**3GPP TSG-SA WG2 Meeting #164 *S2-24xxxxx***

**Maastricht, NL, August 19-23, 2024**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **23.228** | **CR** | **xx** | **rev** | **-** | **Current version:** | **18.6.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network | **X** |

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| ***Title:*** | Support of UE-Satellite-UE communication in IMS | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | NTT DOCOMO | | | | | | | | | |
| ***Source to TSG:*** | S2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | 5GSAT\_ARCH\_Ph3 | | | | |  | ***Date:*** | | | 2024-08-04 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-19 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
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| ***Reason for change:*** | | According to the approved 5GSAT\_ARCH\_Ph3 work item and the conclusion of 5GSAT\_ARCH\_Ph3 captured in clause 8.3 of TR 23.700-29, this CR adds description on Support of UE-Satellite-UE communication in IMS. | | | | | | | | |
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| ***Summary of change:*** | | Addition of Support of UE-Satellite-UE communication in IMS. | | | | | | | | |
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| ***Consequences if not approved:*** | | An objective of the 5GSAT\_ARCH\_Ph3 work item is not achieved. | | | | | | | | |
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| ***Clauses affected:*** | | Annex AX (new) | | | | | | | | |
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|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

---Start of the 1st Change---

Annex AX (normative):  
Support of UE-Satellite-UE communication in IMS

AX.1 General

This annex describes IMS architecture enhancements to support UE-Satellite-UE communication for the satellite constellation with regenerative payloads.

Editor's note: References to the definition of the term "UE-Satellite-UE communication" and to a figure that describes satellite constellation are to be added.

In this Release of the specification, UE-Satellite-UE communication is supported only for IMS voice/video service and UEs served by the same PLMN.

Editor's note: Based on the LS response from SA3 LI, the description below addresses only the case IMS AGW is on board of satellite. FFS if it is ok to consider this is the way forward of Rel-19.

AX.2 Architecture and functional entities

AX.2.1 Architecture

No new IMS entities are introduced to support this feature.

AX.2.2 Functional entities

AX.2.2.1 P-CSCF

P-CSCF is enhanced to support the following functionalities:

- P-CSCF determines the possibility of UE-Satellite-UE communication.

- P-CSCF controls IMS AGW relocation.

- P-CSCF controls insertion and deletion of ULCL and local PSA on satellite.

- P-CSCF discovers and selects IMS AGW on satellite.

AX.3 Determination of the possibility of UE-Satellite-UE communication

AX.3.1 At call setup

P-CSCF should be able to determine the possibility of UE-Satellite-UE communication based on the relation between an identifier of a satellite serving the originating UE and an identifier of a satellite serving the terminating UE.

P-CSCF in the originating network receives the identifier of a satellite serving the originating UE from PCF in the originating network and finds the identifier of a satellite serving the terminating UE in a SIP message received from P-CSCF in the terminating network. The same applies by replacing the term originating and the term terminating in the above.

Editor's note: In order to simplify the P-CSCF's judgement, maybe we can consider (i)satellite ID also conveys satellite constellation ID (i.e., satellite ID is actually satellite-constellation ID + (satellite-constellation-local) satellite ID) and (ii)P-CSCF judges if the satellite constellation ID is the same. FFS.

AX.3.2 At change of satellite

P-CSCF should be able to determine the possibility of UE-Satellite-UE communication based on the relation between an identifier of a satellite that is about to serve a UE after change of satellite and an identifier of a satellite serving the other UE.

P-CSCF receives the identifier of a satellite that is about to serve a UE from PCF.

AX.4 IMS AGW relocation

AX.4.1 At call setup

P-CSCF shall establish an IMS AGW on ground as long as the P-CSCF does not know UE-Satellite-UE communication is possible. After the P-CSCF determines UE-Satellite-UE communication is possible, the P-CSCF should release the IMS AGW on ground and establish an IMS AGW on satellite.

AX.4.2 At change of satellite

If P-CSCF determines that UE-Satellite-UE communication continues to be possible, the P-CSCF should establish an IMS AGW on the target satellite. After completion of establishment of the IMS AGW on the target satellite, the P-CSCF informs UE in the serving network and the IMS AGW in the other network to use the IMS AGW on the target satellite. In the end, the IMS AGW on the source satellite is released.

Editor's note: For now, it's written as in the above. But we need to decide whether (i) P-CSCF triggers UE to send SIP re-INVITE by using an SIP message. or (ii)P-CSCF creates SIP re-INVITE by itself and sends it to S-CSCF. And P-CSCF notifies to UE. or (iii)P-CSCF triggers UE to send SIP re-INVITE by using 5GC procedure (e.g., letting UE to check broadcast and understand PANI changes).

If P-CSCF cannot determine that UE-Satellite-UE communication continues to be possible, the P-CSCF shall establish an IMS AGW on ground. P-CSCF in the opposite network notices UE-Satellite-UE communication becomes not possible based on SIP message not containing any satellite-related information and shall start establishing an IMS AGW on ground in the opposite network. After completion of establishment of both IMS AGWs on ground, P-CSCF informs UEs in both the originating network and the terminating network to use those IMS AGWs on ground. In the end, the IMS AGWs on satellite are released.

Editor's note: The same above also applies here.

AX.5 Insertion and deletion of ULCL and L-PSA on satellite

AX.5.1 At call setup

If P-CSCF determines UE-Satellite-UE communication is possible and decides to establish an IMS AGW on satellite, P-CSCF shall inform it to PCF, so that PCF proceeds to establish ULCL and local PSA on satellite and to setup a QoS flow for voice/video media. At the point of time of setting ULCL, IP address in IMS AGW on satellite that UE is supposed to use as the destination is not available. P-CSCF later requests PCF to update the UL traffic filter in ULCL.

AX.5.2 At change of satellite

If P-CSCF determines that UE-Satellite-UE communication continues to be possible and decides to establish an IMS AGW on target satellite, P-CSCF shall give a positive response to PCF. This response allows PCF to proceed to establish ULCL and local PSA on the target satellite and perform the procedure of the Simultaneous change of Branching Point or UL CL and additional PSA for a PDU Session as specified in clause 4.3.5.7 of TS 23.502 [94].

P-CSCF informs PCF of the completion of establishment of the IMS AGW on the target satellite, so that PCF can proceed to set an IP address reserved in the IMS AGW on the target satellite for receiving packets from UE into the UL traffic filter in the ULCL on the target satellite to the L-PSA on the target satellite. (This means a dummy value is set in the UL traffic filter until then.)

In the end, ULCL and L-PSA on the source satellite are released.

Editor's note: The above paragraph is for avoiding packet loss. To be checked if it works properly.

If P-CSCF cannot determine that UE-Satellite-UE communication continues to be possible, or if P-CSCF does not intend to establish an IMS AGW on the target satellite, P-CSCF should give a negative response to PCF.

In the end, P-CSCF requests PCF to perform the procedure for Removal of additional PDU Session Anchor and Branching Point or UL CL as specified in clause 4.3.5.5 of TS 23.502 [94]. ULCLs and L-PSAs on satellite are released.

AX.6 UE-Satellite-UE communication procedures

AX.6.1 Session establishment procedure

Figure AX.6.1-1 depicts a signalling flow diagram for establishing a session of UE-Satellite-UE communication. The flow starts with UE under a coverage of a satellite constellation making a call to another UE, not knowing whether the terminating UE is under the same coverage or not.

NOTE: IMS entities not relevant for the procedure are omitted below for brevity of the description.



**Figure AX.6.1-1: Session establishment procedure**

The steps in the call flow are as follows:

1. UE sends SIP INVITE to P-CSCF. SIP INVITE contains information indicating that the UE is connected via satellite (access-type=3GPP-NR-SAT) in PANI.

2. Since P-CSCF does not have information on the terminating UE, P-CSCF assumes that the terminating UE is connected to the terrestrial network and determines to establish an IMS AGW on ground. P-CSCF sends H. 248 ADD request to IMS AGW on ground and receives a response.

3. P-CSCF requests PCF to obtain satellite ID of a satellite that serves UE. PCF sends a response containing the satellite ID to P-CSCF.

Editor's note: The name of the request message is added after 23501 CR and 23502 CR become ready.

4. P-CSCF constructs a new SIP header containing the satellite ID, adds this SIP header to the SIP INVITE, and sends further to P-CSCF in the terminating network.

Editor's note: The above suggests using a new SIP header. This is because it's not sure if PANI can be enhanced to carry satellite ID and because PANI cannot be conveyed between different PLMNs and it's not future proof. FFS if it's ok.

5. Since P-CSCF does not have information on the terminating UE, P-CSCF assumes that the terminating UE is connected to the terrestrial network and determines to establish an IMS AGW on ground. P-CSCF sends H. 248 ADD request to IMS AGW on ground and receives a response.

Editor's note: Unprotected SIP Register does not contain PANI. Therefore, P-CSCF might not know that the terminating UE is under a satellite. FFS if this understanding is correct.

6. P-CSCF sends SIP INVITE to UE.

7. UE sends SIP 183 Session Progress to P-CSCF.

8. P-CSCF requests PCF to obtain satellite ID of a satellite that serves UE. PCF sends a response containing the satellite ID to P-CSCF.

9. P-CSCF determines that UE-Satellite-UE communication is possible based on the relation between the satellite ID for the originating UE and the satellite ID for the terminating UE.

10. P-CSCF sends to PCF a request message requesting to establish ULCL/L-PSA on satellite and a QoS flow for IMS voice/video media.

Editor's note: The name of the request message is added after 23501 CR and 23502 CR become ready.

11. P-CSCF releases IMS AGW on ground.

12. P-CSCF sends H. 248 ADD request to IMS AGW on satellite and receives a response.

Editor's note: In this step, P-CSCF treats the content in SDP answer as if it's in SDP offer. FFS if it's ok.

13. P-CSCF sends to PCF a request message requesting to set a correct value, i.e., the IP address in IMS AGW on satellite received in the previous step, for UL traffic filter for the destination L-PSA.

14. P-CSCF sends SIP 183 Session Progress to P-CSCF in the originating network.

15. P-CSCF determines that UE-Satellite-UE communication is possible based on the relation between the satellite ID for the originating UE and the satellite ID for the terminating UE.

16. P-CSCF sends to PCF a request message requesting to establish ULCL/L-PSA on satellite and a QoS flow for IMS voice/video media.

Editor's note: The name of the request message is added after 23501 CR and 23502 CR become ready.

17. P-CSCF releases IMS AGW on ground.

18. P-CSCF sends H. 248 ADD request to IMS AGW on satellite and receives a response.

Editor's note: In this step, P-CSCF treats the content in SDP answer as if it's in SDP offer. FFS if it's ok.

19. P-CSCF sends SIP 183 Session Progress to UE.

20. UE sends PRACK/UPDATE to P-CSCF.

21. P-CSCF completes setting up of IMS AGW on satellite.

Editor's note: In this step, P-CSCF treats the content in SDP offer as if it's in SDP answer. FFS if it's ok.

22. P-CSCF sends PRACK/UPDATE to P-CSCF in the terminating network.

23. P-CSCF completes setting up of IMS AGW on satellite.

Editor's note: In this step, P-CSCF treats the content in SDP offer as if it's in SDP answer. FFS if it's ok.

24. P-CSCF sends to PCF a request message requesting to set a correct value, i.e., the IP address in IMS AGW on satellite received in the previous step, for UL traffic filter for the destination L-PSA.

25. P-CSCF sends PRACK/UPDATE to UE.

26. The rest of the procedure is as usual.

AX.6.2 IMS AGW relocation procedure

AX.6.2.1 Continued UE-Satellite-UE communication procedure

Figure AX.6.2.1-1 depicts a signalling flow diagram for continuation of UE-Satellite-UE communication after change of satellite that serves a UE.



**Figure AX.6.2.1-1: Continued UE-Satellite-UE communication procedure**

The steps in the call flow are as follows:

1. P-CSCF obtains satellite ID of a satellite that is about to serve UE.

2. P-CSCF determines that UE-Satellite-UE communication continues to be possible based on the relation between the satellite ID received in step 1 and the satellite ID stored for the other network.

3. P-CSCF sends positive feedback to PCF.

4. PCF proceeds to establish ULCL and L-PSA on the target satellite and perform the procedure of the Simultaneous change of Branching Point or UL CL and additional PSA for a PDU Session as specified in clause 4.3.5.7 of TS 23.502 [94], while the source ULCL and the source L-PSA are kept until P-CSCF notifies later. The IP address of the termination point for UE in the source IMS AGW on satellite, which SMF has stored in the Session establishment procedure, is set in the UL traffic filter in the target ULCL for the destination of the source ULCL.

5. P-CSCF receives a notification that ULCL and L-PSA on the target satellite have been established.

6. UE and P-CSCF interact. P-CSCF sends H. 248 ADD request to the target IMS AGW on satellite and receives a response.

Editor's note: For now, it's written like this. But there are a few options to realize this part. FFS which option to take.

7. P-CSCF sets the value of c=line to be that of the source IMS AGW on satellite to avoid packets coming to the target IMS AGW on satellite that is not yet fully setup. P-CSCF sends SIP re-INVITE to P-CSCF in the opposite network.

8. P-CSCF determines that UE-Satellite-UE communication continues to be possible based on the relation between the satellite ID stored for its own network and the satellite ID received in SIP re-INVITE for the opposite network.

9. P-CSCF sends SIP re-INVITE to UE.

10. UE sends SIP 200 OK to P-CSCF.

11. P-CSCF sends SIP 200 OK to P-CSCF in the opposite network.

12. P-CSCF completes setting up of the target IMS AGW on satellite.

13. P-CSCF sends to PCF a request message requesting to set a correct value, i.e., the IP address in the target IMS AGW on satellite received in the previous step, for UL traffic filter for the destination of the target L-PSA.

14. P-CSCF sends SIP 200 OK to UE.

15. P-CSCF sends UPDATE to P-CSCF in the opposite network to inform IMS AGW on satellite in the opposite network to use the target IMS AGW on satellite.

Editor's note: This use of UPDATE was not mentioned in the study phase. This idea here attempts to avoid packet loss. FFS if it's ok

16. Setting in IMS AGW on satellite is modified.

17. P-CSCF sends UPDATE to UE.

18. UE sends 200 OK(UPDATE) to P-CSCF.

19. P-CSCF sends 200 OK(UPDATE) to P-CSCF in the opposite network.

20. ULCL and L-PSA on the source satellite are released.

21. The source IMS AGW on satellite is released.

AX.6.2.2 Ground fallback

Figure AX.6.2.2-1 depicts a signalling flow diagram for ground fallback of an ongoing UE-Satellite-UE communication after change of satellite that serves a UE.



**Figure AX.6.2.2-1: Ground fallback**

The steps in the call flow are as follows:

1. P-CSCF obtains satellite ID of a satellite that is about to serve UE.

2. P-CSCF cannot determine that UE-Satellite-UE communication continues to be possible based on the relation between the satellite ID received in step 1 and the satellite ID stored for the opposite network.

3. P-CSCF sends negative feedback to PCF.

4. UE and P-CSCF interact. P-CSCF sends H. 248 ADD request to IMS AGW on ground and receives a response.

Editor's note: For now, it's written like this. But there are a few options to realize this part. FFS which option to take.

5. P-CSCF sets the value of c=line to be that of IMS AGW on ground as usual. P-CSCF sends SIP re-INVITE to P-CSCF in the opposite network. P-CSCF does not include satellite-related information in the SIP re-INVITE.

6. P-CSCF determines that UE-Satellite-UE communication becomes not possible based on that SIP re-INVITE does not contain any satellite-related information.

7. P-CSCF sends H. 248 ADD request to IMS AGW on ground and receives a response.

8. P-CSCF sets the value of c=line to be that of IMS AGW on satellite to avoid packets coming to IMS AGW on ground that is not yet fully setup. P-CSCF sends SIP re-INVITE to UE.

9. UE sends SIP 200 OK to P-CSCF.

10. P-CSCF completes setting up of IMS AGW on ground.

11. P-CSCF sends SIP 200 OK to P-CSCF in the opposite network.

12. P-CSCF completes setting up of IMS AGW on ground.

13. P-CSCF sends SIP 200 OK to UE.

14. P-CSCF sends UPDATE to P-CSCF in the opposite network to inform UE in the opposite network to use IMS AGWs on ground.

Editor's note: This use of UPDATE was not mentioned in the study phase. This idea here attempts to avoid packet loss. FFS if it's ok

15. P-CSCF sets the value of c=line to be that of IMS AGW on ground. P-CSCF sends UPDATE to UE.

16. UE sends 200 OK(UPDATE) to P-CSCF.

17. P-CSCF sends 200OK(UPDATE) to P-CSCF in the opposite network.

18. In both networks, ULCL and L-PSA on satellite are released by using the procedure of Removal of additional PDU Session Anchor and Branching Point or UL CL as specified in clause 4.3.5.5 of TS 23.502 [94].

19. In both networks, IMS AGW on satellite is released.

AX.7 NF discovery

AX.7.1 IMS AGW discovery

In this Release of the specification, this aspect is left to implementation.

Editor's note: This is about how P-CSCF discovers and selects IMS AGW on satellite. To be checked if this description is ok.

---End of the Change---