|  |
| --- |
| 3GPP TR 38.832 V0.4.0 (2020-11) |
| Technical Report |
| 3rd Generation Partnership Project;  Technical Specification Group RAN;  NR;  Study on enhancement of Radio Access Network (RAN) slicing  (Release 17) |
|  |

|  |  |
| --- | --- |
|  |  |
|  | |
| The present document has been developed within the 3rd Generation Partnership Project (3GPP TM) and may be further elaborated for the purposes of 3GPP. The present document has not been subject to any approval process by the 3GPPOrganizational Partners and shall not be implemented. This Specification is provided for future development work within 3GPPonly. The Organizational Partners accept no liability for any use of this Specification. Specifications and Reports for implementation of the 3GPP TM system should be obtained via the 3GPP Organizational Partners' Publications Offices. | |

|  |
| --- |
|  |
| ***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 |
| ***Copyright Notification***  No part may be reproduced except as authorized by written permission. The copyright and the foregoing restriction extend to reproduction in all media.  © 2020, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC).  All rights reserved.  UMTS™ is a Trade Mark of ETSI registered for the benefit of its members  3GPP™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners LTE™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners  GSM® and the GSM logo are registered and owned by the GSM Association |

Contents

Foreword 4

1 Scope 5

2 References 5

3 Definitions of terms, symbols and abbreviations 5

3.1 Terms 5

3.2 Symbols 5

3.3 Abbreviations 5

4 General 6

5 Study mechanisms to enable UE fast access to the cell supporting the intended slice 6

5.1 Slice based cell reselection under network control 6

5.1.1 Scenario and issue description 6

5.1.2 Solutions 7

5.2 Slice based RACH configuration or access barring 7

5.2.1 Scenario and issue description 7

5.2.2 Solutions 7

6 Study necessity and mechanisms to support service continuity 7

6.1 Scenario and issue description 7

6.2 Solutions 10

6.2.1 Re-mapping Policy in target NG-RAN node 10

6.2.2 Slice Re-mapping Message Sequence Charts 12

6.2.2.1 Slice Remapping decision in target gNB at Xn based handover 12

6.2.2.2 Slice Remapping decision in target gNB at NG based handover 12

6.2.2.3 Slice Remapping decision in 5GC at NG based handover 13

6.2.2.4 Slice Remapping Solution for Scenario 6 13

6.2.2.5 Slice Remapping decision in 5GC and target gNB at NG based handover 14

6.2.2.6 Slice Remapping decision in SN for MR-DC case 14

6.2.3 Configuration Based Solution 15

6.2.4 Candidate solutions with/without CN involvement 16

6.2.5 Slice resource re-partitioning 17

6.2.6 Multi-carrier radio resource sharing 17

6.2.7 5GC Solution based on SSC-mode 3 18

6.2.8 Slice Remapping decision in 5GC 19

6.3 Solution evaluation 20

7 Conclusion 20

Annex <A> (informative): Change history 22

# 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 provides descriptions of use cases and solutions with regard to enhancement of Radio Access Network (RAN) slicing for NR.

# 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".

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in 3GPP 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 3GPP TR 21.905 [1].

## 3.2 Symbols

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

<symbol> <Explanation>

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP 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 3GPP TR 21.905 [1].

<ABBREVIATION> <Expansion>

# 4 General

*Editor Note: capture the general descriptions*

# 5 Study mechanisms to enable UE fast access to the cell supporting the intended slice

## 5.1 Slice based cell reselection under network control

### 5.1.1 Scenario and issue description

*Editor Note: capture the description of scenario and issue.*

**General description for the scenario:**

**• Multiple and different slices can be supported on different frequencies**

**• Multiple and different slices can be supported on the same frequency in different regions.**

For each scenario we study both IDLE and INACTIVE and determine whether there is need for a solution and possible solutions. Connected mode will also be considered but with a lower priority.

We will investigate whether the R15 mechanism (e.g. dedicated priority mechanism) can solve the above issues and study if some enhancements are needed.

*Editor Note: Both cell selection and cell re-selection will be studied.*





**Figure 5.1.1-1: An example for slice deployment scenario**

As shown in figure 1, slice1 (e.g. eMBB) is supported in both F1 and F2 everywhere, since the frequency resources are so valuable and the top requirement for all operators’ 5G network is to serve millions or billions of smart phone users. Slice2 (e.g. URLLC) is supported only in F2 in some area, e.g. factory or hospital.

Area 1 is deployed in the factory or hospital. In this area, F1 supports slice1 (e.g. eMBB), while F2 supports both slice 1 and slice 2 (e.g. eMBB and URLLC).

Area 2 is the public area. F1 and F2 all supporting slice1 (e.g. eMBB) for smart phone users, no slice2 (e.g. URLLC) is supported in area 2. And F2 is deployed as hotspot to provide wideband access.

Area 3 illustrates that different slices are supported on different frequencies. F1 only supports slice1 and F2 only supports slice2.

Area 4 illustrates a typical scenario that slices are available via multiple frequencies. And one or a set of frequencies are preferred for certain slice, e.g. F1 is preferred for slice2 and F2 is preferred for slice1 in area 4.

eMBB and URLLC slices are used only as an example of various slices. The deployment of any slice on any frequency band is up to network implementation.

RAN2 common understanding is that intended slice is based on the information AS receives from NAS for the particular use case. This may be different in different cases:

- In case of cell selection/reselection, the intended slice means the allowed or requested S-NSSAI(s).

- For the initial registration, and requesting new S-NSSAI(s): intended slices = Requested S-NSSAI(s)

- For idle-mode mobility: intended slices = allowed S-NSSAI(s)

- In case of MO traffic, the intended slice means the S-NSSAI associated with MO traffic based on indication from NAS to AS. For MO service, UE is aware of the intended slice.

- In case of MT traffic, UE is unaware of the slice for the paged service in current NR specification. FFS whether UE needs to know the intended slice for MT service.

The following issues will be studied:

Issue 1: The UE is unaware of the slices supported on different cells or frequencies, which prevents UE from (re)select to the cell or frequency supporting the intended slice.

Issue 2: Dedicated priorities would not be available to the UE prior to first RRC connection establishment and only remain valid before T320 expires upon entering IDLE mode. In addition, dedicated priorities are discarded each time when UE entering CONNECTED mode and need to be configured again before UE leaving CONNECTED mode.

Issue 3: Operator may require different frequency priority configurations for the specific slice in different areas, however the dedicated priority always overwrites the broadcast priorities if configured.

Issue 4: If the serving cell is unable to support the requested slices for the subsequent access of the UE, the serving cell may bring on handover or rejection of access request. That may increase control plane signalling overhead as well as long control plane latency for the UE to access the network.

### 5.1.2 Solutions

*Editor Note: Capture the solutions for the scenario and issue.*

The following solution approaches will be studied:

Solution 1: Legacy dedicated priority via *RRCRelease* message.

Solution 2: Rel-15 mechanisms such as HO, CA, DC and redirection can be used to access the intended slice in different cell.

Solution 3: Slice related cell selection info, the slice info of serving cell and neighboring cells is provided in the system information or *RRCRelease* message. FFS: what information is broadcast.

Solution 4: Slice related cell reselection info (e.g. Cell reselection priority per slice), the slice info of neighboring cells is provided in the system information or *RRCRelease* message. FFS: what information is broadcast.

## 5.2 Slice based RACH configuration or access barring

### 5.2.1 Scenario and issue description

*Editor Note: capture the description of scenario and issue.*

It will be studied how to enable UE’s fast access for the intended slice with slice-based RACH resources/configuration and RACH parameters prioritization, and whether identified issues can be solved by legacy mechanisms.

The intentions and use cases for slice based RACH configuration are as follows:

Intention 1: RA resource isolation. From marketing point of view, some of the industrial customers have the requirement for access resource isolation, in order to provide guaranteed RA resources for their sensitive slices.

Intention 2: Slice access prioritization. In R15/16, all slices are sharing the same RA resources and cannot be differentiated by network side. But some slices may need to be prioritized during the RA procedure.

### 5.2.2 Solutions

*Editor Note: Capture the solutions for the scenario and issue.*

The following solution approaches will be studied:

Solution 1: Slice-specific separate RACH resources pool can be configured per slice or per slice group, in addition to the existing common RACH resources.

Solution 2: Slice-specific RACH parameters prioritization can be configured per slice or per slice group.

Neither solution may not be applicable to all possible slices.

# 6 Study necessity and mechanisms to support service continuity

## 6.1 Scenario and issue description

*Editor Note: capture the description of scenario and issue.*

*Editor Note: The proposed scenarios listed in this clause remain to be evaluated and updated.*

The following two scenarios are considered to support service continuity.

**Scenario 1: Slice resource shortage in case of Intra-RA mobility and Inter-RA mobility**



**Figure 6.1-1: Service interruption due to slice resource shortage**

As shown by Figure 6.1-1, the UE’s ongoing slice(s) is/are supported by both the source and the target NG-RAN node. At the time of handover, the target node fails to accept the UE with at least one of the ongoing S-NSSAIs due to e.g. high slice-related load at the target node. Under such circumstance, the service(s) for failed ongoing slice(s) is/are interrupted for the UE.

*Editor Note: The study shall analyse the implications of slice remapping in these conditions, e.g. whether or not the remapping of a slice to the re-mapped S-NSSAI, may create an issue of overload in the re-mapped S-NSSAI.*

*Editor Note: It needs to be analyzed how to support the slice recovery (i.e., re-mapping of remapped slice to on-going slice) when the NG-RAN node recovers enough resources to serve the on-going slice(s).*

**Scenario2: Non-supported slice in case of Inter-RA mobility**



**Figure 6.1-2: Service interruption due to slice not supported**

As shown by Figure 6.1-2, the UE is moving towards an area that does not support at least one of UE’s ongoing slices. The target node fails to accept the UE with at least one of the ongoing S-NSSAIs. Under such circumstance, the service(s) for failed ongoing slice(s) is/are interrupted for the UE.

*Editor Note: It needs to be analyzed whether, for a well defined SLA and a correctly defined Registration Area in which the slice needs to be available, the slice services should be available also outside of the RA.*

**Scenario 3: Moving back for slice resource shortage in case of Intra-RA mobility and Inter-RA mobility**



**Figure 6.1-3: Moving back scenario due to slice resource shortage**

This is a continuation scenario of scenario 1. As shown by Figure 6.1-3, the UE’s ongoing slice(s) is/are supported by both the source and the target NG-RAN node. At the time of handover, the source node may serve at least one of the S-NSSAIs with degraded performance, or already rejects at least one of the S-NSSAIs, due to e.g., high slice-related load at the source node. Meanwhile the target node can fully support these S-NSSAIs.

**Scenario 4: Moving back for non-supported slice in case of Inter-RA mobility**



**Figure 6.1-4: Moving back scenario due to slice not supported**

This is a continuation scenario of scenario 2. As shown by Figure 6.1-4, at the time of handover, the source node may serve the UE with at least one of the S-NSSAIs not supported by the target node. The UE is moving towards an area that supports at least one of UE’s these slices.

**Scenario 5: Slice resource shortage for MR-DC**



**Figure 6.1-5: Service interruption due to slice resource shortage in SN**

As shown by Figure 6.1-5, the UE’s ongoing slice(s) is/are supported by both the MN and the SN. However, in case of SN addition or modification procedure, the SN fails to accept the UE with at least one of the ongoing S-NSSAIs due to e.g., high slice-related load at the SN. Under such circumstance, the services associated with these ongoing slices may be interrupted at the SN side.

**Scenario 6: Slice overload in RAN node in absence of mobility**

It is possible that resource shortage happens for a slice 1 as in scenario 1. In this case, some ongoing PDU sessions associated to this slice 1 may be offered degraded service even in the absence of mobility.

## 6.2 Solutions

*Editor Note: Capture the solutions for the scenario and issue.*

### 6.2.1 Re-mapping Policy in target NG-RAN node

*Editor note: Feasibility of this solution at system level requires further work including checking with SA2.*

In solutions where the target NG-RAN node decides the re-mapping at incoming handover, the target NG-RAN node should be aware of the re-mapping policy for the involved PDU session. The following options are available:

**Configuration in target NG-RAN node**

This option assumes that the remapping policy is rather static because it should have been validated by the tenant or the operator.

Therefore, the NG-RAN node is configured in advance with the re-mapping policy by the OAM.

In this option, the granularity of the re-mapping policy is per slice i.e. for each supported S-NSSAI, the target NG-RAN node is configured with a list of possible re-mapped S-NSSAI(s) as follows:

* S-NSSAI 1 <> re-mapped list (S-NSSAI 10, S-NSSAI 11)
* S-NSSAI 2 <> re-mapped list (S-NSSAI 12, S-NSSAI 13)

**Signaling in NG Setup Response**

The NG-RAN node has received in advance the re-mapping policy in the NG Setup Response message (or any update in the AMF configuration Update message) from the CN.

In this option the granularity of the re-mapping policy is the slice i.e. for each S-NSSAI supported by the target NG-RAN node, the CN includes in the NG Setup Response (respectively AMF Configuration Update) message an associated list of possible re-mapped S-NSSAI(s).

**Signaling in NG Handover Request**

At the time of handover, the CN includes in the NG Handover Request message the current PDU Session, the associated S-NSSAI and also the list of S-NSSAI(s) to which this PDU session can be re-mapped.

In this option the granularity of the re-mapping policy can be either:

* Per PDU session (using same principles as slice association in PDU Session Setup)
* Per UE: even though signaled for the involved PDU session, the choice of possible re-mapped slices for a given slice is a general policy for the UE.

Example of per UE policy:

UE 1, any PDU session of S-NSSAI 1 <> re-mapped list (S-NSSAI 10, S-NSSAI 11)

UE 2, any PDU session of S-NSSAI 1 <> re-mapped list (S-NSSAI 12, S-NSSAI 13)

Example of per PDU session policy:

UE 1, PDU Session 1, S-NSSAI 1 <> re-mapped list (S-NSSAI 10, S-NSSAI 11)

UE 1, PDU Session 2, S-NSSAI 1 <> re-mapped list (S-NSSAI 12, S-NSSAI 13)

UE 2, PDU Session 3, S-NSSAI 1 <> re-mapped list (S-NSSAI 14, S-NSSAI 15)

**Signaling from Source NG-RAN node**

When the PDU session is created in the source NG-RAN node, the CN includes in the NGAP PDU Session Resource Setup Request message (or the Initial Context Setup Request message or the NG Handover Request message) the S-NSSAI associated with the PDU session and also the list of S-NSSAI(s) to which this PDU session can be re-mapped.

At the time of subsequent Xn handover, the source NG-RAN node includes in the Xn Handover Request message the current PDU Session, the associated S-NSSAI and also the list of S-NSSAI(s) to which this PDU session can be mapped.

In this option the granularity of the re-mapping policy can be either:

* Per PDU session (using same principles as slice association in PDU Session Setup)
* Per UE: even though signaled for the involved PDU session, the choice of possible re-mapped slices for a given slice is a general policy for the UE.

### 6.2.2 Slice Re-mapping Message Sequence Charts

*Editor note: Feasibility of this solution at system level requires further work including checking with SA2.*

#### 6.2.2.1 Slice Remapping decision in target gNB at Xn based handover



**Figure 6.2.2.1-1: Slice re-mapping/fallback determined by the T-gNB**

1. The S-gNB sends the *HANDOVER REQUEST* message to the T-gNB.
2. If the UE’s ongoing slice(s) is rejected in the target gNB, based on the slice re-mapping policy described in section 6.2.1, the T-gNB makes the slice re-mapping/fallback decision. The T-gNB may send the slice re-mapping/fallback decision in the HANDOVER REQUEST ACKNOWLEDGE message to the S-gNB.
3. The T-gNB shall send the slice re-mapping/fallback decision to the AMF through the *PATH SWITCH REQUEST* message.
4. The AMF responds the *PATH SWITCH REQUEST ACKNOWLEDGE* message. The AMF may reject the PDU sessions in the *PDU Session Resource Released List* IE.

*Editor Note: It is FFS whether and how the UE is aware of slice remapping.*

#### 6.2.2.2 Slice Remapping decision in target gNB at NG based handover



**Figure 6.2.2.2-1: Slice re-mapping/fallback determined by the T-gNB**

1. The S-gNB sends the *HANDOVER REQUIRED* message to the AMF.
2. The AMF sends the *HANDOVER REQUEST* message to the T-gNB.
3. If the UE’s ongoing slice(s) is rejected in the target gNB, based on the slice re-mapping policy described in section 6.2.1, the T-gNB shall include the re-mapped/fallback decision in the *HANDOVER REQUEST ACKNOWLEDGE* message to the AMF.
4. The AMF may send the slice re-mapping/fallback decision to the S-gNB through the *HANDOVER COMMAND* message.

*Editor Note: It is FFS whether and how the UE is aware of slice remapping.*

#### 6.2.2.3 Slice Remapping decision in 5GC at NG based handover



**Figure 6.2.2.3-1: Slice re-mapping/fallback determined by the AMF**

1. The S-gNB sends the *HANDOVER REQUIRED* message to the AMF.
2. If the UE’s ongoing slice(s) is not supported by the T-gNB, the AMF may make the slice re-mapping/fallback decision and include the decision in the *HANDOVER REQUEST* message to the T-gNB.
3. The T-gNB responds to the AMF through the HANDOVER REQUEST ACKNOWLEDGE message.
4. The AMF may send the slice re-mapping/fallback decision to the S-gNB through the *HANDOVER COMMAND* message.

*Editor Note: It is FFS whether and how the UE is aware of slice remapping.*

#### 6.2.2.4 Slice Remapping Solution for Scenario 6

At the same time the NG-RAN node may notice that another slice 2 which is not overloaded has resources available and is still compatible with the SLA of slice 1.

In short, there is a potential that some unloaded but "good enough or better" alternative slices in the RAN could be used for the subscriber to continue to receive service.

#### 6.2.2.5 Slice Remapping decision in 5GC and target gNB at NG based handover



**Figure 6.2.2.5-1: Slice re-mapping/fallback determined by the AMF and T-gNB**

1. The S-gNB sends the *HANDOVER REQUIRED* message to the AMF.
2. If the UE’s ongoing slice(s) is not supported by the T-gNB, the AMF may make the initial slice re-mapping/fallback decision and include the decision in the *HANDOVER REQUEST* message to the T-gNB.
3. If the UE’s ongoing or re-mapped/fallback slice(s) is rejected in the target gNB, based on the slice re-mapping policy described in section 6.2.1, the T-gNB shall include the further re-mapped/fallback decision in the *HANDOVER REQUEST ACKNOWLEDGE* message to the AMF.
4. The AMF may send the slice re-mapping/fallback decision to the S-gNB through the *HANDOVER COMMAND* message.

*Editor’s note: The efficiency of the solution needs to be further evaluated.*

#### 6.2.2.6 Slice Remapping decision in SN for MR-DC case



**Figure 6.2.2.6-1: Slice re-mapping/fallback determined by the SN**

This flow chart applies to the scenario of resource shortage only.

1. The MN sends the *SN Addition Request* message to the SN.
2. If the UE’s ongoing slice(s) is rejected by the SN, based on the slice re-mapping policy described in section 6.2.1, the SN makes the slice re-mapping/fallback decision. The SN shall include the slice re-mapping/fallback decision in the *SN Addition Request Acknowledge* message to the MN.
3. The MN may send the slice re-mapping/fallback decision to the AMF through the *PDU Session Modification Indication* message.
4. The AMF responds the *PDU Session Modification Confirmation* message.

6.2.2.7 Slice Remapping decision in MN for MR-DC case



**Figure 6.2.2.7-1: Slice re-mapping/fallback determined by the MN**

This flow chart applies to the scenario of resource shortage only.

1. The MN makes the slice re-mapping/fallback decision and include the decision in the *SN Addition Request* message to the SN.
2. The SN confirms the slice re-mapping/fallback decision made by the MN in the *SN Addition Request* *Acknowledge* message.
3. The MN may send the slice re-mapping/fallback decision to the AMF through the *PDU Session Modification Indication* message.
4. The AMF responds the *PDU Session Modification Confirmation* message.

### 6.2.3 Configuration Based Solution

The following analysis is provided for the scenario 1 and scenario 2 respectively:

* Scenario 1: Slice resource shortage in case of Intra-RA mobility and Inter-RA mobility

As specified in TS 28.541, the slice re-mapping between different S-NSSAIs can be achieved via the prioritized resource modeling. For example, suppose UE’s ongoing slice is S-NSSAI 1 configured with *rRMPolicyMaxRatio* policy, which can use at least one of the shared resources, prioritized resources and dedicated resources. If the dedicated resources are not available, it can use other un-used prioritized and shared resources.

But the following needs to be further studied, e.g., for the S-NSSAI 1,

* + it can explicitly use resources belonging to which S-NSSAIs;
  + it can use the dedicated but not used resources of other S-NSSAIs;
  + it can preempt the used prioritized and/or shared resources from other S-NSSAIs.

In this case, further involvement with SA5 is required.

* Scenario 2: Non-supported slice in case of Inter-RA mobility

In this case, if the T-gNB does not support certain S-NSSAIs, these S-NSSAIs will not be included in the *RRMPolicyMemberList*, thus no resource will be planned by the T-gNB, as specified in TS 28.541.

For example, suppose UE’s ongoing slice is S-NSSAI 1, it will not be included in the *RRMPolicyMemberList* of the T-gNB. Thus the re-mapping of S-NSSAI 1 to the supported S-NSSAI(s) of T-gNB is not supported.

In this case, slice re-mapping is not supported yet by the prioritized resource modeling defined in SA5. And further involvement with SA5 is required.

### 6.2.4 Candidate solutions with/without CN involvement



**Figure 6.2.4-1: Slice re-mapping solutions: (a) with CN impact; (b) without CN impact**

This solution is applicable to scenario 2, where there are two possible slice re-mapping solutions depending on whether the CN is involved.

Figure 6.2.4-1 (a) shows the re-mapping solution where both the RAN and CN parts are involved. In this case, the CN procedure is involved.

Figure 6.2.4-1 (b) shows the re-mapping solution where the CN pat of the slice is not changed while the RAN part of the slice is remapped. The UL/DL traffics are relayed between the S-gNB and the T-gNB via the Xn tunnel.

*Editor’s note: The handling of the UE at the target node needs to be clarified.*

*Editor’s note: Whether CN involvement is required, needs to be evaluated.*

*Editor’s note: Slice remapping needs to be defined in line with SA2 definitions.*

### 6.2.5 Slice resource re-partitioning

*Editor note: Feasibility of this solution at system level requires further work including checking with SA5.*

This solution is applicable to scenario 1. In this solution, the resource limits for a particular slice in the RAN are relaxed (possibly for a limited time period). This is applicable for resource types which have been hard-partitioned between slices, or where a limit per slice has been defined according to the SLA. For example, such an approach could be applied individually (or jointly) to the following:

* spectrum resource (e.g. slots, beams, carriers etc)
* transport resources (e.g. backhaul capacity)
* hardware resources (e.g. specific processors, processing load, intra-RAN logical nodes such as a gNB-CU-UP)

To solve this problem, the system can allow a slice to use another slice’s resources on a temporary basis i.e. making the partition soft. The RAN may allow such temporary overflow while keeping some form of accounting of resources used which may be used to modify the existing SLA, or provide reporting.

Re-partitioning policy may be configured in the RAN.

The solution may have impacts in metric collection and OAM requirements, but does not impact the core network or the UE.

### 6.2.6 Multi-carrier radio resource sharing

This solution is applicable to scenario 1. In this solution, it is assumed that radio resources are primarily assigned to a slice (or slice sets) on a frequency, or cell, basis. For example, a RAN node may host two layers as shown below:



**Figure 6.2.6-1: RAN node supporting two layers**

The solution addresses temporary resource shortage in one cell as per scenario 1, and where the RAN node hosts another cell with different frequency and overlapping coverage where the same slice is available.

In above, this could be the case for slice 1 and cell 1/F2 (or also slice 1 and cell 2/F1).

The solution consists of setting up DC or CA using user plane resources of F1 (or F2), for some or all UEs with slice1 PDU sessions. This action can be wholly decided by the RAN node, without referring to the CN or other nodes. This solution can be seen as fallback planning in the RAN.

### 6.2.7 5GC Solution based on SSC-mode 3

The call flow below uses SSC mode 3 in 5GC as the service continuity solution:

Source NG-RAN node 1

5GC

Step 2: UE has ongoing PDU session 1 of slice 10

UE

Target NG-RAN node 2

**Step 3: HO request (pdu session 1)**

**Handover command (PDU session 1 temporary accepted)**

**Step 6: NAS PDU Session Modification Command (end slice 10, new slice 11)**

**Handover complete**

**Step 7: Establish resources for PDU session 2 on slice 11**

**Step 8: Release PDU session 1 of slice 10**

SSC mode 3 Timer expiry

**Step 8: UE Configuration Update (new Allowed NSSAI= slice 11 only)**

**Step 4: PSR (end slice 10, new slice 11)**

**Register Accept (Allowed NSSAI (slices 10, 11)**

**Step 5: Register Request**

**Step 1: UE Allowed NSSAI (slices 10, 11)**

**Figure 6.2.7-1 Re-mapping based on SSC mode 3**

**Step 0**: NG-RAN nodes have been configured with slice re-mapping slice 10 to 11.

**Step1**: 5GC has sent the UE Allowed NSSAI to the serving NG-RAN node and to the UE per existing procedures

**Step 2**: UE has ongoing PDU session 1 of slice 10.

**Step 3**: Source NG-RAN triggers Handover to target NG-RAN. The target NG-RAN node 2 informs during the HO procedure the source NG-RAN node 1 that it accepts the PDU session 1 of slice 10 temporarily due to slice re-mapping action.

**Step 4**: at handover completion, the target NG-RAN indicates to 5GC in Path Switch Request that PDU session 1 of slice 10 needs to be terminated and a new PDU session is to be setup with slice 11.

**Step 5**: The UE performs the post-handover registration (as Source and Target NG RAN nodes have different slice support, they don’t belong to the same registration area for the UE). Because 5GC received (end slice 10) at step 4, the 5GC still includes the slice 10 in the *Allowed NSSAI* towards the UE at this step (the slice is indeed still temporarily available until it receives from 5GC notification of the final release of PDU session 1 of slice 10 at step 9).

**Step 6**: In reaction to step 4, the 5GC triggers towards the UE the NAS PDU Session Modification Command to invoke SSC mode 3. The (end slice 10, new 11) may be included towards the UE to prompt the UE to setup the new PDU session 2 with slice 11 even if the URSP in the UE would indicate slice 10 as higher priority.

**Step 7**: the UE triggers the setup of PDU session 2 with slice 11 according to SSC mode 3 procedure as per existing procedures described in 23.502 § 4.3.2.2.1.

**Step 8**: at the expiry of SSC mode 3 timer, the 5GC triggers the release of the PDU session 1 of slice 10 according to SSC mode 3 procedures (existing procedures described in 23.502 § 4.3.2.2.1). The 5GC sends a final the UCU (UE Configuration Update) message in order to update the *Allowed NSSAI* towards the NG-RAN and the UE. In this example, the new *Allowed NSSAI* is slice 11.

*Editor note: This solution is CN-centric and requires confirmation from SA2.*

### 6.2.8 Slice Remapping decision in 5GC

This solution is applicable for scenario 2, when a UE with bearers associated to a given slice, e.g. S-NSSAI1, wants to be handed over to a target cell and where S-NSSAI1 is not supported in the target cell. At NG based HO, the AMF will detect that the target cell is not supporting S-NSSAI1 or that the Allowed NSSAI in the target cell for the UE does not include S-NSSAI1. The 5GC will then decide if the PDU sessions associated to S-NSSAI1 can be re-mapped to another slice. The new S-NSSAI is signalled with the HO Request, using legacy signalling, and there is no impact to the target gNB.

When Xn HO can be used, but the target gNB does not support all slices of an UE, the source gNB will use NG based HO instead, so that 5GC may re-map the slice.

At the end of the HO the UE will be updated with the new Allowed NSSAI through legacy NAS procedures. The original slice will be included in the Rejected NSSAI, and the UE will not be allowed to access it as long as it stays in the current RA. Once the UE enters a new RA, it may request to add the slice to the Allowed NSSAI, and the PDU sessions may be re-assigned to the original S-NSSAI1.

The granularity of slice remapping in this solution is per PDU session. The re-mapping decision can be based on slice awareness in registration area, operator policy for slice re-mapping as well as the subscription of the UE.

**System Impact**

No impact on signalling protocols. gNB should be aware that re-mapping may be used, and select NG based HO when needed.

## 6.3 Solution evaluation

The evaluation criteria are as follows:

* **RAN impact**

The point here is to analyze RAN impact of the solution (standardization and node behaviour), for example what signalling procedures may be affected and at what extent.

* **Core impact**

The point here is to analyze Core impact of the solution (standardization and node behaviour), for example what signalling procedures may be affected and at what extent. Such analysis needs to be carried out together with SA2 and CT groups.

* **OAM impact**

The point here is to analyze operator and maintenance effort, for example how many network elements (e,g. gNB, NF) should be configured and managed by OAM. Such analysis may need to involve SA5.

* **UE Impact**

This is to analyse the impact at NAS and AS level on the UE. Such analysis needs to be carried out together with RAN2, SA2 and CT groups.

* **Effectiveness of solution**

The point here is to analyse the effectiveness after applying the solution, for example the UE’s service experience after applying the solution.

*Editor note: A better definition is needed.*

# 7 Conclusion

Annex <A> (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2020-08 | RAN2#111-e | R2-2007419 | - | - | - | Draft skeleton | 0.0.0 |
| 2020-08 | RAN2#111-e | R2-2008549 | - | - | - | Capture the agreements in RAN2#111-e | 0.1.0 |
| 2020-09 | RAN3#109-e | R3-205815 | - | - | - | Capture the agreed TPs in R3-205626, R3-205729, R3-205783 | 0.2.0 |
| 2020-11 | RAN3#110-e | R3-207235 | - | - | - | Capture the agreed TPs in R3-206807, R3-207106, R3-207107, R3-207124, R3-207136, R3-207193, R3-207194, R3-207195, R3-207197, | 0.3.0 |
| 2021-1 | RAN2#113-e |  | - | - | - | Capture the agreements in RAN2#112-e | 0.4.0 |