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Course Code	Applicable Product	Product Version	Course Version
VN011850	eCore	V100R018C50	01

Developed/Optimized By	Date	Reviewed By	New/Optimized
Chen ShuYue	2017-10-30	Kang kai	New
Fan Yu	2018-07-30	Liu ShiFa	Optimized

eCore V100R018C50 Product Description

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About This Course

- This course:
  - Introduces the broadband access, B-TrunC, and 3GPP trunking solutions in eCore V100R018C50.
  - Helps you achieve the following objectives:
    - Learn the architectures and principles of the broadband access, B-TrunC, and 3GPP trunking solutions.
    - Understand configurations related to the broadband access, B-TrunC, and 3GPP trunking solutions.
    - Know the broadband access, B-TrunC, and 3GPP trunking functions provided by eCore V100R018C50.

Learning Guide

- Before starting this course, you have understood the basic LTE/EPC network knowledge.

References

- [1] 3GPP TS 36.413 v10.3.0: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP)".
- [2] 3GPP TS 23.401 v10.5.0: "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".
- [3] 3GPP TS 23.203 v10.4.0: "Policy and charging control architecture".
- [4] 3GPP TS 29.274 v10.4.0: "Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C)".

Training Objective

- Upon completion of this course, you will be able to:
  - Describe the architectures of the broadband access, B-TrunC, and 3GPP trunking solutions.
  - Describe the principles of the broadband access, B-TrunC, and 3GPP trunking solutions.
  - Undertake the O&M tasks of the broadband access, B-TrunC and 3GPP trunking solutions.

Terminology

Acronym and Abbreviation	Full Name
B-TrunC	Broadband Trunking Communication
eMBMS	evolved multimedia broadcast/multicast service

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Background

The narrowband system requires high costs and cannot meet new service requirements, which drives trunking technologies to develop from narrowband to broadband.

Pain points for narrowband trunking:

1. **Narrowband trunking requires high maintenance costs and is approaching the end of its life cycle.**
2. **The terminal industry develops in closed circles, and the procurement cost is high.**
3. **The narrowband networks cannot provide broadband-based mobile videos or real-time location information.**
4. **If the budget is limited, the narrowband networks cannot achieve national coverage.**
5. **Common commercial UEs cannot provide PS network voice services.**

Broadband service requirements are as follows:

- **Video and HD image transmission**
- **Context awareness and CAD enhancement**
- **HD voice and group call**
- **High-bandwidth application for field operations**
- **Location service and map application**

Legacy public security networks, such as TETRA and P25, support critical voice communication only through narrowband. Mobile broadband services cannot be provided. The TETRA and Critical Communications Association (TCCA) has announced LTE as the chosen technology for critical mobile broadband communication and public security. There are two types of protocols for broadband trunking services. One is the eMBMS-based 3GPP trunking standards. eMBMS stands for evolved multimedia broadcast/multicast service. The other is B-TrunC advocated by China. The protocols are used for public protection and disaster relief (PPDR) trunking communications for public security. The B-TrunC system is designed based on and remains compatible with 3GPP Release 9. The system supports open standard broadband trunking interfaces, supports the IP-based packet data transmission function, and supports B-TrunC services, including voice trunking, multimedia trunking dispatching, trunking data, and trunking supplementary services.

Requirement Description/Benefits

B-TrunC	The eCore system integrates the core-network-side devices, such as the MME, S-GW, P-GW, TRUNK-GW, and TSN, to complete the trunking communications services based on the B-TrunC architecture.
eMBMS	The eCore system integrates the core-network-side devices, such as the MME, S-GW, P-GW, and MBMS-GW, to complete the 3GPP trunking communications services based on the eMBMS architecture.
Benefits	The eCore system supports B-TrunC and meets the public security requirements of Chinese and Chinese-funded markets. The eCore system supports eMBMS and builds the 3GPP MCPTT standard trunking capability. The eCore system uses the light-weight platform, which improves device integration and is highlighted as power saving and easy deployment.

eCore Service Scenarios

The eCore system supports broadband access, B-TrunC, and 3GPP trunking communication.

Application

Command and dispatching

Dispatching system eAPP610

Core network

eCore

1. **Supports B-TrunC.**
2. **Supports the eMBMS function and MCPTT trunking.**

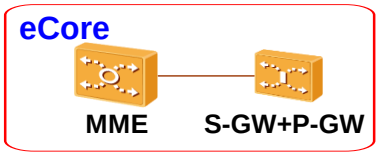
Base station

DBS3900

1. **Supports B-TrunC.**
2. **Supports MCPTT after a software upgrade.**

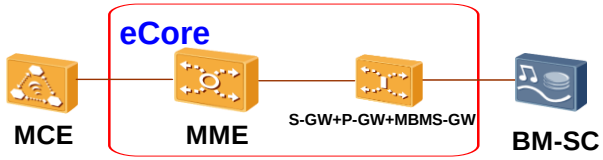
Terminal

Scenario 1: Broadband access



Scenario 2: B-TrunC

Scenario 3: 3GPP trunking



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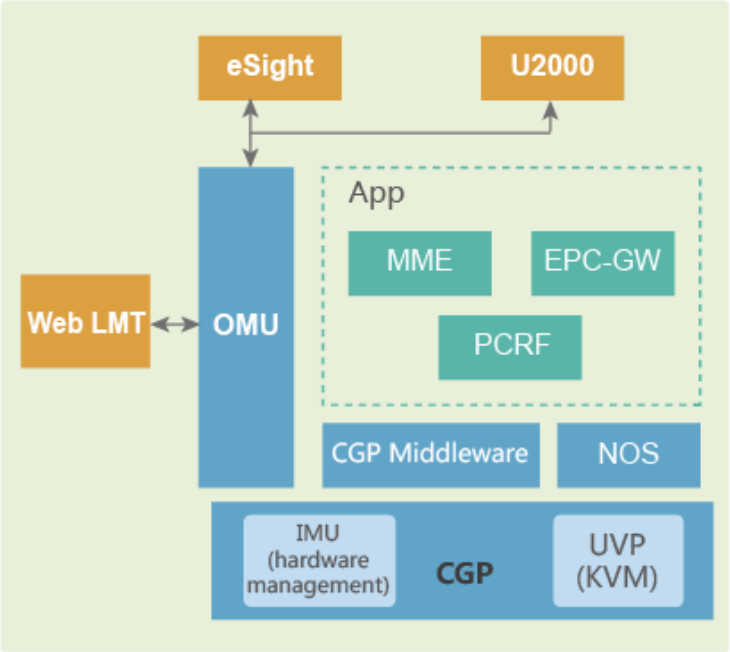
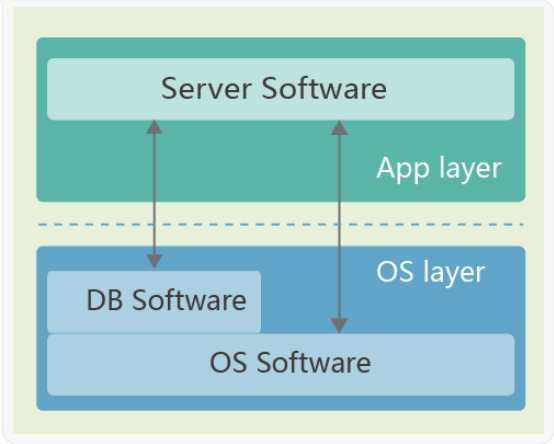
eCore Software Architecture





The eCore software system is composed of the CGP platform software and service application software.

The host software runs on boards in OSTA5.0 subracks. It provides the following functions: Receives and processes signaling messages. Processes calls. Controls services. Manages resources. Responds to operation commands delivered by maintenance personnel through background software. Performs data management, device management, alarm management, performance measurement, and signaling tracing on the host.

The host software consists of the operating system (OS), middleware, and application software from lower layer to upper layer.

1. OS: The OS of host software is Linux, a real-time OS.
2. Middleware: The middleware technology (DOPRA_C) is used between the OS and application software. Therefore, the upper-layer service software is irrelevant to the OS.
3. Application software: It is the functional part of the NEs involved in the eCore solution. Loaded with different software, processes can provide different functions. Application software can be classified into the following types:

Signaling bearer software: receives broadband and narrowband signaling and processes bottom-layer protocols.

Service processing software: processes signaling, and manages sessions, mobility, and resources.

Database software: manages switch data and dynamic subscriber data.

System support software: manages the eCore system and interconnects devices.

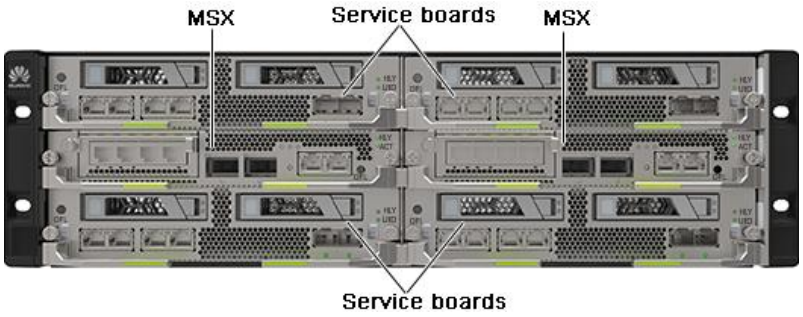
O&M software: receives operation commands from the OMU and replies with results.

The background software runs on the OMU and WebLMT. The background software provides a man-machine interface, which enables the maintenance personnel to implement functions, such as data management, device management, alarm management, performance measurement, and signaling tracing on the host in cooperation with the host software.

The background software adopts the client/server (C/S) model. The background software is classified as the OMU server software and WebLMT software. The OMU server software is installed on an OMU and functions as the server. The WebLMT software is installed on a workstation and functions as the client.

1. Integrating the functions of a communication server and database server, the OMU server software is the core of the terminal OAM software. It forwards the O&M commands from workstations to the host, and returns the responses or operation results from the host to the corresponding workstations.
2. The WebLMT software runs on Windows OSs. It is connected to the OMU server as a client in browser/server (B/S) mode and provides an MML-based GUI for users. The WebLMT can be located locally or remotely. For example, a remote LMT can connect to the OMU server through a WAN in dial-up mode.

eCore Hardware Description



OSTA5.0 (3U) components

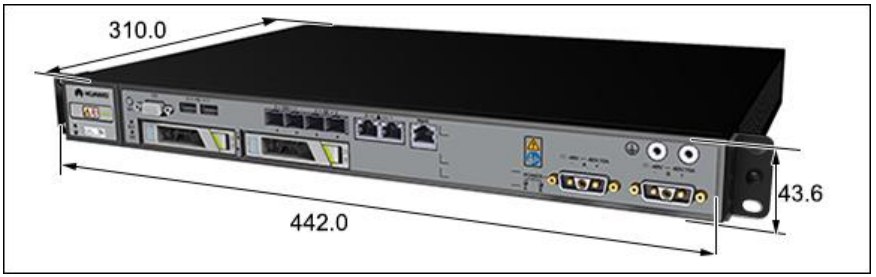
Component	Quantity	Description
Power supply	-	Supports DC or AC.
Typical power consumption	-	1300 W.
Multi-function switch board	2	The multi-function switch boards(MXSC) implement operation, maintenance, and management of the system. Two multi-function switch boards are installed in slots 2 and 5 to work in active/standby mode. Each board provides two 10GE Base ports, 1GE Base ports, two 40GE eFabirc ports and ten 10GE eFabric ports.
Service board	4	The service boards are service processing units and can be installed in slots 1, 3, 4, and 6. The service boards in any two slots can be configured in active/standby mode.
Power entry module (PEM)	2	Two PEMs are configured to work in 1+1 redundancy mode, which prevents single point of failures (SPOFs) for power input.
Fan tray	2	Two fan trays are configured to draw in cool air from the front of the subrack and exhaust warm air from the rear of the subrack.

Functions of OSTA5.0 (3U) service boards

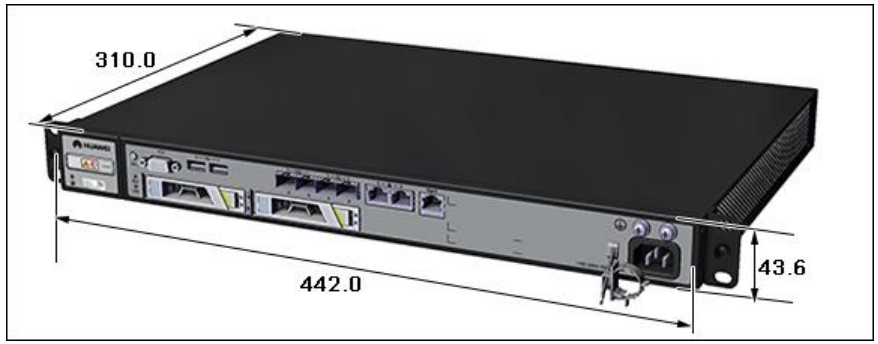
Function	Description
CPU	Uses two Intel® Broadwell-EP Xeon® E5-2600 v4 CPUs.
Memory	Provides eight DDR4 memory channels. The actual memory capacity is 256 GB.
Storage	Supports two 2.5-inch 800 GB SSDs.
Internal switching	Provides two 10GE Base ports for communicating with Base planes of the multi-function switch board through the backplane. Provides two 40GE ports for communicating with Fabric planes.

eCore Hardware Description（Continued）

DC OSTA5.0(1U) Hardware Platform



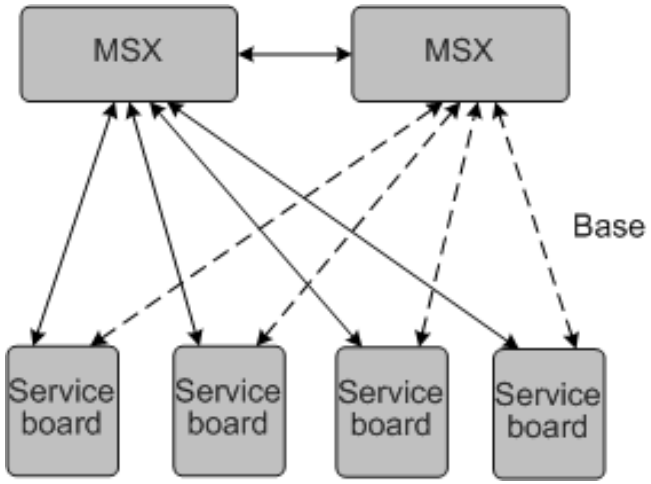
AC OSTA5.0(1U) Hardware Platform

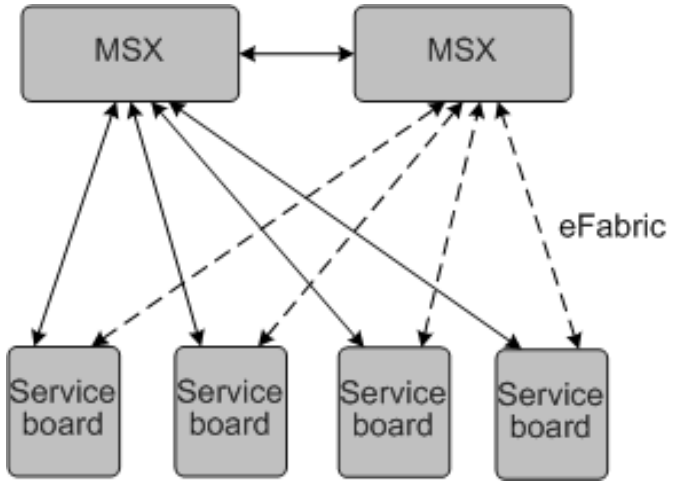


OSTA5.0 (1U) components

Component	Description
DC OSTA5.0(1U)	Supports DC power. Two PEMs are configured in 1+1 backup mode to prevent SPOFs in the power input.
AC OSTA5.0(1U)	Supports AC power. One PEM is configured to provide the power supply.
Computing and processing	Supports two Intel® Xeon® Ivy Bridge E5-2600 or Intel® Broadwell-EP Xeon® E5-2600 v4 CPUs.
Port	•The panel provides one external video graphics array (VGA) port that supports local display. •The panel provides two external USB 2.0 ports. •The panel provides two external 10GE enhanced small form-factor pluggable (SFP+) and two GE SFP optical ports, or provides four 10GE SFP+ optical ports. •The panel provides two external GE network ports. •The panel provides one external GE management network port.
Storage	Supports two 2.5-inch SSD or SAS disks.
Management	•Detects the temperature, voltage, and power, implements power control, manages hard disk hot swap, controls reset, and monitors the operating and health status. •Supports remote management. •Loads software online. •Manages the PEMs and fan modules.

OSTA5.0 (3U)：MSXC System Bus





Bus	Bus Topology	Bandwidth
Base-plane switching	Base plane, the subrack management and control plane, uses the dual-star topology and functions as the communication channel for software loading, alarm reporting, and maintenance information.	1 Gbit/s for each slot
eFabric switching	eFabric provides data exchange channels for system service planes, carries service-related information in the system, and uses the router switching architecture.	2x40 Gbit/s for each slot

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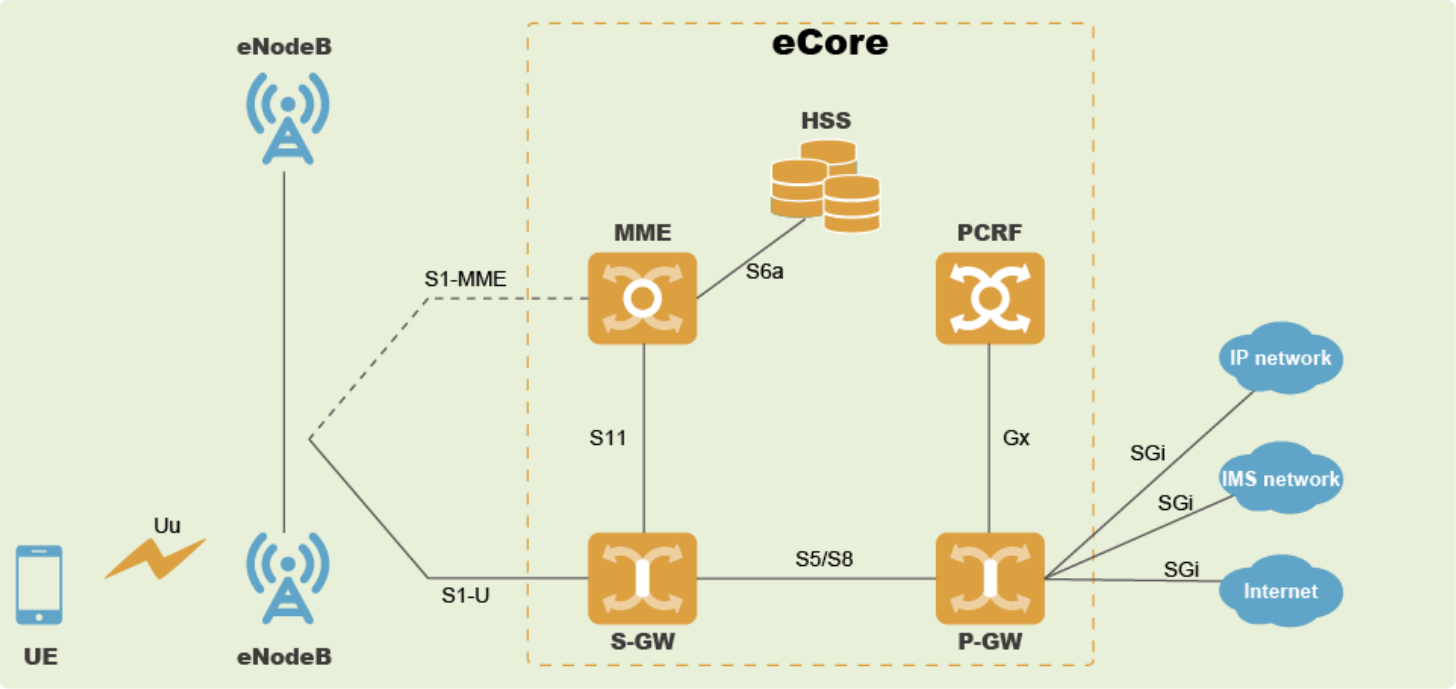
Basic Networking of Broadband Access



The interfaces between the eCore and external NEs are as follows:

1. S1-MME: an interface between the MME and eNodeB
2. S1-U: an interface between the eNodeB and S-GW
3. SGi: an interface between the P-GW and IP network/IMS network/Internet

Functions of the NEs in the eCore Solution

1. MME

The MME is responsible for mobility management in the control plane, including management of the contexts and mobile state, and assignment of temporary identifiers. The MME provides the following functions:

- Non-access stratum (NAS) signaling
- NAS signaling security
- Tracking area list management
- P-GW and S-GW selection
- P-GW and (2) S-GW selection
- Authentication
- Bearer management, including dedicated bearer establishment

S-GW

The S-GW serves as a user-plane anchor between different 3GPP access networks and shields the interfaces of the different 3GPP access networks. The S-GW provides gateway functions for EPC networks and provides interfaces to the evolved universal terrestrial radio access network (E-UTRAN). The S-GW provides the following functions:

- Serves as a local mobility anchor for inter-eNodeB UE handovers.
- Helps the target eNodeB with the reordering function during an inter-eNodeB handover by sending one or more end markers to the source eNodeB.
- Caches downlink data packets for UEs in ECM-IDLE mode and triggers paging to an E-UTRAN.
- Re-marks uplink and downlink data packets with differentiated services code points (DSCPs).

Functions of the NEs in the eCore Solution (Continued)

3. P-GW

The P-GW provides gateway functions for the EPC network and provides the SGi interface to the PDN.

The P-GW provides the following functions:

- Assigns IP addresses to UEs.
- Re-marks uplink and downlink data packets with DSCPs.
- Supports SDF-based gating control for uplink and downlink packets.
- Supports SDF-based traffic policing for uplink and downlink packets.
- Supports per APN-AMBR traffic policing and shaping for uplink and downlink packets that do not have any GBR.
- Supports GBR-based traffic policing for downlink SDFs that have the same GBR QCI based on accumulated transmission rates.
- Obtains UE IP addresses from the DHCP server.
- Maps uplink and downlink bearers.
- Verifies the mapping between uplink and downlink bearers.
- Performs the offline charging function.
- Performs the routing behind MS function.

Functions of the NEs in the eCore Solution (Continued)

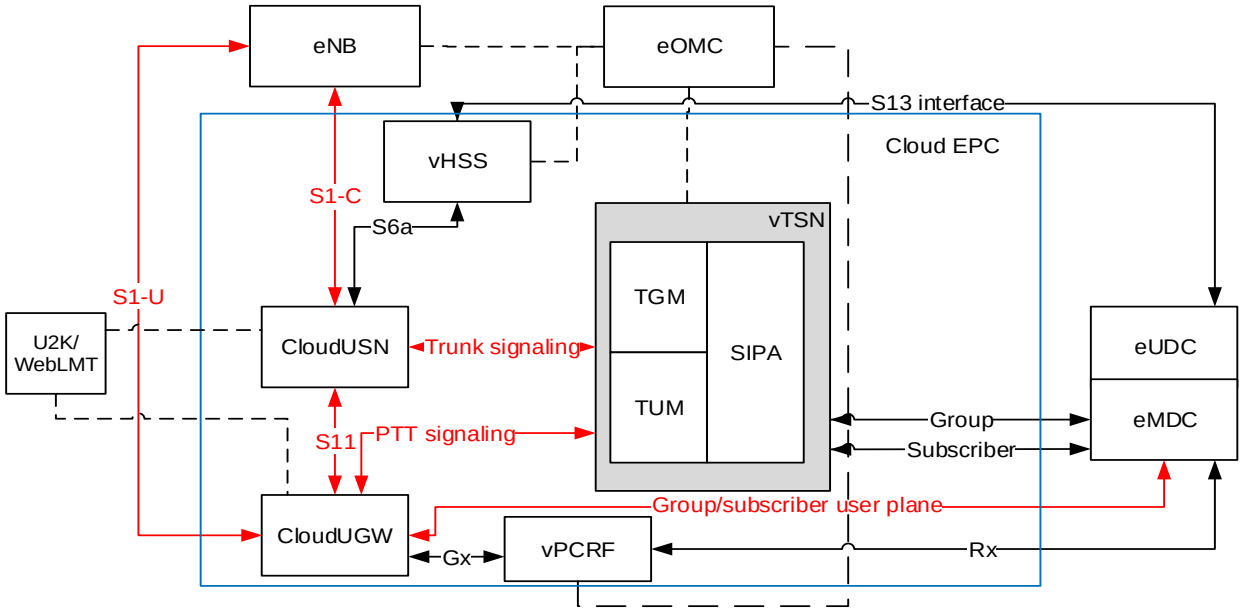
4. The eCore integrates the HSS functions to implement subscriber data management for 3GPP LTE or SAE networks. The HSS stores all service-related data and manages the subscription data and location information of subscribers.
   The HSS provides the following functions:
   - Stores subscribers' configuration data, such as the APNs, IMSIs, and PDN addresses.
   - Performs authentication and encryption, including key generation and distribution.
   - Manages location information.
   - Subscribes to and stores QoS data, such as UE-AMBR.
5. PCRF
   The eCore integrates the PCRF functions to provide the local PCRF policy control function (excluding charging) for the 3GPP LTE/SAE network. The function improves the network resource efficiency and user experience.
   The PCRF provides the following functions:
   - Service-based local QoS control, such as GBR and non-GBR
   - Performs service-based local shaping. For example, the PCRF performs local shaping based on the QoS templates of default and dedicated bearers.
   - Triggers the network side to initiate session creation, deletion, or modification procedures.

Contents

B-TrunC Service Functions

Broadband Trunking Service Type	Broadband Trunking Service Function
Trunking voice services	Voice group call, full-duplex voice P2P call, half-duplex voice P2P call
Multimedia trunking dispatch services	Visual P2P call, same-source group video call, video pushing to groups of UEs/a single UE, video forwarding to groups of UEs/a single UE, video pulling-up/uploading, and different-source group video calls
Trunking data services	Real-time short data, multicast SMs, broadcast SMs, status messages, and locating
Trunking supplementary services	Emergency call, dynamic regrouping, permanently blocked/temporarily Blocked/unblocked, forced release/break-in, and dispatching Subscription, fault weakening, group short number, and dispatching Area selection, preemption call, all call, multicast call, lawful interception, ambience listening, and environment monitoring

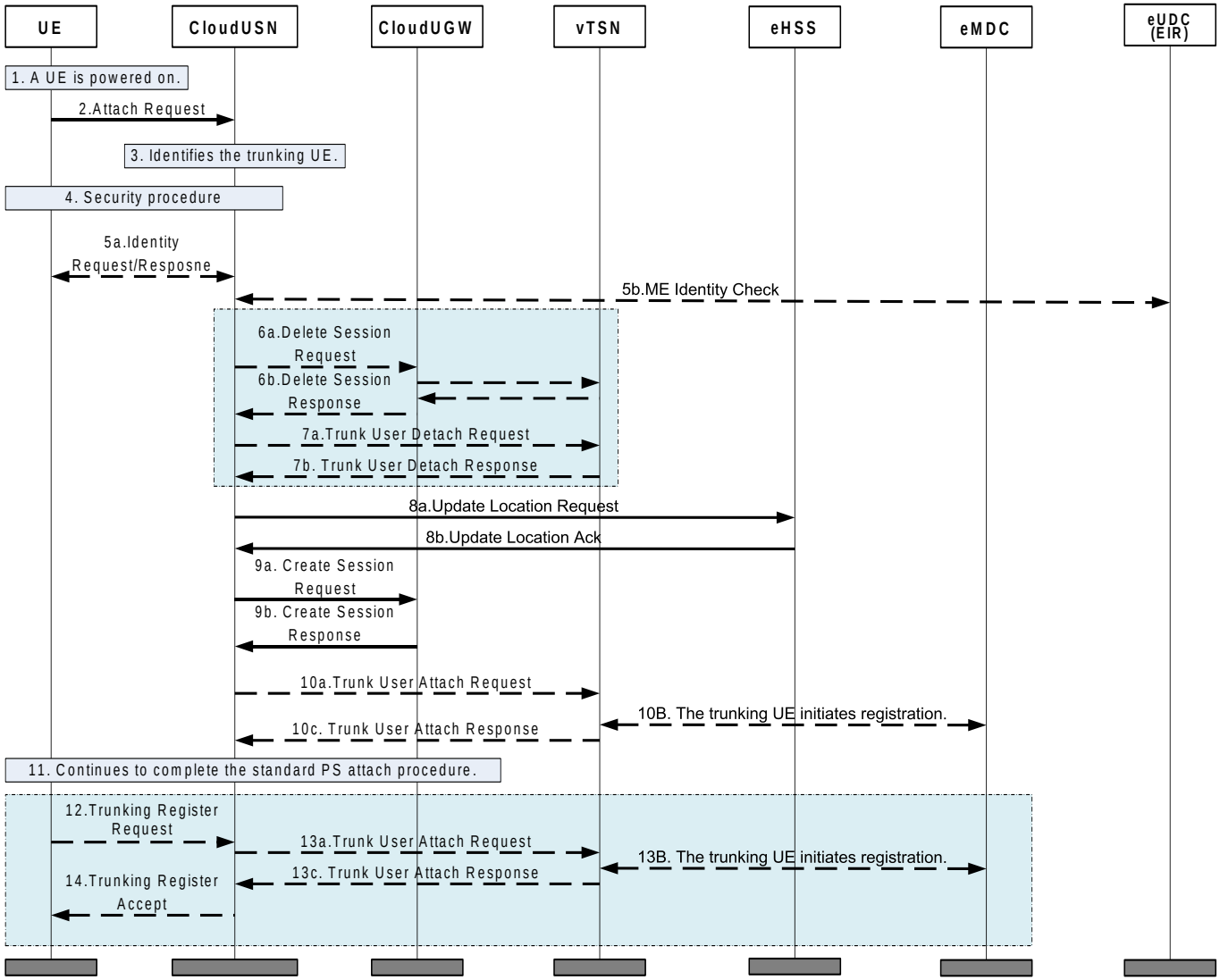
B-TrunC Logical Architecture



The interfaces between the eCore and external NEs are as follows:

1. Enhanced S1-C and S1-U interfaces: interfaces between the CloudUSN/CloudUGW and eNodeB
2. O&M interfaces: interfaces over which the U2000 or WebLMT performs O&M on the CloudUSN and CloudUGW and the eOMC performs O&M on the vHSS/vPCRF/vTSN/eNodeB
3. S13 interface: an interface between the vHSS and eUDC to register subscribers
4. Tx-c: an interface between the vTSN and MDC to manage trunking subscribers or trunking groups
5. Rx interface: an interface between the vPCRF and the MDC to deliver application-layer data
6. SGi interface: a data-plane interface between the CloudUGW and MDC to deliver data

Trunking UE Registration



Service Flow of Trunking UE Registration

1. A UE initiates an LTE network attach request.
2. In addition to the 3GPP standard IEs, the UE PTT Capability, Blocked Status, and PTT Message Container IEs are included in the attach request of a trunking UE.
3. After receiving the attach request, the CloudUSN determines whether the UE is a trunking UE or a public network UE based on the UE PTT Capability IE. If the UE is a trunking UE, the CloudUSN stores the trunking UE identifier in contexts.
4. The CloudUSN interworks with the UE/HSS to complete the standard security authentication procedure.
5. To verify the UE, the CloudUSN obtains the IMEI from the UE, and the eUDC (EIR) completes the validity verification on the UE. The CloudUSN includes the EPS Location Information AVP that contains the UE location reported during registration in request messages for the trunking UE, so that the eUDC records the location of unauthorized UEs. The EPC Location Information AVP supports only E-UTRAN-Cell-Global-Identity and Tracking-Area-Identity.
6. If bearer contexts have been activated on the CloudUSN, the CloudUSN instructs the CloudUGW to delete the bearer contexts. If a trunking voice dedicated bearer is to be deleted, the CloudUGW sends the vTSN a Delete Trunk Bearer Notification message to delete the bearer. For details, see the service flow of trunking UE deregistration.

Service Flow of Trunking UE Registration (Continued)

7. If a session has been created between the CloudUSN and vTSN, the CloudUSN sends the vTSN a Trunk User Detach Request message to delete the session. For details, see the service flow of trunking UE deregistration.
8. The CloudUSN sends an Update Location Request message to the vHSS to request subscription data. The vHSS replies with an Update Location ACK message carrying the subscription data. On the B-TrunC network, the subscription data may contain the UE blocking state (temporarily blocked, unblocked, or permanently blocked) and Routing Behind MS information except for the PS subscription information. If the subscription information does not carry the UE blocking state, the UE is considered to be in the unblocked state.

   If the UE is in the permanently blocked state, the CloudUSN returns an Attach Reject message to the UE. For the trunking UE, the CloudUSN uses EMM Cause (UE Blocked) in the Attach Reject message to indicate that the UE is in the permanently blocked state. The CloudUSN releases all subscriber-related information and then notifies the vHSS through a purge procedure.
9. The CloudUSN instructs the CloudUGW to create a default bearer. If the subscription data contains the Routing Behind MS information, the CloudUSN carries the information in a Create Session Request message. The CloudUGW then requests Gx session creation to the PCRF.
10. If the Attach Request message carries UE PTT Capability and the UE is in the unblocked state, the CloudUSN sends a Trunk User Attach Request message to the vTSN to create a session. This message carries IMSI, MSISDN, TA, TA List, Trunk Trace Information, PTT NAS Message Container, PTT Capability, and PGW Hostname.

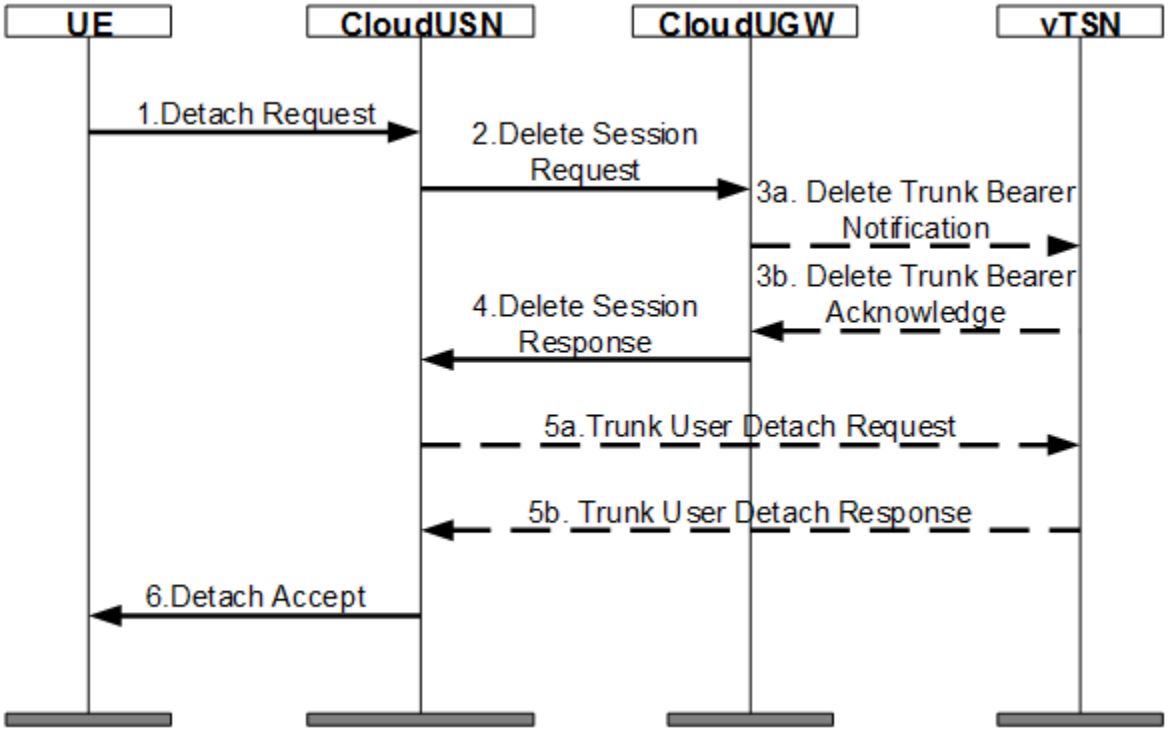
Service Flow of Trunking UE Registration (Continued)

10. The PTT NAS Message Container IE contains PTT Message Container that is carried in the Attach Request message. The vTSN functions as an agent to complete the registration of the UE on the dispatcher.
    If the UE is registered with the vTSN successfully, the vTSN includes Granted Feature, PTT NAS Message Container, and PTT User Protocol Version in the Trunk User Attach Response message destined for the CloudUSN.
    If the Trunk User Attach Response message contains a failure cause value (such as Request rejected) in the Trunk User Attach Response message or the vTSN does not return any response to the CloudUSN within the specified period, the CloudUSN continues to complete the PS attach procedure. In this situation, the UE can access only PS services. The UE can access trunking services unless it re-initiates an attach procedure or trunk registration using trunk signaling.
11. The CloudUSN continues to complete the PS attach procedure. If the UE blocking state obtained by the CloudUSN from the vHSS is different from the UE blocking state carried by the UE in the Attach Request message, the CloudUSN sets Block Type to the latest state in subscription information in the Attach Accept message destined for the UE.
    If the UE has been registered with the vTSN successfully, the CloudUSN should carry Granted feature and PTT MessageContainer in the Attach Accept message.
    If the UE fails to be registered with the vTSN, the CloudUSN needs to initiate a session deletion procedure to delete the sessions between the CloudUSN and vTSN.
    If the UE is in the temporarily blocked state, the CloudUSN should initiate an S1-Release procedure as soon as possible after the PS attach procedure ends to make the UE return to the idle state.

Service Flow of Trunking UE Registration (Continued)

12. If the UE does not carry UE PTT Capability in the Attach Request message, the UE can use a Trunking Register Request message to initiate trunk registration after the PS attach procedure ends.
13. When receiving the trunk registration signaling, if the CloudUSN has not set up sessions with the vTSN, the CloudUSN sends a Trunk User Attach Request message to the vTSN. This message carries the UE's current TAI, the MME-allocated TA list, PGW Hostname, PTT NAS Message Container, and Trunk Trace Information. The trunk signaling Trunk User Attach Request is encapsulated in PTT NAS Message Container. If the CloudUSN has set up sessions with the vTSN, the CloudUSN transparently transmits the trunk information to the vTSN using a Trunk User NAS Direct Transfer Indication message.
    After completing the registration of the UE on the dispatcher, the vTSN returns a Trunk User Attach Response message to the CloudUSN. This message carries PTT User Protocol Version and PTT NAS Message Container. The PTT NAS Message Container IE carries the trunk NAS signaling, the Trunk User Attach Accept message.
14. After receiving the response message from the vTSN, the CloudUSN forwards the trunk NAS signaling carried in the response message to the UE, completing the trunk registration. If the cause value in the Trunk User Attach Response is Failure, the CloudUSN deletes the session information between it and the vTSN after forwarding the trunk NAS signaling.

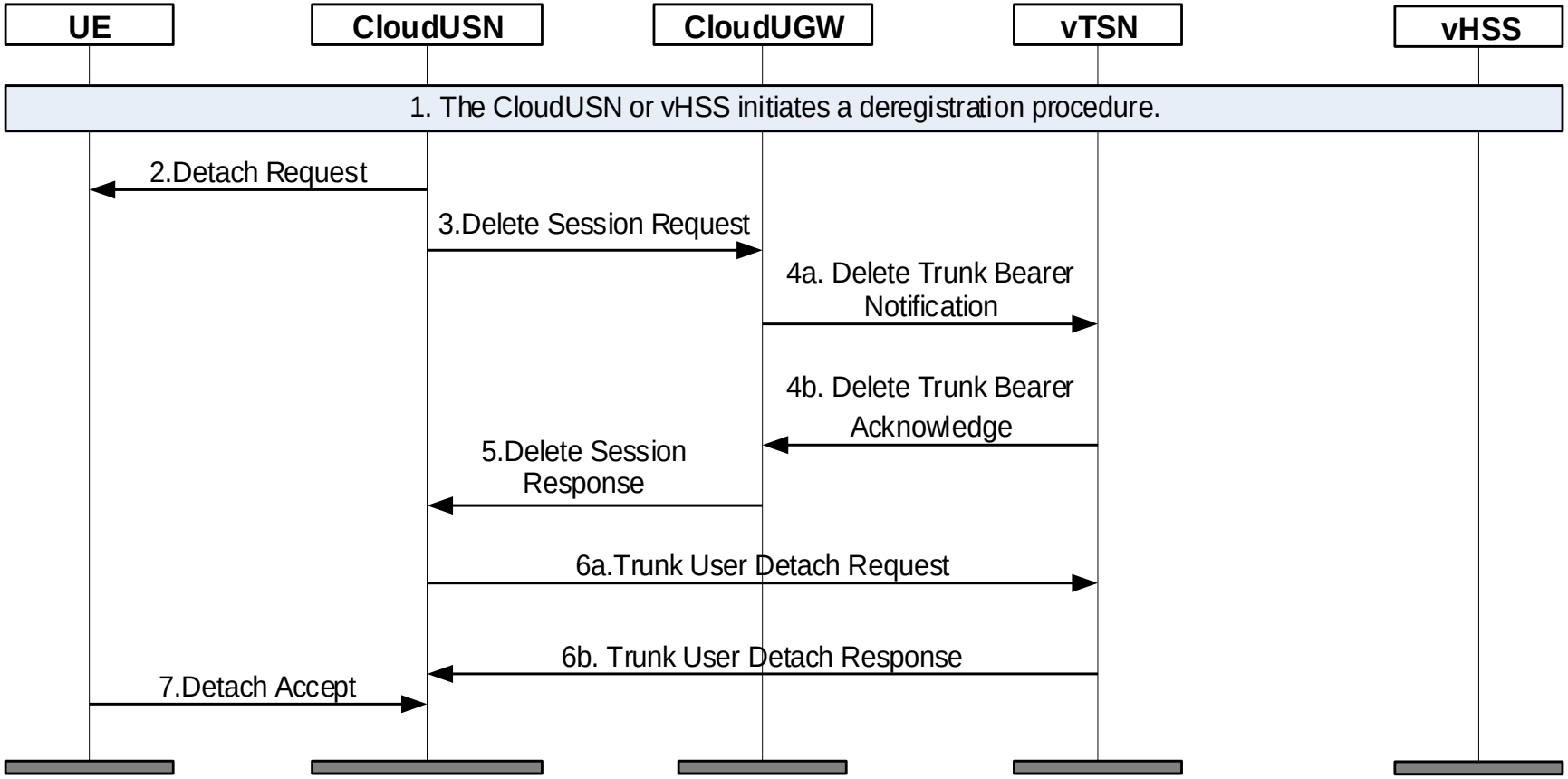
UE-initiated PS Deregistration



Service Flow of UE-initiated PS Deregistration

1. A UE sends a NAS message Detach Request to the CloudUSN.
2. The CloudUSN requests the CloudUGW to delete all bearers of the UE. When deleting the dedicated bearers and PDN connections of the UE, the CloudUGW needs to notify the vPCRF of the deletion over the Gx interface.
3. If the dedicated bearers initiated by the vTSN for trunking services are deleted, the CloudUGW carries EPS Bearer ID and sets Cause to PDN Disconnected in the Delete Trunk Bearer Notification message destined for the vTSN.
   After receiving such a Delete Trunk Bearer Notification message, the vTSN releases the trunking service sessions (including the trunking compere and P2P calls) but does not send trunk signaling to the UE. Then the vTSN waits for the CloudUSN to send a detach message.
   If the CloudUGW does not receive any response from the vTSN within a specified period or the response carries a failure cause value, step 4 is performed.
4. After the CloudUGW releases bearer contexts, the CloudUGW returns a response to the CloudUSN. In addition, the CloudUGW triggers an IP-CAN session release procedure to the PCRF. For details, see 3GPP TS 23.203.
5. If the UE is registered with the vTSN successfully, the CloudUSN sends the vTSN a Trunk User Detach Request message to notify the vTSN of the UE detach. After receiving the message, the vTSN functions as an agent to deregister the UE on the dispatcher and returns an ACK response to the CloudUSN.
   If the CloudUSN does not receive any response from the vTSN within a specified period or the response carries a failure cause value, step 6 is performed.
6. The CloudUSN returns a Detach Accept message to the UE and releases the S1 signaling connections of the UE.

vHSS- or CloudUSN-initiated PS Deregistration



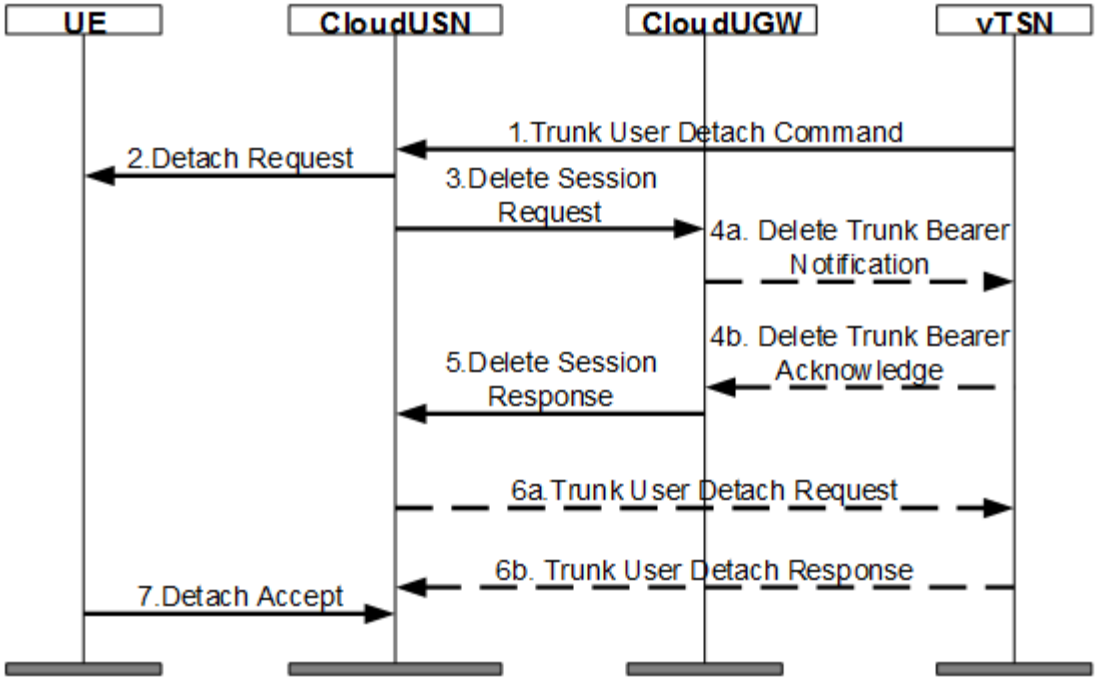
Service Flow of vHSS- or CloudUSN-initiated PS Deregistration

1. The CloudUSN triggers an implicit/explicit detach procedure. Alternatively, the CloudUSN initiates a detach procedure after receiving a Cancel Location message from the vHSS.
2. The CloudUSN sends a Detach Request message to the UE.

3-6. These steps are the same as those in the service flow of UE-initiated PS deregistration.

7. After the CloudUSN receives a Detach Accept message from the UE and the sessions between the CloudUSN and CloudUGW/vTSN are released, the CloudUSN continues to release the S1 signaling connections.

vTSN-initiated PS and Trunk Deregistration



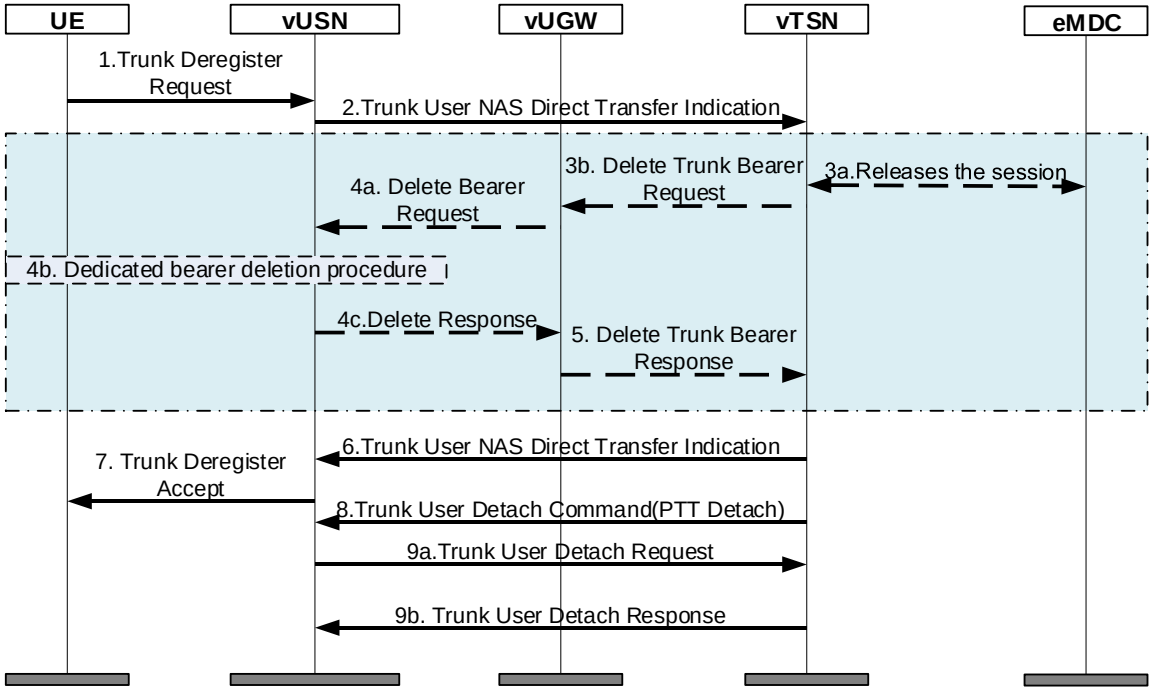
Service Flow of vTSN-initiated PS and Trunk Deregistration

1. The vTSN sends the CloudUSN a Trunk User Detach Command message carrying the Detach Type IE. In this IE, the value of PTT Detach Indication is "ps detach, re-attach required" or "ps detach, re-attach not required".
2. After the CloudUSN receives the Trunk User Detach Command message from the vTSN, if the value of Detach Type Indication in the Detach type IE is combined PS/PTT detach, the CloudUSN sends a Detach Request message to the trunking UE; if the value of Re-attach Required Indication in the Detach type IE is re-attach required, the CloudUSN includes the Detach Type IE and sets Type of detach to re-attach required in the Detach Request message destined for the UE.

3-6. These steps are the same as those in the service flow of UE-initiated PS deregistration.

7. After the CloudUSN receives a Detach Accept message from the UE and the sessions between the CloudUSN and CloudUGW/vTSN are released, the CloudUSN continues to release the S1 signaling connections. If the CloudUSN requires the UE to re-initiate an attach procedure using a Detach Request message in step 2, the UE re-initiates an attach procedure.

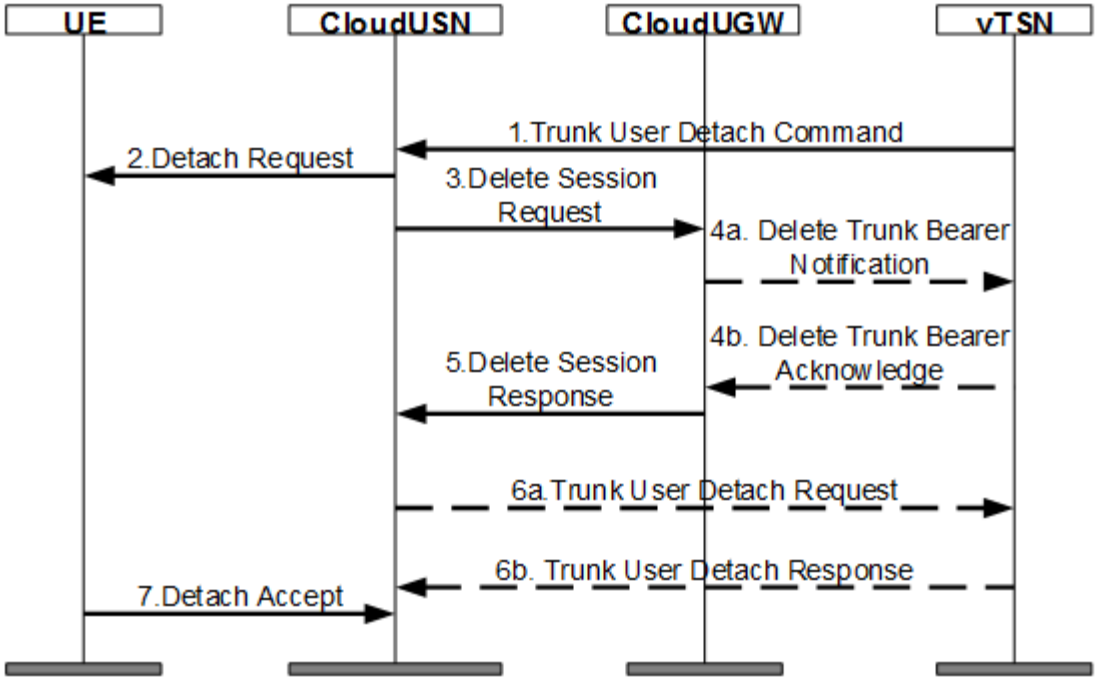
UE-initiated Trunk Deregistration



Service Flow of UE-initiated Trunk Deregistration

1. A UE sends a Trunk Deregister Request message (trunk NAS signaling) to initiate a trunk deregistration procedure.
2. The CloudUSN forwards the received trunk NAS signaling to the vTSN through a Trunk User NAS Direct Transfer Indication message, and encapsulates the Trunk Deregister Request message to the PTT NAS Message Container IE.
3. If the trunking UE is using a trunking service, steps 3 to 5 are performed. The vTSN releases the session with the dispatcher and sends a Delete Trunk Bearer Request message to request the CloudUGW to delete the trunking service dedicated bearer.
4. After receiving the Delete Trunk Bearer Request message, the CloudUGW triggers a dedicated bearer deletion procedure. For details, see section 4.4 in 3GPP TS 23.401.
5. After the trunking service dedicated bearer is deleted, the CloudUGW sends a Delete Trunk Bearer Response message to the vTSN.
6. The vTSN encapsulates Trunk Deregister Accept into Trunk User NAS Direct Transfer Indication and sends it to the CloudUSN.
7. The CloudUSN forwards Trunk Deregister Accept to the UE.
8. After the UE is deregistered from the vTSN, the vTSN sends the CloudUSN a Trunk User Detach Command message with the Detach Type IE. In this IE, the value of PTT Detach Indication is ptt detach.
9. Upon receiving the Trunk User Detach Command (ptt detach) message, the CloudUSN sends the vTSN a Trunk User Detach Request message. After receiving the response message from the vTSN, the CloudUSN deletes the sessions with the vTSN.

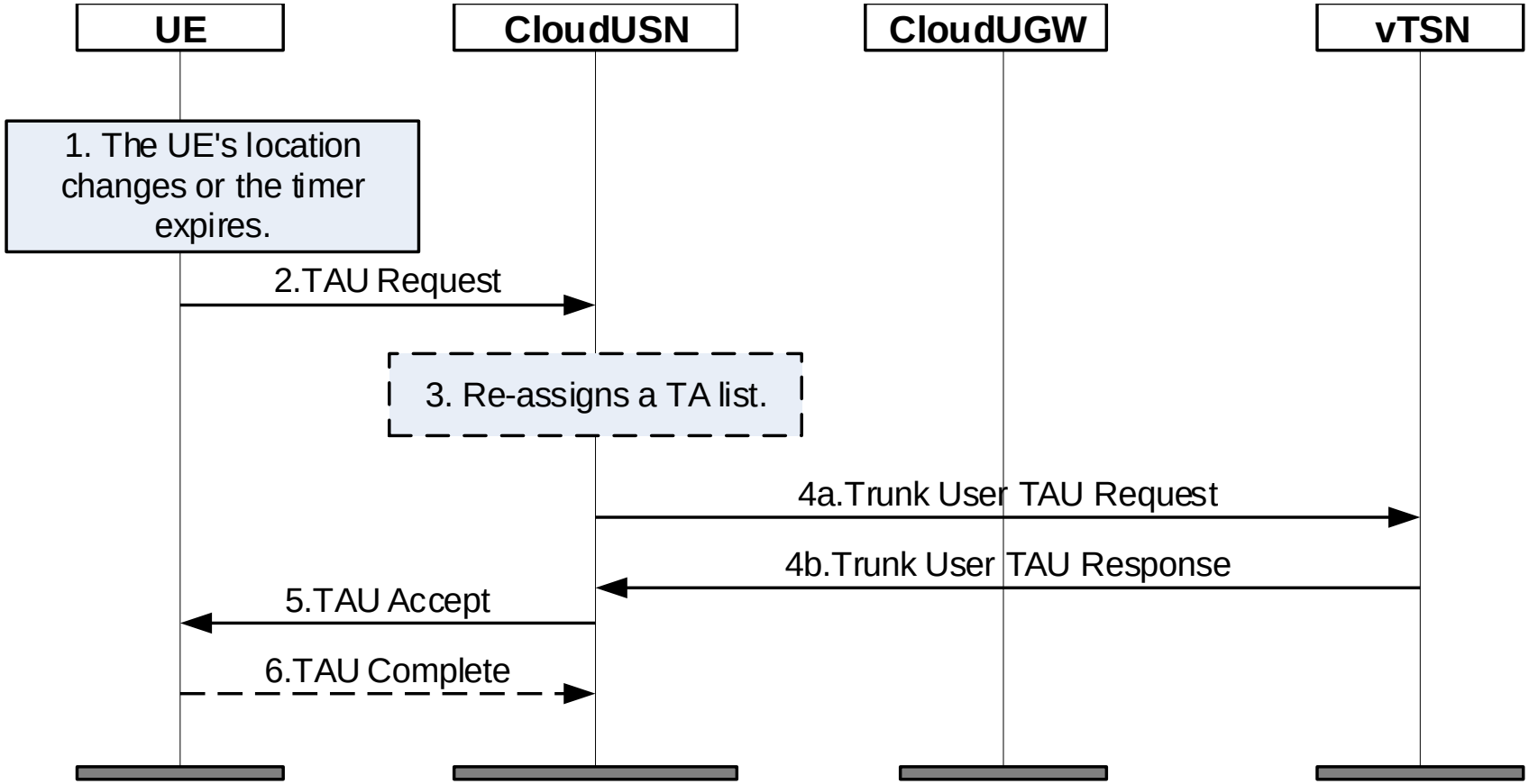
vTSN-initiated Trunk Deregistration



Service Flow of vTSN-initiated Trunk Deregistration

1. The dispatcher may request the vTSN to deregister the trunking UE. Due to the data inconsistency between the vTSN and UE, the vTSN may initiate a trunking UE deregistration procedure. In this case, the vTSN encapsulates the Trunk Deregister Request message (trunk NAS signaling) into the Trunk User NAS Direct Transfer Indication message and sends the message to the CloudUSN.
2. The CloudUSN forwards the trunk NAS signaling to the UE.
   The UE returns a Trunk Deregister Accept message (trunk NAS signaling) to the CloudUSN.
3. The CloudUSN encapsulates the trunk NAS signaling into a Trunk User NAS Direct Transfer Indication message and sends the message to the vTSN.
4. If the vTSN does not require trunk re-registration, the vTSN performs steps 5 to 8.
5. After the vTSN deregisters the UE, the vTSN sends a Trunk User Detach Command message to the CloudUSN with the Detach Type IE. In this IE, the value of PTT Detach Indication is ptt detach.
6. Upon receiving the Trunk User Detach Command (ptt detach) message, the CloudUSN sends the vTSN a Trunk User Detach Request message. After receiving the response message from the vTSN, the CloudUSN deletes the sessions with the vTSN.
   If the vTSN does not receive a Trunk User Detach Command message within a specified period, the sessions between the vTSN and CloudUSN are deleted.
   If the CloudUSN does not receive any response from the vTSN within a specified period, the sessions between the CloudUSN and vTSN are deleted.

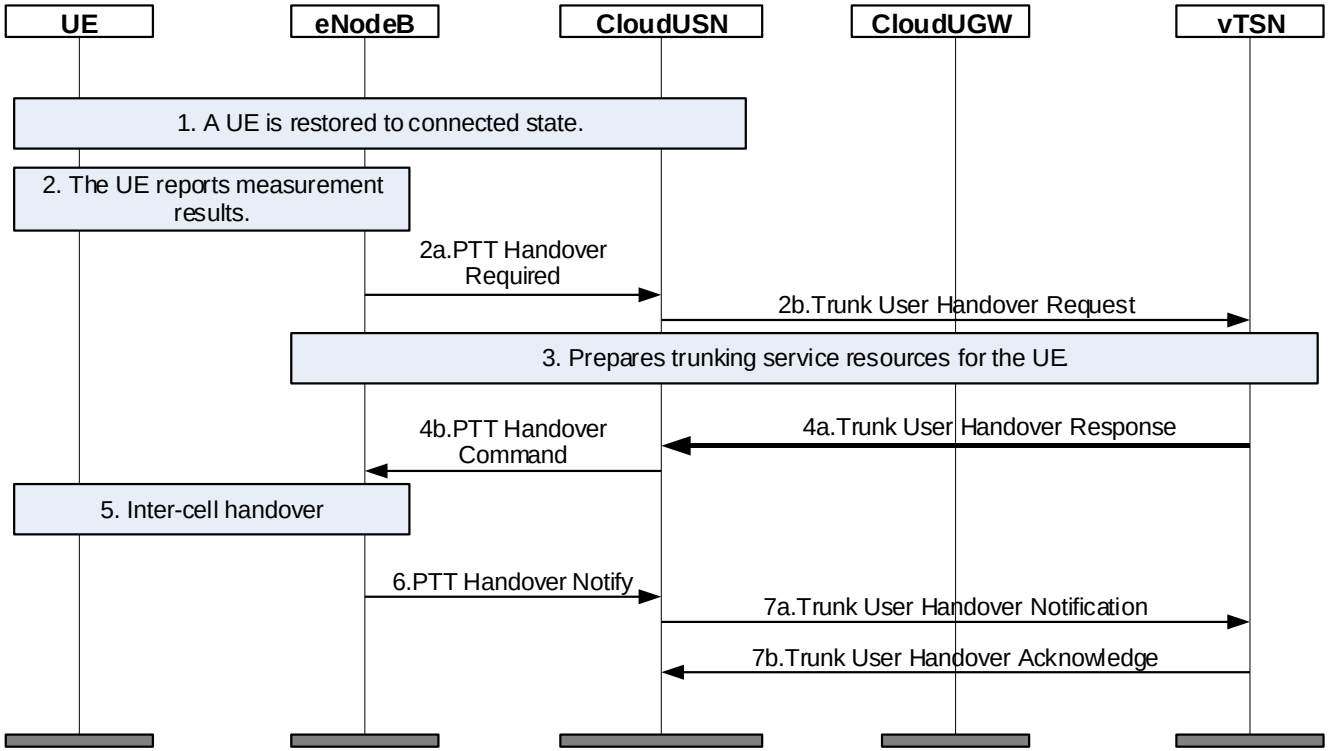
Trunking UE Location Update



Service Flow of Trunking UE Location Update

1. The trunking UE triggers a location update procedure due to a location change or the periodical timer timeout.
2. The UE sends a TAU Request message to the network. The TAU Request message may carry the group ID and Blocked Status IEs. If the message does not carry the Blocked Status IE, the UE is in the unblocked state.
3. If the UE's location changes, the CloudUSN may generate a new TA list.
4. If the CloudUSN has set up sessions with the vTSN and the UE is in the unblocked state, the CloudUSN sends a location update message to the vTSN with the source eNodeB identifier and TAI, target eNodeB identifier and TAI, new TA list, and group ID, so that the vTSN sets up group resources for the UE at the new location. If the vTSN requires the UE to update the group information, the vTSN includes the Group Update Indication IE in the response message destined for the CloudUSN.
   If the CloudUSN does not receive any response from the vTSN within a specified period or the response carries a failure cause value, step 5 is performed.
5. The CloudUSN sends a location update response message to the UE. If the trunking UE blocking state in the contexts on the CloudUSN is inconsistent with the blocking state reported by the trunking UE (for example, the trunking UE reports the temporarily blocked state, but the unblocked state is saved for the trunking UE on the CloudUSN), the CloudUSN needs to carry the Blocked Status IE in the TAU Accept message. If vTSN carries the Group Update Indication IE in the response message destined for the CloudUSN, the CloudUSN carries the Group Update Indicator IE in the TAU Accept message.

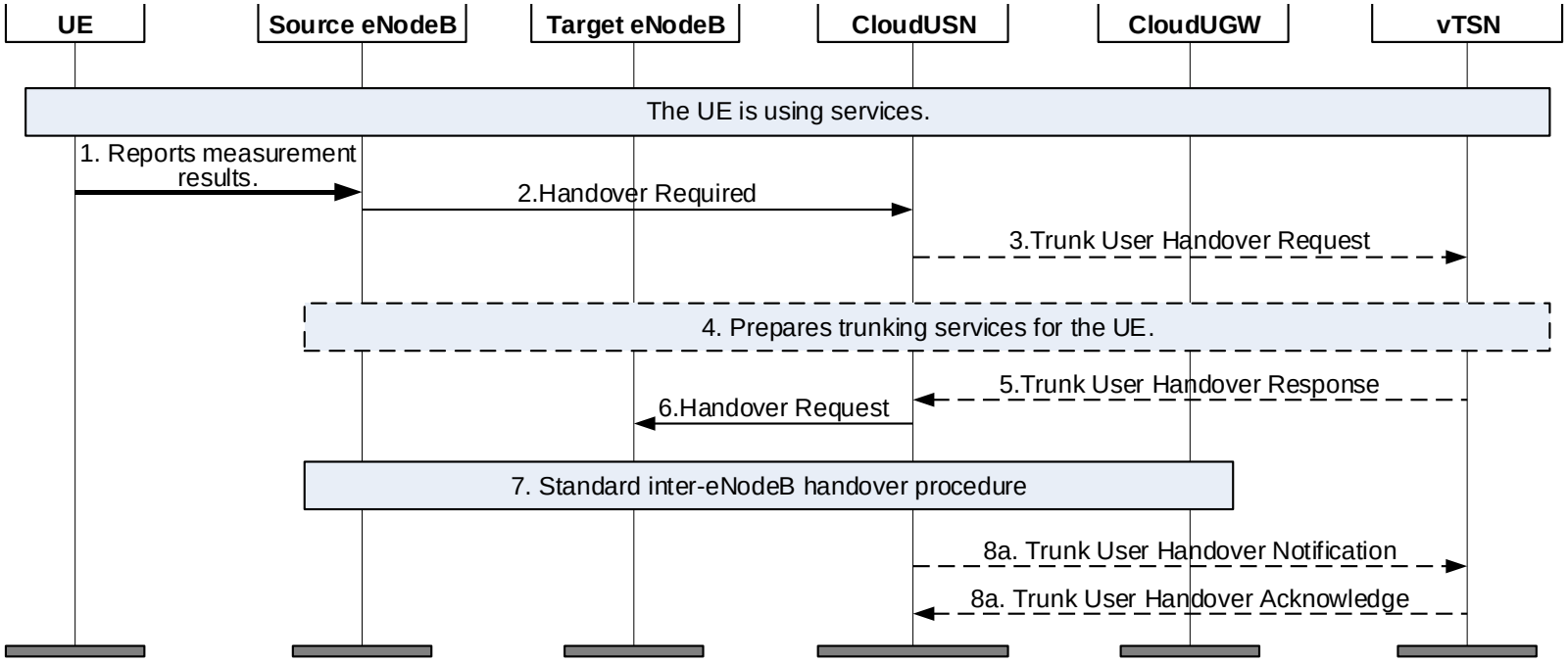
Trunking UE's Intra-eNodeB Handovers



Service Flow of Trunking UE's Intra-eNodeB Handovers

1. When the trunking UE in the idle state moves between intra-eNodeB cells, if the UE uses the trunking services, it is restored to the connected state and then reports measurement information to the eNodeB.
2. The eNodeB sends a PTT Handover Required message to the CloudUSN with the MME UE S1AP ID, eNB UE S1AP ID, Cause, Target ID, and (optional) Group ID. The CloudUSN sends the vTSN a Trunk User Handover Request message with the source eNodeB identifier and TAI, target eNodeB identifier and TAI, and group ID (if the PTT Handover Required message carries the group ID).
3. The vTSN establishes a bearer for the UE in the target cell.
4. The vTSN returns a handover response to the CloudUSN with the group ID (if the request message carries the group ID). The CloudUSN sends a PTT Handover Command message to the eNodeB with the group ID (If the vTSN-returned response message carries the group ID).
   If the CloudUSN does not receive a handover response from the vTSN within a specified period, the CloudUSN sends the eNodeB a PTT Handover Command message without the group ID.
5. The eNodeB performs an inter-cell handover procedure.
6. After the inter-cell handover procedure is complete, the eNodeB sends a PTT Handover Notify message carrying the ECGI and TAI to notify the CloudUSN of the handover result. If the inter-cell handover fails, the eNodeB returns a PTT Handover Failure message with a cause value to the CloudUSN.
7. The CloudUSN sends the vTSN a Trunk User Handover Notification message. If the handover succeeds, this message carries Request accepted; if the handover fails, this message carries the cause value Handover execution failed.

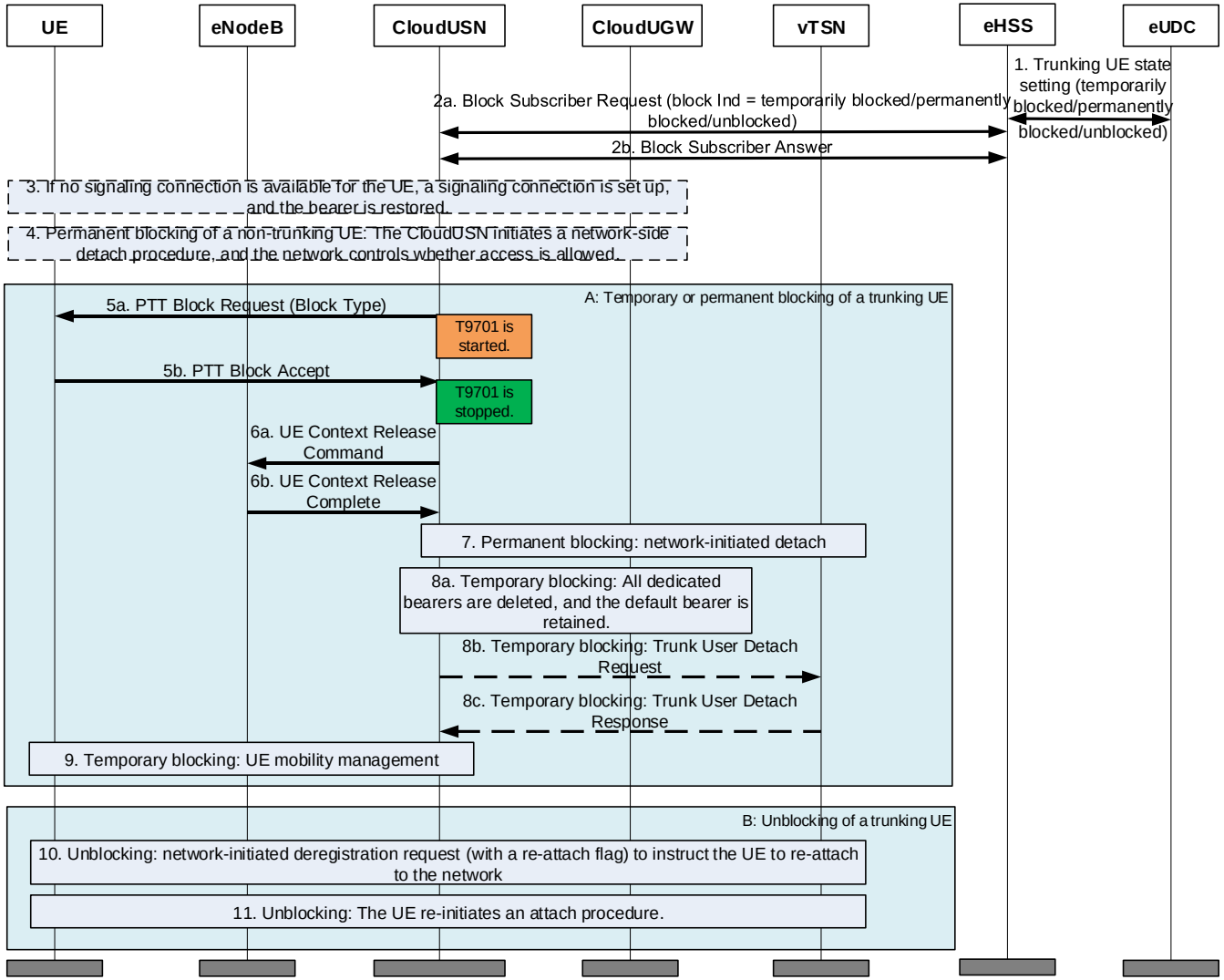
Trunking UE's Inter-eNodeB Handovers



Service Flow of Trunking UE's Inter-eNodeB Handovers

1. When the trunking UE using trunking services moves between eNodeBs, the UE reports measurement information to the source eNodeB.
2. The eNodeB sends the CloudUSN a Handover Required message. If the UE is performing the group listening, the message carries the UE group ID.
3. If the CloudUSN has set up sessions with the vTSN for the trunking UE, the CloudUSN performs steps 3 to 5.
   The CloudUSN sends the vTSN a handover request with the source eNodeB identifier and TAI, target eNodeB identifier and TAI, and group ID.
4. If no group resources have been set up on the target eNodeB, the vTSN initiates a group resource setup procedure.
5. After the group resources are set up on the target eNodeB, the vTSN sends the CloudUSN a response message with the group ID.
6. The CloudUSN sends a Handover Request message to the target eNodeB. For trunking UEs, the CloudUSN should set PTT service Indication to True in Handover Request messages. If trunking UEs are performing group listening, the CloudUSN should include the group ID in the Handover Request message.
7. The CloudUSN continues to complete the 3GPP standard inter-eNodeB handover procedure.
8. After the handover procedure is complete, the CloudUSN sends a Trunk User Handover Notification message to the vTSN with the cause value of Request accepted or Handover execution failed.

Trunking UE Blocking/Unblocking



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Service Flow of Trunking UE Blocking/Unblocking

1. O&M personnel set the UE state on the eUDC, and the UDC delivers the UE state to the eHSS.
   a. A UE that is running properly is in the unblocked state by default. O&M personnel can change the UE state to temporarily or permanently blocked.
   b. A UE that is in the temporarily blocked state can properly access networks but cannot use services. O&M personnel can change its state to unblocked or permanently blocked. The temporarily blocked state is valid only for trunking UEs.
   c. A UE that is in the permanently blocked state cannot access networks or use services.
2. When the UE state changes, the eHSS sends a Block Subscriber Request message to notify the CloudUSN of the UE's unblocked, temporarily blocked, or permanently blocked state.
3. If the UE is in the idle state, it has no signaling connection to the network. The CloudUSN pages the UE so that the UE sets up a signaling connection to the network.
4. If the CloudUSN detects that a non-trunking UE is in the permanently blocked state, a network-initiated detach procedure is triggered. If the non-trunking UE re-initiates an attach request, the CloudUSN determines whether to allow the attach based on the UE state.
5. After the signaling connection between the CloudUSN and trunking UE is restored, the CloudUSN sends the UE a PTT Block Request message with Block Type and starts the T9701 timer to wait for a response from the UE. If no response is received before the timer expires, the CloudUSN retransmits the PTT Block Request message for a maximum of N9701 times. If the CloudUSN still does not receive any response, it continues with the subsequent operation.
6. The CloudUSN instructs the eNodeB to release the UE's contexts.
7. If the UE is in the permanently blocked state, the CloudUSN triggers a network-initiated implicit detach procedure to delete all bearers of the UE and delete the session with the vTSN. The CloudUSN does not inform the UE of these operations.

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Service Flow of Trunking UE Blocking/Unblocking (Continued)

8. If the UE is in the temporarily blocked state, the CloudUSN instructs the CloudUGW to delete all dedicated bearers but retain the default bearer. The CloudUGW sends a Delete Trunk Bearer Notification message with EPS Bearer IDs and the Cause value of PDN Disconnected to notify the vTSN that the P2P call dedicated bearer is deleted.
   If the UE is in the temporarily blocked state and a subscriber session has been established between the CloudUGW and vTSN, the CloudUSN also deletes this session.
   If the UE is in the temporarily blocked state, the CloudUSN performs UE mobility management properly.
9. If the UE is in the temporarily blocked state, the CloudUSN rejects the UE-initiated Service Request procedure.
   For a trunking UE, the Service Reject message carries the cause value #254(UE is Blocked) and the Block Type IE indicating permanent blocking.
   For a non-trunking UE: When the UE is in the temporarily blocked state, the Service Reject message carries the cause value #111(protocol error, unspecified). When the UE is in the permanently blocked state, the Service Reject message carries the cause value #10(Implicitly detached), and the UE re-initiates an attach procedure.
   If the UE is in the temporarily blocked state, the CloudUSN should reject the CloudUGW-initiated dedicated bearer activation procedure.
   If the UE is in the temporarily blocked state, the CloudUSN should discard the Downlink Data Notification message received from the CloudUGW.

Steps 10 and 11 describe how a trunking UE is unblocked.

10. If the state of the UE is changed to unblocked, the CloudUSN triggers a network-initiated detach procedure and sends a Detach Request message with the re-attach flag to instruct the UE to re-attach to the network.
11. The UE re-initiates an attach procedure and uses services.

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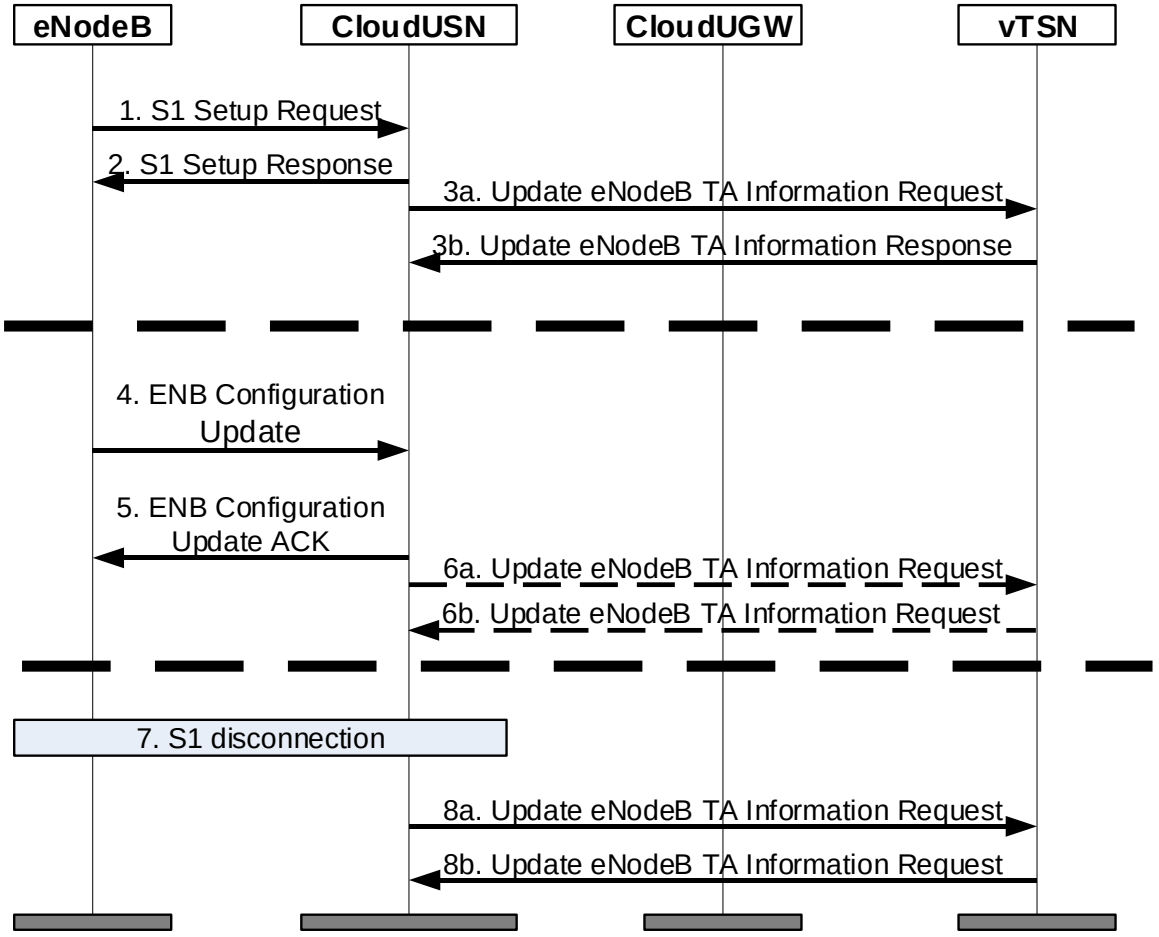
S1 Link Setup and Configuration Update



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Service Flow of S1 Link Setup and Configuration Update

1. The eNodeB initiates an S1 link setup request.
2. The CloudUSN returns an S1 link setup response with Support Trunking Indicator.
3. If the S1 link is set up successfully, the CloudUSN sends the vTSN an Update eNodeB TA Information Request message. This message carries the eNodeB TA Relationship List IE with the eNodeB TA Relationship IE. The eNodeB TA Relationship IE contains the eNodeB ID and all supported TAIs, and eNodeB TA Relationship Update Type must be set to Update eNodeB TA Relationship. Otherwise, the CloudUSN does not need to notify the vTSN.
4. When the eNodeB configuration changes, the eNodeB sends a configuration update message to the CloudUSN.
5. The CloudUSN replies with a configuration update response.
6. If the eNodeB-supported TA information changes, the CloudUSN sends the vTSN another Update eNodeB TA Information Request message, where the eNodeB TA Relationship IE contains the eNodeB ID and all supported TAIs. In addition, eNodeB TA Relationship Update Type must be set to Update eNodeB TA Relationship. Otherwise, the CloudUSN does not need to notify the vTSN.
7. The S1 link between the CloudUSN and eNodeB is disconnected.
8. The CloudUSN sends the vTSN an Update eNodeB TA Information Request message, where the eNodeB TA Relationship IE carries the eNoedB ID and eNodeB TA Relationship Update Type is Delete eNodeB TA Relationship.

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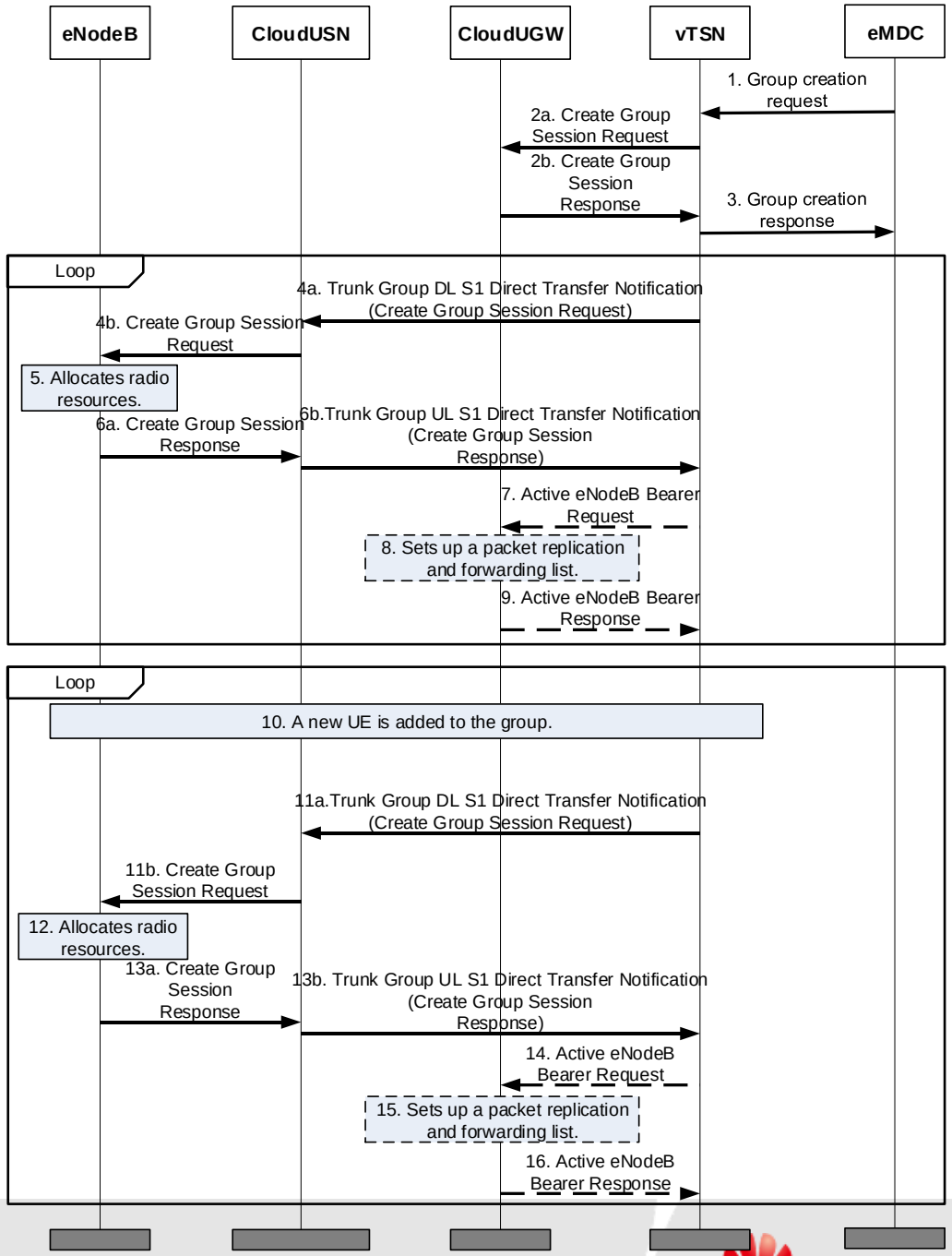
Voice Trunking Group Setup



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Service Flow of Voice Trunking Group Setup

This scenario is applicable when the dispatcher proactively initiates a group call or a trunking UE initiates a trunking call request to the MDC and triggers the dispatcher to initiate a group call.

1. The dispatcher initiates a group creation request.
2. The vTSN sends the CloudUGW a Create Group Session Request message with Group ID and Group Bearer Context. Group Bearer Context contains the flow ID assigned by the vTSN and the Trunk Bearer Flags, QoS, as well as AP Server and S1 Trunk Transport Type Flags IEs.
   - The Trunk Bearer Flags IE indicates the bearer type of the group session. It can be Relay Video Bearer or Relay Audio Bearer.
   - In the AP Server Trunk Transport Type Flags IE, if AP Server Multicast Indicator is set to 1, it indicates that downlink data is received in multicast mode between the CloudUGW and trunking service server, and AP Server Multicast IP should be carried. Otherwise, downlink data is received in unicast mode between the CloudUGW and trunking service server, and the dispatcher-side IP address and UDP Port should be carried.
   - If S1 Multicast Indicator in the AP Server Trunk Transport Type Flags IE is set to 1, the S1 interface between the CloudUGW and eNodeB works in multicast mode, and eNodeB Bearer Count is not carried. Otherwise, eNodeB Bearer Count is carried.
   - The CloudUGW returns a Create Group Session Response message to the vTSN.
   - If the request message indicates that downlink data is received in unicast mode between the CloudUGW and trunking service server, the CloudUGW should include the allocated local IP address and UDP Port in the response message.
   - If the request message indicates that the S1 interface between the CloudUGW and eNodeB works in multicast mode, the CloudUGW should include the allocated multicast IP address and port number in the response message.

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Service Flow of Voice Trunking Group Setup (Continued)

3. If the request message indicates that the S1 interface between the CloudUGW and eNodeB works in unicast mode, the CloudUGW should include the allocated local IP address and TEID in the response message.
   If the CloudUGW stores the session information of the same group, it shall first release local resources.
   If the CloudUGW cannot allocate port resources, it includes the cause value "No resources available" in the response message. The group fails to be created, and the vTSN returns a group creation failure message to the dispatcher.
   If the vTSN does not receive a response from the CloudUGW within the specified time, the vTSN returns a group creation failure message to the dispatcher.
4. The vTSN accepts the group creation request and sends the dispatcher a response message with the information about the CloudUGW-allocated resources.

Steps 5 to 10 apply to each eNodeB confirmed by the CloudUGW.

5. The vTSN sends the CloudUSN a Trunk Group DL S1 Direct Transfer Notification message with the vTSN-allocated Group S1AP ID, eNB ID, and PTT S1 Message Container. The CloudUSN sends the group context setup request encapsulated in the PTT S1 Message Container IE to the specified eNodeB.
6. The eNodeB allocates radio resources and S1 user-plane transmission resources to the group.
7. The eNodeB returns a group context setup response message to the CloudUSN. If the S1 interface works in unicast mode, the response message shall contain the eNodeB-side user-plane IP address and TEID. The CloudUSN identifies the S1 trunking message by Procedure Code, encapsulates the message in a PTT S1 Message Container IE, and sends a Trunk Group UL S1 Direct Transfer Notification message to the vTSN.

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Service Flow of Voice Trunking Group Setup (Continued)

8. If the S1 interface works in unicast mode, after the vTSN receives a group context setup response from the eNodeB, the vTSN sends the CloudUGW an Active eNodeB Bearer Request message, where the Group Bearer Context IE carries the eNodeB's S1-U interface IP address and TEID.
9. If the S1 interface works in unicast mode, the CloudUGW adds the eNodeB to the group packet replication and forwarding list and forwards group packets from the dispatcher to the eNodeB.
10. If the S1 interface works in unicast mode, the CloudUGW sends an Active eNodeB Bearer Response message to the vTSN.
11. Steps 12 to 17 may be performed when a new subscriber is added to a group.
    A subscriber joins an activated group through trunk NAS signaling. If no group resource is available on the eNodeB serving the subscriber, steps 12 to 17 are performed.
12. Steps 13 to 17 describe an eNodeB group resource activation procedure and are the same as steps 8 to 10 in group creation.
13. After a group is created, the vTSN may send the CloudUGW a Create Group Bearer Request message with Group Bearer Context to create service flows. The IDs of service flows are different. The CloudUGW allocates transmission resources for the new service flows, which is the same as that for group setup. Then the vTSN performs steps 5 to 10 to set up new service flows.

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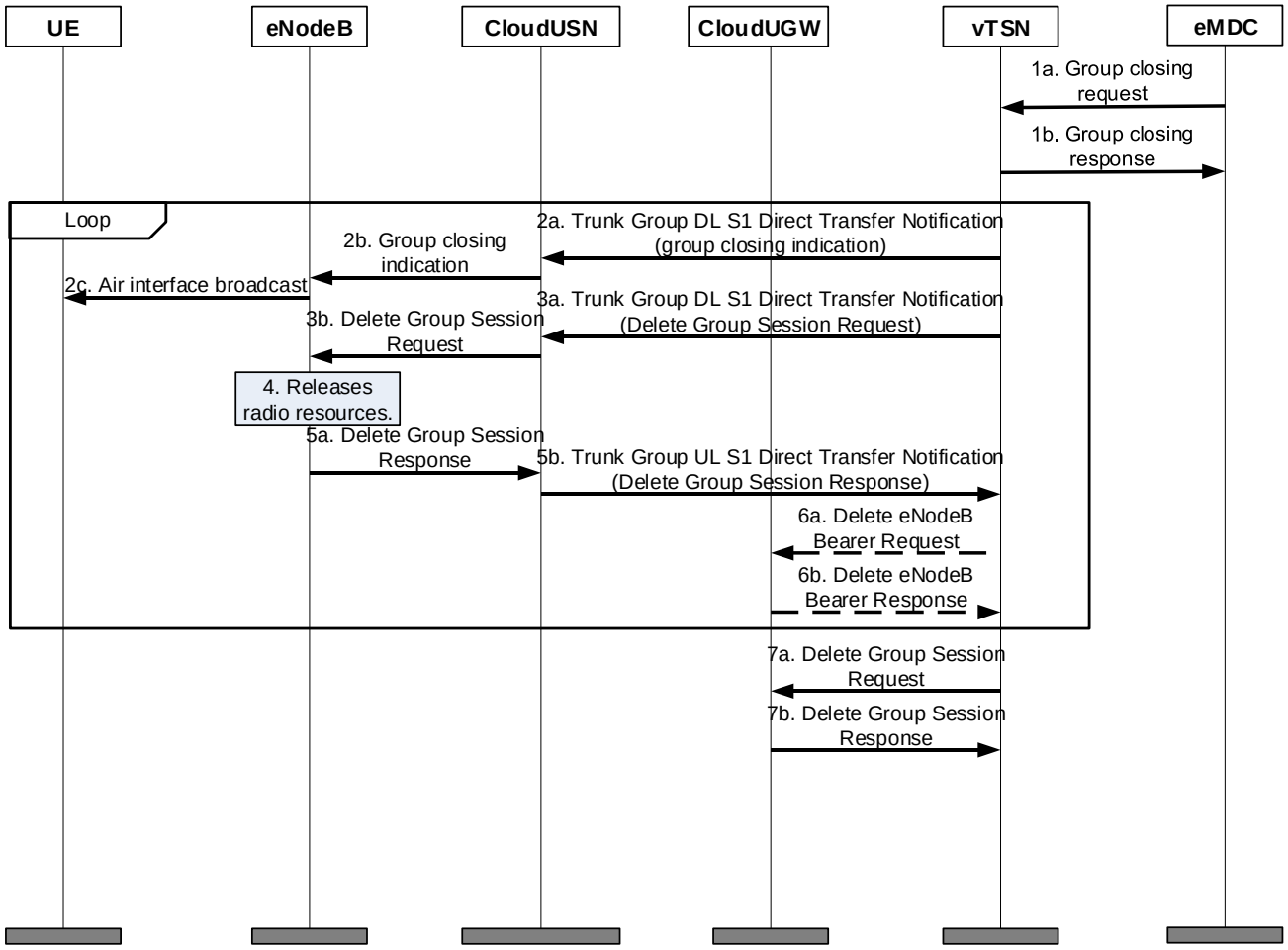
Voice Trunking Group Closing



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Service Flow of Voice Trunking Group Closing

This scenario is applicable when the dispatcher proactively closes a group or a trunking UE initiates a group closing request to the MDC.

1. The dispatcher triggers a group closing procedure.

Steps 2 to 6 apply to each eNodeB in the group.

2. The vTSN sends the CloudUSN a Trunk Group DL S1 Direct Transfer Notification message with the vTSN-allocated Group S1AP ID, eNB ID, and PTT S1 Message Container. The CloudUSN sends the group closing indication encapsulated in the PTT S1 Message Container IE to the specified eNodeB. The eNodeB notifies the UE through a broadcast message. To ensure that the UE receives the group closing indication, the vTSN may send the indication multiple times.
3. The vTSN sends the CloudUSN a Trunk Group DL S1 Direct Transfer Notification message with the vTSN-allocated Group S1AP ID, eNB ID, and PTT S1 Message Container. The CloudUSN sends the specified eNodeB the group context release request encapsulated in the PTT S1 Message Container IE.
4. The eNodeB releases the radio resources allocated to the group.
5. The eNodeB sends a group context release response message to the CloudUSN. The CloudUSN identifies the S1 trunking message by Procedure Code, encapsulates the message in a PTT S1 Message Container IE, and sends a Trunk Group UL S1 Direct Transfer Notification message to the vTSN.
6. After receiving a response message from the eNodeB, the vTSN sends the CloudUGW a Delete eNodeB Bearer Request message, where the Group Bearer Context IE carries the flow ID and eNodeB List.

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Service Flow of Voice Trunking Group Closing (Continued)

7. After group bearer resources are deleted, the vTSN sends the CloudUGW a Delete Group Session Request message to delete the group session. If the CloudUGW has allocated UDP port and TEID resources to the group, these resources are also released.
   If the vTSN does not receive a response from the CloudUGW within the specified time, the vTSN releases the local group session.
   If the vTSN does not perform step 6, the CloudUGW should release all bearer context information with the eNodeB when the group session is deleted.

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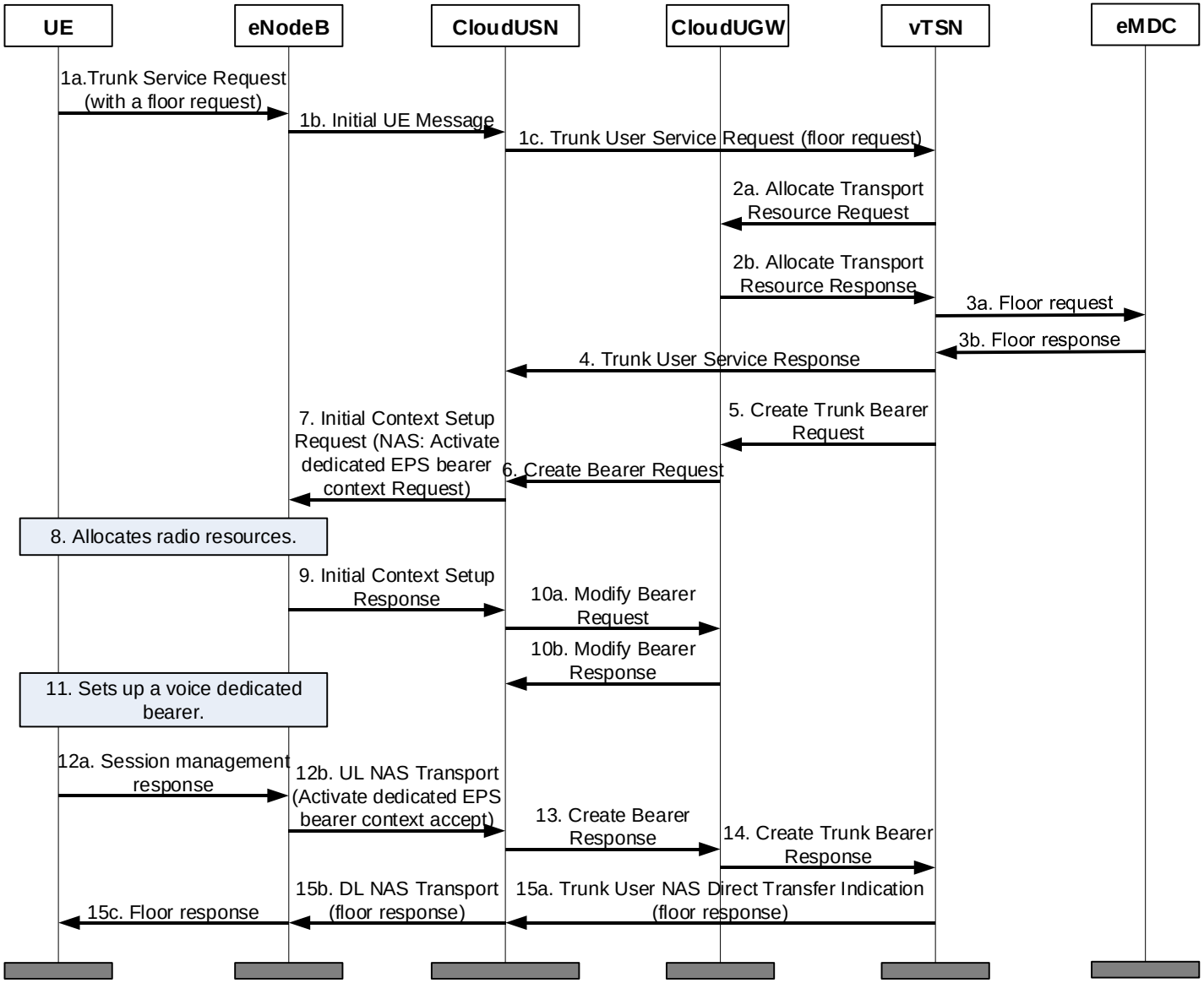
Floor Request by a Trunking UE



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Service Flow of Floor Request by a Trunking UE

This scenario is applicable when a subscriber in a group call wants to speak and presses a certain key on the trunking UE to trigger a floor request procedure. In this procedure, a dedicated bearer is created for the subscriber.

1. A trunking UE in the idle state initiates a floor request by sending a Trunk Service Request message to the CloudUSN. The Trunk Messages IE in the message contains the floor request.
   If a subscriber session has been set up between the CloudUSN and vTSN, the CloudUSN sends the vTSN a Trunk User Service Request message with the Trunk Service Request Type and PTT NAS Message Container IEs. The Trunk Service Request Type IE should be set to 1(Trunk Service Request), and the PTT NAS Message Container IE is encapsulated with the content of the Trunk Messages IE in the received Trunk Service Request message.
2. The vTSN sends the CloudUGW an Allocate Transport Resource Request message, where Trunk Transport Resource Type in the Trunk Transport Context IE indicates the requested resource type (UDP or TCP). The CloudUGW includes the allocated local IP address and port number in the Trunk Transport Context IE of the response message.
   If the CloudUGW fails to allocate resources, it includes a failure cause value in the response message. The vTSN sends the CloudUSN a Trunk User Service Response message with the failure cause value of Request rejected.
3. The vTSN initiates a floor request to the dispatcher. The request message carries the information about the user-plane resources allocated by the CloudUGW. The dispatcher confirms the floor request and replies with a response message with the dispatcher-side user-plane resource information.

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Service Flow of Floor Request by a Trunking UE (Continued)

4. If the UE's floor request is accepted, the vTSN returns a Trunk User Service Response message to the CloudUSN. Trunk Bearer Creating Indication in the Trunk Indication IE is set to 1. Then the CloudUSN waits for a voice dedicated bearer creation request message.
   If the vTSN rejects the floor request (example causes: the CloudUGW fails to allocate port resources, or the dispatcher rejects the floor request), the vTSN includes the failure cause value of Request rejected in the response message. In this case, the CloudUSN does not wait for voice dedicated bearer creation but handles the procedure as a 3GPP-standard Service Request procedure.
   If the CloudUSN does not receive a response from the vTSN within the specified time, it handles the procedure as a 3GPP-standard Service Request procedure.
5. The vTSN sends the CloudUGW a Create Trunk Bearer Request message, with the subscriber identifier (IMSI, MSISDN, or IMEI) and the UE IP, PTI, PTT Speaker Indication, Group ID, and Trunk Bearer Context IEs. The Trunk Bearer Context IE contains the Trunk Bearer Flags, Trunk Audio Codec, QoS, and Trunk Transport Type IEs.
   In trunking voice mode, the Trunk Bearer Context IE should contain the CloudUGW's local IP address and port number and the dispatcher-side IP address and port number.
   In transparent mode, the Trunk Bearer Context IE should contain Bearer TFT.
   TFT is transmitted between the CloudUSN and CloudUGW in both modes.
6. The CloudUGW triggers a dedicated bearer creation procedure by sending the CloudUSN a Create Bearer Request message with the PTI, PTT Speaker Indication, Group ID, and Trunk Audio Codec IEs.

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Service Flow of Floor Request by a Trunking UE (Continued)

7. After receiving a request message for trunking voice dedicated bearer creation, the CloudUSN sends an Initial Context Setup Request message to the eNodeB. The E-RAB to Be Setup List IE in the message should contain the trunk and voice bearer information as well as PTT service Indication(with the value of True). The trunk and voice bearer information contains the PTT Speaker Indication, Group ID, and Traffic Type IEs. The value of the Traffic Type IE is the value of the Trunk Audio Codec IE in the Create Bearer Request message.
   The Initial Context Setup Request message carries the Activate Dedicated EPS Bearer Context Request message destined for the UE. The latter message contains the Trunked transaction identity and Codec Mode IEs.
   The value of Trunked Transaction Identity is the PTI value in the Create Bearer Request message.
   Codec Mode is set to the value of the Trunk Audio Codec IE in the Create Bearer Request message.
   If the CloudUSN does not receive a Create Bearer Request message within the specified time, it handles the procedure as a 3GPP-standard Service Request procedure.
   If the trunking UE is performing an inter-eNodeB handover, the CloudUSN caches the received Create Bearer Request message, and continues with trunking voice dedicated bearer creation after the handover procedure is complete.
   If the trunking UE performs an inter-eNodeB handover during trunking voice dedicated bearer creation, the CloudUSN may terminate the bearer creation procedure and send the CloudUGW a Create Bearer Response message with the cause value of "Temporarily rejected due to handover/TAU/RAU procedure in progress." The CloudUGW returns a Create Trunk Bearer Response message with the cause value of "Temporarily rejected due to handover/TAU/RAU procedure in progress."

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Service Flow of Floor Request by a Trunking UE (Continued)

8. The eNodeB allocates air interface resources, including the default bearer and the dedicated bearer that has been created, to the UE.
9. The eNodeB sends the CloudUSN an Initial Context Setup Response message with the eNodeB-side user-plane information.
10. The CloudUSN instructs the CloudUGW to restore the user-plane data channel with the eNodeB.
11. The eNodeB assigns radio resources for the trunking voice dedicated bearer.
12. The trunk UE sends a message to the CloudUSN to acknowledge voice dedicated bearer activation.
13. The CloudUSN returns a Create Bearer Response message to the CloudUGW.
14. The CloudUGW sends the vTSN a Create Trunk Bearer Response message with a bearer creation success indication or a failure cause. If the bearer is created successfully, its flow ID should also be carried in the message.
15. The vTSN sends the CloudUSN a Trunk User NAS Direct Transfer Indication message with a response to the floor request. The CloudUSN sends a Downlink NAS Transport message to forward the response to the floor request to the UE.

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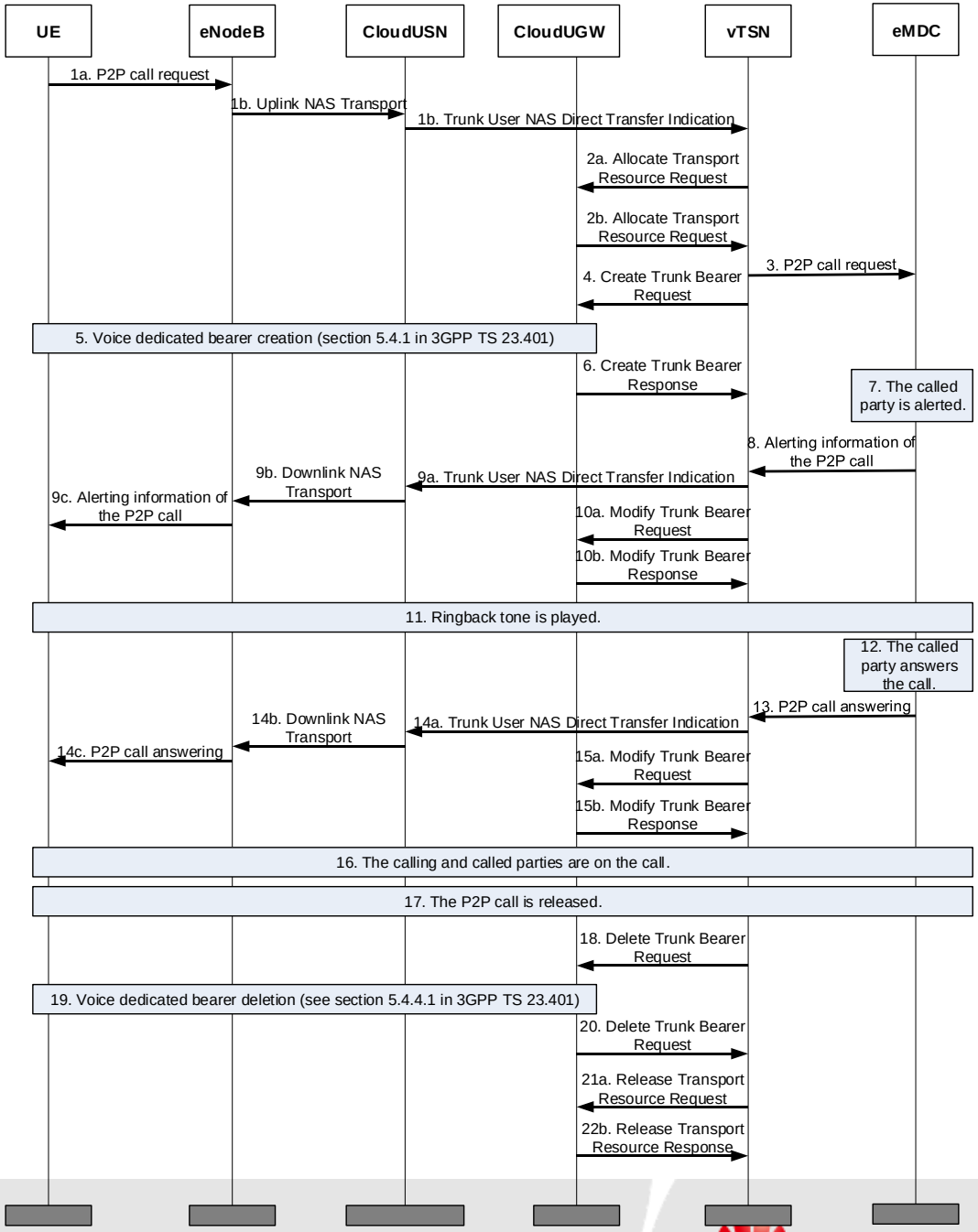
P2P Call Originated by a Trunking UE



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Service Flow of P2P Call Originated by a Trunking UE

This scenario is applicable when a trunking UE proactively initiates a P2P call. It is similar to a VoLTE service, but the vTSN and vMDC have floor control.

1. A trunking UE in the connected state initiates a P2P call by sending a request message to the vTSN. If the UE is in the idle state, it initiates a standard Service Request procedure to switch to the connected state.
2. In trunking voice mode, the vTSN sends the CloudUGW an Allocate Transport Resource Request message, where Trunk Transport Resource Type in the Trunk Transport Context IE indicates the requested resource type (UDP or TCP). The CloudUGW includes the allocated local IP address and port number in the Trunk Transport Context IE of the response message. If the CloudUGW fails to allocate port resources, it includes the Cause value "No resources available" in the response message. The vTSN uses a downlink NAS direct transfer message to send a P2P call failure response to the UE.
3. The vTSN sends the dispatcher a P2P call setup request with the CloudUGW-allocated port information.
4. The vTSN sends the CloudUGW a Create Trunk Bearer Request message, with the subscriber identifier (IMSI, MSISDN, or IMEI) and the UE IP, PTI, PTT Speaker Indication, and Trunk Bearer Context IEs. The Trunk Bearer Context IE contains the Trunk Bearer Flags, Trunk Audio Codec, QoS, and Trunk Transport Type IEs.
   In trunking voice mode, the Trunk Bearer Context IE should contain the CloudUGW's local IP address and port number.
   In transparent mode, the Trunk Bearer Context IE should contain Bearer TFT.

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Service Flow of P2P Call Originated by a Trunking UE (Continued)

5. The CloudUGW triggers a dedicated bearer creation procedure. For details, see section 5.4.1 in 3GPP TS 23.401.
   a. The CloudUGW sends the CloudUSN a Create Bearer Request message. The message should contain the PTI, PTT Speaker Indication, Trunk Audio Codec, and TFT IEs.
      In trunking voice mode, the CloudUGW constructs a TFT template based on information in the Create Trunk Bearer Request message. The remote IP address and port number are those of the dispatcher, and the local IP address and port number are those of the CloudUGW.
      In transparent mode, the TFT template is TFT carried in the Create Trunk Bearer Request message.
   b. The CloudUSN sends the eNodeB an E-RAB Setup message, where the E-RAB to Be Setup List IE contains the trunking voice bearer information. The trunking voice bearer information contains the PTT Speaker Indication and Traffic Type IEs. The value of the Traffic Type IE is the value of the Trunk Audio Codec IE in the Create Bearer Request message.
   c. The CloudUSN sends the eNodeB an Activate Dedicated EPS Bearer Context Request message. The message contains the Trunked transaction identity and Codec Mode IEs.
      The value of Trunked Transaction Identity is the PTI value in the Create Bearer Request message.
      Codec Mode is set to the value of the Trunk Audio Codec IE in the Create Bearer Request message.
6. The CloudUGW sends the vTSN a response message with a bearer creation success indication or a failure cause. If the bearer is created successfully, the message also carries a flow ID. If the bearer fails to be created, the vTSN uses a downlink NAS direct transfer message to send a P2P call failure response to the UE.

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Service Flow of P2P Call Originated by a Trunking UE (Continued)

7. The called party is alerted.
8. The dispatcher sends a message to notify the vTSN that the called party has been alerted, and the message carries the IP address that plays the ringback tone as well as the port information.
9. The vTSN sends the CloudUSN a Trunk User NAS Direct Transfer Indication message with the alerting information. The CloudUSN sends a Downlink NAS Transport message to forward the alerting information to the UE.
10. The vTSN sends the CloudUGW a Modify Trunk Bearer Request message, where the Trunk Bearer Context IE contains the dispatcher-side IP address and port information. The CloudUGW sets up an uplink/downlink forwarding rule and forwards the received ringback tone data packet to the UE.
11. The UE hears the ringback tone.
12. The called party answers the call.
13. The dispatcher sends a message to notify the vTSN that the called party has answered the call, and the message carries the information about the data forwarding ports at the calling and called sides.
14. The vTSN sends the CloudUSN a Trunk User NAS Direct Transfer Indication message with the call acknowledgement information. The CloudUSN sends a Downlink NAS Transport message to forward the call acknowledgement information to the UE.
15. The vTSN sends the CloudUGW a Modify Trunk Bearer Request message, where the Trunk Bearer Context IE contains the dispatcher-side IP address and port information. The CloudUGW re-sets up uplink and downlink data paths to forward uplink and downlink voice data.
16. The calling and called parties are on the call.
17. The calling or called party releases the call. The CloudUSN sends uplink and downlink NAS transport messages to transfer trunk NAS signaling between the vTSN and UE.

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Service Flow of P2P Call Originated by a Trunking UE (Continued)

18. The vTSN requests the CloudUGW to delete the P2P call dedicated bearer.
19. The CloudUGW triggers a dedicated bearer deletion procedure.
20. After the dedicated bearer is deleted, the CloudUGW returns a response to the vTSN.
21. The vTSN instructs the CloudUGW to release the allocated P2P call port resources.

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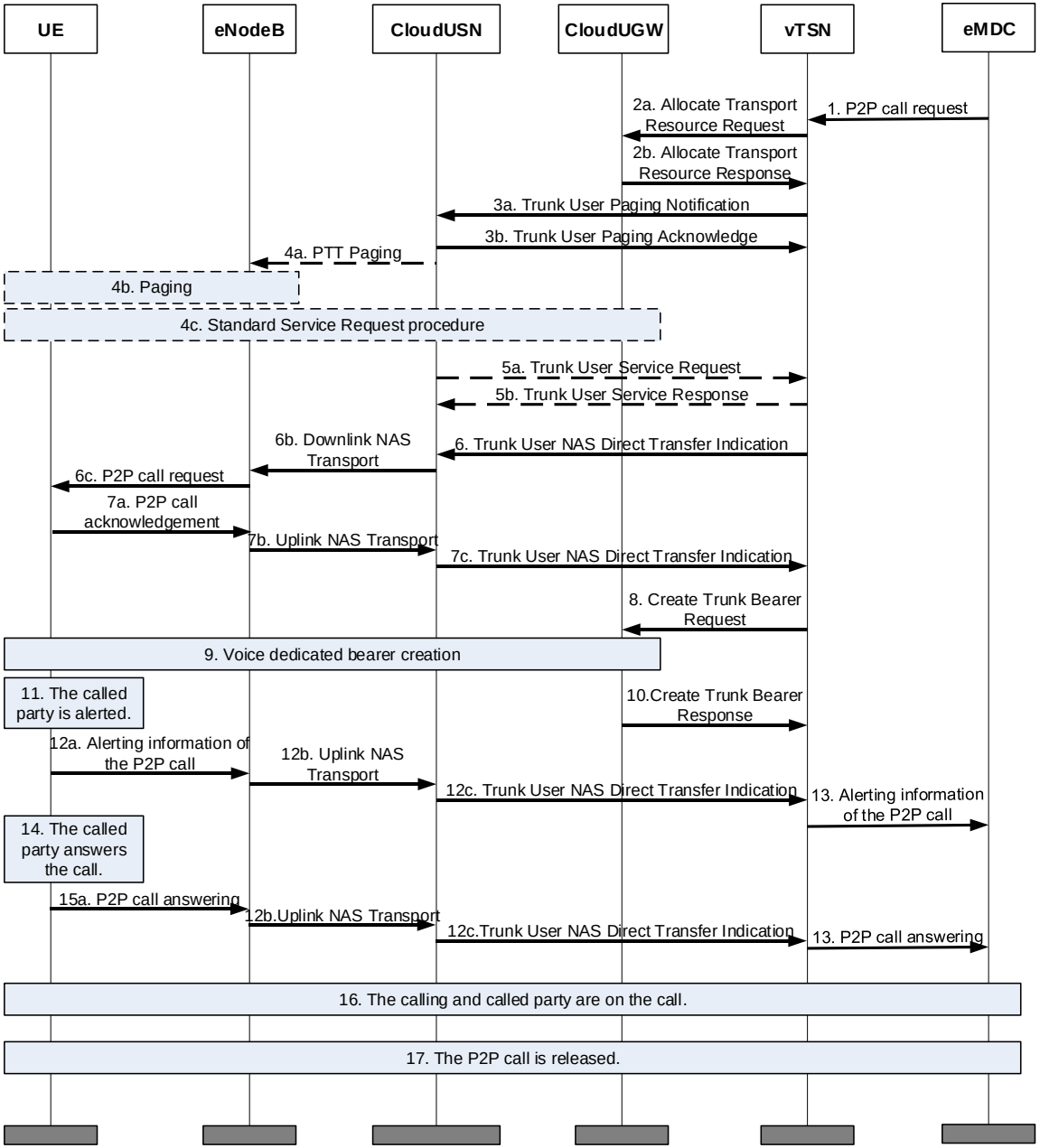
P2P Call Terminated by a Trunking UE



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Service Flow of P2P Call Terminated by a Trunking UE

This scenario is applicable when a trunking UE proactively terminates a P2P call. It is similar to a VoLTE service, but the vTSN and vMDC have floor control.

1. The dispatcher sends a P2P call setup request to the vTSN. The request carries the user-plane port information of the dispatcher side.
2. In trunking voice mode, the vTSN sends the CloudUGW an Allocate Transport Resource Request message, where Trunk Transport Resource Type in the Trunk Transport Context IE indicates the requested resource type (UDP or TCP). The CloudUGW includes the allocated local IP address and port number in the Trunk Transport Context IE of the response message.
3. The vTSN sends the CloudUSN a Trunk User Paging Notification message with the Trunk Call Priority IE. The CloudUSN returns a Trunk User Paging Acknowledge message with the UE Status of EMM-IDLE or EMM-CONNECTED.
4. If the UE is in the EMM-IDLE state, the CloudUSN sends a PTT Paging message with trunk-dedicated paging parameters to the eNodeB.
   The UE receives a paging message from the eNodeB and triggers a standard Service Request procedure to restore the EMM-CONNECTED state. If the CloudUSN is initiating a PS Paging procedure, it does not send a PTT Paging message but waits for the completion of the Service Request procedure triggered by PS paging.
5. After the Service Request procedure is complete, the CloudUSN sends a Trunk User Service Request message to the vTSN. In the message, Trunk Service Request Type is Normal Service. The vTSN returns a Trunk User Service Response message to the CloudUGW, and Trunk Bearer Creating Indication in the Trunk Indication IE is set to 0.

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Service Flow of P2P Call Terminated by a Trunking UE (Continued)

6. The vTSN sends the CloudUSN a Downlink NAS Transport message with the P2P Call Request message.
7. The UE acknowledges the P2P call, and the CloudUSN encapsulates the P2P call acknowledgement information into an Uplink NAS Transport message and sends the message to the vTSN.
8. The vTSN sends the CloudUGW a Create Trunk Bearer Request message, with the subscriber identifier (IMSI, MSISDN, or IMEI) and the UE IP, PTI, PTT Speaker Indication, and Trunk Bearer Context IEs. The Trunk Bearer Context IE contains the Trunk Bearer Flags, Trunk Audio Codec, QoS, and Trunk Transport Type IEs.
   In trunking voice mode, the Trunk Bearer Context IE should contain the CloudUGW's local IP address and port number and the dispatcher-side IP address and port number.
   In transparent mode, the Trunk Bearer Context IE should contain Bearer TFT.
9. The CloudUGW triggers a dedicated bearer creation procedure, which is the same as that in a P2P call originated by a trunking UE.
10. The CloudUGW sets up uplink and downlink data forwarding paths and sends the vTSN a response message with a bearer creation success indication or a failure cause. If the bearer is created successfully, its EBI should also be carried in the message.
11. The UE is alerted.

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Service Flow of P2P Call Terminated by a Trunking UE (Continued)

12. The UE sends the alerting information to the CloudUSN, and the CloudUSN transfers the information to the vTSN through an Uplink NAS Transport message.
13. The vTSN notifies the dispatcher that the called party (UE) has been alerted.
14. The called party answers the call.
15. The UE sends the call acknowledgement information to the CloudUSN, and the CloudUSN transfers the information to the vTSN through an Uplink NAS Transport message.
16. The vTSN notifies the dispatcher that the UE has answered the call.
17. The calling and called parties are on the call.
18. After the call is complete, the session release procedure initiated by the called party is the same as that initiated by the calling party. For details, see steps 18 to 22 in Service Flow of P2P Call Originated by a Trunking UE.

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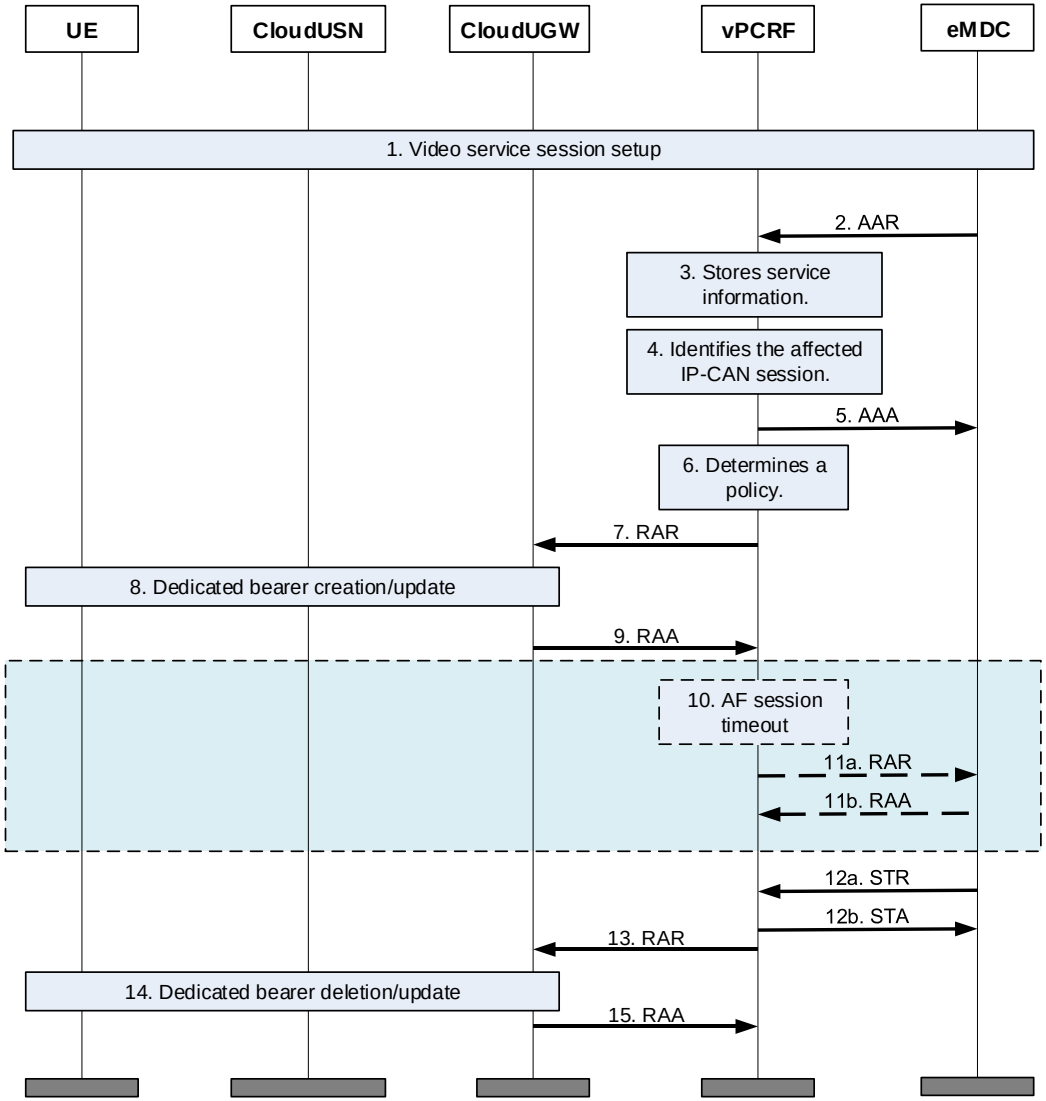
Basic Trunking Video Service



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Service Flow of Basic Trunking Video Service

1. The trunking UE sets up a video service session with the dispatcher through user-plane signaling. The UE triggers the creation of a dedicated bearer with QCI 5.
2. The dispatcher sends an AAR message to instruct the PCRF to set up an application session. The message carries the subscriber identifier, session filter, session type, bandwidth information, and session authorization period.
3. The PCRF stores the session information.
4. The PCRF identifies the affected IP-CAN session.
5. The PCRF returns a service session setup response to the dispatcher.
6. The PCRF determines a rule, such as a QoS rule, based on configured policies.
7. The PCRF sends a RAR message with the determined rule to the CloudUGW.
8. The CloudUGW triggers a dedicated bearer creation or modification procedure.
9. After the dedicated bearer is created or modified, the CloudUGW sends a response to the PCRF.
10. The AF session duration exceeds the authorized period.
11. The PCRF sends another session authorization request to the dispatcher. If session authorization fails, the PCRF terminates the session and instructs the CloudUGW to delete the installed rule after dedicated bearer deletion is triggered.
12. After the video service session between the trunking UE and dispatcher is complete, the dispatcher instructs the PCRF to terminate the AF session.
13. The PCRF instructs the CloudUGW to delete the installed rule.
14. The CloudUGW triggers a dedicated bearer deletion or modification procedure.
15. After the dedicated bearer is deleted or modified, the CloudUGW sends a response to the PCRF.

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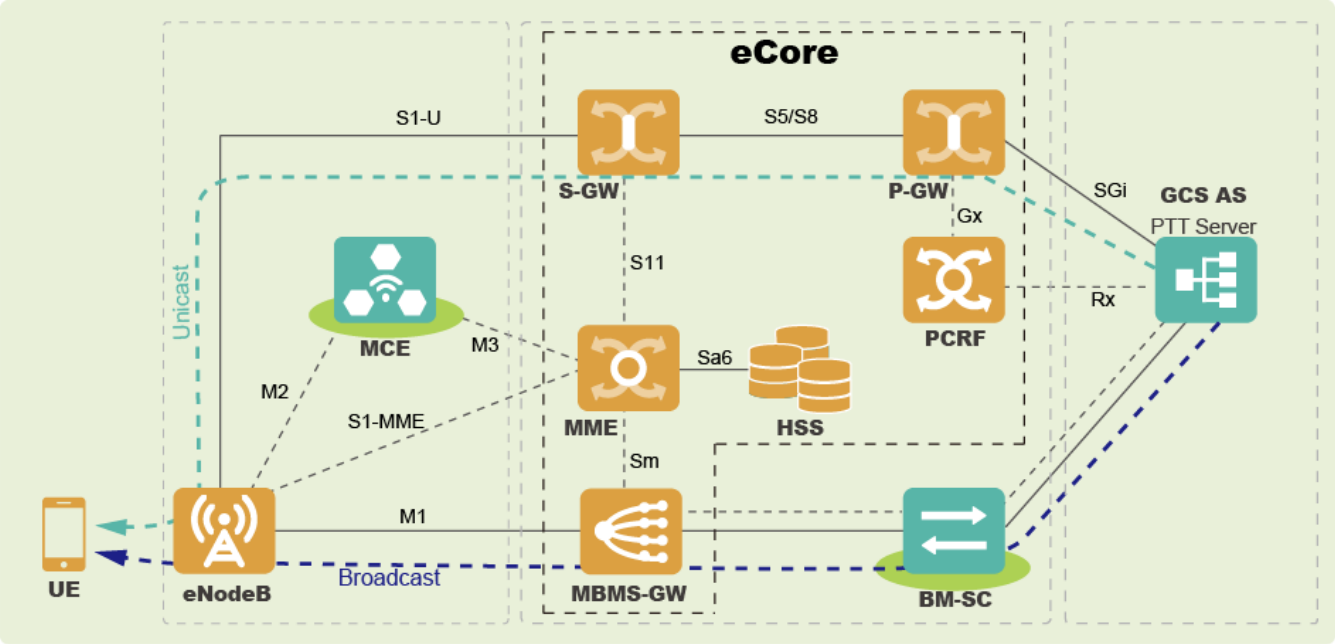
Architecture of a 3GPP Trunking Network

SRVCC networking



- BM-SC: service provisioning, security, session management, and packet synchronization processing
- MBMS-GW: IGMP V3 and PIM-SSM, as well as session management
- MME: session management
- MCE: inter-eNodeB PMCH resource allocation, and session management
- eNodeB: session resource allocation, packet synchronization processing, and session management
- M1 and SGi-mb transmission network: using IGMP V3 and PIM-SSM technologies

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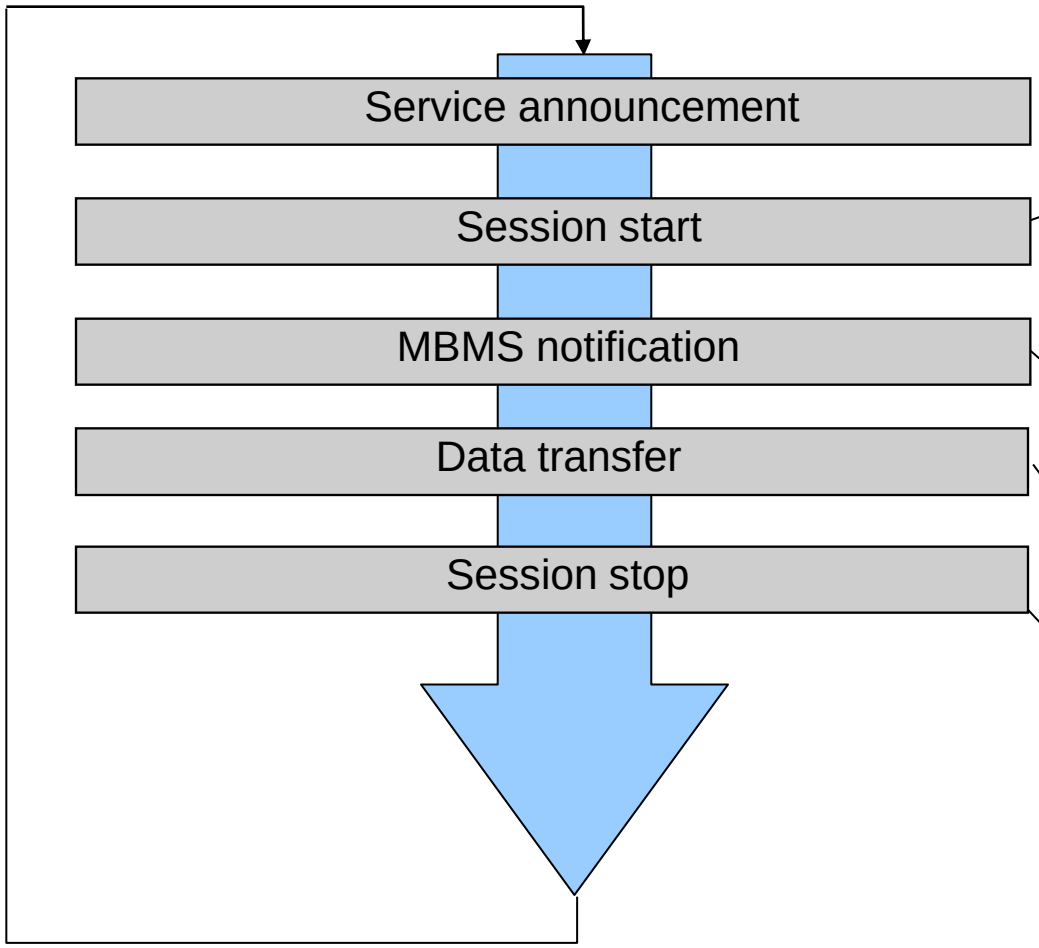
3GPP Trunking Service Processes



Notification of broadcast session start, which triggers the setup of eMBMS bearer resources:

- Broadcast session ID and QoS requirements
- Multicast IP address
- GTP-U TEID

The eNodeB broadcasts the session ID and allocates MBSFN air interface resources.

The eNodeB broadcasts session data through the air interface.

The session is complete, and the eNodeB releases resources.

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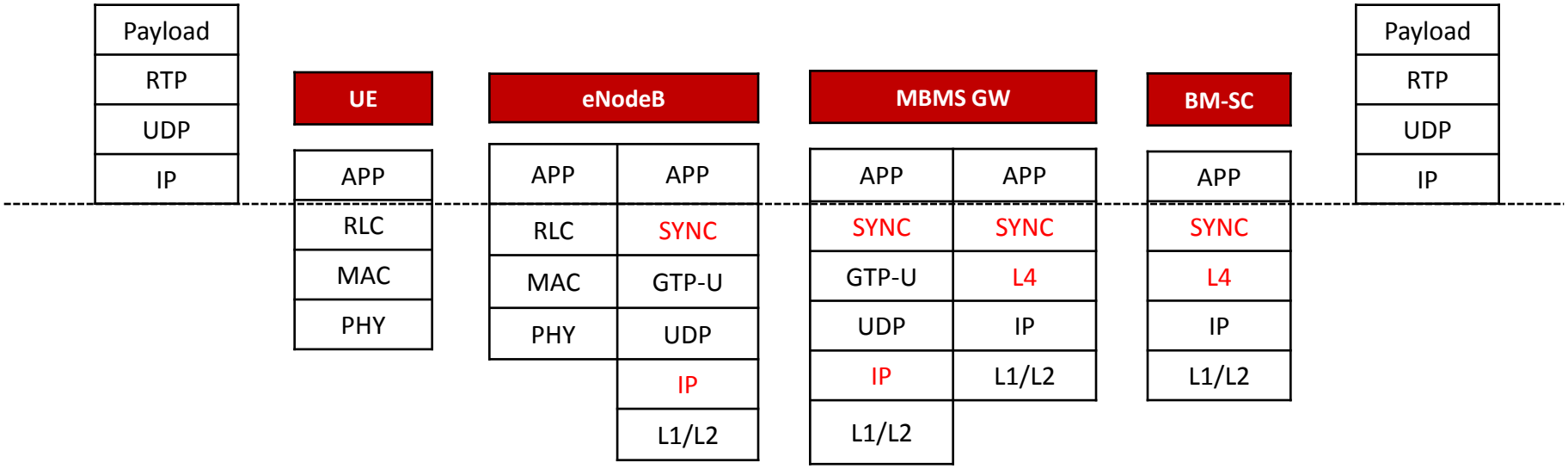
Protocol Stack of 3GPP Trunking Services



User-plane protocol stack of 3GPP trunking services

UE	eNodeB		MCE		MME		MBMS GW		BM-SC
RRC	RRC	M2-AP	M2-AP	M3-AP	M3-AP	GTPv2-C	GTPv2-C	Diameter	Diameter
PDCP	PDCP	SCTP	SCTP	SCTP	SCTP	UDP	UDP	TCP	TCP
RLC	RLC	IP	IP	IP	IP	IP	IP	IP	IP
MAC	MAC	L1/L2	L/L2	L/L2	L/L2	L1/L2	L1/L2	L1/L2	L1/L2
PHY	PHY								

Control-plane protocol stack of 3GPP trunking services

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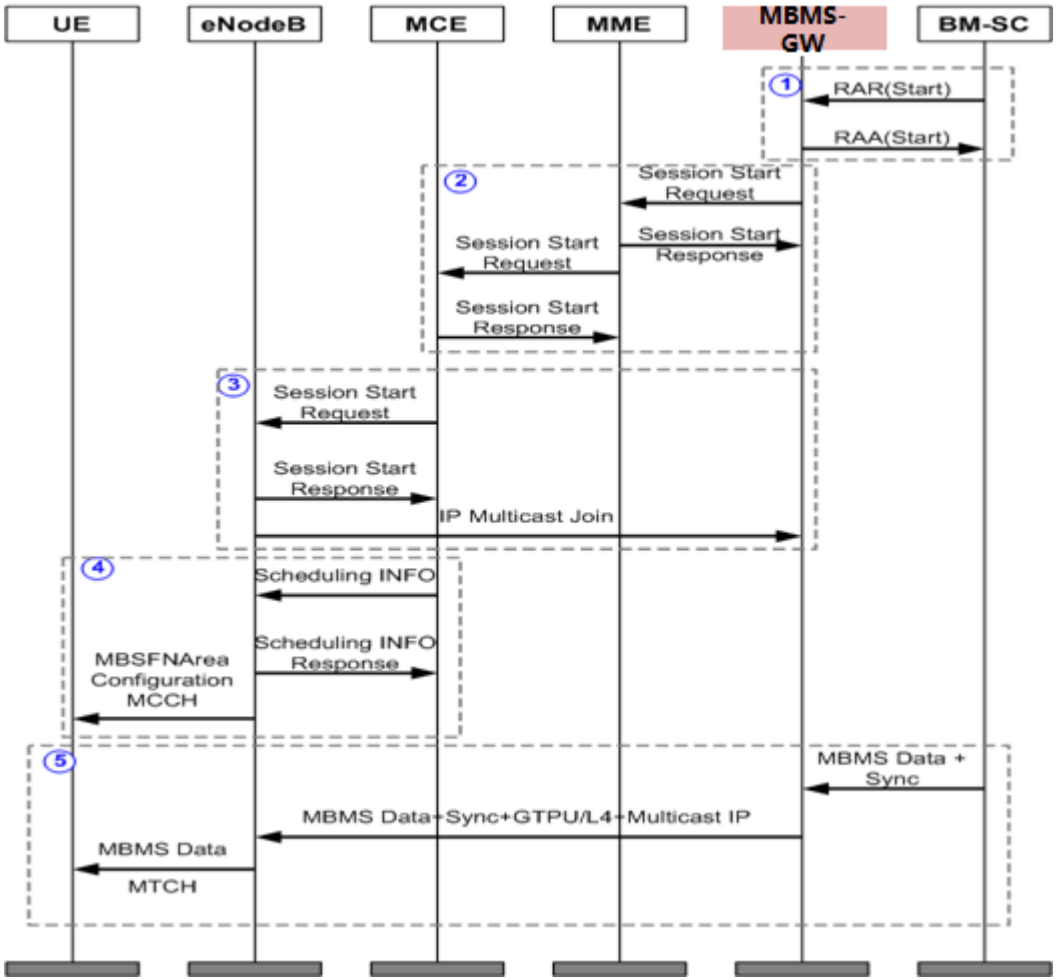
Session Start



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Service Flow of Session Start

The service flow is as follows:

1. The BM-SC sends a Session Start Request message to the MBMS-GW list and MME list corresponding to the broadcast service area to request MBMS-GW session setup.
2. The MBMS-GW creates an MBMS bearer context, assigns a transmission-network multicast IP address and a multicast GTP-U TEID, and forwards the Session Start Request message to an MME in the MME list.
3. The MME obtains the MCE list based on the MBMS SAI of the MBMS service area and forwards the message to an MCE.
4. The MCE obtains the eNodeB list based on the MBMS SAI of the MBMS service area, instructs an eNodeB to reserve air interface resources, and uses a Session Start procedure to instruct the eNodeB to establish an M1 interface.
5. The BM-SC encapsulates Sync Header to MBMS data packets and sends the packets to the MBMS-GW (unicast or multicast; only multicast is supported currently). The MBMS-GW then sends the packets to the eNodeB.

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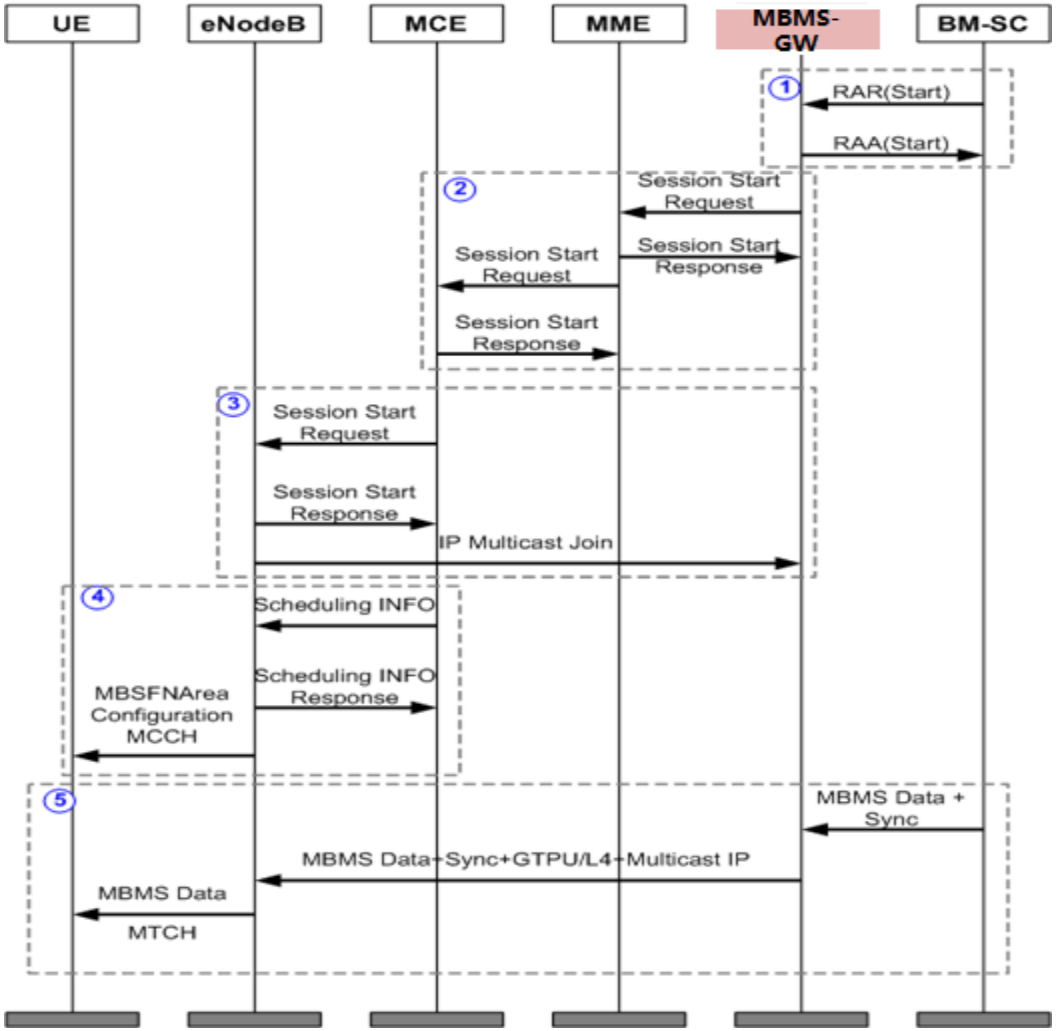
Session Stop



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Service Flow of Session Stop

1. The BM-SC instructs an MBMS-GW in the MBMS-GW list corresponding to the MBMS service area to release the MBMS bearer.
2. The MBMS-GW sends a Session Stop Request message to an MME in the MME list corresponding to the MBMS service area.
3. The MME sends a Session Stop Request message to an MCE in the MCE list corresponding to the MBMS service area.
4. The MCE sends a Scheduling Info message to instruct an eNodeB in the eNodeB list corresponding to the MBMS service area to release air interface resources and a Session Stop Request message to instruct the eNodeB to release the M1 interface.

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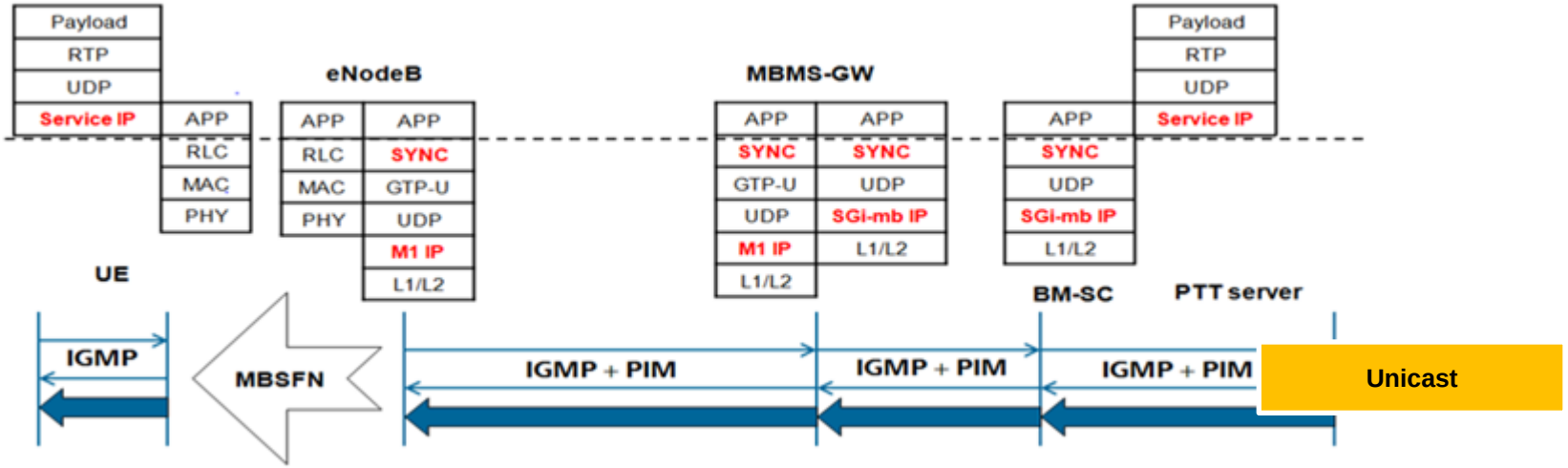
User-Plane Service Flow of 3GPP Trunking Services



The user plane is divided into 1 unicast segment, 3 multicast segments, and 1 air-interface MBSFN broadcast segment.

1. BM-SC to PTT server: PTT server and BM-SC
2. MBMS-GW to BM-SC: SGi-mb interface multicast. The multicast IP address of the SGi-mb interface is used for addressing. The BM-SC assigns the SGi-mb interface IP address and notifies the MBMS-GW of this IP address through an SGi-mb message.
3. eNodeB to MBMS-GW: M1 interface multicast. The multicast IP address of the M1 interface is used for addressing. The MBMS-GW assigns the M1 interface IP address and notifies the eNodeB of this IP address through an M3 or M2 interface message.
4. UE to eNodeB: air-interface MBSFN broadcast. The TMGI is used for addressing.

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Thank you

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