SmallCell LTE Plugfest;
Kranj, Slovenia;
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ETSI

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1 Executive Summary

The Small Cell Forum, in partnership with ETSI, organized the Small Cell LTE Plugfest from 10 -14 June 2013, hosted by the SINTESIO test lab in Slovenia. The Forum's series of Plugfests aim to cultivate an effective ecosystem of standardised small cells (3G, LTE and WiFi). This helps provide operators and consumers with a wider choice of small cell products while also facilitating economies of scale. The Plugfest was supported by companies including equipment vendors, test tool vendors and companies providing test network infrastructure.

The primary objective of the event, organised by the ETSI Centre for Testing and Interoperability, was to demonstrate the effectiveness of the 3GPP LTE standards in supporting interoperability between LTE small cells and EPC equipment from different vendors.

Companies had the possibility of connecting remotely into the hosting lab, both during the event proper and for a number of weeks prior to the event to facilitate pre-testing activity.

The 3GPP LTE Release 9 standards were frozen in December 2009 and are widely used in LTE macro networks. Small cells compliant to the standards allow mobile operators to simplify deployment and enable better coverage and capacity for their LTE networks.

Successful interoperability tests, monitored by test tools, were conducted between small cells and EPCs, security gateways, macro eNodeB and, as an option, HeNB gateways to verify the S1 interface implementations.

In a multi-vendor HetNet environment – as an option – mobility scenarios of hand-out with the macro network using S1 and X2 interface were tested. VoLTE (IMS) calls were also tested. The Plugfest also demonstrated the use of IPsec/IKEv2 security protocols to permit the small cells to communicate over the public Internet to operators' core networks in a highly secure manner.

Highlights of the Plugfest are:

- All vendors succeeded in passing the mandatory S1 tests
- 6 HeNB vendors successfully established the baseline S1 security tests
- 2 HeNB vendors succeeded to make a VoLTE call on the dedicated bearer using Iskratel IMS
- 3 HeNB vendors successfully performed S1 based small cell to macro cell handout
    - inter: band 1 small cell to band 3 macro
    - intra: band 3 small cell to band 3 macro, same frequency
    - inter: band 3 small cell to band 3 macro, different frequency
- 2 HeNB vendor successfully performed S1 based small cell to small cell handover
    - intra: band 1 small cell and band 1 small cell, same frequency
    - inter: band 1 small cell and band 3 small cell, different frequency
- 1 vendor successfully performed X2 based small cell to macro cell handout

2 Introduction

This plugfest aimed to verify the interoperability between small cells and EPC equipment from different vendors and focused on the following types of equipment:

- SmallCells access points, also named Home eNode B (HeNB),
- Security Gateways (SeGW),
- SmallCells Gateways, also named Home eNode B Gateways (HeNB-GW),
- Evolved Packet Cores (EPCs)

A first setup connected all these equipments to a dedicated test network.

A second setup connected local HeNBs to Telecom Slovenia's LTE Network, which is a deployed environment. This setup enabled Hand Out testing from SmallCells to MacroCell.

Also IPsec/PSK security protocols, that allow SmallCells to communicate over the public Internet to system operators' core networks in a highly secure manner, were tested.

3 Abbreviations

HeNB	Home eNode B
HeNB-GW	Home eNode B GateWay
NO	Test is recorded as NOT successfully passed.
NA	Test is not applicable.
OK	Test is recorded as successfully passed.
OT	Test is recorded as not being executed due to lack of time.
SeGW	Security GateWay
EPC	Evolved Packet Core
Test Session	A paring of vendors that test together during a given time slot.
TSR	Test Session Report. Report created during a test session.

4 Participants

The companies, who contributed to the test result are listed in the table below. The companies are listed accordingly to the types and the combination of components they provided.

HeNB	Company Name	Equipment Presence	Staff Presence
1	AIRSPAN	Onsite	Onsite
2	ARGELA	Onsite	Onsite
3	FOXCONN	Remote	Remote
4	FUJITSU	Onsite	Onsite
5	NEC	Remote	Onsite
6	NODE-H	Onsite	Onsite
7	RADISYS	Onsite	Onsite
8	QUCELL	onsite	Onsite
9	SISTEL NETWORKS	Remote	Remote
10	SPIDERCLOUD	Remote	Onsite
SeGW	**Company Name**	**Equipment Presence**	**Staff Presence**
1	STOKE	Remote	Onsite
HeNB-GW	**Company Name**	**Equipment Presence**	**Staff Presence**
1	CISCO	Remote	Onsite
EPC	**Company Name**	**Equipment Presence**	**Staff Presence**
1	ATHONET	Remote	Onsite
2	CISCO	Remote	Onsite
3	QUORTUS	Onsite	Onsite
4	TELECOM SLOVENIA	Onsite	Onsite
IMS	**Company Name**	**Equipment Presence**	**Staff Presence**
1	ISKRATEL	Onsite	Onsite
Test Tools	**Company Name**	**Equipment Presence**	**Staff Presence**
1	JDSU	Onsite	Onsite
2	QOSMOTEC	Onsite	Onsite
3	SAN JOLE	Onsite	Onsite

5 Technical and Project Management

All the information presented in this chapter is a extract of the ETSI event wiki

https://services.plugtests.net/wiki/Small-Cell-LTE-Plugfest/index.php/Main_Page

5.1 Test Plan

The test plan was provided by SmallCell Forum Interoperability Group. During the regular conference calls which were held as part of the event preparation, companies could propose additional tests. Eventually, the original test plan from previous femtocell events was extended with a further 28 tests cases. The Plugfest team constantly reviewed and commented on the test plan, in order to ensure a set of consistent tests with clear PASS/FAIL criteria.Finally, the test cases were prioritized and categorized as being mandatory or optional for the Plugfest.

The following clauses summarise the test cases for the event.

5.1.1 S1 Mandatory Test Cases

Test Id	Test Summary	Test Group
5.1.1.9	SCTP Association / S1 Interface Setup / Successful Operation	Mandatory
5.1.1.10	SCTP Association / S1 Interface Setup / Failure	Mandatory
5.1.1.11	SCTP Association / S1 Interface Setup / Failure with reattempt	Mandatory
5.1.2.7	UE Registration / Default Bearer Setup / Downlink-Uplink Traffic Flow	Mandatory
5.1.4.1	UE Deregistration / Network Detach	Mandatory
5.2.2.2	UEPaging	Mandatory

5.1.2 S1 Optional Test Cases

Test Id	Test Summary	Test Group
5.4.2.4	DPDs	Security
5.4.2.5	IPSec SA Rekeying from HNB	Security
5.4.2.6	IPSec SA Rekeying from SeGW	Security
5.4.2.7	IKE SA Rekeying from HNB	Security
5.4.2.8	IKE SA Rekeying from SeGW	Security
5.4.2.9	Tunnel Deletion	Security
5.4.2.10	H(e)NB Reboot	Security
5.4.2.12	End Entity Certificate Enrolment	Security
5.4.2.13	Uplink Data Transfer – IPSec Pre-Fragmentation on Secure Link	Security
5.4.2.14	Uplink Data Transfer – IPSec Post-Fragmentation on Secure Link	Security
5.4.2.15	Downlink Data Transfer – IPSec Pre-Fragmentation on Secure Link	Security
5.4.2.16	Downlink Data Transfer – IPSec Post-Fragmentation on Secure Link	Security

5.1.3 X2 Optional Test Cases

Test Id	Test Summary	Test Group
5.3.1.7	Intra-Frequency X2 based Femto to Femto Handovers – Success	Mobility
5.3.1.8	X2 Setup on Secure Link	Mobility
5.3.1.9	X2 Reset on Secure Link	Mobility
5.3.1.10	X2 Configuration Update on Secure Link	Mobility
5.3.1.11	X2 Resource Status Reporting on Secure Link	Mobility
5.3.1.12	X2 Load Indication on Secure Link	Mobility
5.3.1.13	X2 Cell Activation on Secure Link	Mobility
5.3.1.14	Intra-Frequency X2 based Femto to Femto Handovers – Too Late Handover Failure	Mobility
5.3.1.15	Intra-Frequency X2 based Femto to Femto Handovers – Too Early Handover Failure	Mobility
5.3.1.16	Inter-Frequency X2 based Femto to Femto Handovers – Success	Mobility

5.2 Test Scheduling

The preliminary test schedule was developed prior to the Plugfest and was circulated to all the participants in advance for comments. The initial test schedule allowed for each company to test against all other companies which led to an initial proposal of 56 test sessions and 8 handover test sessions. Every test slot was of a duration of 4,5 hours. The day was organized in a morning test session from 8.00 to 12.30 and in an afternoon test session from 13.30 to 18.00. Up to 13 parallel test sessions were planned.

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

The figure below shows the last version of the test schedule as of Friday 14 June (Please note that some test sessions extended over muliple test slots).

		Session1 Macro HO	Session2 Macro HO	Session3 TS ePC	Session4 TS ePC	Session5 Cisco ePC	Session6 Cisco ePC
Mon 10	8:00-12:30			Fujitsu HeNB-Fujitsu Telekom Slovenije ePC-TS			SpiderCloud HeNB-SpCloud Cisco ePC-Cisco
	13:30-18:00	Fujitsu HeNB-Fujitsu Telekom Slovenije eNodeB-TS					NEC HeNB-NEC Cisco ePC-Cisco
Tue 11	8:00-12:30			Node-H HeNB-Node-H Telekom Slovenije ePC-TS	Argela HeNB-Argela Telekom Slovenije ePC-TS		Fujitsu HeNB-Fujitsu Cisco ePC-Cisco
	13:30-18:00	Node-H HeNB-Node-H Telekom Slovenije eNodeB-TS					Cisco ePC-Cisco Qucell HeNB-Qucell
Wed 12	8:00-12:30			Airspan HeNB-Airspan Telekom Slovenije ePC-TS	Radisys HeNB-Radisys Telekom Slovenije ePC-TS	Node-H HeNB-Node-H Cisco ePC-Cisco	Argela HeNB-Argela Cisco ePC-Cisco
	13:30-18:00	Radisys HeNB-Radisys Telekom Slovenije eNodeB-TS		Airspan HeNB-Airspan Telekom Slovenije ePC-TS	Argela HeNB-Argela Telekom Slovenije ePC-TS		
Thu 13	8:00-12:30	Airspan HeNB-Airspan Telekom Slovenije eNodeB-TS	Radisys HeNB-Radisys Telekom Slovenije eNodeB-TS			FOXCONN HeNB-FXCON Cisco ePC-Cisco	Argela HeNB-Argela Cisco ePC-Cisco
	13:30-18:00	Airspan HeNB-Airspan Telekom Slovenije eNodeB-TS	Fujitsu HeNB-Fujitsu Telekom Slovenije eNodeB-TS	Telekom Slovenije ePC-TS Qucell HeNB-Qucell		Fujitsu HeNB-Fujitsu Radisys HeNB-Radisys Cisco ePC-Cisco	
Fri 14	8:00-12:30	Airspan HeNB-Airspan Argela HeNB-Argela Cisco ePC-Cisco					

		Session7 Cisco ePC	Session8 Cisco ePC and HNB GW	Session9 Cisco ePC and HNB GW	Session10 Athonet ePC	Session11 Athonet ePC	Session12 Quortus ePC	Session13 Quortus ePC
Mon 10	8:00-12:30	Sistel HeNB-Sistel Cisco ePC-Cisco		NEC HeNB-NEC Cisco HeNBGW-Cisco		Argela HeNB-Argela Athonet ePC-Athonet	Node-H HeNB-Node-H Quortus ePC-Quortus	Radisys HeNB-Radisys Quortus ePC-Quortus
	13:30-18:00	FOXCONN HeNB-FXCON Cisco ePC-Cisco	SpiderCloud HeNB-SpCloud Cisco HeNBGW-Cisco	Cisco HeNBGW-Cisco Qucell HeNB-Qucell	Airspan HeNB-Airspan Athonet ePC-Athonet	Node-H HeNB-Node-H Athonet ePC-Athonet	Argela HeNB-Argela Quortus ePC-Quortus	
Tue 11	8:00-12:30	Radisys HeNB-Radisys Cisco ePC-Cisco	FOXCONN HeNB-FXCON Cisco HeNBGW-Cisco		Qucell HeNB-Qucell Athonet ePC-Athonet	Sistel HeNB-Sistel Athonet ePC-Athonet	SpiderCloud HeNB-SpCloud Quortus ePC-Quortus	NEC HeNB-NEC Quortus ePC-Quortus
	13:30-18:00	Airspan HeNB-Airspan Cisco ePC-Cisco	Argela HeNB-Argela Cisco HeNBGW-Cisco	Fujitsu HeNB-Fujitsu Cisco HeNBGW-Cisco	SpiderCloud HeNB-SpCloud Athonet ePC-Athonet	NEC HeNB-NEC Athonet ePC-Athonet	Sistel HeNB-Sistel Quortus ePC-Quortus	FOXCONN HeNB-FXCON Quortus ePC-Quortus
Wed 12	8:00-12:30		Sistel HeNB-Sistel Cisco HeNBGW-Cisco			FOXCONN HeNB-FXCON Athonet ePC-Athonet		
	13:30-18:00			Node-H HeNB-Node-H Cisco HeNBGW-Cisco		Fujitsu HeNB-Fujitsu Athonet ePC-Athonet		Quortus ePC-Quortus Qucell HeNB-Qucell
Thu 13	8:00-12:30						Fujitsu HeNB-Fujitsu Quortus ePC-Quortus	
	13:30-18:00							
Fri 14	8:00-12:30		Radisys HeNB-Radisys Cisco HeNBGW-Cisco					

5.3 Test Infrastructure

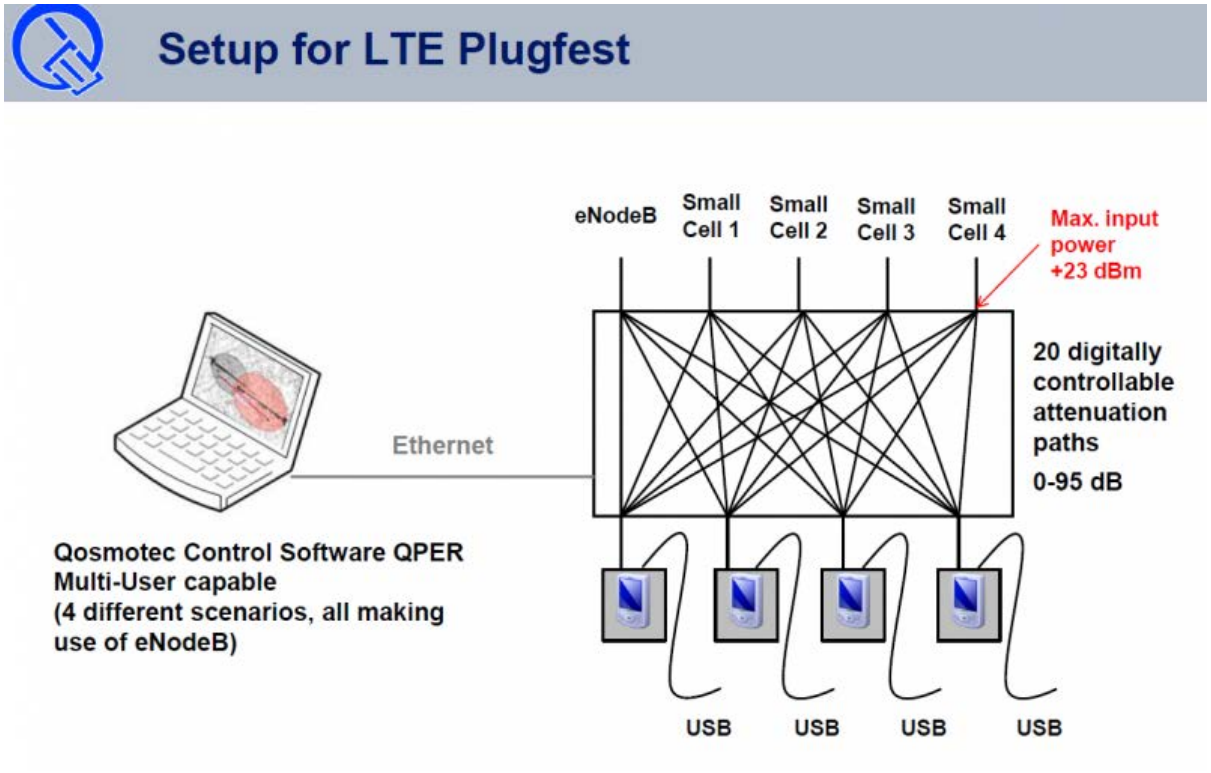
Telekom Slovenije (TS) provided access to their life LTE network infrastructure, including:

- EPC
- Dedicated eNB

In addition, there was a handover station enabling handout testing from Smallcell to TS macrocell.

5.4 Handover Station

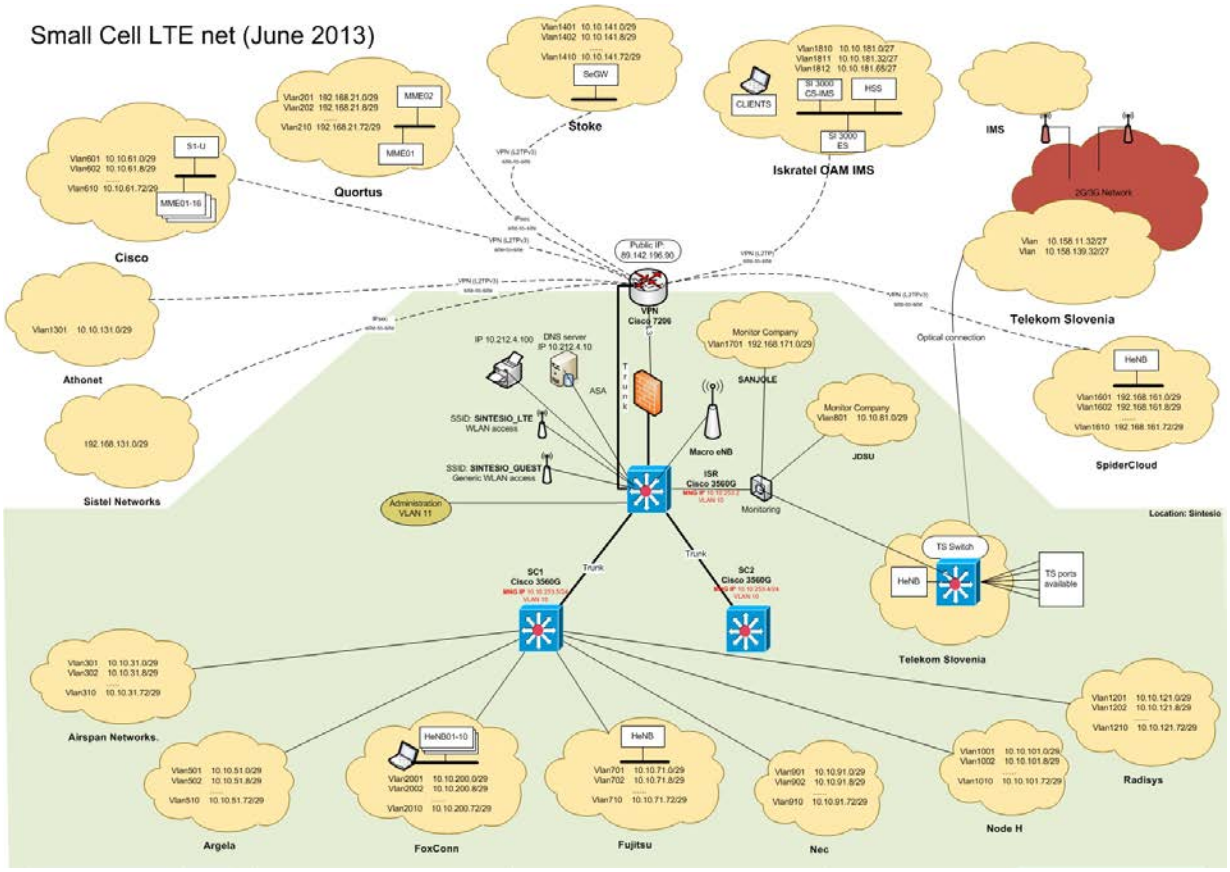
The handover station was setup as depicted below in order to enable to run dynamic signal level attenuation scenarios to test handover from macro cells to small cells, but also from small cells to other small cells. Up to 2 parallel HO sessions were executed in each handover test slot. One staff member from the company providing the station assisted the HeNB teams through the tests. Both intra and inter frequency tests were conducted.



5.5 Local and remote connections to the Test Network

- Some vendors participating in the plugfest used equipment remotely located in their premises and needed reliable connections to the test network in the plugfest venue. In this case, the remote equipment was connected via VPN using a combination of L2TPv3 and IPSEC.
- For privacy purposes it was required to provide separate independent IP subnets to each vendor.

The following figure shows local and remote connections, which were deployed during the plugfest.



5.6 Security Certificates

HeNB digital certificate based authentication was applied (TBC: EAP-AKA with certificate was not applied). ETSI provided the service of certificate creation and support. The process was the following:

1) ETSI also played the CA role and provided the root certificate, reducing the number of root certficates that needed to be installed to 1

2) HeNB vendors provided their own private key and sent a certificate signing request to ETSI CTI

3) ETSI sent back the signed certificates to each vendor.

4) Routing and configuration details based on the certificate, such as FQDN, were provisioned on the SecGW

6 Achieved Results

All vendors were invited to attend the pre-testing session from 4th to 7th June. The goal was to get all equipement ready to avoid delays during the scheduled sessions that followed the pre-testing. This pre-testing was necessary due to the complexity of the test environment, in order to verify the IP security features and to check the basic smallcell features prior to the execution of the interoperability test sessions. From 10th to 14th of June the official test sessions were run. All tests were reported as test session reports via the ETSI Test Reporting Tool.

Highlights of the Plugfest were that

- All vendors successfully passed the mandatory S1 tests
- 6 HeNB vendors successfully established the baseline S1 security tests with 2 vendors testing both Certificates and PSK authentication credentials. 14 out of the 16 the tests were possible with the established infrastructure
- 2 HeNB vendors succeeded to make a VoLTE call on the dedicated bearer using Iskratel IMS
- 3 HeNB vendors successfully demonstrated S1 based small cell to macro cell handout
    - inter: band 1 small cell to band 3 macro
    - intra: band 3 small cell to band 3 macro, same frequency
    - inter: band 3 small cell to band 3 macro, different frequency
- 2 HeNB vendor successfully demonstrated S1 based small cell to small cell handover
    - intra: band 1 small cell and band 1 small cell, same frequency
    - inter: band 1 small cell and band 3 small cell, different frequency
- 1 vendor successfully demonstarted X2 based small cell to macro cell handout

6.1 S1 Interface - Mandatory Tests – Results Overview

There were six mandatory tests defined for the S1 interface. The table below show the results. The companies were able to run almost all the foreseen tests, as the execution rate of more than 80% shows.

100% of the executed tests were evaluated to PASS, which shows the high level of maturity of the S1 interface implementations.

Interoperability Result		Execution Statistic		
OK	not OK	Not Applicable	Out of Time	Run
222 (100%)	**0 (0%)**	**32 (11.9%)**	**16 (5.9%)**	**222 (82.2%)**

6.1.1 Results per test

All tests were performed with 100% PASS rate with the execption of two tests:

- SCTP Association / S1 Interface Setup / Failure with reattempt: Some releases of EPCs did not implement the optional IE ‘Time to Wait IE’ and hence the test did not apply. Other releases of EPCs did not support the feature to dynamically add a new HeNB PLMN identifier and hence the test did not apply.
- UE Paging: Some few releases of EPCs did not implement the feature and hence the test did not apply.

6.2 IPSec/IKEv2 – Optional Tests - Result Overview

According to the conclusions from the last Plugfest the IPSec/IKEv2 were made optional to execute. As a consequence, this was viewed by Small Cells vendors as lower priority, until the mandatory tests had been completed. Companies completing S1 mandatory tests, were able to test the security tests towards the end of the week.

In all, 6 out of 10 vendors tested successfully and there were 16 IPSec/IKEv2 tests defined in the test plan while 14 of which were possible to execute. During the Plugfest, the NAT specific tests were disabled as the network infrastructure did not provide for NAT traversals.

Those Small Cells that were not able to connect into Sintesio using L2TP, were provided with an alternative, directly available via a public interface, to the Sec GW. The Small Cells that connected to the SecGW using this mechanism, were able to complete test case 5.4.2.2 “Use of NAT-T”, successfully.

The final list of tests is shown in the table below.

#	Test Clause	Test Objective
1	5.4.2.1	HeNB Self configuration – Connection to EPC via security gateway
2	5.4.2.2	Use of NAT-T
3	5.4.2.3	Use of NAT-T – Dynamic Address Change
4	5.4.2.4	DPDs
5	5.4.2.5	IPSec SA Rekeying from HNB
6	5.4.2.6	IPSec SA Rekeying from SeGW
7	5.4.2.7	IKE SA Rekeying from HNB
8	5.4.2.8	IKE SA Rekeying from SeGW
9	5.4.2.9	Tunnel Deletion
10	5.4.2.10	H(e)NB Reboot
11	5.4.2.11	WAN side IP address change
12	5.4.2.12	End Entity Certificate Enrolment
13	5.4.2.13	Uplink Data Transfer – IPSec Pre-Fragmentation on Secure Link
14	5.4.2.14	Uplink Data Transfer – IPSec Post-Fragmentation on Secure Link
15	5.4.2.15	Downlink Data Transfer – IPSec Pre-Fragmentation on Secure Link
16	5.4.2.16	Downlink Data Transfer – IPSec Post-Fragmentation on Secure Link

The table below shows the results for security testing. When tests were executed then the success rate was high (over 99%). The high success rate was not unexpected as security tests have been executed in previous plugfest events.. The high rate of ‘Not Applicable’ is explained because some vendors only supported PSK. However, for a next plugfest it should be ensured that every vendor supports IPSec/IKEv2 as well as Certificates.

Also some vendors did run the IPSec/IKEv2 tests in the configuration of HeNB—SeGW-- HeNB-GW--ePC, but did not re-run the IPSec/IKEv2 tests in the configuration of HeNB—SeGW--ePC (i.e. without HeNB-GW). This means that the ‘Not Applicable’ rate can be ignored. However, the low execution rate of only ~15% shows that vendors look towards a new scope of security tests.

Interoperability Result		Execution Statistic		
OK	not OK	Not Applicable	Out of Time	Run
35 (100%)	**0 (0 %)**	**203 (84,64%)**	**2 (0.8%)**	**35 (14.6%)**

One conclusion to be drawn from this event is that a PKI setup should be provided in any future event to allow deployment test scenarios to be tested, e.g.

- to provide a PKI setup (trusted and untrusted Root CA)
- to allow to obtain CERTS online (Certificate Management Protocol (CMP))

- to test the trust chain (unknown certs, revoked certs (CRL))
- to test different root domains

6.2.1 Results per IPSec test

All tests were performed with 100% PASS rate. There was one test that was not executed at all:

- End Entity Certificate Enrolment: No vendor ran a test on the topic of Certificate Management Protocol, while this was achieved “offline” i.e. in a manual fashion. For a next Plugfest, with the PKI setup in place, this test shoud be easier to be performed and tests made mandatory.

6.3 Mobility – Optional Tests - Result Overview

A dynamic attenuation setup (see clause 5.4) was provided which allowed for both small cell to macro handouts as well as small cell to small cell handovers, whilst simultaneously monitoring the output signals of macro and small cell nodes.

Telecom Slovenia (TS) provided a dedicated macro eNB connected to the Telecom Slovenia EPC which was used for the macro handout and small cell handovers. For small cell handovers any EPC which wanted to attend the mobility test sessions could be used.

A principal summary is given below:

- 3 HeNB vendors successfully demonstrated S1 based small cell to macro cell handout
    - inter: band 1 small cell to band 3 macro
    - intra: band 3 small cell to band 3 macro, same frequency
    - inter: band 3 small cell to band 3 macro, different frequency
- 2 HeNB vendor successfully demonstrated S1 based small cell to small cell handover
    - Handout and handin
    - intra: band 1 small cell and band 1 small cell, same frequency
    - inter: band 1 small cell and band 3 small cell, different frequency
- 1 vendor successfully demonstrated X2 based small cell to macro cell handout

Hand ins from Macro cell to small cell were tried, but did not succeed. For more information refer to the next chapter on IOP Issues. A future Plugfest could be focussed only on mobility in order to allow enough time for all vendors to run all the handover test combinations.

6.4 VoLTE Calls – Optional Tests - Results Overview

The event host Sintesio provided access to the Iskratel IMS, which was connected to the EPCs which supported the IMS tests. The IMS tests were optional, and schedule at the end of the week. There was thus only a very limited time available for testing and debugging. Nevertheless it can be reported that:

- 2 HeNB vendors succeeded to make a VoLTE call on a dedicated bearer via Iskratel IMS.

6.5 Summary of Wrap Up Sessions

6.5.1 IOP Issues

- The remotely located equipment was connected into the Sintesio lab via VPN using either L2TPv3 or IPSEC, with the former being the preferred technology. Some remote equipments were connected via IPSEC and isses were encountered which hindered testing progress :
    - In one case, it was not possible to establish the IPSEC connection due to inter-operability issues between the IPSEC GWs at each end. This caused an issue during the pre-test week and was solved for the event proper when the equipment was physically located in the Sintesio lab. To allow testing to proceed, a public IP address connection to a SecGW was made available, where the SecGW then connected into Sintesio for EPCs.
    - There were issues encountered in routing packets between 2 remotely located equipments when both were connected via IPSEC VPNs. Some of these issues were not encountered when Small Cells connected into Sintesio via L2TPv3; however, there were interoperability issues when using different vendors implementations of L2TPv3, leading to IPsec only being the available option for some.
- Attendance at the pre-testing week. Despite attendance at the pre-testing being mandatory, in some cases participants attended for part of the week, in others not at all. This resulted in related delays during the testing week due to encountering issues that should have been resolved in the pre-test week.
    - All participants need to attend the pre-test week.
- S1 Set-Up Failure. This was a mandatory test but an issue was highlighted regarding the duration of the re-try timer prior to resending the S1 SET UP REQUEST message. The issue is that, according to TS 36.413 clause 9.1.8.6, the TimeToWait IE is optional in the S1 SET UP FAILURE message. Therefore, the cited test case should not have been mandatory as it was dependent on an optional parameter. It is also noted that in real deployments the presence of the TimeToWait IE would be benficial in order to facilitate prevention of overload by smoothing the rate of re-attempts. This is particularly true for small cells with relatively many HeNBs trying to attach in parallel.
- SCTP multi homing. Some EPCs supported SCTP multi homing to realise connection redundancy via 2 separate SCTP connections, each using a different IP address. Some HeNBs did not support multi-homing and did not respond to SCTP HEARTBEAT received from the second IP address, and in some cases terminated the SCTP connection to the first IP address. A workaround was employed whereby the HeNB responded to the SCTP HEATBEAT (from the second address) by sending SCTP SHUTDOWN in response but leaving the connection in place to the first IP address. This enabled S1 to be established over the (now non-redundant) remaining SCTP connection.
    - HeNBs ought to support SCTP multi-homing.
- Global eNB ID. Issues were encountered regarding the global eNB IDs, in particular discriminating between macro eNBs and HeNBs. Acording to TS 36.413 clause 9.2.1.37, the eNB identity should be 20 or 28 bits long dependent on whether the eNB is a macro or home eNB respectively. Some HeNBs incorrectly signalled that they were macro eNBs rather than HeNBs (although this did not cause an issue per se). In addition, the EPC core only discriminated the leftmost 11 bits as the eNB ID and this resulted in all the different HeNBs appearing to the EPC as using the same eNB ID. This resulted in the first HeNB being able to connect to the EPC, but subsequent ones failing.
    - HeNBs should signal their eNB type correctly,
    - The EPC should take note of the type of eNB and read the complete bit string of 20 or 28 bits as required.
- Authentication of the UE during attachment. An issue was encountered due to the criticality id-TAI ID not being set correctly in the S1 UPLINK NAS TRANSPORT message . The criticality was incorrectly set to “reject” rather than “ignore” as specified in TS 36.413.
    - HeNBs should set the criticality of the id-TAI in line with the specification.
- There was an issue with S1 establishment due to the DefaultPagingDRX IE in S1 SET UP REQUEST being set to “reject” rather than “ignore”.
    - HeNBs should set the criticality of the cited parameter correctly.

- There was an issue with the paging response timer (to receipt of a Service Request) not being specified in the paging test. This is due to the specifications (TS 23.401 & TS 36.413) being deliverately vague as paging optimizations are left to the EPC vendors.

- Hand In (Macro to Femto). Two issues were encountered:

    1) **Handover parameters in "measObjectToAddModList"**

    The Macro eNB's "RRC Connection Reconfiguration" message did not configure the handover parameters in "measObjectToAddModList". This parameter needed to specify the small cell's frequency and physical Cell ID.

    2) **UE is never reporting Femto as a neighbour cell**

    It was found from the UE logs that A2 Event Threshold RSRP is configured as zero. This can limit UE not to report A2 event until serving cell, i.e. macro cell, RSRP goes less than -144dB. It's been requested to TS to have higher threshold something in the range [-70dB, -90dB] so that UE can report A2 event at good channel conditions and configure A5 event and initiate HO procedure

- For a future event a PKI setup should be provided to allow PKI deployment scenarios to be tested. Some of the tests where only possible using FQDN as the identifier for the tunnel end point, e.g. IP address changing tests such as NAT-T.
- End Entity Certificate Enrolment: No vendor ran a test on the topic of Certificate Management Protocol. For a next Plugfest speciall attention neds to be paid to include this test in the test execution.
- Some vendors only supported PSK. However, for future plugfests, it should be ensured that every vendor supports IPSec/IKEv2.

- A future Plugfest could focus only on mobility in order to allow enough time for all vendors to run all the handover test combinations.

6.5.2 Base Spec Issues

- The text in TS 36.413 could be more explicit in clause 9.2.1.38 regarding the E-UTRAN CGI IE. The descriptive text states that "the leftmost bits of the Cell Identity correspond to the eNB ID (defined in subclause 9.2.1.37)". This could be made more explicit and the words could be modified to align with those in clause 9.2.1.37 where there is an explicit distinction between the length of the bit string corresponding to macro and home eNB IDs.

- The TimeToWait IE is optional in the S1 SET UP FAILURE message in TS 36.413. Further, clause 8.7.3.3 of the specification states that "If the S1 SETUP FAILURE message includes the *Time To Wait* IE, the eNB shall wait at least for the indicated time before reinitiating the S1 setup towards the same MME". There is thus no guidance as to how long an eNB should wait before re-attempting in the absence of this IE. This is somewhat vague from an interoperability point of view although it is recognized that the presence of this IE is related to the reason for S1 set up failure (*Cause* IE). It would be beneficial to add some words to clarify which causes would be have/no have a related *TimeToWait* IE plus some words for a suggested default value for this timer. This would better enable the EPC to smoothe out potentially large numbers of S1 establishment messages.

6.5.3 Test Spec Issues

- The mandatory test for S1 Interface Failure with Repeat Attempt (clause 5.1.1.11) will be editted to add some clarifications on different failure causes in order to test both the absence and presence of the optional *TimeToWait* IE. A test based on support of an optional IE should not be made mandatory to execute.

- The following optional tests were excluded from the test plan :-

    - UE Initiated E-RAB establishment and Release (clauses 5.2.2.3 & 5.2.2.6) due to these tests not being supported by the UEs.

    - Duplication of NAT tests: 5.4.2.3 and 5.4.2.11 are duplicates and one test should be deleted.

        - 5.4.2.3 Use of NAT-T – Dynamic Address Change – Verification that the SeGW is capable of detecting and honouring the NAT device in front of the HNB changing its public address (e.g. due to reboot or operator intervention). Use of FQDN, instead of specific IP Address, solves this issue.

- 5.4.2.11 WAN side IP address change - Verification that the SeGW is capable of detecting and honouring the NAT device in front of the H(e)NB changing its public address (e.g. due to replacement of DSL/Cable router). Conclusion: Delete 5.4.2.11

- NAT devices were not available and hence tests 5.4.2.3 and 5.4.2.4 were disabled for the direct connection into Sintesio. It was possible when connecting directly to remote SecGW via public interface.

History

Document history		
V0.0.3	June 2013	Stable draft for review to SCF
V0.0.4	June 2013	Comments on Security Section integrated