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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:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

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.

# 1 Scope

The present document is related to the study item "Study on additional topological enhancements for NR" [1].

# 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 RP-240319, " Study on additional topological enhancements for NR "

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

[4] 3GPP TS 38.300: "NR; Overall description; Stage-2".

[5] 3GPP TR 37.803: "Mobility enhancements for Home Node B (HNB) and Home enhanced Node B (HeNB)".

[6] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

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

[8] 3GPP TS 23.548: "5G System Enhancements for Edge Computing; Stage 2".

[9] 3GPP TS 33.501: "Security architecture and procedures for 5G system".

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] 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].

**BH-RAN-node**: The NG-RAN node serving the WAB-MT.

**BH-gNB**: The gNB serving the WAB-MT.

**BH-AMF**: The AMF serving the WAB-MT.

**BH-5GC**: The 5GC serving the WAB-MT.

**BH-UPF**: The UPF serving the WAB-MT for backhauling.

**UE´s 5GC**: The 5GC connected to the WAB-gNB and serving the UEs.

**UE´s AMF**: The AMF connected to the WAB-gNB and serving the UEs.

**UE´s UPF**: The UPF connected to the WAB-gNB and serving the UEs.

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

void

## 3.3 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].

WAB Wireless Access Backhaul

BH Backhaul

# 4 Wireless Access Backhaul (WAB)

## 4.1 General

The study is based on the following requirements:

- The WAB-node includes a gNB component (WAB-gNB) and an MT component (WAB-MT).

- The WAB-gNB is based on the gNB functionality specified in TS 38.300 [4] and TS 38.401 [3].

- The CU-DU split of the WAB-gNB is not considered in this study.

- The WAB-MT supports at least a subset of UE functionalities.

- The NR Uu is used for the radio link between WAB-gNB and the served UEs.

- The NR Uu radio link between the WAB-gNB and the served UEs does not use NTN.

- The study focuses on NR-Uu backhaul.

- In-band scenario for access and backhaul is not precluded to be studied.

- The study precludes the scenario where the access and the backhaul are in-band while the backhaul uses NTN.

- The study focuses on the use of WAB-MT´s PDU session via NR Uu as backhaul of WAB-gNB. Other options for the backhaul (including non-3GPP radio technology) are not precluded but are not a part of the study.

- A WAB-gNB cannot serve WAB-MT(s).

- The study includes a scenario where the WAB-gNB and the WAB-MT connect to the same PLMN or to different PLMNs.

- The WAB-MT may connect to a public PLMN or an SNPN.

- The WAB-gNB may connect to a public PLMN or an SNPN.

- Legacy UEs can connect to the WAB-gNB. There are no WAB-specific enhancements for UEs that connect to the WAB-gNB.

## 4.2 WAB Architecture

Figure 4.2-1 shows an example of WAB architecture for 5GS when the WAB-gNB’s NG traffic is transported via PDU session backhaul.



Figure 4.2-1: The WAB architecture example for 5GS when the WAB-gNB traffic is transported via PDU session backhaul

The neighbour NG-RAN node can be a BH-RAN-node, or a surrounding NG-RAN node. The WAB-gNB’s OAM traffic can also be transferred over the BH PDU session(s).

Figure 4.2-2 shows an example of WAB architecture for 5GS when the WAB-gNB’s NG traffic is transported via non-3GPP backhaul:



Figure 4.2-2: The WAB architecture example for 5GS when the WAB-gNB traffic is transported via non-3GPP backhaul

Figure 4.2-3 shows protocol stack examples of NG Control plane and User plane transport for a UE connected to the network via a WAB-node.



Figure 4.2-3: Protocol stack examples of NG Control plane and User plane transport for a UE connected via WAB-node

Figure 4.2-4 shows protocol stack examples of Xn Control plane and User plane transport for WAB-node.



Figure 4.2-4: Protocol stack examples of Xn Control plane and User plane transport

Figure 4.2-5 shows an example of WAB architecture for using aN L2TP tunnel gateway (LNS) for WAB-gNB’s traffic over the BH PDU session(s).



Figure 4.2-5: The WAB architecture example for 5GS using an L2TP tunnel gateway to convey the WAB-gNB’s traffic over the BH PDU session(s)

Figure 4.2-6 shows protocol stack examples for NG Control plane and User plane transport using an L2TP tunnel.



Figure 4.2-6: The protocol stack for NG-U and NG-C transport using L2TP tunnel over BH PDU session(s)

The solutions using L2TP shown in Figures 4.2-5 and 4.2-6 do not guarantee inter-vendor interoperability since support of L2TP is not mandated for NG and Xn. Therefore, these solutions are out-of-scope of this study.

## 4.3 Operational aspects

### 4.3.1 WAB-node integration procedure



Figure 4.3.1-1 WAB-node integration procedure

**Phase 1: WAB-MT setup.** The WAB-MT of a WAB-node connects to the network in the same way as a UE, by performing RRC connection setup procedure with the BH-RAN-node. The WAB-MT then performs authorization and authentication with the BH-5GC. After the WAB-MT is authorized, the WAB-MT can establish one or more PDU sessions for backhauling.

**Phase 2: WAB-gNB setup.** This phase includes the following 3 sub-phases:

**Sub-phase 2-1: WAB-gNB initialization.** In this phase, the WAB-gNB is configured by the OAM (e.g., with the information of AMF(s) to serve the UE) and service-authorized by the SeGW or by the OAM.

**Sub-phase 2-2: NG connection setup.** The WAB-gNB establishes NG connection(s) toward the AMF(s). This step may follow legacy procedures. After the NG is set up, the WAB-gNB can start serving UE(s).

### **Sub-phase 2-3: Xn connection setup.** If needed, the WAB-gNB may establish Xn connection(s) towards the BH-RAN-node and/or other NG-RAN node(s).4.3.2 WAB authorization

WAB authorization includes the authorization of the WAB-MT and the service authorization of the WAB-gNB. The authorization of the WAB-MT is different from the service authorization/configuration/activation of the WAB-gNB.

Authorization of the WAB-MT provides the WAB-MT with the right to support backhauling the traffic of the co-located WAB-gNB via BH PDU session(s).

Authorization of the WAB-gNB provides the service authorization, i.e., the right to serve UEs. The service authorization of the WAB-gNB is performed by e.g., OAM/SeGW using legacy procedures.

The WAB-gNB’s service authorization status may change. In case the WAB-gNB’s service authorization status changes from “authorized” to “not authorized”, the UEs served by the WAB-gNB can either be handed over to other RAN nodes or they can be released, after which the NG and Xn connection(s) of the WAB-gNB can be removed.

### 4.3.3 Configuration of WAB-node

Certain configurations of the WAB-node may need to be updated as the node moves, e.g.:

- The parameters that enable the WAB-gNB to select and connect to the AMF(s) to serve the UE(s).

- The parameters that enable the WAB-gNB to connect to, and communicate with, the OAM system.

- The configuration parameters that the WAB-gNB should broadcast, e.g., the TAC(s), the cell ID(s), the RANAC(s).

A WAB-node may be provisioned with the parameters pertinent to different potential locations of the WAB-node.

Alternatively, the OAM can provision configuration parameters to the WAB-node based on the location of the node. In that, case the continuity of OAM connectivity needs to be ensured as the WAB-node moves.

#### 4.3.3.1 IP address configuration for WAB-gNB

A WAB-MT obtains IP address(es) for the PDU sessions in the same manner as a legacy UE.

The WAB-gNB can use the IP address(es) of the WAB-MT for the PDU sessions that backhaul the NG, Xn and OAM traffic. The WAB-gNB supports security protection of NG and Xn via IPsec, as defined by TS 33.501 [9].

In case the WAB-gNB uses the IPsec tunnel mode to protect the OAM, NG and/or Xn traffic, the allocation of the inner tunnel IP address(es) is outside of 3GPP scope.

It is possible to transport OAM, NG or Xn traffic over other types of tunnel protocols on top of the WAB-MT’s PDU session(s), e.g., such as L2TP. In this case, the WAB-gNB uses different IP address(es) from WAB-MT. Since the support of these tunnel protocols is not defined for NG and/or Xn, such tunnel protocols are out-of-scope of this study.

#### 4.3.3.2 TAC/RANAC (re-)configuration for WAB-gNB’s cell

The TAC/RANAC of WAB-gNB’s cell is configured by the OAM, and it can be reconfigured by the OAM during the mobility of WAB-node. The TAC/RANAC of the WAB-gNB’s cell may be the same as, or different than, the TAC/RANAC of the co-located WAB-MT’s serving cell. The TAC/RANAC broadcast by the WAB-gNB’s cell can be changed in order to reflect the WAB-node’s physical location.

### 4.3.4 Mobility handling

The following scenarios for WAB-node mobility are supported:

1. The UE´s AMF/UPF remains unchanged as the WAB-gNB moves.

2. The UE´s AMF/UPF changes as the WAB-gNB moves.

3. The BH-UPF/-AMF remains unchanged as the WAB-MT moves inside a PLMN.

4. The BH-UPF/-AMF changes as the WAB-MT moves inside a PLMN.

#### RAN3 assumes that the WAB-gNB does not change PLMN while the WAB-node moves across the network.4.3.4.1 WAB-MT mobility

The WAB-MT reuses legacy mobility handover procedures for the UE as it moves throughout the BH-RAN.

##### 4.3.4.1.1 The BH-UPF remains unchanged as the WAB-MT moves inside a PLMN.

In case the WAB-MT’s PSA UPF does not change during these mobility procedures, the IP addresses allocated for the WAB-MT’s PDU sessions do not change. Therefore, the NG and Xn connections of the WAB-gNB carried over the BH PDU session(s) remain unaffected.

##### 4.3.4.1.2 BH-UPF changes as the WAB-MT moves inside a PLMN.

When the WAB-MT’s PSA UPF need to be changed due to WAB-MT’s mobility, new BH PDU session(s) need to be established reusing existing mechanisms defined in TS 23.501 [6]/TS 23.502 [7]. In this case, the (outer) IP addresses used by the WAB-gNB for the transport of NG and Xn connections of the WAB-gNB will change.

##### 4.3.4.1.3 Roaming of the WAB-MT

During WAB-node movement, the WAB-MT may connect to a PLMN different than its HPLMN.

#### 4.3.4.2 WAB-gNB mobility

During WAB-node movement, establishment, and removal of the WAB-gNB’s NG and/or Xn connections may be needed.

##### Establishment of Xn connections of the WAB-gNB with BH-RAN nodes, as well as with surrounding RAN nodes, is supported, and it can follow legacy procedures.4.3.4.2.1 WAB-gNB mobility without change of UE’s AMF(s)

During WAB-node movement, radio configuration parameters of the WAB-gNB may be changed (e.g., cell ID, PCI and/or TAC) without the change of the UE’s AMF(s). This change of radio configuration parameters may require the UE handling by means of, e.g., intra-gNB handover and/or Mobility Registration Update as defined in TS 23.502 [7].

##### 4.3.4.2.2 WAB-gNB mobility with change of UE’s AMF(s)

Due to WAB-node movement, the change of UE’s AMF(s) may be needed, based on, e.g., WAB-node’s current location and/or additional criteria. The NG connection handling and WAB-gNB configuration update may affect the served UEs.

###### 4.3.4.2.2.1 Solution with two logical WAB-gNBs

The steps for the solution with two logical WAB-gNBs are as follows:

1. The WAB-node may obtain the configuration parameters needed to establish the connection to the UE’s new AMF(s).

2. A new logical WAB-gNB is instantiated, and it establishes NG connection(s) towards one or more new AMF(s).

3. The new logical WAB-gNB may activate one or more new cells, with new cell configuration parameters related to the WAB-gNB’s current location. The new cells may broadcast the radio parameters configured for the new AMF(s), e.g., TAC, etc. The old cell(s) remain(s) active.

4. The UEs are handled as follows:

- A UE in RRC\_CONNECTED state is handed over between an old cell served by the old logical WAB-gNB and a new cell served by the new logical WAB-gNB via NG-based handover with AMF relocation, as defined in TS 23.502 [7]. When all UEs in RRC\_CONNECTED state have been handed over, the old cell(s) are removed from service.

- A UE in RRC\_IDLE or RRC\_INACTIVE state camping on the old cell(s) reselects a new cell, and legacy procedure (e.g., Mobility Registration Update procedure as defined in TS 23.502 [7]) is performed.

5. The NG connection(s) between the old logical WAB-gNB and the initial AMF(s) are removed and the WAB-gNB is removed from service.

###### 4.3.4.2.2.2 Solution with single logical WAB-gNB

It may be possible to support the change of UE’s AMF(s) with a single logical WAB-gNB on the WAB-node. The following options may be considered, their feasibility and the impact on CN needs to be confirmed with SA2, and potentially RAN2 if needed.

**Option 1**: Single WAB-gNB with a single cell using mobility registration update due to TAC change

In this option, the WAB-gNB establishes a new NG connection towards the new AMF and concurrently maintains NG connections to both AMFs. The WAB-gNB reports a new TAC only to the new AMF. The WAB-gNB initiates the change of the UE’s AMF by updating the SI with the new TAC. When the UE detects the new TAC in the SI broadcast, it initiates the Mobility Registration Update procedure as defined in TS 23.502 [7] clause 4.2.2.2.3. After all UEs have been migrated to the new AMF, the NG connection between the WAB-gNB and the initial AMF(s) can be removed.

To enable this option, modifications to gNB behavior may be needed.

**Option 2**: Single WAB-gNB with two cells with different TACs, using NG-based HO

In this option, the procedures defined in clause 4.3.4.2.2.1 of the present document can be reused with the difference that the new cell(s) and the old cell(s) are served by the same WAB-gNB, i.e., no new logical WAB-gNB needs to be instantiated. The gNB-ID part of the cell ID of the new cell is the same as that of the old cell. The WAB-gNB further has to report the new TAC only to the new AMF as described in Option 1. This ensures that AMF reallocation can be achieved via the NG-based handover for RRC\_CONNECTED UEs and via Mobility Registration Update for RRC\_IDLE/RRC\_INACTIVE UEs.

To enable this option, modifications to gNB behavior may be needed.

**Option 3**: Single WAB-gNB single cell without TAC change

In this option, during the AMF change, the WAB-gNB retains its TAC. When the WAB-gNB establishes an NG connection to the new AMF, the WAB-gNB indicates the TAC to the new AMF, and removes the TAC from the supported TAC list at the initial AMF. After this, the UE context transfer between the old and the new AMF is triggered, which requires enhancements in the core network (e.g., either the initial AMF or the new AMF can trigger UE context transfer for both RRC\_CONNECTED and RRC\_IDLE UEs, for example based on the GUAMI of the new or initial AMF, respectively).

### 4.3.5 Resource multiplexing

In scenarios where WAB-node’s access link and backhaul link mutually interfere, resource coordination may be needed to facilitate the resource multiplexing of the WAB-node’s access links and backhaul link. For this purpose, the resource coordination mechanism introduced for IAB can be considered as the starting point. For resource coordination between the access link and backhaul link, the BH-gNB may need to discover co-location of the WAB-MT and the WAB-gNB.

## 4.4 Other

Void.

# 5 5G Femto

## 5.1 General

NR Femto enables use cases to provide NR access at home or at enterprise premises. The study of NR Femto is based on following assumptions:

- An NR Femto node only supports NR;

- No impact on the UE is in scope of the study;

- Support for a large number of NR Femto nodes should be possible in a scalable manner.

## 5.2 Architecture

### 5.2.1 Architecture Options for NG interface

#### 5.2.1.1 Option 1

As shown in Figure 5.2.1.1-1, in this option the NR Femto node connects to the 5GC directly as a gNB by means of the NG interface.



Figure 5.2.1.1-1: Option 1 for NR Femto Architecture

NOTE: The SeGW is out of RAN3 scope.

#### 5.2.1.2 Option 2

Figure 5.2.1.2-1 shows a logical architecture for the NR Femto that has a set of NG interfaces to connect the NR Femto node to the 5GC.



Figure 5.2.1.2-1: Option 2 for NR Femto Architecture

NOTE: The SeGW and the NR Femto Management System are out of RAN3 scope.

The NG-RAN architecture may deploy an NR Femto Gateway (NR Femto GW) to allow the NG interface between the NR Femto node and the 5GC to support a large number of NR Femto nodes in a scalable manner. The NR Femto GW serves as a concentrator for the C-Plane, specifically the NG-C interface.

The NG interface is defined as the interface:

- Between the NR Femto GW and the 5GC;

- Between the NR Femto node and the NR Femto GW;

- Between the NR Femto node and the 5GC;

The NR Femto GW appears to the AMF as a gNB. The NR Femto GW appears to the NR Femto node as an AMF. The NG interface between the NR Femto node and the 5GC is the same regardless of whether the NR Femto node is connected to the 5GC via an NR Femto GW or not.

#### 5.2.1.3 Option 3

An SCTP concentrator acts as an IP proxy between an NR Femto node and the AMF. It addresses the issue of reducing the number of SCTP connections toward the 5GC by leaving the NGAP layer untouched and by concentrating the SCTP layer. The SCTP concentrator is part of the transport layer, and it is transparent to the application layer. This solution was studied for E-UTRAN and is described in detail in TR 37.803 [5].



Figure 5.2.1.3-1: Option 3 for NR Femto Architecture.

NOTE: The SeGW is out of RAN3 scope.

A single SCTP association per NG-C interface instance is used with one pair of stream identifiers for NG-C common procedures. An SCTP concentrator terminates the lower layers so that the AMF does not need to be aware that several peers, with which it maintains NG interfaces, are actually behind the concentrator.

The key characteristics are:

1. There is a single NGAP association (application layer) between the AMF and each NR Femto node.

2. There is a single SCTP association (transport layer) between the AMF and the SCTP concentrator.

3. There is a single SCTP association (transport layer) between the SCTP concentrator and each NR Femto node connected to it.

4. The SCTP concentrator does not touch the application layer and transports it transparently.

5. For each NR Femto node, the SCTP concentrator maps the NGAP signaling on the appropriate SCTP association, “switching” between the various SCTP streams from the NG interface between itself and the AMF.

6. The SCTP concentrator can also act as a “smart NAT”, in case the NR Femto nodes are assigned private IP addresses.

#### Point 5 above descends from the multi-streaming capabilities of SCTP. The AMF can map NGAP signaling for different NR Femto nodes on different streams over the same SCTP association. The concentrator receives the messages, terminates the SCTP connection, and maps each message on a new SCTP association toward the appropriate NR Femto node according to the stream number used. Since there can be up to 65535 streams in an SCTP association, in principle it is possible to address a large number of NR Femto nodes from the same AMF through the same SCTP concentrator. The SCTP concentrator handles the appropriate switching between each stream number on the SCTP concentrator-AMF association and each NR Femto node-SCTP concentrator association (see Figure 5.2.1.3-1). This functionality is completely contained in the SCTP concentrator and only requires that the AMF and NR Femto nodes map NGAP signaling to different peers, on different SCTP stream identifiers.5.2.1.4 Option 4

In this option, the NR Femto node is a gNB-DU as defined in TS 38.401 [3]. The gNB-CU is used as the concentration node for connecting the NR Femto nodes to 5GC on both control plane and user plane.



Figure 5.2.1.4-1: Option 4 for NR Femto Architecture

NOTE: The SeGW is out of RAN3 scope.

### 5.2.2 Architecture Options for Xn interface

#### 5.2.2.1 Option A for Xn support without Xn GW

As shown in Figure 5.2.2.1-1, in this option the NR Femto Node connects to the other NR Femto Node(s)/gNB(s) directly as a gNB by means of the Xn interface.



Figure 5.2.2.1-1: OptionA Xn interface Architecture for NR Femto

#### 5.2.2.2 Option B for Xn support via Xn GW

As shown in Figure 5.2.2.2-1, the logical architecture for NR Femto node when Xn connectivity via the Xn GW is supported.

NR Femto

NR Femto

gNB

SeGW

Xn GW

5GC

NR Femto Mgmt System

Xn-C

NG

NG

Xn-C

Xn-C

Figure 5.2.2.2-1: NR Femto operating with Xn GW - Logical Architecture

Support for the Xn GW relies on following principles:

- A NR Femto node connects to a single Xn GW only. Each NR Femto node is preconfigured with information about which Xn GW it connects to, e.g. an IP address of the Xn GW.

- There is no limitation on the number of Xn GWs a gNB may connect to.

- Interface between two Xn GWs is not supported. The routing of XnAP messages via more than one Xn GW (i.e. more than two SCTP hops) is not allowed.

- XnAP contexts only exist in the two peer NR Femto nodes or in the NR Femto node and its peer gNB (same as without Xn GW). The peer XnAP contexts define an "XnAP association" between peer NR Femto nodes or between the NR Femto node and its peer gNB which spans over two SCTP associations (one per each hop).

- The Xn GW puts no constraints on the Xn user plane interface (Xn-U).

- For each NR Femto node or gNB connected to the Xn GW, the Xn GW maintains the association information, i.e. the mapping of the Global gNB ID to the TNL address(es).

### 5.2.3 Evaluation of Architecture options for the NG interface

**Option1: direct connection of NR Femto to 5GC**

**Pros**:

1. Already supported by current architecture.

2. Less CP latency and no processing delay due to absence of a concentration stage.

3. Suitable for certain deployments depending on number of NR Femtos to connect and/or virtualization support of the 5GC.

4. Local breakout can be supported.

**Cons:**

1. Not suitable for certain deployments with large number of NR Femtos and/or 5GC not virtualized.

2. Not suitable for residential deployments with frequent switch on/off of NR Femtos.

**Option 2: NR Femto GW**

**Pros:**

1. Only one SCTP association from 5GC to NR Femto GW, so it can support large number of femtos and/or no virtualization of 5GC.

2. 5GC is shielded from frequent switch on/off of the NR Femtos.

3. Enables operators who have already deployed 4G Femtos using HeNB GW to capitalize on operating model and integration process of 5G Femtos.

4. Foreseen specification impacts are already well known from 4G.

5. Allows to decouple concentration of CP and concentration of UP: concentration of UP is optional i.e. the NR Femto GW can concentrate CP only while the NR Femto connects directly to the UPF.

6. Local breakout can be supported.

**Cons:**

1. Some stage3 specification impact.

2. Some processing delay for CP message.

**Option 3: SCTP concentrator**

**Pros:**

1. Only one SCTP association from 5GC to SCTP concentrator due to using multi-streaming.

2. Local breakout can be supported.

3. Only stage2 specification impact.

**Cons:**

1. The solution requires consistent configuration and handling of SCTP stream identifiers.

2. The solution requires consistent SCTP implementation of AMF, SCTP concentrators and NR Femtos.

3. Some processing delay for CP message.

4. Does not provide an evolution path for operators that have already deployed a HeNB GW for E-UTRAN.

**Option 4: NR Femto as a gNB-DU**

**Pros:**

1. Reuse existing split gNB architecture.

**Cons:**

1. F1-C was not designed to face frequent switch on/off. Usually F1-C is operated by the network operator and statically configured.

2. Foreseen additional interoperability issue of F1 compared to NG.

3. F1-C carried over internet backhaul can lead to latency and reliability issue not meeting the stringent requirement for F1-C interface.

4. This option forces the concentration of User Plane and not only control plane i.e. concentration of CP only while NR Femto UP connects directly to UPF is not possible.

5. Does not provide an evolution path for operators that have already deployed a HeNB GW for E-UTRAN.

6. Specification impact for F1 needs to be further assessed.

7. Local breakout requires collocation of NR Femto with CU UP.

### 5.2.4 Evaluation of Architecture options for the Xn interface

Following table concludes the comparison of the two Xn interface options.

Table 5.2.4-1: Evaluation of Architecture options for the Xn interface

|  |  |  |
| --- | --- | --- |
| Option | Pros | Cons |
| **A** | Already supported by current architecture.  Less CP latency and no processing delay due to absence of a concentration stage. |  |
| **B** | Can support large number of Xn connections for one NR Femto node.  Enables operators who have already deployed HeNBs using X2 GW to capitalize on operating model and integration process of 5G Femto nodes.  Foreseen specification impacts are already well known from 4G. | Some stage3 specification impacts.  Some processing delay for CP message.  Hard to select an optimal deployment location of the Xn GW. |

## 5.3 Access control

With the existing CAG mechanism, the open, hybrid and closed access mode, can be supported as follows:

- To support the open access mode: The NR Femto node activates a PLMN cell, which can be accessed by legacy UE without access control of CAG.

- To support the hybrid access mode: The NR Femto activates a cell shared by both PLMN and CAG, through broadcasting both the *plmn-IdentityInfoList* and the *npn-IdentityInfoList-r16* in the SIB1, but without the *cellReservedForOtherUse*. Then, this cell is accessible to UEs which have the allowed CAG list including a CAG-ID broadcasted by the cell. For the legacy UE not supporting CAG, this cell is viewed as a normal PLMN cell.

- To support the closed access mode: The NR Femto node activates an NPN-only cell by broadcasting the *cellReservedForOtherUse IE* with value “true”, then this cell can only be accessed by the UEs whose allowed CAG list includes a CAG-ID broadcasted by the cell.

## 5.4 Local services access

In order to support access to local services, NR Femto nodes reuse LADN and edge computing functionality as specified in TS 23.501 [6] and TS 23.548 [8].

The local UPF may be either stand-alone or co-located with the NR Femto node.

The following aspects, out of RAN3 scope, have been identified and may require further analysis:

*Aspect #1:* Scalability of local UPF discovery e.g. when using mobile edge computing solutions,

*Aspect #2:* N4 interface switch-on/off,

*Aspect #3:* N4 interface aggregation.

# 6 Conclusions

## 6.1 Conclusion and Recommendation for WAB

RAN3 confirms the feasibility of WAB functionality and recommends that a normative phase for WAB is pursued. The conclusions of the WAB part of the SI are as follows:

- The normative work for WAB should be based on the functionalities, terminology and requirements captured in the present TR. Addition of further details during normative phase is not precluded.

- The normative work should consider the following architectural aspects for WAB according to the present TR:

- Backhauling of the WAB-gNB’s NG, Xn and OAM traffic is conducted over the WAB-MT’s PDU session(s).

- WAB-gNBs can establish Xn interface(s) with the WAB-MT’s serving BH RAN node and with other surrounding gNBs.

- The interface between the WAB-MT and the co-located WAB-gNB is out-of-scope for the normative phase.

- Split architecture of the WAB-gNB is out-of-scope for the normative phase.

- Authorization procedures for the WAB-MT are out of RAN3 scope, and are expected to be handled by SA2. RAN3 should define the WAB-node behaviour in case the authorization status of the WAB-MT and/or WAB-gNB changes.

- The normative phase should define the integration procedure for WAB nodes following the description in the present TR.

- Mobility procedures to be used for the UEs served by a WAB-gNB are legacy UE mobility procedures. Mobility of the WAB-MTs is based on legacy UE mobility procedures.

- During the normative phase, handling of WAB-gNB’s traffic (including Xn, NG and OAM traffic) during WAB-node mobility should be defined, including the case where the WAB-MT’s BH PDU session changes.

- During the normative phase, the procedure to support the UE’s AMF change for UEs connected to, or camped on, a WAB-gNB, should be defined in cooperation with SA2.

- Solutions for mobility will be further analysed during normative phase.

- RAN3 concludes that the two-logical-gNB solution is feasible.

- It remains to be verified, based on feedback from SA2 and, potentially, RAN2 if needed, whether the single-gNB solution is feasible and whether enhancements are needed.

- During the normative phase, enhancements to the UE’s ULI that reflect the WAB node’s location should be defined.

- During the normative phase, the handling of the following should be discussed and captured:

- PCI collision.

- Reconfiguration of TAC and RANAC on WAB-gNBs.

- Avoidance of multi-hop WAB topology.

- Radio-resource coordination between access and backhaul links.

- The normative phase may further discuss the following:

- Handling of backhaul link degradation by the backhaul network and the WAB-gNB.

- Xn connection management (e.g., potential avoidance of setting up Xn between WAB-gNBs, dynamic establishment/removal of Xn connectivity with BH-RAN-node and surrounding NG-RAN-nodes).

- NG connection management (e.g., procedures for NG connection removal/suspension).

- QoS (e.g., PDB, PER).

- Handling of RRC\_INACTIVE UEs.

## 6.2 Conclusion and Recommendation for NR Femto

### 6.2.1 Architecture for NG interface

Option 1, namely direct connection of an NR Femto node to the 5GC via the NG interface, is already possible.

In order to maintain the existing infrastructure for an operator who has deployed LTE HeNBs, Option 2 with an optional NR Femto GW is recommended for a normative phase.

### 6.2.2 Architecture for Xn interface

Option A, namely direct connection of an NR Femto node to other NR Femto nodes / gNBs via the Xn interface, is already possible.

### 6.2.3 Access Control

For Access control, NR Femto reuses the existing CAG functionalities, no stage3 impact has been identified.

### 6.2.4 Access to Local Services

In order to support access to local services, NR Femto nodes reuse LADN and edge computing functionality as specified in TS 23.501 [6] and TS 23.548 [8].

Aspects out of RAN3 scope, described in Sec. 5.4, have been identified and may require further analysis.

Annex <A> (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Change history | | | | | | | |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2024-03 | RAN3#123bis |  |  |  |  | Draft skeleton | 0.0.0 |
| 2024-05 | RAN3#124 | R3-243171 |  |  |  | Including text proposals R3-242236, R3-242237, R3-242238, R3-242239, R3-242240 agreed in RAN3#123bis meeting. | 0.0.1 |
| 2024-06 | RAN3#124 | R3-243970 |  |  |  | Including text proposals R3-243959, R3-243860, R3-243863, R3-243960, R3-243862, R3-243851, R3-243953, R3-243835, R3-243852 agreed in RAN3#124 meeting.  Submit to RAN#104 for information | 1.0.0 |
| 2024-08 | RAN3#125 | R3-244029 |  |  |  | Editorial corrections for following drafting rules.  Resubmit to RAN3#125 | 1.1.0 |
| 2024-08 | RAN3#125 | R3-244849 |  |  |  | Including text proposals R3-244828, R3-244829, R3-244833, R3-244720, R3-244834, R3-244835, R3-244832 agreed in RAN3#125 meeting. | 1.2.0 |