that the UE can access. The enhanced Allowed CAG list will be provided to UE and AMF for enforcement, to make sure that UE not accessing the MWAB-gNB cell outside of the time duration. For example, if the time when a certain CAG is allowed for a UE is up, the CAG for the UE is revoked from the network.

- For the Case of a MWAB that broadcasts the HPLMN ID while the MWAB-UE is served by a roaming partner gNB, the CAG values used are those of the HPLMN.

NOTE 3: Control of the MWAB-UE access to the serving network is based on normal mobility restriction management based on subscription data from MWAB-UE.

### 6.6.3 Procedures



Figure 6.6.3-1: Reusing CAG mechanism for managing UE's access to MWAB-gNB

NOTE: The procedure is for demonstrative purpose, the steps are all supported by VMR.

1. MWAB-UE registers to the network, and if it is authorized to operate as an MWAB-gNB, the flow continues.

2. MWAB communicates with the OAM of the MWAB-gNB and obtains the CAG ID(s) optionally with the time duration restriction.

3. As an alternative to step 2, the MWAB can be preconfigured with the list of PLMN, and the associating CAG ID(s) of each PLMN. The CAG ID can be optionally with time duration restriction. The list of PLMN denotes the PLMN(s) that the MWAB is allowed to operate as MWAB-gNB.

4. MWAB-gNB announces the CAG ID(s) in the SIB message.

5. The UE sends RRC message.

6. MWAB-gNB sends N2 to AMF message including the CAG ID list of MWAB-gNB.

7. The AMF serving the UE verifies the request from the UE.

8. If the verification is successful, the AMF sends Mobility Restrictions to MWAB-gNB, which includes Allowed CAG ID list.

9. The MWAB-gNB decides the serving PNI-NPN or PLMN based on the Mobility Restrictions and the supported CAGs of the serving cell.

### 6.6.4 Impacts on existing services, entities and interfaces

No impact to the NFs.

## 6.7 Solution #7: Architecture enhancement to support MWAB-gNB for SNPN

### 6.7.1 General

This solution addresses the KI#1 and KI#3 if the MWAB connects to an NG-RAN of an SNPN.

Figure 6.7.1-1 presents an example architecture for the MWAB operation when the serving SNPN of the MWAB-UE is the same as subscribed SNPN of MWAB-UE. In this case, there may be two SNPNs involved, i.e. the SNPN 1 that serves the MWAB-UE, and the SNPN 2 that serves the UE connected to the MWAB. The MWAB-gNB logically belongs to SNPN 2 and establishes N2 and N3 connection with the UE AMF and UE UPF via the PDU session of the MWAB-UE established with SNPN 1. MWAB-gNB announces SNPN ID of SNPN 2.



Figure 6.7.1-1: Architecture for MWAB operation support for SNPN – with MWAB-UE is served by the subscribed SNPN (SNPN 1)

Figure 6.7.1-2 presents an example architecture for the MWAB operation when the serving SNPN of the MWAB-UE is the different from subscribed SNPN of MWAB-UE. In this case, there may be two SNPNs involved, i.e. the SNPN 1 that serves the MWAB-UE, and the SNPN 2 that serves the UE connected to the MWAB. The MWAB-gNB logically belongs to SNPN 2 and establishes N2 and N3 connection with the UE AMF and UE UPF via the PDU session of the MWAB-UE established with SNPN 1. MWAB-gNB announces SNPN ID of SNPN 2.



Figure 6.7.1-2: Architecture for MWAB operation support for SNPN – with MWAB-UE is served by a SNPN (SNPN 1) other than the subscribed SNPN

### 6.7.2 Functional descriptions

Except control of UE's access to MWAB, procedures and enhancement applied to MWAB-UE connecting to an NG-RAN of a PLMN can be also applied to MWAB-UE connecting to an NG-RAN of a SNPN.

### 6.7.3 Control of UE's access to MWAB

In figure 6.7.1-1 and figure 6.7.1-2, if the SNPN 2 only has MWAB-gNB, then a dedicated SNPN ID can be used to control the UE to access the MWAB-gNB.

In figure 6.7.1-1 and figure 6.7.1-2, if the SNPN 2 has both normal gNB and MWAB-gNB with specific time or location, then the MWAB-gNB can be considered as part of SNPN providing access for Localized Services. To control the UE's access to MWAB-gNB for SNPN, the UE is required to support accessing an SNPN providing access for Localized Services and has been configure the following information as specified in clause 5.30.2.3 of TS 23.501 [2]:

- Credentials Holder controlled prioritized list of preferred SNPNs for accessing Localized Services, each entry of the list includes:

- an SNPN identifier;

- validity information; and

- optionally, location assistance information.

- Credentials Holder controlled prioritized list of GINs for accessing Localized Services, each entry of the list includes:

- a GIN;

- validity information; and

- optionally, location assistance information.

Validity information consists of:

- Time validity information, i.e. time periods (defined by start and end times) when access to the SNPN for accessing Localized Services is allowed; and

- optionally, location validity information containing one or more location information as defined in TS 24.501 [14].

### 6.7.4 Procedures

For the scenario that the SNPN 2 as shown in figure 6.7.1-1 and figure 6.7.1-2 has both normal gNB and MWAB-gNB:

1. If the UE supports accessing an SNPN providing access for Localized Services and the end user enables to access Localized Services, the UE performs the SNPN selection if validity information is met as specified in clause 5.30.2.4.2 of TS 23.501 [2].

2. When a UE camps on the MWAB-gNB and requests a connection, e.g. initiates a registration procedure, the MWAB-gNB performs usual operation as specified in TS 23.501 [2] and route the message to a suitable UE AMF in SNPN. The AMF may be aware of that the UE is served by a MWAB-gNB based on the ULI information as the MWAB-gNB is connecting to NG-RAN in PLMN.

3. If the UE is not allowed to this specific MWAB-gNB due to invalid time or location, then the AMF can reject the registration request from the UE with an appropriate cause code.

### 6.7.5 Impacts on services, entities, and interfaces

None.

## 6.8 Solution #8: Provisioning of efficient mobility and service continuity when served by MWAB

### 6.8.1 Key Issue mapping

This solution addresses Key Issue #4.

### 6.8.2 Functional Description

This solution proposes to make use of the OAM method to provide efficient mobility and service continuity when served by MWAB.

Regarding the mobility of MWAB, the following aspects are specified:

- The address of the serving PLMN OAM is pre-configured at the MWAB.

- MWAB obtains the MWAB configuration parameters from PLMN OAM via the PDU Session of the MWAB-UE after successfully authorized by the serving PLMN of MWAB-UE, especially the following MWAB configuration parameters should be provided by the PLMN OAM:

- Cell ID and the associating geographical information;

- TAC and the associating geographical information;

- AMF related information including AMF address and the associating geographical information.

NOTE 1: The authorization of MWAB-UE is addressed by the solution of KI#1, which is out of scope of this solution.

- The MWAB-gNB uses the Cell ID and TAC in the SIB message based on its location information (e.g. geographical information) and received MWAB configuration parameters.

- The MWAB-gNB manages (e.g. establishes, updates, releases) the NGAP connection with the AMF(s) as per the MWAB configuration parameters.

NOTE 2: The MWAB configuration parameters can be updated by the OAM as per the physical location of MWAB.

NOTE 3: In this solution it is assumed that the only the serving PLMN OAM of the MWAB-gNB provides the parameters for MWAB operation in the serving PLMN.

Regarding the mobility of UE, the following aspects are specified:

- UE mobility between a fixed cell and the MWAB cell;

- UE mobility between MWAB cells;

- UE mobility when moving together with the MWAB cell.

### 6.8.3 Procedures

#### 6.8.3.1 Mechanism upon MWAB mobility



Figure 6.8.3.1-1: OAM method to provide efficient mobility and service continuity when served by MWAB

1. MWAB-UE registers to the network, and if it is authorized to operate as an MWAB-gNB, the flow continues.

2. MWAB communicates with the OAM of the MWAB-gNB, and obtains the MWAB configuration parameters. The MWAB configuration parameters contains Cell ID(s), TAC(s), AMF ID(s) and the associating geographical information as described in clause 6.8.2.

3. The MWAB-gNB chooses the Cell ID, TAC, AMF instance based on its physical location and received MWAB configuration parameters.

4. The MWAB-gNB establishes the NGAP connection with the AMF (i.e. AMF1) as defined in TS 38.413 [8], based on the MWAB configuration parameters.

5. The MWAB-gNB broadcasts the Cell ID and TAC determined in step 3. In case MWAB detects it needs to update the broadcasted Cell ID/TAC, or establish the NGAP connection with a new AMF, step 7 to 9 continues.

The MWAB can based on its location capability (e.g. by using GNSS), or making use of the LCS procedure as defined in TS 23.273 [6] to obtain its information.

7. In case only the Cell ID/TAC needs to be updated, MWAB-gNB updates the NGAP connection with AMF (i.e. AMF1) as defined in TS 38.413 [8], and the flow continues in step 9.

8. In case the AMF needs to be re-allocated, the MWAB-gNB establishes the NGAP connection with the new AMF (i.e. AMF2) using the updated Cell ID/TAC.

It is assumed that the AMF relocation is performed during mobility registrations triggered by the UEs served by a MWAB cell.

In case of UE in RRC\_CONNECTED state served by the MWAB-gNB, the new AMF (i.e. AMF2) is selected for UE during handover procedures. After the UEs accessing the MWAB-gNB and served by the AMF1 are registered with the AMF2, the MWAB-gNB releases the NGAP connection with the old AMF (i.e. AMF1) based on the expiration of a timer configured on the MWAB-gNB.

NOTE: The details of AMF relocation during handover procedures when UE is accessing the same MWAB-gNB will be coordinated with RAN.

9. The MWAB-gNB broadcasts the Cell ID and TAC determined in step 6.

Editor's note: Details of the subsequent mobility procedure of the UE, (e.g. NAS mobility), is FFS.

#### 6.8.3.2 Mechanisms upon UE mobility

##### 6.8.3.2.1 UE mobility between a fixed cell and the MWAB cell

UE mobility between a fixed cell and the MWAB cell can take the current handover procedure using the Xn/N2 reference points as defined in TS 23.502 [7] as the basis.

Editor's note: It is FFS whether the Xn reference points will be used for this scenario and needs RAN coordination.

For UEs in RRC\_IDLE and RRC\_INACTIVE state when a MWAB goes out-of-service, current procedure for cell (re‑) selection for RRC\_IDLE and RRC\_INACTIVE is used.

For UEs in RRC\_CONNECTED state, if the MWAB goes out-of-service due to e.g. MWAB moves to an area where the MWAB is not allowed to provide the relay service, the MWAB keeps the NGAP connection with the AMF until all of the RRC\_CONNECTED UEs are handed over to the other cells.

Editor's note: Whether and how to wait until all handover procedures of UEs in RRC\_CONNECTED are finished is FFS, and will be aligned with RAN3 and authorization update procedures.

##### 6.8.3.2.2 UE mobility between MWAB cells

Existing procedures (e.g. defined in TS 38.401 [5], TS 23.502 [7]) can be used to handle the mobility between MWAB cells.

Editor's note: It is FFS whether the Xn reference points will be used for this scenario and needs RAN coordination.

##### 6.8.3.2.3 UE mobility when moving together with the MWAB cell

The TAC broadcasted by the MWAB cell(s) can be configured by the OAM. The TAC to be broadcasted by the MWAB-gNB may change upon its mobility.

For a UE served by a MWAB cell, it may observe change of TAC and/or cell IDs, even if it is still connected to the same MWAB-gNB. This can trigger mobility registrations, as defined in TS 23.502 [7], if the new TAC is not in the TAI list in the RA.

### 6.8.4 Impacts on existing services, entities and interfaces

**MWAB:**

- Obtains the MWAB configuration parameters from the OAM via the PDU Session of the MWAB-UE.

- Uses the Cell ID and TAC in the SIB message based on its physical location and received MWAB configuration parameters.

- Manages (e.g. establishes, updates, releases) the NGAP connection with the AMF(s) as per the MWAB configuration parameters.

**OAM:**

- Provides MWAB configuration parameters to the MWAB.

## 6.9 Solution #9: UE mobility handling due to MWAB mobility

### 6.9.1 Introduction

This solution addresses issues related to KI#4. It provides methods to support UE mobility handling in combination with the MWAB node mobility.

### 6.9.2 Functional Description

When the MWAB node moves nationally and internationally, the MWAB-gNB and MWAB-UE may be connected to different networks e.g. MWAB-UE may select PLMN A to register and establish PDU sessions for backhaul communication, while the MWAB-gNB may broadcast/serve a different PLMN B and be connected to the 5GC of the broadcasted PLMN B. The MWAB-UE may also change UPF and/or AMF used for BH connections upon mobility, and upon mobility the TAC and/or cell ID advertised by the MWAB-gNB may change as well as the AMF serving the UE at the new MWAB-gNB cell TAC and/or Cell ID.

It is proposed that no UE impact should be expected to support mobility involving a MWAB, so that there is no need to support MWAB specific features at the UE. Any N2 and Xn handover impacts on the MWAB gNB and the other gNBs should be studied also in RAN WGs but from SA2 perspective existing procedures are considered applicable unless the need is identified to do otherwise.

For UEs in RRC\_IDLE and RRC\_INACTIVE any optional MWAB-specific optimization of procedures for cell (re‑) selection should be in scope of RAN WGs. But from SA2 perspective normal Cell selection and reselection should be sufficient for a UE to be able to select and reselect cells in presence of MWABs.

For UEs in RRC\_CONNECTED state, if the MWAB-gNB goes out-of-service due to e.g. MWAB-UE moves to an area where the MWAB is not allowed to provide the relay service, the procedures for MWAB authorization state change are followed.

The TAC/Cell ID broadcasted by the MWAB-gNB cell(s) can be reconfigured by the OAM server used by the MWAB when MWAB-UE moves to a serving cell with a different TAC or also other reasons to reconfigure the TAC/Cell ID, e.g. the need to change the PCI (the potential change of PCI without change of Cell ID could be supported but is not considered necessary in this solution). The gNB ID may change as well.

For a UE served by a MWAB cell, it may observe change of TAC and/or cell IDs, even if it is still connected to the same MWAB. This can trigger mobility registrations, as defined in TS 23.502 [7], if the new TAC is not in the TAI list in the RA.

#### 6.9.2.1 MWAB mobility

When MWAB node moves nationally, the MWAB-UE selects either its HPLMN to register or another PLMN to register when there is no HPLMN coverage. The MWAB-gNB connects to the core network based on configuration (e.g. the HPLMN of the MWAB-UE).

When MWAB node moves internationally, it is assumed that based on current regulations the MWAB-gNB may need to broadcast PLMN IDs with the MCC and MNC of network of the visited county. Since the OAM of the gNB has to be associated to one such PLMN it is assumed the MWAB has to be authorized to obtain backhaul connectivity in the visited country.

The scenarios of interest are as follows:

- The MWAB-gNB connects to the same AMF as it moves (scenarios A, B and C in Figure 6.9.2.1-1).

- The MWAB-gNB connects to different AMFs in the same PLMN as it moves (scenarios D and E in Figure 6.9.2.1-1).

- The MWAB-gNB connects to different AMFs in different PLMNs as it moves (scenario F in Figure 6.9.2.1-2).



Figure 6.9.2.1-1: MWAB-gNB in same PLMN

When MWAB node moves internationally, the MWAB-gNB is required to be connected to a local network (e.g. broadcast the local network PLMN ID). Figure 6.9.2.1-2 below illustrates such possibility.

Editor's note: It is FFS if this scenario F needs to be supported.



Figure 6.9.2.1-2: MWAB-gNB in different networks

When MWAB node moves nationally or internationally, the MWAB-UE performs the normal CONNECTED mobility procedures as specified in TS 23.502 [7] and, based on PDU session continuity function provided by handover procedures, the IP connectivity established by the MWAB-UE for backhaul communication is maintained if the UPF does not change. If the UPF changes adjustment of BH connections is required and SSC mode 3 may help to minimize interruption. See more BH connection handling in clause 6.9.2.3.

#### 6.9.2.2 UE mobility

When MWAB node moves, the mobility for the UEs that are registered to network via the MWAB is handled in two different and separate ways:

- The UEs do not move together with the MWAB cell (i.e. UE moves away from MWAB) and will be served by other cells.

- The UEs moves together with the MWAB cell and continue to be served by the MWAB cell.

##### 6.9.2.2.1 UEs moves away from MWAB node

For the UEs that do not move together with MWAB node and are in IDLE mode or in RRC\_INACTIVE state, the UEs perform cell (re-)selection as normal based on TS 23.122 [9] and camp on other cells. For the UEs in CONNECTED mode, the MWAB-gNB applies the existing mobility methods of normal gNB to transfer the UEs to other cells (e.g. Handover procedures).

##### 6.9.2.2.2 UEs moves together with MWAB node

For the UEs that move together with the MWAB node and therefore continue to connect to cells configured on MWAB-gNB, there are 3 different types of scenarios:

- The MWAB-gNB remains connected/served by the same AMF as it moves (scenarios A, B and C above in clause 6.9.2.1).

- The MWAB-gNB needs to be connected/served by a different AMFs in the same PLMN as it moves (scenarios D and E in clause 6.9.2.1).

- The MWAB-gNB needs to be connected/served by a different AMF in different PLMNs as it moves (scenario F in clause 6.9.2.1).

For the case of MWAB-gNB moving in the same AMF area or different AMF areas but in the same PLMN, the MWAB-gNB configuration parameters may or may not need to be updated and the MWAB-gNB broadcast the same or different TAC/Cell ID. The UEs connected to MWAB-gNB perform UE mobility procedures as described in clause 6.9.3.2.

For the case of MWAB-gNB mobility result in change of serving 5GC in a different PLMN, the MWAB-gNB is configured with different parameters and broadcasts different PLMN ID, TAC/Cell ID. The UEs connected to MWAB-gNB perform the mobility procedures as described in clauses 6.9.3.2 and 6.9.3.3.

NOTE: How the MWAB-gNB receives needed parameters for operation in same or different PLMNs is addressed by other solutions.

#### 6.9.2.3 Impact on BH connections

There are two possible scenarios that can be considered: the BH connection is retained as the MWAB-UE moves, meaning that the same UPF is kept. In this case the IP address of the MWAB-gNB remains unchanged, hence there is no impact on the BH connection as such.

If however the BH-UPF changes, SSC mode 3 could be beneficial for the BH PDU sessions to ensure a Make before Break approach is used to ensure the NG-AP connections are not disrupted by using SCTP association migration between the original SCTP association to the secondary SCTP association which is taking over as primary upon release of the original BH PDU session.

The GTP-U tunnels used to support the UEs PDU sessions, the MWAB uses PDU Session Resource Modify Indication to each AMF of the UEs it serves as specified in TS 38.413 [8].

### 6.9.3 Procedures

#### 6.9.3.1 Impact on UEs served by a MWAB upon mobility of MWAB or mobility of UE with respect to the MWAB

Existing IDLE mode, RRC\_INACTIVE state and CONNECTED mode mobility procedures and existing cell reselection procedures specified in TS 23.122 [9].

#### 6.9.3.2 Impact on the network when UEs moves together with MWAB node in the same PLMN

For the scenarios A, B, C (i.e. no UE AMF change) described in clause 6.9.2.1. it is assumed there is no need to change the MWAB-gNB's gNB ID as there is no change of AMF upon mobility, which can be supported by keeping the same gNB, so the UE is assumed to keep the same AMF and gNB. If there is no new TAC/Cell ID advertised by the MWAB-gNB, it is assumed also there is also no physical cell ID change, and therefore there is no impact for the UEs either in IDLE mode or in CONNECTE mode. No extra action is needed for UEs.

If TAC changes, the MWAB-gNB has to update its NG-AP connections to the AMFs it is connected with, to advertise it supports the new TAC and does not support the old TAC to such AMFs. Then, as soon as the new TAC is advertised, CM-IDLE UEs may need to perform a Mobility registration update if the new TAC is outside the RA, but all operates as usual for the involved network nodes and the MWAB-gNB (TAC and CELL ID updates works as usual in a gNB).

As the MWAB-UE moves, if the BH UPF does not change a simple handover procedure for BH connection is executed using SSC mode 1, hence there is no impact on the NG-AP association with AMFs. If the BH UPF changes, then SSC mode 3 procedures are reused by MWAB-UE as described in clause 6.9.2.3 above.

When BH PDU sessions with the old and new UPFs are established in make before break using SSC mode 3, the MWAB-gNB needs to:

- For N2, the MWAB triggers the SCTP level associations reconfiguration to use the new IP address for b/h for NG-AP. The MWAB-gNB uses the new IP address associated with the new b/h UPF to establish a SCTP with the AMF(s) it is configured to connect with, then the MWAB-gNB sends NG Configuration Update message (including gNB ID) over the new SCTP association, so that the AMF can know this is the new SCTP association for the MWAB-gNB. Then the MWAB-gNB initiates NG Configuration Update procedure to inform AMF to remove the SCTP association related to the old IP address.

- For N3 GTP-UE tunnels used for the PDU sessions of the UEs the MWAB serves, the MWAB-gNB uses the PDU session Resource Modify Indication to each AMF of the UEs it serves to update the DL transport network level information for the sessions as specified in TS 38.413 [8]. See figure 6.9.3.2-1.



Figure 6.9.3.2-1: MWAB executes the PDU Session Resource Modify procedure when it is connected to a new UPF for B/H link for N3 GTP-UE tunnels of the UEs the MWAB serves

**Change of TAC only without change of AMF (scenario A, B, C as described in clause 6.9.2.1).**

The Figure 6.9.3.2-2 below depicts the case of change of TAC without change of AMF. The MRU is invoked only if the UE exits the RA. For Connected mode UEs the MAWB gNB reconfigures them with the new value of TAC. The Cell ID does not change.



Figure 6.9.3.2-2: Change of TAC without Change of AMF

1. The MWAB-UE upon mobility may report to MWAB-gNB the new TAC/Cell ID of the gNB that is serving it. Also it may report any new IP address for NG-AP if BH connection changes.

2. The MWAB-gNB reports new location information (e.g. the new TAC/Cell ID of the gNB serving the MWAB-UE or its geo-location info) to the OAM server

3. The OAM server, based on location information from MWAB-gNB (e.g. the TAC/Cell ID value or geo-location) provided in step 2, provides configuration parameters to the MWAB-gNB (e.g. with new TAC with same gNB ID and Cell ID). Any update of the NG connection to the AMFs occurs at this time.

4. The MWAB-gNB advertises the new TAC and reconfigures the CM-CONNECTED UEs with the new value of TAC via RRC reconfiguration procedure.

5. The UEs, if the RA is crossed, perform MRU.

**Change of TAC and Cell Id or change of Cell ID, without change of AMF (scenario A, B, C as described in clause 6.9.2.1).**

The Figure 6.9.3.2-3 below depicts the case of change of TAC/Cell ID without change of AMF. This case exists if the RAN needs to update e.g. the Physical Cell ID. The MRU is invoked only if the UE exists the RA. The CM Connected UEs are handed oved to the new Cell with an intra-gNB Handover by a RRC reconfiguration. During the Handover two virtual cells are instantiated.



Figure 6.9.3.2-3: Change of TAC without Change of AMF

1. The MWAB-UE upon mobility may report to MWAB-gNB the new TAC/Cell ID of the gNB that is serving it. Also it may report any new IP address for NG-AP if BH connection changes.

2. The MWAB-gNB reports the new location information (e.g. TAC/Cell ID of the gNB serving the MWAB-UE or its geo-location info) to the OAM server

3. The OAM server, based on location information from MWAB-gNB (e.g. TAC/Cell ID value or geo-location) provided in step 2, provides configuration parameters to the MWAB-gNB (e.g. with new TAC with same gNB ID and Cell ID). Any update of the NG connection to the AMFs occurs at this time.

4. The MWAB-gNB advertises the new TAC and it reconfigures the CM-CONNECTED UEs with the new value of TAC and Cell ID by performing an intra-gNB Handover by emulating two cells.

5. The UEs, if the RA is crossed, perform MRU.

**Change of UE AMFs due to mobility (scenario D, E as described in clause 6.9.2.1)**

Scenarios D, E (i.e. with AMF change upon mobility, not because of change of AMF due to e.g. new slices or due to other reason which can happen even when the gNB does not change) described in clause 6.9.2.1, can happen depends on the deployments (e.g. When there is a mobility over a wide area). This may include the MWAB gNB ID changes (e.g. different gNB IDs towards old and new AMFs).

When there is a mobility over a wide area, the OAM, when it receives the location information of the MWAB-gNB (e.g. TAC/Cell ID of the gNB serving the MWAB-UE or other geo-location information), may configure the MWAB-gNB with new parameters (e.g. a new gNB ID and related new TAC/Cell ID).

As a result, the MWAB may instantiate a new instance of MWAB-gNB for the new virtual cell and keeps the old instance of MWAB-gNB and related virtual cell on, for as long as there are connected UEs that are not transferred to the new MWAB-gNB instance.

As an alternative, e.g. if the MWAB-gNB has only one instance and handles UEs in CONNECTED mode the same way as for scenario A, B, C (i.e. after MWAB-gNB setting up the new NGAP interface towards the new AMF, UEs are handled as intra-MWAB-gNB cell mobility and MWAB-gNB does not trigger specific UE signalling towards AMF to trigger the UE context move between AMFs immediately). However, the UE triggered NAS mobility registration procedure (after AS providing the new TAI info to NAS) can be used by new AMF to trigger the UE context retrieval from old AMF. See figure 6.9.3.2-4 for the detailed handling.

NOTE: The support of inter-gNB HO procedure or intra-gNB cell mobility will be coordinated with RAN WGs.

The new MWAB-gNB establishes the NG connection with the AMFs it is configured with, and we assume that OAM configures all possible AMFs that any fixed gNB may be configured with in the same service area for the TA that the MWAB-gNB is supporting. So, there is no issue in selecting an AMF for the UE that matches those that are configured in the MWAB-gNB.

The detailed procedures is in figure 6.9.3.2-4.



Figure 6.9.3.2-4: Change of AMF without new MWAB-gNB using same resources as old MWAB-gNB

2. The MWAB-gNB reports the new location information (e.g. TAC/Cell ID of the gNB serving the MWAB-UE or its geo-location info) to the OAM server

3. The OAM server provides the new configuration parameters (e.g. MWAB-gNB TAC/Cell ID for new MWAB-gNB instance). The new MWAB-gNB instance proceeds to establish NG to the AMFs it is configured with.

4. The old MWAB-gNB hands over connected mode UEs to the new MWAB-gNB.

5. The Handover completes, and UE performs a Mobility registration update (Idle mode UEs camping on MWAB gNB cell will also perform MRU when they detect the new cell of the new MWAB-gNB).

Editor's note: It is FFS on the need to handle the scenario that MWAB-gNB supports the same TAC/Cell ID during the mobility. Further synch with RAN WG is needed.

#### 6.9.3.3 UEs move together with MWAB node to different PLMN

For scenario F (i.e. the AMF, that MWAB-gNB connects to, changes in different PLMNs) when MWAB moves, the MWAB-UE needs to establish a BH connection and the MWAB-gNB connects to AMFs in the new PLMN. The issue now is that we need simultaneous registrations in two PLMNs with one credentials (the MWAB-UE credential) to perform connected mode handover in a smooth way across the MWAB-gNB instances in the two PLMNs and this is not supported currently. However, it may be possible to cause the UEs to become CM-IDLE and then change PLMN. So, it is proposed that MWAB-gNB may release all the connected UEs. When a UE is in IDLE mode, it may perform the PLMN selection procedure, and it may select the cell of MWAB-gNB in the new PLMN.

Editor's note: It is FFS if UE needs to be maintained in CONNECTED mode in this scenario.

### 6.9.4 Impacts on services, entities, and interfaces

**MWAB:**

- Support multiple instances of MWAB-gNB as outlined above.

- Handle UE mobility as outlined above.

- Interact with OAM server as outlined above.

- Rearrange NG connection as needed upon change of UPF.

- Support the UE mobility procedures for UE in CONNECTED mode in case of different or same TAC/Cell ID.

**OAM:**

- Reconfigure the MWAB as it moves as described above.

## 6.10 Solution #10: New solution to address mobility aspects of an MWAB

### 6.10.1 General

This solution addresses the below highlighted aspects for Key Issue#4 defined as:

When the moving vehicles are equipped with MWAB, the MWAB-gNB can provide 5G coverage and communication to UEs (inside the vehicle and/or in its vicinity) and connected wirelessly to the 5G network via a macro NG-RAN node. When one or a group of UEs are already served by the MWAB, there are two mobility scenarios to be studied as the following:

- Scenario A (mobility within the same 5GC node): When the UEs are continuously served by a MWAB (e.g. inside the vehicle and/or in its vicinity), and this MWAB-gNB is moving around within a limited geographical area while keeping connecting with the same 5GC nodes (e.g. AMF and UPF). In this case, the UE keeps the connection with the MWAB, and there is no change of the connections as in figure 5.4.1-1. However, the change of the NG-RAN nodes serving the MWAB-UE and the MWAB location may have impact on the mobility or service restrictions to the UE served by the MWAB.

- Scenario B (mobility between different 5GC nodes): When the UEs are continuously served by a MWAB (e.g. inside the vehicle and/or in its vicinity), and this MWAB is moving around over a long distance. To continue to provide services to the UEs, the MWAB needs to change the 5GC nodes it connects to. In this case, the UE keeps the connection with the MWAB-gNB, but there is a possible change of the AMF and UPF.

The following aspects need to be studied for UEs served by the MWAB in the case of mobility in the scenarios A and B:

- Whether and how to enhance current procedures of mobility and service continuity for a UE. The following aspects need to be considered in potential solutions:

- How to efficiently manage the mobility of the UEs served by the MWAB, when 5GC node change is necessary.

- How to manage the RAN-CN interfaces.

### 6.10.2 Functional descriptions

#### 6.10.2.1 Solution for mobility aspects related to Scenario A (mobility within the same 5GC node)

Figure 6.10.2.1 covers mobility of MWAB nodes between different gNBs but the 5GC nodes serving the UEs doesn't change in this scenario. MWAB-UE's backhaul PDU session is established via gNB1 terminating at MWAB-UPF which is the PDU Session Anchor for MWAB-UE. As the MWAB moves, signal strength received at MWAB-UE from gNB1 reduces. MWAB-UE detects better signal strength from gNB2, so the MWAB gets handed over to gNB2. This is a conventional inter-gNB handover, as described in clause 4.9.1.2 of TS 23.502 [7]. The backhaul PDU session of MWAB-UE is now established via gNB2 to the MWAB-UPF (PSA).



Figure 6.10.2.1: Mobility of MWAB and UEs within the same 5GC nodes

Although, MWAB gNB's backhaul PDU session is being handed over in this scenario, it doesn't have any impact on the UE's ongoing (N1) signalling exchange with UE-AMF and data transfer via UE-UPF.

NOTE: Handover procedures as described in clause 4.9.1.3 of TS 23.502 [7] apply here (for MWAB-UE backhaul PDU session) for home routed roaming scenario. However, those handovers shall not have any impact on the UE's ongoing N1 signalling or PDU sessions.

#### 6.10.2.2 Solution for mobility aspects related to Scenario B (mobility between different 5GC nodes)

Figure 6.10.2.2 covers mobility aspects between different 5GC nodes, for the UEs being served by an MWAB. For the MWABs moving over a long distance, there are 2 stages of handover, first being the handover between different NG-RAN nodes serving the MWAB and second, the handover of UEs between different 5GC nodes. As discussed in previous section, first handover is between different NG-RAN nodes and doesn't have any impact on the UE.



Figure 6.10.2.2: Mobility of MWAB and UEs between different 5GC nodes

The second handover between 5GC nodes may happen when the MWAB has moved over a long distance. UEs being served by MWAB are initially connected to UE-AMF1 and UE-UPF (PSA) via UE-UPF1 for signaling and data paths. As the MWAB moves, UE-AMF1 cannot serve the UEs anymore, so it triggers a handover based on the location information reporting from the MWAB. UEs get handed over from UE-AMF1 to UE-AMF2. In the case of PDU sessions, UE-UPF (PSA) doesn't change since is the PDU session anchor, only the intermediate UPFs change from UE-UPF1 to UE-UPF2. The detailed handover procedure between the different 5GC nodes is covered in next section.

NOTE: Handover procedures as described in clause 4.9.1.3 of TS 23.502 [7] apply here for home routed roaming scenario.

### 6.10.3 Mobility between different 5GC nodes, when UEs are served by MWAB

Figure 6.10.3.1 covers the mobility procedure between different 5GC nodes when UEs are served by MWAB traveling over a long distance.



Figure 6.10.3.1: Mobility between different 5GC nodes, for UEs served by MWAB

1. MWAB can provide regular updates about MWAB-UE location (it indicates MWAB's location) to the source AMF (S-AMF) in terms of TAI + Cell Identity, as defined in clause 4.10 of TS 23.502 [7]. Assuming that the MWAB has travelled a long distance, due to which there may be some restrictions on S-AMF related to the change in the service area of MWAB. This could potentially trigger an AMF relocation.

NOTE 1: The location reporting feature shall be enabled by default when a MWAB is authorized to serve.

NOTE 2: This is a single message from the MWAB to AMF based on its location, so the AMF can initiate handover for UEs connected via MWAB-gNB.

2. When the S-AMF cannot serve the UE anymore, S-AMF selects a target AMF (T-AMF) as defined in clause 6.3.5 of TS 23.501 [2].

3. S-AMF initiates a 'UE Context Create Request' message to T-AMF including MWAB ID and PDU Session ID information in the message.

4. S-AMF also initiates a message to MWAB to indicate AMF handover with 'MWAB Handover Update' message providing UE ID and T-AMF ID.

5. [Optional] If the T-AMF is not part of AMF set with which MWAB has N2 association pre-configured with, then MWAB shall follow the N2 configuration procedures defined in clause 4.2.7.1 of TS 23.502 [7].

6. MWAB-gNB and T-AMF exchange NGAP UE association related information as defined in clause 6.4 of TS 38.401 [5]. A UE-associated NG logical connection is established between MWAB-gNB and T-AMF.

7. T-AMF sends 'PDU Session Update Request' along with UE location information to SMF. This location information is used by the SMF to decide if a new intermediate UPF needs to be allocated.

8. SMF checks if the UE location is within the service area of the UPF. If it determines that the UE is moved out of that service area, it selects a new intermediate UPF (T-UPF) as defined in clause 6.3.3 of TS 23.501 [2].

Editor's note: Intermediate UPF selection is according to clause 4.9.1.3.2 of TS 23.502 [7], however, its applicability for MWAB scenario is FFS

9. SMF sends 'Session Modification Request' to PDU Session Anchor (PSA) UPF to update it about the different CN Tunnel Info based on the new intermediate UPF selection in step 8. This CN tunnel info will be used by the UPF (PSA) to setup the new downlink N9 path to facilitate the handover to T-UPF.

10. UPF (PSA) sends 'Session Modification Response' to SMF by providing CN Tunnel Info for establishing N9 interface (with T-UPF).

11. SMF sends 'Session Establishment Request' with CN Tunnel Info of UPF (PSA) to T-UPF. This information will be used by the T-UPF to establish N9 interface with UPF (PSA).

12. T-UPF responds SMF with 'Session Establishment Response' including UL CN Tunnel Info for N3.

NOTE 3: MWAB can also choose to modify its tunnel to facilitate the path switch. This would entail additional steps for both the entities to exchange the updated tunnel information.

13. SMF sends 'Session Establishment Request' with N3 forwarding information of MWAB to the T-UPF. This establishes N3 downlink tunnel at T-UPF towards MWAB.

14. T-UPF allocates the Tunnel Info and responds to SMF with 'Session Establishment Response'.

15. SMF sends 'PDU Session Update Response' to T-AMF including CN Tunnel Info of T-UPF to be forwarded to MWAB.

16. T-AMF sends 'MWAB Handover Update' by providing the CN Tunnel Info of T-UPF received from SMF to MWAB. This information is used by the MWAB to establish the N3 interface with T-UPF.

NOTE 4: This stage completes the uplink path establishment, after which the uplink data start flowing through the T-UPF to UPF (PSA).

17. MWAB send 'MWAB Handover Complete' to T-AMF indicating path establishment with T-UPF.

NOTE 5: To assist the reordering function in the MWAB, UPF (PSA) sends one or more 'end marker' packets for each N3 tunnel on the old path, immediately after switching the path. So, the data flow now happens between UPF(PSA) and UE through T-UPF.

18. Once the handover is complete on MWAB, T-AMF informs SMF to release the old session tunnels on S-UPF.

Editor's note: Reuse of existing procedures for Mobility Registration Update for UEs with AMF change is FFS.

### 6.10.4 Handover of MWAB-UE

Editor's note: Mobility of MWAB-UE including the scenario of AMF change for MWAB-UE due to its mobility is FFS.

### 6.10.5 Impacts on services, entities, and interfaces

Impacts on existing entities:

**AMF:**

- Support relevant message exchange and functionality for handling the handover procedure.

Functions required at new entities:

**MWAB:**

- Support relevant message exchange for handling the handover procedure.

## 6.11 Solution #11: Location services involving MWAB

### 6.11.1 General

This solution addresses KI#5 and proposes to reuse the location functionality specified for MBSR in Rel-18. According to clause 4.1, the MWAB-UE may be served by different PLMN than the UE connected to the MWAB-gNB. The N2 reference point between the MWAB-gNB and the AMF serving the UE is provided by IP connectivity addressed in KI#1.

Editor's note: Whether and how to attach the Additional ULI (i.e. the cell-ID of the cell serving the MWAB-UE) to the N2 message is FFS.

### 6.11.2 Functional descriptions

A MWAB may have location service capability as specified in TS 38.305 [11] and participate in the location service of a UE. As the MWAB may be moving, the location service procedures need to be enhanced as following for an accurate estimation of the UE positioning:

- The UE reports the cell-IDs of all the cells the UE performed DL positioning measurements on as specified in TS 37.355 [12].

- The MWAB which performed the location service procedures for the UE includes its cell-ID in the reported UL positioning measurement.

- The LMF decides whether the cell ID(s) corresponds to MWAB(s) based on information received in a TRP information exchange i.e. that the cell-ID belongs to a MWAB and the UE-ID (GPSI) associated with MWAB.

Editor's note: It is FFS whether the AMF serving the UE provides an indication that UE is connected via MWAB node to the LMF.

- The LMF uses the serving cell-ID provided by the AMF in the Nlmf\_Location\_DetermineLocation service operation. Or,

- The LMF uses the reported cell-ID(s) in the measurement report to derive whether the cell-ID(s) corresponds to a MWAB. There can be multiple MWAB cells in the measurement report.

- To aid the LMF to improve the accuracy of the UE location estimation, the MWAB's location and velocity information and time of obtaining its location measurement data should be obtained by the LMF when available. The LMF uses the received location and velocity of the MWAB(s) when estimating the location of the Target UE.

- The LMF can derive the location and velocity of the MWAB by using NRPPa or by requesting the GMLC to derive the location of the MWAB-UE using the UE-ID of the MWAB. The GMLC triggers MT-LR procedure as specified in clause 6.11.1 or 6.11.2 in TS 23.273 [6].

- As the timing of the location estimations for the Target UE and MWAB(s) is important for the quality of the location estimation of the Target UE, the LMF needs to reduce the timing offset of the positioning measurements, i.e. the positioning of the Target UE and MWAB can be scheduled with using the same scheduled location time and compensate for the potential time difference of the positioning measurements, e.g. taking velocity of MWAB into account.

- The GMLC may skip the privacy check of the MWAB if the MWAB is involved in the positioning of a UE (UE different from the MWAB). If the positioning of the MWAB is performed for the location estimation of the MWAB itself when MWAB acts as a normal UE, the UE privacy check is performed as specified in TS 23.273 [6].

### 6.11.3 Procedures

#### 6.11.3.1 5GC-MT-LR procedure involving MWAB (same PLMN)

The 5GC-MT-LR procedure involving MWAB when the UE and MWAB-UE is served by the same PLMN is shown in Figure 6.11.3.1-1.



Figure 6.11.3.1-1: 5GC-MT-LR procedure involving MWAB (same PLMN)

The differences with the 5GC-MT-LR procedure involving Mobile Base Station Relay procedure in clause 6.1.4 in TS 23.273 [6] are that the AMF/LMF can interact directly with the MWAB instead of via the Donor-CU, the NRPPa termination point is the MWAB-gNB and the following:

Precondition: The OAM have triggered the LMF to perform TRP Information Exchange procedure. The LMF learns that a new integrated TRP at the MWAB-gNB is mobile and its MWAB-UE ID (GPSI) via a TRP information exchange towards the gNB with the cell-ID of the TRP.

NOTE: Signalling between MWAB and the network where the MWAB is connected, including the TRP Information Exchange procedure, is carried via the BH PDU Session of MWAB-UE as defined in Key issue#1.

- Step 1: the MBSR is replaced by the MWAB.

- Step 2: same as step 2 in clause 6.1.4 in TS 23.273 [6].

- Step 3: the MBSR is replaced by the MWAB.- Step 4: the step can be simplified as follows:

- LMF derives if any MWAB(s) is involved in the positioning of the target UE based on the cell-ID(s) used for positioning measurements in the step 3. If the LMF selects any cell for UE positioning measurements, and the LMF determines it needs to perform a TRP information exchange with the cell, it performs TRP Information Exchange procedure as specified in TS 38.455 [13]. As the MWAB can be mobile the LMF may need to determine an updated location of the MWAB by either performing step 5-7 (option 1) or performing step 8-10 (option 2) if option 1 is not feasible. If several MWABs were derived, then step 5-7 or step 8-10 are be performed for each MWAB.

- Step 5: the interaction on F1 interface is removed and the MBSR is replaced by MWAB.

- Step 6: the MBSR IAB-UE is replaced by MWAB-UE, the co-located MBSR IAB-DU is replaced by co-located MWAB-gNB.

- Step 7: the interaction on F1 interface is removed and the text is replaced by the following sentence:

- [Conditional] The MWAB reports its updated TRP location, e.g. TRP's geo-coordinate, velocity, and the time for obtaining them to the LMF.

- Step 8: the MBSR IAB-UE is replaced by MWAB-UE and the MBSR is replaced by MWAB.

- Step 9: the MBSR (IAB-UE) and MBSR IAB-UE are replaced by MWAB-UE, and the MBSR is replaced by MWAB.

- Step 10: the MBSR IAB-UE is replaced by MWAB-UE.

- Step 11: the MBSR is replaced by MWAB.

- Step 12: the MBSR is replaced by MWAB.

- Step 13-15: same as step 13-15 in clause 6.1.4 in TS 23.273 [6].

#### 6.11.3.2 5GC-MT-LR procedure involving MWAB (roaming to same PLMN)

If the MWAB-UE is roaming to a VPLMN and the MWAB-gNB operates as a gNB in the VPLMN (i.e. MWAB-UE and MWAB-gNB are, respectively, registered and connected to the same PLMN), then the procedure in clause 6.11.3.1 can be used with the following difference.

- After the (H)GMLC received the LCS Service Request from the LCS Client the (H)GMLC invokes the Nudm\_UECM\_Get service operation towards the UDM and the UDM returns to the (H)GLMC the network addresses of the current serving AMF and additionally the address of a VGMLC (for roaming case) as step 3 in clause 6.1.2 in TS 23.273 [6].

- Step 4 in clause 6.1.2 in TS 23.273 [6] is performed.

- Step 2-14 as in clause 6.11.3.1 is performed as described with the difference that the GMLC is the VGMLC.

- Step 23-24 clause 6.1.2 in TS 23.273 [6] is performed.

#### 6.11.3.3 5GC-MT-LR procedure involving MWAB (different PLMN)

If the MWAB-UE is served by PLMN 1 as shown in figure 6.1.1-1 and the MWAB-gNB operates as a gNB in PLMN 2 as shown in figure 6.1.1-1 i.e. MWAB-UE and MWAB-gNB are, respectively, registered and connected to the different PLMNs, then the procedure in 6.11.3.1 can be used with the following difference.

- Step 3 When the Target UE is served by a MWAB-gNB in a coverage area of the PLMN 1, then the Target UE may only perform measurements on TRP(s) of PLMN 2 or only TRP(s) of PLMN 2 would perform measurements on the SRS transmitted by the Target UE.

- Step 6 The MWAB-UE will trigger 5GC-MO-LR in PLMN 1.

- Step 9 The GMLC of the Target UE will trigger the (H-)GMLC of the MWAB-UE to perform the location estimation of the MWAB-UE as specified in clause 6.1.2 in TS 23.273 [6].

- Step 12 The accuracy of the location estimation of the Target UE may be limited as only one TRP was part of the measurement report, if there are no further TRPs of same PLMN used.

#### 6.11.3.4 5GC-MO-LR Procedure involving MWAB (non-roaming and roaming to same PLMN)

This procedure is based on clause 6.2 of TS 23.273 [6] as illustrated in figure 6.11.3.4-1 below. The procedure support both the non-roaming case and when the MWAB-UE is roaming to a VPLMN and the MWAB-gNB operates as a gNB in the VPLMN(i.e. MWAB-UE and MWAB-gNB are, respectively, registered and connected to the same PLMN).



Figure 6.11.3.4-1: 5GC-MO-LR procedure involving MWAB node (same PLMN)

The following steps, referring to steps in clause 6.2 of TS 23.273 [6] as baseline, are enhanced to replace the MSBR with MWAB.

3. The AMF selects a LMF that supports MWAB. The AMF may know the UE is served by a MWAB as it uses an NG connection of a MWAB.

5. If the LMF detects based on the cell-ID and additional indication that the UE is served by a MWAB, the LMF may perform the operation of clause 6.11.3.1 step 5 to step 7, or step 8 to step 10, to obtain the MWAB location information. The LMF will take the MWAB location into account when determining the UE's location.

#### 6.11.3.5 5GC-MO-LR Procedure involving MWAB (different PLMN)

If the MWAB-UE is served by PLMN 1 as shown in figure 6.1.1-1 and the MWAB-gNB operates as a gNB in PLMN 2 as shown in figure 6.1.1-1 i.e. MWAB-UE and MWAB-gNB are, respectively, registered and connected to the different PLMNs, then the procedure in clause 6.11.3.4 can be used with the following difference.

- Step 5 When the LMF in PLMN 2 performs the operation of clause 6.11.3.1 step 5 to step 7, or step 8 to step 10, to obtain the MWAB location information, In step 6 the MWAB-UE will initiate 5GC-MO-LR in PLMN 1. In step 8 the GMLC in PLMN 2 will trigger the GMLC in PLMN 1 to perform the location estimation of the MWAB-UE as specified in clause 6.1.2 in TS 23.273 [6]. The accuracy of the location estimation of the Target UE may be limited as only one TRP was part of the measurement report.

### 6.11.4 Impacts on services, entities, and interfaces

**UE:**

- No impact.

**AMF:**

- No impact.

**LMF:**

- Manage a list of which cell-ID(s) corresponds to a TRP(s) of MWAB-gNB(s).

- When performing location estimate apply same method when a MWAB is involved as when a MBSR is involved.

**GMLC:**

- No impact.

**NRPPa:**

- No impact, same TRP information Type is set to 'mobile trp location type' for a MWAB as for a MBSR.

## 6.12 Solution #12: support of Emergency services for UEs via a MWAB

### 6.12.1 Key Issue mapping

This solution addresses Key Issue #6.

### 6.12.2 Functional Description

This solution proposes to support the following features regarding emergency services when the UE connecting to MWAB:

- Report the Cell ID/TAC that the UE is currently located when the target UE is connected to MWAB and is in CM-CONNECTED state. It is essentially meaningless to reporting the Cell ID/TAC of the MWAB-UE to the serving PLMN OAM of the MWAB-gNB since they are typically different. Therefore, it is suggested to timely update the Cell ID/TAC broadcasted by the MWAB-gNB as per its location, so as to resolve the emergency service concern.

NOTE 1: Update the Cell ID/TAC broadcasted by the MWAB-gNB as per its location will be addressed by the solution of KI#4.

- Support the location services for UEs when MWAB(s) is involved, especially when the MWAB roams to the VPLMN.

NOTE 2: Support the location services for UEs when MWAB(s) is involved will be addressed by the solution of KI#5.

- Support of graceful Release (i.e. not affecting the on-going potential emergency service of the UE(s) connecting to MWAB-gNB). Note that this issue is also related to KI#2 (*Authorization of a MWAB and configuration of MWAB*), and KI#4 (*Efficient mobility and service continuity when served by MWAB*) when the authorization of the MWAB updates or MWAB moves to the area where the MWAB cannot act as MWAB-gNB. This solution mainly addresses the release procedure in those conditions.

NOTE 3: Support of the authorization update will be addressed by the solution of KI#2.

### 6.12.3 Procedures

With extrapolation of the features defined in TS 23.501 [2] to emergency service and Rel-18 MBSR, the following is defined:

- Report the Cell ID/TAC that the UE is currently located when the target UE is connected to MWAB and is in CM-CONNECTED state.

NOTE 1: Timely update the Cell ID/TAC broadcasted by the MWAB-gNB as per its location will be addressed by the solution of KI#4.

- Support the location services for UEs when MWAB(s) is involved, including when the MWAB roams to the VPLMN.

NOTE 2: Support the location services for UEs when MWAB(s) is involved will be addressed by the solution of KI#5.

- Support of graceful Release (i.e. not affecting the on-going potential emergency service of the UE(s) connecting to MWAB-gNB), i.e. when there is an update of the MWAB authorization from authorized to non-authorized, the release of the NGAP connection between AMF and MWAB-gNB will consider the service continuity.



Figure 6.12.3-1: Support of Emergency Services for UEs via a MWAB

0. MWAB-UE triggers registration towards the selected PLMN and authorization of the MWAB operation is performed as defined in Key Issue#2.

1. The MWAB-gNB establishes BH PDU Session for N2/N3 and initiates NG setup procedure with AMF.

The BH PDU Session is associated with dedicated DNN/S-NSSAI as defined in Key Issue#1.

2. The MWAB-gNB initiates the service towards normal UE. The normal UE registers with network via MWAB-gNB.

3. The normal UE requests PDU Session Establishment.

In the case of PDU Sessions for Emergency Services (i.e. with a Request Type indicating 'Emergency Request'), the details of handling of PDU Sessions for Emergency Services are described in clause 5.16.4 of TS 23.501 [2].

4. The authorization of MWAB-UE is changed (from authorized to non-authorized) as defined in Key Issue#2. The BH AMF notifies the current authorization status to the MWAB-UE.

NOTE 3: The procedure below applies to the scenario that the authorization status of the MWAB-UE is changed due to subscription update from the 5GC, or the mobility of the MWAB-UE (e.g. to the restricted Area).

5. The MWAB-gNB triggers the handover procedures of the for UEs in RRC\_CONNECTED state served by the MWAB-gNB, no matter whether the UEs are accessing Emergency Services or not.

6. The NGAP connection between AMF and MWAB-gNB is released.

7. If the MWAB-UE's serving PLMN allows the non-authorized MWAB to be registered in the PLMN:

- The release of BH PDU Session for N2/N3 may be initiated by the MWAB-gNB after the MWAB has completed the related operations, including e.g. the handover of the UEs the MWAB and NGAP connection release.

- After a certain period (e.g. based on the expiration of a timer configured on the AMF, if the AMF haven't received the release request of BH PDU Session for N2/N3 by the MWAB-gNB, the BH AMF may determine the BH PDU Session based on dedicated DNN/S-NSSAI and may trigger to release the BH PDU Session.

If the MWAB-UE's serving PLMN doesn't allow the non-authorized MWAB to be registered in the PLMN, the handling is described in the following:

- The deregistration is initiated by the MWAB-UE after the MWAB-gNB has completed the related operations, including e.g. the handover of the UEs the MWAB and NGAP connection release.

NOTE 4: It is assumed that the MWAB-UE is notified that the MWAB-gNB has completed the related operations via internal interface.

- After a certain period (e.g. based on the expiration of a timer configured on the AMF), if the AMF doesn't receive the deregistration request of the MWAB-UE, the BH AMF triggers the deregistration.

### 6.12.4 Impacts on existing services, entities and interfaces

Impacts of the Network Entities as per the solution of KI#2, KI#4 and KI#5.

## 6.13 Solution #13: Support of emergency calls in MWAB

### 6.13.1 General

This solution addresses Key Issue #6: Support of Emergency services for UEs via a MWAB.

### 6.13.2 Functional descriptions

The solution proposes that the MWAB establishes a dedicated BH PDU session for emergency when an emergency session is ongoing, using the S-NSSAI and a DNN reserved for emergency sessions backhaul support. These are configured in the MWAB-gNB and AMF of the PLMN the MWAB-gNB broadcasts the PLMN ID of.

The BH PDU session is also provided an ARP value that corresponds to the ARP values reserved for emergency services.

NOTE: It is assumed the N2 BH PDU session supports adequate QoS and resiliency to not require any special handling when some UEs served by the gNB are in an emergency call. The BH-PDU session for emergency is used for the UP only.

The trigger for the MWAB to establish a BH PDU session for emergency is one of these:

*UE places emergency call from CM-IDLE*

If the UE was CM-IDLE mode before initiating the emergency call, the MWAB-gNB detects that the UE includes EMERGENCY as RRC establishment cause. If so the MWAB-gNB immediately starts establishment or modification of a BH PDU session for emergency. When the BH session is established the MWAB-gNB further associates UE PDU sessions for emergency (i.e. sessions with ARP value for emergency) to the BH PDU session for emergency support.

*UE places the emergency call from CM-CONNECTED*

If the UE was in CM-CONNECTED mode before it initiates the emergency call, the MWAB-gNB detect the emergency call by inspection of the ARP value it received for a session of a UE. This triggers the MWAB-gNB to establish an emergency BH session if one was not already established, and to associate this UE session to the BH session for emergency.

In all cases, if the BH PDU session for emergency support was already established because of another ongoing or recently terminated emergency PDU session of another UE, the MWAB-gNB only associates the new UE emergency PDU session to the BH PDU sessions for emergency, and it may trigger a modification to ensure incremental QoS.

When the MWAB-gNB detects a UE emergency PDU session is released, if this is the last emergency PDU session then the MWAB-gNB may release the BH PDU session for emergency.

### 6.13.3 Procedures

This clause provides high level view of the type of impact expected by this solution.

*UE places emergency call from CM-IDLE*



Figure 6.13.3-1: Emergency BH PDU session establishment for a UE which was CM-IDLE

0. AMF serving MWABs is configured by OAM with S-NSSAI and DNN value for BH PDU session for emergency support.

1. The MWAB-gNB is configured (e.g. by OAM) with the S-NSSAI, DNN of emergency BH sessions.

2. The UE is in CM-IDLE state.

3. The UE needs emergency service; hence it triggers RRC connection establishment with indication of RRC connection establishment cause code 'emergency'.

4-5. The MWAB-gNB detects the emergency cause code and starts the establishment/modification of a BH PDU session for emergency support using the configured data at step 1.

6. The UE served by MWAB starts establishment of the emergency session and the AMF of the UE sends to MWAB the SMF requested N2 information for SM and this includes the ARP value for the session to be one of the emergency services reserved value. Note the UE may start this step while the MWAB is performing steps 4-5 as the BH-PDU session for emergency is for the UP of emergency calls. However, steps 4-5 need to complete before step 7.

7. The MWAB-gNB detects the emergency services ARP value and associates the emergency PDU session for UE to the emergency BH PDU session.

8. The emergency PDU session establishment for UE completes.

*UE places the emergency call from CM-CONNECTED*



Figure 6.13.3-2: Emergency BH PDU session establishment for a UE which was CM-CONNECTED

0. AMF serving MWABs is configured by OAM with S-NSSAI and DNN value for BH PDU session for emergency support.

1. The MWAB-gNB is configured (e.g. by OAM) with the S-NSSAI, DNN of emergency BH sessions.

2. The UE is CM-CONNECTED state.

3. The UE served by MWAB starts establishment of the emergency session and the AMF of the UE sends to MWAB the SMF requested N2 information for SM and this includes the ARP value for the session to be one of the emergency services reserved value.

4-5. The MWAB-gNB detects the emergency PDU session is being established by the ARP values and starts the establishment of a BH PDU session for emergency support using the configured data at step 1.

7. The MWAB associates the emergency PDU session for UE to the emergency BH PDU session.

8. The emergency PDU session establishment for UE completes.

### 6.13.4 Impacts on services, entities, and interfaces

**MWAB:**

- Support the establishment and maintenance of the BH PDU session for emergency as outlined above.

**OAM:**

- configuration of S-NSSAI, DNN for BH PDU session for emergency at MWAB-gNB and AMF supporting MWAB UEs handling.

**AMF:**

- support of BH PDU session for emergency configuration data.

## 6.14 Solution #14: Graceful release of emergency services.

### 6.14.1 Description

1) When AMF decides to deregister the UE for e.g. because of notification from UDM, and if it finds the emergency PDU session is active for the UE, then AMF sends UE configuration command message and indicates registered for emergency services (see TS 24.501 [14]and TS 23.502 [7]). The AMF meanwhile initiates for release of non-emergency PDU session. Thus, there is no opportunity for MWAB to perform graceful release of servicing UEs.

2) When AMF needs to deregister the UE, it may first send the MWAB-unauthorized information to the MWAB-UE (following discussion of KI#2), but it is possible that serving UEs (having emergency session) may not be able to get handed over to another NG-RAN. In such a case, emergency sessions of the serving UE will be impacted.

This clause proposes solutions to above problems.

### 6.14.2 Procedures

#### 6.12.2.1 Procedure for graceful release of serving UEs when MWAB-UE is having active emergency PDU session



Figure 6.14.2.1-1: Graceful release of serving UEs when MWAB-UE is having active emergency PDU session

1. MWAB-UE is authorized for MWAB operations.

2. MWAB-UE is having an emergency PDU session.

3. UDM triggers Deregistration notification for MWAB-UE.

4. The AMF will first inform MWAB-UE that it should be registered for emergency services and non-emergency PDU sessions are not allowed.

5-8. The MWAB performs clean-up and hands over the UEs to neighbouring NG-RAN.

9. UE configuration update (UCU) complete message is sent to the AMF indicating MWAB operations have stopped. Optionally UE can enter registered for emergency services state and release all non-emergency PDU sessions.

Editor's note: How to avoid potential time out at network due to delay in sending UCU complete message from UE is FFS.

10.The AMF may send UE configuration update command to indicate to registered for emergency services as described in TS 24.501 [14]. The UE enters registered for emergency services state and releases all non-emergency PDU sessions.

11. The AMF triggers release of non-emergency PDU sessions.

#### 6.14.2.2 Procedure for graceful release of serving UEs when they have active emergency PDU session



Figure 6.14.2.2-1: Graceful release of serving UEs when they have active emergency PDU session

1. MWAB-UE is authorized for MWAB operations.

2. MWAB-UE is having an emergency PDU session.

3. UDM triggers deregistration notification for MWAB-UE.

4. The AMF will first inform MWAB-UE that it is unauthorized for MWAB operations.

5-6. The MWAB-gNB identifies a UE having an PDU session for emergency services and that the UE could not be handed over to target gNB. The MWAB-gNB may broadcast appropriately such that other UEs do not get into connected mode any more.

7. MWAB-UE sends UE configuration update complete to the AMF indicating emergency services are pending.

8. On completion of emergency services, the UE indicates to the AMF emergency services are completed as part of UE configuration update complete message.

9. The AMF now triggers deregistration procedure.

### 6.14.3 Impacts on services, entities and interfaces

This solution impacts the following system entities.

**AMF:**

- Before sending UCU with registered for emergency services, the AMF should indicate to MWAB-UE that it is unauthorized for MWAB operations. So that it can gracefully stop MWAB operations and later the non-emergency PDU sessions are released.

- If MWAB-UE indicates emergency services are pending then it should delay the deregistration procedure.

**MWAB-UE:**

- The MWAB-UE should gracefully stop MWAB operations and later the non-emergency PDU sessions are released. If any emergency session of serving UEs cannot be released, then AMF is informed so that deregistration procedure is delayed.

## 6.15 Solution #15: Protocol Stacks of backhaul link to support the N2/N3 interface for MWAB node

### 6.15.1 General

This solution is for Key Issue #1, which addresses the protocol stacks of the backhaul link using a PDU session to support the N2/N3 interfaces for a MWAB node.

### 6.15.2 Description

Based on the Non-Roaming MWAB architecture for 5GS in Figure 4.1-1, BH PDU sessions are established between MWAB-UE and UPF for MWAB-UE (i.e. MWAB-UE-UPF) within BH-5GC to transfer N2/N3 signalling/data, where N2 interface is between MWAB-gNB and AMF within 5GC serving UE and N3 interface is between MWAB-gNB and UPF for UE (i.e. UE-UPF) within 5GC serving UE. In this solution, the protocol stacks for wireless backhauling of N2/N3 interface of MWAB via IP connectivity provided by PDU sessions are introduced.

### 6.15.3 Procedures

#### 6.15.3.1 Protocol Stacks of backhaul link to support the N2 interface for MWAB node

Figure 6.15.3.1-1 illustrates Protocol Stacks of backhaul link to support the N2 interface for MWAB node. MWAB-UE connects to BH gNB. A PDU session between MWAB-UE and MWAB-UE-UPF is established as a backhaul link to support the overlayed N2 interface. The N2 interface terminates at MWAB-gNB and AMF respectively, which includes NGAP and SCTP/IP layer protocols between them.



Figure 6.15.3.1-1: Protocol Stacks of backhaul link to support the N2 interface for MWAB node

#### 6.15.3.2 Protocol Stacks backhaul link to support the N3 interface for MWAB node

Figure 6.15.3.2-1 illustrates Protocol Stacks backhaul link to support the N3 interface for MWAB node. A PDU session between MWAB-UE and MWAB-UE-UPF is established as a backhaul link to support the overlayed N3 interface. The N3 interface terminates at MWAB-gNB and UE-UPF respectively, which includes GTP-U and UDP/IP layer protocols between them. UE connects to MWAB-gNB. A PDU session between UE and UE-UPF is realized by 1) the Uu DRB between UE and MWAB-gNB, and 2) the NG-U between MWAB-gNB and UE-UPF on top of the backhauling PDU session between MWAB-UE and MWAB-UE-UPF.



Figure 6.15.3.2-1: Protocol Stacks of backhaul link to support the N3 interface for MWAB node

### 6.15.4 Impacts on services, entities and interfaces

The impacts will be captured in the related procedures of establishing the backhaul links to support N2/N3 interface.

## 6.16 Solution #16: Support for multiple backhaul PDU sessions

### 6.16.1 Introduction

This solution addresses how backhaul PDU sessions can be established by the MWAB-UE and how MWAB-gNB can utilise different BH PDU sessions for different traffic types of the MWAB-gNB and the UEs connected via the MWAB-gNB. It provides methods to support traffic categorization for MWAB.

### 6.16.2 Functional Description

A MWAB node includes an MWAB-gNB function and an MWAB-UE function as described in clause 4. The MWAB-gNB part further provides access connectivity to the UEs.

There are different types of traffic will be transmitted from MWAB-gNB. The traffic can be categorized in different ways. One example is shown below:

- RAN-CN N2 interface management.

- UE N2 signalling (including mobility and session).

- UE N3 user plane traffic.

- MWAB-gNB OAM access.

- Xn traffic and signalling.

Based on local implementation-based mapping and optionally URSP rule deployed in the MWAB-UE, these different types of traffic can be used by the MWAB-gNB and the MWAB-UE to decide if an existing BH PDU session can be used or a new BH PDU session shall be established.

For the UE N3 user plane traffic, MWAB-gNB and MWAB-UE implementation can further decide, e.g. based on mapping of QoS flow of the UE PDU session and QoS flow of the BH PDU session, how the traffic of different UE PDU sessions can be delivered in the existing or new BH PDU sessions.

### 6.16.3 Procedures

#### 6.16.3.1 Triggering of PDU session establishment or modification

This procedure describes the MWAB node authorization steps and the operations with focus on the 5GC aspects.



Figure 6.16.3.1-1: MWAB node authorization and operation initiation

1. The MWAB-UE triggers registration and becomes authorized to operate as MWAB.

2. Based on different traffic types that are transmitted by the MWAB-gNB, local implementation-based mapping configuration, and optionally URSP rule deployed in the MWAB-UE, the MWAB decides to establish a new BH PDU session, or to modify an existing BH PDU session or to use an existing BH PDU session without any modification.

3. The MWAB-UE may trigger either the PDU session establishment procedure or the PDU session modification procedure, if needed.

4. Different traffic types are exchanged among UE, MWAB-gNB and destination NFs.

NOTE 1: The detailed communication between MWAB-gNB and MWAB-UE is implementation based and not in SA WG2 scope.

NOTE 2: The categorization of the signalling and traffic from MWAB-gNB needs to further synch with RAN WGs.

### 6.16.4 Impacts on services, entities, and interfaces

None.

# 7 Evaluation

Editor's note: This clause provides the evaluations of the solutions of clause 6.

# 8 Conclusions

## 8.1 KI#1: Architectural enhancements for the support of a MWAB Conclusion

The system architectures as shown in Figure 6.1.1-1 to 6.1.1-3 are agreed to be used as the basis for normative work for the cases where PLMNs are involved. Following additional aspects to be addressed in normative phase:

- Naming of the entities, e.g. MWAB-UE UDM vs. HPLMN UDM;

- Clarifications that the MWAB's HPLMN and PLMN2 can be the same PLMN;

The system architecture as shown in Figure 6.7.1-1 and 6.7.1-2 are agreed to be used as the basis for normative work for the case of SNPN(s) are involved. Additionally, the architecture also supports the following option:

- SNPN 1 is replaced by PLMN, and SNPN 2 is a SNPN.

The following general principles are agreed to be used as the basis for normative work:

- MWAB-gNB connection with OAM server is over the IP connectivity provided by the PDU session of MWAB-UE.

- MWAB-gNB N2 interface with UE-AMF is provided over the IP connectivity offered by the PDU session of MWAB-UE.

- MWAB-gNB N3 interface with UE-UPF is over the IP connectivity provided by the PDU session of MWAB-UE.

- MWAB-gNB Xn interface with other gNBs can be supported over the IP connectivity provided by the PDU session of MWAB-UE.

- Same or different PDU Sessions of MWAB-UE can be used for carrying the above traffic.

NOTE 1: The use of multiple PDU Sessions for N2 vs. N3 vs. Xn vs. OAM access, and what specific configuration is needed will be addressed in normative phase.

- If QoS optimization of the N3 connection is required, then the MWAB-gNB is configured (e.g. by OAM) with the mapping of the 5QIs to the DSCP field for TNL used by the UPFs/gNBs in the PLMN/SNPN serving the UE via the MWAB-gNB. This is then used to establish SDFs at the BH-PDU session used for N3 connection(s) based on existing procedures.

- OAM server address(es) for the PLMN(s) is assumed to be configured on MWAB-gNB.

- The AMF address is assumed to be configured by the OAM server to the MWAB-gNB.

- The MWAB-gNB indicates to the AMF(s) it is a MWAB when it establishes the N2 connection to the AMF(s).

NOTE 2: This requires RAN3 to define this indication.

- The PLMN serving the MWAB-UE should NOT be assumed to have control of MWAB-gNB's configurations (as the MWAB-gNB can be serving a different PLMN than the PLMN serving the MWAB-UE).

- MOCN should be supported by MWAB-gNB.

NOTE 3: Whether any specification impact is needed for MOCN support can be decided in normative phase.

## 8.2 KI#2: Authorization of a MWAB and configuration of MWAB Conclusion

It is proposed to proceed normatively based on these principles:

- MWAB-UE authorization and MWAB-gNB service authorization are two different authorizations and managed by different entities in the networks. The BH PLMN 5GC controls the first based on MWAB-UE subscription; and the OAM the MWAB-gNB connects to controls the latter.

- There is no need to specify AS level indication in RRC connection establishment that the MWAB-UE intends to operate as MWAB. Dedicated S-NSSAI(s)/DNN for MWAB operation may be used for a MWAB-UE to indicate the intension to BH 5GC.

- There is no need to indicate to NG-RAN serving a MWAB-UE that the MWAB-UE is authorized to act as MWAB-UE.

- The MWAB-UE authorization supports time based or location-based control. For time-based control, existing slice subscription control can be reused. For location-based control, existing mechanism, e.g. service area restriction, DNN/LADN based control can be reused.

In addition, per operator/PLMN based location restriction on S-NSSAI can also affects the MWAB-UE authorization.

- MWAB-gNB's OAM is assumed to be aware of the MWAB-UE authorization limitations (pre-determined authorizations) and may (pre-)configure/trigger MWAB-gNB to turn on/shut down accordingly.

- When the MWAB-UE's authorization status changes from "authorized" to "unauthorized", if the AMF recognized the dedicated S-NSSAI/DNN used by the MWAB-UE, e.g. a S-NSSAI for BH PDU session support, the AMF triggers the BH PDU session handling based on existing mechanism e.g. the AMF sends an UCU to MWAB-UE and may determine to delay the corresponding PDU session release based on an operator configuration (e.g. local configured timer).

If the AMF does not recognize the dedicated S-NSSAI/DNN, or is not configured with a timer, the AMF release the PDU session as usual.

If the AMF choose to de-register the MWAB-UE, no enhancement is introduced in this release.

- When the MWAB-gNB is no longer authorized to operate by OAM, the MWAB-gNB should hand over the UE(s) it serves to other cells For the case that the BH PDU sessions are released by the MWAB-UE, the MWAB-gNB also performs shut-down steps.

NOTE 1: The assumptions on RAN WGs and SA5 impacts of this KI will be further aligned during normative phase.

NOTE 2: It is assumed that the OAM ensures the de-authorization of a MWAB-gNB (as described in bullet 4 above) is not conflicting with the de-authorization of MWAB-UE e.g. the allowed NSSAI for the BH PDU sessions of the MWAB-UE is maintained long enough for the MWAB-gNB to moves the connected UE away. The coordination of the MWAB-gNB service authorization/configuration from OAM and the update of subscription data (e.g. slice/DNN) of the MWAB-UE is handled by OAM/management system.

## 8.3 KI#3: Control of UE's access to 5GS via a wireless access backhaul Conclusion

The following principles are agreed to be used as the basis for normative work:

- The existing CAG mechanism (as defined in Rel-18 for MBSR) can be used as an optional method for managing UE's access to MWAB-gNB, for PNI-NPN deployment cases.

- Existing SNPN control mechanism can be used to manage the UE's access to MWAB-gNB, in case the MWAB-gNB is serving a SNPN.

- When there is mixed deployment of fixed gNB(s) and MWAB-gNB(s) for SNPN, existing SNPN control mechanism can be reused to differentiate the cells, and no standards impact is expected.

## 8.4 KI#4: Efficient mobility and service continuity when served by MWAB Conclusion

The following principles are agreed to be used as the basis for normative work:

- There is no requirement to change the UE mobility behaviour for UEs served by a MWAB-gNB.

- MWAB-gNB's configurations (e.g. Cell ID/TAC, AMF address, etc.) are managed by OAM of the PLMN it serves, based on the location information of the MWAB.

- The MWAB UE, can, provide to the MWAB-gNB its current geolocation or TAC/Cell ID of the BH gNB serving the MWAB-UE. SA2 will not further work on this aspect that is internal to the MWAB.

- The MWAB- gNB can obtain from the OAM of the PLMN/SNPN it serves new Cell ID, TAC as it moves around in the PLMN/SNPN. The OAM can provide the new configuration by receiving geolocation of MWAB UE or TAC/Cell ID serving the MWAB-UE (the latter is possible only if the MWAB UE PLMN/SNPN and MWAB-gNB PLMN/SNPN are the same), or by providing to the MWAB the applicable configurations of the MWAB-gNB that take into account different geographic locations in the PLMN/SNPN serving the MWAB-UE (based on geodetic shapes or cell ID/TAC of cells serving the MWAB-UE if that is possible).

- The detailed interactions between MWAB-gNB and OAM, e.g. the location information, is out of scope of SA WG2. In normative phase, requirements on the information provided to OAM and impact on the MWAB-UE/MWAB-gNB interface will be identified together with SA WG5.

- The existing mobility procedures without enhancements can be reused to handle UE's mobility to/from a MWAB-gNB or while the UE is served by a MWAB-gNB.

- It is assumed that when MWAB-gNB changes the AMF it connects due to mobility, the TAC(s) and Cell ID(s) it announces also change.

NOTE 1: The change of TAC triggers MRU of CM-IDLE UE(s) and change of Cell ID (including gNB-ID) triggers N2 handover of CM-CONNECTED UE(s) (the source AMF decides the new AMF during a N2 HO preparation).

- No specific enhancements will be introduced to support the mobility scenario F (Figure 6.9.2.1-2) with UE(s) kept in CONNECTED mode.

NOTE 2: Any enhancements on this based on other WGs' input should be handled in normative phase as alignment work.

- The MWAB-UE may request new / modify existing N2/N3 BH PDU sessions as the MWAB moves to a new region, upon request from the MWAB-gNB which are based on triggers configured by OAM depending on the MWAB-gNB location. The MWAB-gNB updates the TNL association of the N2 interface and N3 interfaces by using the new IP addresses of the new BH PDU sessions after the new BH PDU sessions are established.

NOTE 3: It is assumed the MWAB-gNB is in control of the establishment and release of the BH PDU sessions in MWAB-UE.

- The MWAB instantiates a new logical MWAB gNB when it is configured with a new TAC (and possibly Cell ID ) and with a different gNB ID. This may be used to support migrating / handing over of UEs served by the MWAB to the new logical gNB. Once all UEs have been migrated, the MWAB removes the old logical MWAB-gNB instance. This can happen e.g. when AMF, serving the UEs of the MWAB, change is required based on the operator policy.

NOTE 4: This aspect will be coordinated with RAN WG3. Whether the gNB ID will be changed will be reviewed in normative phase based on RAN WG3 input taking into account potential AMF impacts.

NOTE 5: The solution based on instantiating multiple virtual cells by the same MWAB-gNB needs to wait for RAN WG3 confirmation.

## 8.5 KI#5: Support of location services for UEs when MWAB(s) is involved Conclusion

The following aspects are taken as way forward during normative work:

- Existing principles (e.g. the two options for LMF to retrieve the MWAB location either via NRPPa procedure or via GMLC) are re-used for UE location service when MWAB is involved as described in sol#11.

- The MWAB-gNB provides to the AMF an Additional ULI. The Additional ULI is:

- TAC/Cell ID of the cell serving the MWAB-UE if the PLMN serving the MWAB-UE and the PLMN broadcasted by the MWAB-gNB are the same PLMN.

- If the PLMN serving the MWAB-UE and the PLMN broadcasted by the MWAB-gNB are not the same PLMN, which below option used for the Additional ULI will be determined in normative phase.

- option 1: mapped TAC/Cell ID based on geo-location of the MWAB based on input from OAM.

- option 2: geo-location of the MWAB.

- option 3: TAC/Cell ID of the cell serving the MWAB-UE in other PLMN.

- The AMF may provide the received Additional ULI to LMF in LCS request.

NOTE: If option 2 is selected in normative phase, support of passing Additional ULI to LMF needs to be reviewed.

## 8.6 KI#6: Support of Emergency services for UEs via a MWAB Conclusion

The following principles are agreed for emergency service support in normative work:

- Emergency services can be supported by MWAB based on the configuration of OAM.

- Some dedicated BH PDU sessions (with specific S-NSSAI and DNN) may be established by MWAB-UE when the MWAB-gNB serves an emergency session. The S-NSSAI of this PDU session is defined by the HPLMN of MWAB-UE. The HPLMN includes this S-NSSAI in the MWAB-UE Subscribed S-NSSAIs.

- The "specific S-NSSAI and DNN" can be operator configured, and S-NSSAI does not require a new standardized SST.

NOTE 1: The roaming agreement is expected to specify this S-NSSAI explicitly. The DNN can be assigned by the serving AMF from a default DNN in subscription for the S-NSSAI.

NOTE 2: The MWAB gNB may choose to not have the dedicated BH PDU session established for N2 or N3 when it serves an emergency session. In this case, the existing BH PDU session for N2 or N3 needs to have QoS sufficient to support high availability of the N2 or N3 interface.

- MWAB-gNB will handover the UEs to other cells before stopping operating as MWAB.

- No enhancements will be introduced for the case where the MWAB-UE itself has an emergency service session and continue to serve the MWAB-gNB.

- When the MWAB is de-authorized and if there are served UEs with emergency calls, the MWAB-UE can be gracefully released (if possible) following the conclusion principles of KI#2

NOTE 3: Clarification on the operation support for international roaming, e.g. how to route the emergency service to local PSAP, will be handled in normative phase.

Annex A:  
Change history

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| --- | --- | --- | --- | --- | --- | --- | --- |
| Change history | | | | | | | |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2400128 | - | - | - | TR skeleton agreed in SA2#160-Ad Hoc-e | 0.0.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401701 | - | - | - | Scope for TR 23.700-06 on VMR\_Ph2. | 0.1.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401702 | - | - | - | Definitions and terminologies for TR 23.700-06 on VMR\_Ph2. | 0.1.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401703 | - | - | - | Architecture assumptions and requirements for TR 23.700-06 on VMR\_Ph2. | 0.1.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401704 | - | - | - | Architecture assumptions for FS\_VMR\_Ph2. | 0.1.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401705 | - | - | - | New KI: Authorization of a MWAB and Configuration of a MWAB-UE | 0.1.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401706 | - | - | - | New KI: MWAB Architecture and procedures | 0.1.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401707 | - | - | - | New KI: Control of UE's access to 5GS via a wireless access backhaul. | 0.1.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401708 | - | - | - | New key issue for VMR\_Ph2 on mobility support. | 0.1.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401709 | - | - | - | New KI: Support of location services. | 0.1.0 |
| 2024-01 | SA2#160-Ad Hoc-e | S2-2401710 | - | - | - | New KI: Support of emergency services. | 0.1.0 |
| 2024-03 | SA2#161 | S2-2403279 | - | - | - | KI #2, 4 - Update with clarification on the RAN-CN connection aspects. | 0.2.0 |
| 2024-03 | SA2#161 | S2-2403713 | - | - | - | New solution proposal: Architecture enhancements for the support of MWAB | 0.2.0 |
| 2024-03 | SA2#161 | S2-2403845 | - | - | - | Key Issue #1: New solution for MWAB architecture and procedures | 0.2.0 |
| 2024-03 | SA2#161 | S2-2403834 | - | - | - | KI#1, New solution: N3 backhaul PDU session management | 0.2.0 |
| 2024-03 | SA2#161 | S2-2403716 | - | - | - | KI#2, New solution, MWAB authorization handling | 0.2.0 |
| 2024-03 | SA2#161 | S2-2403717 | - | - | - | KI#2: New solution on MWAB authentication and authorization | 0.2.0 |
| 2024-04 | SA2#162 | S2-2405501 | - | - | - | KI#3: New solution on reusing CAG mechanism to address the control of access of UE | 0.3.0 |
| 2024-04 | SA2#162 | S2-2405502 | - | - | - | KI#3, New solution on access control to MWAB-gNB for NPN. | 0.3.0 |
| 2024-04 | SA2#162 | S2-2405503 | - | - | - | KI#4, New Sol: Provisioning of efficient mobility and service continuity when served by MWAB | 0.3.0 |
| 2024-04 | SA2#162 | S2-2405504 | - | - | - | KI#4, New solution, UE mobility handling due to MWAB mobility. | 0.3.0 |
| 2024-04 | SA2#162 | S2-2405505 | - | - | - | KI#4, New solution to address mobility aspects of MWAB. | 0.3.0 |
| 2024-04 | SA2#162 | S2-2405506 | - | - | - | KI#5, New Solution: Location services involving MWAB. | 0.3.0 |
| 2024-04 | SA2#162 | S2-2405507 | - | - | - | KI#6: New solution on the support of Emergency services for UEs via a MWAB . | 0.3.0 |
| 2024-04 | SA2#162 | S2-2405508 | - | - | - | KI#6 new solution on Support of emergency calls in MWAB. | 0.3.0 |
| 2024-04 | SA2#162 | S2-2405509 | - | - | - | KI#6: New solution on handling of emergency services. | 0.3.0 |
| 2024-04 | SA2#162 | S2-2405512 | - | - | - | New solution for KI#1, Protocol stacks of backhaul link using a PDU session to support the N2/N3 interface for MWAB node. | 0.3.0 |
| 2024-04 | SA2#162 | S2-2405513 | - | - | - | KI#1, new solution, Support for multiple backhaul PDU sessions. | 0.3.0 |
| 2024-04 | SA2#162 | S2-2405787 | - | - | - | KI#2: Interim conclusions. | 0.3.0 |
| 2024-06 | SA2#163 | S2-2407340 | - | - | - | Conclusion based on NWM discussions | 0.4.0 |
| 2024-06 | SA2#163 | S2-2407341 | - | - | - | KI#1: conclusions | 0.4.0 |
| 2024-06 | SA2#163 | S2-2407342 | - | - | - | KI #2 conclusions. | 0.4.0 |
| 2024-06 | SA2#163 | S2-2407343 | - | - | - | KI #4 conclusions. | 0.4.0 |
| 2024-06 | SA2#163 | S2-2407344 | - | - | - | KI #5 conclusions. | 0.4.0 |
| 2024-06 | SA2#163 | S2-2407274 | - | - | - | KI #6 conclusions. | 0.4.0 |
| 2024-06 | SP#104 | SP-240609 | - | - | - | MCC editorial update for presentation to TSG SA#104 for approval | 1.0.0 |
| 2024-06 | SP#104 | - | - | - | - | MCC editorial update for Publication after TSG SA#104 approval | 19.0.0 |