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Part 1: Critical Communications Architecture Reference Model

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Contents

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Foreword

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

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 describes an architecture that will allow Critical Communications applications to operate across a broadband IP network. The IP network may be a wireless network, for example, a 3GPP™ specified LTE™ network. The various interfaces and reference points that comprise the architecture are detailed within the present document together with a brief outline of some of the most important services that the architecture supports.

The interfaces described include those relevant to a network to terminal application, a terminal to terminal application, and network to terminal application via a relay terminal.

2 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 referenced 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.

2.1 Normative references

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

Not applicable.

2.2 Informative references

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 TS 122 011: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Service accessibility (3GPP TS 22.011)".

3 Definitions and abbreviations

3.1 Definitions

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

call: a set of exchanges of information between two or more users that takes place in a conversational service

Critical Communication Application (CCA): application providing professional communication services to critical communication users over broadband IP networks, e.g. LTE networks, and to legacy professional networks

Critical Communication System (CCS): the whole system that is providing Professional Communication Services to Professional Users

NOTE: The CCS may include Access Network, Core Network, Control Rooms and Applications.

professional operator: operator in charge to provide Critical Communication Services to Professional Users (Public Safety users, Rail Users, Utility users, other professional users)

session: set of information sent from one user to one or more other users outside a Conversational Service

3.2 Abbreviations

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

ARP	Allocation and Retention Priority
CCA	Critical Communication Application
CCS	Critical Communication System
DMR	Digital Mobile Radio
EPC	Evolved Packet Core
GSM-R	Global System for Mobile communication for Railway application
HSS	Home Subscriber Server
LMR	Land Mobile Radio
LTE	Long Term Evolution
MNO	Mobile Network Operator
MVNO	Mobile Virtual Network Operator
PMR	Professional Mobile Radio or Private Mobile Radio
QCI	QoS Class Identifier
QoS	Quality of Service
SLA	Service Level Agreement
UE	User Equipment

4 Architectural Requirements

In order to satisfy the Critical Communication User requirements the Critical Communication System:

- provides generic multimedia individual and group services for Professional Communication to the Application layer (Control Rooms, Localization Applications and Multimedia Applications);
- addresses several professional markets including: Public Safety, Railway, Utilities;
- has full control of user profiles;
- has full control of security level;
- supports interworking with legacy Professional Networks (TETRA, TETRAPOL, DMR, GSM-R, P25, etc.);
- provides mechanisms ensuring the required level of resiliency;
- controls the resources usage according to users' and communications' priorities;
- supports efficient use of features such as broadcast transport and/or QoS management when these are available. This is typically the case when the broadband access is an LTE network.
- supports the ability to connect one or more broadband networks to a CCA and allows multiple CCAs to be connected to a broadband network.

5 Critical Communication System Architecture

5.1 CCS Reference Model

The Critical Communication System architecture model considers the following aspects:

- services and facilities that are provided to professional users;
- reference points / interfaces for the user plane and control plane between the CCA, Core IP Network(s) (e.g. LTE network) and legacy professional networks;

- reference points / interfaces for the user plane and control plane between the CCA and Application Layer;
- reference points / interfaces for the user plane and control plane between the CCAs on terminals (e.g. LTE UEs) for Proximity scenarios;
- reference points /interfaces to the 3rd party application layer functions in the terminal and CCA;

The performance and security aspects of the architecture are also important considerations.

To meet the Mission Critical requirements, the complete architecture of the Critical Communication System, CCS has to be considered, not only the Critical Communication Application (CCA). The CCS model also includes also the underlying IP Core Network (e.g. LTE EPC) and other functions.

The CCS Reference Model considered is the following.

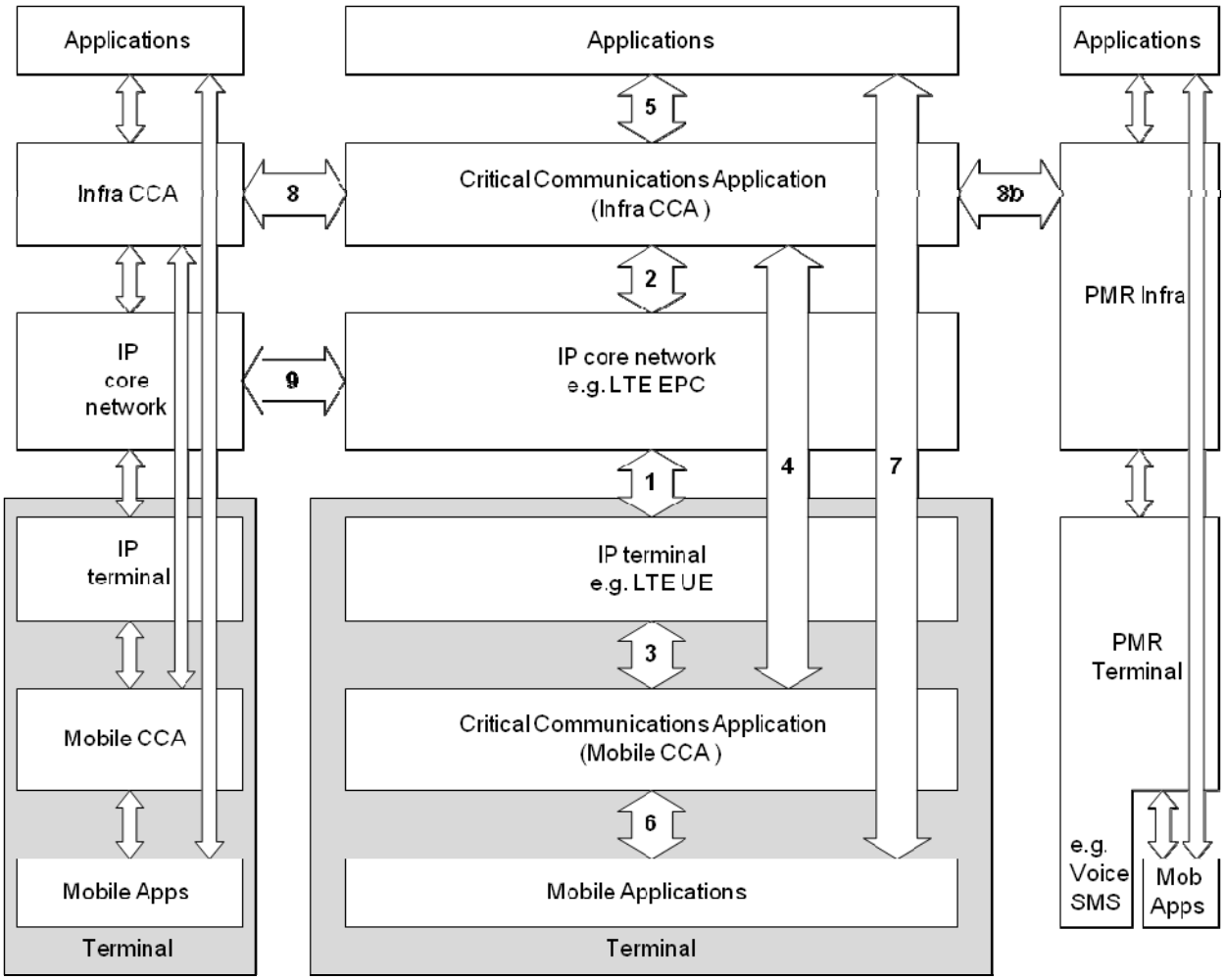

Figure 1: CCS Reference Model

In addition, derived reference models apply to the Direct Mode of Operations - see figure 2, to the Terminal to Terminal Repeater - see figure 3, and to the Terminal to Network Relay - see figure 4.

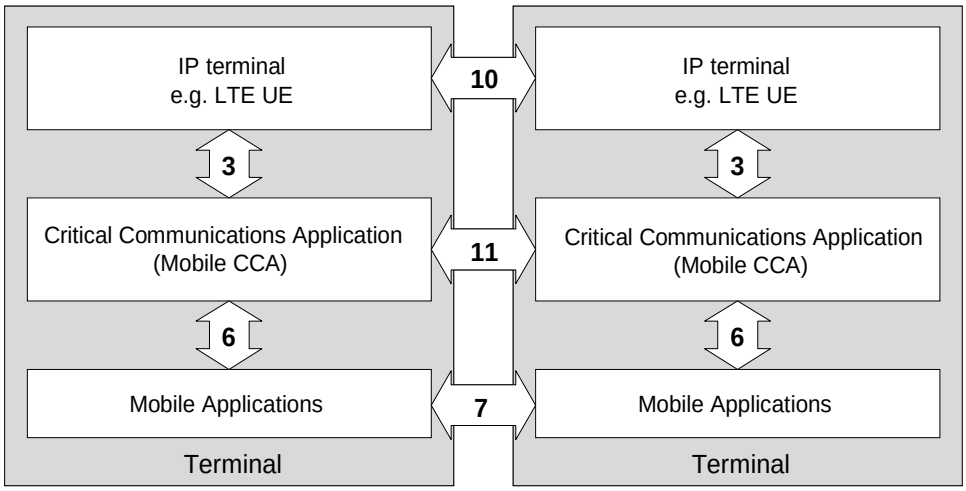

Figure 2: Direct Mode of Operations Reference Model

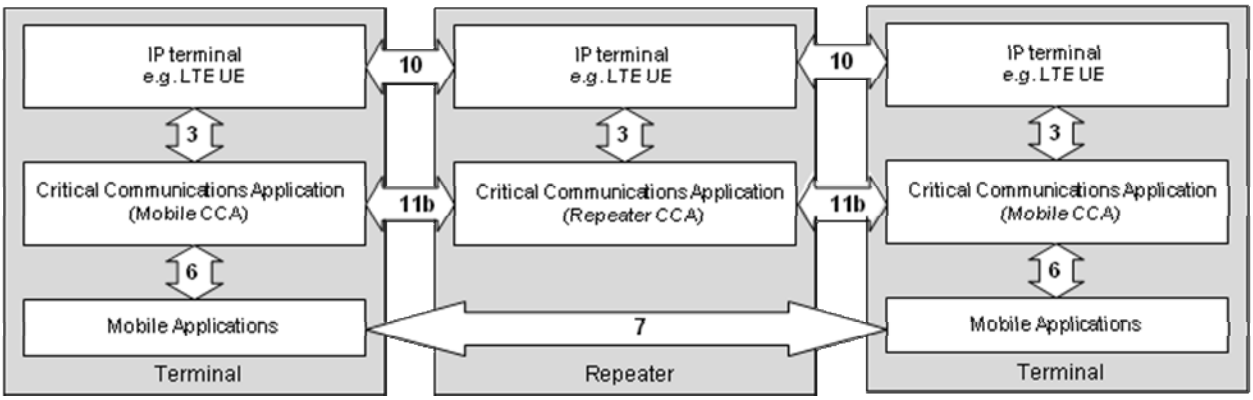

Figure 3: Terminal to Terminal Repeater Reference Model

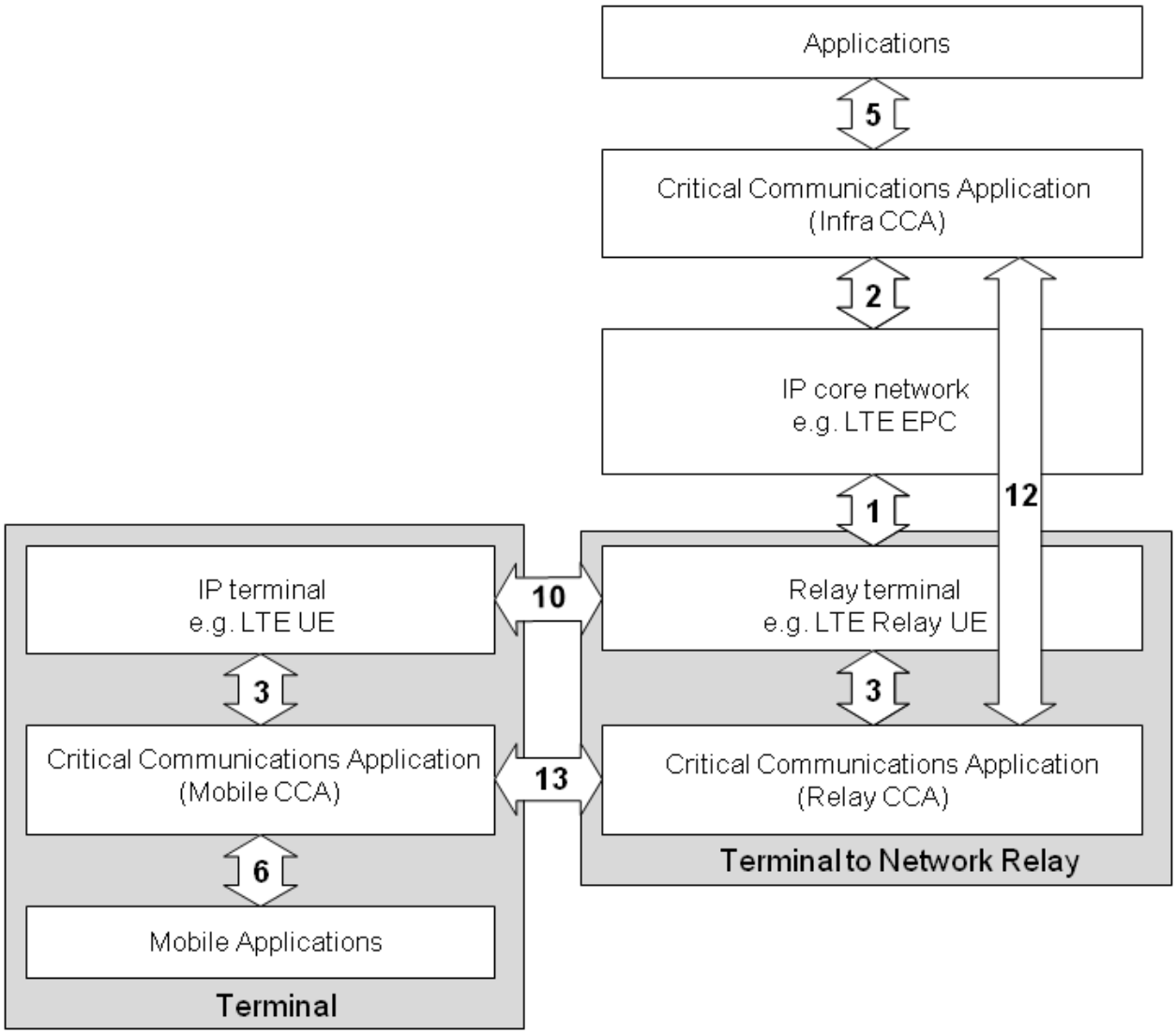

Figure 4: Terminal to Network Relay Reference Model

5.2 Interfaces

5.2.1 [1] IP Core Network - IP Terminal interface

This interface is specified according to the network protocols of the underlying IP network. Where the underlying network is LTE, it consists of the 3GPP specified LTE UE to EPC interfaces.

5.2.2 [2] Infra CCA - IP Core Network interface

The objective of this interface is to allow interworking between an Infrastructure CCA and IP Core Networks from different manufacturers. This interface is specified according to the network protocols of the underlying IP network.

Where that underlying network is an LTE EPC, it consists of existing Rx and SGi interfaces, plus the MB2 interface developed in the GCSE-LTE work item from 3GPP Release 12, to allow use and control of LTE broadcast bearers

This interface may also provide additional reporting information from the IP network (e.g. location, charging or some other function).

One CCA may make use of more than one broadband IP 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 CCA. 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 CCA. Multiple CCAs may also share the same broadband IP access network. Therefore there can be a many-to-many relationship of CCAs and broadband IP access networks.

5.2.3 [3] IP Terminal to Mobile CCA interface

This interface relies on the services available from the IP network terminal.

In an LTE environment, it utilizes the interfaces provided by the UE to any application and may evolve to include developments related to GCSE-LTE work item from 3GPP Release 12.

This interface itself is not fully standardized since it is dependent on the terminal implementation and operating system.

5.2.4 [4] Infra CCA to Mobile CCA interface

The objective of this interface is to allow interoperability between a CCA infrastructure and terminals from different manufacturers.

This interface provides similar functionality to existing digital PMR Layer 3 Air Interface messages, supporting, but not limited to, user registration, setup and control of individual and group communications, media transfer and management and short data transport.

5.2.5 [5] Infra CCA to Application interface

The objective of this interface is to allow easy integration of Applications in a CCA environment, and portability of those applications to CCAs from different manufacturers. This interface supports for instance the dispatcher functionalities.

This interface is made of two main components:

- A Call interface, to provide control of sessions (C-Plane) and of media transport (U-Plane) within a communication. This interface may be similar to a Dispatch interface in existing PMR systems, extended to Multimedia.

NOTE: A single communication session can be an organized set of one or more communications used to transport the same information to or from one or several mobiles. Independent sessions implies that there can be several separate communications taking place between different sets of parties which can be accessed through this interface.

- A Routed Transport interface to transport and route data messages (e.g. signalling, geo-location information, text messages) and data files (e.g. picture, map) between mobiles and applications.

5.2.6 [6] Mobile CCA to Mobile Application Interface

The objective of this interface is to allow easy integration of Mobile Applications in a CCA environment, and portability of those applications between terminals from different manufacturers.

5.2.7 [7] Application to Application interface

Some components of this interface may be defined by standards, for specific applications that require generic formats to ensure interoperability between mobile applications and control room application for instance: geo-location, video format, vocoder.

5.2.8 [8] Inter CCA interface

The objective of this interface is to allow interoperability and interworking between CCS.

This interface supports interconnection of communications between users operating on different CCS.

This interface should support mobility of users between different CCS.

5.2.9 [8bis] CCA to Legacy PMR interface

The objective of this interface is to allow interworking between a CCS and existing legacy PMR systems such as TETRA, TETRAPOL and P25.

This interface is intended to support interconnection of communications between users operating on a CCS and on a legacy PMR system.

5.2.10 [9] Core Network to Core Network interface

This interface is determined by the underlying core IP network. Where the underlying network is an LTE EPC, it makes use of 3GPP standard interfaces.

This interface provides support and control of mobility and roaming of terminals between different core networks.

NOTE: Where the underlying core networks use different technologies, a standardized interface may not be available.

5.2.11 [10] IP Terminal to IP Terminal interface

This interface is determined by the terminal technology.

Where the terminals are LTE UEs, this interface will be a standard 3GPP interface, defined under the Proximity Services (ProSe) work item in 3GPP Release 12.

This interface supports direct communications between terminals and also the terminal to repeater and the terminal to Network Relay configurations.

5.2.12 [11] Mobile CCA to Mobile CCA interface

The objective of this interface is to provide control of direct CCA Services between two or more terminals without any infrastructure path. Where the terminals are LTE UEs, it relies on underlying services defined by 3GPP ProSe.

5.2.13 [11bis] Mobile CCA to Repeater CCA interface

The objective of this interface is to provide communication between a terminal and a repeater, such that the repeater can relay communications to one or more additional terminals. Where the terminals are LTE UEs, it relies on underlying services defined by 3GPP ProSe.

5.2.14 [12] Infra CCA to Relay CCA interface

The objective of this interface is to support the specific configuration of a Terminal to Network Relay. This interface can be considered to be a subset of the [4] Infra CCA to Mobile CCA interface.

5.2.15 [13] Mobile CCA to Relay CCA interface

The objective of this interface is to support the specific configuration of a Terminal to Network Relay.

6 Services provided by the CCA

The Critical Communication Application is responsible for providing a complete set of professional services to upper layers. The principal services are described in this clause of the present document.

In order to deliver these services with the correct characteristics and attributes, the CCA needs to make use of prioritization and quality of service aspects of the underlying IP network. In the case of LTE, this will mean that the services are mapped to parameters such as QCI, ARP and, if relevant, Extended Access Barring.

6.1 Call Services (Real Time Conversational Services)

The following real time conversational services are supported by the CCA:

- Voice Individual Call (Half-/Full-duplex):
  - On/off-hook Calls (waits for the response from the called user)
  - Direct (does not wait for a response from the called user)
- Voice Group Call:
  - Unacknowledged Group Call (no information about the presence of group-members is required to setup the call)
  - Acknowledged Group Call
  - Emergency Call
  - Broadcast Group Call (only the Call originator has permission to talk)

NOTE: A Voice Broadcast Group is extensible up to the full number of Users populating the network.

- Video-call (proposal): This service is intended to be a One-to-One or a One-to-Many conference call where the Voice and Video media are synchronized and handled by PTT.

Such Conversational Services will support communications:

- From Application (e.g. Dispatch) to Mobile(s)
- From Mobile to Application(s) (e.g. Dispatch, logging recorders, etc.)
- From Mobile to Mobile(s)

A communication may have multiple types of end point, for example Mobile to Mobile and to Application at the same time.

QoS needs for Conversational Services

Real-time conversational services are characterized by a transfer time that needs to be low because of the interactive nature of the service and also the time variation between information entities (i.e. samples, packets, etc.) of the stream needs to be minimized.

The maximum transfer delay is limited by human perception in video and audio conversation.

6.2 Session Services (Real Time Streaming)

The following real time conversational services are supported by the CCA:

- Real Time Video transmission:
  - Streaming video High-quality (with constant guaranteed bandwidth)
  - Streaming video Medium/Low-quality (with a minimum, not constant, guaranteed bandwidth)
  - Slow-video (few frames per sec - this type of video can be shared also with TETRA/TEDS or similar networks)

NOTE: Video is generally considered to consist of combined sound and video. Sound is optional. It is also possible to have a separate and independent session for sound/voice without any synchronization with the video.

Session Services supported include:

- Individual sessions

- Group sessions (Broadcast/Multicast type)
- From Application to Mobile(s)
- From Mobile to Application

A communication may have multiple types of end point, for example Mobile to Mobile and to Application at the same time.

QoS needs for Streaming Services

This class is characterized by a time variation between information entities within a flow which needs to be minimized, although it does not have any requirements on low transfer delay. The delay variation of the end-to-end flow should be limited, to preserve the time relation (variation) between information entities of the stream.

6.3 Professional Supplementary Services

The Critical Communication Application supports the following Supplementary Services in relation with Call and Session services:

- Priority and Preemption management (any type of Call or session)
- Late Entry (for joining an ongoing Group Call)
- Call/session Identification Services (e.g. Talking Party Identification, Calling Line Identification presentation / restriction, etc.)
- Discreet Listening (for intercepting ongoing connection without alerting the involved parties)
- Ambience Listening (the addressed radio terminal is forced to transmit information without any external sign of such status change)
- Dynamic Group Number Assignment (for dynamically create/modify/delete groups of Users)
- Call/session authorized by Dispatcher (when a User is allowed by a Dispatcher to place or receive a call or session for which he/she normally has no right)
- Call Termination forced by Dispatcher
- Call/session Forwarding (unconditional, busy, on no reply, not reachable)
- Call Hold
- Call Waiting (user alerted about another incoming call; this call can be accepted, ignored or refused)

The CCA supports the following Security Supplementary Services:

- Mobile CCA Disabling/Enabling

6.4 Data Services (non-Real Time)

The following non-real time services are supported by the CCA:

- Interactive services:
  - Telemetry data (to be used e.g. in SCADA as well as in Telemedicine or in M2M systems)
  - Web browsing
  - Database query
- Text messages:
  - Individual sessions

  - Group sessions (Multicast type)

- Pre-defined Status messages:
  - Individual sessions
  - Group sessions (Multicast type)
- Image sending:
  - Individual sessions
  - Group sessions (Multicast type)
- Text + image sending:
  - Individual sessions
  - Group sessions (Multicast type)
- E-mail
- File transfer:
  - This service is also intended to permit the transmission of "bulk" files as video-clips and other similar large data contents
- Location Services
- Presence

Non real time data services support transfer of information:

- Individually addressed
- Group addressed
- From Application to Mobile(s)
- From Mobile to Application

A communication may have multiple types of end point, for example Mobile to Mobile and to Application at the same time.

QoS needs for non Data Services

Interactive Services are characterized by the request - response pattern of the end-user. At the message origin there is an entity expecting the message response within a certain time. Round-trip delay time is therefore one of the key attributes.

A common characteristic for non real time Data Services is that the content of the packets needs to be transparently transferred (with very few or no errors).

6.5 Application Registration Services

Application registration services are needed to manage the relationship of users and groups to terminal equipment at the CCA level, i.e. on top of what is done at the Access Network level (e.g. LTE Attach), to manage Critical Communication users.

Such Critical Communication users may not be permanently linked to a single device and may use over time different methods for accessing the Critical Communication System, e.g. wireless and wireline, and a single device may be used over time by different Critical Communication users.

- User Management:
  - User Registration

  - User Authentication
  - User Profile Management
- Group Management:
  - Group Profile Management
  - Users Registration to Groups

7 Roaming and interoperability

The Critical Communication System is interoperable at several levels:

- With legacy systems TETRA/TETRAPOL/P25.
- Between CCAs.
- Between UEs for proximity services.

7.1 Roaming aspects

Roaming has three aspects:

- At the underlying network level, for example between 3GPP networks. Roaming between 3GPP networks is defined by the 3GPP standards and it is a task of the 3GPP layers. This is part of the functionality contained in interface [9] in the present document.
- Migration between different CCA/CCS, for example to provide mutual aid. This is a part of the functionality of interface [8] in the present document.
- For Users moving their point of registration between a CCA and a TETRA/TETRAPOL/P25 network. Roaming in this case is currently outside the scope of the present document.

7.2 Interoperability between CCAs

The CCA will support full interoperability with other CCAs in term of:

- Authentication/authorization
- Encryption
- Individual Calls
- Group Calls
- Supplementary Services
- Multimedia Services
- Mobility Management

7.3 Interoperability between UE CCAs for Proximity Services

The user devices have the capability to interoperate at UE CCA level even if they are out of the network coverage (Proximity Services). This requirement is limited to the LTE UE technology.

The interoperability will include:

- Security services

- Individual Calls services
- Group Calls
- Supplementary Services
- Multimedia Services

7.4 Interoperability with legacy systems

The interoperability with existing PMR technologies will not constrain the definition nor limit the functionalities of the new Critical Communications Broadband standard.

This interface supports at least a minimum set of features to TETRA, TETRAPOL and P25 systems:

- Individual Calls
- Group Calls
- Short Data services

8 Management services

8.1 Management of Mission Critical services for professional users

The Mission Critical services of professional users should be managed directly by the CCS Operators even if the Access Network is shared with other operators (i.e. Mobile Network Operators, MNOs). Therefore, the CCS Operator should manage, for example:

- User profile, including the enabled services
- Encryption keys
- USIM for LTE users
- Access Classes (TS 122 011 [i.1])

This implies that where LTE is used, some LTE Core Network elements may be part of the Professional Core Network, for example HSS and encryption key management functions.

The LTE SIM card may be also provided by the CCS Operator.

8.2 QoS management

The CCS will require full and direct control of the QoS for Professional LTE users even if the RAN is shared with public Mobile Network Operators.

If the LTE network is shared between CCS users and commercial users, a Service Level Agreement will be needed with the MNO(s) to fulfil the Critical Communication requirements.

It is out of the scope of the present document to define Service Level Agreement with MNOs, however the SLA will need to include a specific definition of QCI for Critical Communication services.

The QoS framework in CCA is also capable of dynamic management of the QoS, in order to have, for instance, different QoS policies between normal activities and a special event.

9 Security aspects

The security framework includes CCA security aspects and transport layer security.

For the transport layers (e.g. LTE and TETRA/TETRAPOL/P25) the security features are defined by the standards relating to those access networks. However the security keys may need to be managed in the CCS domain and not, for example, in the MNO domain.

The CCA security will provide application level security, for all services provided, on both Control and User planes. The User Plane will additionally support an overlay of end to end encryption where this is required.

Where interoperability with existing narrowband networks (e.g. TETRA) is required, the end to end security may be extended through the CCA to LMR network interface (interface [8bis]) to the users of that network.

History

Document history		
V1.1.1	July 2014	Publication