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9th ETSI MCX Plugtests
College Station, Texas, USA
24 February – 28 February 2025

Keywords

Testing, Interoperability, Mission-Critical, LTE, MCPTT, MCData, MCVideo, FRMCS

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Executive Summary

The capabilities of Mission Critical Push to Talk (MCPTT), Mission Critical Data (MCData) and Mission Critical Video (MCVideo) – together abbreviated as MCX services – were tested during the ninth MCX Plugtests from 24h February to 28th February 2025 at the The Center for Infrastructure Renewal (CIR) part of Texas A&M University System (TAMUS) in College Station, Texas, USA using 4G and 5G test networks. 174 test cases were executed between vendors, based on 3GPP Release 18.

The 9th ETSI MCX Plugtests have concluded with a success rate of 83% of the executed tests in the validation of 3GPP mission critical services vendor interoperability. More than 200 delegates participated during the 9th MCX Plugtests event on-site in College Station and off-site from their labs.

These tests are essential to ensuring seamless access to mission-critical services over 4G and 5G networks across different vendor products and implementations.

The MCX ETSI Plugtests series is the first independent testing of public safety and other mission critical services over 4G/LTE and 5G networks. The Interworking Function IWF to LMR (narrowband Land Mobile Radio networks) systems like TETRA, Interconnection (Inter-MCX) between MCX servers, MCX Off-network (device to device communication), eMBMS (multicast) and test tools were particularly tested in these 9th MCX Plugtests. The preparations for the ninth Plugtests started in October 2024, were followed by one month of integration with the test network in January 2025, a two-week pre-testing in February 2025, and were finalized with a one week of face-to-face end-to-end interoperability testing with 4G and 5G test networks in College Station.

The tests were based on 3GPP Release-18, and 174 tests were executed between the different vendors in 146 test sessions. The test cases have been amended with additional multi client and off-network test scenarios which will be included in a future version of ETSI TS 103 564 (after the ETSI committee TCCE approval). A total of more than 400 test cases are now available for the MCX and FRMCS Plugtests. Besides the MCPTT, MCData and MCVideo Application Servers and Clients, the testing also included devices (UEs), Interworking (IWF) with TETRA, eMBMS (Evolved Multimedia Broadcast Multicast Services) multicast components, off-network (device to device) and inter-MCX (server-to-server) communication. Both 4G and 5G networks were used as radio access network.

Additionally, gathered observations from the Plugtests events provide essential feedback to 3GPP Working Groups as work continues on mission-critical communication specifications.

The testing during the 9th MCX Plugtests was complemented by an observer program with presentations, round-table discussions, and demos for the observers.

This ninth MCX Plugtests was organized by ETSI with the support of the TAMU, TCCA, and UIC.

The Plugtests event was a **pure interoperability testing event, and no products were certified**.

The next FRMCS and MCX Plugtests events are planned for October 2025 and April 2026 respectively.

The following observer organsiations participated in this Plugtests:

- A.S.T.R.I.D, Public saftey network operator, Belgium
- AstaZero – RISE Research Institutes of Sweden, Sweden
- AT&T - USA
- BDBOS, Federal Agency for Public Safety Digital Radio, Germany
- Cybersecurity and Infractructure Security Agency / Department of Homeland Security, USA
- Directorate for Civil Protection (DSB), Norway
- Erillisverkot, Public Saftey Network Operator, Finland
- FirstNet, Public Saftey Network Operator, USA
- GCF, Global Certification Forum
- Home Office, United Kingdom
- Lower Colorado River Authority, USA
- MSB, Swedish Civil Contingencies Agency, Sweden
- National Police ICT-unit, Norway
- N.C. Department of Information Technology, USA
- SNCF Reseau, Railway operator research, France
- TCCA, The Critical Communication Association
- Trafikverket, Swedish Transport Administration, Sweden

1. Introduction

Mission Critical Push To Talk (MCPTT) is a 3GPP standardized voice service for mobile radio systems which ensures that LTE and 5G systems support mission-critical communications.

The global mission-critical communication market was valued at approximately US$17.03 billion in 2022 and is projected to reach US$27.88 billion by 2028, growing at a compound annual growth rate (CAGR) of 8.6% during the forecast period as per the Insight Partners.

This growth is driven by the increasing adoption of mission-critical communication systems across various sectors, including public safety, transportation, energy, utilities, and mining.

Several regions have initiated nationwide rollouts of mission-critical LTE or 5G networks, leading to significant investments in this sector. Notably, countries such as the United States, South Korea, Finland, France, and various nations in the Middle East and Asia have been at the forefront of these developments, as per GlobeNewswire.

Mission Critical Push To Talk (MCPTT) was the first of several Mission Critical features standardized by 3GPP in Release-13. Mission Critical Video and Mission Critical Data standardization started with Release-14. With the standardization of MCX (Mission-Critical PTT, Video & Data) and other critical communications features by 3GPP, LTE and 5G NR networks are increasingly gaining recognition as an all-inclusive communications platform for public safety, rail, utilities and other critical communications sectors.

Preparations for the 9th ETSI MCX Plugtests event started in October 2024 with the registrations of vendors and observers. During bi-weekly conference calls from October 2024 to February 2025 the setup of the tests, the test specification and organizational discussions were agreed between the participants. Before the main event, the vendors integrated with the test network and remote pre-testing of their implementations via VPN tunnels, which connected their labs to a central exchange hub.

All the information required to organise and manage the 9th MCX Plugtests event was compiled and shared with participants in a dedicated private WIKI which was put in place by ETSI. All participants were provided with credentials that allowed them to access and update their details. All the information presented in this document has been extracted from the 9th MCX Plugtests event wiki: https://wiki.plugtests.net/9th-MCX-Plugtests/ (login required).

Clause 4 describes the management of the Plugtests event.

The following equipment was tested – please see also clause 5:

- MCX Application Servers (MCX AS)
- MCX Clients
- Evolved Node B (eNB)
- Next Generation Node B (gNB)
- User Equipment (UE) – including Sidelink functionality
- Land Mobile Radio (LMR) Systems – TETRA
- Evolved Packet Core (EPC)
- 5G Core (5GC)
- Broadcast Multicast Service Center (BMSC)
- Evolved Multicast/Broadcast Multimedia Service Gateway (eMBMS-GW)
- MCX Conformance Test Tools
- Dispatchers

In this Plugtests, multiple Application Servers and Clients were evaluated in a dedicated test stream (Stream A & B). Stream A and B were available for vendors to evaluate their equipment for end-to-end interoperability testing over 4G and 5G networks respectively. In this Plugtests it was required to test each Application Server with at least 2 different Client implementations.

The Interworking Function (IWF) with LMR systems was evaluated in another dedicated IWF test stream (Stream C).

Stream D was available for vendors to evaluate their equipment in interconnected MCX systems.

Off-network functionality (device to device communication over the PC5 sidelink) was tested in a dedicated off network test stream (Stream E), which was available for sidelink UEs and MCX off network client vendors to test off-network implementations.

A dedicated Test Tools test stream (Stream F) was available for test tool vendors and MCX server and client vendors to check their tools and the conformance of their implementations with these test tools.

The remote test infrastructure is described in clause 6; the test procedures are described in clause 7.

The vendors and ETSI have set up VPN-Tunnels from the vendors' premises to the ETSI VPN hub. This allowed the vendors to start integration work and pre-testing of MCX services.

For the 9th MCX Plugtests, 19 additional test cases were developed by ETSI for Multi-Client scenarios and Off network testing. In total, the MCX test specification has now 402 test cases. See clause 8. An updated test specification version will be published as a new version of ETSI document ETSI TS 103 564 (after ETSI TC TCCE approval).

174 tests were conducted by the vendors. 83% of the tests were successful, the remaining 17% failed for various reasons. The detailed results of the tests are available for the involved vendors in these test sessions but are not disclosed to the other vendors or to the public. All participants had to sign a Non-Disclosure Agreement and Rules of Engagement before joining the Plugtests event. The statistics of the test results are listed in clause 9.

The failed tests are very valuable because they give the vendors valuable information to improve their implementations. They also help to discover errors or ambiguities in the standards and to clarify and improve the specifications.

ETSI plan to conduct more FRMCS/MCX Plugtests in the future. The next FRMCS/MCX Plugtests sessions are planned for Q4 2025 and Q2 2026. Vendors and observers who have not participated in the previous MCX Plugtests events are welcomed and encouraged to join the next MCX Plugtests event.

2. References

The following documents have been used as references in the Plugtests. The participants in the Plugtests agreed on a set of specific documents and Release 17 versions for the eighth MCX Plugtests. Please see also the test specification document for the references.

[1] ETSI TS 103 564: Plugtests scenarios for Mission Critical Services.

[2] 3GPP TS 22.179: Mission Critical Push to Talk (MCPTT) over LTE.

[3] 3GPP TS 23.280: Common functional architecture to support mission critical services.

[4] 3GPP TS 23.379: Functional architecture and information flows to support Mission Critical Push To Talk (MCPTT)

[5] 3GPP TS 24.229: IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP).

[6] 3GPP TS 24.281: Mission Critical Video (MCVideo) signalling control.

[7] 3GPP TS 24.282: Mission Critical Data (MCData) signalling control.

[8] 3GPP TS 24.379: Mission Critical Push To Talk (MCPTT) call control.

[9] 3GPP TS 24.380: Mission Critical Push To Talk (MCPTT) media plane control.

[10] 3GPP TS 24.481: Mission Critical Services (MCS) group management.

[11] 3GPP TS 24.482: Mission Critical Services (MCS) identity management.

[12] 3GPP TS 24.483: Mission Critical Services (MCS) Management Object (MO).

[13] 3GPP TS 24.484: Mission Critical Services (MCS) configuration management.

[14] 3GPP TS 24.581: Mission Critical Video (MCVideo) media plane control.

[15] 3GPP TS 24.582: Mission Critical Data (MCData) media plane control.

[16] 3GPP TS 26.179: Mission Critical Push To Talk (MCPTT); Codecs and media handling.

[17] 3GPP TS 26.346: Multimedia Broadcast/Multicast Service (MBMS).

[18] 3GPP TS 29.212: Policy and Charging Control (PCC).

[19] 3GPP TS 29.214: Policy and Charging Control over Rx reference point.

[20] 3GPP TS 29.468: Group Communication System Enablers for LTE(GCSE_LTE); MB2 reference point.

[21] 3GPP TS 33.180: Security of the mission critical service.

[22] IETF RFC 3515: The Session Initiation Protocol (SIP) Refer Method.

[23] IETF RFC 3856: A Presence Event Package for the Session Initiation Protocol (SIP).

[24] IETF RFC 3903: Session Initiation Protocol (SIP) Extension or Event State Publication.

[25] IETF RFC 4488: Suppression of Session Initiation Protocol (SIP) REFER Method Implicit Subscription.

[26] IETF RFC 4825: The Extensible Markup Language (XML) Configuration Access Protocol (XCAP).

[27] IETF RFC 5366: Conference Establishment Using Request-Contained Lists in the Session Initiation Protocol (SIP).

[28] IETF RFC 5373: Requesting Answering Modes for the Session Initiation Protocol (SIP).

[29] IETF RFC 5875: An Extensible Markup Language (XML) Configuration Access Protocol (XCAP) Diff Event Package.

[30] IETF RFC 6135: An Alternative Connection Model for the Message Session Relay Protocol (MSRP).

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

[32] IETF RFC 7647: Clarifications for the use of REFER with RFC6665.

[33] OMA. OMA-TS-XDM_Core-V2_1-20120403-A: XML Document Management (XDM) Specification.

[34] OMA. OMA-TS-XDM_Group-V1_1_1-20170124-A: Group XDM Specification.

[35] IETF RFC 7230: Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing.

[36] IETF RFC 5246: The Transport Layer Security (TLS).

[37] IETF RFC 6101: The Secure Sockets Layer (SSL).

[38] IETF RFC 4975: The Message Session Relay Protocol (MSRP).

[39] 3GPP TR 21.905: Vocabulary for 3GPP Specifications.

[40] ETSI TS 100 392-19-1: Interworking between TETRA and Broadband systems: Critical Communications Architecture for Interworking between TETRA and Broadband applications. (not published)

[41] ETSI TS 100 392-19-2: Interworking between TETRA and Broadband systems: Format for the transport of TETRA speech over mission critical broadband systems.

[42] TIA-102.BACA-B-3: Project 25 Inter-RF Subsystem Interface Messages and Procedures for Voice Services, Mobility Management, and RFSS Capability Polling Services.

[43] TIA-102.BACD-B-3: Inter-RF Subsystem Interface (ISSI) - Messages and Procedures for Supplementary Data.

[44] OMA. OMA-TS-REST-NetAPI-NMS-V1-0-20190528-C: RESTful Network API for Network Message Storage".

[45] OMA. OMA-TS-REST-NetAPI-NotificationChannel-V1-0-20200319-C: RESTful Network API for Notification Channel.

3. Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [39] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [39].

AMR	Adaptative Multi-Rate Audio Codec
AMR-WB	Adaptative Multi-Rate Audio Codec Wideband
APP	Application
AS	Application Server
CMS	Configuration Management Server
CSC	Common Services Core
CSCF	Call Session Control Function
CSK	Client-Server Key
DHS	Department of Homeland Security
DUT	Device Under Test
E-UTRAN	Evolved Universal Terrestrial Radio Access Network
EPC	Evolved Packet Core
EPS	Evolved Packet System
ETSI	European Telecommunications Standard Institute
EUT	Equipment Under Test
FD	File Distribution
FE	Functional Element
FRMCS	Future Railway Mobile Communication System
GCSE	Group Communication Service Enabler
GMK	Group Master Key
GMS	Group Management Server
iFC	Initial Filter Criteria
IFS	Interoperable Functions Statement
IMPI	IP Multimedia Private Identity
IMPU	IP Multimedia Public identity
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IdMS	Identity Management Server
IWF	Interworking Function
KMS	Key Management Server
MBMS	Multimedia Broadcast and Multicast Service
MCData	Mission Critical Data
MCPTT ID	MCPTT user identity
MCPTT	Mission Critical Push-To-Talk
MCVideo	Mission Critical Video
MCX	Mission Critical Services (X stands for PTT, Data and Video)
OAM	Operation and Maintenance
OTT	Over the Top
P25	Project 25
PCC	Policy and Charging Control
PCRF	Policy and Charging Rules Function
PTT	Push-To-Talk
ProSe	Proximity-based Services
RAN	Radio Access Network
RTP	Real-time Transport Protocol
SDS	Short Data Service
SIP	Session Initiation Protocol
SPK	Signalling Protection Key
TAMU	Texas A&M University
TCCA	The Critical Communications Association
TD	Test Description
TETRA	Terrestrial Trunked Radio
TR	Technical Recommendation
TRT	Test Reporting Tool
TS	Technical Specification

UE	User Equipment
UIC	International union of railways (Union Internationale des Chemins de fer)

4. Technical and Project Management

4.1 Scope

The main goal of the ninth MCX Plugtests was testing the interoperability of the MCPTT, MCData and MCVideo ecosystem signalling and media plane at different levels. The Multi-client scenarios, Off-Network, Inter MCX, Multicast and interworking (IWF) with LMR were tested during the event.

The basic scenario tested comprised MCX application server(s) -both controlling and participating- and multiple MCX clients deployed over a generic SIP/IMS core, LTE & 5G access network with and without MCX required PCC capabilities with native multicast support (i.e. Release-14 -and higher- eMBMS) and UEs. The following Figure 1 illustrates the basic test infrastructure. Additionally, off-network communications between two UEs using 5G sidelink was evaluated.

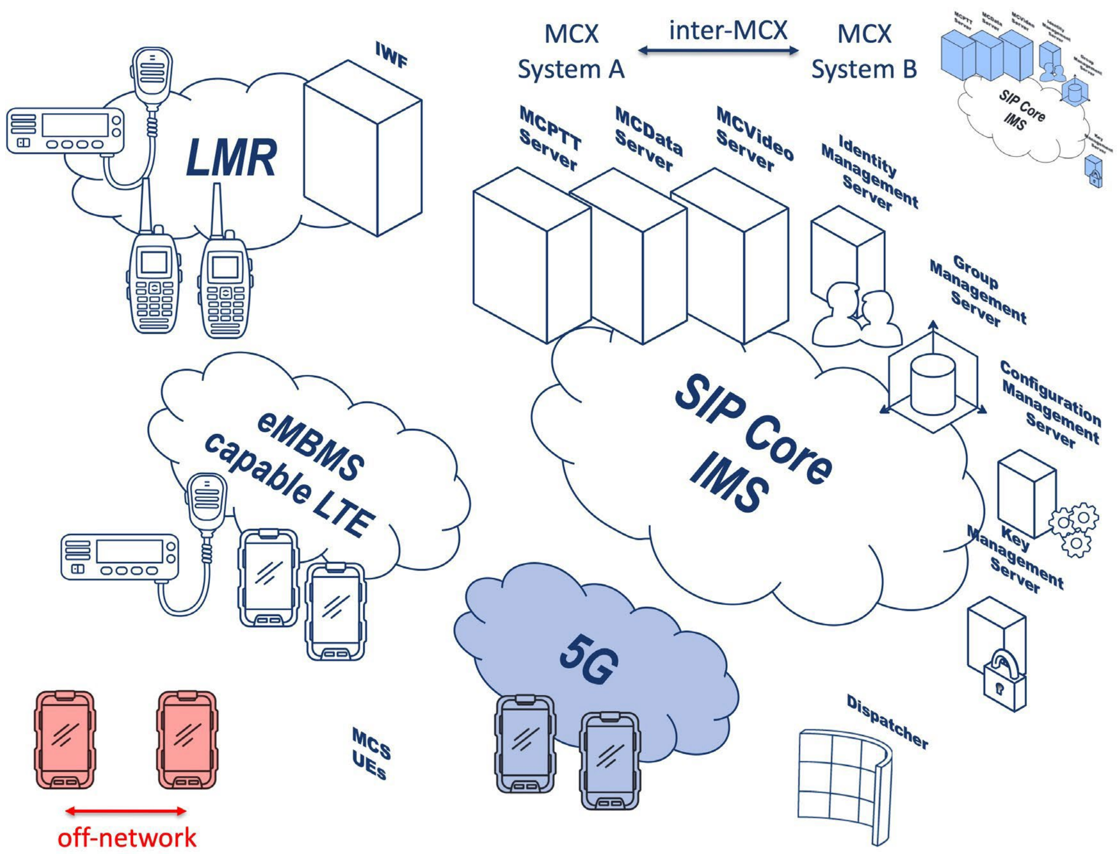

Figure 1. Typical MCPTT/MCData/MCVideo scenario to be considered in the Plugtests

In the scope of this Plugtests event, the following high level test objectives were performed

- **Connectivity (CONN)**: Tests covered basic connectivity between functional elements at different levels including Access Network (LTE), IP Network, SIP/IMS and MCPTT/MCData/MCVideo Application level. At LTE level, unicast and more particularly eMBMS multicast connectivity was evaluated. Tests at IP layer targeted pure OTT connectivity regardless the underlying access network. SIP connectivity tests checked proper deployment of MCX AS over the selected SIP Core/IMS so that all SIP messages were successfully delivered from MCX Clients to Participating/Controlling MCPTT Servers and vice versa. In this 9th Plugtests, AS vendors provided their own built-in SIP/IMS cores so that Clients registered into different cores depending on the specific test session. Application level refers to e2e signalling, media, floor controlling (and other involved) protocols in use. Plugtests participants were encouraged to carry on CONN tests over Mission Critical LTE/5G for unicast – or UNI-MC-LTE/5G – and Mission Critical LTE with multicast eMBMS-capabilities – so called MULTI-MC-LTE. Additionally, low level configuration-specific details (i.e. MCPTT. MC QCI and eMBMS bearer management) were considered in the PCC and eMBMS specific objectives. MCData and MCVideo features were mostly analysed in test cases associated to the CONN objective while sibling procedures (i.e. registration to different MCPTT/MCData/MCVideo servers) were carried out when needed.

- **eMBMS (EMBMS)**: Comprised checking of eMBMS specific signalling both in the MB2-U/C interface and e2e.
- **Multi IOP**: Interoperability testing-oriented complex test cases were added for Multi-client scenarios.
- **Interworking Function (IWF)**: MCPTT connectivity test cases were re-used to test interworking with LMR systems (Tetra and P25).
- **Inter MCX**: MCPTT/MCVideo connectivity test cases were used to test interworking between application servers.
- **Off-Network:** MCPTT off network test cases were used to test direct mode communication using Sidelink UEs.

4.2 Timeline

The preparation was run through different phases as described in the Figure 2 below.

	October		November				December				January					February			
	wk 43	wk 44	wk 45	wk 46	wk 47	wk 48	wk 49	wk 50	wk 51	wk 52	wk 01	wk 02	wk 03	wk 04	wk 05	wk 06	wk 7	wk 08	wk 09
Conference Calls	X - Open		X		X		X		X			X		X		X		X	
Registration		28/10/24 - 01/12/24																	
Equipment Registration											02/01/25 - 11/01/25								
VPN Integration											02/01/25 - 17/01/25								
Integration MCX AS with 4G/5G Network													13/01/25 - 09/02/25						
Pre-Testing																	10/02/25 - 14/02/25	Reserved	
Plugtests																			24/02/25 - 28/02/25

Figure 2. Plugtests event timeline

Registration to the MCX Plugtests event was open from 28th October 2024 to 01st December 2024 to any organisation willing to participate in testing the MCX Services Ecosystem. A total of 221 people were finally involved in the Plugtests event.

The following clauses describe the different phases of the Plugtests event preparation. It is worth noting that since the start of the documentation phase until the first week of the Plugtests event, bi-weekly conference calls were run among organisers and participants to discuss and track the progress, anticipate and solve technical issues, review the test plan, etc.

4.2.1 Documentation

Once the registration to the Plugtests event was closed, the following documentation activities were launched in parallel:

1) **EUT Documentation**

Participants documented their EUTs, by providing the information directly to the Plugtests event team. The Plugtests event team compiled the final EUT table for all the participating vendors and was appended to the Plugtests event Test Plan,

All the information described above was made available in the Plugtests event WIKI, so that it could be easily maintained and consumed by participants.

2) **Test Plan Development**

The Test Plan development was led by ETSI Centre for Testing and Interoperability following the methodology defined by 3GPP TSG SA6 and 3GPP TSG CT1. The Test Plan was scoped around 3GPP Test Specification Release-18 capabilities and concentrated on the features supported by the implementations attending the Plugtests event.

The Test Plan was developed and consolidated in an iterative way, considering input and feedback received from Plugtests event participants. See details in clause 8.

4.2.2 Integration & pre-testing

Participants connected their implementations remotely to the Plugtests event infrastructure, known as HIVE: Hub for Interoperability and Validation at ETSI. Participants also integrated their equipment with LTE and 5G test network cores to participate in all the streams.

From 13th January to 9th February 2025, participants connected their equipment's with LTE and 5G network to collaboratively run the Interoperability Test Sessions remotely. Over the top IP based testing was performed during the pretesting phase from 10th February to 21st February 2025.

During this phase, up to 29 remote labs connected to HIVE and each of them was allocated a dedicated network. The interconnection of remote labs allowed running integration and pre-testing tasks remotely among any combination of participating EUTs, in order to ensure an efficient use of the Plugtests event time and smoother Interoperability test sessions.

A VPN connection to the HIVE was highly recommended for participants providing MCX Application Servers, MCX Clients, Dispatchers, gNB and EPC for first connectivity tests, trouble shooting and infrastructure access purposes.

Additional details on the remote test infrastructure, remote integration and pre-testing procedures are provided in Clauses 6 and 7.

For the LTE and 5G testing in College Station, MCX AS Servers were connected to the LTE and 5G test systems. Assistance was provided by the test system experts to debug integration issues with the test networks.

During this phase, the bi-weekly conference calls were continued among organisers and participants to synchronise, track progress and get ready for the on-site phase.

4.2.3 Plugtests event

From 24th February to 28th February 2025, participants connected their equipment with the test network to collaboratively run the Interoperability Test Sessions onsite.

The scheduling of individual test combinations was partly done randomly using the ETSI Test Reporting tool from Tuesday, 25th February, to Thursday, 27th February. Participants agreed on test session slots between themselves for Monday, 24th February, and Friday, 28th February. The schedule was adapted during the test session slots on a per-need basis.

4.3 Tools

4.3.1 Plugtests event WIKI

The Plugtests event WIKI was the main source of information for the MCX Plugtests event, from logistics aspects to testing procedures. Access to the WIKI was restricted to participating companies.

The main technical information provided in the wiki was organised as follows:

- **Event Information** – Logistics aspects of the Plugtests event.
- **Host Information** – Information about the equipment available.
- **Shipment of Equipment** – Information regarding shipment of equipment.
- **Visa Information** – Visa related information was provided for vendors require visa for travel.
- **List of Participants** – List of participants in the event.
- **Schedule –** Complete schedule of the event.
- **Observer Program** – Information about the Observer presentations and Observer demo during the Plugtests event.
- **Test Tools** – Information from the Test Tool vendors about what kind of tests they are offering for the Plugtests.

- **Test Network Information –** LTE and 5G test network information.
- **Frequency Allocation** - Information related to frequency allocation for the radio equipment (eNBs, gNBs).
- **IT Infrastructure** - HIVE connection request tool, and remote connections status overview.
- **Specifications -** High Level Test Scope including the test specification and reference to 3GPP and IETF specifications.
- **Equipment under Test** - Participating EUTs overview and contact information.
- **Off-Network** – Information regarding sidelink UEs for port numbers/broadcast address.
- **Provisioning Information -** Pre-configured parameters for EUTs.
- **Test Reporting Tool** - Documentation of the Test Reporting Tool.
- **Conf Calls** - Calendar, logistics, agendas and minutes of the bi-weekly conference calls run during the remote integration and pre-testing phase.
- **Observations** - Issues found during Plugtests event.
- **Networking Dinner** – Information regarding networking dinner.

In addition, the participants communicated with each other during the pre-testing phase and Test Sessions using Slack and Google Sheets, and they included their remote colleagues (back-office support) in the discussions.

4.3.2 Test Reporting Tool (TRT)

The Test Reporting Tool guides participants through the Test Plan test cases during the pre-testing and main Test Sessions. It allows creating Test Session Reports compiling detailed results for the individual scheduled Test Sessions.

Only the companies providing the EUTs for each specific Test Session combination have access to their Test Session Reports contents and specific results. All companies involved in a specific session and who have entered the test results were required to verify and approve the reported results at the end of each session. Only test report which has been approved by all involved parties are considered as valid.

Another interesting feature of this tool is the ability to generate real-time stats (aggregated data) of the reported results, per test case, test group, test session or overall results. These stats are available to all participants and organisers and allow tracking the progress of the testing with different levels of granularity, which is extremely useful to analyse the results.

5. Equipment Under Test

The tables Table 1 to Table 9 below summarise the different EUTs provided by the Plugtests event participants:

5.1 MCX Application Servers

Organisation	Support
Airbus	MCPTT, MCDATA, MCVIDEO, Inter-MCX
Alea	MCPTT, MCDATA, MCVIDEO, IWF, Inter-MCX
Consort	MCPTT, MCDATA, MCVIDEO
Cybertel	MCPTT, MCDATA, MCVIDEO, IWF
Frequentis	MCPTT, MCDATA, MCVIDEO, IWF
HMF	MCPTT, MCDATA, MCVIDEO
Hytera	MCPTT, MCDATA, MCVIDEO, IWF, Inter-MCX
Kontron	MCPTT, MCDATA, IWF
MCLabs	MCPTT, MCDATA, MCVIDEO, Inter-MCX
Motorola	MCPTT, MCDATA, MCVIDEO, IWF, Multicast
Nemergent	MCPTT, MCDATA, MCVIDEO, IWF
Pocstars	MCPTT, MCDATA
StreamWide	MCPTT, MCDATA, MCVIDEO, IWF, Inter-MCX, Multicast
Tassta	MCPTT, MCDATA, MCVIDEO
TDtech	MCPTT, MCDATA, MCVIDEO, IWF, Inter-MCX
Teltronic	MCPTT, MCDATA, IWF, Inter-MCX
Valid8	MCPTT, MCDATA, MCVIDEO

Table 1. MCX Application Servers Under Test

5.2 MCX Clients

Organisation	Support
Alea	MCPTT, MCDATA, MCVIDEO, Off-Network
Consort	MCPTT, MCDATA, MCVIDEO
Cybertel	MCPTT, MCDATA, MCVIDEO
Eviden	MCPTT, MCDATA, MCVIDEO
Funkwerk	MCPTT, MCDATA
HMF	MCPTT, MCDATA, MCVIDEO
Hytera	MCPTT, MCDATA, MCVIDEO
Kontron	MCPTT, MCDATA
MCLabs	MCPTT, MCDATA, MCVIDEO, Off-Network
Motorola	MCPTT, MCDATA, MCVIDEO
Nemergent	MCPTT, MCDATA, MCVIDEO
Pocstars	MCPTT, MCDATA
Sanchar	MCPTT, MCDATA, MCVIDEO
Sepura	MCPTT, MCDATA
Softil	MCPTT, MCDATA, MCVIDEO, Off-Network
StreamWide	MCPTT, Off-Network
Tassta	MCPTT, MCDATA, MCVIDEO
TDtech	MCPTT, MCDATA, MCVIDEO
Teltronic	MCPTT, MCDATA
Viavi	MCPTT, MCDATA, MCVIDEO

Table 2. MCX Clients Under Test

5.3 Dispatcher (DISP)

Organisation	Support
Amper	MCPTT, MCDATA,
Catalyst	MCPTT, MCDATA,
Eviden	MCPTT, MCDATA, MCVIDEO
Frequentis	MCPTT, ,
Hytera	MCPTT, MCDATA, MCVIDEO
Kontron	MCPTT, MCDATA,
Softil	MCPTT, MCDATA, MCVIDEO
Tassta	MCPTT, MCDATA, MCVIDEO
Teltronic	MCPTT, MCDATA,
Valid8	MCPTT, MCDATA, MCVIDEO
Zetron	MCPTT, MCDATA, MCVIDEO

Table 3. Dispatcher (DISP) Under Test

5.4 Evolved Packet Core (EPC) and Evolved Node B (eNB)

Organisation	Support
Druid	with Nokia eNB
Teltronic	

Table 4. Evolved Packet Core and eNB Under Test

5.5 5G Core (5GC) and 5G New Radio (5GNR)

Organisation	Support
Druid	
Teltronic	

Table 5. 5G Core and 5G NR Under Test

5.6 User Equipment (UE)

Organisation	Support
Cybertel	4G, 5G-NSA, 5G-SA
Funkwerk	4G, 5G-NSA, 5G-SA
Hytera	4G, 5G-NSA, 5G-SA
Qualcomm	5G NR Sidelink
Sepura	4G, 5G-NSA, 5G-SA
Zebra	4G, 5G-NSA, 5G-SA

Table 6. User Equipment Under Test

5.7 Land Mobile Radio (LMR)

Organisation	Support
Amper	TETRA System, MCPTT, located in Spain
Rohill	TETRA System, MCPTT, MCDATA, on-site
Teltronic	TETRA System, MCPTT, located in Spain

Table 7. Land Mobile Radio Under Test

5.8 Evolved Multimedia Broadcast Multicast Services (eMBMS) Components

Organisation	Support
Teltronic	Teltronic: EPC, eMBMS (MB2)
Druid / Nokia / Enensys	Druid: EPC, Nokia: eNB, Enensys: eMBMS
Druid / Enensys / Enensys	Druid: EPC, Enensys: eNB, Enensys: eMBMS

Table 8. Evolved Multimedia Broadcast Multicast Services (eMBMS) Components Under Test

5.9 Test Tools

Organisation	Support
MIW	KPI Tester
Teraquant	KPI Tester

Table 9. Testers Under Test

6 Test Infrastructure

6.1 Remote Test Infrastructure

The remote testing and pre-testing phase were enabled by the setup as shown in Figure 3:

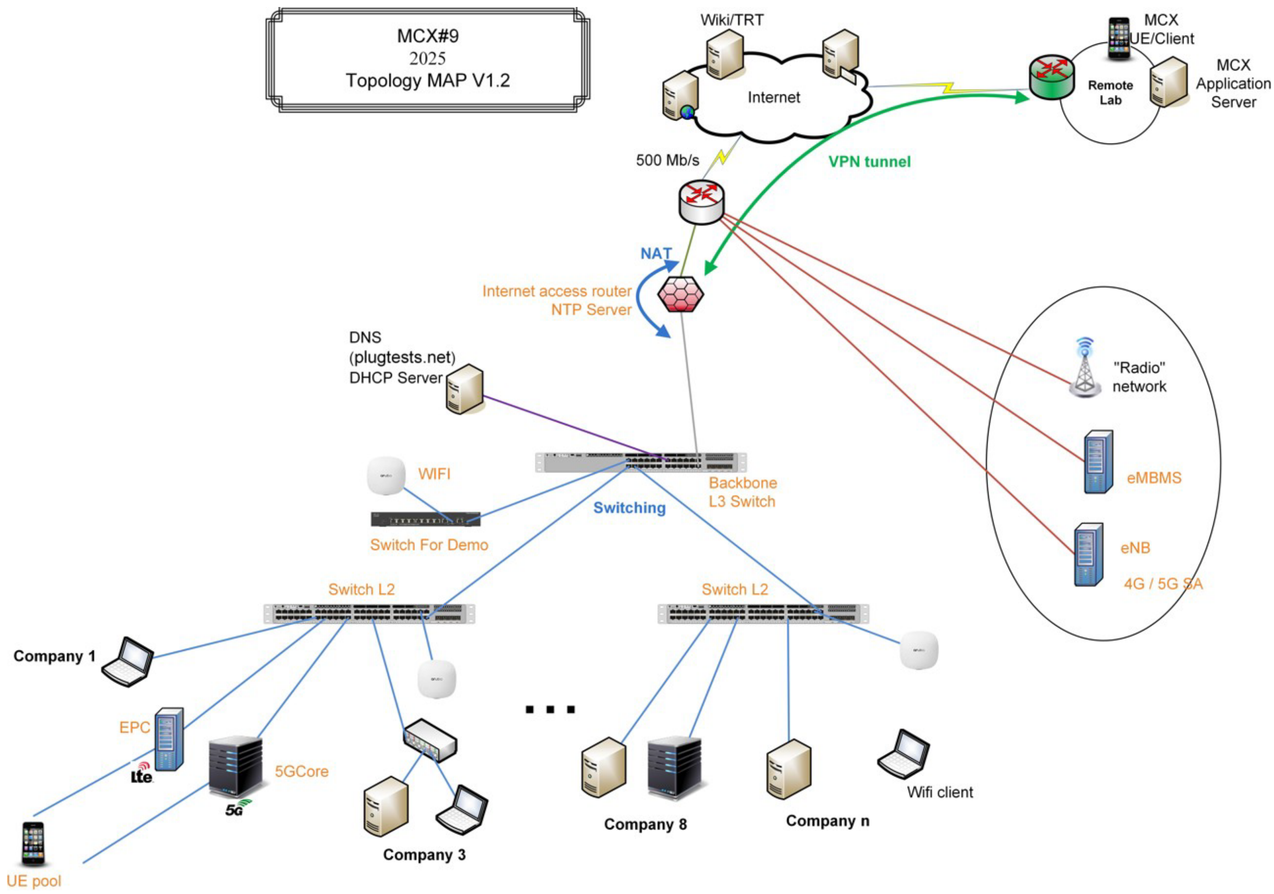

Figure 3. Remote Test Infrastructure

Once HIVE was deployed, a number of VPN tunnels were created to interconnect the equipment of the participants where the EUTs were running.

A total of 29 Remote Labs connected to the setup described above as a participant's lab.

7 Test Procedures

7.1 Test Streams

The testing and test setup were structured in different test streams in this Plugtests. Table 10 shows the available test streams in the MCX#9 Plugtests.

Stream	Purpose	Description
A	MCX/4G	Testing of MCX components over a 4G network
B	MCX/5G	Testing of MCX components over a 5G network
C	IWF	Testing of MCX and LMR components, connected via IWF
D	Inter-MCX	Testing of Interconnected MCX servers
E	Off-network	Testing of sidelink with off-network MCX clients
F	Multicast	Testing of Multicast/eMBMS components with MCX components
G	Test Tools	Conformance test tools and MCX server/clients

Table 10. Available test streams in MCX#9 Plugtests

7.2 Remote Integration & Pre-testing Procedure

During the remote integration and pre-testing phase, the participating Equipment Under Test followed the following procedures: Once the EUT documentation and HIVE connection had been successfully completed, the test cases from the test specifications were executed as part of the pre-testing.

The progress of these procedures for the different combinations of EUTs was captured in the reporting function of TRT. The following Pre-Testing configurations (see Table 13) were used in the pretesting phase.

The pre-testing reports were not considered for the final Plugtests statistics.

Config Name	Pre-testing Configuration
Config Pretest OTT	MCX Client + MCX AS
Config Pretest OTT Disp	Dispatcher + MCX AS
Config Pretest IWF	MCX Client + MCX AS + LMR
Config Pretest Inter MCX	MCX Client + MCX AS + MCX Client + MCX AS
Config Integ 4G	MCX AS + 4G
Config Integ 5G	MCX AS + 5G

Table 11. Pre-testing Configuration

7.3 Interoperability Testing Procedure

During the Plugtests event, a daily Test Session Schedule was added and shared via the TRT. Test Sessions were organised in several parallel tracks, ensuring that all participants had at least one Test Session scheduled any time. The different test configurations were used for the main event (see Table 14).

Stream	Config Name	Main Test Configuration
A	Config 4G MCX	MCX Client + MCX AS + MCX Client + 4G
A	Config 4G MCX Disp	MCX Client + MCX AS + MCX Client + 4G + Dispatcher
B	Config 5G MCX	MCX Client + MCX AS + MCX Client + 5G
B	Config 5G MCX Disp	MCX Client + MCX AS + MCX Client + 5G + Dispatcher
C	Config 4G IWF	MCX Client + MCX AS + Tetra + 4G
C	Config 5G IWF	MCX Client + MCX AS + Tetra + 5G
C	Config 5G IWF Disp	MCX Client + MCX AS + Tetra + 5G + Dispatcher
D	Config 4G Inter MCX	MCX Client + MCX AS + 4G + MCX Client + MCX AS
D	Config 4G Inter MCX Disp	MCX Client + MCX AS + 4G + MCX Client + MCX AS + Dispatcher
D	Config 5G Inter MCX	MCX Client + MCX AS + 5G + MCX Client + MCX AS
D	Config 5G Inter MCX Disp	MCX Client + MCX AS + 5G + MCX Client + MCX AS + Dispatcher
D	Config Multi RAN Inter MCX	MCX Client + MCX AS + 5G + MCX Client + MCX AS + 4G + Dispatcher
D	Config Multi 5G RAN Inter MCX	MCX Client + MCX AS + 5G + MCX Client + MCX AS + 5G + Dispatcher
E	Config Off Network	MCX Client + Off Network UE + MCX Client + Off Network UE
E	Config Off Network Multi	MCX Client + Off Network UE + MCX Client + Off Network UE + MCX Client + Off Network UE
F	Config eMBMS	MCX Client + MCX AS + 4G + eMBMS
G	Config TT AS	MCX AS + Test Tool
G	Config TT Client	MCX Client + Test Tool
G	Config TT Dispatcher	Dispatcher + Test Tool

Table 12. Main Test Configurations

During each test session, for each tested combinations the Interoperability testing procedure was as follows:

1. The participating vendors opened the Test Session Report and the Test Plan.

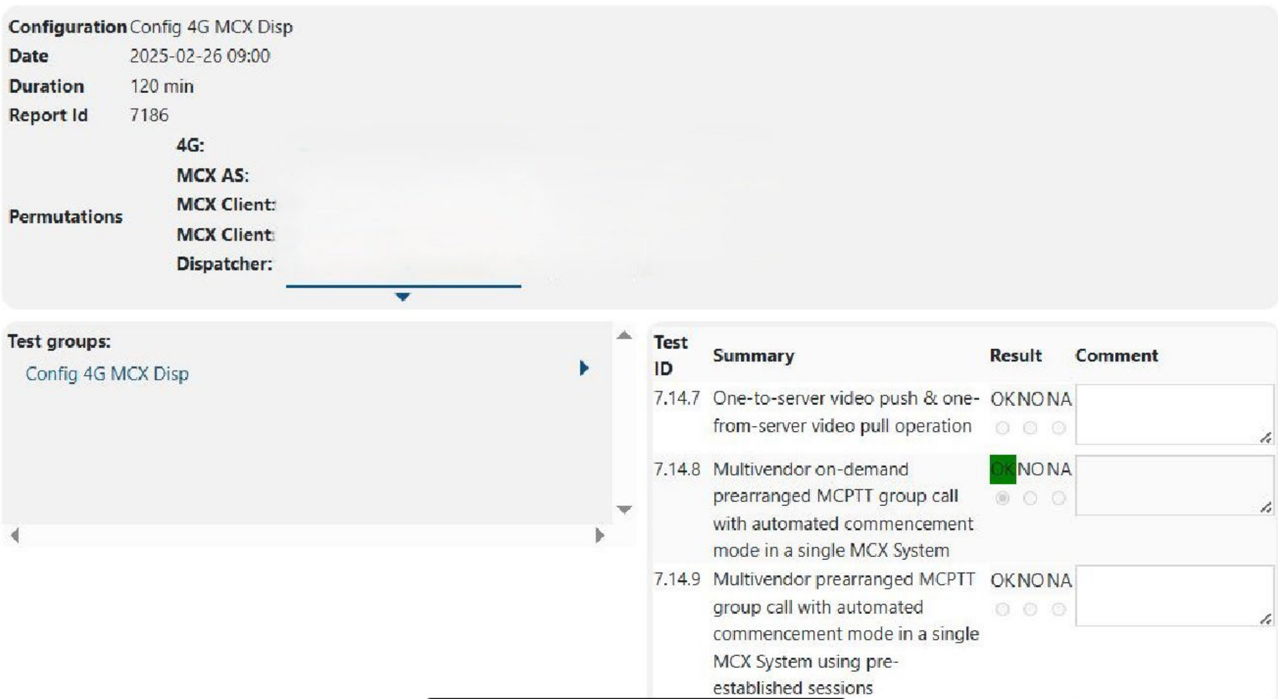

Figure 4. Test Session Report

2. For each Test in the Test Plan:

   a. The corresponding Test Description and EUT Configuration were followed.

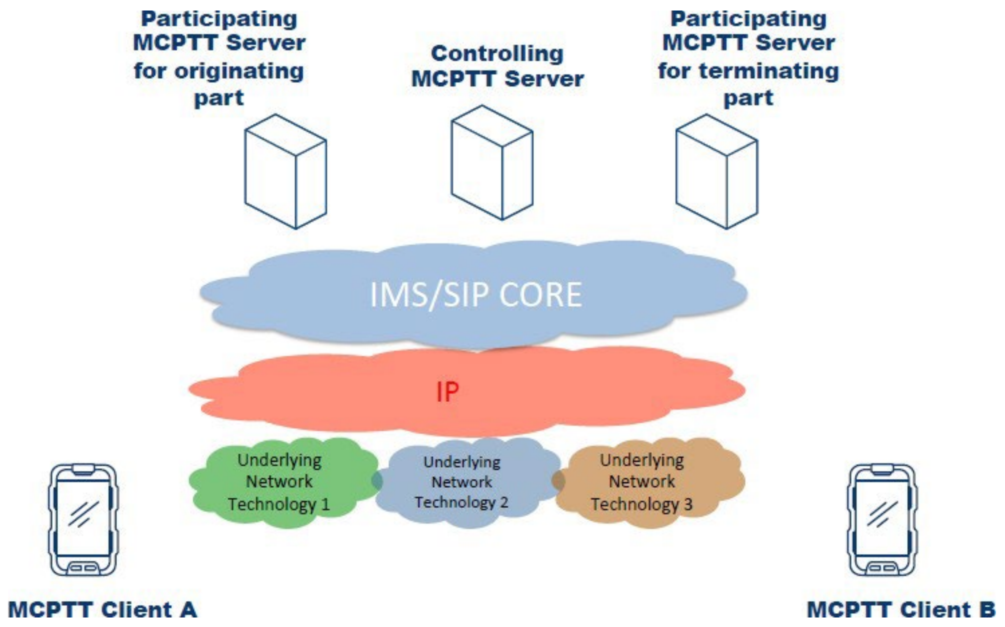

Figure 5. System Under Test (SUT) Configuration – MCPTT example

Interoperability Test Description			
Identifier	IWF/MCPTT/CONN/ONN/CTRL/PRIV/AUTO/ONDEM/WFC/NFC/01		
Test Objective	Verify IP connectivity, SIP core/IMS configuration and proper routing and SIP signalling for LMR user, LMR user triggering a private call to a MCPTT user in automatic commencement mode with the IWF on the controlling role		
Configuration(s)	• CFG_ONN_OTT-1 (clause 5.2) • CFG_ONN_UNI-MC-LTE-1 (clause 5.3) • CFG_ONN_MULTI-MC-LTE-1 (clause 5.4)		
References	• SIP (see ETSI TS 124 229 [6] and other references in ETSI TS 124 379 [9])		
Applicability	• IWF-MCPTT_AFFIL • IW-MCPTT_PART • IWF-MCPTT-Part_ONN-MCPTT-CALL • IWF-MCPTT-Part_MCPTT-FC • MCPTT-Client_ONN-MCPTT-CALL, MCPTT-Client_AMR-WB • MCPTT-Client_AFFIL, MCPTT-Client_MCPTT-FC (clause 6.2) • MCPTT-Part_ONN-MCPTT-CALL, MCPTT-Part_AFFIL (see note) • MCPTT-Part_MCPTT-FC, MCPTT-Part_RX (CFG_ONN_UNI-MCLTE-1 only) • MCPTT-Part_GCSE (CFG_ONN_MULTI-MC-LTE-1 only) (clause 6.5) • MCPTT-Ctrl_ONN-MCPTT-CALL, MCPTT-Ctrl_AFFIL (see note) (clause 6.6)		
Pre-test conditions	• IP connectivity among all elements of the specific scenario • Proper configuration of the SIP core/IMS to forward the signalling to the specific controlling and participating servers including the IWF in participating mode • LMR UEs and MC clients properly registered to the LMR and SIP core/IMS and MC system respectively • Static/dynamic mapping of the SIP identity (i.e. IMPU) vs. mcptt_id		
Test Sequence	**Step**	**Type**	**Description**
	1	stimulus	LMR user triggers a private call towards a user mapped to a mcptt_id (i.e. mpctt_id_clientB)
	2	check	Resulting INVITE is generated in the IWF on a controlling role providing the private calling function to the LMR user
	3	check	The IWF forwards it to the terminating participating
	4	check	MCPTT client receives the INVITE, send a notification to the user (i.e. rings) and sends back a 200 OK
	5	verify	Call connected and private call between LMR and MCPTT user stablished
NOTE: It is not considered the triggering and possible effects of (un)successful implicit affiliation in the MCPTT participating server for the case when the calling is not affiliated to the group identified in the "SIP INVITE request for originating participating MCPTT function" as determined by clause 9.2.2.2.11 in ETSI TS 124 379 [9].			

Figure 6. Test Description example

3. MCX equipment providers jointly executed the different steps specified in the test description and evaluated interoperability through the different IOP Checks prescribed in the Test Description

    b. The MCX equipment provider recorded the Test Result in the Test Session Report, as follows:

        i. OK: all IOP Checks were successful

        ii. NOK: at least one IOP Check failed. A comment was requested.

        iii. NA: the feature was not supported by at least 1 of the involved EUTs. A comment was requested.

4. Once all the tests in the Test Session Report were executed and results recorded, the participants reviewed the Report and approved it.

7.4 Identified Challenges

During and after the MCX#09 Plugtests participating vendors, observers, and the ETSI Plugtests team made a few observations on potential improvements. These observations will help to organize the next Plugtests better.

Observations were:

- Stable and available networks are key for the Plugtests. It is important to ensure that test networks are available during the Plugtests week and provide stable services. The radio signal strength should be available everywhere in the test room. Sufficient personnel and support from the network vendors should be available during the pre-integration and testing phases and on-site during the Plugtests week to help The other vendors integrate their equipment and help troubleshoot any issues.
- It is important to have sufficient test devices available during the whole testing week. The devices should be available from the first testing day until the last testing day. Support personnel should be available during the whole Plugtests week to help other vendors integrate their clients and with any troubleshooting. It would be good to motivate a high number of device vendors to come to the Plugtests and to bring a sufficient number of devices to the Plugtests.
- Attending the observer demos may prevent vendors to continue testing. This should not be the case. It may make sense to limit the number of demos a vendor can participate in to ensure vendors can continue testing with other vendors during the time of the observer demos.

8 Test Plan Overview

8.1 Introduction

This 9th MCX Plugtests Test Plan was developed following ETSI guidelines for interoperability. Additional Release-18-based test cases, comprising Multi-Client scenarios, Off-Network, and IWF, were included.

The Test Plan was reviewed and discussed with participants during the preparation and pre-testing phase. Considering the huge number of resulting test cases and difference expected maturity of the implementations and differences from participants in the previous Plugtests event and new companies, vendors selected the subset of test cases to evaluate in a per-testing slot basis.

The following sections summarise the methodology used for identifying the different configuration and test objectives leading to different test cases subgroups.

8.2 Test configurations

The overall MCX ecosystem comprises both controlling and participating MCPTT/MCData/MCVideo application server(s), MCPTT Clients deployed over a generic SIP Core/IMS, LTE/5G access network with and without MCPTT required PCC capabilities and native multicast support (i.e. Release-14 eMBMS). Furthermore, a series of support servers were integrated in the so-called Common Services Core provide configuration, identity, group, and key management capabilities. Note, again. 3GPP Off-Network operations were also considered.

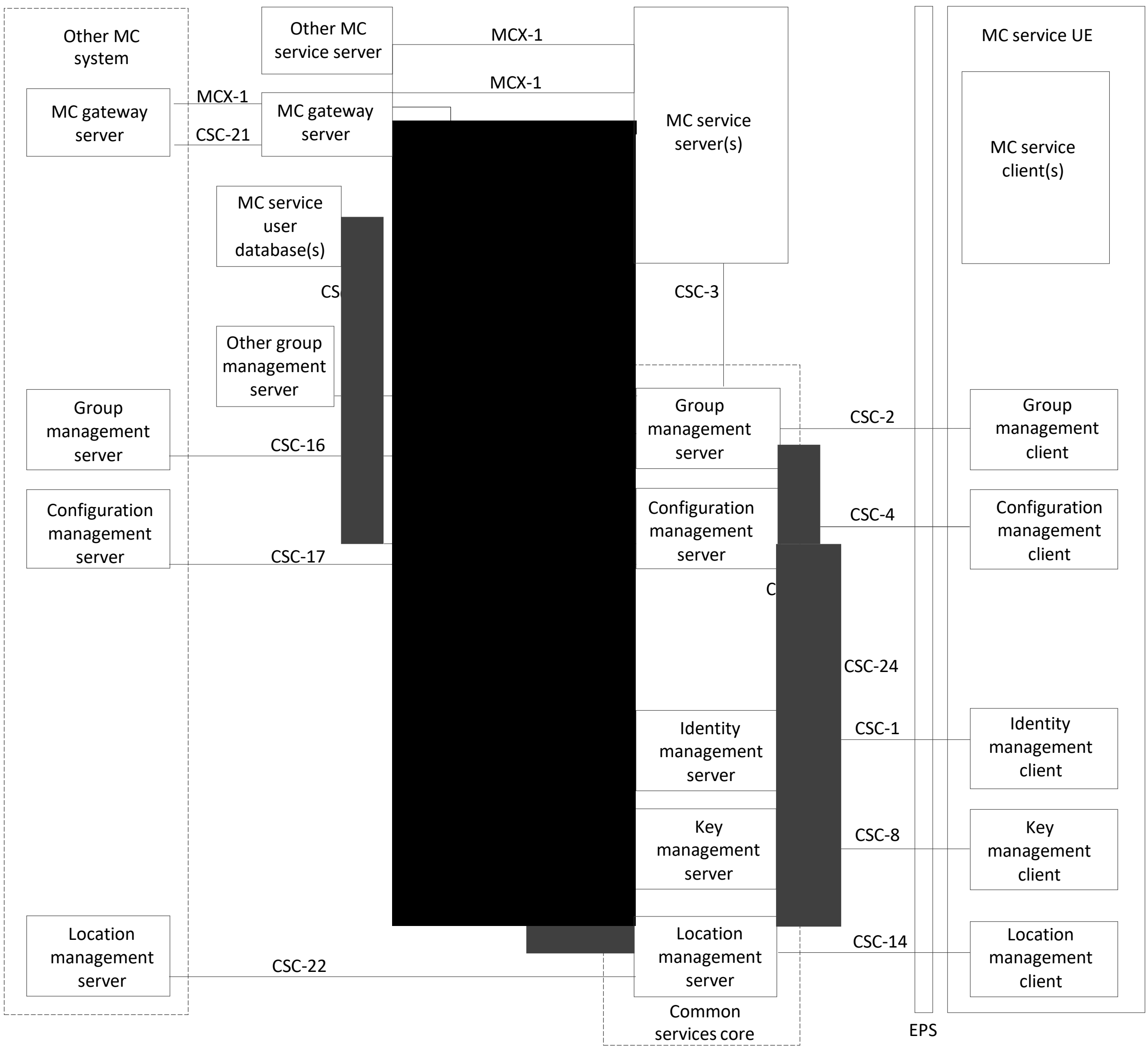

Figure 7. Functional model for on network application plane Figure 7.3.1-1 in 3GPP TS 23.280 [3]

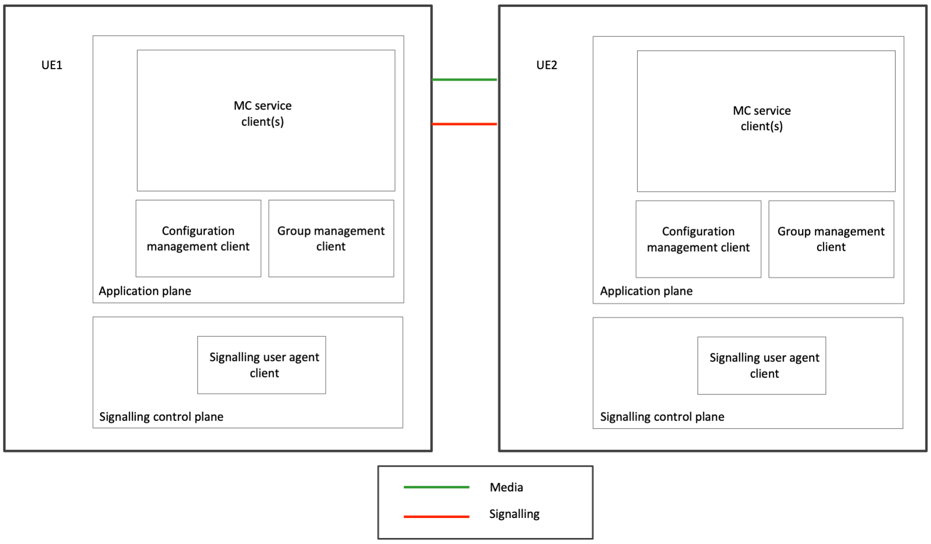

Figure 8. Functional model for off network application plane Figure 7.3.2-1 in 3GPP TS 23.280 [3]

Figure 7.3.1-1 in 3GPP TS 23.280 [3] (see Figure 7) describes the overall architecture and the reference points considered for the interoperability testing for any (MCPTT/MCData/MCVideo) MC Service (MCS). As can be seen, the resulting number of functional elements, interfaces and protocols involved is quite large. Furthermore, there are MCPTT/MCData/MCVideo-only specific interfaces and others (like Rx/N5/N33 and MB2-C/MB2-U) involving other supporting technologies like LTE EPS, 5G, etc. In order to focus on MCS signalling the following three different configuration were initially considered: MCPTT/MCData/MCVideo as an application service over IP networks (Over-the-Top), unicast Mission Critical LTE/5G and multicast Mission Critical LTE/5G (all of them for On-Network calls only).

Similarly, Figure 7.3.2-1 in 3GPP TS 23.280 [3] (see Figure 8) describes the overall architecture and the reference points considered for the interoperability testing among MCS clients in off-network operations.

8.2.1 Over-The-Top Configuration for On-Network calls (CFG_ONN_OTT-1)

This configuration considered On-Network Calls (ONN) with a pure Over-The-Top (OTT) approach. It emulated a scenario where any underlying network (i.e. commercial LTE/5G, WiFi or any wired technology such as Ethernet) would provide a bit-pipe type only access. No QoS/prioritization enforcement neither access-layer multi/broadcasting capabilities would be provided (i.e. nor unicast PCC support or multicast mechanisms in LTE/5G). Therefore, although not usable in a real world Mission Critical environment but for non-3GPP devices such as dispatchers, it was used for connectivity tests since it did not require any binding between the IMS/SIP Core and the underlying LTE/5G infrastructure and allowed both signalling and media plane parallel testing easily.

8.2.2 Unicast Mission Critical LTE/5G for On-Network calls (CFG_ONN_UNI-MC -1)

In this configuration the LTE network (both EPC and eUTRAN) and 5G network (both 5GC and gNB) provided PCC capabilities and therefore enforced QoS policies in terms of prioritization and pre-emptiveness of Mission Critical unicast bearers. That included new Public Safety QCI 65/69 support in UEs and EPC/eUTRAN (or 5G Qi 65/69), and the availability of a PCRF with MCPTT compliant Rx/MCPTT-5 interface (or PCF with an N5/N33 in a 5G core). Specific Rx/MCPTT-5/N5/N33 reference points and unicast bearer setup and update triggering mechanisms were tested using this configuration. Note that, although MCPTT only is mentioned and depicted in the following Figure 9, MCVideo/MCData could follow the same approach.

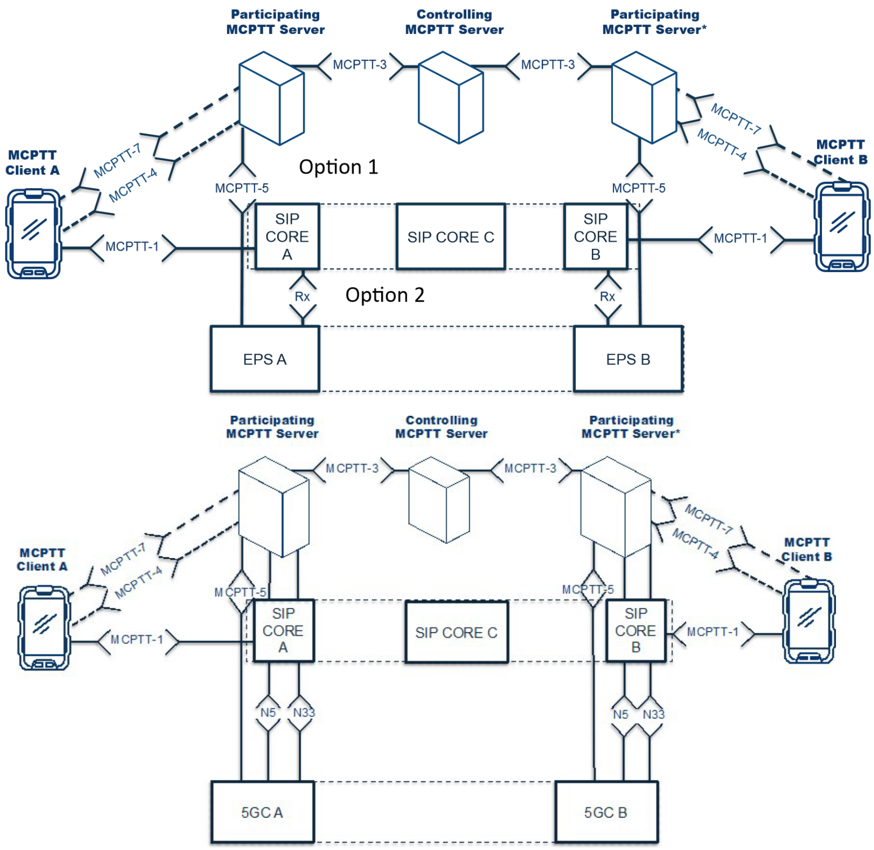

Figure 9. CFG_ONN_UNI-MC- 1 configuration

8.2.3 Multicast Mission Critical LTE for On-Network calls (CFG_ONN_MULTI-MC-LTE-1)

In this configuration LTE provided multicast capability including Rel. 14 (and beyond) LTE-A Pro eMBMS and needed interfaces both in the core side (MB2-C and MB2-U with the BM-SC) and in the eUTRAN/UE side. It was used to test eMBMS bearer setup and update related test cases.

NOTE: In this 9th MCX Plugtests both configurations (unicast and multicast scenarios) were possible.

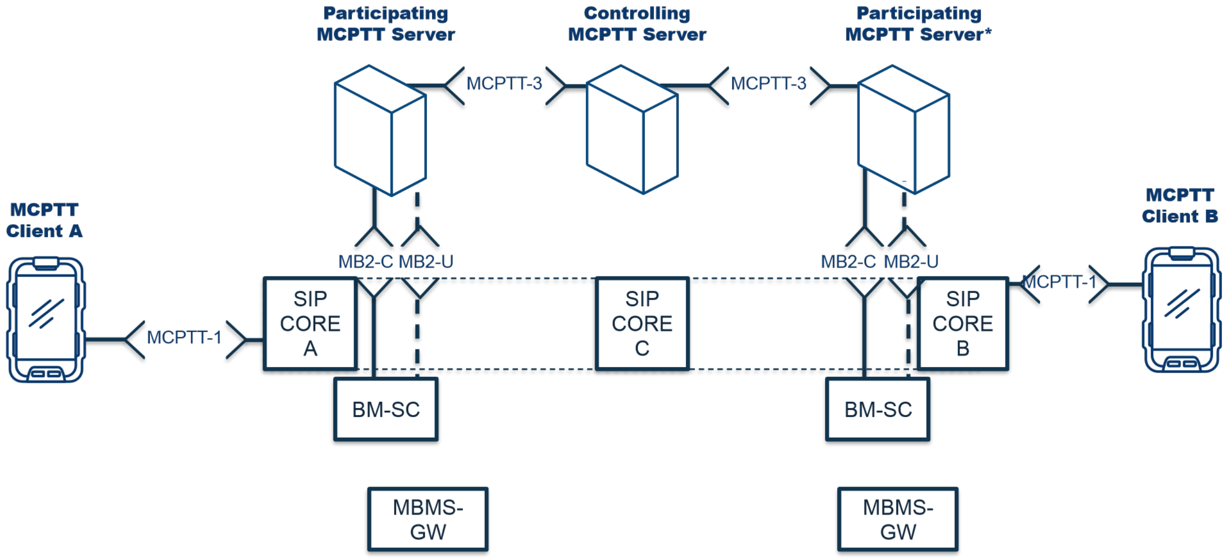

Figure 10. CFG_ONN_MULTI-MC-LTE-1 configuration

In order to deal with the different test setting according to the three aforementioned configurations and cover specific more complex test configuration involving different clients and Observer test cases, the following configuration modes were defined in the TRT tool.

Configuration	Resulting configuration mode in the Plugtests (TRT)
ONN-OTT	Config Pretest OTT Config Pretest OTT Disp Config Pretest IWF Config Pretest Inter MCX
ONN-LTE	Config Integ 4G Config 4G Inter MCX Config 4G Inter MCX Disp Config 4G IWF Config 4G MCX Config 4G MCX Disp Config Multi RAN Inter MCX
ONN-5G	Config Integ 5G Config 5G Inter MCX Config 5G Inter MCX Disp Config 5G IWF Config 5G IWF Disp Config 5G MCX Config 5G MCX Disp Config Multi 5G RAN Inter MCX Config Multi RAN Inter MCX
ONN-OFF	Config Off Network Config Off Network Multi

Table 13. Mapping of scenario architecture configurations and Plugtests event practical configurations

9 Interoperability Results

9.1 Overall Results

During the Plugtests event, a total of 146 Test Sessions were run: that is, 146 different combinations based on different configurations in Test Scope: MCX Client, MCX Server (Participating and Controlling), eNB, EPC, gNB, 5GC, LMR, Dispatcher, 4G UE, 5G UE, Sidelink UE, MBMS GW, BMSC and Testers were tested for interoperability. Overall, 174 test executions were conducted and reported interoperability and conformance results.

Table 16 and Figure 11 below provides the overall results (aggregated data) from all the Test Cases run during all the Test Sessions with all the different combinations of Equipment Under Test from all the participating companies.

Interoperability		Totals
PASS	**FAIL**	**Run**
145 (83.3 %)	29 (16.7 %)	174

Table 14. Overall Interoperability Results based on executed test cases

Figure 11. Overall Interoperability results based on executed test cases

A overall interoperability success rate of 83.3% was achieved, which indicates a very high degree of compatibility among the participating implementations (EUTs) in the areas of the Test Plan where features were widely supported and the test cases could be executed in most of the Test Sessions. In the next clauses, we will see that this high rate is also a consequence of the good preparation and involvement of participants during the remote integration and pre-testing phase of the Plugtests.

Compared to previous Plugtests the success rate is lower. This may be due to the more complex test configurations which were introduced in this MCX#9 Plugtests. More vendors had to test with each other in a test session in MCX#9 Plugtests compared to the previous Plugtests, making it a bit more difficult to set up all equipments for a test execution.

9.2 Results per Test Configuration

Table 17 below provides the results for each test configuration in the scope of the Plugtests event. The below configurations are defined in clause 7.2.

Interoperability				
Stream	**Configurations**	**PASS**	**FAIL**	**Run**
A	**Config 4G MCX**	12 (85.7%)	2 (14.3%)	14
A	**Config 4G MCX Disp**	19 (76.0%)	6 (24.0%)	25
B	**Config 5G MCX**	9 (75.0%)	3 (25.0%)	12
B	**Config 5G MCX Disp**	22 (75.9%)	7 (24.1%)	29
C	**Config 4G IWF**	38 (84.4%)	7 (15.6%)	45
C	**Config 5G IWF**	5 (100.0%)	0 (0.0%)	5
C	**Config 5G IWF Disp**	0 (0.0%)	0 (0.0%)	0
D	**Config 4G Inter MCX**	5 (62.5%)	3 (37.5%)	8
D	**Config 4G Inter MCX Disp**	0 (0.0%)	1 (100.0%)	1
D	**Config 5G Inter MCX**	0 (0.0%)	0 (0.0%)	0
D	**Config 5G Inter MCX Disp**	6 (100.0%)	0 (0.0%)	6
D	**Config Multi RAN Inter MCX**	0 (0.0%)	0 (0.0%)	0
D	**Config Multi 5G RAN Inter MCX**	0 (0.0%)	0 (0.0%)	0
E	**Config Off Network**	19 (100.0%)	0 (0.0%)	19
E	**Config Off Network Multi**	0 (0.0%)	0 (0.0%)	0
F	**Config eMBMS**	10 (100.0%)	0 (0.0%)	10
G	**Config TT Client**	0 (0.0%)	0 (0.0%)	0
G	**Config TT AS**	0 (0.0%)	0 (0.0%)	0

Table 15. Results per Test Configuration

The table shows the execution and interoperability rates for different Test Configurations.

9.3 Equipment Integrations and Test Combinations

The following Figures Figure 12 to Figure 18 show the integrated equipments and test combinations for each test stream. The grey lines show the initially planned integrations; the blue lines show the successful pre-integrations during the pre-integration phase which were done via the VPN connections; and the green lines show the actual test combinations which were used for the tests during the Plugtests week.

Please note that the indicated combinations do not bear any information whether a specific test combinations has passed or failed the test cases.

Please note that for all test streams UEs, and for some test streams Dispatchers, were not reported in the TRT reports, hence no information about their involvement during the Plugtests week (green lines) is shown.

Greyed out equipment was registered for the test stream but was involved in any test session in this stream.

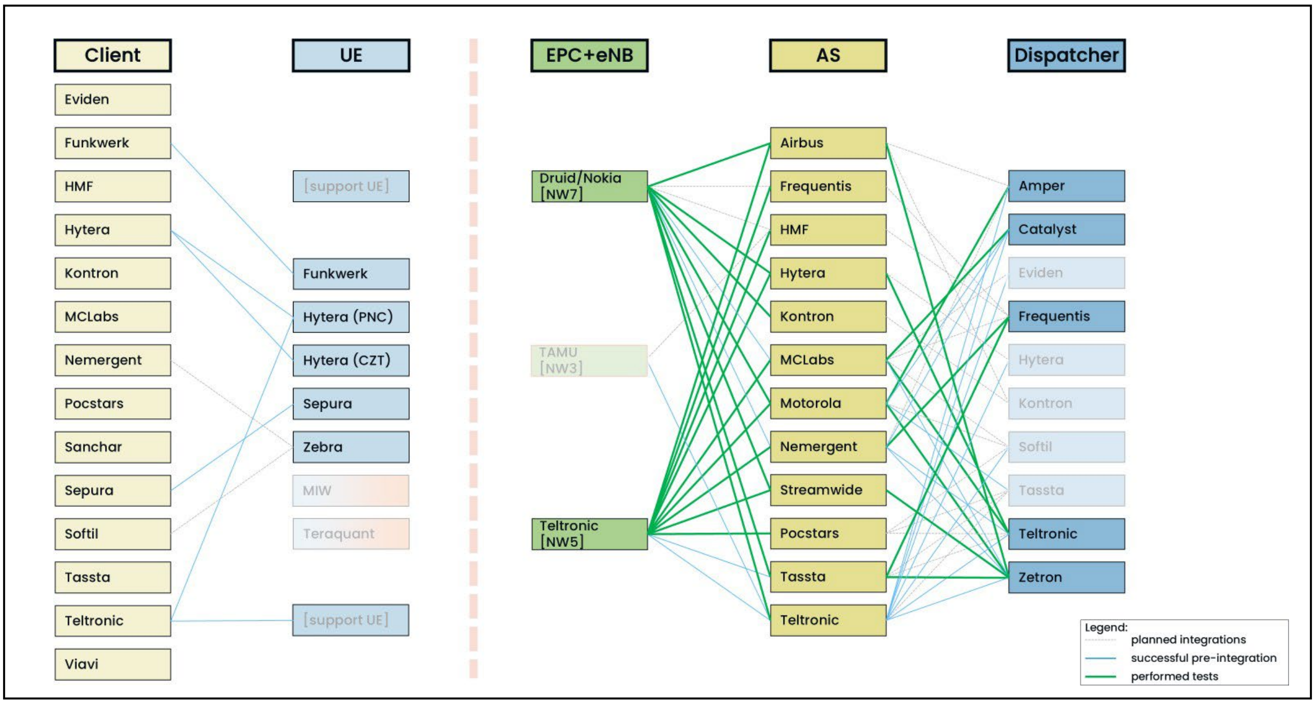

Figure 12. Tested Equipment for Stream A: MCX over 4G

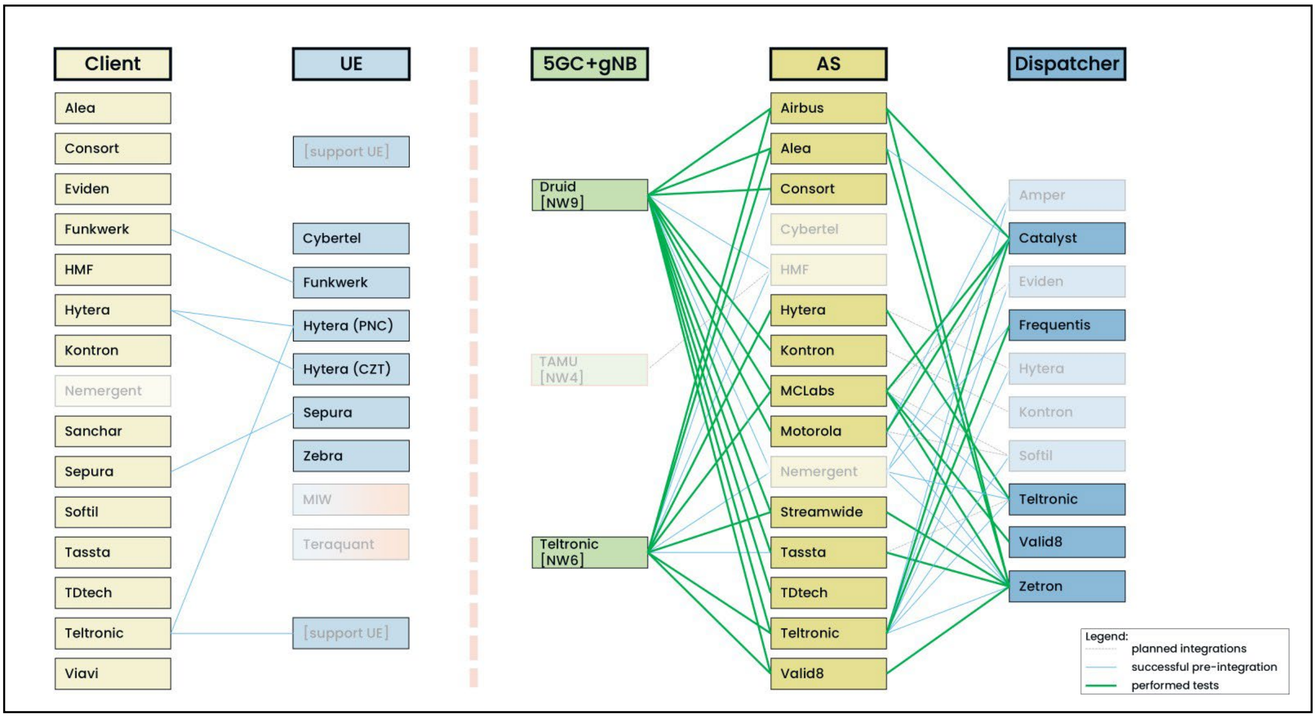

Figure 13. Tested Equipment for Stream B: MCX over 5G

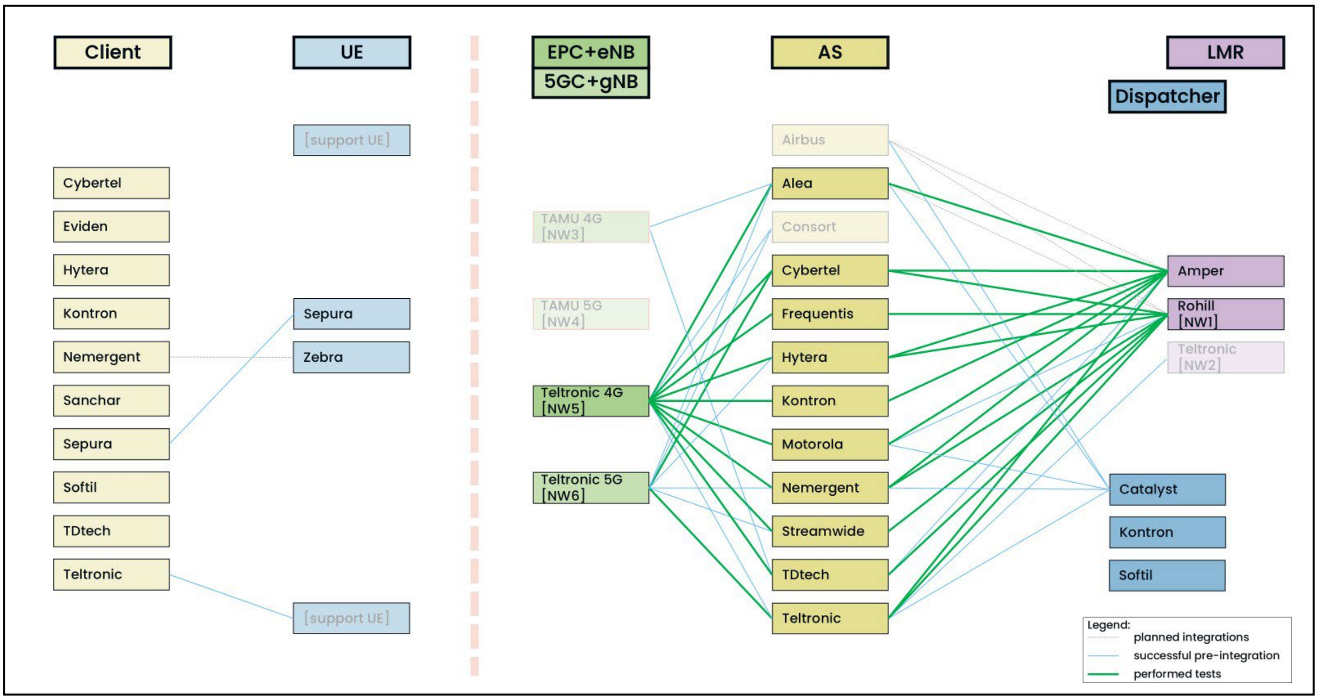

Figure 14. Tested Equipment for Stream C: Interworking Function (IWF)

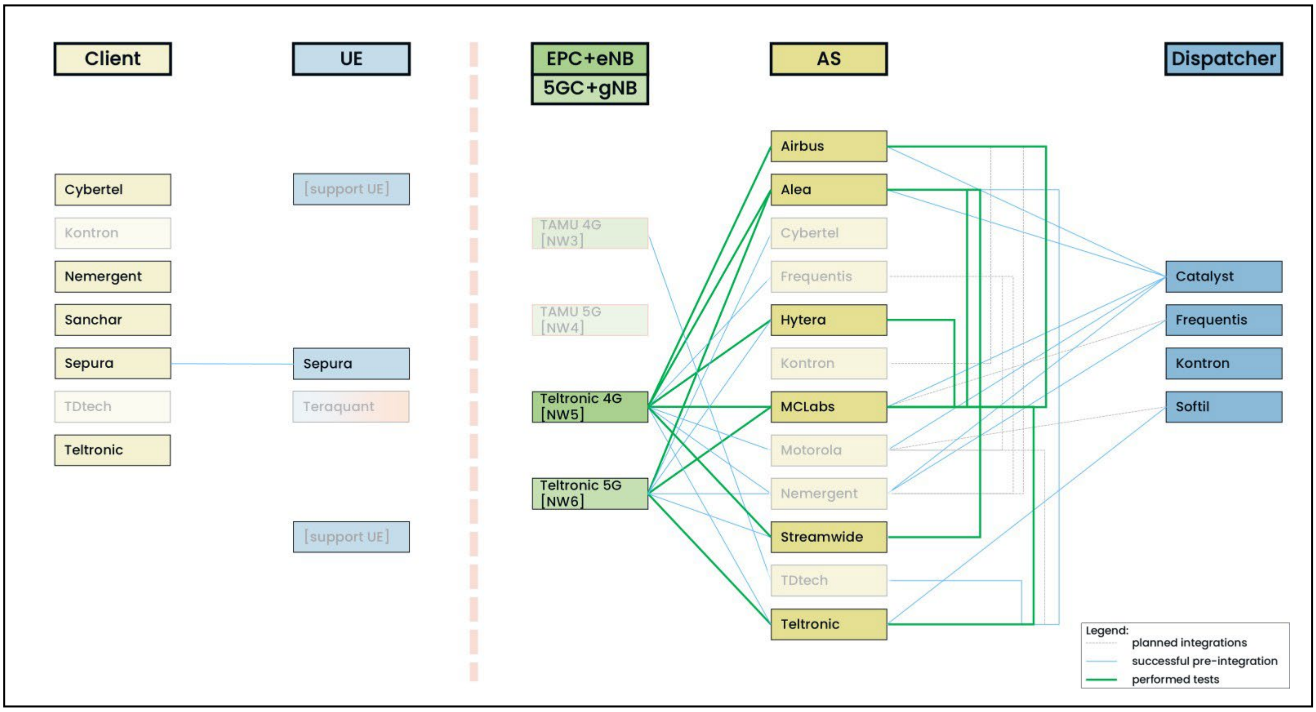

Figure 15. Tested Equipment for Stream D: Inter-MCX

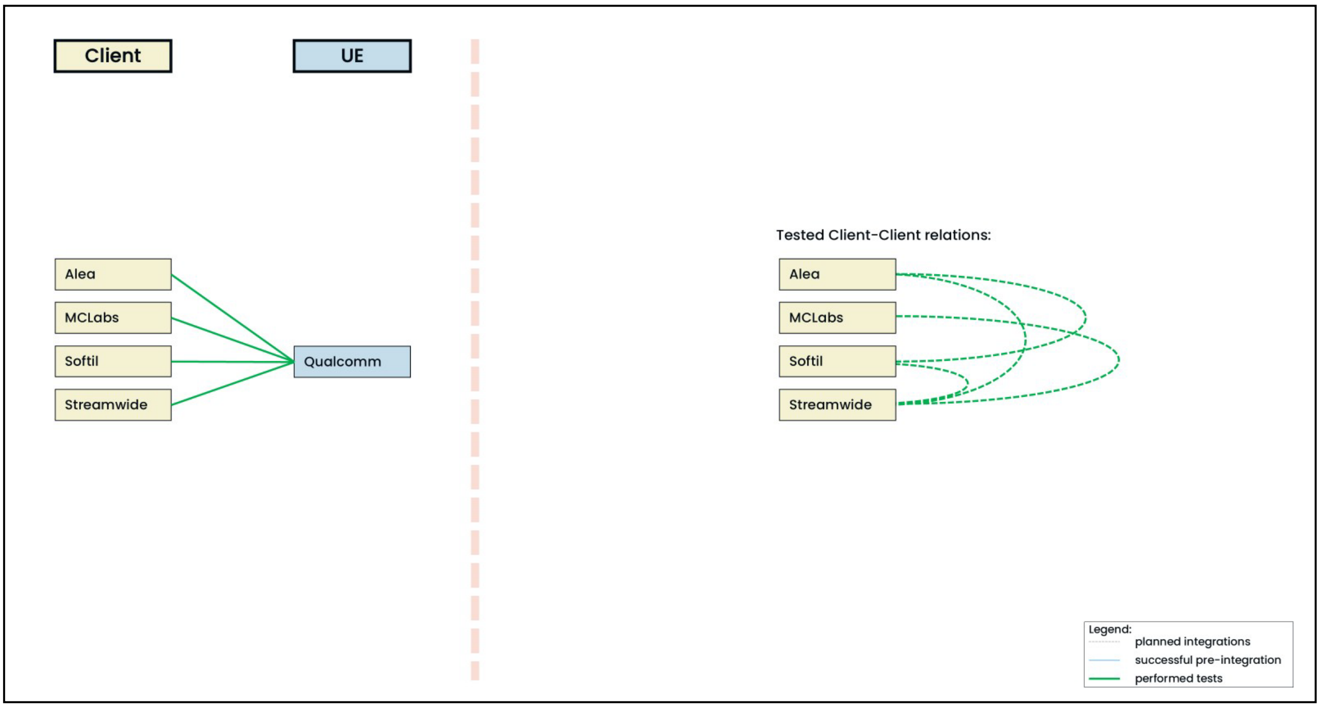

Figure 16. Tested Equipment for Stream E: Off-network

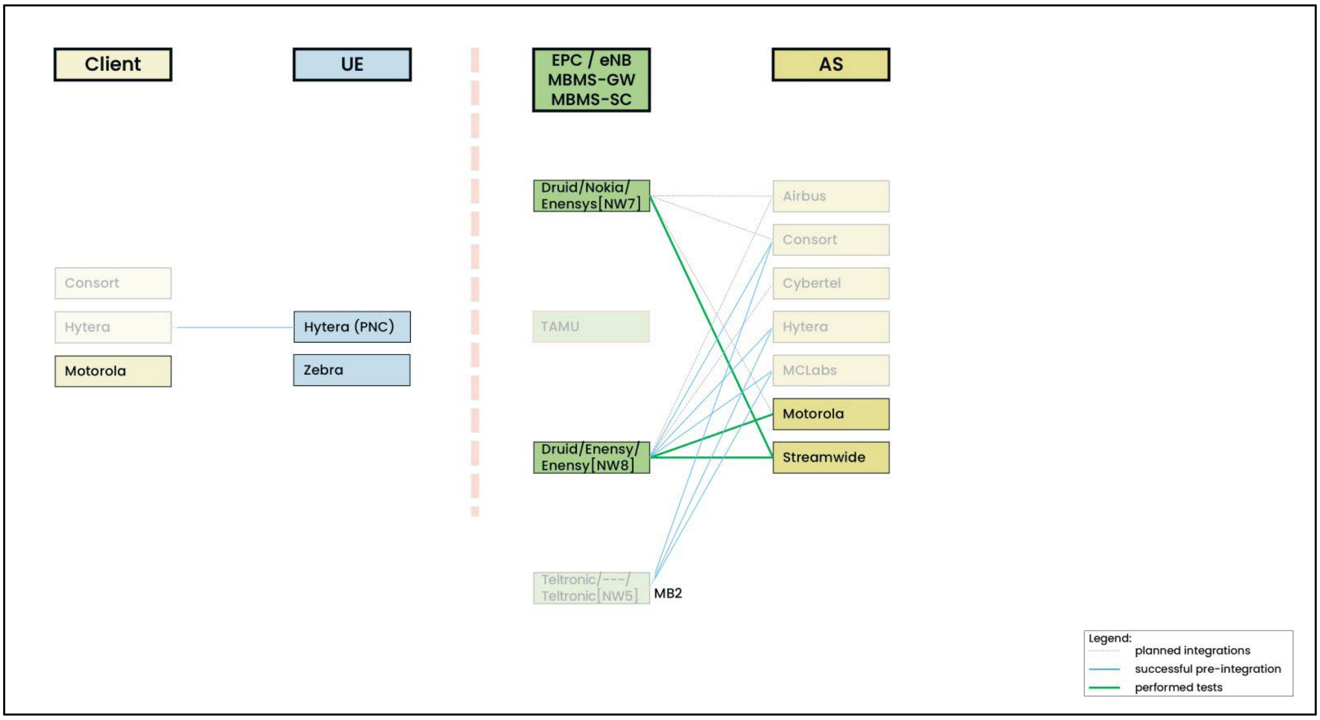

Figure 17. Tested Equipment for Stream F: Multicast - eMBMS

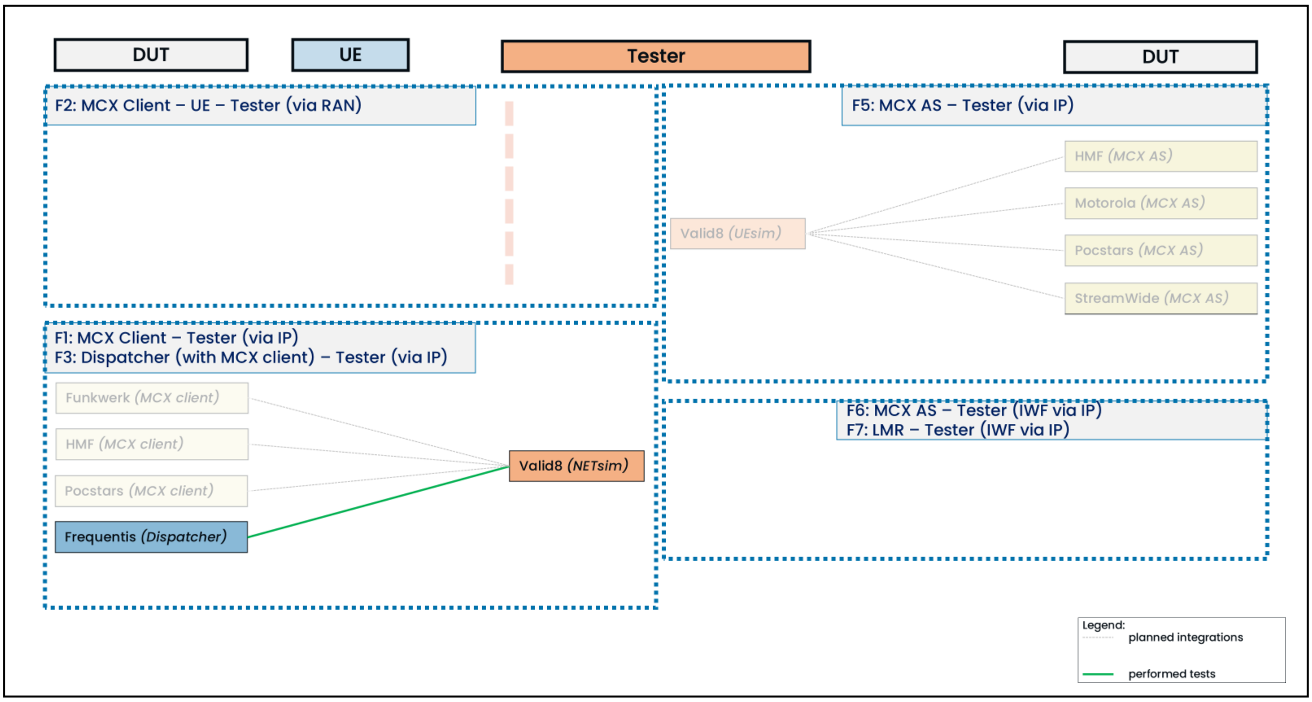

Figure 18. Tested Equipment for Stream G: Test Tools

Figure 19 shows all client-server relations which were tested during the MCX#9 Plugtests in all Streams. This information cannot be shown in the above figures, hence is provided here for information. Please note that a shown relation only means that this specific client-server combination was tested, it does not give any information whether the tests have passed or failed.

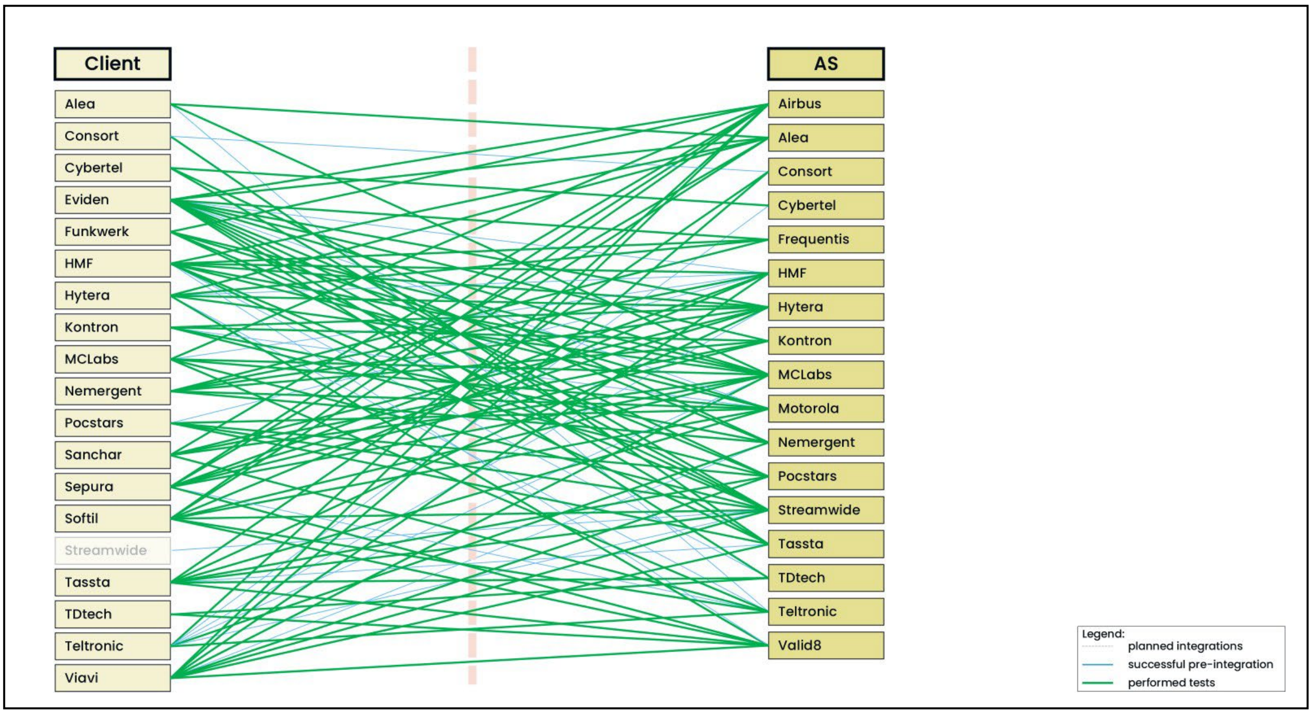

Figure 19. Client-Server Relations over all Streams

9.4 Results per Test Case

Table 18 below provides the results for each test case in the scope of the Plugtests event. Test Cases numbering is referred from ETSI TS 103 564.

Please note that for this MCX#9 Plugtests only a subset of all test cases from ETSI TS 103 564 were selected and could be executed by the vendors.

Test Case #	Interoperability	
	PASS	FAIL
7.6.2	0 (0.0%)	0 (0.0%)
7.6.3	2 (100.0%)	0 (0.0%)
7.6.4	1 (100.0%)	0 (0.0%)
7.6.5	2 (100.0%)	0 (0.0%)
7.6.6	0 (0.0%)	0 (0.0%)
7.6.7	2 (100.0%)	0 (0.0%)
7.6.8	0 (0.0%)	0 (0.0%)
7.6.9	0 (0.0%)	0 (0.0%)
7.6.10	2 (100.0%)	0 (0.0%)
7.6.11	0 (0.0%)	0 (0.0%)
7.6.12	0 (0.0%)	0 (0.0%)
7.6.13	0 (0.0%)	0 (0.0%)
7.6.14	1 (100.0%)	0 (0.0%)
7.6.15	0 (0.0%)	0 (0.0%)
7.6.16	0 (0.0%)	0 (0.0%)
7.6.17	0 (0.0%)	0 (0.0%)
7.6.18	0 (0.0%)	0 (0.0%)
7.6.19	0 (0.0%)	0 (0.0%)
7.6.20	0 (0.0%)	0 (0.0%)
7.6.21	0 (0.0%)	0 (0.0%)
7.14.7	0 (0.0%)	0 (0.0%)
7.14.8	32 (72.7%)	12 (27.3%)
7.14.9	1 (50.0%)	1 (50.0%)
7.14.10	24 (82.8%)	5 (17.2%)
7.14.11	0 (0.0%)	0 (0.0%)
7.14.12	4 (100.0%)	0 (0.0%)
7.14.13	4 (57.1%)	3 (42.9%)
7.14.14	0 (0.0%)	0 (0.0%)
7.14.15	3 (100.0%)	0 (0.0%)
7.14.16	0 (0.0%)	0 (0.0%)
7.14.17	0 (0.0%)	0 (0.0%)
7.14.18	0 (0.0%)	0 (0.0%)
7.14.19	2 (66.7%)	1 (33.3%)
11.2.1	3 (60.0%)	2 (40.0%)
11.2.2	5 (83.3%)	1 (16.7%)

Test Case #	Interoperability	
	PASS	FAIL
11.2.3	0 (0.0%)	0 (0.0%)
11.2.4	0 (0.0%)	0 (0.0%)
11.2.5	0 (0.0%)	0 (0.0%)
11.3.1	7 (100.0%)	0 (0.0%)
11.3.2	0 (0.0%)	0 (0.0%)
11.3.3	0 (0.0%)	0 (0.0%)
11.3.4	5 (62.5%)	3 (37.5%)
11.3.5	0 (0.0%)	0 (0.0%)
11.3.6	0 (0.0%)	0 (0.0%)
11.3.7	0 (0.0%)	0 (0.0%)
11.3.8	0 (0.0%)	0 (0.0%)
11.3.9	1 (100.0%)	0 (0.0%)
11.3.10	0 (0.0%)	0 (0.0%)
11.3.11	0 (0.0%)	0 (0.0%)
11.3.12	0 (0.0%)	0 (0.0%)
11.3.13	1 (100.0%)	0 (0.0%)
11.3.14	0 (0.0%)	0 (0.0%)
11.3.15	9 (100.0%)	0 (0.0%)
11.3.16	8 (100.0%)	0 (0.0%)
11.3.17	0 (0.0%)	0 (0.0%)
11.3.18	0 (0.0%)	0 (0.0%)
11.3.19	1 (100.0%)	0 (0.0%)
11.3.20	0 (0.0%)	0 (0.0%)
11.3.21	0 (0.0%)	0 (0.0%)
11.3.22	0 (0.0%)	0 (0.0%)
11.3.23	0 (0.0%)	0 (0.0%)
11.3.24	0 (0.0%)	0 (0.0%)
11.3.25	0 (0.0%)	0 (0.0%)
11.3.26	0 (0.0%)	0 (0.0%)
11.3.27	1 (100.0%)	0 (0.0%)
11.4.1	0 (0.0%)	0 (0.0%)
11.4.2	0 (0.0%)	0 (0.0%)
12.2.2	0 (0.0%)	1 (100.0%)
12.2.3	2 (100.0%)	0 (0.0%)
12.2.4	3 (100.0%)	0 (0.0%)
12.2.5	0 (0.0%)	0 (0.0%)
12.2.6	0 (0.0%)	0 (0.0%)
12.3.2	0 (0.0%)	0 (0.0%)
12.3.3	0 (0.0%)	0 (0.0%)
12.3.4	0 (0.0%)	0 (0.0%)
12.3.5	0 (0.0%)	0 (0.0%)
12.3.6	0 (0.0%)	0 (0.0%)

Test Case #	Interoperability	
	PASS	FAIL
13.2.1	1 (100.0%)	0 (0.0%)
13.2.2	5 (100.0%)	0 (0.0%)
13.2.3	5 (100.0%)	0 (0.0%)
13.2.4	0 (0.0%)	0 (0.0%)
13.2.5	5 (100.0%)	0 (0.0%)
13.2.6	0 (0.0%)	0 (0.0%)
13.2.7	0 (0.0%)	0 (0.0%)
13.2.8	0 (0.0%)	0 (0.0%)
13.3.1	0 (0.0%)	0 (0.0%)
13.3.2	1 (100.0%)	0 (0.0%)
13.3.3	1 (100.0%)	0 (0.0%)
13.3.4	1 (100.0%)	0 (0.0%)
13.3.5	0 (0.0%)	0 (0.0%)
13.3.6	0 (0.0%)	0 (0.0%)

Table 16. Results per Test Case

10 Plugtests Observations

As a result of the Plugtests event activities some issues in 3GPP Technical Specifications (TSs) and related standards were identified together with practical deployment problems that may demand some clarification or feedback from the related SDOs. We have classified those aspects into the following two categories:

- **Observations to MCX Standards**: Missing, erroneous or ambiguous definition of procedures in 3GPP's MCPTT TSs.

- **Technical constraints**: Related to implementation issues, not covered by the standards, but which need to be faced by MCX vendors in most deployments.

The reader should note that 3GPP Release 18 was considered for the ninth MCX Plugtests event.

The 9th MCX Plugtests event team wants to thank all the participants in the Plugtests for kindly sharing the following lessons learned. Specific actions towards pushing this feedback to relevant TSGs in 3GPP have already been started at the time of the release of this report.

10.1 Observations

10.1.1 Lack of explicit description of FD dynamics for interMCX scenarios

Trusted mode has been removed from MCData Stage 3 in 3GPPT TS 24.282 for SDS and MCVideo 3GPP TS 24.281 (while it's kept for MCPTT and a specific reference to that for MCVideo is included in 9.2.1.5.2.2 in TS 24.281) but there's no reference to the behaviour of an eventual non-controlling controlling server for FD operations. Plugtests participants would like to request 3GPP CT1 for clarification regarding whether such mechanism is eventually considered for MCData FD.

[EDITORIAL] Additionally, note that there's a typo assuming MCVideo (instead of MCData) in Section 9.2.2.5

10.1.2 Unclear mapping of MCVideo Transmission Control timers in TS 24.483 and mismatches between TS 24.483 and TS 24.484

In TS 24.581- Section 11 (Table 11.1.1-1, Table 11.1.3-1, Table 11.1.4-1) MCVideo Transmission Control related timers are defined. However, either they are not defined in the TS 24.484 or they are referenced to TS 24.483 and "shared" with MCPTT.
Plugtests participants would like to request 3GPP CT1 for clarification regarding the use in TS 24.483 of the same name timers for MCPTT/MCVideo (i.e. T100, T101…) and/or otherwise include the definitions in TS 24.483 and TS 24.484 of MCVideo timers and missing tags (i.e. T2-transmission-idle, T3-transmission-revoke, T4-transmission-granted...).

10.1.3 Inclusion in the Floor Release Multi Talker message of the SSRC of the participant whose floor has been released

3GPP TS 24.380 Section 6.3.4.4.3 states that that Floor Release Multi Talker message shall include the ssrc field of the floor participant for which T1 expired. However, in the definition in Section 8.2.14 of the Floor Release Multi Talker message this SSRC is not included. Plugtests participants would like to request 3GPP CT1 to include the ssrc field of the participant on the Floor Release Multi Talker message definition.

10.1.4 Media reception notification message to include the SSRC of the receiving user

In 3GPP TS 24.581 Section 9.2.16, the Media Reception notification message includes both "Audio SSRC of the transmitting user" and "Video SSRC of the transmitting user" fields. However, Plugtests participants believs that for this particular message the useful information would be the receiver side in this message. Since this message is received by the transmitter, to inform that media reception to a user has been initiated, receptor's information should be included, instead of the transmitter's.

Plugtests participants would like to kindly request 3GPP CT1 to consider that change.

10.1.5 Lack of "Presence" procedure for Off-network when in S3 state ongoing call

In all Off-network calls defined in 3GPP TS 24.379 , there is currently no equivalent to the presence event in On.-network or any other way to obtain an updated list of MCPTT clients currently active of the call (i.e.list of MCPTT-IDs , functional-alias, datetime of joining the call, etc…).

As a solution, Plugtests participants have drafted a specific behavior for the S3 “part of ongoing call” state in the Off-network state machine that comprises the periodic submission of “User Announcements” and would like 3GPP CT1 to consider such (or any other) mechanism.

10.1.6 Inconsistent definition of associated-group-id

In 3GPP TS 24.379 - Annex F (XML Schema), the <associated-group-id> element is defined as string. However, in different parts of the document it is clearly referenced as contentType element (i.e. to allow being encrypted). 3GPP CT1 is kindly requested to fix the inconsistency by defining <associated-group-id> as mcpttInfo:contentType as the rest of the similar sensitive elements.

10.1.7 Track Info field missing in non-controlling ⇔ controlling messages for MCVideo

For MCPTT, the Track Info field is defined in all the Floor Control messages in 3GPP TS 24.380. However, for MCVideo in 3GPP TS 24.581 it is only defined in a few messages of the Transmission Control mechanism (i.e. it is missing in the Transmission Request, Transmission Granted, Transmission Rejected, Transmission Release...). Plugtests Participants would request 3GPP CT1 to consider its inclusion in all Transmission Control messages to be consistent with Floor Control.

10.1.8 Late call entry in MCPTT trusted mode

In trusted mode, the controlling server does not know if a user is affiliated in a constituent group; since it is managed by the non-controlling controlling server. Therefore, the controlling node can not include the new affiliated user in the ongoing call (late call entry feature). Participants request clarification regarding how that functionality is considered to be provided in a trusted mode configuration.

10.1.9 SSRC management in implicit floor/transmission request MCPTT/MCVideo calls in controlling ⇔ non-controlling interface not defined

When a user initiates a call with implicit floor/transmission request, the controlling server tells the user which SSRC to use for every stream. However, in case of controlling/non-controlling scenarios, it is not defined who should define the SSRC, therefore clarification is requested.

10.1.10 Missing MCData procedures for non-controlling

File distribution delivery/read notification, emergency alerts and upgrade/downgrade of emergency calls procedures are not defined for non-controlling node in 3GPP TS 24.282.

10.1.11 CSK management for multi service (MCPTT/MCData/MCVideo) during service authorization

When service authentication is done during the registration (i.e. section 5.1.3.2.1in 3GPP TS 33.180), the CSK is sent along the Access Token. Plugtest Participants request clarification regarding the situation where, assuming the CSK is different per service, how theoretically different CSKs per service should be included (i.e. should the MCS client send three different mikey-sakke payloads?).

10.1.12 Format of UserID in KMS exchanges

In 3GPP TS 33.180 Release 16, the format of the UserID string was not specifically stated in Table D.3.3.2-1 (and actually the example in F.2.1 suggested an hexadecimal/OctetString). From Release 17+, the base64 encoding has being specified in both the table and F.2.1. Since that might eventually lead to backwards incompatibility between different releases KMS client and servers a Plugtests Participant suggests to add a "format" attribute to the XML tag (i.e. <UserID format="base64"> or <UserID format="OctetString">).

10.1.13 KMS Key generation and test vectors

In 3GPP TS 33.180 F.2.1 for Release 19, UserID is replacing "ID" in RFC 6507/6508, as Tel-URI may not exist. However, the format to be provided for RFC 6507/6708 would be according to Plugtests participants a bit confusing. The RFC states "The format of Identifiers MUST be specified by each implementation.". F.2.1 would according to some Plugtest Participant explain how to build the UserID, but not explicitly how to use it for RFC 6507/6708 (i.e. what is the input of crypto functions or whether binary representation of the digest or the base64 encoded string of the digest -while the specified format of UserID and base on the fact that RFCs are taking URI's string as example-). Clear test vectors would greatly enhance validation of implementation and interoperability.

10.1.14 Ambiguities in SSRCs to be used in different MCVideo transmission control messages

3GPP TS 24.581 Section 4.2.2 states that an MCVideo call uses 3 different and unique SSRC values. One for audio, one for video and another one for transmission control. It also states that the transmission participant is uniquely identified in the MCVideo call using the 'SSRC value'. This statement doesn't clarify which of the 3 SSRCs it is referring to. Even assuming this statement means the “SSRC used for Transmission Control” further issues may appear.
If the SSRC values for each 'm=' stream in the MCVideo call are different then it is unclear how the 'Active SSRC List' in section 6.3.7 is expected to function. This stores the SSRC of the participant who has been granted to send to. Section 6.3.7.4.3 states that the SSRC value of RTP packets to forward are compared to this list and forwarded if found. It is unclear how SSRC values should be added to this list to make it work. Should the SSRC values for both audio and video of the originator be added and how would they be learnt by the terminator when the Transmission Notification message only contains a single SSRC value is unclear.
Plugtests participants propose (apart from internal clarification in Plugtests Test Case Document ETSI TS 103.564) for 3GPP CT1 to add an appendix to TS 24.581 with example use case for the 'Active SSRC List' as defined in section 6.3.7. Furthermore, they kindly suggest that, when SSRC values are referred to in 3GPP TS 24.581, they should be qualified with exactly which of the SSRCs is being referred to (i.e. originating audio SSRC, terminating transmission control SSRC, etc).

10.2 Technical constraints

10.2.1 Possible timing/synching issues leading to overlapping "has permission" in Off-network calls

In case of slow and/or lossy network, when floor control messages and/or media rtp packets eventually suffered a delay greater than T201 * C201 (40 *3) 120ms, multiple participants could move simultaneously from the “pending request” to the "has permission" state (assuming no floor arbitrator is in place and sending a floor taken). Plugtests participant have drafted a two timers based mechanism for the consideration of 3GPP CT1.

10.2.2 Assessment of realistic capacity for massive MCPTT group calls in unicast LTE/5G networks

During the Observer program the actual capacity of non-eMBMS LTE/5G radio access networks to support massive group calls (i.e. in crisis events) was questioned, specially due to PDCCH channel congestion.
Research paper in https://doi.org/10.1109/ACCESS.2024.3350902 was used as a discussion paper and, although mitigation techniques (framing, non dynamic scheduling, eMBMS/5G MBS) have been identified Plugtests Participants consider that how to address such limitations in hybrid (mission critical/commercial) radio access networks is still worth analyzing by 3GPP or other relevant stakeholders.

11 ObserverProgram

The Observers contributed to the MCX#9 Plugtests in the definition of the scope and scenarios, in the Observer Program and for the Observer demo.

11.1 Preparation Phase

During equipment registration, interested vendors provided their intention to showcase during the observer demo. Test cases from ETSI TS 103 564 were used for the observer demo.

11.2 Observer Presentations

Observer presentation during MCX Plugtests event focused on the deployment plans and challenges of mission critical services.
The observer program provided a platform to the various stake holders in the critical communication industry to discuss the progress of MCS technology. The speakers were from government organisations, operators, regulators, users, associations which provide updates on deployment plans in their respective countries, pilot projects and updates on standards.
The observer program was conducted during half a day on 25th February 2024. The speakers presented to program outlined in Table 19.
Presentations in the observer program and the Questions & Answers are available on the Plugtests WIKI.

Presentations included:

Moderator – Nathan Jeyaratnarajah / UK Home Office - Tuesday 25th Feb 2025

Program	Name/Organisation	Allocated Time
Welcome and Agenda	Nathan Jeyaratnarajah / UK Home Office	09:20
Update on ETSI Activities	Saurav Arora / ETSI	09:20 - 09:40
Update on TCCA Activities	Kevin Graham / TCCA	09:40 - 10:00
Status of the TCCA & GCF activities for MCX Certification	Asif Hamidullah / GCF	10:00 - 10:20
MCX Conformance Server-Side Testing Challenges	Fidel Liberal / University of Basque	10:20 - 10:40
Transitioning TETRA to MCX-Broadband	Jacqueline Dix / BDBOS	10:40 – 11:00
Coffee Break – 20 mins		
Status report and challenges with Virve 2.0	Junttila Kari / Erillisverkot	11:20 - 11:40
Performance of Mission Critical ProSe	Nathan Jeyaratnarajah / UK Home Office	11:40 - 12:00
Special Session on Off Network - Qualcomm (20 mins)		
FirstNet 101 and the MCPTT Deployment	Charles Hardnett / FirstNet	12:20 - 12:40
Update on our next generation mission-critical communications project (Rakel G2 project	Anton Engström / MSB	12:40 - 13:00
Lunch - 13:00 to 14:00		

Table 17. Observer Program

11.3 Observer Round Table Discussion

Observer round-table discussions were organized on 26 February 2025 during the MCX Plugtests event, which focused on sharing ideas and strategies for testing mission-critical networks and the ecosystem.

Some of the topics discussed during the roundtable discussion are:

- Dedicated signalling load affecting the voice quality of MCPTT – Nathan Jeyaratnarajah (UK Home Office)
- Discussion on Virve2.0 Challenges and TTI-bundling Performance evaluation MCPTT and VoLTE – Joel Lehtomäki (Erillisverkot)
- Server-side conformance testing - Fidel Liberal (University of the Basque Country)
- Discussion on GCF MCX Conformance with focus on server-side - Harald Ludwig (TCCA)

11.4 Observer Demos

The Observer Demo allowed vendors to present their solutions and features to the observers. The demos took place on the 27th of February 2025. The demos are shown in Table 20 were presented:

Demo no.	Time	Participants	Test Cases
#03	09:30 – 09:50	Amper, Cybertel, Teltronic	11.3.15, 11.3.16
#02	09:55 – 10:15	Amper, Nemergent, Teltronic, Zebra	7.14.8, 7.14.19, 11.3.15, 11.3.16
#01	10:25 – 10:45	Cybertel, Nemergent, Teltronic, Viavi, Zebra	7.14.8
#06	10:50 – 11:10	Alea, Frequentis, Nemergent, Teltronic, Zebra	12.2.3, 12.2.4
#09	11:20 – 11:40	Alea, Qualcomm, Softil, Streamwide	Alea, Softll, Streamwide: 13.2.1, 13.2.2, 13.2.3, 13.2.4, 13.2.5 Alea, Softll: 13.3.2, 13.3.4, 13.3.5
#13	11:45 – 11:55	Hytera, Softil, Teltronic	7.14.8, 7.14.10, 7.14.18
#10	12:05 – 12:25	Alea, Catalyst, Hytera, MCLabs, Teltronic, Zebra	12.2.3, 12.2.4, 7.14.15
#04	12:30 – 12:50	Alea, Druid, Eviden, MCLabs, Teltronic, Zebra, Zetron	7.14.8, 7.14.10, 7.14.12, 7.14.8, 7.14.10, 7.14.13, 7.14.15
#14	14:00 – 14:20	Alea, MCLabs, Teltronic, Valid8, Zebra	11.3.1, TS 36.579-3 test 7.2
#07	14:25 – 14:45	Druid, Enensys, Motorola, Nokia, Softil	7.6.4, 7.6.14
#12	14:55 – 15:15	Hytera, Rohill, Teltronic	7.14.19, 11.3.15, 11.3.16
#08	15:20 – 15:40	Catalyst, Motorola, Rohill, Softil, Zebra	11.3.1, 11.3.4, 11.3.8, 11.3.10
#11	15:50 – 16:10	Catalyst, Motorola, Softil, Zebra	12.2.3, 12.2.4
#05	Withdrawn	n/a	

Table 18. Observer Demos

12 History

Document history		
V0.0.0	10/March/2025	First Draft
V0.0.1	18/March/2025	Stable Draft
V0.0.2	24/March/2025	Stable Draft with corrections
V0.0.3	27/March/2025	Stable Draft with corrections
V.0.1.0	29/March/2025	Final Draft with corrections
V1.0.0	29/March/2025	Report Published