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2nd SmallCell LTE Plugfest
Paris, France
23 June - 3 July 2014

PLUGTESTS INTEROP EVENTS

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Keywords

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Contents

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Executive summary

The 2nd Small Cell LTE Plugfest was organised by the Small Cell Forum in partnership with the ETSI Centre for Testing and Interoperability, and hosted by ORANGE Labs in Paris from 23 June to 02 July 2014.

These series of Plugfests aim to cultivating an effective ecosystem of interoperable small cells, helping to debug vendor implementations and drive the resolution of standards ambiguities and gaps. These activities help to provide operators and consumers with a wider choice of small cell products while also facilitating economies of scale to bring the small cell mass market closer

Multi-vendor Self Optimizing Networks (SON) and voice over LTE were two of the topics given attention at the fifth Plugfest in the series, which was also the second one to focus exclusively on LTE small cells and saw attendance almost double compared to previous year’s event.

The scope of this 2nd LTE Plugfest included various small cell LTE variations. Testing concentrated on S1, X2 and management interface (TR-069) and covered testing areas such as Regression, Handover, Mobility (Outbound, Inbound), Voice Support via CS Fall-back schemes, Voice and Video over LTE, CMAS and SON. As well as testing small cell/macro handover and security gateways, another key area of focus was the testing of multi-vendor SON in heterogeneous networks.

The Plugfest was supported by 26 different organisations with 65 engineers onsite, including equipment vendors, test tool vendors and companies providing test network infrastructure: Airspan, Airvana, Alcatel-Lucent, Broadcom, Casa Systems, Cavium, Cisco, Com4Innov, Contela, Fujitsu, IP.access, Ixia, JDSU, NEC, Node-H, One2Many, Orange, Public Wireless, PureWave Networks, Qosmotec, Qucell, Quortus, Radisys, Sistel Networks, SMEC and Stoke.

All participants were requested to conduct remote pre-test integration. By connecting to the remote test infrastructure, enabled by ETSI, participants had a chance to anticipate and mitigate connectivity problems during the Plugfest. Running remote pre-testing allowed to target a large scope and ensured a good rate of successful test case execution during the event.

Introduction

This Plugfest aimed at verifying the interoperability between different players in the Small Cell and LTE ecosystems which included the following categories of equipment:

- Different types of SmallCell: Home eNodeB (HeNB), micro eNB, pico eNB
- Security Gateway (SeGW),
- Home eNodeB Gateway (HeNB-GW),
- Home eNodeB Management System (HeMS)
- Evolved Packet Core (ePC)
- Macro eNB

- Cell Broadcast Centre (CBC)
- IP Multimedia Subsystem (IMS)

All of them were either deployed locally at Orange Labs, or connected remotely to the test network.

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.

[TS29.168] 3GPP TS 29.1680 - "Universal Mobile Telecommunications System (UMTS); LTE; Cell Broadcast Centre interfaces with the Evolved Packet Core; Stage 3”

[TS36.300] 3GPP TS 36.300 - "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN); Overall description; Stage 2"

[TS36.413] 3GPP TS 36.413 - LTE; Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP)

[TS36.423] 3GPP TS 36.423 - LTE; Evolved Universal Terrestrial Radio Access Network (E-UTRAN); X2 Application Protocol (X2AP)

[TS23.272] 3GPP TS 23.272 - Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Circuit Switched (CS) fallback in Evolved Packet System (EPS); Stage 2

[TS23.401] 3GPP TS 23.401 - LTE; General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access

[TR-069] BBF TR-069 amendment 2 - CPE WAN Management Protocol v1.1. http://www.broadband-forum.org/technical/download/TR-069_Amendment-2.pdf

3 Abbreviations

CA	Certification Authority
CBC	Cell Broadcast Centre
CBS	Cell Broadcast Service
CMAS	Commercial Mobile alert System
CMP	Certificate Management Protocol
CSFB	Circuit Switch Fall-Back
CSR	Certificate Signing Request
CTI	Centre for Testing and Interoperability
DUT	Device under Test
SCF	Small Cell Forum
eNB	Evolved Node B
EPC	Evolved Packet Core
ETSI	European Telecommunications Standards Institute
IOP	Interoperability
HeMS	HeNB Management System
HeNB	Home eNodeB
HeNB-GW	Home eNodeB Gateway
HIVE	Hub for Interoperability and Validation at ETSI
HO	Hand Over
IMS	IP Multimedia Subsystem
MOB	Mobility
NA	Test recorded as Not Applicable
NGMN	Next Generation Mobile Network
NO	Test recorded as Not OK
OK	Test is recorded as successfully passed
OT	Out of Time. Test is recorded as not being executed due to lack of time
PEM	Privacy Enhanced Mail
PKI	Private Key Infrastructure
SeGW	Security Gateway
TAC	Tracking Area Code
TAI	Tracking Area Identity
SON	Self-Organising Networks
TRT	Test Reporting Tool
TSR	Test Session Report. Report created during a Test Session.
VPN	Virtual Private Network

4 Participants

The Plugfest was supported by 26 organisations. The table below summarizes the companies that participated to the Plugfest and the equipment/tools they provided.

	HeNB	HeNBGW	SeGW	HeMS	CBC	pico/micro eNB	macro eNB	ePC	IMS Core	NodeB + 3G core	Tools	Local/Remote. Comments
Airspan						2						Local. Pico eNB
Airvana	2											Local
ALU France						2						Local. 2 Pico eNB
ALU India				1								Local
Broadcom	2											Local
Casa Systems		1										Remote
Cavium	2										1	Local
Cisco Systems		1	1					1				Remote
Com4Innov								1	1			Remote
Contela		1		1								Local
Fujitsu	2	1										Local
IP.access	1											Local
Ixia								1	1			Local. Simulators
JDSU											1	Local
NEC	2	1				2						2 micro Local, other Remote
Node-H	2											Local
One2many					1							Remote
Orange							4	2		1		Local
Public Wireless						1						Local. Pico eNB
PureWave Networks	1											Local
Qosmotec											2	Local
Qucell	2											Local
Quortus								2	2			Local. Built-in IMS
Radisys	2											Local
Sistel Networks	2			1								Remote
Smec		1	1									Remote
Stoke			1									Remote
TOTAL	20	6	3	3	1	7	4	7	4	1	4	

Overall, a total of 27 Small Cells (20 HeNBs, 5 pico eNBs and 2 micro eNBs) participated to the interoperability test sessions together with 6 HeNB-GWs, 3 SeGWs, 3 HeMS, 1 CBC, 4 macro eNBs, 7 ePCs, 4 IMS cores, 1 3G core and several test tools, including protocol and spectrum analyser and programmable attenuators.

While participating companies could decide to bring their equipment physically to the lab, or to operate it remotely from the Plugfest venue, engineering presence at the Plugfest lab was mandatory for all participating companies.

5 Technical and Project Management

All the information required to organise and manage the Plugfest was compiled and shared with participants in a dedicated private WIKI put in place by ETSI. Participants were provided with credentials that allowed them to access and update their details. All the information presented in this chapter is an extract of the ETSI Plugfest wiki: https://services.plugtests.net/wiki/Small-Cell-LTE-Plugfest-2 (login required)

5.1 Test Plan

The test plan was originally produced by the Small Cell Forum IOP Group. In addition, NGMN contributed to the test plan with SON test cases. During the regular conference calls which were held as part of the event preparation, companies could discuss, modify existing test cases or propose additional tests. Eventually, the original test plan from previous Small Cell LTE event was extended with new test cases covering a number of additional topics: CMAS, CSFB, IMS, …The Plugfest organisers and participants reviewed the test plans to check if these TCs could be executed with the registered equipment & tools. TCs were also reviewed to make sure they fall under correct category and are defined with clear Pass / Fail criteria. Finally, the test cases groups were assigned to the different test configurations in scope.

The following clauses summarise the 78 test cases in scope for the event.

5.1.1 Regression

The regression test group included the following 9 test cases

Test ID	Summary
FIC/HENB/01	SCTP Association / S1 Interface Setup / Successful Operation
FIC/UELTE/01	UE Registration / Default Bearer Setup / Downlink-Uplink Traffic Flow
FIC/HENB/02	SCTP Association / S1 Interface Setup / Failure
FIC/S1/01	UE Deregistration / Network Detach
SVC/LTEPS/01	Paging
FIC/HENB/03	SCTP Association / S1 Interface Setup / Failure with reattempt
SVC/LTEPS/03	Network initiated ERAB setup - GBR
SVC/LTEPS/04	Network initiated ERAB release
SVC/LTEPS/06	ERAB modification by the network

5.1.2 Security

The Security test group included the following 15 test cases:

Test ID	Summary
SEC/FSG/01	HNB -> SeGW Crypto Profile Configuration and Basic Tunnel Establishment...
SEC/FSG/02	Use of NAT-T
SEC/FSG/03	Use of NAT-T -> Dynamic Address Change
SEC/FSG/04	DPDs
SEC/FSG/05	IPSec SA Rekeying from HNB
SEC/FSG/06	IPSec SA Rekeying from SeGW
SEC/FSG/07	IKE SA Rekeying from HNB
SEC/FSG/08	IKE SA Rekeying from SeGW
SEC/FSG/09	Tunnel Deletion
SEC/FSG/10	HNB Reboot

SEC/FSG/12	End Entity Certificate Enrolment
SEC/FSG/13	Uplink Data Transfer -> IPSec Pre-Fragmentation on Secure Link
SEC/FSG/14	Uplink Data Transfer -> IPSec Post-Fragmentation on Secure Link
SEC/FSG/15	Downlink Data Transfer -> IPSec Pre-Fragmentation on Secure Link
SEC/FSG/16	Downlink Data Transfer -> IPSec Post-Fragmentation on Secure Link

5.1.3 HeMS

This test group focused on the Management interface and included the following 27 test cases:

Test ID	Summary
TC/HeMS/Reg/01	HeNB registration with Serving HeMS.
TC/HeMS/CMP/02	Configuration Management Procedure - Using SetParameterValues RPC meth...
TC/HeMS/FR/01	Factory Reset.
TC/HeMS/Conn/01	Requests connection - HeMS to HeNB
TC/HeMS/Conn/02	Requests connection - HeNB to HeMS
TC/HeMS/CWMP/02	CPE WAN Management Protocol - SetParameterValues
TC/HeMS/CWMP/03	CPE WAN Management Protocol - GetParameterValues
TC/HeMS/CWMP/04	CPE WAN Management Protocol - SetParameterAttributes
TC/HeMS/CWMP/05	CPE WAN Management Protocol - GetParameterAttributes
TC/HeMS/Notification/01	Notification - Configuration
TC/HeMS/Notification/02	Notification - HeNB sends notification to HeMS
TC/HeMS/CWMP/10	CPE WAN Management Protocol - Inform
TC/HeMS/CMP/01	Configuration Management Procedure - Using file download
TC/HeMS/Alarm/01	Alarm Reporting Procedures - Alarm configuration including Alarm repo...
TC/HeMS/Alarm/02	Alarm Reporting Procedures - Alarm reporting procedure for expedited ...
TC/HeMS/PM/01	Performance management - Performance management configuration (includi...
TC/HeMS/PM/02	Performance management - File upload.
TC/HeMS/SWID/01	SW image download
TC/HeMS/Set/01	HeMS sets up HeNB profiles
TC/HeMS/Get/01	HeMS checks HeNB profiles
TC/HeMS/CWMP/01	CPE WAN Management Protocol - GetRPCMethods
TC/HeMS/CWMP/06	CPE WAN Management Protocol - AddObject
TC/HeMS/CWMP/07	CPE WAN Management Protocol - DeleteObject
TC/HeMS/CWMP/08	CPE WAN Management Protocol - Download
TC/HeMS/CWMP/09	CPE WAN Management Protocol - Reboot
TC/HeMS/CWMP/11	CPE WAN Management Protocol - TransferComplete
TC/HeMS/CWMP/12	CPE WAN Management Protocol - AutonomousTransferComplete

5.1.4 MOB

The mobility test group included the following 7 test cases:

Test ID	Summary
MOB/LTEPS/01	S1 based Femto to Macro Handovers -> Success
MOB/LTEPS/02	Intra-Frequency S1 based Femto to Femto Handovers -> Success

MOB/LTEPS/03	Inter-Frequency S1 based Femto to Femto Handovers -> Success
MOB/LTEPS/05	X2 Setup on Secure Link
MOB/LTEPS/06	X2 Reset on Secure Link
MOB/LTEPS/04	Intra-Frequency X2 based Femto to Femto (or macro eNodeB) Handovers -> Success
MOB/LTEPS/13	Inter-Frequency X2 based Femto to Femto (or macro eNodeB) Handovers -> Success

5.1.5 SON

The test group dedicated to Self-Organising Networks included the following 12 test cases:

Test ID	Summary
DSON/PCI/05	PCI Conflict / Confusion Detection: Detect PCI Confusion with X2 Neighbor Cells
DSON/PCI/08	PCI Conflict / Confusion Resolution: PCI Confusion Resolution with X2 Neighbor Cells
DSON/ANR/01	ANR in existing network with one LTE Macro Cell
DSON/MRO/01	Basic Too Late Handover Test Case: Vendor A is a Small Cell eNB: Radio Link Failure occurs in Small Cell eNB (Cell 1)
DSON/MRO/02	Basic Too Late Handover Test Case: Radio Link Failure occurs in Macro Cell eNB (Cell 2)
DSON/MRO/06	Basic Too Early Handover Test Case: Vendor A is a Small Cell eNB: Radio Link Failure in Small Cell (Cell 1) occurs after Handover Executio
DSON/MRO/11	Basic Ping-Pong Handover Test Case: Ping-Pong detected in the Macro Cell
DSON/MRO/20	Combined Test Case: Multiple Too Late Handovers, Vendor A is Small Cell, Single Direction (Small Cell (Cell 1) -> Macro Cell (Cell 2))
DSON/CCO/01	Basic Test Case: Resource Status Reporting Initiated from Small Cell eNB (Cell 1) towards Macro Cell eNB (Cell 2)
DSON/CCO/10	Combined Test Case: Static UE Distribution: Decrease in Small Cell DL Tx Power
DSON/ANR/02	ANR in existing network with non-overlapping Small Cells
DSON/MRO/12	Basic Handover to Wrong Cell Test Case: Small Cell eNB Handed over to Macro Cell eNB, then Re-Establishment attempt in a different Small Cell eNB

5.1.6 CSFB

This test group targeted voice calls via Circuit Switch Fall Back schemes, and included the following 4 test cases:

Test ID	Summary
SVC/CSFB/01	CSFB Mobile originating call - Idle mode
SVC/CSFB/02	CSFB Mobile originating call - Active mode
SVC/CSFB/03	CSFB Mobile terminating call - Idle mode
SVC/CSFB/04	CSFB Mobile terminating call - Active mode

5.1.7 IMS

The IMS test group included the following 2 test cases:

Test ID	Summary
TC/IMS/VoLTE01	End to end VoLTE Call
TC/IMS/ViLTE01	End to end video call over LTE

5.2 Test Sessions

The test sessions were split in pre-testing sessions and face to face sessions.

Pre-testing sessions were enabled by ETSI HIVE (see section 5.3 Test Infrastructure) which was available, for testing, a month in advance prior to the Plugfest event. Participants who were not able to complete these sessions remotely, could also run these during the Plugfest.

Remote pre-testing facilitated in covering a large scope of IOT activity for Plugfest such that the face to face test sessions could be used only for complex scenarios which required physical access to equipment's, tools and lab setup.

5.2.1 Test Configurations

A detailed study was undertaken to identify the test configuration which could combine Test Scope, Test Cases, available equipment, tools, features and support from participants. This set of configurations (tabled below) made sure that each equipment was given a chance to test with most of the peer equipment (from other vendors).

Test Configuration	Equipment under Test	Support Equipment	Pre-testing	Duration	Test Group
Security	1xHeNB 1xSeGW		Yes	2h	Security
Management	1xHeMs 1xHeNB	ePC	Yes	2h	HeMS
S1 w/Gw	1xHeNB 1xHeNBGw	ePC SeGW	Yes	2h	Regression
S1	1x(H)eNB ePC	SeGW HeNBGW (*)	Yes	4h	Regression
Multivendor Mobility	2x(H)eNB	ePC	Yes	4h	Mobility
Mobility w/Macro	1x(H)eNB 1xeNB	ePC	No	4h	Mobility
SON w/Macro	1-2x(H)eNB eNB	ePC	No	4h	SON
Multivendor SON	2-3x(H)eNB	ePC HeMS (*)	No	4h	SON
CSFB	1x(H)eNB NodeB	3G core ePC	No	4h	CSFB
CMAS	1x(H)eNB CBS	ePC	No	2h	CMAS
IMS	1x(H)eNB ePC IMS		No	2h	IMS

5.2.2 Test Schedule

The face to face Plugfest ran from Monday 23rd June to Wednesday 2nd July 2014. Local test network, laboratory and all the supporting equipment provided by Orange (eNBs, ePCs …) had already been deployed onsite before the Plugfest started. All the remote equipment had been previously connected to the test infrastructure. The first morning on-site was dedicated to local equipment deployment and troubleshooting connectivity problems.

The preliminary face to face test session schedule was developed prior to the Plugfest and was circulated among the participants in advance for comments. The features supported by each vendor were taken into account to produce an efficient scheduling.

The test schedule allowed to execute up to 18 parallel test sessions, organised in several test tracks, including:

- S1 interface (regression with all ePCs) – 7 test tracks (one per ePC)
- Circuit Switch Fall Back (CSFB) – 1 test track

- Mobility (with macro, multi-vendor) – 2 test tracks
- SON (with macro, multi-vendor) – 2 test tracks
- Pre-testing completion (Security, S1 with HeNB-GW, Management Interface) – 4 test tracks

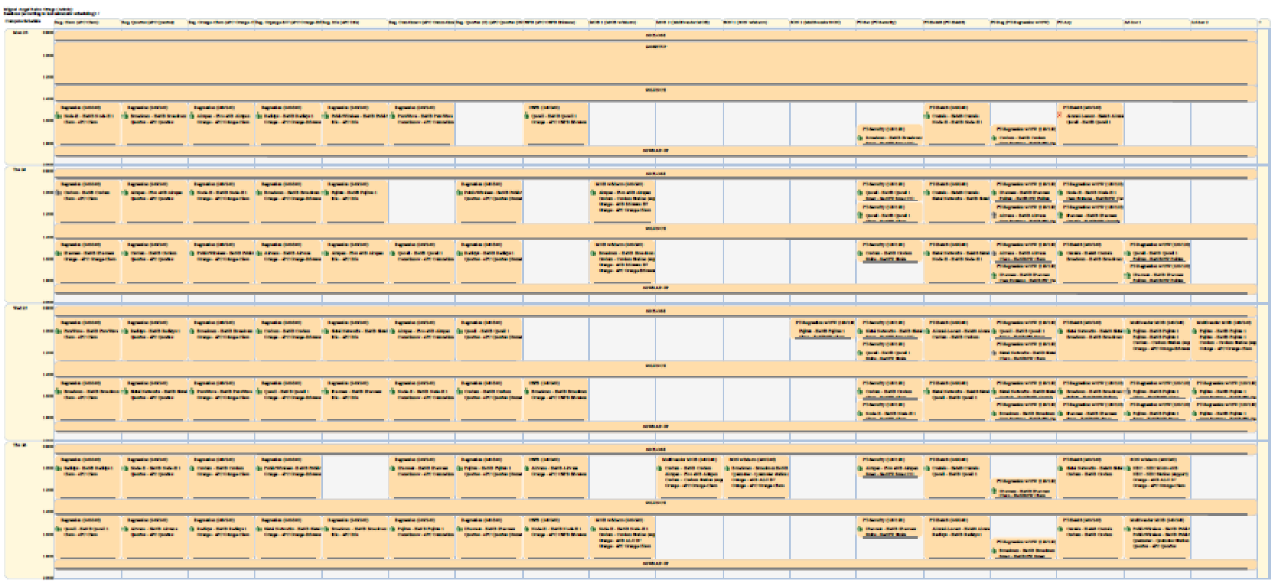
In addition some ad-hoc test sessions allocated on the fly allowed to re-run uncompleted test sessions when required and additional test sessions to cover the following topics (2 test tracks):

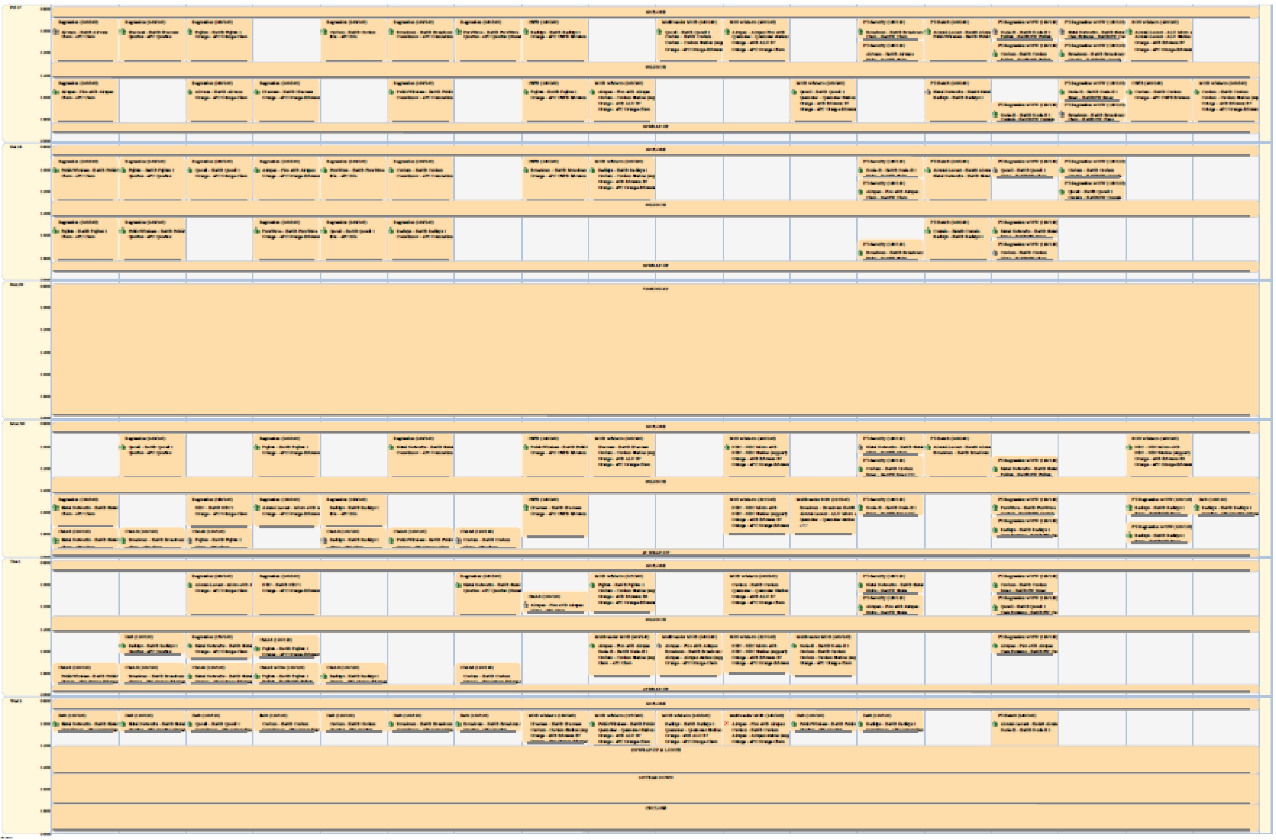
- IMS
- CMAS

Most test sessions had a duration of 4 hours, while some specific topics (Security, S1 with HeNB-GW, IMS, CMAS) could be run in 2 hour sessions. The day was organized in a morning test session from 9.00 to 13.00 and an afternoon test session from 14.30 to 18.30. A wrap-up meeting to discuss the day's findings was scheduled every evening before closure.

During the test event the test schedule was constantly reviewed and adapted according to the progress of the Plugfest test sessions. This was done during the wrap-up meetings at the end of the day and during regular face-to-face meetings with participants.

The figure below shows the last version of the test schedule as of Wednesday 3rd July (Please note that some test sessions extended over multiple test slots, which is not visible in the schedule).





5.3 Test Infrastructure

5.3.1 Remote Test Infrastructure

Pre-testing was remote and mandatory for all participants. Remote pre-testing was enabled with HIVE (Hub for Interoperability and Validation at ETSI). All the participating companies and labs were connected to ETSI via VPN, with ETSI playing the role of a VPN Hub.

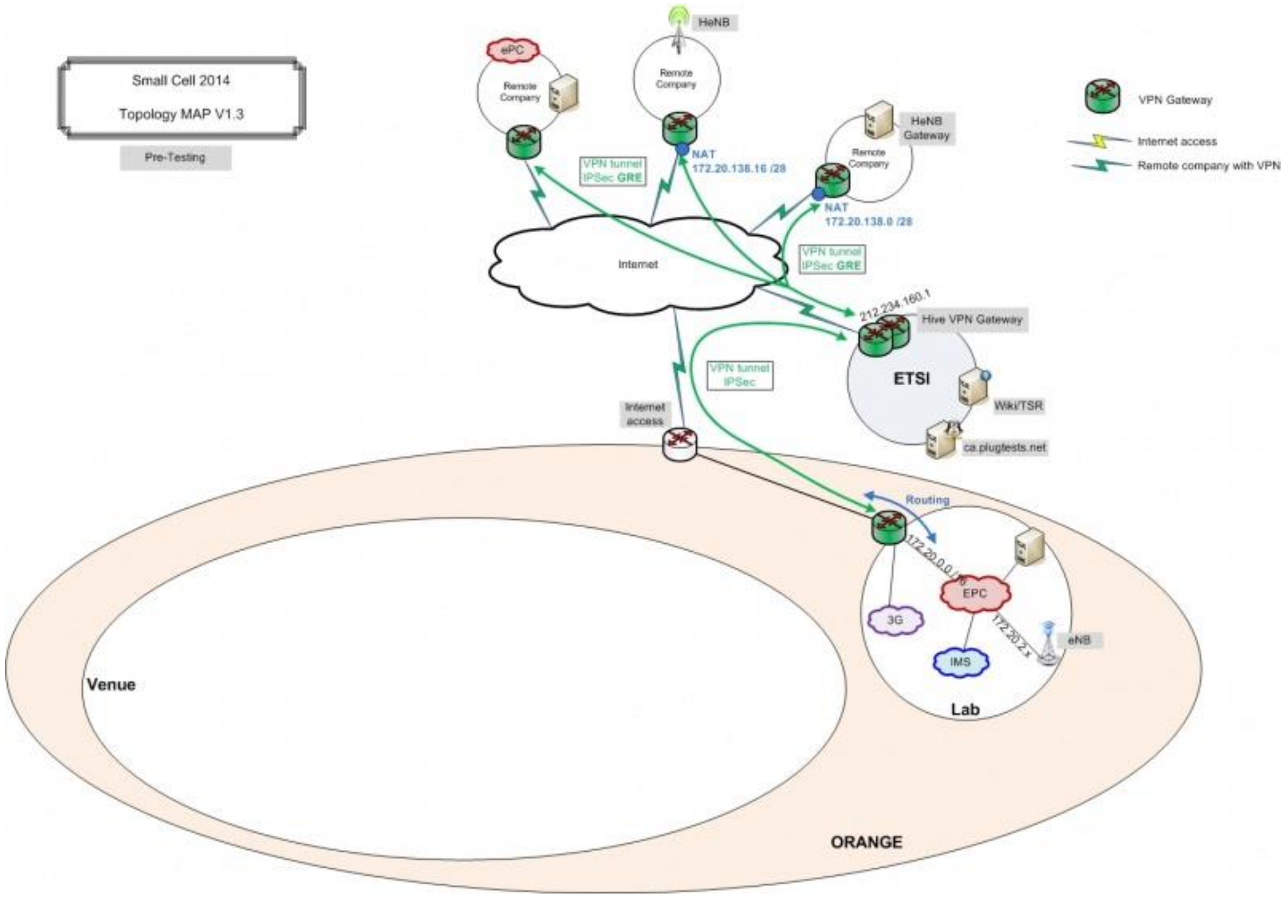


Figure 2. Remote test infrastructure (pre-testing)

Integration of remote equipment started several months before the Plugfest. Remote integration and pre-testing progress was discussed during weekly conference calls with participants and tracked in the Plugfest wiki.

5.3.2 Local Test Infrastructure

A few days before the Plugfest, the local test infrastructure was deployed by ETSI at Orange Labs to enable participating companies to bring their equipment locally. Local deployment of equipment under test was a requirement for Mobility and SON scenarios. All the other topics could be tested remotely.

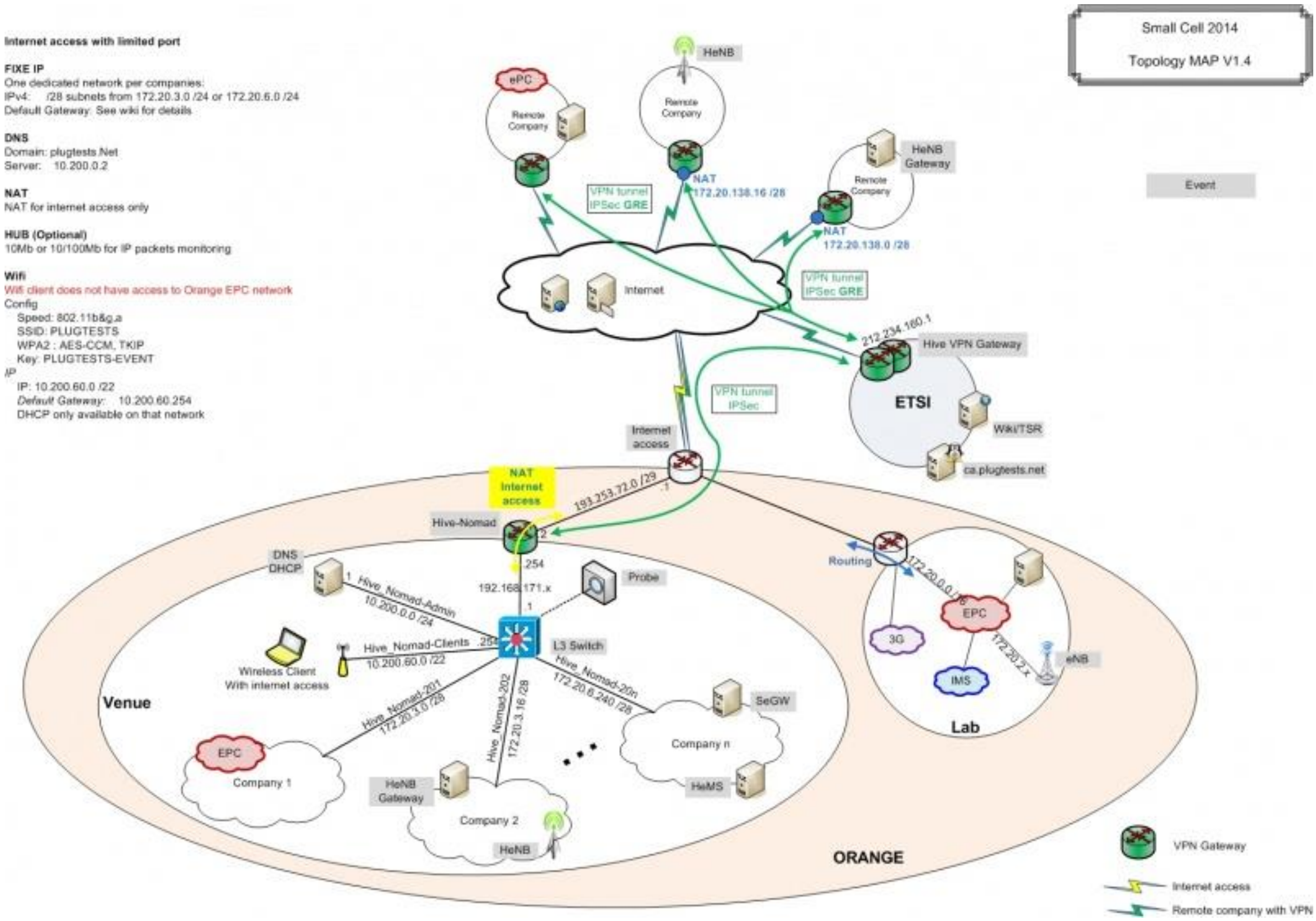
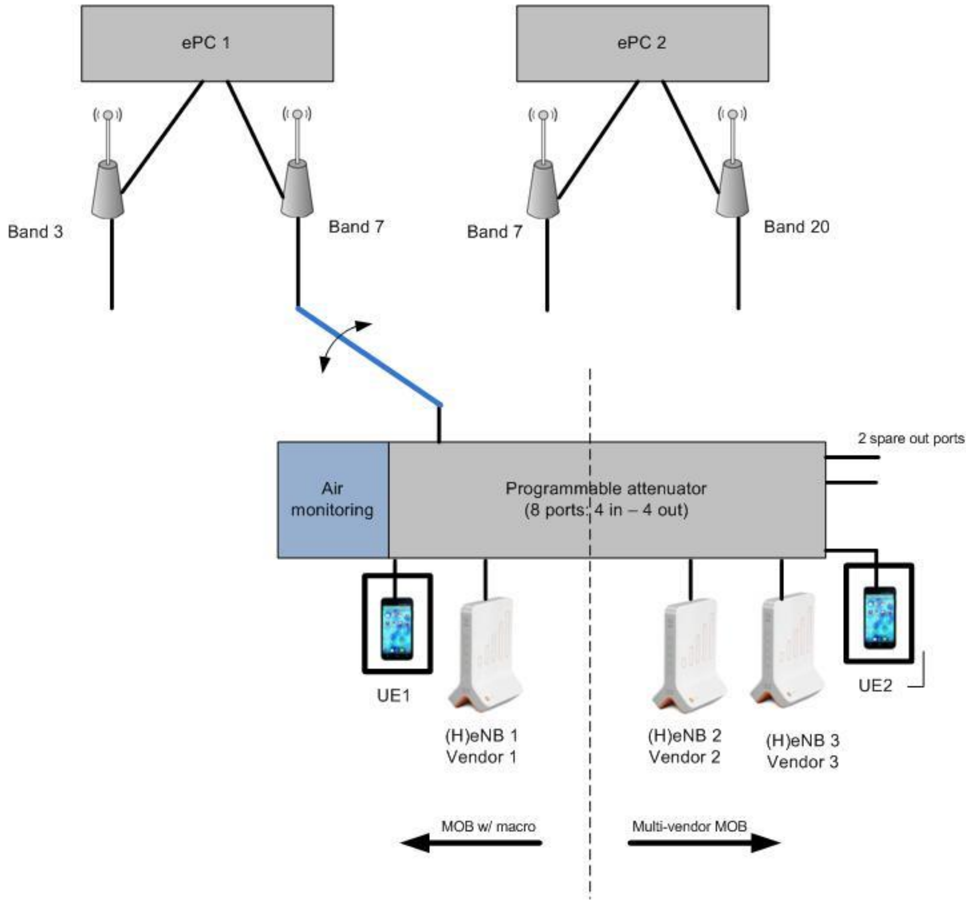


Figure 3. Plugtest infrastructure

5.3.3 Mobility Test infrastructure

The mobility test infrastructure included an eight port programmable attenuator that allowed to run 2 Mobility test sessions in parallel. During the Plugfest preparation it was decided to dedicate one of them to Mobility with macro eNB (Hand-over from Small Cell to macro eNB and back) and the second to multi-vendor mobility (hand-over from Small Cell to Small Cell).



5.3.4.1 Mobility with macro

This setup allowed to test hand-over scenarios between Small Cells and macro eNBs provided by Orange. Up to 4 macro eNBs from different vendors operating in different frequency bands were available for the Plugfest. In addition 2 ePCs from different vendors were provided to support this setup. This setup allowed to test S1 and X2 based intra and inter-frequency hand-over procedures.

Macro eNBs had been previously configured in order to see Small Cells under test as neighbour cells. Small Cell vendors could choose the eNB and ePC that they wanted to test with, or, when time permitted, test with several macro ePCs and/or eNBs.

5.3.4.2 Multi-vendor Mobility

This setup allowed to test hand-over scenarios from one vendor's Small Cell to another vendor's Small Cell. Small Cell vendors were requested to agree on the ePC to be used as well as to decide on the usage of HeNB-GW and SeGW to complete the test setup.

This setup allowed to test S1 and X2 based intra and inter-frequency hand-over procedures, depending on the features supported by the Small Cells.

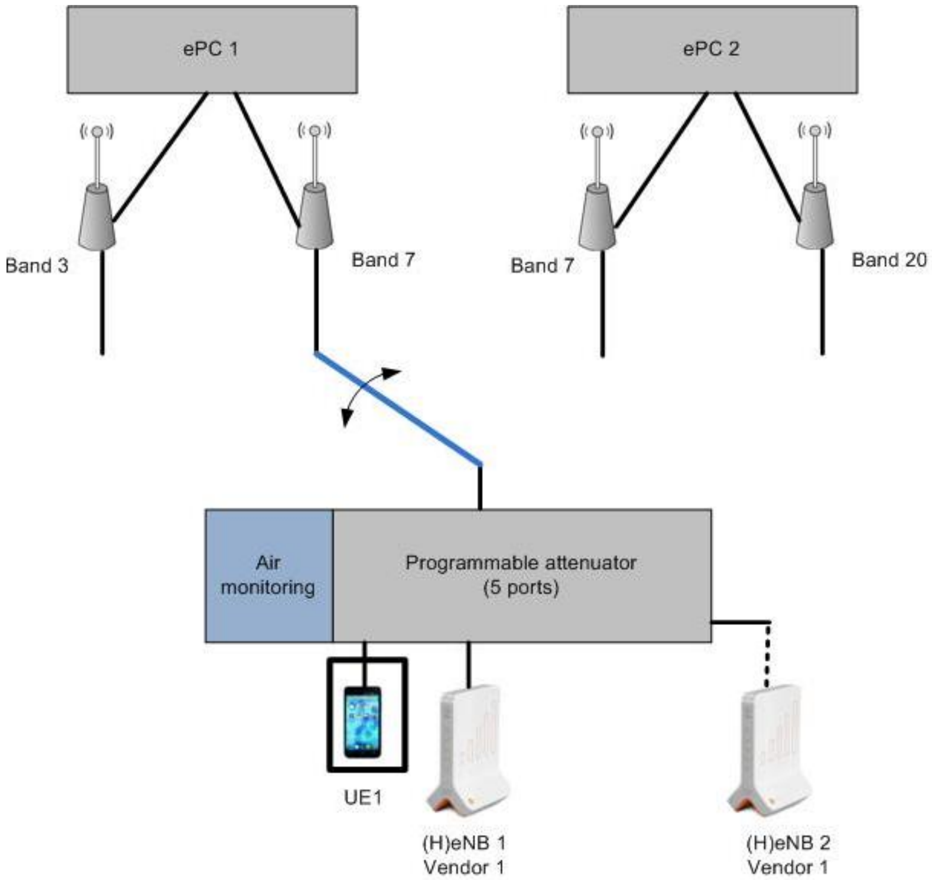
5.3.4 SON Test infrastructure

The SON test infrastructure was very similar to the Mobility test infrastructure, and included 2 programmable attenuators, one providing 5 ports and the other one providing 4 ports, which allowed to run 2 SON test sessions in parallel. During the Plugfest preparation it was decided to dedicate one of them to SON with macro eNB and the second one to multi-vendor SON.

5.3.4.1 SON with macro

This setup allowed to test SON scenarios with macro eNBs provided by Orange. Up to 4 macro eNBs from different vendors operating in different frequency bands were available for the Plugfest. In addition 2 ePCs from different vendors were provided to support this setup. This setup allowed to test PCI, ANR, MRO, and CCO based SON test cases.

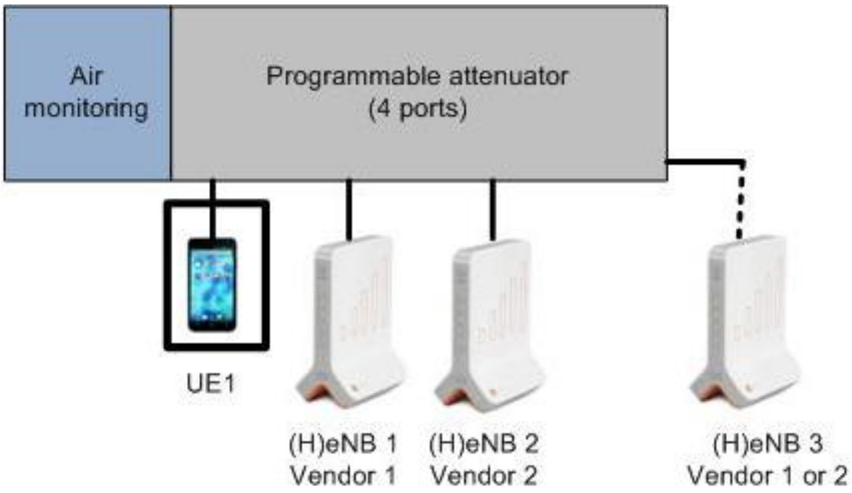
Small Cell vendors could choose the eNB and ePC that they wanted to test with, or, when time permitted, test with several macro ePCs and/or eNBs. For test cases requiring 2 Small Cells (PCI) the second Small Cell was provided by the same vendor.



5.3.4.2 Multi-vendor SON

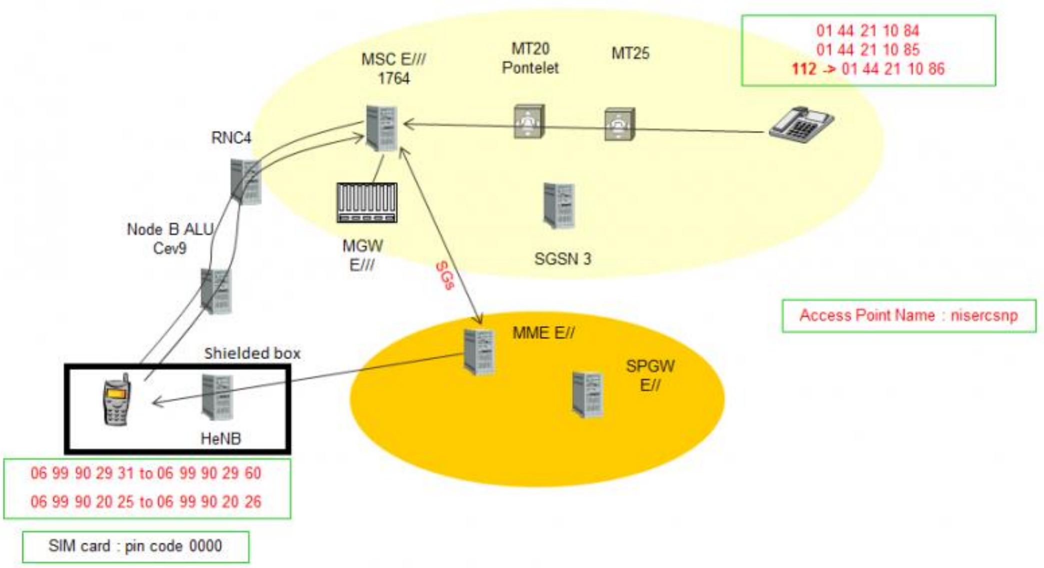
This setup allowed to test SON scenarios among Small Cells from different vendors. Small Cell vendors were requested to agree on the ePC to be used as well as to decide on the usage of HeMS, HeNB-GW and SeGW to complete the test setup.

This setup allowed to test PCI, ANR, MRO, and CCO based SON test cases, depending on the features supported by the Small Calls. For test cases requiring 3 Small Cells (PCI) the third Small Cell was provided by one of the two vendors participating in the test session.

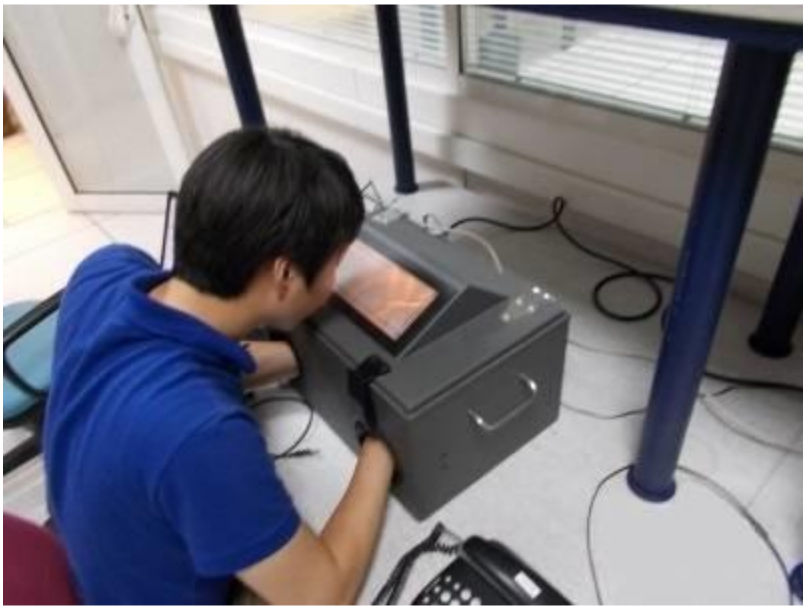


5.3.5 CSFB Test Infrastructure

Testing of voice calls and emergency calls following Circuit Switch Fall-Back feature was enabled. The test setup was configured with a UTRAN NodeB and 3G core coupled with one of the ePCs provided by Orange, as depicted in the schema:



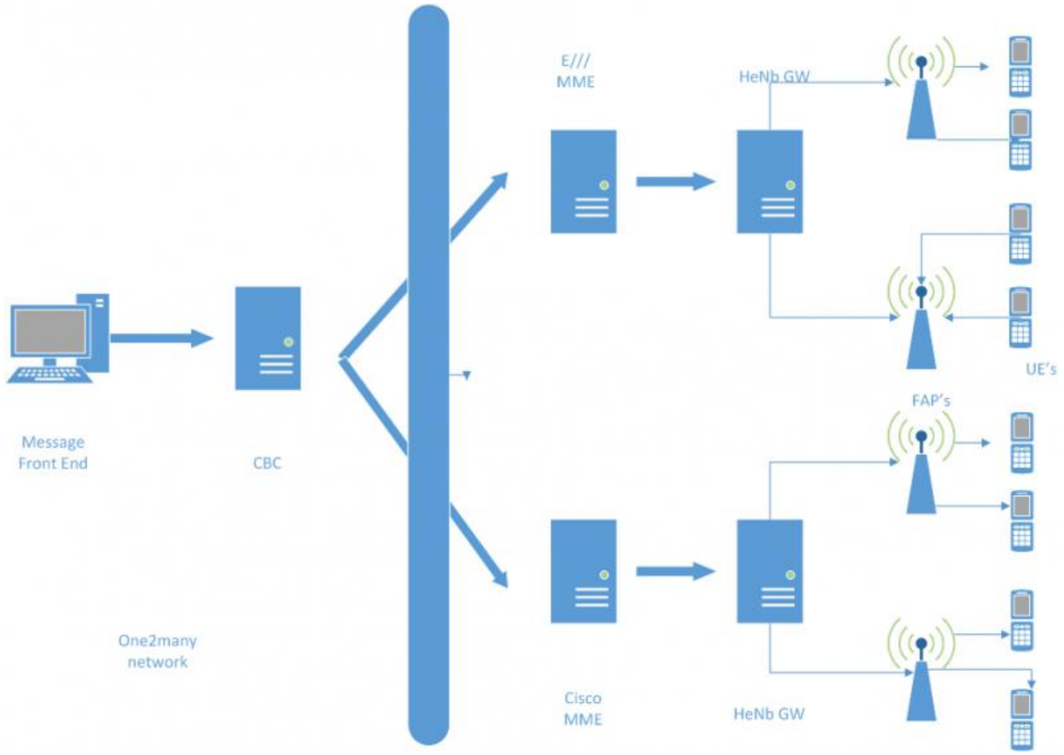
3G signal was provided with a radio cable connected into a shielded box that was be able to host participants' Small Cell and UE. Once in the shielded box, UE manipulation was possible through gloves, as shown in the picture:



Emergency call testing was also enabled in this setup by the translation of the Emergency number (112) into an E164 number (01 44 21 10 86).

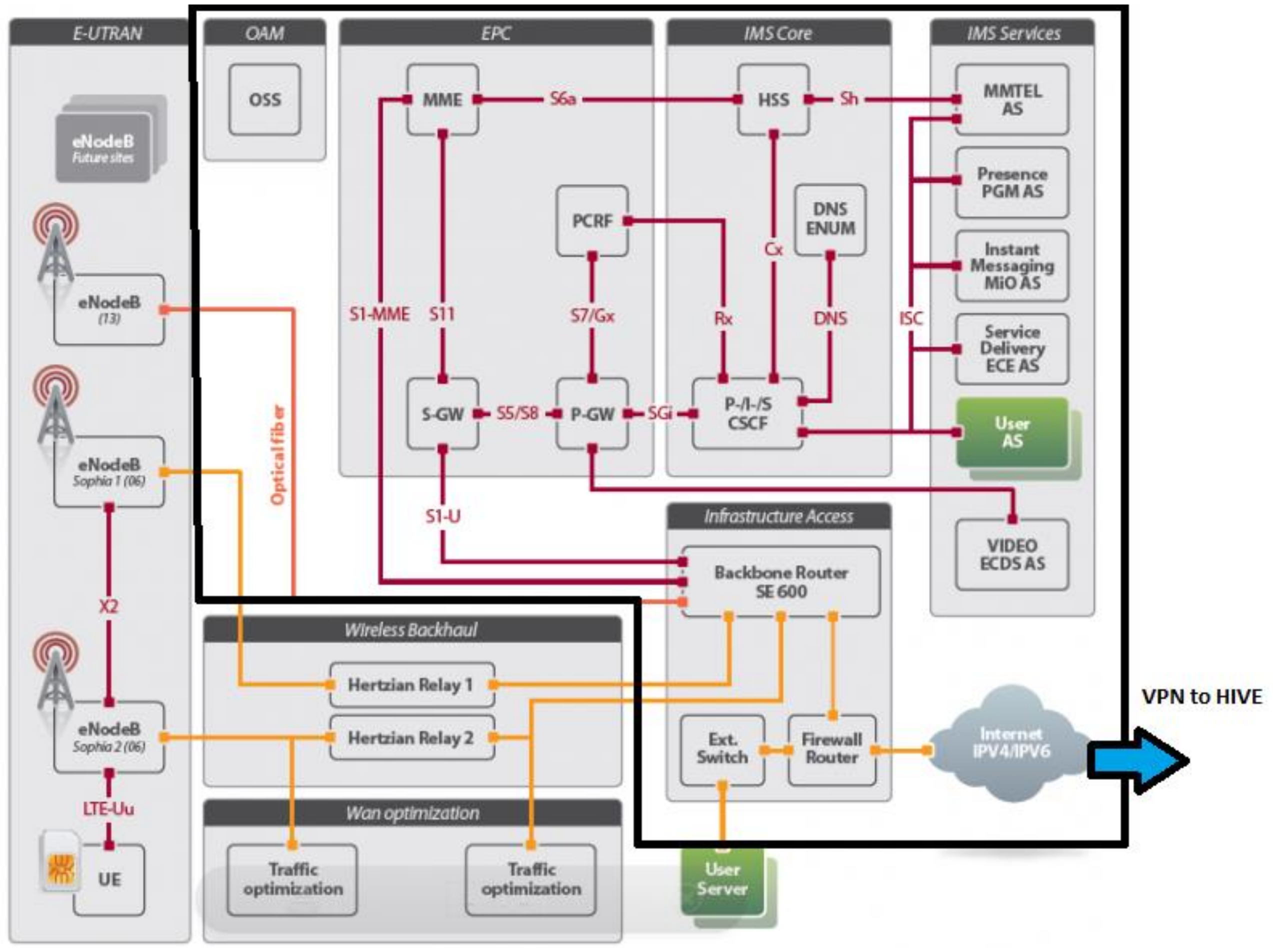
5.2.2 CMAS Test Infrastructure

In order to test Commercial Mobile Alert System, a Cell Broadcast Centre was integrated with 2 of the ePCs available for the Plugfest, as depicted in the figure below. Alert messages broadcast through Small cells was tested with and without HeNB-GWs.



5.3.6 IMS Test Infrastructure

Voice and Video over LTE testing was enabled by the integration of IMS cores into some of the available ePCs. When these ePCs were remote, the whole system was available remotely through ETSI HIVE as depicted in the figure below:



Voice over LTE requires an MMtel Application Server in the IMS infrastructure to provide the functions related to voice applications (supplementary services) for mobile equipment.

In addition, to provide voice and video over LTE, the core network needs to support Policy management and QoS and be able to handle dedicated bearers, allow to limit congestion and to enhance the service quality.

Default bearers provide non-guaranteed bit rate (non-GBR). For services that do not require IMS, the QoS parameter stems from the HSS configuration. For example Internet access will use a priority with QCI 9 (see Table below). For services based on IMS, there is a link between the Application Server and the PCRF (which manages the QoS and billing policy). Through this link, and the configuration associated with the requested service, the LTE network can establish the necessary dedicated bearers with the appropriate QoS (QCI value).The Default Bearer is obtained during the attach process, and ensures continuous IP connectivity.

Dedicated bearers are obtained on demand, when it is required to carry guaranteed bit rate (GBR) for certain delay-sensitive services, such as voice or video. The same dedicated bearer is used in case of multiple concurrent voice sessions (as in call waiting, conference supplementary services, etc...).

In a VoLTE session, the following three bearers are used:

- Bearer with QCI 9: Default bearer created when connecting to the network.
- Bearer with QCI5: Bearer created for IMS signalling (SIP messages) as soon as the connection to the IMS APN is established.

- Bearer with QCI1: This bearer is created once the voice session has been successfully initiated, to ensure audio transport (RTP messages)

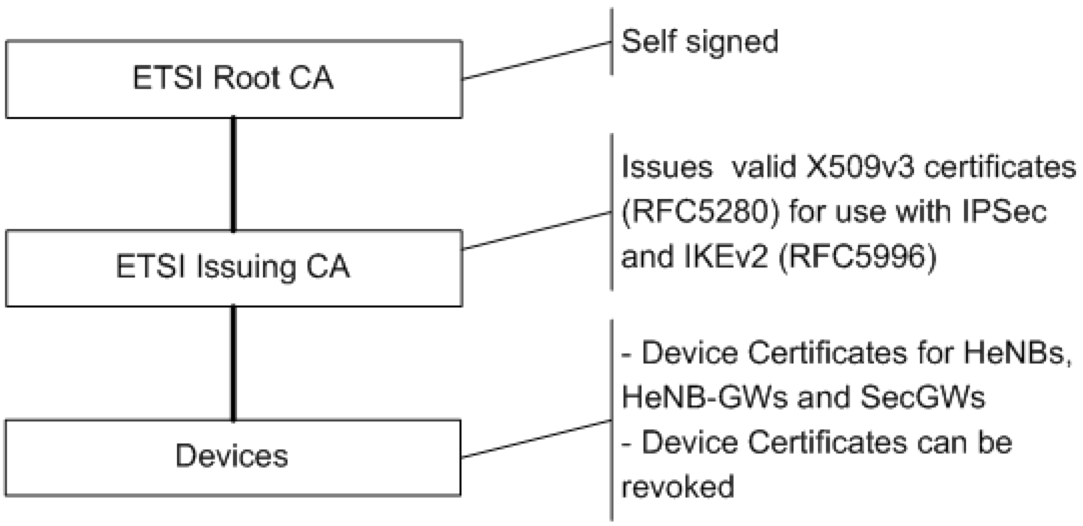
The table below summarized the QCIs used for IMS services:

QCI	Resource Type	Priority	Packet Delay Budget	Packet Loss Rate	Example Services
1	GBR	2	100 ms	10 -2	Conversational Voice
2		4	150 ms	10 -3	Conversational Video (Live Streaming)
3		3	50 ms	10 -3	Real Time Gaming
4		5	300 ms	10 -6	Non-Conversational Video (Buffered Streaming)
5	Non-GBR	1	100 ms	10 -6	IMS Signalling
6		6	300 ms	10 -6	-Video (Buffered Streaming) -TCP-based (for example, www, e-mail, chat, FTP, P2P file sharing, progressive video, and so forth)
7		7	100 ms	10- 3	-Voice -Video (Live Streaming) -Interactive Gaming
8		8	300 ms	10 -6	-Video (Buffered Streaming) -TCP-based (for example, www, e-mail, chat, FTP, P2P file sharing, progressive video, etc).
9		9	300 ms	10 -6	

Standardized QCI Characteristics (from 3GPP TS 23.203)

5.3.7 Security Test Infrastructure

A Public Key Infrastructure (PKI) setup was created for the Plugtest as depicted in the figure below. It was explicitly mentioned that the root certificate and Certificate Authority (CA) certificates were only to be used in the scope of the Plugfest.



The PKI setup consisted of the following certification authorities:

- Self-signed Root CA

- Trusted Issuing CA

All the certificates provided for the event followed X.509v3 and contained a validity restriction of type "time_start_and_end" with:

  - Start time = Generation time
  - Validity of 1 year

5.3.7.1 Procedure to obtain certificates

In order to perform positive security tests each Device Under Test (DUT: HeNBs, HeNB-GWs, SeGWs …) needed to follow these steps:

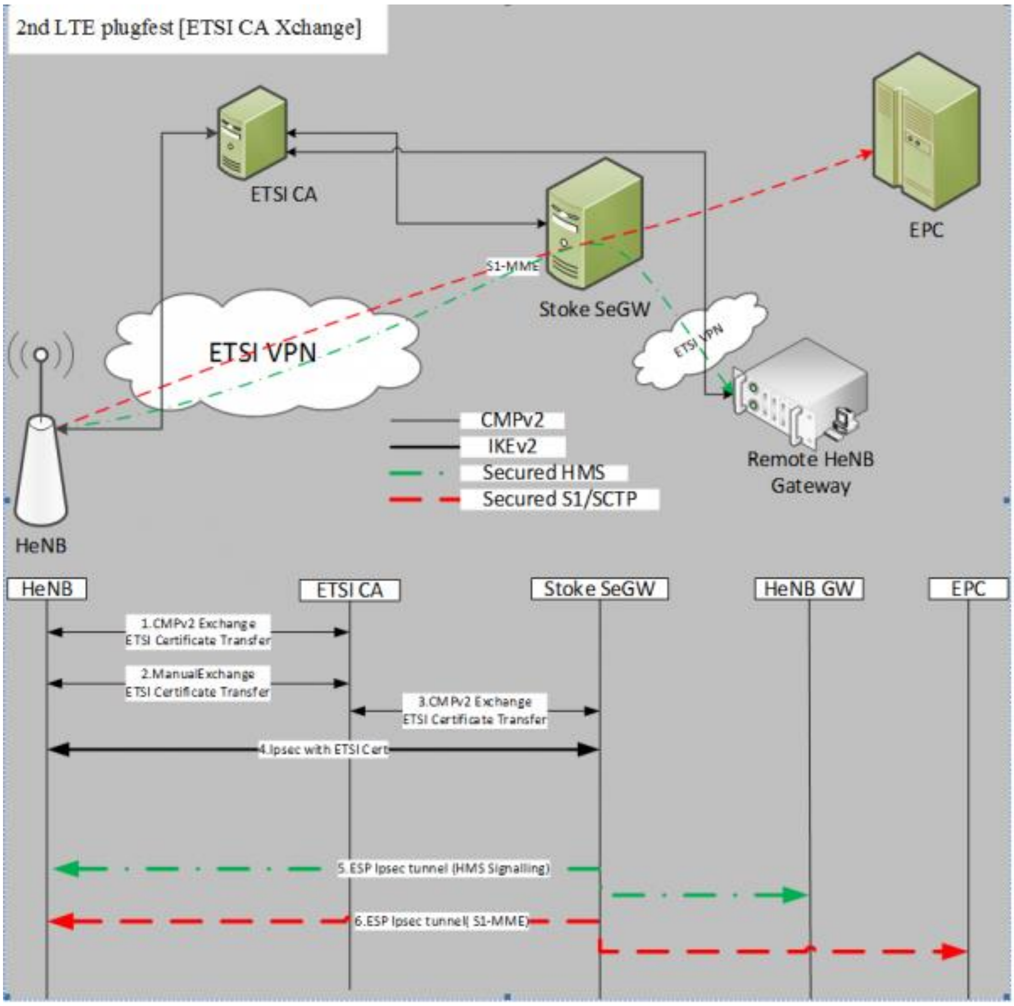
1. The equipment vendor sent an email to the Plugtest mailing list SMALL_CELL_LTE_PLUGFEST_2@LIST.ETSI.ORG stating its wish to run security tests
2. The ETSI team registered it with the ETSI CA server and sent back an enrolment code by email

3.1 If the DUT supported Certificate Management Protocol (CMPv2), it retrieved the device certificate via CMPv2.

3.2 If the DUT could issue a Certificate Signing Request (CSR) it was requested to go to http://ca.plugtests.net:8080/ejbca/ and to follow the instructions to obtain a Privacy Enhanced Mail (PEM)

5.3.7.2 Secure connection call flow

The following figure depicts the secure connection call flow.



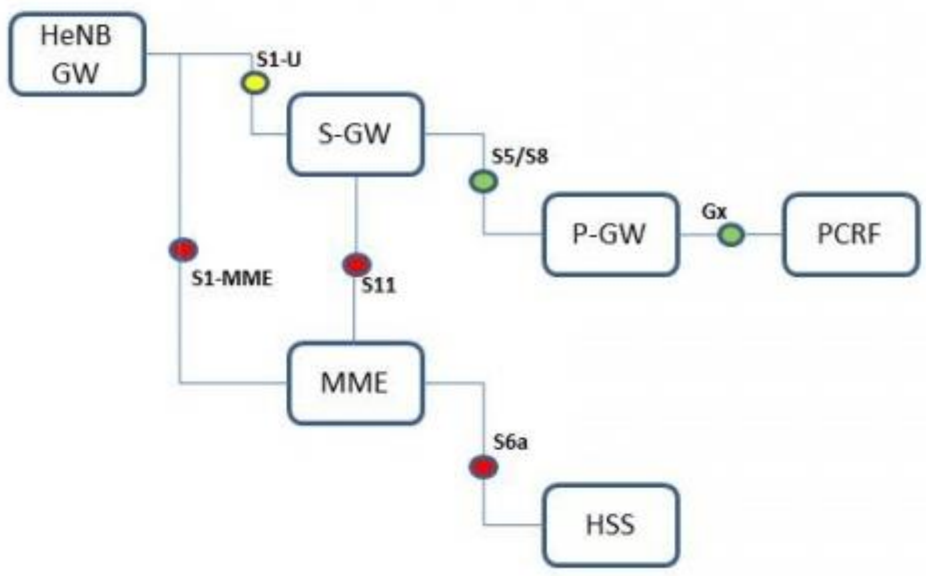
All the messages in the call flow above were exchanged within a VPN tunnel. The VPN tunnel acts as Transport layer for all the nodes including the SeGW to connect to the ETSI HIVE.

Call Flow details:

1. SeGW connects to the ETSI CA server via CMPv2 protocol or manually to fetch the ETSI Certificate.
2. (omitted) HeNB connects to the security gateway with temporary, pre-assigned keys, e.g. PSK or self-signed certificates with mutual roots installed in SecGW and small cells
3. HeNB connects to the ETSI CA server via CMPv2 protocol or manually to fetch the ETSI Certificate.
4. HeNB establishes IPsec tunnel with SeGW using IKEv2 protocol and ETSI certificate
5. HeNB registers with HeNB Gateway over the Secured tunnel with SeGW. All further communication like UE registration, re-registration /redirection, etc continues via secured IPsec tunnel though SeGW.
6. HeNB establishes SCTP/ S1 link to the EPC via the secured tunnel through the SeGW. All further communication on S1AP continues via the secured IPsec tunnel

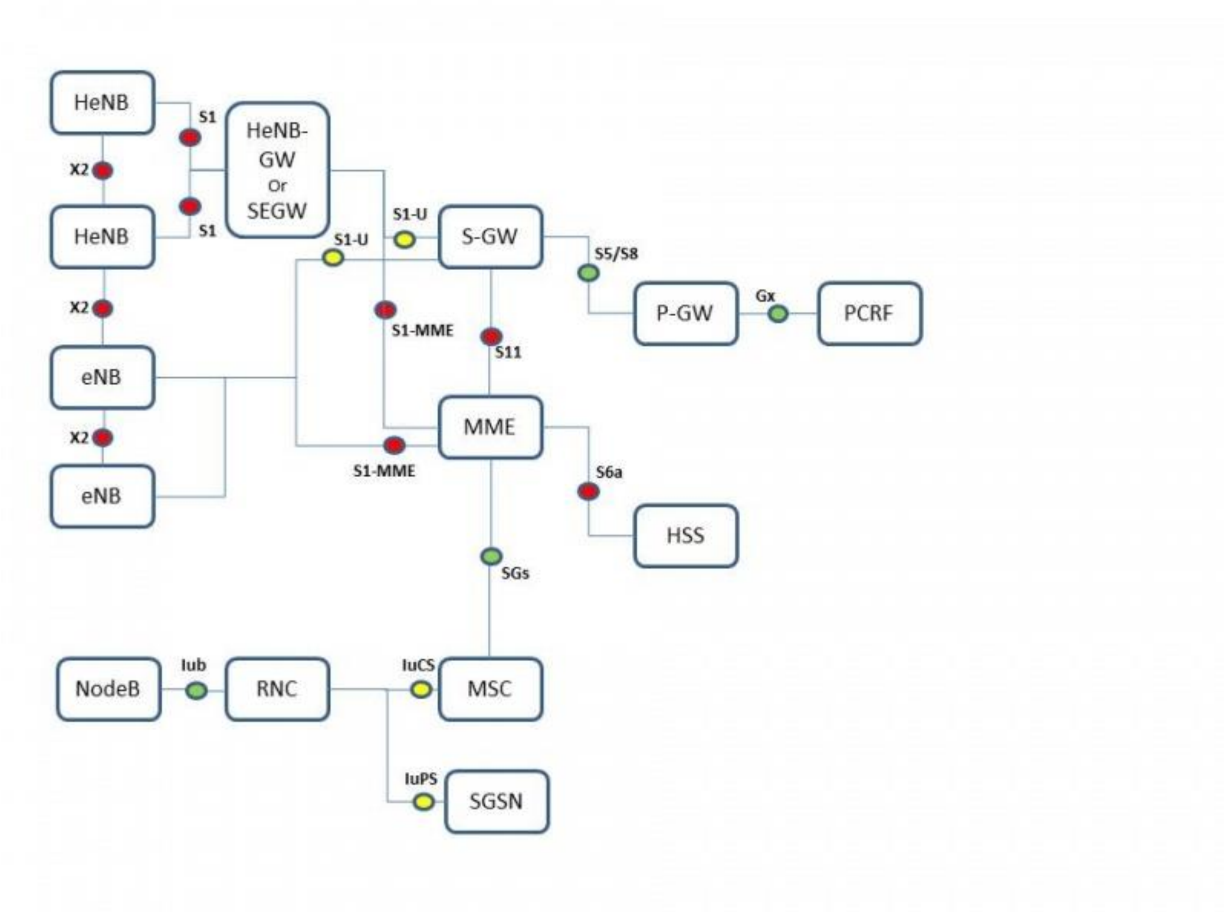
5.3.6 Tracing

A complex tracing system was put in place to allow monitoring and correlating messages exchanged between both local and remote equipment. For debugging purposes, it was important to be able to correlate the messages exchanged between the equipment under test with the messages exchanged through the ePCs' internal interfaces. This was especially challenging in case of remote ePCs, where the messages exchanged on the internal interfaces were not meant to be routed through the Plugfest test infrastructure. A specific VPN setup was put in place with the organisations providing remote ePCs to enable the rerouting of these messages through the probe. The schema below depicts the observed interfaces in case of a test session including a remote ePC.



In the case of ePCs deployed locally at Orange Labs, all the traffic through the internal interfaces was mirrored and made available to the probe via a 1Gbps Ethernet link.

The schema below depicts the observed interfaces in case of a test session including an ePC deployed locally.



A centralized independent monitoring solution was used to collect messages from all Access and Core Network interfaces simultaneously, performing real time end-to-end monitoring.

This way, it was possible to follow the message flow for a single user or a single call throughout the network in real time, highlighting problems (and possible solutions) in a fast and effective way.

The picture below highlights an example of Multi-Vendor test involving SON, captured by the above mentioned tracing solution.

NAS	Activate default EPS bearer context accept
S1AP	E_RABSetupResponse
NAS	Activate default EPS bearer context accept
S1AP	ENBConfigurationTransfer
S1AP	ENBConfigurationTransfer
S1AP	MMEConfigurationTransfer
S1AP	ENBConfigurationTransfer
S1AP	MMEConfigurationTransfer
S1AP	MMEConfigurationTransfer
X2AP	X2SetupRequest
X2AP	X2SetupResponse
X2AP	HandoverRequest
X2AP	HandoverRequestAcknowledge
X2AP	SNStatusTransfer
S1AP	PathSwitchRequest
S1AP	PathSwitchRequestAcknowledge

5.4 Interoperability Test Procedure

5.4.1 Pre-testing procedure

Companies were requested to run remote integration and pre-testing as follows:

1. Provide configuration parameter values to ETSI Team

   ✓ Configuration information was compiled and made available in the wiki

2. Set VPN with ETSI HIVE. Ping ETSI ping host.

   ✓ VPN creation status was tracked in the wiki

3. If supporting 3GPP IPsec, request and obtain an ETSI certificate

=> Security Certificates delivery status was tracked in the wiki.

4. ePC vendors deliver SIM cards to HeNB vendors, which confirm reception

   ✓ SIM cards delivery status was tracked in the wiki

Once a vendor had achieved remote connectivity, obtained the security certificate and received SIM cards (if applicable), it was considered to be ready for pre-testing.

5. SeGW, HeNBGW, ePC, HeMS vendors announced their availability for supporting pre-testing

   ✓ Support availability and time-zone was tracked in the wiki

6. (H)eNB vendors announced their targeted pre-testing slots (in accordance with supporting vendors availability)

   ✓ Targeted/completed test slots were tracked in the wiki

7. (H)eNB vendors run through the pre-testing test list and indicated when the pre-testing (for the concerned equipment combination) was completed without specifying the results.

8. For completed Test Sessions, detailed results were entered to the TRT during the Plugfest.

5.4.2 Face-to-Face testing procedure

During the setup session at the beginning of the face-to-face Plugfest, vendors that were bringing their equipment locally to the Plugfest venue, integrated it to the local test network and tested the connectivity with other local or remote equipment. Vendors that kept their equipment remote, just needed to re-check connectivity.

After this 4 hour session dedicated to local equipment setup and integration, connectivity among all the participating equipment, local or remote, had been successfully validated.

The Plugfest schedule determined the test sessions to be run. The procedure to be followed during a face-to-face session was as follows:

1. Login to the Test Reporting Tool. This will display the Plugfest schedule and identify the applicable test session.

2. When applicable, complete the list of supporting equipment involved test session. As an example, for some test sessions it was up to the vendors to decide on the ePC to be used.

3. Verify connectivity among all the involved equipment.

4. Choose a Test Session Secretary who is in charge of reporting the results. Usually the HeNB vendor was in charge of this role.

5. Open the Test Session Report.

6. Run the first test according to the detailed test case description.

7. Check that messages are exchanged as expected.

8. Determine and report test result in the Test Session Report.

    OK – Test Successful. Expected result obtained

    NOK – Test not successful. Check monitoring tools to identify source of error. Enter comment in the Test Session Report without explicitly referencing participating companies or products.

    NA – Feature not applicable or not implemented by one or several of the involved parties. Enter comment.

9. Run next test.

10. Once all the tests planned for the test session are run, all the involved parties verify and accept the test session report.

6 Interoperability Results

6.1 Results Overview

The table below provides the overall results from all the test cases run by all the companies during the Plugfest. A total of 2124 test results were entered by participants, from which 1370 (64.5 %) were actually executed.

The execution rate above 64%, while acceptable should be improved for future events. This figure can be explained by the larger scope of this year's event, as well as by the incorporation of some new features and test cases that were being targeted for the very first time. The non-executed test cases correspond either to non-implemented features (NA) or to companies running out of time during the test sessions (OT).

Enhancing the test execution rate of SON, MOB and SEC test cases should be a goal for future events.

Interoperability		Not Executed		Totals	
OK	**NO**	**NA**	**OT**	**Run**	**Results**
1283 (93.6%)	87 (6.4%)	507 (23.9%)	247 (11.6%)	1370 (64.5%)	2124

Table 1: Results Overview

The PASS rate (Interoperability – OK) of above 93 % indicates a very satisfactory level of interoperability of the products and the high skills of participating companies in preparing and executing the test cases.

The failure rate of 6.4%, which is very acceptable, can be explained by software bugs and implementation errors that could not be fixed during before the end of the Plugfest as well as some ambiguities or errors in standards.

6.2 Results per Test Group

The table below provides the results for each test group in the scope of the Plugfest. Following sections intend to analyze and understand these results.

	Interoperability		Not Executed		Totals	
	OK	**NO**	**NA**	**OT**	**Run**	**Results**
CSFB	37 (97.4%)	1 (2.6%)	0 (0.0%)	0 (0.0%)	38 (100.0%)	38
HeMS	316 (98.1%)	6 (1.9%)	57 (14.0%)	28 (6.9%)	322 (79.1%)	407
SON	12 (66.7%)	6 (33.3%)	4 (8.5%)	25 (53.2%)	18 (38.3%)	47
MOB	29 (53.7%)	25 (46.3%)	39 (32.8%)	26 (21.8%)	54 (45.4%)	119
Regression	688 (94.5%)	40 (5.5%)	227 (21.6%)	94 (9.0%)	728 (69.4%)	1049
CMAS	30 (85.7%)	5 (14.3%)	6 (13.6%)	3 (6.8%)	35 (79.5%)	44
SEC	142 (97.3%)	4 (2.7%)	78 (28.5%)	50 (18.2%)	146 (53.3%)	274
IMS	10 (100.0%)	0 (0.0%)	1 (9.1%)	0 (0.0%)	10 (90.9%)	11

Table 2: Results per test groups.

6.2.1 CSFB

Voice calls via Circuit Switch Fall-Back scheme were in scope of a Plugfest for the first time. While the amount of available test cases was relatively small, the execution level (100%) and the interoperability level (97%) are very satisfactory and encouraging. It would be advisable to extend the number of test cases to include mobile terminated scenarios.

6.2.2 HeMS

Test results of the management interface test group, with an execution rate close to 80% and an interoperability level above 98% reflect a good integration between HeMS and HeNB vendors. The 14% of Not-Applicable (NA) results can be explained by pico/micro eNBs not supporting TR-069 EMS management and some level of incompleteness in standards. Next Plugfest could focus in achieving an industrial common standard in provisioning HeNBs.

6.2.3 SON

Self-Organizing Networks Test Cases were in the scope of the Plugfest for the first time, which explains the relatively low execution rate (38%) and interoperability level (66%). The main reasons for these relatively low rates was the lack of support from macro eNB vendors. Test cases and test setup are expected to be refined for future events as companies get familiar with this test group. An improvement in these results can be expected in future events.

6.2.4 MOB

Mobility test group is one of the most challenging in terms of preparation, configuration, lab setup and tools, which explains the low execution rate (45%) and interoperability level (53%). As for SON testing, the lack of support from macro eNB vendors is causing long ramp-up periods and misconfiguration problems. These issues were largely discussed with participants during and after the Plugfest, and it was agreed to proceed to a thorough review of both the lab requirements and test cases.

6.2.5 Regression

Although the interoperability level (94%) is very satisfactory for regression testing, the relatively low execution rate (69%), while acceptable, indicated that these test cases need to be kept in the scope of future Plugfests. Moreover, the test cases could be extended to include more complicated scenarios. A revision of the existing test cases could also be advisable.

6.2.6 CMAS

Commercial Mobile Alert Systems test case were included in the scope of a Plugfest for the very first time. Given this, and that this scenario involves most of the participating equipment in the signaling path (UE, HeNB, HeNB-GW, ePC and CBC) the execution rate of 79% and interoperability level above 85% can be considered as very satisfactory.

6.2.7 SEC

Security test cases have been in the scope of the Plugfest for now 5 times. Security test cases were aimed to be executed during the pre-testing phase, remotely. The low execution rate (53%) can be explained by pico/micro cells not implementing IPSec (e.g. relying on satellite link encryption), and/or participating companies focusing in new topics added to the scope of the Plugfest more recently.

6.2.8 IMS

IMS testing, with voice and video call over LTE, were explicitly part of the Plugfest scope for the very first time. However this test group was added to the Plugfest test list relatively late in the Plugfest preparation process, and only included 2 very high level test cases, which were to be considered as optional for participants. To smooth the testing, IMS cores were pre-integrated and supported by the same organizations providing the ePCs. All these explains the high execution rate (90%) and interoperability levels (100%).

7 Plugfest Outcome

7.1 Feedback on Base Specifications

The following sections describe the base spec issues discovered during the Plugfest.

7.1.1 3GPP TS 36.413

<table>
<tr><th>Item</th><th>Section</th><th>Issue Description</th><th>Corrective Proposal</th></tr>
<tr><td>Cell Identity in E-UTRAN CGI.</td><td>9.2.1.38</td><td>The number of leftmost bits of the Cell Identity corresponding to the eNB ID is missing in section 9.2.1.38. It can be deducted from section 9.2.1.37

“9.2.1.38 E-UTRAN CGI

This information element is used to globally identify a cell (see TS 36.401 [2]).

<table>
<tr><th>IE/Group Name</th><th>Presence</th><th>Range</th><th>IE type and reference</th><th>Semantics description</th></tr>
<tr><td>PLMN Identity</td><td>M</td><td></td><td>9.2.3.8</td><td></td></tr>
<tr><td>Cell Identity</td><td>M</td><td></td><td>BIT STRING (28)</td><td>The leftmost bits of the Cell Identity correspond to the eNB ID (defined in subclause 9.2.1.37).</td></tr>
</table>
“</td><td>Add the number of leftmost bits of the Cell Identity corresponding to the eNB ID.</td></tr>
</table>

Table 3~~7~~: 3GPP 36413 issues

7.1.2 3GPP TS 29.168 and TS 36.300

TS 29.168 and TS 36.300 both have the MME using TAI-based routing of messages, particularly in the case of a HeNB-GW being present. In the case of a HeNB-GW it will register with the MME as an eNB with the capability to support up to 256 different TACs in the S1 registration message. However, a HeNB-GW is intended to support many thousands of HeNBs. A question for 3GPP is whether it is intended by 3GPP that a HeNB-GW should support more than 256 different TACs amongst the HeNBs connecting to it?

7.2 Feedback on Test Specifications

7.2.1 CSFB

CSFB test cases should be extended to include:

- mobile terminated calls
- CSFB based emergency calls

7.2.2 HeMS

The following test cases were removed from the test execution list because the SeGW and Serving HeMS were not part of the test configuration:

- TC/HeMS/CMP/03 – Configuration Management Procedure – IPSec tunnel IP address change
- TC/HeMS/Discovery/01 Serving HeMS Discovery – via initial HeMS accessible inside operator
- TC/HeMS/Discovery/02 Serving HeMS Discovery – via initial HeMS accessible on the public Int

7.2.3 SON

Remote pre-testing was not possible for this feature which requires the equipment under test (small cells) to be physically close to each other and/or to the macro eNBs. SON test cases could only be run during the face 2 face test sessions: in order to maximize the benefits of the Plugfest, the following tests cases (which are somehow similar to the ones that were executed) were removed from the test execution list:

- DSON/MRO/03
- DSON/MRO/04
- DSON/MRO/07
- DSON/MRO/10
- DSON/MRO/13
- DSON/MRO/21
- DSON/CCO/02

7.2.4 MOB

Test reporting on mobility test cases was sometimes inconsistent, due to different interpretations from participants of the mix of references to small cells, femtocells and macro cells in the test descriptions. It was decided to rework the test cases in a generic way (i.e. source cell, target cell) and to create explicit test cases in the test execution list for each of the possible combinations and test groups:

1. Mobility with macro:
    1.1. S1
        1.1.1. Intra-frequency
            1.1.1.1. Hand-out: Small Cell to macro
            1.1.1.2. Hand-in: macro to Small Cell
        1.1.2. Inter-frequency
            1.1.2.1. Hand-out: Small Cell to macro

        1.1.2.2. Hand-in: macro to Small Cell

  1.2. X2

    1.2.1. Intra-frequency

        1.2.1.1. Hand-out: Small Cell to macro

        1.2.1.2. Hand-in: macro to Small Cell

    1.2.2. Inter-frequency

        1.2.2.1. Hand-out: Small Cell to macro

        1.2.2.2. Hand-in: macro to Small Cell

2. Multi-vendor Mobility:

  2.1. S1

    2.1.1. Intra-frequency

        2.1.1.1. Hand-out: Small Cell 1 to Small Cell 2

        2.1.1.2. Hand-in: Small Cell 2 to Small Cell 1

    2.1.2. Inter-frequency

        2.1.2.1. Hand-out: Small Cell 1 to Small Cell 2

        2.1.2.2. Hand-in: Small Cell 2 to Small Cell 1

  2.2. X2

    2.2.1. Intra-frequency

        2.2.1.1. Hand-out: Small Cell 1 to Small Cell 2

        2.2.1.2. Hand-in: Small Cell 2 to Small Cell 1

    2.2.2. Inter-frequency

        2.2.2.1. Hand-out: Small Cell 1 to Small Cell 2

        2.2.2.2. Hand-in: Small Cell 2 to Small Cell 1

It could also be advisable to include HeNB-GW (when applicable) in the MOB test configurations, and to consider testing intra and inter gateway mobility.

7.2.5 Regression

The following test cases were removed from the test execution list because there was no UE that implemented the service which triggers the requested behaviour:

- SVC/LTEPS/02 UE initiated ERAB establishment
- SVC/LTEPS/05 UE initiated ERAB release

It was discussed a possible extension on the regression test group to include more complex scenarios.

7.2.6 CMAS

It would be advisable to include HeNB-GW (when applicable) in the CMAS test configurations, as its presence mayhave an impact in the way the ePC Routes the broadcast messages.

7.2.7 IMS

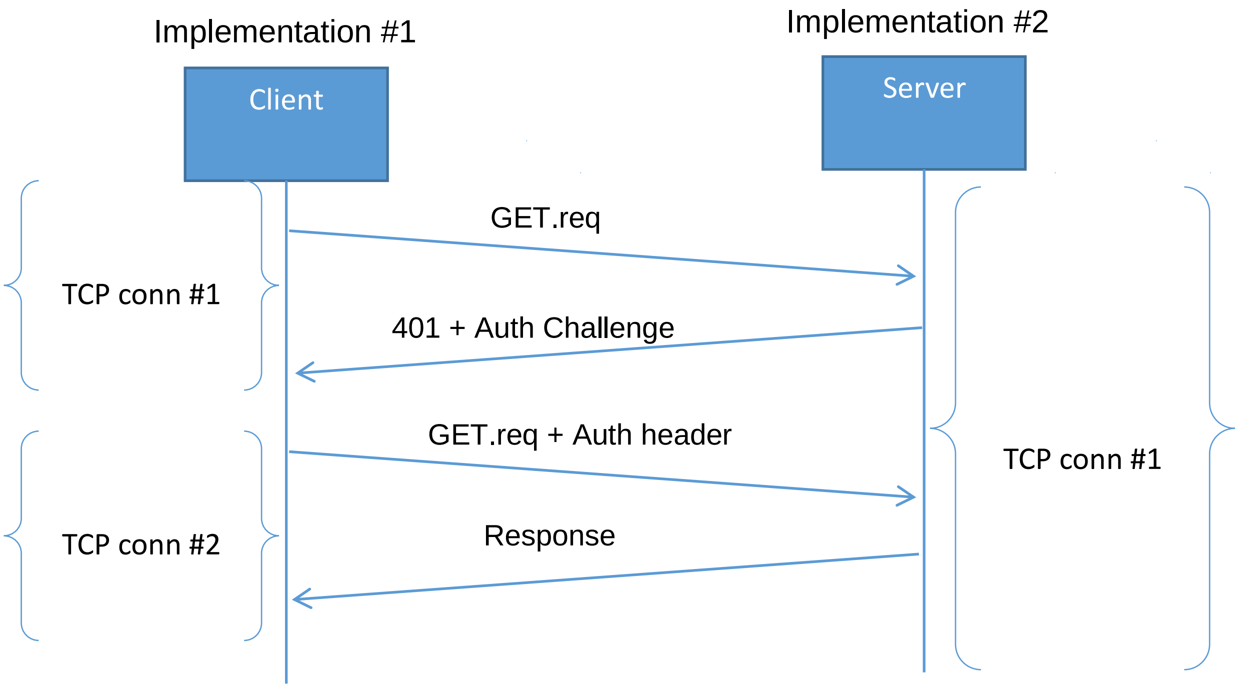
IMS test group was added to the Plugfest test list relatively late in the Plugfest preparation process, and only included 2 very high level test cases. Detailed description for these test cases should be provided for future events. IMS-based emergency calls could also be added to the IMS test list.

7.3 Feedback on IOP Issues

7.3.1 HeMS Test Group Authentication Issue

During HeMS test sessions, it was discovered that TR-069 allowed for 2 different implementation options that are not interoperable. Indeed, TR-069 (Section 3.4.4 Authentication and 3.4.5 Digest Authentication) and RFC2617 specify the HTTP sequence, but do not recommend the number of TCP connections to be used during the message exchange.

As a result one implementation could use a different TCP connection for each message exchange, while another one could use the same TCP connection for the complete message flow. This 2 implementations will not interoperate.



This issue was discussed during the Plugfest and the conclusion was to recommend vendors to support both options.

7.3.2 Small Cell provisioning in CBC

This was the first Plugfest were Mobile Alert message broadcast through small cells was tested. 2 different scenarios were tested, one with small cells directly connected to the ePC and a second one with the small cells connected to the ePC through a HeNB-GW.

During the testing it was discovered that the different equipment in the message flow were building and using the Small Cell E-UTRAN CGI in different ways, which lead to interoperability issues.

This issue could be solved during the Plugfest by changes in the configuration of the involved equipment, and both scenarios could be successfully validated. Nevertheless, it was foreseen that the configuration parameters assigned to each small cell should be clarified and that very clear guidelines on their use should be provided for future events (see 7.4.4)

7.3.3 Small Cell provisioning in macro eNBs neighbour list.

During the event, it was discovered that Small Cells had been provisioned in macro eNBs neighbour lists as if they were macro cells, which lead to interoperability issues in mobility test cases, especially when testing hand-over from macro cell to small cell. The workaround for this issue was done by small cells simulating being macro cells during mobility test sessions. A clarification of the configuration parameters assigned to small cells and on the way they should be provisioned on peering equipment will allow a reduction in the ramp-up time and having more efficient mobility test sessions (see 7.4.4)

7.4 Feedback on Organizational Issues

7.4.1 Remote test infrastructure

Remote pre-testing was highly appreciated by participants and most probably one of the keys of the success of this Plugfest. However the following points could be improved:

- When connecting remote equipment to HIVE, NAT should be discouraged. Instead, when possible, a fixed IP addresses should be assigned to each piece of remote equipment.
- The VPN request form could be simplified and integrated to the WIKI. Additional documentation can be made available in the WIKI.
- After the Plugfest, participating companies were requested to backup and save their VPN configuration: next Plugfest should capitalize on this and re-use as much as possible the IP address scheme.

7.4.2 Pre-testing

Pre-testing could be more efficient if a clear and explicit pre-testing test cases list was made available for review & comments by participants well in advance of the pre-testing phase.

7.4.3 Event format and duration

The face-to-face Plugfest had a duration of 9 days organised as follows:

- 0,5 days for local equipment setup (Monday morning)
- 5,5 days of testing (Monday to Saturday)
- 1 day off (Sunday)
- 2,5 days of testing (Monday to Wednesday)
- 0,5 day for tear-down (Wednesday afternoon)

It was discussed with participants that a better balance between the 2 weeks of testing could be beneficial, a longer break (2 days) between the 2 weeks could also be advisable. Both could be achieved by organising the Plugfest as follows:

- 0,5 days for local equipment setup (Monday afternoon)
- 4 days of testing (Tuesday to Friday)
- 2 days off (Saturday and Sunday)
- 4 days of testing (Monday to Thursday)
- 0,5 day for final wrap-up and tear-down (Friday morning)

7.4.4 Configuration parameters

The way some of the configuration parameters were assigned to Small Cells caused confusion, configuration misalignments, and eventually interoperability issues (see 9.2, 9.3).

Long discussions were held with participants during and after the Plugfest, and the following clarifications were agreed:

1. Small Cells should indicate if they act as macro cells.
    1. If they do:
        1) They will be assigned a 20 bits eNBId.
        2) They will choose a 8 bits cellId
        3) ECGI will be built as eNBId * 256 + cellId
    2. If they do not:
        1) They will be assigned a 28 bits HeNBId
        2) ECGI will be the HeNBId.
2. HeNB-GWs will be assigned:
    1. a 20 bits eNBId
    2. a (list of) unique TAC (different for each HeNB-GW) to be used by the HeNBs connecting through the HeNB-GW. The HeNB-GW should not register any of these TACs with the MME until the HeNB(s) supporting them has connected to it

3GPP specifications ([TS36.300], Section 4.6.2 require that he TAC and PLMN ID used by a HeNB shall also be supported by the HeNB GW, and that the MME shall be able to route handover messages, MME configuration transfer messages and MME Direct Information Transfer messages based on TAI. To minimise any possible routing problem in the ePCs, an additional (list of) TACI, different from the ones used by the HeNB-GWs, will be shared by Small Cells acting as macro cells. 3GPP specifications suggest that the sets of TACs supported by two different HeNB-GWs under an ePC must not intersect – i.e. have any elements in common – in order to avoid routing confusion.

All this information will be shared in the WIKI, so that all the equipment involved in such test sessions can provision Small Cells in a consistent way and Global eNB IDs exchanged among them are properly built and understood, as described in 3GPP TS 36.413 (Section 9.2.1.37)

IE/Group Name	Presence	Range	IE type and reference	Semantics description
PLMN Identity	M		9.2.3.8	
CHOICE *eNB ID*	M			
>Macro eNB ID				
>>Macro eNB ID	M		BIT STRING (20)	Equal to the 20 leftmost bits of the *Cell Identity* IE contained in the *E-UTRAN CGI* IE (see subclause 9.2.1.38) of each cell served by the eNB
>Home eNB ID				
>>Home eNB ID	M		BIT STRING (28)	Equal to the *Cell Identity* IE contained in the *E-UTRAN CGI* IE (see subclause 9.2.1.38) of the cell served by the eNB

7.4.5 Security Certificates

ETSI provided a Certificate Authority (CA) server at http://ca.plugtests.net:8080/ejbca/ where vendors could retrieve their security certificates either via download of .p12 files or via Certificate Signing Requests (CSR). CMPv2 was not enabled.

Participant registration on the Certificate Authority was performed manually on request. For future events, this could be done by default as soon as participants register their equipment. Like this the operators of the devices will receive their login information directly, and will then decide themselves whether or when to download the certificates.

Some participants experienced issues to follow the instructions in the login information email. This text should be reviewed and clarified to ensure the instructions are understandable and easy to follow.

7.4.6 GPS Signal

GPS signal was required by some of the Small Cells for synchronization purposes. As the Plugfest venue was several floors underground, bringing the GPS signal to the lab was a real challenge. Several solutions were studied and following solutions were used across various vendors:

1) Installing individual PTP master clocks in level -1(where GPS cable was available) and making the masterclock available over Ethernet in the test lab

2) Using a GPS simulator which re-played a previously saved live GPS recording.

3) NTP server provided by Orange lab.

For future Plugfests, GPS signal availability in the lab should be discussed and arranged with the hosting lab before the event starts.

7.4.7 Mobility Testing

Mobility test sessions are probably the most complex ones, and the ones that require longer troubleshooting from participants. The following best practises should be considered to make Mobility test sessions more efficient in future Plugfests:

- **Clear guidelines on neighbour cells provisioning** in eNBs (see 10.4)
- **Equipment pre-calibration:** when possible, LTE Measurement Events should be configured consistently on all the equipment participation to the mobility test sessions, so that the same hand over scenario is run each time. The following values were agreed during the Plugfest

  Event A2 – Serving becomes worse than threshold: -70 dBm

  Event A3 – Neighbour becomes offset better than serving. Offset: 3db, Hysteresis: 1dB

  Event A4 – Neighbour becomes better than threshold: -70dBm

- **Mobility station pre-testing**. All the mobility scenarios should be pre-tested with at least one Small Cell to validate the tools and support equipment setup and configuration. Lessons learnt and work-around should be exchanged and discussed with participants. Small Cell vendors could volunteer to participate to pre-testing.
- **On-site support from eNB vendors.** As in previous Plugfests, it was noted that the physical presence and local support from macro eNB vendors during the Plugfests would allow to make the mobility test sessions much more efficient.
- **Additional attenuators.** Due to the physical presence and support of all the involved parties, multi-vendor mobility is easier to run and troubleshoot that mobility with macro scenarios. Multi-vendor mobility test sessions could be offshored from the mobility test benches to the participants' tables, if some vendors could bring with them additional attenuators to support the tests.

7.4.8 Test Session Chairs

It could be beneficial for the Plugfest to provide Test Session Chairs to overview and support test sessions. This would be especially beneficial for complex scenarios where the ramp-up time has been observed to be significant (SON, MOB). The role of test session chairs could be played by neutral parties, like students or contractors, or by recognised experts in each area from the vendor or operator communities. The Test Session chairs will help to:

- Review and detect errors on the test specifications
- Anticipate configuration problems in the involved equipment
- Reduce the test session ramp-up time, by briefing participants on previously detected errors, misconfigurations.
- Improve the execution rate of the test cases
- Ensure a consistent reporting across test sessions.

This possibility should be discussed during the organisation of future Plugfests.

History

Document history		
V0.1.0	08/09/2014	First version