

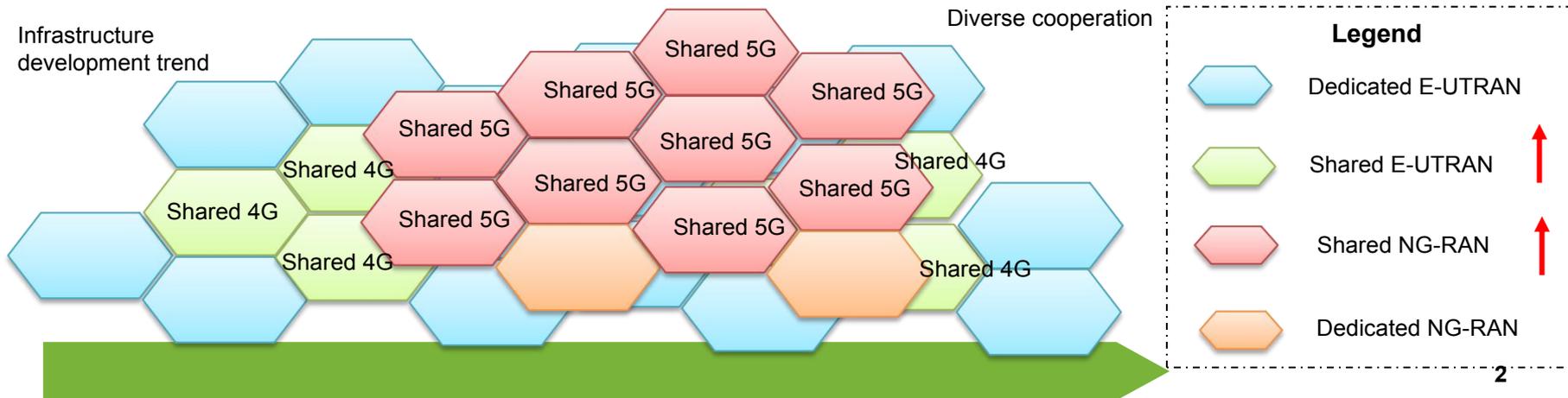
Discussion paper of network sharing in 5G

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Trend and new cooperation

☛ Sharing networks and network infrastructure has become more important part of 3GPP systems.

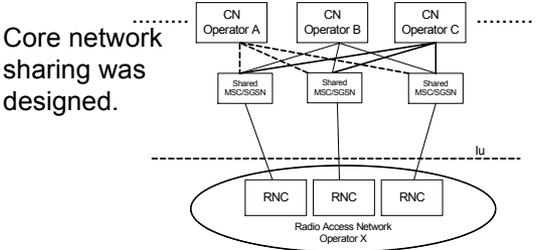
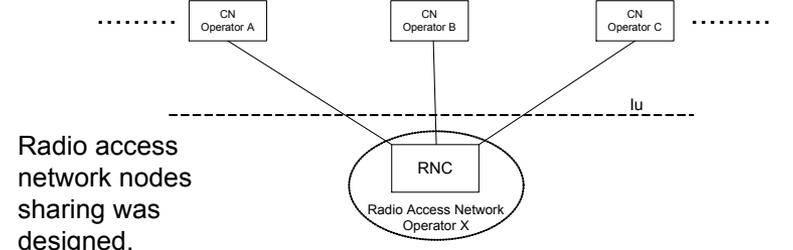
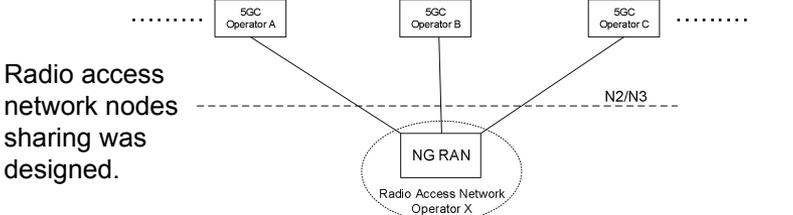
- **Infrastructure at long-term sharing**—In 5G, the network-sharing scenario not only allows operators without a 3GPP license to share the network and provide 4/5G services to their customers, but also provides solution alternatives targeting at dedicated networks, **such as infrastructure sharing aiming at long-term sharing**, which for example is the case when one or more operators lack frequency license or not.
- **More shared NG-RAN** — It is worth mentioning that 5G networks have been designed to share facilities at the beginning of the deployment. That means when 4G networks have independent E-UTRAN coverage and shared E-UTRAN coverage, users served by shared NG-RAN may have **more than independent dedicated NG-RAN**.
- However, With the development of sharing technology, **new ways of cooperation and scenarios have emerged**, which may lead to the enhancement of technology.



Historical silhouettes and missing case

There are many network-sharing scenarios possible depending on different operator strategies but also on rules and legislation in different countries.

- **More kinds of possible cooperation need to be introduced**—When In TS 23.501 R17, only the 5G Multi-Operator Core Network (5G MOCN) network sharing architecture is supported, in which **only the RAN is shared in 5G System**, it is suggested to investigate what shortcomings currently in the specifications may prevent a standardized approach to the deployment of shared networks, e.g. **when the connection between shared RAN and core is not feasible(Lack case).**

<p>Previous system R16</p>	<p>Core network sharing was designed.</p> 	<p>Radio access network nodes sharing was designed.</p> 
<p>R17</p>	<p>Not defined</p>	<p>Radio access network nodes sharing was designed.</p> 
<p>Future functions</p>	<p>lack of cases?</p>	<p>Radio access network nodes sharing was designed</p>

- And core network sharing has been discussed with historical reference and is understood to be valuable in 3G.
- We could find out Multi-Operator Core Network (MOCN) and Gateway Core Network (GWCN) in “Network Sharing; Architecture and functional description” both in R16, but only RAN is shared for 5G access for IP based network.
 - GWCN: Besides shared radio access network nodes, the core network operators also share core network nodes.
 - MOCN: refers to which multiple CN nodes are connected to the same RNC and the CN nodes are operated by different operators.

Differences between RAN sharing and missing scenario

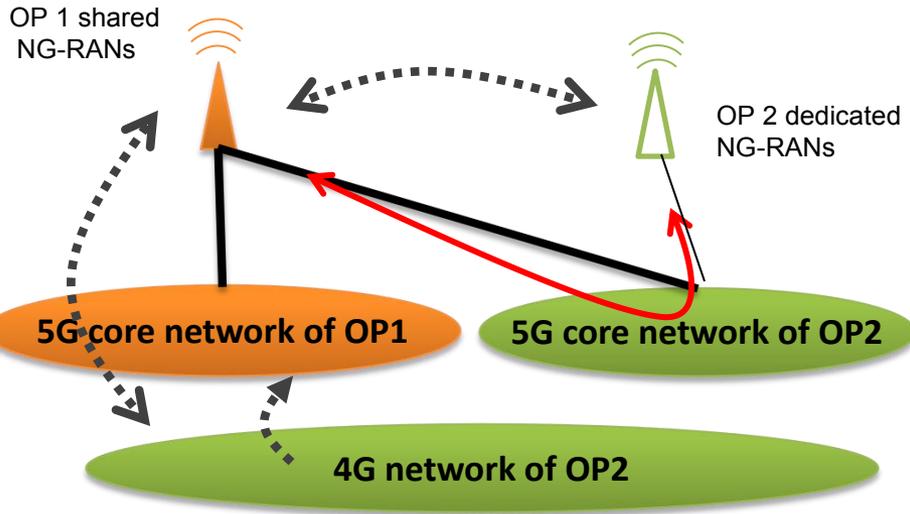


Figure1: RAN sharing(Existing case)

1, OP2's core network has a direct physical link with the shared RAN of OP1, and the mobility could be done by the home network of OP2.

2, OP2's UE could move to OP 1's shared NG-RANs and obtain services from it.

3, OP2's UE could receive OP2's PLMN through SIB.

Note1: Reference from TS 23.501 R17.

Note2: Please notice the black and red lines.

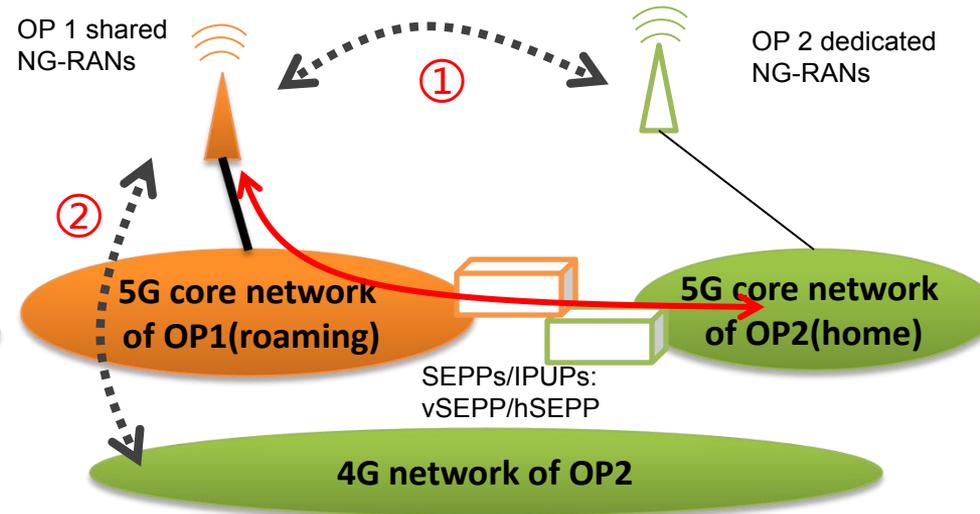


Figure2: RAN sharing with roaming(Lack case)

1, Different from RAN sharing, OP 2's core network and shared RAN do not have a direct physical link, but transfer the route through the core network of OP1.

2, same as left one.

3, same as left one.



Differences between inter-national roaming and missing scenario

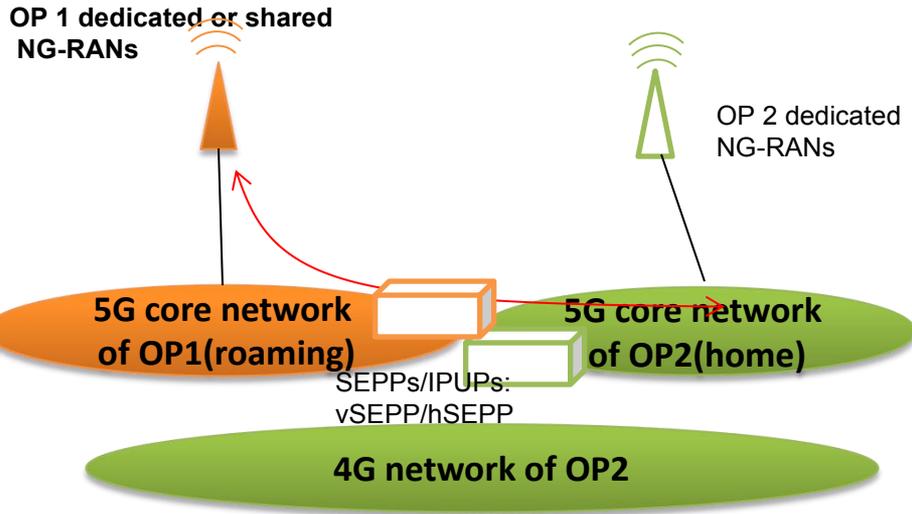


Figure1: Inter-national roaming(Existing case)

1, OP 2 core network and dedicated/shared RAN do not have a direct physical link, but transfer the route through the core network of OP1.

2, OP2's UE could move to OP 1's shared NG-RANs and obtain services from it.

3, OP2's UE could receive OP1's PLMN through SIB.

4, OP1's RAN could be dedicated or shared.

5, There is no mobility between OP1's radio and OP2's.

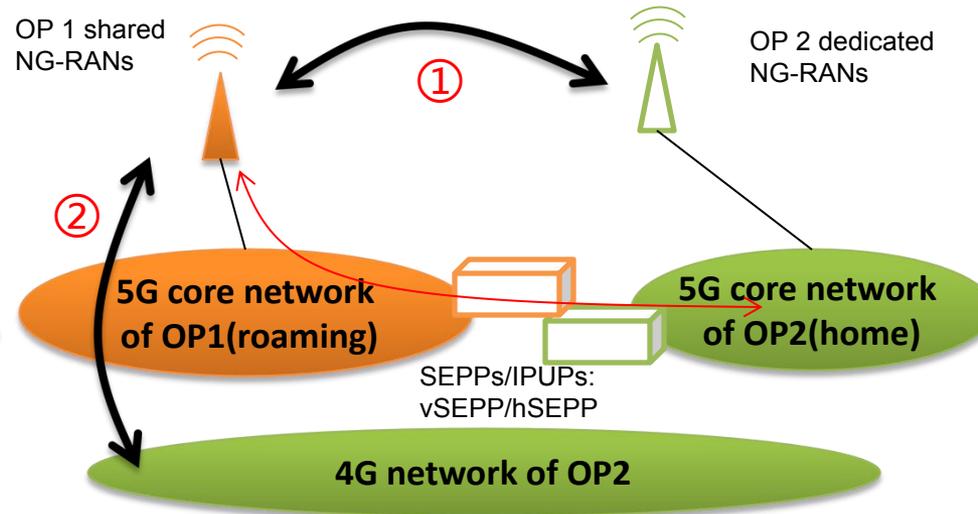


Figure2: RAN sharing with roaming(Lack case)

1, same as left one.

2, same as left one.

3, OP2's UE could only receive OP2's PLMN through SIB.

4, OP1's RAN need to support sharing.

5, There is mobility between OP1's radio and OP2's.

Note1: Also different from national roaming, which needs mobility of inter PLMN of different OPs,

Differences between NPN and missing scenario

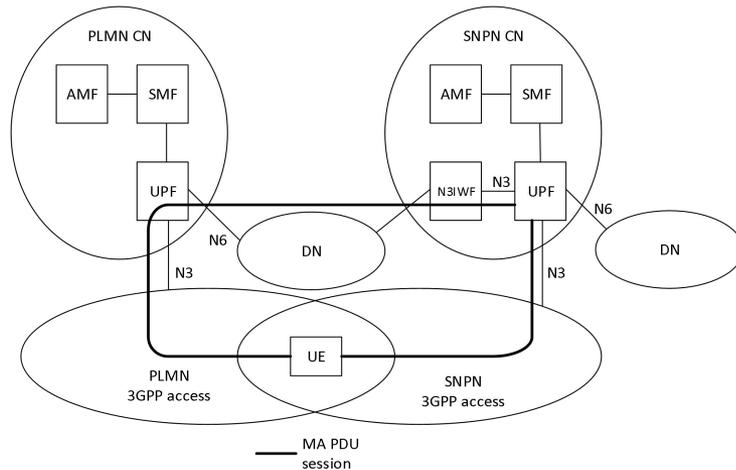


Figure D.6-1: MA PDU session with ATSSS support for dual radio UE accessing to Stand-alone Non-Public Network services via Uu and NWu interfaces(Existing case)

1, SNPN's core network and PLMN's RAN do not have a direct physical link, but transfer the route through the core network(by session).

2, SNPN's UE could move to PLMN's NG-RANs and obtain services from it.

3, SNPN's UE could receive PLMN's PLMN through SIB.

4, UE need to register PLMN and SNPN both.

5, Interworking with EPS is not supported for SNPN。roaming is not supported for SNPN, e.g. roaming between SNPNs. Handover between SNPNs, between SNPN and PLMN or PNI NPN are not supported.

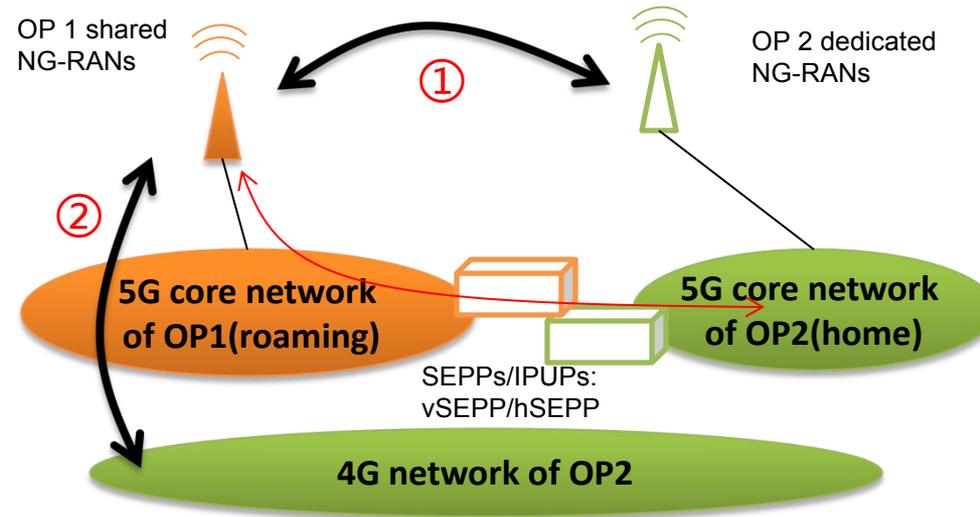


Figure 2: RAN sharing with roaming(Lack case)

1, same as left one,OP 2 core network and shared RAN do not have a direct physical link, but transfer the route through the core network of OP1.

2, same as left one.

3, OP2's UE could only receive OP2's PLMN through SIB.

4, UE could only have one register.

5, There is mobility between OP1's radio and OP2's 5G/4G.

Note1: Reference from TS 23.501 D.6 Support for session/service continuity between SNPN and PLMN when using N3IWF.

mobility scenario assumptions

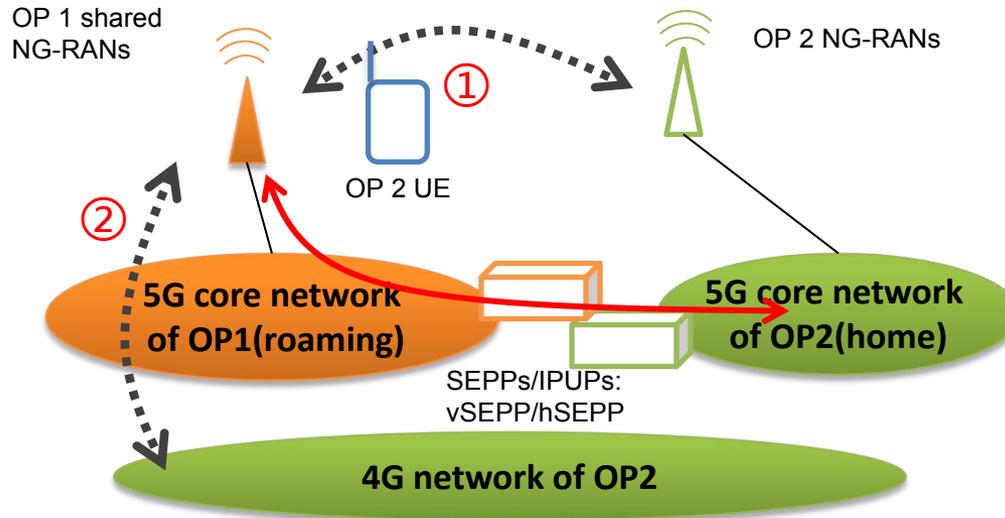


Figure: RAN sharing with roaming(Lack case)

In the condition:

- 1, UE belongs to OP2
- 2, UE register from OP2's PLMN in shared NG-RAN area
- 3, UE move between OP1's and OP2's area

Scene discovery and examples:

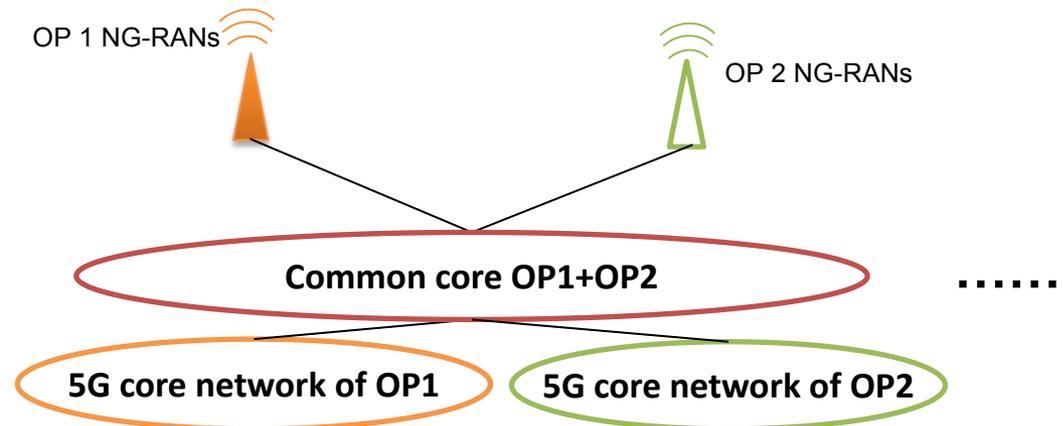
- **Scenario (1)** the 5G terminal initiates a voice call in the shared area and establishes a voice call with VONR. The terminal does not move. The standard roaming scheme is shown in the red line in the figure2;
- **Scenario (2) shared 5G->home 5G**, the 5G terminal initiates a voice call in the shared area, establishes a voice call with VONR, and moves to home 5G network. As shown as ① in figure , N14 interface needs to be established, otherwise the service will be interrupted for 2-3 seconds, affecting the user experience;
- **Scenario (3) shared 5G->home 4G**, 5G terminal initiates a voice call in the shared area, establishes a voice call with VONR, and moves to home 4G network. As shown as ② in Figure , N26 interface needs to be established, otherwise the service interruption will last for 2-3 seconds, affecting the user experience;
- **Scenario (4) home 4G->shared 5G**, the 5G terminal initiates a voice call at home 4G and establishes a voice call with EPS fallback. During the call, it moves to the shared area without handover. After the voice is finished, it quickly accesses to the shared 5G;
- **Scenario (5) home 5G->shared 5G**, the 5G terminal initiates a voice call at home 5G, establishes a voice call with VoNR, and moves to the shared area. As shown as ① in Figure , N14 interface need to be established, otherwise the service interruption will last for 2-3 seconds, affecting the user experience.

Note: the PLMN of shared NG-RAN may be the same or different from home PLMN

Other aspects 2

- 📶 In order to simplify the research complexity. We can temporarily **assume none E-UTRAN sharing cases**. But obviously, this will not restrict 3GPP.
- 📶 What are the **security considerations** when users roam between the shared area and home area? What security can be achieved while maintaining service continuity?
- 📶 Does roaming consider both **home network anchoring** and **visiting network anchoring**?
- 📶 Is the mobility scenario between **boundary** between PLMNs considered?

- 📶 According to the different cooperation mode of operators, do we need service mode for virtual operators or common core network mode?



Gap analysis



What we already support:

- there has been functionality that supports a basic network sharing since the Release 5 versions of the 3GPP specifications, which experienced discussion of five scenarios related to GERAN and UTRAN described, on the basis of R99 version, and relevant normative work were incorporated into 3GPP TS 22.011, TS 22.101, TS 22.115, TS 22.129, TS 22.951.
- 3GPP TS 23.251 allow different core network operators to connect to a shared radio access network, and the operators do not only share the radio network elements, but may also share the radio resources themselves, which introduced the stage 2 details and descriptions of how these requirements are supported in a 3GPP GERAN, and UTRAN based network. To scope with Release 8 in 3GPP E-UTRAN, RAN Sharing Enhancements are further updated in TS 22.101.
- Only the evolution of access network sharing in 5G is completed in TS 23.501, considering the mechanisms we already have as equivalent PLMN, PLMN restrictions, network selection between different PLMNs, and mobility, without other scenarios, such as core network sharing in TS 23.251.
- Various effort of other working groups, etc..

Objective



-  What we need to analyze:
- New scenarios as the shared NG-RAN with roaming in 5G?
 - Whether there are different understanding for user registration, roaming and service continuity, etc.?
 - And whether the new case can also include the Security considerations and mobility continuity when moving near the boundary?
 - Requirements related, e.g. Charging requirements, and analyze the limited impact on UE, etc..

Thank you

