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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee TETRA and Critical Communications Evolution (TCCE).

The present document is part 2 of a multi-part deliverable covering TETRA and Critical Communications Evolution (TCCE); Critical Communications Architecture, as identified below:

TR 103 269-1: "Critical Communications Architecture Reference Model";

TS 103 269-2: "Critical Communications application mobile to network interface architecture".

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**may not**", "**need**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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1 Scope

The present document presents an overview of the architecture for a generic mission critical service for use by a Critical Communications Application in network and terminal over a broadband IP bearer, with specific focus for LTE. The architecture is part of the overall Critical Communications Architecture Reference Model, described in ETSI TR 103 269-1 [1]. The overall architecture and services are described and the implementation of services equivalent to the existing narrowband technologies, for example those in TETRA and Tetrapol systems. Off network services are for future study and so are outside the scope of the present document.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI TR 103 269-1: "TETRA and Critical Communications Evolution (TCCE); Critical Communications Architecture; Part 1: Critical Communications Architecture Reference Model".

[2] IETF RFC 3261: "SIP: Session Initiation Protocol (SIP)".

[3] IETF RFC 5389: "Session Traversal Utilities for NAT (STUN)".

[4] IETF RFC 6665: "SIP-Specific Event Notification". .

[5] IETF RFC 3428: "Session Initiation Protocol (SIP) Extension for Instant Messaging".

[6] IETF RFC 3903: "Session Initiation Protocol (SIP) Extension for Event State Publication".

[7] IETF RFC 4566: "Session Description Protocol (SDP)".

[8] IETF RFC 5359: "Session Initiation Protocol Service Examples".

[9] IETF RFC 791: "Internet Protocol (v4)".

[10] IETF RFC 2460: "Internet Protocol, version 6".

[11] IETF RFC 793: "Transmission Control Protocol (TCP)".

[12] IETF RFC 4960: "Stream Control Transmission Protocol (SCTP)".

[13] IETF RFC 5246: "Transport Layer Security protocol (TLS)".

[14] IETF RFC 6347: "Datagram Transport Layer Security (DTLS)".

[15] IETF RFC 768: "User Datagram Protocol (UDP)".

[16] IETF RFC 3550: "Real Time Protocol (RTP)".

[17] IETF RFC 3711: "Secure Real Time Protocol (SRTP)".

[18] IETF RFC 5245: "Interactive Connectivity Establishment (ICE)".

[19] IETF RFC 5766: "Traversal Using Relays around NAT (TURN)".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 102 022-2: "User Requirements Specification Mission Critical Broadband Communications; Part 2: Critical Communications Application".

[i.2] TETRA and Critical Communications Association; List of TIP features.

NOTE: Available at http://www.tandcca.com/Library/Documents/ListofTIPfeaturesv3.0.pdf

[i.3] ETSI EN 300 392-12: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 12: Supplementary services stage 3".

[i.4] 3GPP TS 22.179: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Mission Critical Push to Talk MCPTT".

[i.5] IEEE 802.11: "IEEE Standard for Information technology- Telecommunications and information exchange between systems Local and metropolitan area networks- Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

[i.6] IEEE 802.16: "IEEE Standard for Air Interface for Broadband Wireless Access Systems".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

affiliation: process of negotiating access to communications with a group

NOTE 1: The TETRA term for affiliation is 'Group Attachment'.

NOTE 2: 3GPP TS 22.179 [i.4] uses the term 'Affiliation'.

call: set of one or more transmissions of media between two or more parties

call hang time: period within a call during which no communications are sent or received, and following expiry of which, the call will be cleared

critical communications application: infrastructure based application which provides critical communications services to its client Mobile Units

migration: obtaining Critical Communications service from a CCA other than the home CCA

mobile unit: combination of access network client terminal and client application for critical communications which provides critical communications services to its user

registration: process of negotiating service from a CCA

roaming: obtaining an IP connection to the home CCA from a broadband IP network other than the home broadband IP network

NOTE: If a 3GPP LTE PLMN provides home service to a user, obtaining service from a different PLMN is an example of roaming.

session: period within a period of affiliation to a group within which transmissions may be sent and received to and from that group by using media control signalling only

session hang time: the period following a call during which the CCA may maintain a session before clearing it

3.2 Abbreviations

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

3GPP	3rd Generation Partnership Project
AL	Ambience Listening
APN	Access Point Name
ASSI	Alias Short Subscriber Identity
AVL	Automatic Vehicle Location
BIC	Barring of Incoming Calls
BOC	Barring of Outgoing Calls
BS	Base Station
CAD	Call Authorised by Dispatcher
CCA	Critical Communications Application
CCAS	Critical Communications Application Server
CCS	Critical Communications System
CF	Call Forwarding
CFB	Call Forwarding on Busy
CFU	Call Forwarding Unconditional
CW	Call Waiting
DGNA	Dynamic Group Number Assignment
DHCP	Dynamic Host Control Protocol
DL	Discreet Listening
DMO	Direct Mode Operation
DNS	Domain Name Server
DOTAM	DMO Over The Air Management
DTLS	Datagram Transport Layer Security
DTMF	Dual Tone Multi Frequency
eMBMS	evolved Multimedia Broadcast Multicast Service
EPC	Evolved Packet Core
EPS	Evolved Packet System
E-UTRAN	Evolved Universal Terrestrial Access Network
FFS	For Further Study
GBR	Guaranteed Bit Rate
HPLMN	Home Public Land Mobile Network
ICE	Interactive Connectivity Establishment
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
ISDN	Integrated Services for Digital Network
LIP	Location Information Protocol
LTE	Long Term Evolution
MCP	Media Control Protocol
MU	Mobile Unit
N/A	Not Applicable
NAT	Network Address Translation
PABX	Private Automatic Branch Exchange
PDN	Packet Data Network
PIN	Personal Identification Number
PLMN	Public Land Mobile Network

PMR	Private/Professional Mobile Radio
ProSe	Proximity Services
PSTN	Public Switched Telephone Netwokr
PTT	Press To Talk
RFC	Request For Comment
RTCP	Real-time Transport Control Protocol
RTP	Real-time Transport Protocol
SCTP	Stream Control Transmission Protocol
SDP	Session Description Protocol
SDS	Short Data Service
SDS-TL	Short Data Service – Transport Layer
SIM	Subscriber Information Module
SIP	Session Initiation Protocol
SIP/IP	Session Initial Protocol/Internet Protocol
SMS	Short Message Service
SRTCP	Secure Real-time Transport Control Protocol
SRTP	Secure Real-time Transport Protocol
SS	Supplementary Service
STUN	Session Traversal Utilities for NAT
TBD	To Be Decided
TCP	Transport Control Protocol
TIP	TETRA Interoperability Process
TLS	Transport Layer Security
TMGI	Temporary Mobile Group Identity
TURN	Traversal Using Relays around NAT
TX	Transmitter
UDP	User Datagram Protocol
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
URI	Universal Resource Identifier
URS	User Requirements Specification
UTRAN	UMTS Terrestrial Radio Access Network
VPLMN	Visited Public Land Mobile Network
WAP	Wireless Application Protocol
WCMP	Wireless Control Message Protocol
WLAN	Wireless Local Area Network
WMAN	Wireless Metropolitan Area Network
XML	Extensible Markup Language

4 Architecture overview

4.1 Architecture reference

The Critical Communications Architecture Reference model is detailed in ETSI TR 103 269-1 [1]. The architecture and interfaces are shown in Figure 1.

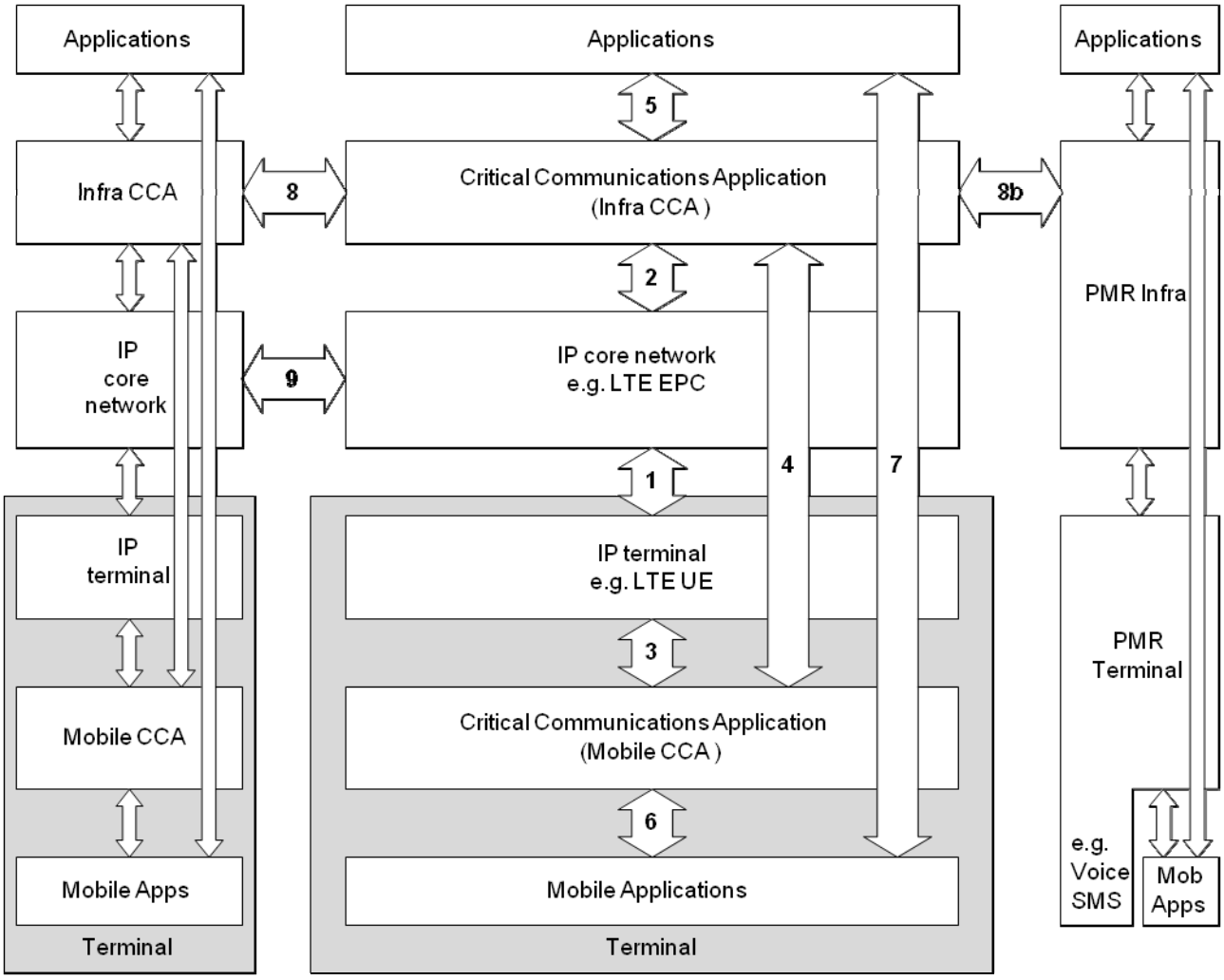


Figure 1: CCS Reference Model

The present document describes the architecture of interface 4 in the reference model shown in the figure.

NOTE: ETSI TR 103 269-1 [1] contains the normative version of this figure.

4.2 Configurations

The functional architecture covered in the present document is presented below.

4.2.1 Single CCA system

The functional architecture for a single CCA system according to the present document is presented in Figure 2.

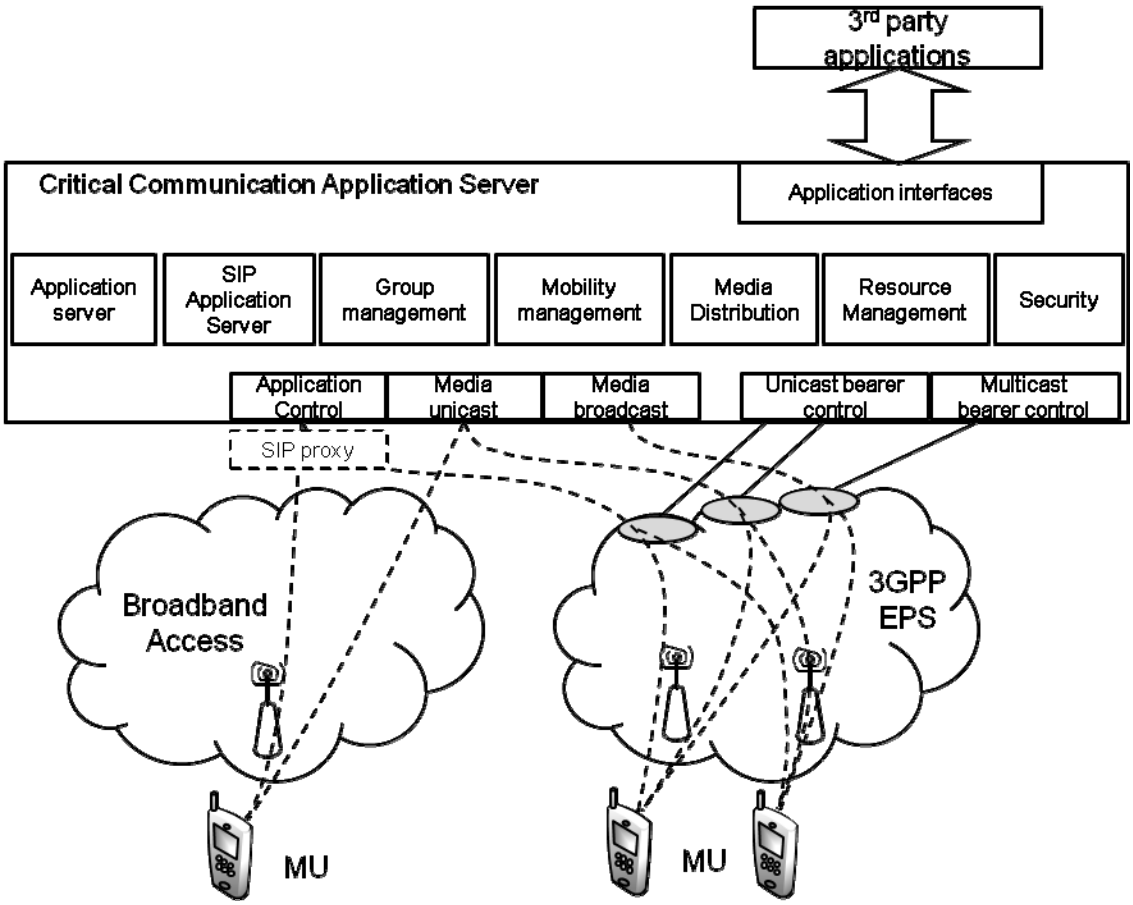


Figure 2: Functional architecture

NOTE 1: The SIP proxy function may be part of the 'application control' interface or may be separate.

The Critical Communications Application Server CCAS has a number of entities responsible for establishing the service and for exchanging individual and group communications with Mobile Units. The various entities of the CCAS use the transport interfaces of the underlying broadband networks to exchange signalling and media with the mobile units. Depending on the nature of the broadband access and of its capabilities and available interfaces, the CCA uses Control interfaces of the broadband network to manage the transport bearers, i.e. to set up and release bearers and to request for specific Quality of Service. This is typically the case when the Broadband access is an LTE Core Network, as illustrated by the '3GPP EPS' in Figure 2. If those Control interfaces do not exist, for instance in the case of WiFi access, or are not available, for instance in the case of an LTE network for which the control interface (Rx) is not made available to the CCAS (for example in a back up commercial operator network), then the CCAS uses transport on default bearers. (Note that in this case, a fully mission critical service may not be available.) This is illustrated by the 'Broadband Access' network in Figure 2.

NOTE 2: The term Critical Communications Application Server is used to denote the set of entities that provide the fixed end part of the CCA, which provide service to the client, or mobile, part of the application in the MUs. The term 'server' does not imply any physical structure or number of physical devices that provide this service.

One CCAS may make use of more than one broadband network. The broadband networks may be of the same type, for example in the case where multiple 3GPP LTE networks are used to provide access to one CCAS. The broadband networks may also be of mixed network types, such as a mixture of 3GPP LTE and WiFi networks which provide service to the same CCAS. Multiple CCASs may also share the same broadband IP access network. Therefore there can be a many-to-many relationship of CCASs and broadband IP access networks.

The CCA provides services to additional third party applications, for example to provide group addressed services, or prioritised access services.

4.2.2 Multi-CCA system

A multi-CCAS system is depicted in Figure 3.

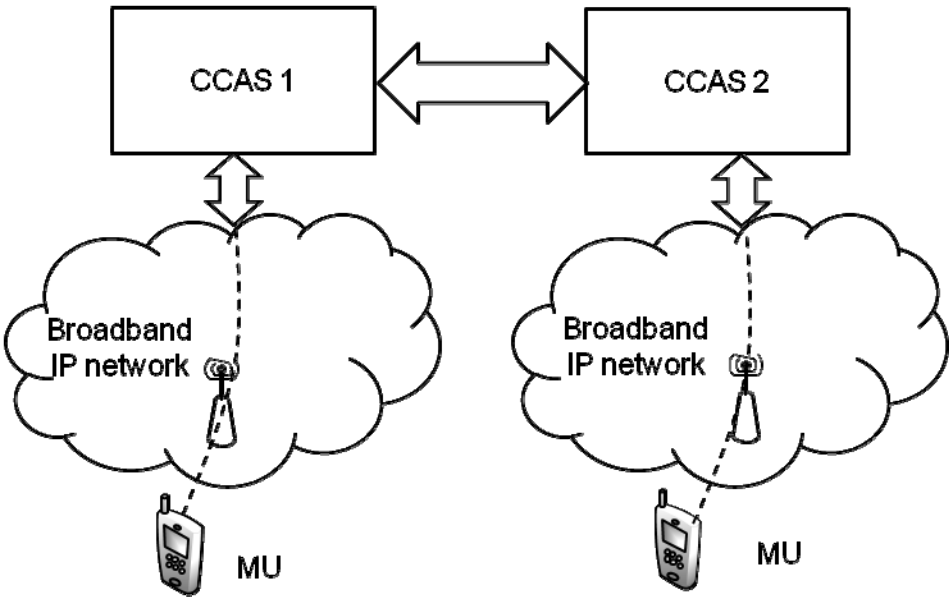


Figure 3: Multi-CCAS system

In the multi-CCAS system each CCAS may be in contact with "home" mobile units, but may also offer access to mobile units that have migrated to that CCAS as visitors. The visited CCAS allows routing of the signalling from a migrated mobile unit to its home CCAS. The same inter-CCAS connection may also support communications between two MUs, each at home in different CCASs.

NOTE 1: Each CCAS may use one or more broadband IP network for access by MUs.

NOTE 2: Multiple CCASs could be using one or more broadband IP networks in common for communication with their respective MUs, and still support the migration behaviour.

NOTE 3: The interface between CCASs is outside the scope of the present document.

4.2.3 Interconnection with legacy

Interconnection with legacy networks is outside the scope of the present document. It will be satisfied by interface 8b (8 bis) in figure 1, and its function is described in [1]. It may be realised by an existing interface from a legacy technology, for example an Inter System Interface from the appropriate technology.

An interconnection with a legacy network may put constraints on services within the CCA, where a call includes one or more parties connected over a legacy interface.

5 Components

This clause describes the functional groups involved in the implementation of the mission-critical PMR services over broadband.

5.1 Mobile unit

The Mobile Unit (MU) is the (mobile) sub-system used by the user to access the mission critical application. The MU contains the client part of the application and one or several modems able to interface with the access sub-systems which provide IP connectivity for the client application.

The access device may be an LTE UE, but the MU may alternatively comprise further access devices such as a WLAN interface based on IEEE 802.11 standard [i.5] and/or various types of IP based wire-line interfaces.

5.2 Access sub-systems

The access sub-systems provide the link between the mobile client application and the infrastructure based application. They are generally based on wireless technologies, particularly the 3GPP Long Term Evolution (LTE) technology, but access may also be based on other type of wireless technologies such as WLAN (IEEE 802.11) or WMAN (IEEE 802.16 [i.6]), or wire-line technologies.

It is assumed that the access sub-systems provide an IP based transport from the mobile unit (MU) to the application server(s). It is also assumed that the corresponding sub-systems provide any ancillary functions required for proper use of IP, e.g. a DHCP function to give a dynamic IP address to the MU where required and a master DNS function to allow the MU to discover the addresses, ports and protocols, etc. of the available CCA server(s) where this is needed.

NOTE: No assumption is made on the use of a specific version of IP, i.e. IPV4 and/or IPV6.

5.3 Critical Communication Application

The CCA comprises a number of functional entities which when combined provide the application service to the MUs. The functional entities are not prescriptive, but illustrate the functionality required in offering the various aspects of the service.

The CCA contains both application related services, for example which provide registration of users, affiliation to groups, call services, etc. and control functionality, for example the ability to set up bearers with the required characteristics to communicate with the MUs and control the levels of priority of the various bearers in the access sub-system, where this control is available. The application level services are described further in the present document. The control functions make use of interfaces provided by the access sub-systems, and whereas aspects of their functionality are described in the present document, the interfaces will be specified by standards relating to the access sub-system, not the application standards.

5.3.1 Access interfaces

The CCA provides a number of access interfaces for both application purposes and for access network control, where available.

The interfaces described in this clause are logical and do not imply a specific physical implementation. For example, a CCAS may employ more than one interface of each type to distribute the load, or may use different physical interfaces for different types of media.

Each interface point will provide appropriate security protection for the packets flowing in and out of the interface (encryption, integrity protection, etc.).

5.3.1.1 Application control interface

The application control interface is the access point for signalling for the implementation of mission critical services over broadband. It is not used for the actual media flows. It provides facilities such as registration with the CCA, affiliation to groups and other such services. It also may provide a SIP [2] proxy function for the other entities of the CCA.

It is recommended that the MU accesses a single (logical) application control interface, which may be accessed at a pre-provisioned IP address within the Access Point Name APN provided by the access sub-system, or may be discovered by DNS search. The physical nature of the interface and relationship between host name and physical interface is outside the scope of the present document; for example a DNS search by the MU for a single DNS access name may be resolved by the DNS into different physical access points at different times for reasons such as for load sharing or redundancy. The access to the application control interface may be limited by Network Address Translators (NATs) and/or firewalls.

NOTE: Use of a DNS is optional for the MU, but DNS search will be necessary if a pre-provisioned IP address cannot be reached (e.g. when NAT is used, or when obtaining service on a foreign IP network).

The MU may be provided with further relevant interface information (IP address, port numbers) for the unicast and multicast media interfaces subsequent to the registration process, e.g. when selecting or initiating a service.

The application control interface may also be used by other applications to provide a single point of access to services.

5.3.1.2 Media unicast interface

The media interface is the access point for media and media control signalling sent to and from the MU in unicast mode. The discovery of its transport address(es) is derived from service initiation dialogue with the application control interface.

Information sent via this interface includes the media which is the content of calls (e.g. speech flow), and also media related signalling (e.g. PTT signalling in a speech call). The interface is bi-directional. It is always used for uplink communications sent from the MU and may be used for downlink communications sent from the CCAS.

5.3.1.3 Media multicast interface

The media multicast interface is used by the CCA to transmit media to a group of MUs simultaneously using only a single resource from the underlying access sub-system. An example of a means of transport is the enhanced Multimedia Broadcast Multicast Service eMBMS offered by 3GPP LTE. The interface may also carry control signalling related to calls.

5.3.1.4 Unicast bearer control interface

The unicast bearer control interface is used by the CCA to set up unicast bearers with the relevant characteristics for control signalling and media exchange. More than one bearer may be established between CCAS and MU at any time, as the quality of service and priority characteristics required for control and various types of media are likely to be different.

5.3.1.5 Multicast bearer control interface

The multicast bearer control interface is used by the CCA to set up multicast bearers for carrying control and media information to groups of users using the broadcast service of the underlying access sub-system. Note that depending on the characteristics of the access sub-system, more than one application layer group may be multiplexed over the same broadcast bearer.

5.4 CCA functional entities

The notional functional entities of the CCAS which, when combined, provide the application service to the MUs, are described in this clause. Please note, as stated earlier, that the functional entities are not prescriptive, but illustrate the functionality required in offering the various aspects of the service.

5.4.1 SIP application server

The SIP application server provides functionality for terminal registration, and additionally provides registration functions for naming, group membership and individual call processes. Once the MU has established an IP connection with the application control interface, it performs a registration with the SIP application server. The SIP application server is then responsible for routing calls and group affiliations to and from the MU.

5.4.2 Mobility management

The mobility management entity tracks the location of both individual MUs and the various communication groups of MUs that will participate in the various services. The mobility management entity tracks the following with respect to individuals and group members:

- To the current CCAS which is providing service to an MU or a group.
- To the current broadband IP network which is providing service between the CCAS and an MU or a group.

- The current IP addresses (and relevant subnets, etc.) of individual subscribers.
- In a multicellular environment which offers multicast services, to the current multicast operating area (e.g. an LTE eMBMS broadcast area).

When a call is to be placed to a target individual or group, the mobility management entity is responsible for indicating the available paths to that target individual or group. This information is used by the resource management entity.

5.4.3 Group management

The group management entity is responsible for the definitions and memberships of communication groups within the CCA. For migrating MUs, the visited CCAS co-operates with the home CCAS. Each group has a defined set of parameters, such as priority level, permitted media types and so on, and also the defined membership list. When an MU makes a request for affiliation to a group to the SIP server, the SIP server checks with the group manager that the MU is allowed to be a member of the group.

5.4.4 Resource management

The resource management entity is responsible for interaction with the access networks for setting up and maintaining the appropriate bearers to and from MUs and groups of MUs in order to carry signalling and media information related to calls.

It makes use of the information provided by the mobility management entity in order to determine the optimum path to transport call related control information and media between participants in a call. If participants can be reached by multiple paths, e.g. unicast and multicast, the resource management entity determines the most efficient means of distributing the information. The resource management entity also determines the available and required quality of service for each of the connections comprising the call, and reports to the application control function if there are insufficient resources of adequate quality to carry some parts or all parts of the call.

5.4.5 Application server

The application server functional entity is responsible for managing call related information. When a call is to be placed, the application server receives the call request from the initiator; determines whether the called party or group is available; requests resources from the resource management entity and determines whether the call should go ahead based on the available resources, and sends appropriate signalling to the parties in the call to initiate the call using the resources provided by the resource management entity.

The application server also provides priority management within calls based on the priority of the users within the groups, and on the call priority requested by each user.

The quality of service and priority may vary according to a number of factors such as media type, individual role, location, etc. and the application server makes its decisions according to these various factors.

5.4.6 Media distribution

The media distribution entity distributes the media within calls from current sourcing party to target party/parties within a call, making use of the various unicast and multicast paths provided by the resource management entity.

5.4.7 Security

The security entity is responsible for maintaining all elements of application related security, to ensure that CCA signalling and media is protected even when carried over otherwise unprotected bearers. Its functions include:

- Authentication of the user upon registration, based on the application level identity of that user.
- Control of encryption of signalling and media flows.
- Control of integrity protection for signalling and media flows.
- Key management for the authentication, encryption and integrity functions.

- Support for end to end encryption between users at appropriate security levels, with appropriate algorithm negotiation and clear override where needed.

6 Reference points and protocols

The reference points are defined with reference to Figure 4 where an LTE EPS provides the broadband IP connection between MU and CCAS.

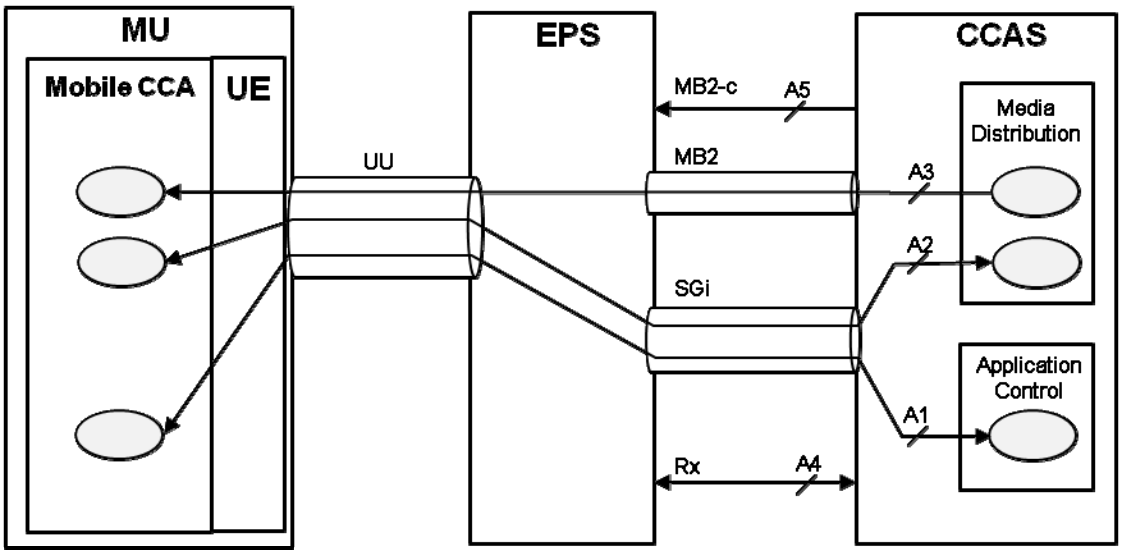


Figure 4: Reference points

A1: is the channel used for communication between the Mobile CCA (which is part of the Mobile Unit) and the Application Control entity of the CCA Server. The protocol over this reference point carries all individual signalling except for the media associated signalling, and may include location information.

A2: carries media and associated signalling flows carried over unicast transport bearers, between the mobile CCA (which is part of the Mobile Unit) and the media distribution entity of the CCAS.

A3: carries media and associated signalling flows carried over broadcast transport bearers, from the media distribution entity of the CCAS to the mobile CCA (which is part of the Mobile Unit).

A4: provides control of unicast bearers for application signalling and media flows.

A5: provides control of multicast bearers for application signalling and media flows.

The set of reference points A1, A2 and A3 corresponds to interface 4, and the set of A4 and A5 corresponds to interface 2 described in [1].

NOTE 1: A future interface, or an extension of an existing interface, may allow flow of location information from EPS (or alternative broadband IP network) to the CCAS.

NOTE 2: A broadband IP network other than an LTE EPS may not offer equivalents of reference points A3, A4 and A5.

6.1 Identities and protocols

6.1.1 Application level identities

Application level individual and group identities take the form of SIP Universal Resource Identifiers (URIs), which have a format of user@application_domain.org. If the network design permits, external calling to and from a user will be possible. See clause 8.

6.1.2 Transport protocols

All transport protocols utilised by the CCA make use of IP (IPv4 [9] or IPv6 [10]), to allow operation over any broadband IP network.

The main signalling channel (SIP) is carried over a reliable transport protocol, such as TCP [11] or SCTP [12]. This enables early re-transmission of signalling messages without forcing short application layer timers. Appropriate higher layer signalling such as TLS [13] and/or DTLS [14] are used to encapsulate signalling flows.

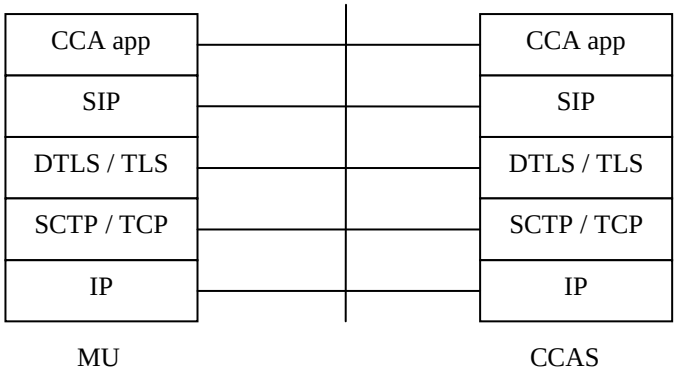


Figure 5: MU to CCAS interface, control plane part

NOTE: SCTP may be run over UDP where NAT traversal is required.

Media and media related signalling are carried over UDP [15] to allow unidirectional flows and to avoid latency issues using TCP. Where protection against lost packets is required, the application provides the appropriate resilience, e.g. by application level retransmissions. Call related signalling and media make use of protocols such as (S)RTP (S)RTCP [16], [17] and carried over UDP/IP.

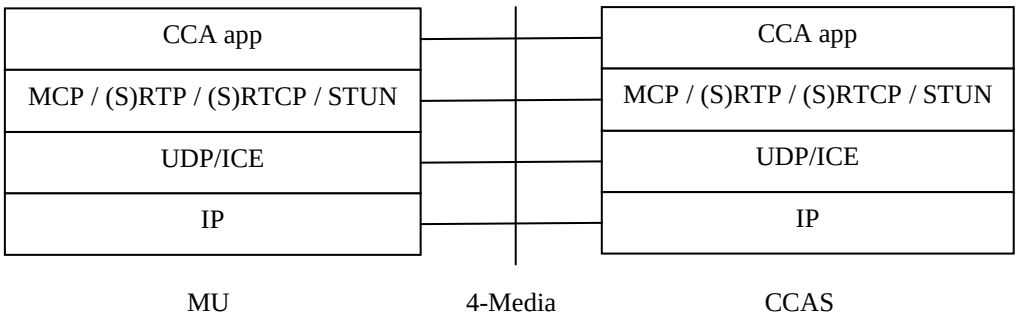


Figure 6: MU to CCAS interface, media plane unicast part

Further protocols such as ICE [18] will be utilised where the path between the MU and CCA requires NAT traversal. The ICE protocol uses STUN [3] and TURN [19] for NAT traversal setup and NAT maintenance.

An MU may have several transport sessions to the CCA active at any one time, differentiated by UDP port number. It is possible that more than one IP address will be used at the CCA. The IP address(es) and port numbers will be determined at session establishment.

Media and media-related signalling can alternatively be transported over a transparent broadcast bearer. In this case, the unicast transport is partly replaced by a simple multiplexing layer.

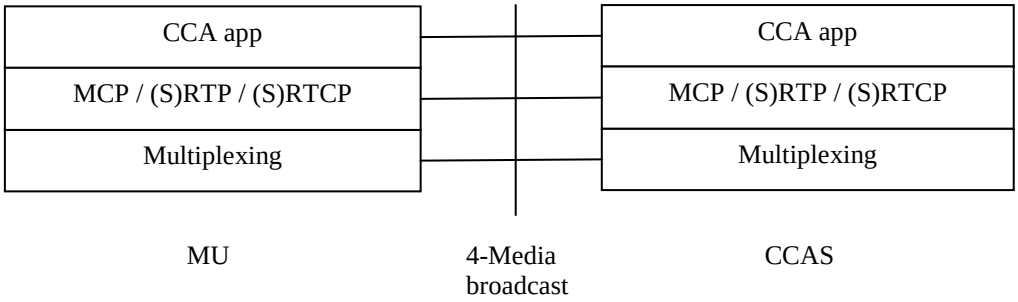


Figure 7: MU to CCAS interface, media plane multicast part

6.1.2.1 Unicast transport

Unicast transport will be provided by all types of underlying broadband IP network. Where an LTE EPS is the underlying network, the CCA makes use of the SGi interface for signalling and media. The characteristics of the bearer may be different for different application flows; for example an application signalling flow will use a non guaranteed bit rate bearer, but a real time media stream (e.g. containing speech) will require a guaranteed bit rate. The characteristics of bearer for different media flows (e.g. speech, video) may be different. The parameters with which the bearers are established is a matter for the application and outside the scope of the present document.

A unicast bearer will always be used to carry information from the MU to the CCAS. A unicast bearer may be used to carry information relating to either individual services or group services from the CCAS to the MU.

The bearers needed for the support of mission critical voice may be set up by the CCA after registration and authentication as required, to join any ongoing calls or to take part in new calls. The strategy adopted by the CCA when setting up such bearers is outside the scope of the present document.

6.1.2.2 Multicast transport

For group addressed media and signalling, unicast bearers may be complemented by a broadcast bearer if the access sub-system provides this. Inbound traffic for media and associated signalling related to group addressed media (from MU to CCAS) is always provided by a unicast bearer, while outbound traffic may be provided by transmission in a multiplex of several channels over a broadcast bearer.

NOTE 1: While the addressing of the unicast channel is specific for a given mobile unit, the addressing of the broadcast channel (TMGI in the case of LTE) is defined on a per group basis. There may be more than one group making use of the same TMGI.

NOTE 2: Although several media flows may be multiplexed on a single broadband bearer, the actual multiplexing policy is left to the implementation.

6.1.2.3 Control of unicast/broadcast transport over LTE

When an MU which is receiving media over a unicast bearer or set of unicast bearers moves into an area where the corresponding media stream(s) are broadcast over a set of broadcast bearers, transmission of this same information over the unicast bearers may be suspended. The CCA may interact with the LTE EPC to release the bearers.

Conversely, when an MU which is receiving one or more media streams over broadcast bearers loses the required level of quality (or anticipates this loss), or moves outside the area where media broadcast is available, it may request that the infrastructure resumes transmission of the corresponding media over unicast bearers. The CCA may need to interact with the LTE infrastructure to establish appropriate unicast bearers if none are presently active between CCA and MU.

To achieve this successfully, the CCA will need to understand the relationships between the areas where media broadcast is available and where it is not available. This may require having knowledge of cell by cell allocation of the multicast broadcast service. The CCA may be provided with this as a static configuration, or may be able to access this information dynamically. The MU may assist by reporting the availability of multicast channels in its serving cells. The CCA will also need to be aware of any provisioning restrictions concerning which MUs are permitted to use any configured multicast service.

The CCA may also decide to move communications between unicast and multicast at any time on the grounds of efficiency.

6.1.3 Network layer protocols

The CCA makes use of SIP [2] for network layer protocols. SIP is used for:

- Application level registration and deregistration.
- Affiliation to groups for group calls.
- Session initiation (individual and group calls).
- Messaging and other such services.

The parameters of each service such as service type, codec type and bit rate are proposed and negotiated using SDP [7] parameters contained in the SIP messages. A separate SIP setup with appropriate SDP is required for each separate session, whether the different sessions carry the same or different media types.

6.1.4 Application layer protocols

Application layer protocols will be based on existing protocols where appropriate and carried over IP.

The application layer protocols may include a periodic 'keep alive' message which firstly ensures continuous information about the status of the MU to the CCAS, and secondly may be used to maintain lower layer transport paths, especially where NAT traversal is used.

NOTE: The MU may not be aware that a NAT is in use unless specifically configured to know this.

6.1.4.1 Pseudo-broadcast protocol

The purpose of this protocol is to provide an information transmission function of background information from CCAS to its served MUs. Two main types of information may be transmitted using this method:

- Service related information: this is information is related to the services provided by the infrastructure, including relevant network status information if it is impacting the provision of some service (for example isolated system).
- Geographically related information: for example, information about neighbouring systems or list of border cells for the current eMBMS area in LTE.

To provide accurate geographically related information, the application using this protocol shall be aware of the geographic location of the MU.

Neither type of information requires fast real time updates.

6.2 Standardised application codecs

6.2.1 Voice Codec

For voice, two categories of vocoder should be considered:

- a CCA code : the choice of this codec is outside the scope of the present document;

- interoperability codecs: TETRA, Tetrapol, P25 Full Rate, P25 Half Rate.

Any CCA codec shall have good intelligibility in noisy conditions.

6.2.2 Video Codec

The selection of a CCA video codec is outside the scope of the present document.

7 Overview of services

The following clauses provide an overview of the services provided and a brief generic description of the signalling involved when applicable.

7.1 CCA system access

Before access to the CCA is possible, the MU takes all necessary steps for registration and any network level authentication so that IP access is possible to the Application Control interface of the CCAS.

When the access is performed through a 3GPP E-UTRAN (LTE) network, this implies the attachment of the mobile (UE) to E-UTRAN, the activation of a default bearer of appropriate QoS in the PDN offering the access to the CCAS, the allocation of an IP address, and the determination of a serving DNS address.

The MU establishes an IP connection to the Application Control interface, secured by an appropriate protocol (e.g. DTLS). The IP address and UDP port number of the interface may be known in advance by the MU by configuration, or may need to be discovered by performing a DNS lookup. If the MU is unable to establish a connection to its home CCAS, it may attempt to establish a connection to a visited CCAS. The IP address, etc. of the visited CCAS may also be known to the MU by configuration, or may be discovered by DNS search.

NOTE: Any mechanism by which the MU decides which visited CCAS to access, for example based on the addressing of the underlying broadband IP network, is outside the scope of the present document.

The MU may use ICE protocols to establish a connection with the CCAS through a NAT. If a NAT is in use, the MU may also use STUN protocols [3] to provide periodic keep-alive messages between MU and CCAS to keep the NAT address translation process alive.

7.2 Service registration

The mobile unit needs to perform an application level registration with the CCAS before receiving any services. The registration may be performed on the Home network or may be performed on a visited network and shall be periodically refreshed. Registration is performed after a secure protocol (e.g. DTLS) has been established between MU and CCAS.

Once the MU has been registered with the CCAS, the secure connection (e.g. by DTLS) is used by the signalling protocols to set up group affiliations and calls as needed. The SIP message exchange which sets these calls and affiliations up will also be used to establish a secure communications path to allow the exchange of media and media related signalling. The security parameters for the secure path which will carry media and media related signalling may be exchanged using the signalling path.

7.2.1 Home network registration

When in the coverage of a wireless network which provides connectivity to an APN allowing access to the Home CCAS, the MU performs a SIP registration procedure with the home CCAS. A mutual authentication process takes place to establish the credentials of the MU. As the result of the registration, the transport parameters of the media interfaces of the home CCAS are known to the MU.

If registration is rejected, the rejection is reported to the user application and the rejection cause is analysed. Depending on the reason for failure, a timer controlled retry may be decided or a permanent barring of access means may be decided.

Home registration is possible as soon as the wireless network used to access the Critical Communication Application provides connectivity to the appropriate APN. While this is usually achieved when the MU is in its Home wireless network (e.g. when its LTE modem is attached to its HPLMN), it can also be achieved when the MU is using a non-Home wireless access network (e.g. when its LTE modem is attaching to a VPLMN, from another country/organization or from another Mobile Network Operator). See Figure 8.

In the latter case, the MU activities and the usage of wireless network resources are controlled by the Home application, based on service agreements with the visited wireless network. A charging agreement may be in force.

NOTE: If the visited access network (e.g. VPLMN) also hosts a CCAS, in this mode of operation the MU does not obtain service from the visited CCAS and therefore does not have direct access to groups hosted by that CCAS, unless these groups are available through an inter-CCAS connection.

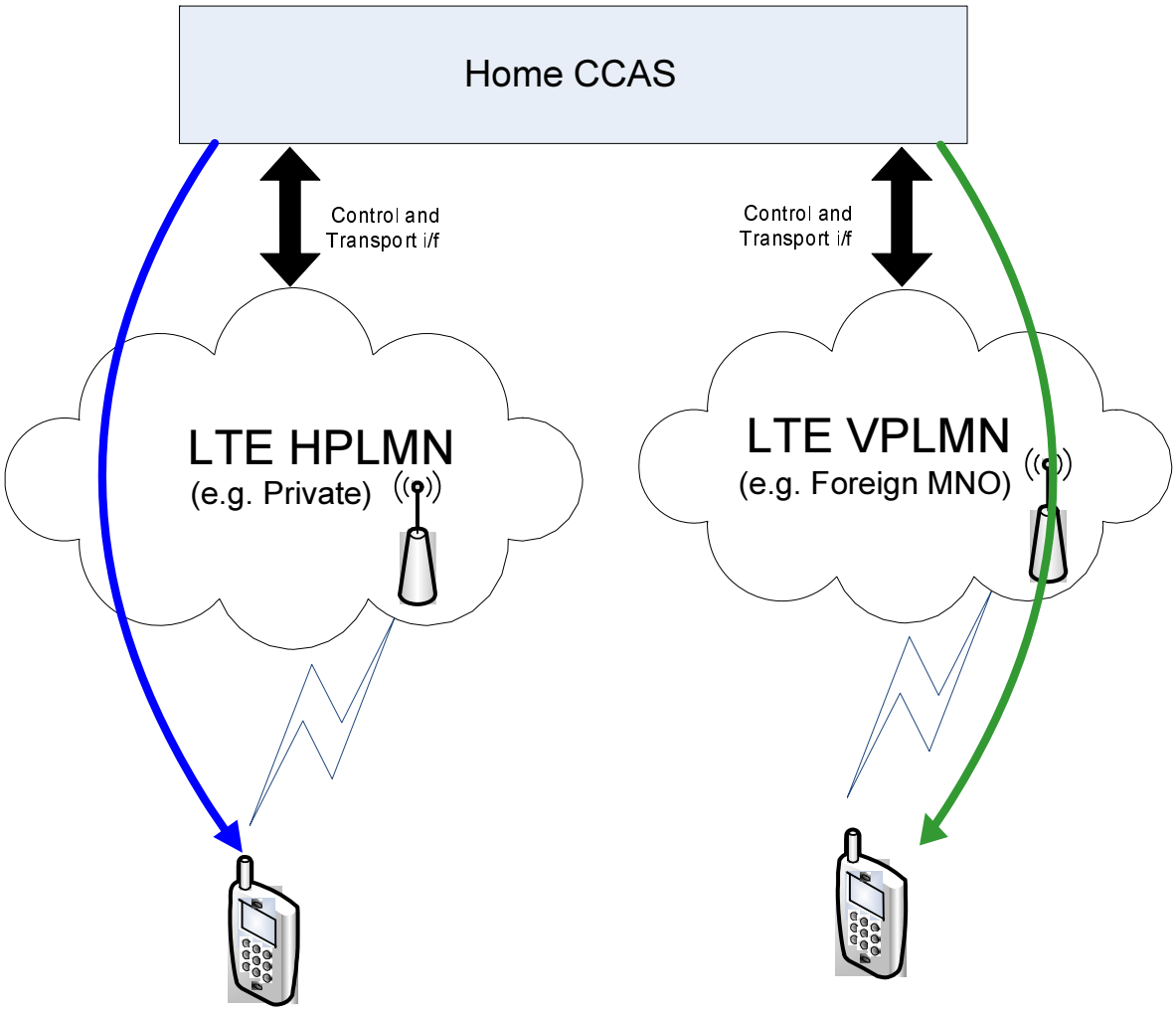


Figure 8: Home registration

7.2.2 Migration registration

When under the coverage of a wireless network which provides connectivity to an APN allowing access to a visited CCAS, the MU may elect to perform registration to the visited CCAS (See Figure 9). The MU may be provisioned with access rights locally, or more typically the visited CCAS may communicate with the home CCAS in order to retrieve service information and authentication parameters. If registration and authentication with the visited CCAS is successful, the MU is marked as migrated in the home CCAS location registers. At the completion of the registration process, the MU is provided with transport parameters of the media interfaces of the visited CCAS. The service level may be different from that available to the MU within its home CCAS.

If registration is rejected, the rejection is reported to the user application and the rejection cause is analysed. Depending on the reason for failure, a timer controlled retry may be decided or a permanent barring of access means may be decided. The behaviour when rejected from a visited CCAS may be different to the behaviour when rejected from the home CCAS.

A MU having performed a migration registration does not have a new identity, but may be member of both groups managed by the non-home application server and groups managed by the Home application server, under control of the visited CCAS. QoS for all the services remains under the final control of the visited CCAS.

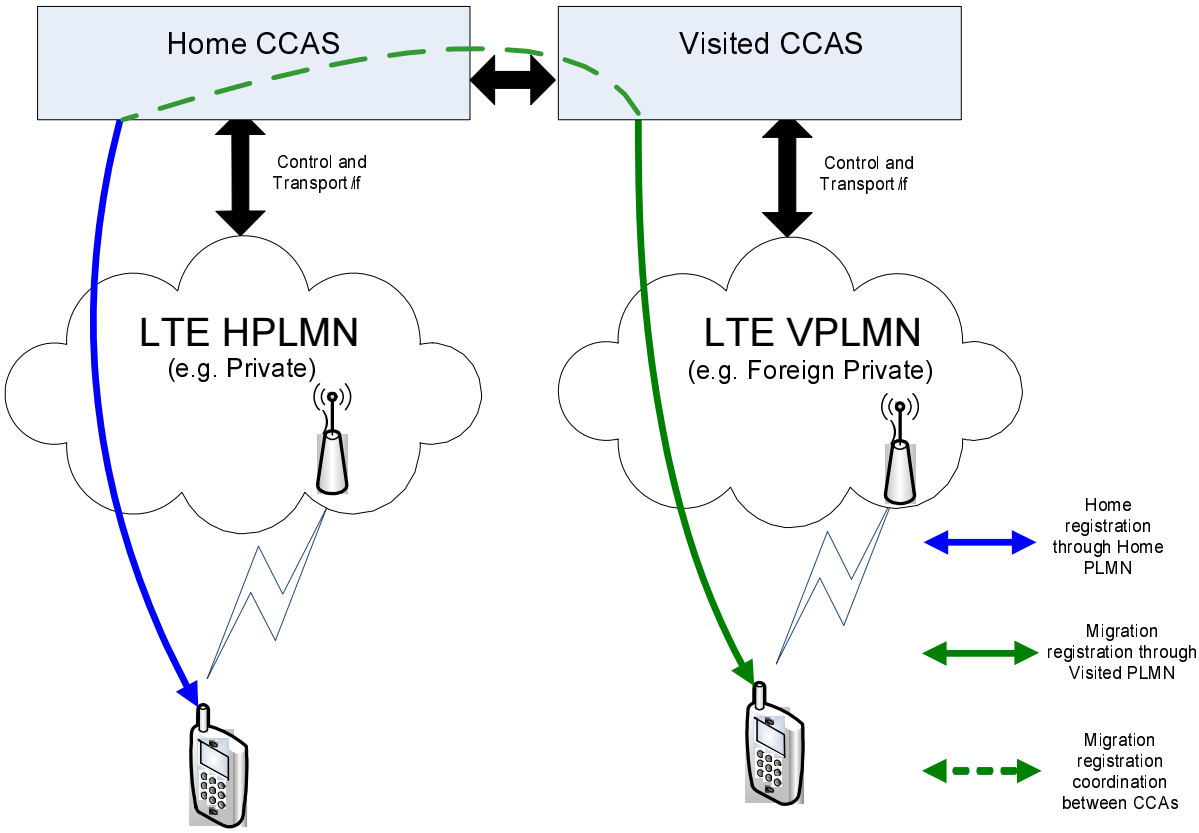


Figure 9: Migration registration

7.2.3 Registration procedure

The registration process uses the registration function of SIP [2]. The MU then provides the CCAS with its relevant capabilities, and the capabilities of the underlying UE where relevant, using the PUBLISH message to ensure that the CCAS can provide the appropriate service to the MU. The MU may register to a SIP/IP Core external to the CCAS, which then in turn registers with the CCAS on behalf of the MU. On completion of the registration and publication process, the MU shall subscribe to event services relevant to the CCA using the SIP Specific Event Notification process [4] (SIP SUBSCRIBE) and subscribing to the 'reg' event package, and may subscribe to other relevant event packages using further SIP SUBSCRIBEs. Following the subscription(s), the CCAS may notify the MU of relevant events using SIP NOTIFY messages.

The case for direct registration is shown in Figure 10. The rejection and re-registration is the process whereby authentication is carried out to the CCAS at the SIP level, as the challenge from the CCAS is returned in the 401 Unauthorised message.

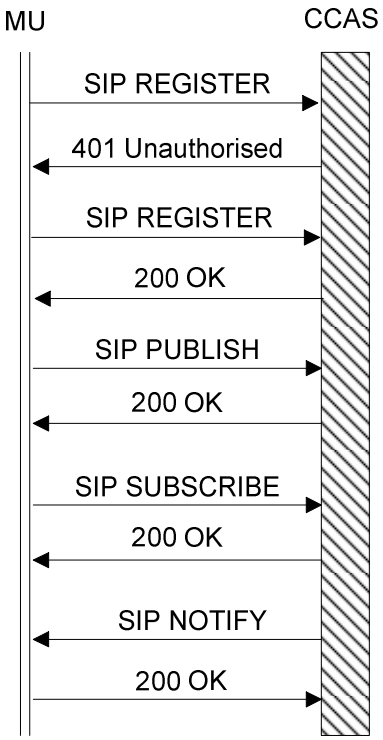


Figure 10: Message sequence chart for registration process

Following the registration procedure, the MU may send a SIP INVITE to a generic address. This is not used to set up a call, but is used to set up a media path which allows a path through a NAT to be set up and maintained. This will expedite call set up procedures when group sessions are not joined until calls are set up.

7.2.4 Periodic update

A periodic registration update procedure allows the maintenance of accurate registration records in the CCAS and purging the database of records corresponding to units which have silently disappeared due to link failures. Timing of the periodic update is determined by a combination of the home and serving CCASs. On initial registration, the MU and serving CCAS agree an expiry time by negotiating the 'expires' time interval in the contact header of the REGISTER message according to [2]. Subsequent REGISTER messages are used to extend the registration period.

The MU may periodically include location information as part of the procedure.

NOTE: The loss of connectivity through one network or one type of network (for example LTE) may not be deemed as an application level loss of connectivity as the mobile unit may re-establish connectivity through a different network or a different type of network.

Additionally, a periodic 'heartbeat' may be required to keep IP paths including NAT alive (see clause 7.1). Application layer location information may also be used for this purpose (but note that if the NAT requires a frequent update, location information may add unnecessary load).

7.2.5 Deregistration

When the MU no longer requires service from the CCA (for example as the result of a user action such as switching off the MU) the MU deregisters from the CCAS. A SIP REGISTER message is sent, with the 'expires' header set to zero (i.e. reducing the lifetime of the current registration to zero).

The MU may send information during the deregistration process to indicate a change to a different state, for example entering into Direct Mode (direct MU to MU communication outside of an infrastructure).

If the CCAS wishes to deregister the MU from the CCA, a SIP NOTIFY is sent to inform the MU that its registration has been terminated.

7.3 Individual streaming communication

Individual communications may be established between two MUs or an MU and a fixed unit or external telephony subscriber, both in incoming or outgoing call mode. The individual calls that do not include an external telephony subscriber may use on/off hook signalling with explicit alerting of the call recipient, or may use direct signalling for automatic call setup. Calls may use a duplex or a half-duplex media flow. The overall call control protocol is derived from IP based digital call control protocol used for IP telephony and is based on SIP [2].

NOTE: The messages that are shown in this clause follow the use of SIP protocols and terminology. For convenience and comparison with other technologies, Q.931 terminology is also shown, with the addition of a D- or U- prefix to denote respectively the Downlink messages (from the CCAS to the Mobile unit) and Uplink (from the Mobile unit to the CCAS).

7.3.1 Individual unit to unit call with on/off hook signalling

This service is analogous to the normal fixed telephony or cellular telephony service. After dialling by the calling party, the calling MU sends a SIP INVITE (U-SETUP) to initiate call set up signalling to the CCAS. The CCAS both acknowledges the set up signalling by returning a SIP TRYING (D-PROCEEDING) message, and forwards the call request as a SIP INVITE (D-SETUP) to the called MU.

The called MU acknowledges the setup using a SIP RINGING (U-ALERT) message, and a corresponding SIP RINGING (D-ALERT) message is passed to the called party. The called MU alerts its user.

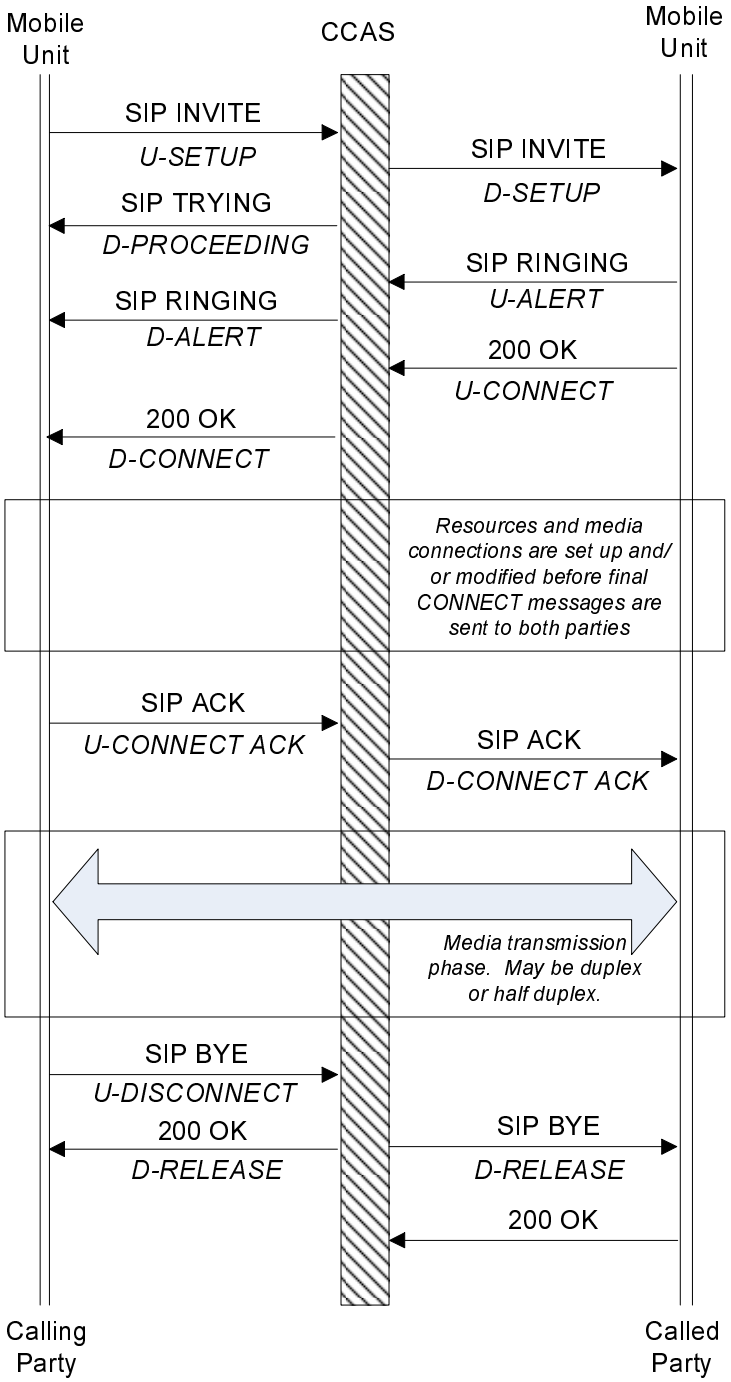
The acceptance of the call by the called user causes the transmission of a SIP OK (U-CONNECT) connection message, and the SIP OK (D-CONNECT) is forwarded by the CCAS to the calling MU. At this point, media paths are made available by the CCAS to carry the call. The SIP ACK (D-CONNECT ACK) acknowledgement message from the calling MU is forwarded to the called party, and this completes the call setup. Media exchange can then be performed in duplex or half-duplex mode depending on setup information.

Additional information may be exchanged during the setup procedure through the exchange of SIP 183 SESSION PROGRESS messages (D-INFO or U-INFO), but the transmission or reception of these messages does not lead to any state transition in the call setup state machines. SIP INFO messages may also be used if needed following the set up completion (200 OK).

The call may be queued, for example whilst waiting for a bearer to become available for either party; in this case, the CCAS will send 182 QUEUED messages, and may send 183 SESSION PROGRESS messages whilst waiting for the bearer to be available. Such messages may be sent to both parties prior to the 200 OK which connects the call.

Both units may request call release by sending a SIP BYE (U-DISCONNECT) call disconnection message, or the CCAS may terminate the call (for example following expiry of an inactivity timer) by itself sending a SIP BYE (D-RELEASE) message.

The sequence of messages is outlined in Figure 11.



NOTE: Either party may end the call; calling party ending the call is shown in the figure.

Figure 11: Message sequence chart for a successful individual unit-to-unit call setup

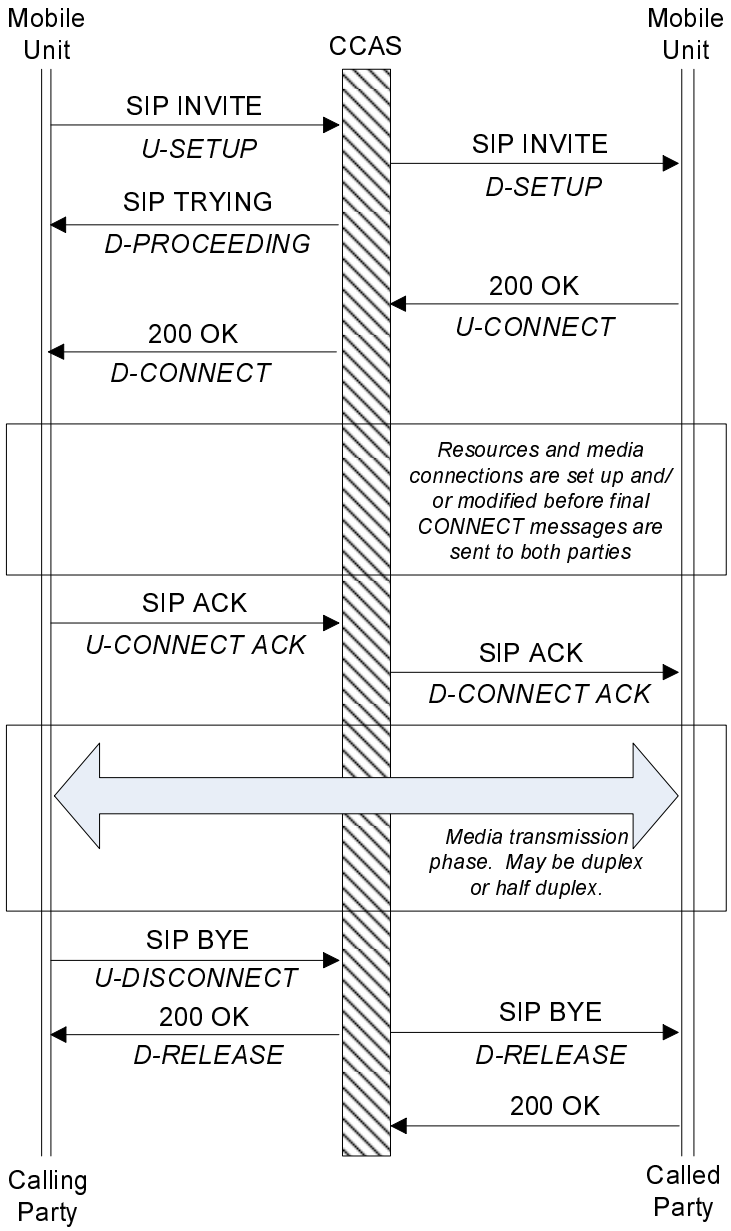
7.3.2 Individual unit to unit call with direct signalling

It is possible to shorten the call setup time for individual call by bypassing the alerting step and connecting directly as soon as the called unit is reachable. This also allows the user experience to be more similar to normal (unacknowledged or unconfirmed) group call.

In this case, the alerting step of sending SIP RINGING (U-ALERT and D-ALERT) is omitted leading to the shorter message sequence outlined in Figure 12. However, the 200 OK (CONNECT) messages are retained in order to make sure that media capabilities of the calling and called parties (for example codecs) are properly matched before the setup is completed.

Call queuing and call release are similar to the previous case.

The sequence of messages is outlined below.



NOTE: Either party may end the call; calling party ending the call is shown in the figure.

Figure 12: Message sequence chart for a successful individual unit-to-unit call setup with direct signalling

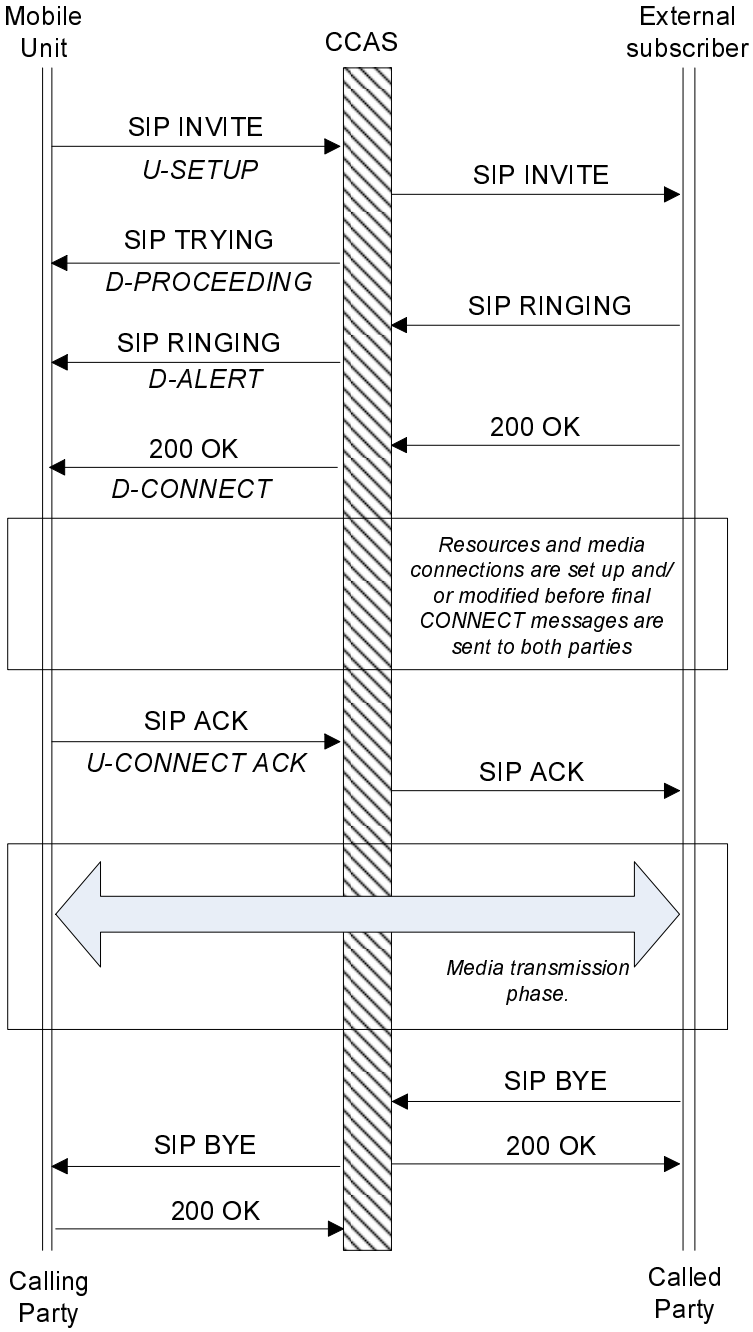
7.3.3 Individual unit to telephony call (outgoing call)

Mobile units may perform calls to external subscribers (including emergency addresses) using fixed telephony interface. Only the message flows for a SIP based interface are standardised, but legacy ISDN interfaces may be supported through additional (non-standardised) gateways.

Figure 13 presents an example of the sequence of messages exchange for outgoing call setup and release with an external telephone subscriber.

NOTE 1: Support of call to an external subscriber may be subject to restrictions. These restrictions may be general or a per subscriber basis. Dispatcher controlled bypass of these restrictions may be performed using call forwarding and call transfer supplementary services, which can replicate a Call Authorised by Dispatcher supplementary service, as used in some narrowband technologies.

NOTE 2: Media transmission to an external subscriber may imply several transformations of the media, including encryption/decryption of end-to-end encrypted media and vocoder adaptation as required.



NOTE: Either party may end the call; called party ending the call is shown in the figure.

Figure 13: Message sequence chart for outgoing call to an external subscriber

DTMF signalling may be carried in SIP INFO messages during the call.

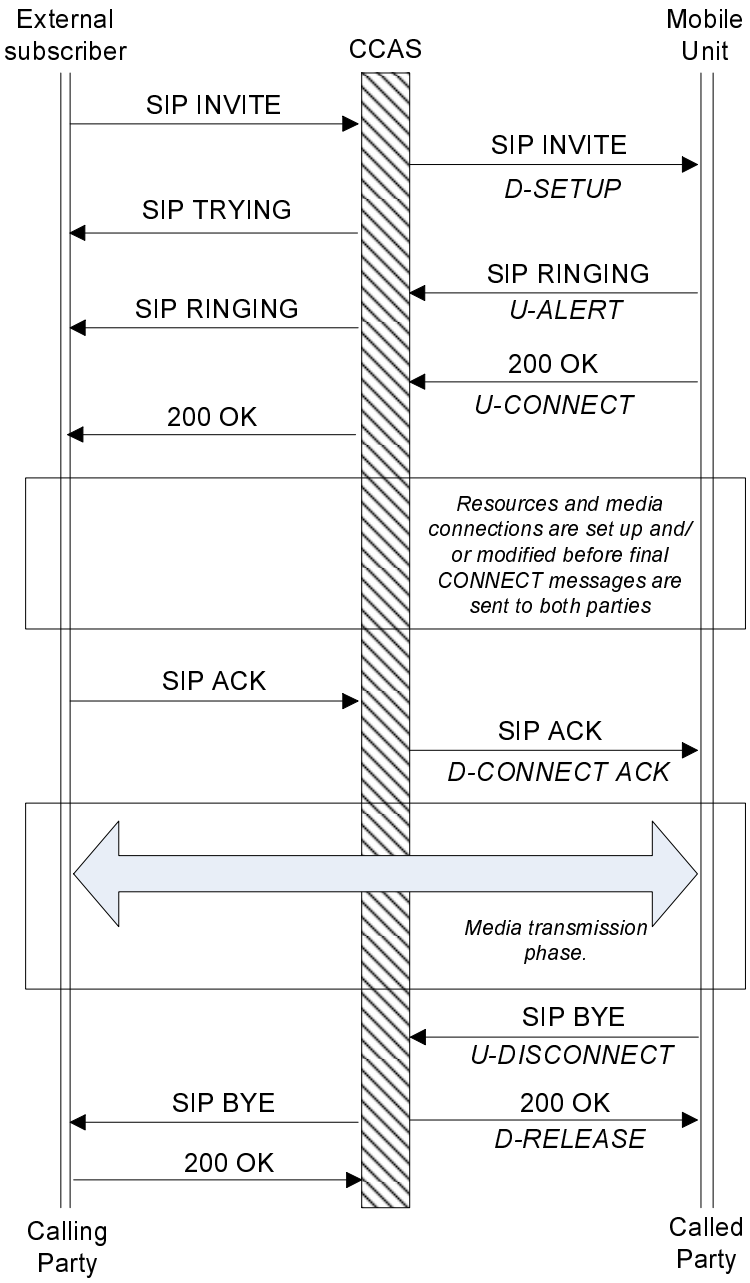
7.3.4 Individual unit to telephony call (incoming call)

Mobile units may receive calls from external subscribers using a fixed telephony interface. As indicated above, only SIP based message flows are standardised, but legacy ISDN interfaces may be supported through additional (non-standardised) gateways.

Figure 14 presents an example of the sequence of messages exchange for incoming call setup and release with an external telephone subscriber.

NOTE 1: Support of call from an external subscriber may be subject to restrictions under infrastructure control. These restrictions may be general or a per subscriber basis. External calls may be diverted to a dispatcher, who may permit a call to be forwarded to the MU using the call transfer service (see clauses 7.11.5 and 7.11.9). This provides an equivalent of a 'Call Authorised by Dispatcher' function as provided in narrowband technologies.

NOTE 2: Media transmission to an external subscriber may imply several transformations of the media, including encryption/decryption of end-to-end encrypted media and vocoder adaptation as required.



NOTE: Either party may end the call; called party ending the call is shown in the figure.

Figure 14: Message sequence chart for incoming call from an external subscriber

DTMF signalling may be carried in SIP INFO messages during the call.

7.4 Group streaming communication

The group call service is a point to multipoint service, where one MU transmits to a group of MUs who receive the transmitted information almost simultaneously (subject to small variations in delay of the media transport service). In the normal case, group members affiliate to the group before placing calls. This allows the CCA to prepare to manage resources for the group in real time, even whilst calls are not taking place, and ensures the best possible response time for the group call service. It allows permissions to take part in the group to be determined at affiliation time to avoid any delays due to security procedures at call set up time, and allows parameters for the call (e.g. codec types) to be agreed in advance.

There are four steps to consider in a group communication process:

- Provisioning.
- Affiliation.
- Session join.
- Call start.

The timing of these steps allows slight variations in the service to be offered. The process for each is described in the following clauses of the present document.

An MU may participate in more than one group call at the same time. Different calls will be distinguished by different session and/or call identifiers. Within the same group, different media types may be exchanged in different calls at the same time as each other. Under some circumstances more than one instance of the same media type may be sent to the group (e.g. a partial pre-emption scenario where both the originator and pre-emptor are allowed to transmit, or when multiple group members are sharing video for situational awareness purposes within the same group). The MU may also be a participant in more than one call of the same media type within different groups. Likewise, the MU may be in a different call of a different call type (e.g. in an individual call) at the same time as in a group call. Depending on the capabilities of the MU and the configuration of the CCA, the second and further calls may be offered to the MU by the CCA for the MU to respond before receiving media, or media streams may be directly set up. The CCA may decide to present or withhold lower priority calls than the current call when the MU is sending or receiving information during a call, or in between transmissions during a call. The MU may present the call media from the second and further calls to the user depending on its capabilities and configuration. The MU's decision on whether to indicate that the additional calls are taking place, or to present the media to the user, may depend on whether the MU considers itself to be within a current call (which may include being within the call hang time between transmissions or at the end of a call).

An MU may request to leave a call in progress by sending appropriate signalling to the CCAS. An authorised MU may be able to clear a call in progress for all group members.

The various procedures for taking part in mission critical group streaming communications are described below, together with some closely related services.

Group calls may be unacknowledged, where the calling user does not receive specific feedback about receiving participants in the call, or acknowledged, where feedback from some or all recipients may be used by the CCA in setting up the call, and where some or all of this feedback may be relayed to the calling party.

A group communication may be setup by an external subscriber (or including an external subscriber) using SIP signalling. The signalling to the called parties is identical to the signalling used for a normal call setup. Acknowledged group call is not supported in this case.

7.4.1 Broadcast and system call

A broadcast call is a group communication to a given group where the receiving parties are not allowed to request transmission. Thus, the authorisation to request transmission shall be indicated in an information element of the call setup or TX Granted message.

A system call is a communication that shall reach a larger subset of mobile units than a single group, whilst being of a broadcast nature. The group identifier used for a system call is generally provided to the corresponding mobile units at group affiliation time and may be related to the organisation the user is belonging to and/or the groups to which it has affiliated.

An emergency call may be automatically linked to a broadcast or system call within an area.

7.4.2 Group communication coverage

The coverage of a group communication may be potentially unlimited, i.e. extended to the location of every group member, including members migrating in all or part of any visited networks, or potentially unlimited but only inside the home network, or limited inside a given geographic area defined by a subset of the access sub-networks. A group member may only make and receive group communications if that group member is inside the permitted coverage.

There is an exception to this. When the mobile unit setting up the call is in an emergency condition, but is not within the nominal permitted coverage area, the call can be setup over an area which contains at least the nominal permitted coverage area and the (normally non-permitted) cell where the mobile unit is located. As a matter of policy, the infrastructure may decide to further extend the coverage to some cells neighbouring the one where the mobile unit is located, or to other cells pre-defined for inclusion in the emergency call.

NOTE: The purpose of the coverage restriction is to save network resources (by not using network resources where unnecessary) and human resources (by not disturbing users which are far from an event and unable to provide any help). However, the implementation of coverage restriction should be smart enough to avoid a bad user experience with ping-pong behaviour at the edge of the communication coverage.

An MU may also request that a group call is placed within a local area only by inclusion of an appropriate parameter in the call setup request. The CCA configuration will determine the actual coverage when such a request is received. The definition of this local coverage is outside the scope of the present document.

7.4.3 Group provisioning

The group(s) to which an MU may request affiliation are expected to be provisioned in the database of the terminal. The configuration may be programmed statically or may be updated using the individually addressed Dynamic Group Number Assignment supplementary service (DGNA). The CCA may accept or deny the affiliation(s). The affiliation to some group(s) may trigger further affiliation(s) initiated by the CCAS to group(s) to be used for announcement or system calls or for emergency related group communications.

NOTE: The CCAS may also direct the MU to affiliate to certain groups which are not provisioned in the database of the MU (either statically or by DGNA). It is possible that CCA directed affiliation would only be used in some instances, with no MU requested affiliations.

It is possible that in a simple system, a group could be joined by the user simply entering the group name or identity in the terminal and performing an affiliation to the group by this means, but permission for access to the group will be determined by the CCA.

Groups may be provisioned in the MU with certain parameters which determine how the MU will behave in those groups. In particular, for the purposes of scanning or reception of broadcast calls, groups may be provisioned as receive only. A receive only group may be allowed to operate without a specific group affiliation process, as described in clause 7.4.4 (for example, a default broadcast group for an organisation), or may still require affiliation (for example a scanned supervisory group related to the MUs current role).

The CCA may also support MUs who are provisioned with no groups. In this case the CCAS may determine which group or groups that the MU should use, and may affiliate the MU to those groups.

7.4.4 Group affiliation

The group service affiliation procedure allows the MU and infrastructure to negotiate membership of the MU to various groups. The affiliation process supports both MU-requested group affiliations and CCA-directed affiliations. In any situation either MU-requested, or CCA-directed, or a combination of both affiliation processes may be supported. The group affiliation process is performed by one or more SIP procedures described in clause 7.4.5. Group membership achieved by affiliation is necessary before an MU is able to transmit to a group. If an MU needs to urgently send information to a group to which it is not affiliated, it shall carry out the affiliation procedure before attempting to send information. The CCAS will reject requests to transmit information to a group if the MU has not previously affiliated. The CCA may also reject a request by the MU to be affiliated to one or more groups.

Group affiliation may be managed as a combined procedure with the service registration or as a separate procedure.

Certain groups may be provisioned as receive-only groups for an MU. The MU may not need to carry out an explicit affiliation procedure in order to affiliate to those groups. If the MU does carry out an explicit affiliation process, the response from the CCAS will indicate that the group is receive-only, and that the MU is not allowed to transmit to the group. Such groups may be used for such purposes as organisation wide broadcast calls, area related broadcast calls and suchlike.

The CCA may allow an MU to transmit an emergency call to a specific address to which it has not explicitly affiliated. This address will be known to the MU by configuration.

There shall be a default address (a system wide address), and all MUs shall be capable of receiving transmissions to this address.

The CCA may change the group affiliations of an MU by the CCAS initiated procedure, both to affiliate the MU to further groups and to de-affiliate the MU from any previously affiliated groups. The CCA may make the changes in response to movement of the MU to different geographic areas.

NOTE 1: There is no theoretical limitation to the number of groups to which a MU may simultaneously belong and thus no limitation of the number of simultaneous group calls that a MU may simultaneously be part of. Therefore, scanning is provided natively and does not require any specific protocol (although the CCA may prioritise the media flows and restrict the number of media flows sent simultaneously to the same MU). Any such restriction may be made with knowledge of the capabilities of the terminal.

NOTE 2: The provisioned capabilities of the MU may be changed as a result of configuration, and the capabilities of each MU may be also be configured in the CCA rather than learnt by a specific message exchange. The configuration process of the MU may take place independently by an appropriate management process (which may use the same bearers as are used by the CCA). The means for loading the configuration into the MU and CCA are outside the scope of the present document.

When the MU wishes to not participate in further communications within a group, it shall perform a de-affiliation procedure. This is achieved by a SIP procedure.

7.4.4.1 Relation between group affiliation and mobility

When the geographic location reported, for example by the signalling channel heartbeats, indicates that the MU has moved outside a designated coverage are for a group (see clause 7.4.1.2), for example due to a change of jurisdiction, the network may modify or suspend the group affiliations of the mobile unit. This may be considered as a special case of CCA initiated group affiliation triggered by MU location reporting.

When the MU migrates to a visited CCAS, it may be affiliated to its home groups, but it may also request or be directed to affiliate to groups that are locally defined in that visited CCAS in order to be able to interwork with other local MUs. An MU may also be permitted to affiliate to a group that is home in a different CCAS, even while the MU is registered in its home CCAS.

7.4.5 Session join and call start

A group session is joined by an exchange of SIP signalling between MU and CCAS. Once an MU has joined a session, only media control signalling is required to perform call transactions.

An MU may join more than one session within the same group in order to send or receive different media types within that group. Separate media control state machines are used for each session, such that transmission control is independent for different media types.

If a session join is combined with the affiliation process, calls may be started using media plane signalling, providing an 'open session' (or 'chat model') call service. In this case the session remains open until explicitly cleared by further SIP signalling. Alternatively, the session join may be combined with the call setup process, and ended at the end of call, providing more of a 'discrete call' service where a call and a session are coincident. A parameter in the SIP/SDP signalling which joins the session may indicate whether an MU is requesting to set up a call at the same time as joining a session.

A call set up request may be rejected by the CCAS, either when made with a request to join a session, or when a session is already joined. If a request is rejected together with a session join, a SIP 4xx rejection response may be sent. If the session is already joined, an MCP Reject may be sent. The reason codes may include 'not authorised' if the MU is not authorised to send calls to the group (or the group is receive only) and 'no other group members' if the MU is the only participant currently affiliated to the group. The rejection may also indicate reasons such as capacity limitations.

A call setup request using either SIP signalling or media control signalling may include parameters with which the calling party wishes to determine the characteristics of the call, such as call priority (see clause 7.7) or selected area (e.g. local/wide area).

At the end of a call, the CCAS may decide whether to continue or end the session. The CCAS may decide to maintain a session for a period, considered to be a 'session hang time' following completion of a call, but may then decide to end the session if no further calls take place by the end of the session hang time.

NOTE: The CCAS determines the lifetime of a session, and when the session starts and ends. A new session may be started when a new call is set up, or the CCAS may decide to maintain one session permanently for one group (or for one media type within one group, etc.) and simply join MUs to that session either at affiliation time or at the start of a call.

7.4.6 Late entry

The late entry function allows the setup of a group call to a called party when the initial setup message has been missed, for various reasons such as radio conditions, mobility or late affiliation to the corresponding group.

The late entry function is implemented through appropriate repetition of the corresponding call set up message, triggered by the relevant events.

7.4.7 Message exchanges related to group call

7.4.7.1 Group subscription and affiliation

Group subscription and affiliation are achieved by exchange of SIP messages. The MU achieves subscription by sending a SIP SUBSCRIBE in order to express an interest in a group and to receive relevant events relating to the group's operating state, according to a defined event package. The MU may subscribe to an individual group, or send separate SUBSCRIBEs to several groups individually. The MU may also send a SUBSCRIBE containing a list of groups in order to be subscribed to several groups at the same time.

The SUBSCRIBE message will indicate whether the subscription is also a request for affiliation, i.e. whether the MU is requesting to join sessions automatically when calls are set up and to receive or send media in those calls, or to simply receive events related to the group without joining sessions and receiving media streams.

The CCAS will respond to the SUBSCRIBE with a NOTIFY response, which is used to inform the MU about relevant parameters for the group, and may include parameters such as media characteristics. If the MU subscribes to a list of groups, the NOTIFY response from the CCAS may indicate the list of groups to which the MU is affiliated; this list may omit groups requested by the MU if the affiliation is refused, and may include additional groups if the CCAS wishes to affiliate the MU to further groups that were not requested by the MU.

The MU may change its subscriptions to groups at any time by sending new SUBSCRIBE message(s). If a list of groups is used, the MU shall send the complete list of groups to which it now wishes to subscribe, and will receive a complete list back from the CCAS which indicates to which groups it has successfully subscribed.

The SUBSCRIBE may be omitted if the MU also joins a session at affiliation time. However in this case, the MU will not be notified of events relating to the group, unless is also sends a SUBSCRIBE to the CCAS.

The subscription to the group allows the MU to receive notification of relevant events within the group which are both non-call related (e.g. relating to affiliations of other users) or call related (e.g. relating to current membership of a group within a call).

Subscription and affiliation is shown in Figure 15.

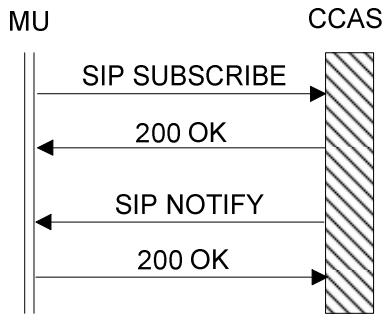


Figure 15: Message sequence chart for subscription and affiliation

7.4.7.2 Joining a session

To join a session, a SIP INVITE is sent. This may be subsequent to the subscription described in clause 7.4.6.1. The INVITE may be sent by MU or CCA depending on the scenario.

If the MU has not affiliated by use of a SIP SUBSCRIBE, the SIP INVITE will cause the CCA to affiliate the MU to the group for the duration of this session. The MU shall send a SUBSCRIBE if it also wishes to be notified about events in the group.

The sequence of messages for session join following affiliation using the SUBSCRIBE process is shown in Figure 16.

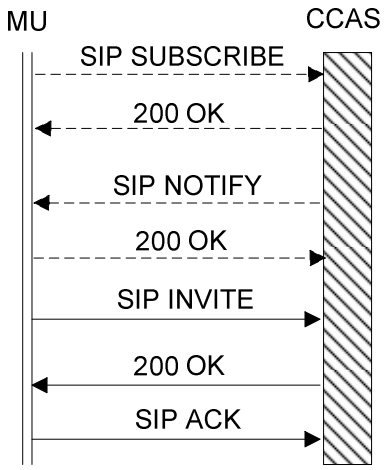


Figure 16: Message sequence chart for joining a session

Note that the optional SUSCRIBE and corresponding NOTIFY may also be sent following the INVITE, instead of prior to it as illustrated here.

The CCA may also join the MU to the session, for example if the MU has already performed a SUBSCRIBE to the group in order to affiliate. This may be done at the start of the call, or in advance of the start of a call. If the MU has not previously used the SUBSCRIBE mechanism to affiliate to the group, the CCA initiated session join shall also make the MU consider itself to be affiliated to the group for the duration of the session. Note that in this latter case, the MU will not receive events related to the group unless it also subscribes to the group.

The sequence of messages is shown in Figure 17.

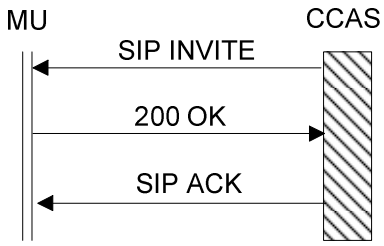


Figure 17: Message sequence chart for infrastructure initiated session join

Session join requires two way signalling. A unicast bearer (previously established at registration) is used between the CCAS and the MU in order to carry this signalling. However if the CCAS has directed the MU to a multicast bearer with the objective of receiving calls and call related signalling, the CCA may start a call and include MUs receiving on this bearer without explicitly joining the MU to the session. In this case, the MU may consider itself to be temporarily attached to the session. Note that each MU still has the a separate non-GBR bearer for mobility and other individual signalling functions, and therefore a path does exist for any further signalling that the MU needs to send outside the call.

7.4.7.3 Non acknowledged group communication

The call setup sequence for normal group communication is similar to unit to unit call with direct signalling as the called parties do not answer to the call setup message but proceed immediately to a reception state.

NOTE: As the called parties belong to the same group as the caller, it is assumed that they have negotiated compatible capabilities at group affiliation time, so that there is no need for any negotiation that could impair setup time due potentially unlimited number of group members.

7.4.7.3.1 Group call combined with session join

If the group members are not currently included in a session for that group, the calling party sends a SIP INVITE to join a session for the group, which includes a parameter indicating that the INVITE also is a request to start a call, and to request transmit permission. The CCAS will send a corresponding INVITE to the called group members to join them to the session to allow reception of the call. The final SIP 200 OK from CCAS to MU may give the calling MU transmit permission, although a following explicit Media Control Protocol message may be used. Once the calling MU has received transmit permission, it starts to send media. Reception of this media causes receiving parties to unmute and play the media stream to their users.

The message exchange where receiving parties use unicast bearers is shown in Figure 18.

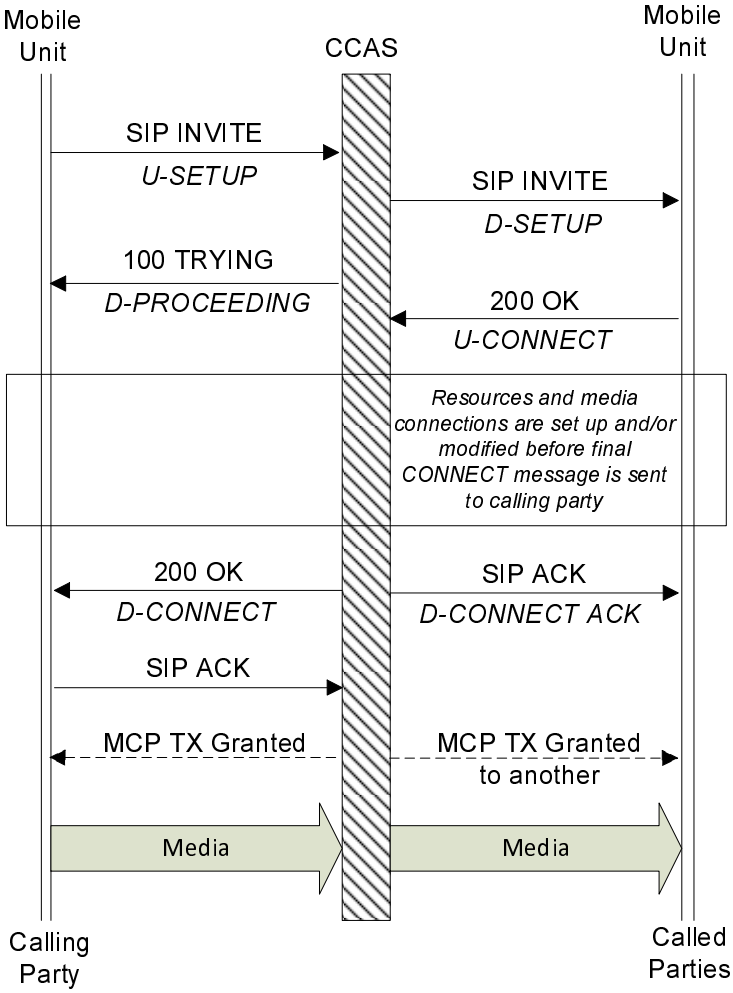


Figure 18: Non-acknowledged group call setup including session join, using unicast bearers

The message exchange where receiving parties use multicast bearers is shown in Figure 19. The MCP 'Setup' message will contain the parameters relating to the media type (e.g. codec type and rate, etc.). An MU that receives the start of the call on a multicast bearer will not join the session at this time, but will join the session if it moves from the multicast to a unicast bearer (e.g. due to movement outside the coverage area of a multicast bearer).

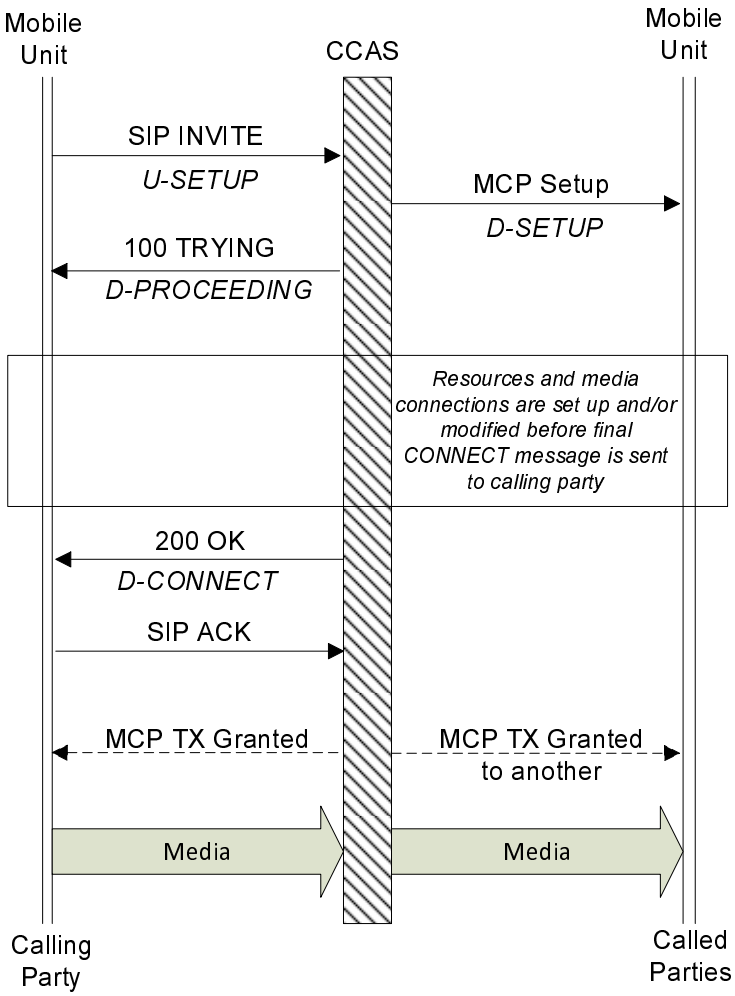


Figure 19: Non-acknowledged group call setup with multicast bearer for receiving parties

If the calling party's request to place the call is rejected, the CCAS will send a 4xx (client error) message to the calling party instead of the 200 OK message; alternatively if the call is rejected or cleared by the CCAS following the 200OK, but before the optional MCP 'TX Granted' message has been sent, a SIP BYE can be sent by the CCAS to clear the call. If the MCP 'TX Granted' has been sent, but the CCAS then requires to terminate the call, an MCP message removing transmit permission shall be sent prior to sending the SIP BYE.

If the MU moves from a multicast to a unicast bearer whilst the call is continuing, for example due to a change in location that causes the MU to move outside the coverage area of the multicast bearer, the MU shall send a SIP INVITE to the CCAS to join the session and to restore the call. If the CCAS decides to withdraw the multicast bearer serving the MU, the CCAS may initiate the move to a unicast bearer, and to join the MU to the session by sending a SIP INVITE to the MU. If the MU moves from a unicast bearer to a multicast bearer during the call, the MU will consider itself to be still attached to the session; however the MU shall send a re-INVITE or UPDATE which removes the unicast media stream. If the MU should move back to a unicast bearer (having previous established a unicast bearer and then moved to a multicast bearer), the MU shall send a re-INVITE or UPDATE to re-establish the media session, or if the move was due to the CCAS withdrawing a multicast bearer, the CCAS shall send the re-INVITE or UPDATE to re-establish the media session. At the end of the session, the CCAS will release any sessions from MUs that have transferred from unicast to multicast bearers by sending a SIP BYE (individually) to those MUs.

If the CCA is unable to start (or join MUs to) the session immediately, for example because of resource limitations, or because a critical group member is occupied in another call, and so needs to delay the call start, the CCAS may queue the call. In this case, the CCAS will complete the SIP signalling to set up the media paths, but will not provide the calling party with transmit permission in the 200 OK message. The CCAS may immediately send an MCP 'Queued' message to the calling party to allow the user to be informed of the queued condition. Further MCP 'Queued' messages may be sent to update the calling party of the status of the queue. When the queuing condition clears, MCP 'TX Granted' signalling is sent to the calling party to allow the call to commence.

The CCAS may adopt various strategies in deciding whether to queue a call: it may decide to queue until one or more specific users is able to hear the call, and then proceed even if other users do not have available resources; it may decide to queue until all users can receive the call, or it may even decide not to queue a call and simply start the call with whichever MUs are able to receive the call.

The case for a queued call where called parties receive the call using unicast bearers is shown in Figure 20.

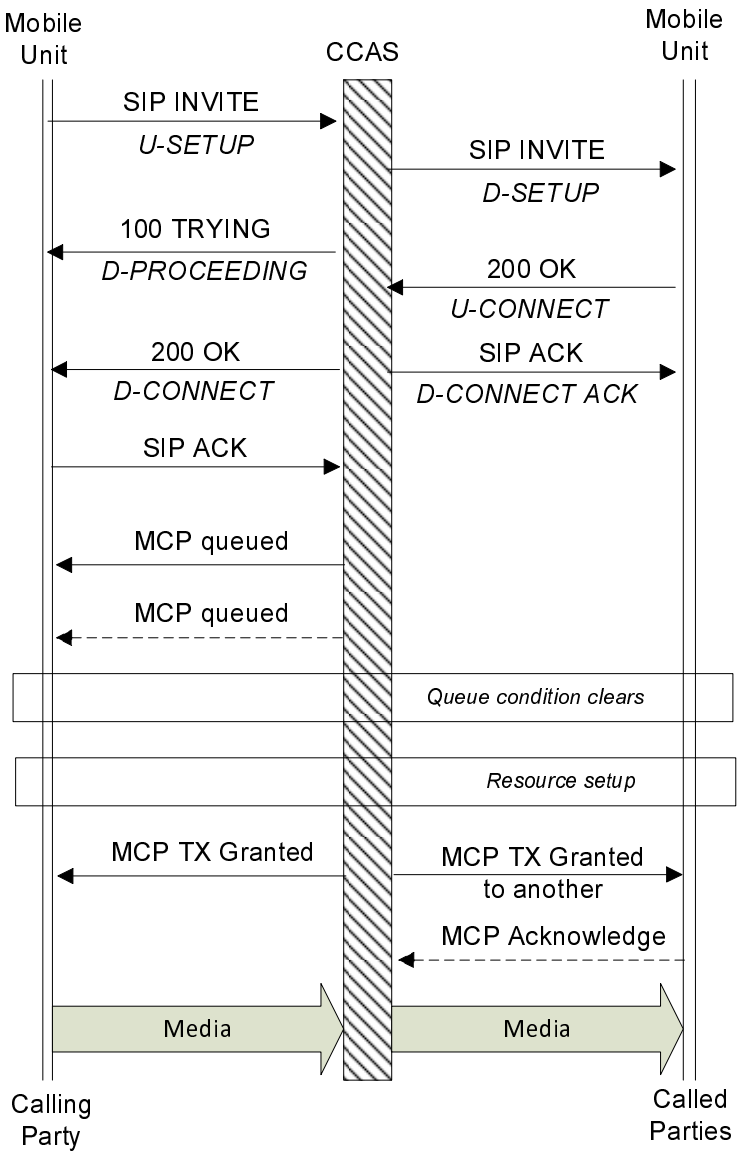


Figure 20: Non-acknowledged group call at session join time with call queuing

The case where called parties make use of a multicast bearer is similar, i.e. the called parties are signalled with the appropriate MCP signalling at the start of the call once the queue condition has cleared.

If a second party attempts to set up a call whilst the calling party is queued, the CCA will reject the second caller, unless it is of a higher priority. In that case, the original calling party may be rejected, and the new calling party placed in a queue instead (depending on the relative priority to other ongoing communications).

In the event of a collision between two parties, i.e. both parties attempt to set up a call at the same time, the CCA will arbitrate and decide which call to grant. The unsuccessful party may receive a 4xx rejection message, which will be followed by the INVITE which brings that party as a receiving party into the call; alternatively the CCA may still complete the session setup for the unsuccessful party, but will indicate that transmit permission has been granted to another user.

7.4.7.3.2 Group call in pre-joined session

If the MU has already joined the session at group affiliation time, the SIP signalling has completed with the session establishment phase. Media Control Protocol is used by the calling party to request resources for transmission, to grant transmission to the calling party and to inform the called parties of the commencement of the call. The calling party sends an MCP 'call request', which identifies the target group; the CCAS responds with an MCP 'TX granted' message to grant the call and provide transmit permission. The called parties receive an MCP 'TX granted to another' message which informs them of the start of the call, and the identity of the transmitting party; receiving parties may send an application level response if requested within the 'TX granted to another' message. The CCA may delay the transmission of the MCP 'TX Granted' message to the calling party until after one or more acknowledgements have been received, in order to generate a simple acknowledged group call service, but a service which does not provide information to the calling party concerning which parties have responded.

If the talking party is denied permission to transmit, an MCP 'Deny' message is sent. In the event of a collision, this may be followed by an MCP 'Granted to another' message indicating the granted talking user.

At the end of transmission, the talking party sends an MCP 'Release' message. The CCAS will send MCP 'TX ceased' messages to receiving parties.

The MCP signalling is the same whether the receiving MU receives the call on a unicast or multicast bearer. If the MU moves between bearer types (where the move may be either initiated by the MU or the CCAS) there is no change to the SIP session.

The message sequence is shown in Figure 21.

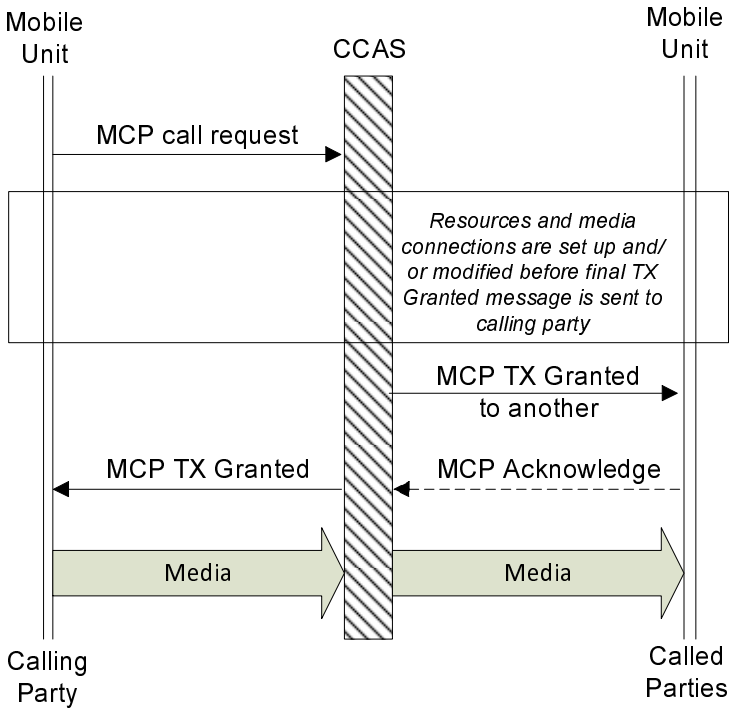


Figure 21: Non-acknowledged group call setup with pre-joined session

In the event of a call queued situation, for example because of resource limitations, or because a critical group member is occupied in another call, media control protocol is used to indicate the queued state to the calling party. One or more MCP 'Queued' messages may be sent, to provide an updated status of the call queue. The CCA strategy in deciding when to queue a call may depend on the availability of certain specific users as described in clause 7.4.7.3.1. The process is shown in Figure 22.

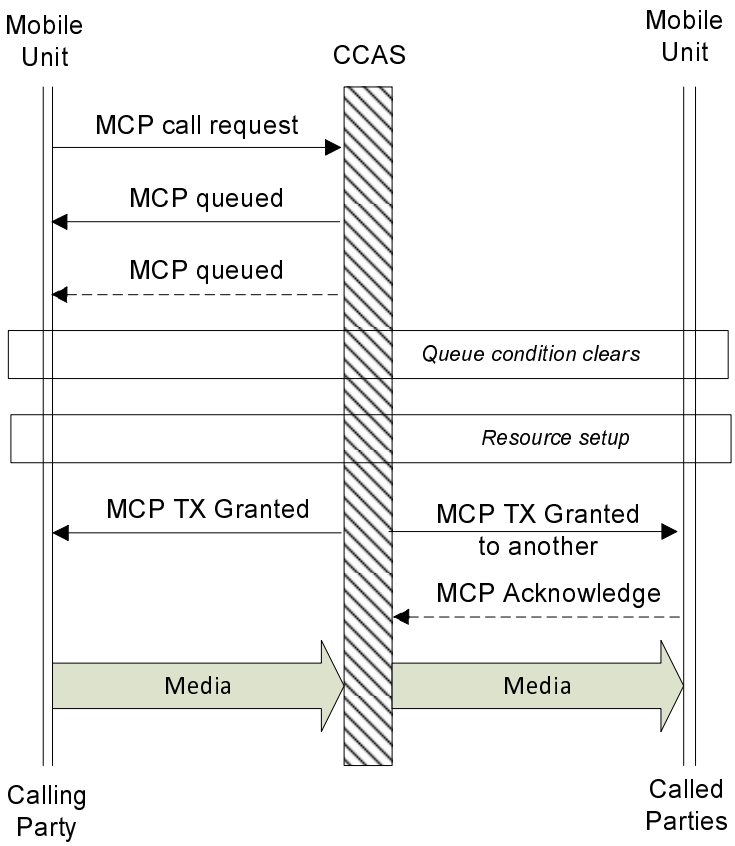


Figure 22: Non-acknowledged queued group call setup pre-joined session

A second party attempting to set up a call whilst the calling party is queued may be rejected by the CCA using media control signalling, unless the call request is of a higher priority. In that case, the original calling party may be rejected, and the new calling party placed in a queue instead (depending on the relative priority to other ongoing communications). Alternatively, the unsuccessful party may simply be sent into the call using media control signalling, with the other party's identity given in the 'TX Granted' message.

7.4.7.4 Acknowledged or ringing group communication

The purpose of the acknowledged or confirmed group call is to provide to the calling party information that a number of called parties or specific called parties will be available to receive the call. Several options may be offered depending on network operator requirements.

There can be different strategies for confirmation, which may be based on the number of mobile units which have affiliated to the group and are still reachable, or on the number of mobile units which have explicitly acknowledged the call, or the acknowledgement of a predefined subset of mobile units. In this later case, the message sequence for the set up of the group call is a mix of the acknowledged group call set up (see Figure 23) for the mobile units whose acknowledgement is required, and of the non-acknowledged group call set up (see Figure 18) for the other mobile units participating in the group call.

Optionally, the acknowledgement may be triggered by a ringing and on/off hook signalling for the mobile units whose acknowledgements are required, to ensure that the users are consciously alerted and are required to respond before joining the call. Confirmation may not be provided to the calling party until this response has been sent.

Acknowledged or ringing group calls may also be emergency calls, i.e. such calls set up with an emergency priority requested.

The acknowledged call service where information on called parties' responses is sent to the calling party can only be achieved where session join takes place at the same time as the call is started. Note however that a simple acknowledged service is possible, where feedback on users' responses is not provided to the calling party, if the session is joined at affiliation time: this service is described in clause 7.6.4.3.2.

The message sequence chart shows the addition of information messages to the calling party to provide information on the progress and/or final result of the polling. The 183 SESSION PROGRESS message is used until the CCA decides that the responses have been sufficient to allow the call to proceed. Further SIP INFO messages may be sent following the grant of the call.

The message sequence for calling party and for parties who are requested to acknowledge is given in Figure 23. The message exchange requesting and providing acknowledgement will be carried over a unicast bearer. However the final MCP 'Tx Granted to another' message and the following media may still be sent over a multicast bearer to acknowledging MUs who have a multicast bearer available.

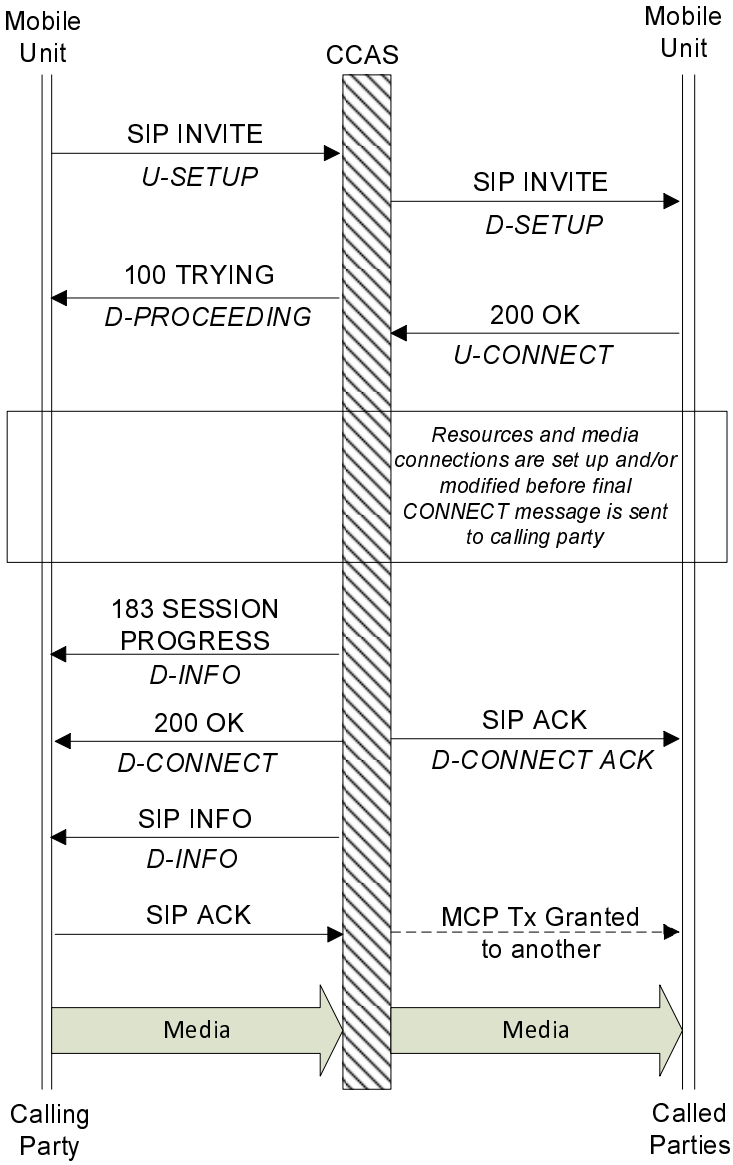


Figure 23: Acknowledged group call setup with session join

NOTE 1: The actual timing between the 200 OK from called MUs (U-CONNECT) messages and the 200 OK sent from CCAS to calling MU (D-CONNECT) message is flexible to accommodate with the different confirmation modes (all, some, pre-defined subset of mobile units) and the case illustrated in Figure 23 is purely illustrative. Moreover, nothing precludes the sending of several information messages to the calling party for size and/or incremental update reasons.

The message sequence for a receiving MU that takes part in a call where the calling party requires acknowledgement, but where that particular receiving MU is not one of those from whom acknowledgement is demanded, follows that for the unacknowledged case. An MU who is required to acknowledge may therefore receive both an MCP 'Setup' message over a multicast bearer, addressed to the group, and an individually addressed SIP INVITE message on a unicast bearer.

NOTE 2: To avoid an uplink load caused by unnecessary acknowledgements from MUs whose acknowledgements is not required by the CCA, the MCP 'TX Granted to another' message should not include an acknowledgement request when sent over a multicast bearer.

In the event of a need to queue the call before its completion, the process follows that for the unacknowledged group call. The calling party is informed of the queue, and the called parties are not informed about the call until the queue condition clears.

The MU may move to a multicast bearer when the media flow starts, or during the call. If so, the SIP session shall be modified to remove media by following the processes for unacknowledged group call with session join described in clause 7.4.7.3.1. The procedures described in clause 7.4.7.3.1 shall also be followed if the MU moves between multicast and unicast bearers during the call.

7.4.7.5 Bearer control

In all types of call, the CCAS will assign appropriate bearers (unicast and/or multicast) to carry the media and media related signalling within the call as part of the call setup process. The process is outside the scope of the present document. Note that the CCA may have a little more time available when acknowledgement is required due to the additional time needed to poll and receive response from acknowledging group members.

NOTE: If a 3GPP specified IMS is in use, there still may be practical limitations in the speed of bearer set up particularly if the group has a large number of members making use of unicast bearers. In any case, the CCA may need to delay the 'Tx granted' messages until bearers are in place.

7.5 Push-to-talk management procedures

The infrastructure controls the management of the transmission rights and implements PTT management procedures as detailed below.

NOTE: This clause applies to both individual and group streaming communications.

7.5.1 Initial allocation of right to transmit

The initial allocation of the right to transmit is defined by default behaviour according to the type of communication. However this behaviour may be overridden by the CCA if it needs to modify the service.

In a semi-duplex call by default, the called party of an individual call with on/off hook signalling should be given transit permission when the call is completed. However, the right to transmit is given by default to the calling party in the cases of group call or individual call with direct signalling. In a duplex call, both parties are able to transmit as soon as the call set up phase has been completed.

7.5.2 Releasing the right to transmit

When a MU which has been granted transmission wants to release the floor, it shall send an indication of this release (MCP 'TX Ceased') and immediately stop the transmission of any media traffic, including buffered media whenever possible.

The CCAS should inform all MUs involved in the call that the floor control has been released by sending outbound floor release messages (MCP 'TX Ceased'). Further MUs may then request the right to transmit, and may be granted transmit permission by the CCA (MCP 'TX Granted'). In event of contention, the CCA may decide which MU to allow transmit rights according to priority, or in accordance with the first request received. The MCP 'Granted to another' message informs MUs who have not been granted transmit permission of which MU has been granted transmission rights.

If requests to transmit have been previously made and queued, the CCAS shall send a message to the designated MU (MCP 'TX Granted') indicating that it has been granted the right to transmit and shall send a message to the other MUs (MCP 'TX Granted to another') indicating that the right to transmit has been granted to another MU.

7.5.3 Requesting the right to transmit

The right to request the right to transmit may be denied to all MUs at call setup time for broadcast calls.

Otherwise, a MU in the call hang time, or in a receiving state of a streaming communication may at any time request the right to transmit (MCP 'TX demand') and shall indicate a priority level for the processing of the request.

7.5.4 Interrupting a granted transmission

If an MU requests transmit permission whilst receiving media sourced from another user, but the priority level does not lead to an immediate allocation (pre-emption) and when the currently granted party has not released the floor, the request may be rejected or queued and the requesting party shall be notified of the status of its request.

If the requesting MU is rejected, Figure 24 shows the sequence of messages.

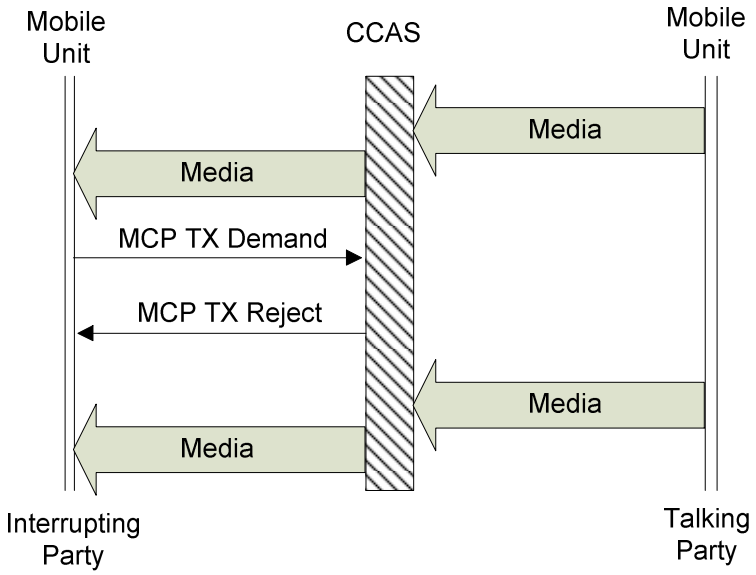


Figure 24: Rejection of talking party interruption

If a pre-emption request is made but the request is queued by the CCA without interrupting the currently transmitting MU, when the floor is released the granted party receives a positive acknowledgement of its request with the right to transmit and the other parties are notified of the fact that another party has been granted the right to transmit (MCP 'TX granted'). See Figure 25.

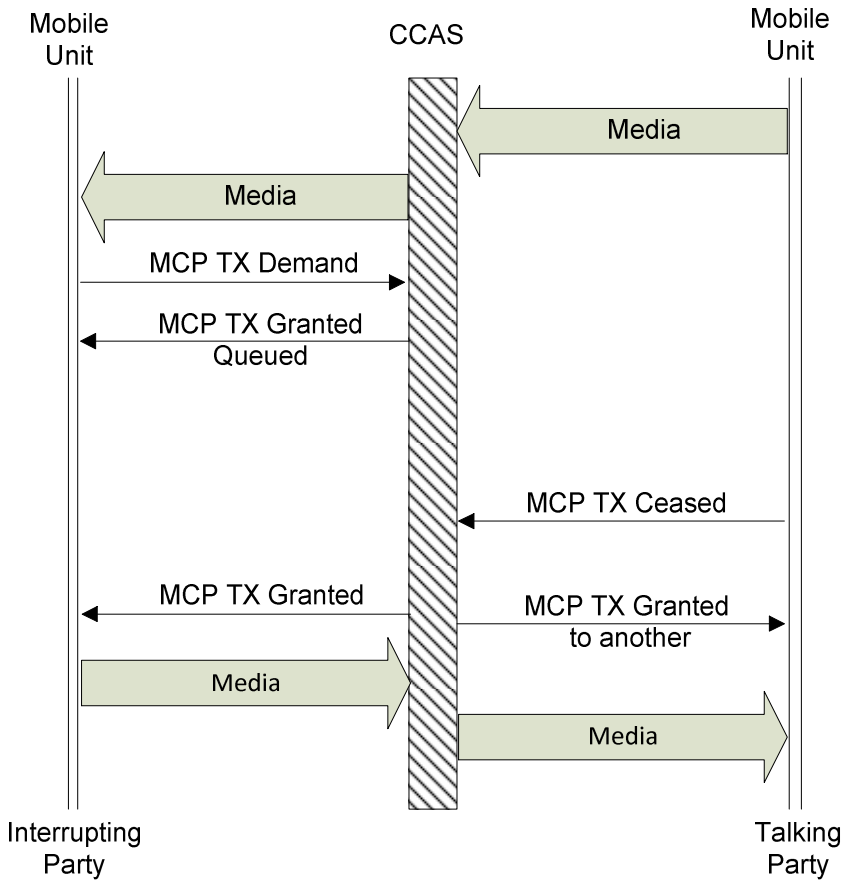


Figure 25: Processing of a request to transmit without pre-emption

If a request to transmit is made which is considered having a higher priority than the currently granted transmission, the CCA should stop the transmission of the currently granted MU and grant the right to transmit to the requesting MU. This is accomplished by sending a message to the transmitting MU to stop transmission (MCP 'TX Interrupt'). The infrastructure may then send a message (MCP 'TX Ceased') to the interested parties to inform them about the interruption before sending a further message indication the granting of the right to transmit to the interrupting party (MCP 'TX Granted'). Note that due to latency in the system, the interrupting party may still receive media sourced from the currently transmitting party even after the interrupting TX Demand has been sent. See Figure 26.

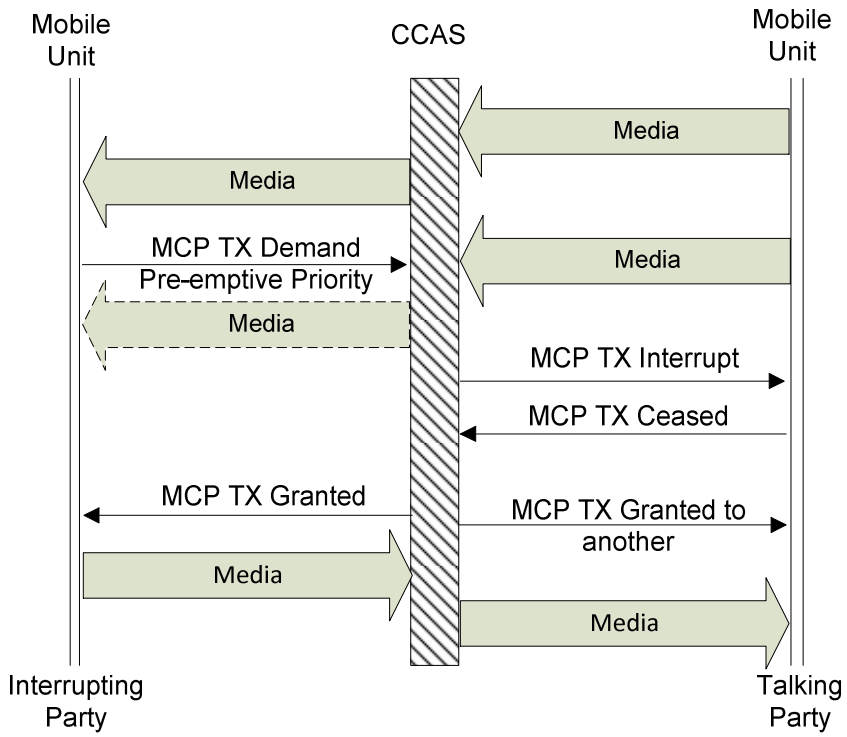


Figure 26: Stopping a granted transmission

However, in some specific cases, the pre-emption of the media flow shall apply only to the outbound media and the inbound media shall continue to be transmitted, for example, to be recorded in emergency situations. In that case, the interruption message shall indicate to the currently granted MU that the interruption does not apply to its current inbound transmission and that it may continue transmission over an independent call leg until transmission right is released using the corresponding release message (MCP 'TX Ceased').

7.5.5 Suspending a transmission

The CCAS may decide to temporarily suspend the call by removing transmit permission from the talking party using the MCP TX Interrupt message without granting transmission rights to another user. This may be adopted if some critical resource or user (e.g. a dispatcher) becomes unavailable, or if the talking party is served by a cell which exceeds its capacity limit.

Similarly, the media flow to a receiving user may be suspended if the user is served by a cell which exceeds its capacity limit. If the user was defined as critical for that call (or the call was an individual call), the transmitting party may have transmit permission withdrawn until the critical user is able to receive media once more.

7.5.6 End of call

Following the last transmission, after the end of an appropriate timer, the call will be ended. The call may also be ended by the CCA if the overall call time exceeds some provisioned value. Provisioned values of timers for call ending (whether following the last transmission or because of call length considerations) may be different for different call priority types.

If the session is to be ended at the end of the call, a SIP BYE is sent by the CCAS to return the MUs to the idle state. If an authorised MU (or dispatcher) wishes to end the call and session prior to expiry of a timer, it may transmit a SIP BYE to the CCAS which includes a parameter requesting the end of the call.

If the session is not to be ended at the end of the call, MUs may return to an idle state following expiry of a timer within the MU following the last MCP 'Tx ceased' message received. Alternatively, an MCP 'Clear' message may be sent by a CCAS to explicitly end the call. An authorised MU may send an MCP 'Clear' message to the CCAS if it wishes to end the call prior to expiry of the timer.

If the group was in an emergency state, the MU (or dispatcher) may make a request to clear the emergency state of the group, and further calls within the group are returned to being normal calls. The CCAS may reject such a request if the MU does not have authority to request this.

An MU may withdraw itself from a call whilst the call continues. If the MU also wants to end its session, a SIP BYE is sent to the CCAS. If the MU does not want to end its session, an MCP 'Clear' message can be sent. In both cases, a parameter in the message is used to indicate that the MU intends only to withdraw itself, and not end the call for other users.

NOTE 1: The definition of an authorised user who is able to end the call and/or session is outside the scope of the present document. It could be a user with specific privileges, or could be related to users participating in the call, for example only the user that initiates the call could be authorised, or any user participating in the call could be authorised.

NOTE 2: In some narrowband PMR/LMR technologies, one or more 'call owners' who are authorised to end the call can be defined, and may also the person who initiates the call. The present document does not consider a group call initiator to be a call 'owner' but the call initiator may be one of those authorised to end a call.

In certain circumstances, for example emergency conditions, the CCA may suspend the end of a call (e.g. set the timer to infinity).

7.6 Call modification

A call may be modified at setup or whilst it is continuing. Call modifications include:

- Simplex to duplex and vice versa (individual calls only).
- Direct to hook signalling and vice versa (individual calls only).
- Group to individual (e.g. call diversion when out of area).

Where the media characteristics of an individual call are to be modified (e.g. a call changing from simplex to duplex or vice versa), a re-INVITE may be used, conveying the new characteristics in the SDP descriptors.

Where the type of call is modified, the CCAS may reject a call setup request, and instead set up the required type of call (either using SIP signalling or MCP signalling as required) with transmit permission granted to the appropriate party. Alternatively the CCAS may simply complete the call, but modify the parameters of the call in the call completion signalling; or may modify parameters in the session related signalling if the session is joined at the same time as the call is started.

The target address of a call may also be translated to another address by the CCAS according to a local policy. In this case, the calling party may request a call to a generic address; the CCAS will determine the actual address (URI) of the target of the call according to some rules concerning the condition of the calling party, for example its location. This allows services to be provided such as ensuring that an emergency call can always be sent to a local dispatcher, and functional addressing, where a caller places a call to an address associated to a role, and the CCAS transfers the call to the user(s) responsible for that role at that time.

7.7 Management of priority and pre-emption

The management of priority and pre-emption covers several aspects listed below.

7.7.1 Provisioned priority

Individual MUs and groups may each be provisioned with a relative priority level. The CCA uses this provisioned priority to decide which calls to grant first and which calls to queue in the event of resource limitations. It may also be used to decide whether to pre-empt a user or a group when another user wishes to place a call of pre-emptive priority which includes a particular user or set of group members.

The CCA may change the priority of an individual or group dynamically to react to user operational needs.

If an MU is active in a call, and receives a setup indication for a call of pre-emptive priority, the MU shall release the ongoing call and join the pre-emptive priority call instead.

7.7.2 Setup priority

Each call set up request may include a priority value which can be determined either by the user or the application in the MU. This shall distinguish between at least:

- Normal calls.
- Urgent calls.
- Immediate peril calls.
- Emergency calls.

Additionally, the setup request may indicate whether the call request is for a pre-emptive call or not.

Priority of setup request applies to both individually and group addressed calls.

The priority of a call in progress may be modified by the CCAS, for example to convert a normal call into an emergency call. This may be as a result of an action by a dispatcher.

An MU receiving an emergency call setup may alert its user and present the media, even if the group was being scanned at a lower priority than the currently selected group. The CCAS may also include designated MUs and dispatchers in the call, affiliating them to the group if necessary. The CCAS may continue to give the group emergency priority even if following transmissions do not request emergency priority, until a specific action is taken by a dispatcher or administrator.

7.7.3 Push-to-talk priority

Each request for transmission using MCP includes a priority indication (with the same possibilities as the call setup priority). An emergency priority transmission request shall convert the call into an emergency call.

During a (half-duplex) call, an authorised user may pre-empt the floor allocation of another user by setting the priority indication to 'pre-emptive'. The mechanism for interruption is described in clause 7.5.4.

7.7.4 Scanning priority

A MU may receive several calls simultaneously and shall be able to select the calls to be presented to the user application based on a predefined set of priorities. The affiliation messages will include a parameter which indicates the relative priority of a group (the class of usage) to the CCA.

Call with the emergency status and system calls shall have a pre-emptive priority over the other type of calls.

7.7.5 Resource allocation priority and resource retention

When queuing for resources, several queues may be organised for the different priorities and resources will be allocated based on relative priorities. However, a call with a non pre-emptive priority shall not lead to tear down of resources already allocated to another ongoing call.

Pre-emptive communication shall be able to tear down other communications in order to get access to the required resources.

If some group members become excluded from a call in progress due to loss of capacity, the CCAS may inform the calling/talking party and/or other group members by SIP NOTIFY or MCP 'Info' signalling. Parties excluded from a call in progress for capacity reasons may also be notified of this MUs that suffer call termination due to pre-emption may be given an appropriate reason code in call termination signalling.

7.8 Status and messaging

The CCA shall support both pre-defined status transmission, and free format messaging. Both functions shall use the SIP MESSAGE facility [5]; which will include an application dependent message body header within the message to identify status, pre-defined messages and free format messages, as well as other applications of messages (e.g. simple terminal control and management facilities).

Status is used to transmit a pre-defined message with a limited size to an MU, to a group of MUs or to a system address. There shall be status values whose meaning is predefined in the standard, and freely chosen values which can be defined by the application.

The transport of the status to the recipients is acknowledged by the recipient using a 200 OK message. However this merely indicates that the status has reached its destination, not that the receiving application has interpreted it (or presented it to a user). It is up to the application using the status(es) to create higher layer acknowledgement statuses as required.

7.8.1 Standard defined status

Some statuses have a predefined meaning and a mandatory processing as defined below. Further definitions are possible.

7.8.1.1 Emergency status

The emergency status is sent by a MU upon action of the user to signal an emergency condition. The emergency status is then sent to a pre-programmed set or group of MUs which usually includes one or several wire-line connected units for dispatchers.

When the emergency status has been sent, the MU is considered in emergency and all communications that are setup by this MU or directed to this MU and the requests to transmit of this MU will be managed with an emergency priority.

The emergency status of the MU can be cleared by its own initiator and may be cleared by a designated authorised user.

7.8.1.2 Call alert

The call alert (or call back or request to speak) function allows the indication of a willingness to be called back at a later time without the need of trying a call which may fail. The call alerting message is routed to the "alerted" party and contains the address of the altering party in order to allow a simple call-back. No resource allocation is needed at any step of the processing of this feature.

7.8.1.3 Urgent call back

The urgent call back status provides the same facility as the call alert status, i.e. a desire to enter into a communication, but with an increased degree of urgency. The CCA actions in processing such a status are outside the scope of the present document.

7.8.1.4 Ambience listening call request

The ambience listening call request provides a similar function to the call alert request; except that the user desires the recipient (usually a dispatcher) to activate ambience listening on the user's terminal.

7.8.1.5 Ambience listening urgent call request

The ambience listening call request is similar to the ambience listening call request, but indicates an increase degree of urgency. The CCA actions in processing such a status are outside the scope of the present document.

7.8.1.6 Scanning on and off

Scanning on and off status values may be used to indicate to the CCA whether the MU wishes to be presented with calls from its list of scanned groups or no.

7.8.1.7 Transmit inhibit on and off

A user may select a transmit inhibit mode which restricts the transmissions made by an MU. The status indicates the current state of this function.

NOTE: It is for further study whether a transmit inhibit mode can prevent UE/terminal transmissions, or can only suppress CCA level messages.

7.8.2 Messaging

Messaging is a service that supports transfer of messages that are usually, but not required to be, short. The maximum size of a single message is defined by [5] as 1 300 bytes or less, and may be defined by system specific parameters. The CCA may employ application level chaining of several messages to achieve a greater overall message length.

The Messaging service supports transfer of messages between users, from a user to a group or from/to a user to/from a system functional entity such as e.g. a chat room.

Messages can be either acknowledged or non-acknowledged, the acknowledgement being end to end.

The Messaging service relies on SIP method MESSAGE described in [5]. SIP MESSAGE method allows for two types of acknowledgement: one, SIP 200 OK, is end to end and means that the message has been delivered to the target user or entity; the other, SIP 202 Accepted, is a partial acknowledgment, in case the message goes through a message relay such as a Store & Forward server, and it confirms that the message has been correctly transmitted e.g. from a Mobile Unit to the infrastructure. In this later case, if end to end acknowledgement is required, it will be managed by the application on top of SIP. Status or other messaging functions may be used to create such an end to end acknowledged service. Parameters may be included in messages to indicate their eligibility for storing and forwarding, and any validity time for the storage.

NOTE 1: Presence (clause 7.9) and Messaging are building blocks that can be combined and used at the application level to provide further application features.

NOTE 2: One example of an application feature is 'Callout', where a message is sent to one or more MUs which requires an acceptance or rejection response, and where the response may be sent in the form of a simple status or message. On acceptance, further messages may be sent, or group calls may be set up that include the accepting MU, in order to provide details of an incident to which the user is being called.

Messages may be linked to other services, for example may contain a hyperlink to a location where stored media can be retrieved.

7.8.2.1 Message broadcast

Messages may be sent to specific broadcast addresses, both defined organisationally and system wide. Broadcast messages may be intended for user consumption (i.e. may be human readable text), but also may be used for functions usable by the mobile application. When the CCA receives a request for a message to be sent to a broadcast address, it shall send individual messages to the intended recipients.

7.9 Presence

Presence is a service that provides information about user availability (presence) to authorised users.

A Mobile Unit may publish the Presence status of its user(s) to the CCA. Presence status includes an availability status and may include other metadata such as e.g. the group(s) the mobile unit is monitoring or a system functional entity the user is part of or interested in, like a chat room or an adhoc group.

Mobile Units can subscribe to the presence status of users of other Mobile Units, subject to adequate authorization controlled by the CCA. Authorized subscribers are notified of the presence status of a target MU following successful subscription when a new status is published by that target MU.

The presence service relies on SIP Methods SUBSCRIBE and NOTIFY described in [4] and on SIP Method PUBLISH described in RFC 3903 [6].

7.10 Localisation and geographic information

The MU shall be able to provide its geographic location when it is able to discover it, for example when in an outdoor location.

7.10.1 Mode of transmission

The system shall support different modes of transmission of the geographic location information as listed below:

- Spontaneous transmission mode: in this mode, the MU spontaneously transmits its location information to the infrastructure. The transmission may be one-shot, periodic with a programmable period or may be dependant of a change of location.
- Status triggered transmission mode: when the status of the MU is modified by an external event, especially when triggering to an emergency status, the MU shall be able to send its location information.
- Queried transmission mode: in this mode, the MU shall transmit its location information when explicitly queried by the infrastructure.

The location information shall contain an MU identifier and a timestamp and may contain in addition to the coordinates, the direction of mode and velocity, estimates of resolution, triggering conditions and suchlike.

NOTE: The location message content should allow location applications to provide a compatible service with applications build on legacy narrowband standard protocols.

7.10.2 Assisted location

The system shall support assisted location for improved accuracy. Assistance may be broadcast in a suitable manner, see clause 6.1.4.1.

7.11 Supplementary services

The following supplementary services complement the services described in the previous clauses.

7.11.1 Ambience Listening

Ambience Listening AL is a service available to authorised units (such as dispatchers) allowing them to silently trigger transmission of a mobile unit. This may be required when the actual user of the mobile unit has been in some way incapacitated to allow the dispatcher to listen at the environment to assess the situation without the help of the user. This may also be required in the case of stolen terminal to allow assessing the situation around the terminal.

This service shall be unnoticeable at the terminal and should have minimal interaction with other services, in particular with location services. In particular, there shall be no ringing and no display of the calling party (dispatcher invoking the service).

The service is similar to the individual call procedure, sent without alerting, and with transmit permission granted to the target unit. The target unit may request that an AL call is set up by use of a status function (see clause 7.8.1).

7.11.2 Talking party and calling party identity

Talking party identity (PTT calls) and calling party identity (duplex/telephone calls) are transmitted for display by the receiving parties in a call at the beginning of a media transmission sequence. The identity may be the actual identifier of mobile unit or connected telephone subscriber or it may be an alias.

This service may be subject to restrictions (i.e. able to provide anonymous transmissions) which may be overridden by authorised users. Restrictions shall be configurable in the CCA with potential dispatcher control. They are not intended to be configured by the MUs themselves.

7.11.3 Dynamic group number allocation and group merging

The dynamic group number allocation allows the dynamic provision of additional group identities to the MU. These identities may immediately be used for group communications when the allocation uses simultaneous affiliation or they may be kept inside the MU memory for later use under user control. In this later case, selection of the dynamically programmed group will be lead to a MU initiated affiliation.

The allocation messages may be either individually addressed for one-by-one programming of the MUs or group addressed (with appropriate repetitions) for on the fly group merging, eventually with additional individual additions to the merged group. Where groups are merged, the merged group may be given the higher priority of the constituent groups, for example may give the merged group emergency priority if one of the constituent groups was in an emergency condition.

De-allocation may be performed by explicit de-allocation message or by use of a temporary allocation for a duration ranging from one call to a full mission.

The facility may be provided by a document management service or other alternative means.

7.11.4 Disabling and enabling

The MU application may be disabled and re-enabled under control of the infrastructure to manage stolen MU or rogue user cases. The disabling process shall be appropriately secured to avoid misuse of this feature. This disabling and enabling applies only to the client part of the MU and not to the LTE UE.

When the MU is involved in a communication at the time of the reception of the disabling message, it shall immediately leave the communication and not re-enter until it has been re-enabled.

However, the mobility update function of the MU remains activated when the MU is disabled to allow tracing of the unit and the ambience listening supplementary service may be activated. All keys except the ones required to allow these two functions shall be erased. Re-enablement of the MU requires a full refresh of the non-permanent cryptographic elements contained in the MU.

Disabling and enabling may be carried out by the NOTIFY procedure (related to the REGISTRATION). The message shall be authenticated cryptographically.

NOTE: It is for further study whether the enable/disable supplementary service can provide further disabling of the UE or terminal, e.g. to prevent transmission.

7.11.5 Call forwarding

Call forwarding (or call diversion) reroutes a call for a given MU to another one when some conditions are fulfilled. This service only applies to individual streaming calls.

As the MU which is the target of the call redirection may itself be subject to call forwarding, a redirection counter is maintained during the redirection process to check that the total number of redirections remains lower than a system defined limit, preventing the risk of looping.

In all cases, the MU receiving the redirected call shall be indicated that the call is redirected and should receive the identity of the initially called party.

7.11.5.1 Call forwarding unconditional

The unconditional call forwarding service (CFU) redirects to another MU every individual call to a given MU. This may apply for all type of calls or only for some specific types. The other MU may be statically designated at the time of the definition of the forwarding or may belong to a list address, allowing the redirection of the call to an available party among a predefined set of MUs.

This service may only be activated by authorised parties and is configured in the CCAS (not configured by the MU) and may apply to call to external parties (PSTN) or from external parties to given MUs. The service is achieved by the CCAS on receiving an INVITE from the calling party, first sending a 100 TRYING message back to the calling party, and then sending a 181'Call is being forwarded' message back to the calling party, and sending an INVITE to the party who is the target of the diversion.

The use of CFU combined with call transfer provides a simple management of the call authorised by dispatcher feature. The dispatcher may decide whether to allow the call to be transferred or not; the decision process is outside the scope of the present document.

7.11.5.2 Call forwarding on busy subscriber and on no reply

The main use of this type of call forwarding is the implementation of voice messaging services. When the service is activated and when an individual call cannot be completed for one of the above reasons (the subscriber is already involved in a call and not willing to respond or the subscriber does not reply, including for MU which are not reachable), then the call is directed to another party.

In the case of a busy subscriber, the CCAS may know that the called party is engaged in another call immediately. and then follows the message sequence used for unconditional call forwarding without attempting to complete the call to the originally called party. However the situation can also arise where the CCAS is not aware that the called MU is not able to accept the call: in this case an INVITE is first sent by the CCAS to the intended called party; the called party responds with a 486 BUSY response; and then the CCAS sends the 181 'Call is being forwarded' to the calling party, and the INVITE to the target of the forwarding.

7.11.6 Call barring

The call barring supplementary service triggers the failure of calls when some conditions are met.

7.11.6.1 Barring of outgoing calls

An authorised user may prohibit a MU from setting up calls (individual and/or group) to defined set of recipients. This barring of outgoing calls triggers the failure of any call attempt by the barred MU to the barred individual or group recipients. The code for failure shall unambiguously indicate the cause of the failure.

NOTE: Barring of an individual MU as a call destination does not imply barring of communications to a group in which that individual is a member. Therefore MU A may be barred from making individual calls to MU B, but may still place calls to a group where MU B is a receiving member.

7.11.6.2 Barring of incoming calls

An authorised user may prohibit a MU from receiving calls (individual and/or group) from a given source or a given set of sources. The calling party shall be notified the cause for failure of the call attempt.

NOTE: In the same way as for outgoing calls, barring of incoming calls from an individual MU does not imply barring of group calls where that individual MU is the talking party.

7.11.7 Call waiting and call hold

Call waiting and call hold enable simple management of the reception of several individual calls which are setup during the same period of time. The process follows normal SIP procedures; examples of such can be found in [8].

When a MU receives a call setup (i.e. receives a SIP INVITE) while being already involved in a previous call, it may let the setup of the new call continue but may prevent media from flowing, thus providing the user with an indication of a waiting incoming call. It achieves this by negotiating a call which completes without allowing a media stream to start, i.e. using the SDP information in the 200 OK message.

Alternatively, the CCAS may also inform a MU that is already engaged in a call of a waiting call by the same mechanism, i.e. the INVITE sent from CCAS to MU contains no media. In this second case, the CCAS has effectively intervened in the set up process using knowledge that the called user is busy, and therefore the CCAS has taken the decision not to attempt to present a media flow. In either case, the setup may be later completed and media started when the called unit sends a new INVITE message which allows the media to flow.

If the MU wishes to keep an ongoing call while responding to another call, the former call may be put on hold. This may be achieved in the same way be sending a SIP INVITE removing media content from the call. The call may then be taken out of hold or released: in this case a further INVITE may be used to re-establish the media stream.

7.11.8 Discreet listening

The discreet listening service allows an authorised user to listen an individual or group call without any party of the call being notified of this intervention. The authorised user may release the call at any time.

This function is a system level feature which does not impact MU protocol.

7.11.9 Call transfer

An MU receiving a call may perform a call transfer to another MU once the call has been setup. This step may be performed after a call diversion (or call forwarding unconditional) in order to implement a simple call authorised by dispatcher feature. The process follows normal SIP procedures; examples of such can be found in [8].

When the called MU want to perform a transfer to a third party, it may put the existing call on hold, if media transfer is taking place, and may contact the party to whom it wishes to transfer the call by sending an INVITE. The party to be transferred is then sent a SIP REFER to inform it of the new called party. The new call is setup, and the original call shall be released by use of SIP BYE messages.

7.11.10 Area restriction

Area restriction allows limiting the actual coverage of a group communication. This restriction activated by calling party at setup time can restrict the coverage to a pre-programmed sub-coverage or to a sub-coverage dynamically defined based on calling party location (for example, all cells within a radius of x kilometres from that party's location).

7.11.11 Tracing & Recording

Tracing allows an authorized user to subscribe to events linked to an entity (e.g. a user, a group) to get real-time notifications and/or to log those events.

Recording shall be possible for any type of media stream or data exchanged between or within entities. Recording shall be achievable at the home system of the recorded entity (individual or group).

Tracing and Recording are system level features which do not impact MU protocol but have an impact on the routing of calls and data to ensure the home system of the recorded entity is able to capture the media or data in order to deliver the feature.

7.12 Principles for mobility management

7.12.1 Roaming and Migration

As described in clause 7.2, two configurations have to be considered for roaming and registration, depending on whether a single CCAS or multiple CCASs are involved.

If the transport network (e.g. LTE Core Network) allows direct access to the home CCAS of the user, then roaming is transparent to the user and to the application, it is entirely managed at the transport network level.

In case the transport network does not allow direct access to the home CCAS of the user, i.e. if local breakout is imposed, then the MU shall access its home server(s) through the local CCAS. In this configuration, the MU may have access to both its home and local services (e.g. groups from its home system and groups from the local system).

In case the home server(s) of the MU are not reachable from the CCA, i.e. in case of isolation of the systems, the MU should be able to register with local server(s) with a default profile. The MU can have access to local services only.

7.12.2 Media gateway re-allocation

A Critical Communication Application can comprise several media interfaces, in order to provide redundancy and/or load balancing and/or geographic zones.

It can therefore be necessary or desirable to switch an MU from one media interface to another media interface, while staying attached to the same CCAS. The decision to switch media interface can be triggered by MU payload information, such as the MU's current LTE cell, which may be carried with the regular heartbeats exchanged between the MU and the CCAS.

In order to perform a seamless handover between the two media interfaces, the system uses a "make before break" procedure. This procedure consists in setting up a new permanent secure channel between the MU and the new media interface. Once this new secure channel is established, the CCA updates the SDP of every group call and individual call to have them redirected on the same 5-tuple as the new channel, i.e. to the new Media Gateway, using a SIP UPDATE method.

In case the "make before break" is not possible, e.g. in sudden unavailability of the current media interface, the system proceeds with the set up of a new secure channel between the MU and an available media interface before using call restoration procedures to re-established the ongoing calls. In that case, the switching of the media interface is not seamless.

8 Addressing and identities

8.1 Identifiers

Two types of identifiers will be available externally for the access to the above services, i.e. permanent user identities and functional identities. A user may be reached via more than one device.

There may be extra 'layers' of addresses if the terminal or its subscription has its own address; e.g. a SIP URI related to the SIM which is used for IMS in a 3GPP LTE system. This is however distinct from the address used for the terminal's user (and distinct from addressing structures used for groups), and is not used as a mechanism by which the user is addressed. The user identities may need to be secured or hidden from the underlying broadband network.

Functional addressing may be supported by allocating suitable addresses to user functional roles. The CCA may translate calls sent to or from these addresses to user addresses, as described in clause 7.6. A call to a functional identity may result in more than one actual user being called, for example in a control room.

The addressing structure uses a SIP URI, which allows an almost infinite number of addresses to be formulated.

A user may be reached by more than one address, e.g. a SIP URI and a routable (e.g. telephone) number.

8.2 List identifiers

List identifiers are used for the implementation of functions such as list addressing or list search call in existing narrowband systems. It allows a call to be directed to a set of individuals (for example dispatchers), without knowing which one will answer. The various individuals in the list are polled at call setup and one of the individuals acknowledging the call is the actual called party.

It is not specified whether the polling is sequential, parallel or a combination of both methods.

Annex A (informative): Analysed services and requirements

This clause contains listed requirements for the CCA derived from the User Requirements Specification for Mission Critical Broadband ([i.1] and implied from existing functionality within TETRA derived from TETRA Interoperability Profile documents. A list of functions which are specified in TIPs can be found in [i.2]. The tables of requirements can be used to cross check the architecture solution described in the present document, and in protocol specifications compliant to this architecture.

Table A.1 identifies function requirements applicable to the CCAS to MU interface. Table A.2 identifies function requirements applicable to the equivalent interface for a base station operating in base station fallback mode. Table A.3 identifies performance requirements for the interface.

Table A.1 categorises each service listed in the table according to predicted impact on an underlying broadband IP network as well as impact (i.e. standardisation requirement) on the CCAS to MU interface. The sources of each requirement are identified as follows:

URS: Taken from User Requirements Specification [i.1]. Requirements are numbered according to URS clause.

TIP: Taken from the named TETRA Interoperability Profile specification and implied to be necessary for the MU to CCAS interface based on existing TETRA functionality. A list of functions for which TIPs have been written is given in [i.2].

SS: Taken from set of TETRA Supplementary Service specifications [i.3].

The 'Clause' column in Table A.1 indicates which clause within the present document satisfies the relevant requirement.

Table A.1: List of services for CCAS to MU interface

Service	Transport layer impact	Application layer impact	Source	Clause
Identities and addressing				
Support 500 000 group (address)s per system	No	Yes	URS 4.2-15	8.1
Functional addressing by role	No	Yes	URS 4.2-20	7.6
Location dependent addressing of dispatcher	No	Yes	URS 4.2-21	7.6
Registration				
Registration of user/identity	Yes for IMSI	Yes for application layer identity	Core TIP	7.2
Use of ASSI	Yes for IMSI	No for application: identity protected	Core TIP	N/A
Energy saving mode	Yes	No (see note1)	Core TIP	N/A
Periodic location update	Yes (as required by network)	Yes - keep alive for application, also if needed for any IP connection	Core TIP	7.2.4
Mobility related location update	Yes	Potential need for application to be aware of its location (resource management, etc.)	Core TIP	7.2.4
Deregistration	Yes	Yes for application	Core TIP	7.2.5
Entry to dual watch	TBD – technology dependent	TBD - technology dependent	Core TIP	7.2.5
Entry to DMO	TBD – technology dependent	TBD - technology dependent	Core TIP	7.2.5
Subscriber class	Yes NOTE: Need to consider how to achieve air to ground and similar cell steering.	No: network access function	Core TIP	N/A
Individual call				
Semi duplex	No	Yes	Core TIP	7.3
Full duplex	No	Yes	Core TIP	7.3
Hook signalling/direct call	No	Yes	Core TIP	7.3.1, 7.3.2
Calling/Talking party identity	No	Yes	Core TIP	7.11.2
Call proceeding indications	No	Yes	Core TIP	7.3.1, 7.3.2
Transmission control grant	No	Yes	Core TIP	7.5
Call waiting function	No	Yes	SS list SS_CW	7.11.7
Call modification				
Direct to hook	No	Yes	Core TIP	7.6
Simplex-duplex (both ways)	No	Yes	Core TIP	7.6
End of transmission	No	Yes	Core TIP	7.5.2
End of call	Yes – bearer release under application control	Yes	Core TIP	7.5.6
Call queue	No NOTE: Feedback from the network when bearer released.	Yes	Core TIP URS 4.3-5	7.3.1, 7.3.2
Call hold (duplex call)	No	Yes	SS Call Hold	7.11.7
Call maintenance				
Call maintenance information transmission (Note 1)	No	Yes	Core TIP	7.3.1, 7.3.2
Emergency/priority				
Emergency individual call	Yes - pre-emptive bearer demand	Yes	Core TIP URS 4.2.1-3	7.7.2

Service	Transport layer impact	Application layer impact	Source	Clause
Emergency speech item request	Yes - pre-emptive bearer demand	Yes	Core TIP	7.7.3
Emergency call set up modification	No	Yes	Core TIP	7.7.2
Pre-emptive priority individual call	Yes - pre-emptive bearer demand	Yes	Core TIP URS 4.3-2	7.7.2
Priority call – terminal demanded priority	No	Yes	Core TIP	7.7.2
Priority call – SwMI configured priority	No	Yes	Core TIP	7.7.1
Group management				
Broadcast address	Yes	Yes	Core TIP	7.4.1, 7.4.4
Single group attachment (affiliation)	No	Yes	Core TIP URS 4.2-2	7.4.4
Multiple group attachment (affiliation)	No	Yes	Core TIP	7.4.4
Selected group attachment (affiliation)	No	Yes	Core TIP	7.4.4, 7.7.4
Class of use – scanning – 8 values	No	Yes	Core TIP	7.7.4
SwMI initiated attachment (affiliation)	No	Yes (see note2)	Core TIP URS 4.2-3b	7.4.4
SwMI rejection of MU attachment (affiliation) request	No	Yes	URS 4.2-1	7.4.4
SwMI acceptance of MU attachment (affiliation) request	No	Yes	URS 4.2-3a	7.4.4
SwMI forced detachment (de-affiliation)	No	Yes	Core TIP	7.4.4
Scanning on/off indication	No	Yes	Core TIP	7.8.1.6
Attachment (affiliation) lifetime	No	Yes	Core TIP	7.4.4
MU initiated detachment (de-affiliation)	No	Yes	Core TIP	7.4.4
Group call	Yes – for group bearer	Yes		
Calling/talking party identity	No	Yes	Core TIP URS4.2-5	7.11.2
Suppression of talking party identity (set by CCA, not user)	No	Yes	URS clarification	7.11.2
Notify MU if only group member at call set up	No	Yes	URS 4.2-4	7.4.5
Call queuing when not all resources available ('all start')	No	Yes	URS 4.2-11, 4.3-5	7.4.7.3.1, 7.4.7.3.2
Call partial completion when not all resources available ('fast start')	No	Yes	URS 4.2-12	7.4.7.3.1, 7.4.7.3.2
Ringing group call	No	Yes		7.4.7.4
Transmission control	No	Yes	Core TIP	7.5
End of transmission	Yes – bearer release	Yes	Core TIP	7.5.2
Transmission interrupt	No	Yes	Core TIP URS 4.2-6, 4.2.2-3, 4.2.2-5	7.5.4
Indication of attempted interruption	No	Yes	URS 4.2-7. 4.2.2-8	7.5.4
Dispatcher hears interrupted and interrupting parties	No	Yes	URS 4.2-8, 4.2.2-6	7.4, 7.5.4
Call disconnection	Yes – bearer release	Yes	Core TIP	7.5.6
Call maintenance (wait)	No	Yes	Core TIP	7.5.5
Late entry – roaming	Yes (reconnection of bearer on roaming	No	Core TIP	7.4.6
Late entry – late group selection	No	Yes	Core TIP URS 4.2-10	7.4.6
Late entry – resources become available	No	Yes	URS 4.2-13	7.4.6
Call bearer modification (LTE unicast/multicast)	Yes (NOTE: could be under application control or network function)	Yes – if application controlled	Core TIP	7.4.7.3.1, 7.4.7.3.2

Service	Transport layer impact	Application layer impact	Source	Clause
Multipoint to point-point	No	TBD – TETRA function used for out of area call diversion to dispatcher. Can be an application above the standard (achieved using standard signalling)	Core TIP	7.6
Local/wide area call	No	Yes	SS Area Selection	7.4.2
Call waiting indication (incoming individual call)	No	Yes	SS CW	7.11.7
Multiple media types in same group	No	Yes	URS 4.2-16	7.4
Multiple instances of same media type in same group	No	Yes	URS 4.2 clarification	7.4
Video 'push' call	No	Yes	URS 4.2 clarification	7.4
Independent transmission control for different media in same group	No	Yes	URS 4.2-17	7.4.5
Rejection/suspension of user from call if cell capacity reached	No	Yes	URS 4.2-34	7.5.5
Signalling of congestion with rejection for capacity reasons	No	Yes	URS 4.2-35	7.5.5, 7.7.5
Emergency/priority call				
Emergency group call highest priority	Yes – pre-emptive bearer demand	Yes	Core TIP URS 4.2.1-5, 4.3-3	7.7.2
Emergency group call can include group members and dispatcher	No	Yes	URS 4.2.1-11	7.7.2
Emergency speech item request	Yes – pre-emptive bearer demand	Yes	Core TIP	7.7.3
Emergency call set up modification	No	Yes	Core TIP	7.7.2
Emergency call patching	No	Yes	URS 4.2.1 clarification	7.11.3
Pre-emptive priority group call	Yes – pre-emptive bearer demand	Yes	Core TIP URS 4.2.1-6, 4.2.1-18, 4.3-2, 4.3-8	7.7.2
Signalling to talking party that some group members have been lost due to resource pre-emption	No	Yes	URS 4.3-18	7.7.5
Priority call – terminal demanded priority	No	Yes	Core TIP & URS 4.2 clarification	7.7.2
Priority call – SwMI configured priority	No	Yes	Core TIP	7.7.1
Broadcast call	Yes	Yes	Core TIP	7.4.1, 7.4.4
Priority group scanning	No	Yes	Core TIP	7.4
Area related emergency call	No	Yes	URS 4.2.1-4	7.4.1, 7.4.2
Termination of emergency call by user	No	Yes	URS 4.2.1-7	7.5.6
Termination of emergency call by dispatcher	No	Yes	URS 4.2.1-8	7.5.6
Termination of emergency call by system (e.g. time-out)	No	Yes	URS 4.2.1-9, 4.2.1-19	7.5.6
Ringing/alerting emergency call	No	Yes	URS 4.2.1-12	7.4.7.4
Alert authorised users of emergency call if they are in other calls	No	Yes	URS 4.2.1-13	7.7.2
Accept or reject ringing emergency call	No	Yes	URS 4.2.1-14	7.4.7.4
Imminent peril call (pre-emptive, pre-emptable by emergency call)	No	Yes	URS 4.2.1-16; Clarification	7.7.2
Priority (general)				
Degrade QoS of lower priority sessions (data)	Yes	Yes	URS 4.3-6	7.7.5

Service	Transport layer impact	Application layer impact	Source	Clause
Move lower priority sessions to queue in congestion (data)	Yes	Yes	URS 4.3-7	7.7.5
Cell reselection	Yes	No		
Broadcast of network area information	Yes	Yes (to configure the broadcast)	Core TIP	7.8.2.1
Status message	No	Yes	Core TIP	
Status individual to individual	No	Yes	Core TIP	7.8
Status to group	No	Yes	Core TIP	7.8
Emergency status	No	Yes	Core TIP URS 4.2.1-1	7.8.1.1
Pre coded status	No	Yes	Core TIP	7.8
Telephone call				
PSTN call – direct LTE routed	Yes	No	Core TIP	N/A
PABX call	No	Yes	Core TIP	7.3.3, 7.3.4
PSTN call – home application routed	No	Yes	Core TIP	7.3.3, 7.3.4
DTMF overdial	Yes (direct LTE routed)	Yes (home application routed)	Core TIP	7.3.3, 7.3.4
Call disconnect	Yes	Yes (application routed)	Core TIP	7.3.3, 7.3.4
Emergency phone call	Yes (direct LTE, 112, etc.)	Yes (home application routed)	Core TIP	7.3.3
Incoming and outgoing number presentation	No	Yes	SS list	7.11.2
Outgoing number presentation restricted by CCA (not user set)	No	Yes	SS list & URS clarification	7.11.2
Call hold	No	Yes	SS list	7.11.7
Transmit inhibit	Yes (if it is possible)	Yes (if LTE supports; for application information)	Core TIP	7.8.1.7
Short Data Service	No	Yes		7.8.2
SDS-TL	No	Yes	SDS TIP	7.8.2
Predefined service types for SDS-TL (e.g. text, AVL, etc.) Note 2, Note 3	No	Yes	SDS TIP	7.8.2
Notification of available video	No	Yes	URS 4.2 clarification	7.8.2
Individually addressed SDS	No	Yes	SDS TIP	7.8.2
Group addressed SDS	TBD: could make use of MBMS/GCSE	Yes	SDS TIP	7.8.2
Store and forward of messages	No	Yes	SDS TIP	7.8.2
Message validity time for store and forward	No	Yes	SDS TIP	7.8.2
Message reports	No	Yes	SDS TIP	7.8.2
Multiple forms of message addressing	No	Yes - at least application level address, TETRA addressing and external subscriber number	SDS TIP	7.8.2
Support of SS control application	No	Yes	SS list	7.8
Support of (existing TETRA) DMO management application (DOTAM)	No	Yes	SS list	7.8
Support of management of ProSe operation through the CCA	FFS	FFS		FFS
DGNA				
Assignment of groups	No	Yes	DGNA TIP URS 4.2-32	7.11.3
De-assignment of groups	No	Yes	DGNA TIP	7.11.3
Forced attachment (affiliation) to assigned group	No	Yes	DGNA TIP	7.11.3
Forced detachment (de-affiliation) of assigned group	No	Yes	DGNA TIP	7.11.3

Service	Transport layer impact	Application layer impact	Source	Clause
DGNA addressed to individual address	No	Yes	DGNA TIP URS 4.2-32, 4.2-37	7.11.3
DGNA addressed to group address	TBD: could make use of MBMS/GCSE if service needed	TBD: service may be achieved to individual address only.	DGNA TIP	7.11.3
Group merging	No	Yes (see note 3)	DGNA TIP URS 4.2-38	7.11.3
Provision/modification of group mnemonic name	No	Yes	DGNA TIP	7.11.3
DGNA rejection and/or error reporting by MU	No	Yes	DGNA TIP	7.11.3
Authentication				
Mutual authentication (application level)	No	Yes	Auth. TIP	6.1.2, 7.2
Ambience Listening				
AL request from target user	No	Yes	AL TIP	7.11.1, 7.8.1.4, 7.8.1.5
AL setup by SwMI	No	Yes	AL TIP URS 4.2.1-10	7.11.1
AL cleardown by SwMI	No	Yes	AL TIP	7.11.1
End to End Encryption	No	Yes	URS 6-1	5.4.7
Clear voice override	No	Yes	E2EE TIP	5.4.7
Algorithms to be upgradable	No	Yes	URS 6-2	5.4.7
Enable/disable				
Enable/disable of UE	Yes – whichever LTE mechanisms apply (possibly network barring only)	No	En/Dis TIP	N/A
Enable/disable of application	No	Yes	En/Dis TIP	7.11.4
Disable of the UE by application action (cf disable of ME)	Yes (UE) (FFS)	Yes	En/Dis TIP	7.11.4
Call authorised by dispatcher				
Call transfer by SwMI	No	Yes (if required)	CAD TIP	7.11.9
Call acceptance or rejection by dispatcher	No	Yes (if required)	CAD TIP	7.11.5.1
Air to Ground	Yes	No	A2G TIP	N/A
Location Information Protocol		See note 4	LIP TIP	7.10
Unsolicited location reports	No	Yes	LIP TIP	7.10.1
Trigger based reporting	No	Yes	LIP TIP	7.10.1
Control of reporting	No	Yes	LIP TIP	7.10.1
Net Assist protocol	No	Yes	SS list	7.10.2
Call forwarding Configured in SwMI				7.11.5
Call forward telephone calls	Yes	No	CF TIP	7.11.5
Call forward PTT calls	No	Yes	CF TIP	7.11.5
Callout				
Alerting, terminal response and user response	No	Yes	Callout TIP	7.8.2
Group call information phase	Yes – for group bearer	Yes	Callout TIP	7.8.2
Barring of incoming calls	No	Yes	SS list SS-BIC	7.11.6.2
Barring of outgoing calls	No	Yes	SS list SS-BOC	7.11.6.1

Service	Transport layer impact	Application layer impact	Source	Clause
Call forwarding – individual calls	No	Yes	SS list SS-CF	7.11.5
Call forward on busy	No	Yes	SS list SS-CFB	7.11.5.2
Call forward on no reply	No	Yes	SS list SS-CFNR	7.11.5.2
Call forward on not reachable	No	Yes	SS list SS-CFNRy	7.11.5.2
Call forward unconditional	No	Yes	SS list SS-CFU	7.11.5.2
Discreet listening (by dispatcher only)	No	Yes	SS list SS-DL	7.11.8
Dual Watch				
Monitor infrastructure group calls when in ProSe	Yes	Yes	URS 4.10-1	FFS
Switch between infrastructure and ProSe modes	Yes	Yes	URS 4.10-2	FFS
Simultaneously listen to infrastructure and ProSe calls	Yes	Yes	URS 4.10-3	FFS
Detect an emergency ProSe call when in infrastructure or ProSe mode	Yes	Yes	URS 4.10-4	FFS
Interoperability with legacy systems				
Communicate via gateway	No	Yes	URS 4.5-1	4.2.3; N/A
Data transfer to/from legacy systems	No	Yes	URS 4.5-1	4.2.3; N/A
Voice calls to/from legacy systems	No	Yes	URS 4.5-1	4.2.3; N/A
Share groups with legacy system	No	Yes	URS 4.5-1	4.2.3; N/A
End to end encrypted calls with legacy system	No	Yes	URS 4.5-1	4.2.3; N/A
Priorities consistent with legacy system	No	Yes	URS 4.5-1	4.2.3; N/A
Miscellaneous				
Adequate speech performance in noisy environments	No	Yes	URS 5-1	6.2.1

NOTE 1: Application layer may need to control the way that UE saves energy to achieve call setup, etc. performance requirements.
NOTE 2: To be checked whether the same as DGNA with forced attachment.
NOTE 3: Not specifically specified in TETRA TIPs, but application can provide the function using TIP mechanisms.
NOTE 4: The actual protocol is TBD.

Table A.2 lists the set of services derived from the same source for base station fallback mode.

Table A.2: List of services required in Base Station fallback mode

Service	IP layer impact	Application layer impact	Source
BS fallback	Yes - TBD	TBD - network; Yes - UE app.	Core TIP
BS fallback – neighbour cell state	Yes	No	Core TIP
Group call services	Yes	Yes	URS 4.2.3-1
Group multimedia services	Yes	Yes	URS 4.2.3-2
Disconnection or continuation of calls at point of disconnection	TBD	TBD	URS 4.2.3-3
Indication of serving cell fallback state	Yes	TBD	URS 4.2.3-4
Continue to use normal addressing	No	Yes	URS 4.2.3-6
Maintain security in fallback mode, including encryption	TBD	Yes	URS 4.2.3-8
Authentication in fallback mode, which may be implicit	TBD	Yes	URS 4.2.3-9
BS provides list of served users to others receiving service from that BS	TBD	TBD	URS 4.2.3-10
Restrict list of served users to those within same group	TBD	TBD	URS 4.2.3-11
Cancel local service indication when reconnected to infrastructure	Yes	TBD	URS 4.2.3-13

NOTE 1: Call maintenance signalling includes signalling in circumstances such as impending disconnection warning, call timer extension.

NOTE 2: The SDS message types which should be supported include at least the following:

- Text messaging, including immediate text messaging.
- End to end encrypted messaging.
- End to end encryption key management.
- Location reporting and control of reporting.
- Wireless Datagram Protocol WAP.
- Wireless Control Message Protocol WCMP.
- Managed DMO service.
- PIN authentication.
- Net Assist Protocol.
- Messages with user data header.

NOTE 3: Current TETRA theoretically can support concatenated text messages of up to 2 048 bytes x 255 messages.

Table A.3 lists performance requirements for the services, where specified. All are taken from the URS, [i.1].

Table A.3: Performance requirements

URS clause	Requirement
4.2-9	Talker changeover, with delay no longer than initial call setup
4.2-14	MU support for 5 000 groups
4.2-22	Call setup within 300 msec
4.2-23a	Minimal audio delay within a call
4.2-23b	Minimal difference in delay for users in same cell, and nearby users on different cells
4.2-24	Efficient use of resources
4.2-25	Group size from 2 participants to all on system
4.2-26	Group size within a cell from 1 to all users within the cell
4.2-29	High speed handover, 300 km/h, preferably 500 km/h
4.2-30	At least 36 simultaneous group calls per cell/sector
4.2-31	At least 2 000 users per cell/sector
Clarification URS 4.2	One group may contain all (2 000) users in a cell/sector
4.2.1-14	Ringing emergency call: same capacity and performance requirements as normal call
5-2	No echo on voice
5-3	Consistent quality with range of speeds up to 300, pref 500 km/h

History

Document history		
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