



DP on mobility support

vivo

- I. **Which case is in scope? How to understand serving satellite changes?**
- II. How many satellite IDs?
- III. Action orders in 5GC to ensure service continuity
- IV. Options in IMS to update IP addresses

I. Which case is in scope?

Generally, UE's serving satellite changes mean gNB changes. However, in the context of U-S-U communication, there could be more than one UE's serving satellite, as UPF, AGW are also onboarding the satellite to support the U-S-U.

To ensure connectivity, no matter which serving satellite changes, the in-charge NF needs to be notified and further decide whether the U-S-U can be continued or not:

- **Case#1:** If UPF satellite changes, SMF will be notified via N4 interface, and SMF check the N3 connectivity, SMF may fall back the call to the ground, and notify P-CSCF of the new event
- **Case#2:** If AGW satellite changes, P-CSCF will be notified via Iq interface, and P-CSCF check the N6 connectivity, and connectivity with the other side, and may fall back the call to the ground
- **Case#3:** If gNB satellite changes, the normal handover procedure can be executed. SMF should be enhanced to check the N3 connectivity between target gNB and UPF, P-CSCF will re-check the N6 connectivity and in addition the connectivity with the other side UE.

Observation#1: case#1 and case#2 need new enhancements on N4 and Iq interface to monitor the connectivity.

Observation#2: case#3 is the one we discussed in TR phase.

Proposal#1: we only focus on case#3 as the mobility support, i.e. only gNB onboarding satellite changes is to be discussed.

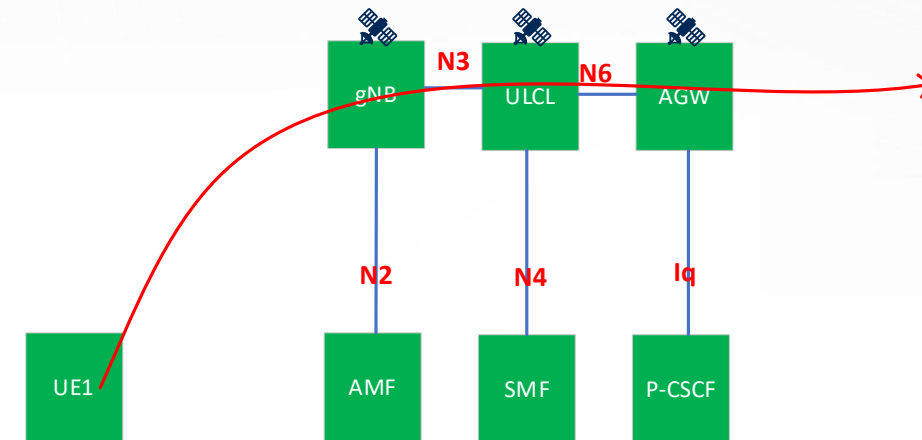


Fig.1: one of UE's serving satellite changes

- I. Which case is in scope? Which case is in scope? How to understand serving satellite changes?
- II. How many satellite IDs?**
 - I. Deploy#1: gNB+ULCL+AGW on the same satellite, only 1 satelID
 - II. Deploy#2: gNB+ULCL on the same satellite, and AGW on a different, 2 satelIDs
 - III. Deploy#3: gNB, ULCL and AGW on different satellite, 3 satelIDs
- III. Action orders in 5GC to ensure service continuity
- IV. Options in IMS to update IP addresses

Connectivity among satellites is very important in U-S-U communication. The decision maker P-CSCF needs to check the connectivity between UE1 and UE2 to decide whether to activate the U-S-U or not. It has a dependency on deployment and also current ISL technology. From 3GPP's scope, we can have the following options considering deployment:

Deploy#1: one satellite ID for a UE, i.e. gNB, UPF and AGW onboarding the same satellite;

Deploy#2: two satellite IDs for a UE, i.e. gNB, UPF onboarding the same satellite, and AGW onboarding a different satellite;

Deploy#3: three satellite IDs for a UE, i.e. gNB, UPF and AGW onboarding different satellites. When gNB changes, N3 is by

1 satellite ID for a UE



Fig.2.1: Deploy#1-1serving satellite

2 satellite IDs for a UE

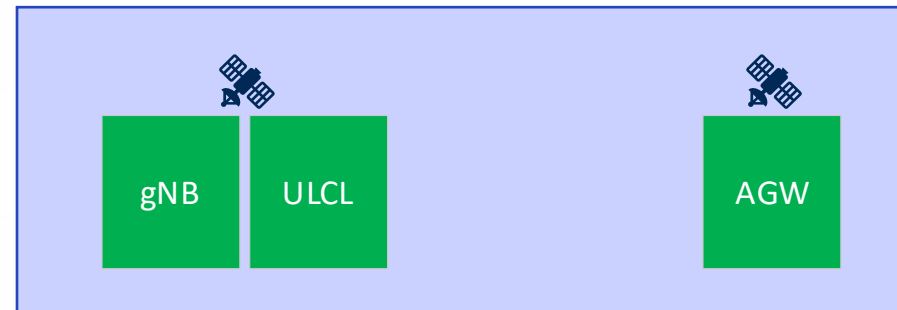


Fig.2.2: Deploy#3-2 serving satellites

3 satellite IDs for a UE



Fig.2.3: Deploy#3-3 serving satellites

Satellite ID can be used to check the connectivity between satellites.

When gNB onboarding satellite changes, depending on different deployments and type of HO, there could be by default connectivity status.

- Deploy#1, N2 HO means there is no connectivity between source sate and target sate, resulting in no connection between UL CL, AGW

To make things clearer,

- **N3'connectivity** stands for the connection between target gNB and source UL CL
- **N6'connectivity** stands for the connection between target UL CL and source AGW

Call continuity - Deploy#1, only 1 satellite ID

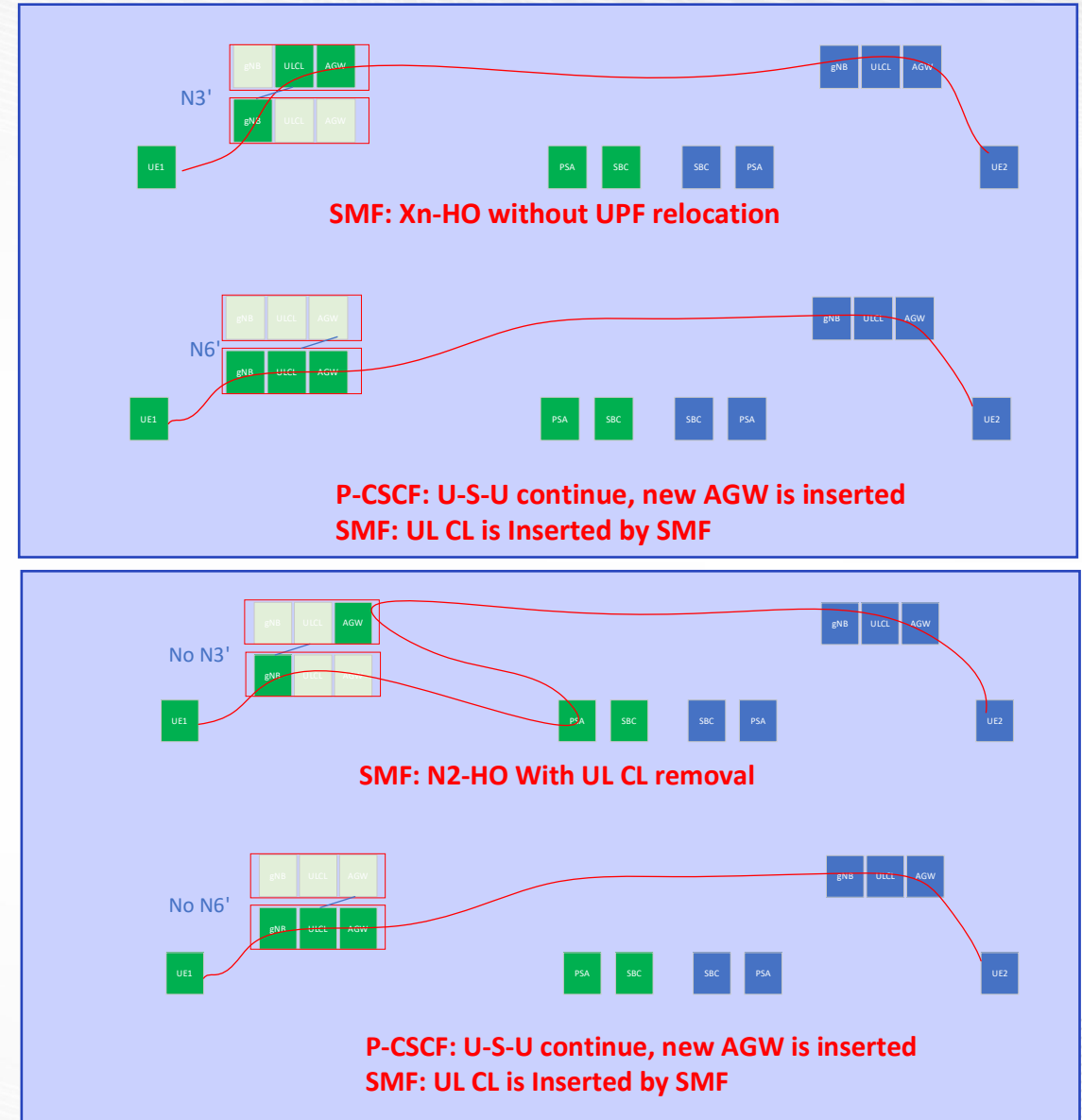
When gNB changes, Xn/N2 handover will be executed.

- N3' connectivity stands for the connection between target gNB and source UL CL
- N6' connectivity stands for the connection between target UL CL and source AGW

Deploy#1: If there is only one serving satellite,

- Xn HO means there is N3', N6' connectivity,
 - As there is N3', during HO, the SMF **keeps** the existing UL CL (to save N4 signalling with new satellite)
 - As there is N6', P-CSCF **may** optimize the media path to change AGW from source satellite to target satellite
 - If so, the SMF should *change* UL CL to the target satellite accordingly
- N2 HO means there is no N3', no N6' connectivity
 - As no N3', during HO, the SMF **should** fall back the PDU session from satellite to the ground;
 - As no N6', P-CSCF may optimize the media path to change AGW from source satellite to target,
 - If so, the SMF should *insert* UL CL to the target satellite accordingly

Proposal#2: Deploy#1 is suggested to be in scope.



Call continuity - Deploy#2, 2 satellite IDs

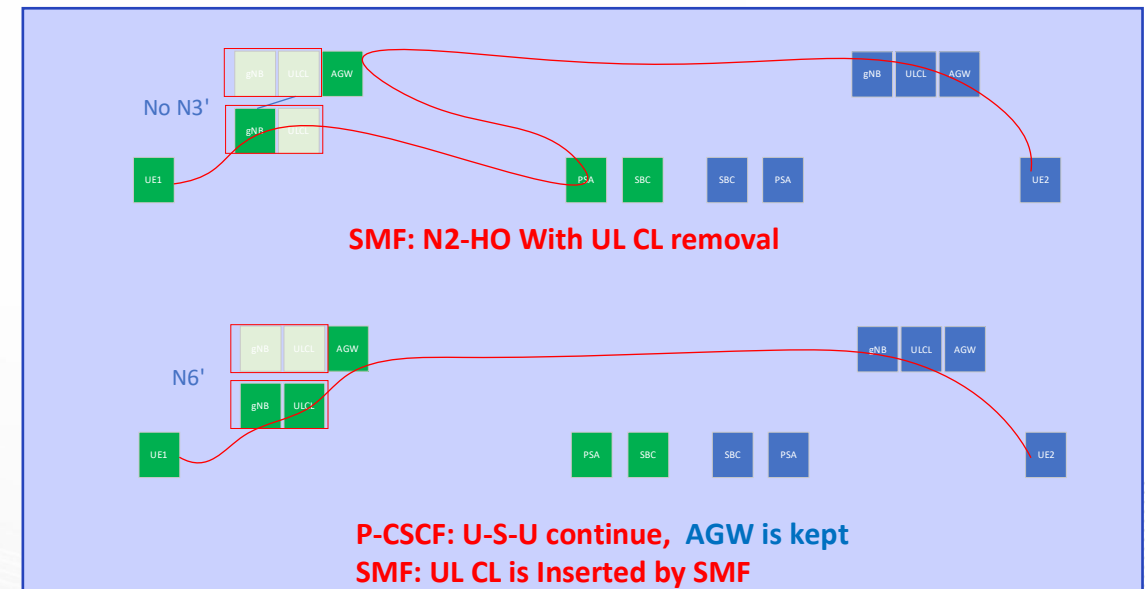
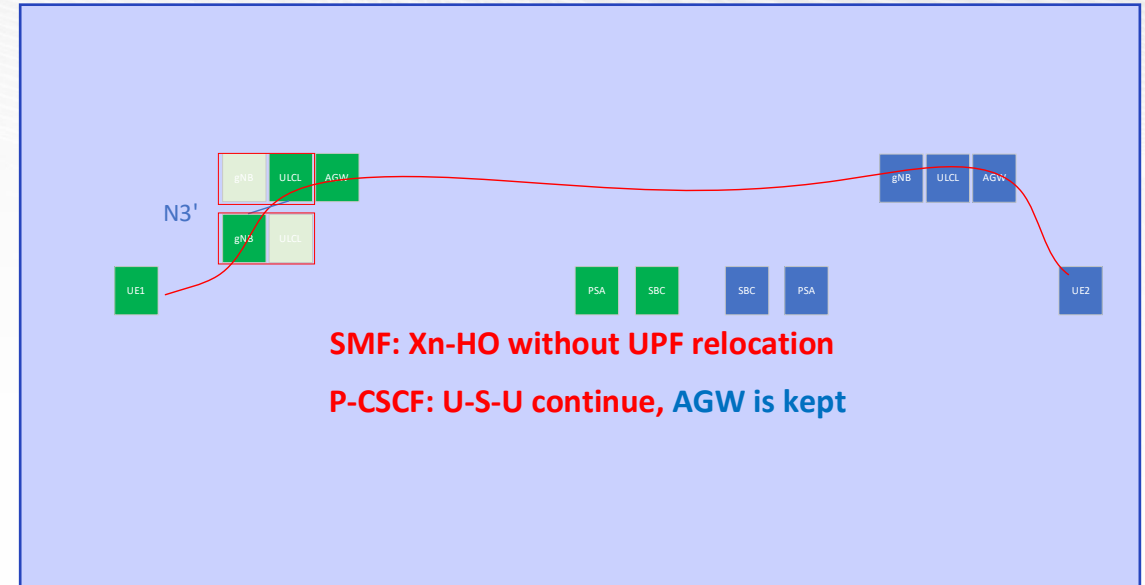
When gNB changes, Xn/N2 handover will be executed.

- N3' connectivity stands for the connection between target gNB and source UL CL
- N6' connectivity stands for the connection between target UL CL and source AGW

Deploy#2: If there are 2 serving satellites,

- Xn HO means there is N3', N6' connectivity,
 - As there is N3', during HO, the SMF **keeps** the existing UL CL (to save N4 signalling with new satellite)
 - As there is N6', P-CSCF **may** optimize the media path to change AGW from source satellite to target satellite
 - If so, the SMF should *change* UL CL to the target satellite accordingly
- N2 HO means there is no N3', but potentially no N6' connectivity
 - As no N3', during HO, the SMF **should** fall back the PDU session from satellite to the ground;
 - As there may be N6', P-CSCF needs to re-check UE1's serving satellites connectivity, i.e. P-CSCF needs to obtain UL CL satellite ID and AGW satellite ID
 - If there is N6', the P-CSCF may do nothing
 - If there is no connectivity, AGW should be relocated to keep the session alive

Proposal#2: Deploy#2 is suggested to be out of scope, as **P-CSCF** needs to obtain 2 satellite IDs, gNB+UL CL's and AGW's



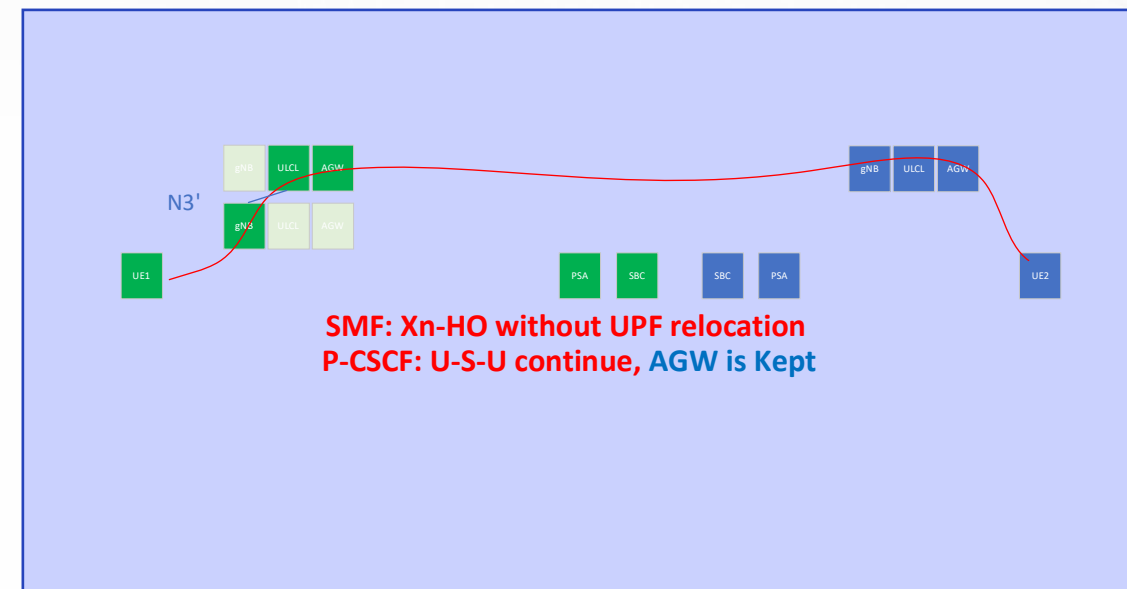
Call continuity - Deploy#3, 3 satellite IDs

When gNB changes, Xn/N2 handover will be executed.

- N3' connectivity stands for the connection between target gNB and source UL CL
- N6' connectivity stands for the connection between target UL CL and source AGW

Deploy#3: If there are 3 serving satellites,

- Xn and N2 means potentially there are N3' connectivity. N6' has no relationship with HO
 - As there may be N3', during HO, the SMF checks N3' connectivity, i.e. SMF needs to obtain gNB's and UL CL's satellite IDs
 - If there is, the SMF keeps the existing UL CL
 - If there is no connectivity, the SMF **should** fall back the PDU session from satellite to the ground;
 - As it is fully mesh connectivity, whenever gNB changes, **P-CSCF needs to re-check UE1's serving satellites connectivity, i.e. P-CSCF needs to obtain gNB satellite ID, UL CL satellite ID and AGW satellite ID**
 - If there is connectivity, the P-CSCF may do nothing
 - If there is no connectivity, AGW should be relocated to keep the session alive, the UL CL should also be instructed to change



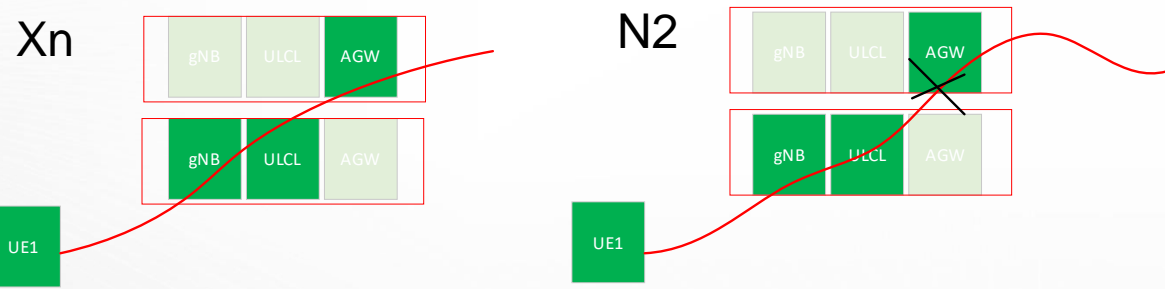
Proposal#4: Deploy#3 is suggested to be out of scope, as **P-CSCF** needs to obtain 3 satellite IDs, gNB's, UL CL's and AGW's, and whenever any of them changes, P-CSCF needs to re-obtain the satellite IDs to check the connectivity

- I. Which case is in scope? Which case is in scope? How to understand serving satellite changes?
- II. How many satellite IDs?
- III. Steps to maintain call continuity with 1 satellite ID**
 - I. $X_n - HO$
 - II. $N_2 - HO$
- IV. Who sends RE-INVITE?

Generally, 5GC is in charge of both gNB and UL CL/L-PSA connectivity, and IMS is in charge of AGW connectivity. As gNB+UL CL+AGW onboarding the same satellite, it is possible to change UL CL simultaneously:

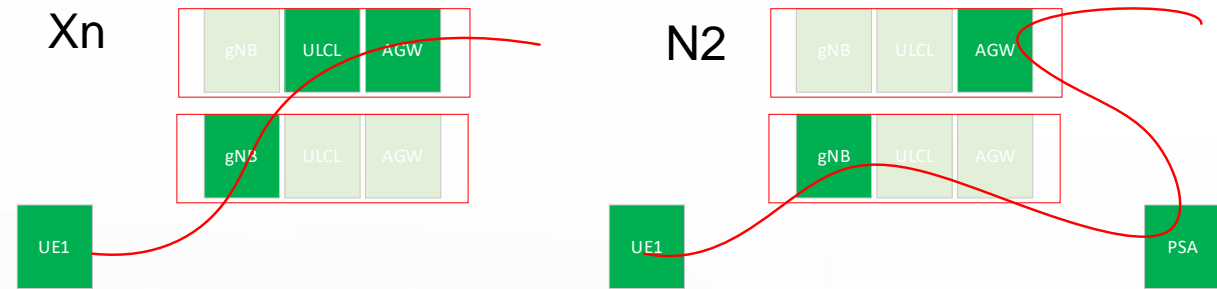
HO procedure, gNB + UL CL change simultaneously

Observation#1: gNB + UL CL change simultaneously results in a period of call interruption in N2 HO, as there is no N6'connectivity between source AGW and target UL CL.
 One solution could be to enhance SMF to interact with P-CSCF during the HO to shift the media path to the target satellite.
 However, this still cannot ensure the service continuity, new AGW address negotiation with the other side UE takes time.



HO procedure, change gNB only

Observation#2: only gNB changes can ensure call continuity:
 In Xn HO, gNB can connect back to UL CL via ISL, the call can be ensured.
 - Media path can be optimized by shifting AGW from source to the target, and change UL CL from source to the target
 In N2 HO, gNB cannot connect back to UL CL, the call should be fall back to ground.
 - Media path can be optimized by shifting AGW from source to the target and insert UL CL to the target



Proposal: when gNB onboarded satellite changes, HO only deals with the UL CL should be kept either to the source satellite or back to the ground,

Xn-HO means here is connection between source satellite and target satellite.

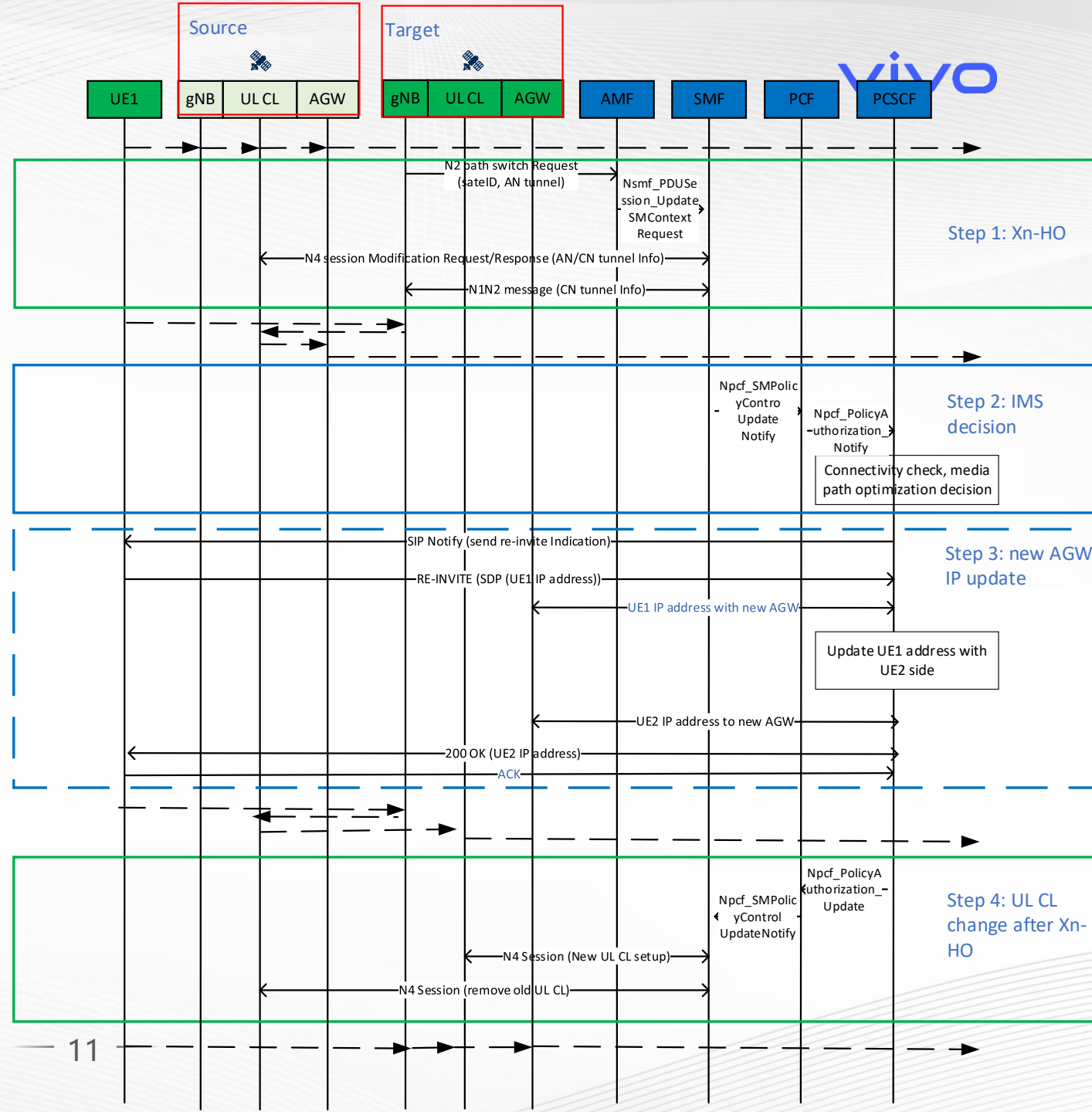
Observation#1: Step 1, Step 4 can be executed together if SMF in prior know P-CSCF's Step 2 decision.

Observation#2: Step 3 only happens if Step 2 decides to optimize the call media plane. The order of step 2 and step 3 cannot be swapped

Observation#3: Step 3 and Step 4 can happen simultaneously, as there is connection between source satellite and target satellite

Proposal: the order in scope of Xn HO is:

- Step1: Xn-HO
- Step2
- [Conditional] Step 3 and Step4



N2-HO means here is no connection between source satellite and target satellite, **PDU session should fall back to ground PSA** to keep continuity:

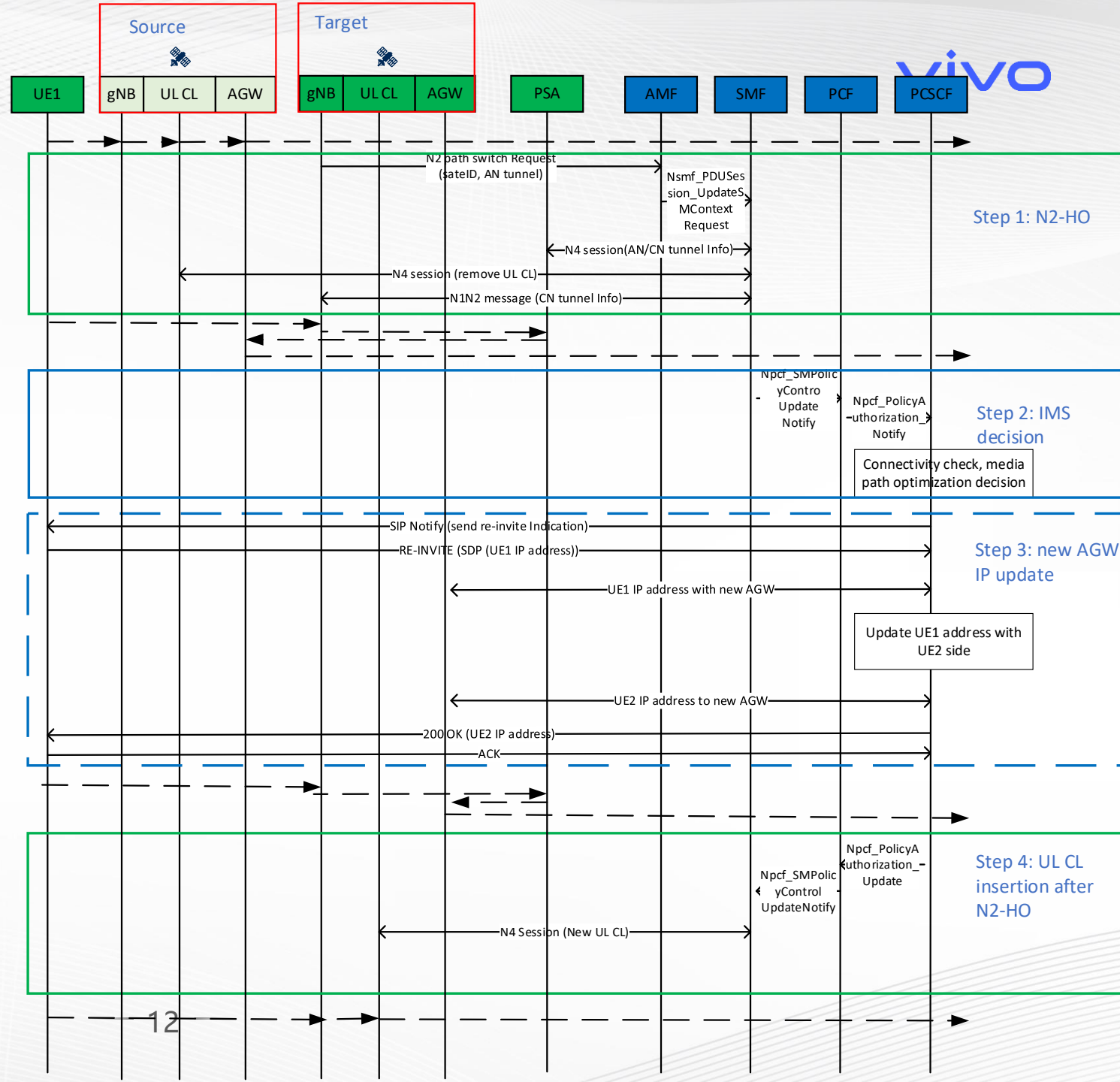
Observation#1: Step 1, Step 4 **cannot** be executed together, as it will result in call interruption, as there is no connection between target ULCL and source AGW.

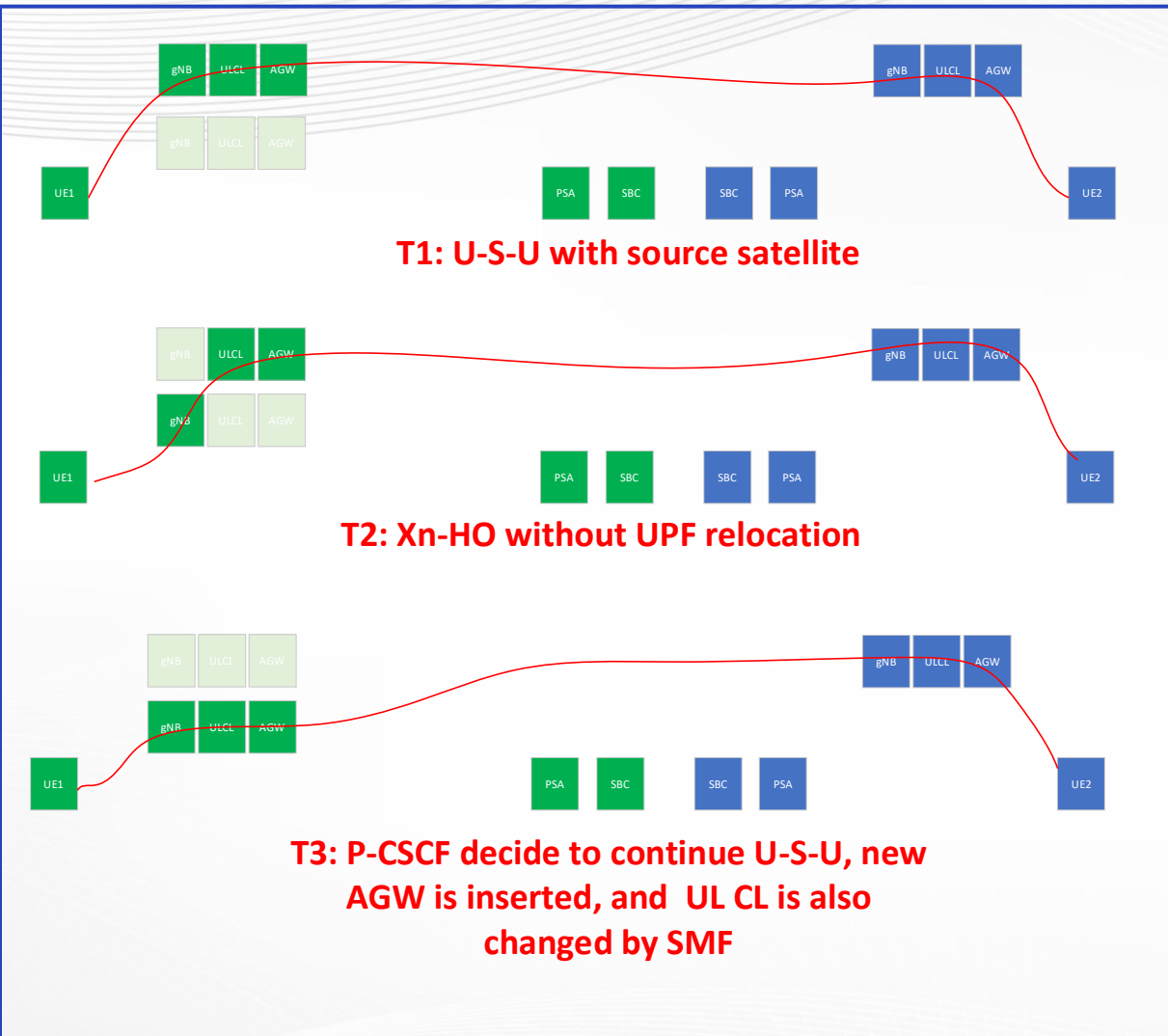
Observation#2: Step 3 happens if Step 2 decides to optimize the call media plane. The order of step 2 and step 3 cannot be swapped

Observation#3: Step 3 and Step 4 can happen simultaneously, as there is connection between source satellite and target satellite

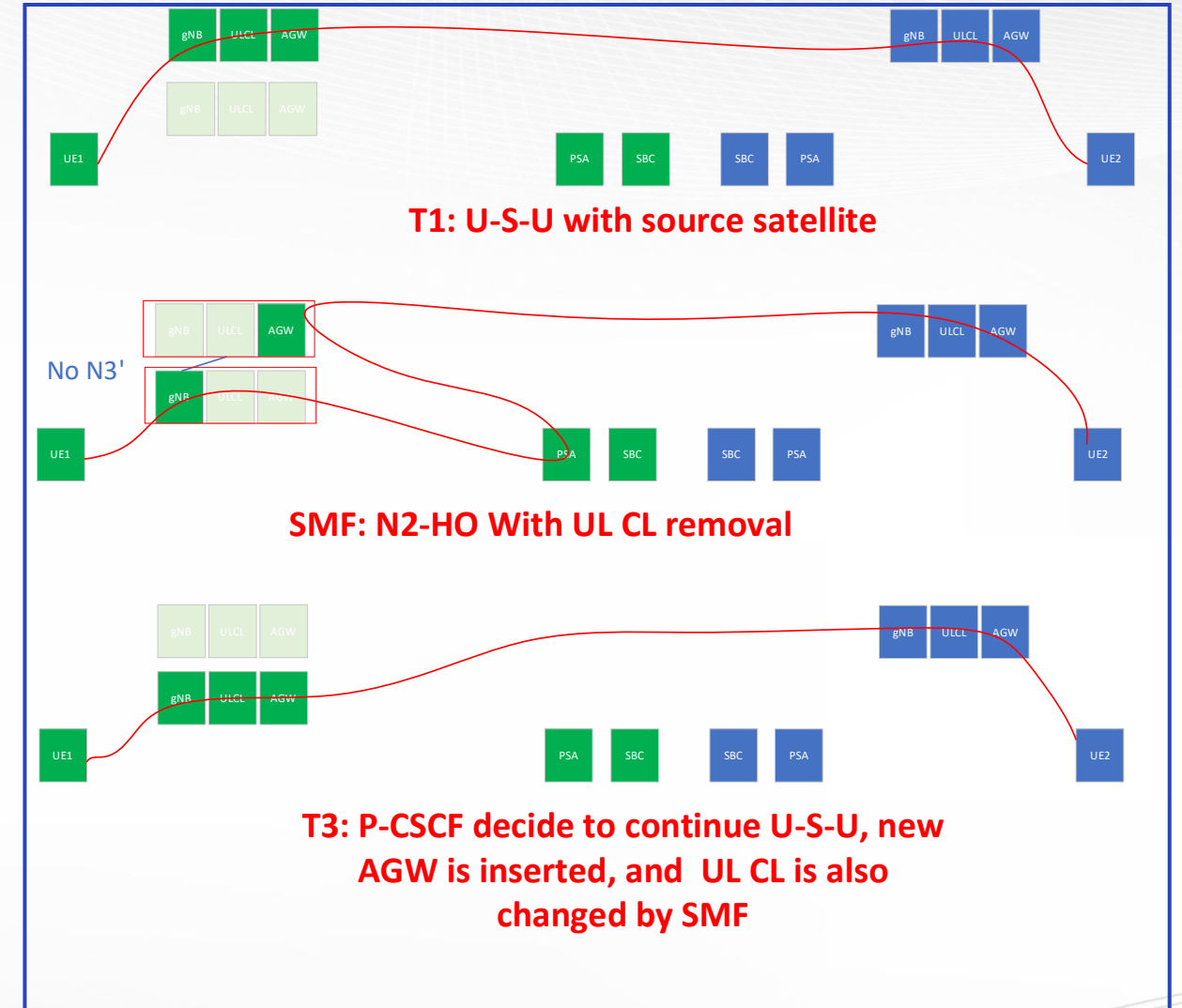
Proposal: the order in scope of N2 HO is:

- Step1: N2-HO
- Step2
- **[Conditional]** Step 3 and Step4





Xn



N2

- I. Which case is in scope? Which case is in scope? How to understand serving satellite changes?
- II. How many satellite IDs?
- III. Steps to maintain call continuity with 1 satellite ID
- IV. **Who sends RE-INVITE?**

Who sends RE-INVITE?



Re-invite is only useful when P-CSCF decides to relocate AGW. If AGW is kept, there is no need to send a re-invite.

| | Option#1 | Option#2 | Option#3.1 | Option#3.2 |
|----------------------------------|--------------------------|----------------------------|----------------------------------|--|
| Who triggers | P-CSCF | UE AS layer | P-CSCF | P-CSCF |
| Who notifies | No need | UE AS layer | P-CSCF | S-CSCF |
| Who sends Re-invite | P-CSCF | UE | UE | UE |
| New indication? | No need | Yes, AS layer to IMS layer | Yes, P-CSCF to UE via SIP NOTIFY | Yes, P-CSCF to S-CSCF via xxx, S-CSCF to UE via SIP Notify |
| Violate AGW relocation decision? | No | Could be | No | No |
| Enhancements? | P-CSCF that serves U-S-U | UE | P-CSCF that serves U-S-U, UE | P-CSCF that serves U-S-U, UE, S-CSCF |

Proposal#1: Option2 causes ambiguity at P-CSCF, resulting in P-CSCF re-check the decision of IMS media plane optimization decision, proposed to be deprioritized.

