IPX Test Execution Instructions
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1 Introduction

1.1 Overview

This document should be read by organisations interested in executing IPX Tests.

IP based services are central to the future growth of telecommunications. As the transmission of voice and data migrates to the packet switched world, a wide range of technical and commercial benefits become available to all stakeholders and the customers they serve. Mobile service providers are already exploring exciting new services based on IP technology, including innovative messaging applications and rich content delivery of simultaneous voice and images with high quality, reliable levels of service.

The GSMA has produced the technical specifications [3] and commercial templates [4, 7, 8, 9] for the IP eXchange (IPX), a next generation interconnect solution. IPX is a managed network environment, engineered to support specific IP services at specific quality levels. The IPX solution is a premium quality solution that promises secure and error free delivery of traffic whilst offering the flexibility to apply an appropriate level of quality as demanded by each different class of service.

Between April 2007 and November 2008, IPX specifications have been verified through practical trials within the GSMA's IPX Pre-Commercial Implementation (PCI) Project. The test specifications developed over this period, are available for use by any telecommunications service providers looking to utilise IPX.

1.2 Scope

1.2.1 In Scope

- End-to-end sessions (calls) using all services
- all IPX entity types (retail or wholesale telecommunications service provider)
- all geographic scenarios (national, international and intercontinental), and
- any IPX interconnection modes (IPX Transport, IPX Service Transit and IPX Service Hub

1.2.2 Out of Scope

- Commercial negotiations and agreements
- Retail billing systems and other operations support systems.
- Signalling within the service provider's own domain.

1.3 Abbreviations

Term	Definitions
AMR	Adaptive Multi-Rate
BAIC	Barring of All Incoming Calls
BAOC	Barring of All Outgoing Calls
BOIC	Barring of Outgoing International Calls
CDR	Call Detail Record
CFB	Call Forwarding on *Busy*
CFNR	Call Forwarding on No Reply

Term	Definitions
CFN	Confusion Message (ISUP)
CFU	Call Forwarding Unconditional
CFNRc	Call Forwarding on Mobile Subscriber Not Reachable
CFNRy	Call Forwarding on No Reply
CLIP	Calling Line Identification Presentation
CLIR	Calling Line Identification Restriction
CNAP	Calling Name Presentation
COLP	Connected Line Identification Presentation
COLR	Connected Line Identification Restriction
CPN	Called Party Number
DTMF	Dual Tone Multiple Frequency
E2E	End-to-end
EFR	Enhanced Full Rate
End-to-end	End-to-end means from Service Provider premises to Service Provider premises thus, Service Provider core and access networks are excluded.
FNO	Fixed Network Operator or Wireline Operator
G.711	An audio data compression algorithm specified by ITU-T
G.729	An audio data compression algorithm specified by ITU-T
GPRS	General Packat Radio Service
GRX	GPRS Roaming eXchange
GSM-EFR	Enchanced Full Rate codec of GSM
GSMA	GSM (Groupe Spéciale Mobile) Association
IBCF	Interconnect Border Control Function
IETF	Internet Engineering Taskforce
IOP	Interoperability
INT Format	Called and calling party numbers are presented in international format
IP	Internet Protocol
IPX	IP Packet eXchange. A private managed backbone providing guaranteed QoS, security and cascading payments. The IPX is a network of networks provided by the whole group of interconnected IPX Provider's networks.
IPX P	IPX Provider. A business entity (such as an IP Carrier) offering IP interconnect capabilities to Service Providers, possibly through interconnection with other IPX Providers for one or many IPX services compliant with the IPX operation criteria and compliant with the defined SLA and interconnect agreement for that end-to-end service.
IREG	Interworking and Roaming Expert Group
ISUP	Integrated Services Digital Network User Part
ITU	International Telecommunications Union
MGW	Media Gateway
MNO	Mobile Network Operator (GSM)
MOS	Mean Opinion Score
MOS-LQO	Mean Opinion Score – Listening Quality Objective
ms	Millisecond
MSC-S	Mobile Switching Centre – Server
MSP	Multiple Subscriber Profile
NB-AMR	Narror Band AMR
NTP	Network Time Protocol
PCI	(IPX) Pre Commercial Implementation, a GSMA project
PRD	Permanent Reference Document
PVI	Packet Voice Interworking
QoS	Quality of Service
RFC	Request for Change
SBC	Session Border Controller
SDO	Standard Developing Organization
SIP	Session Initiation Protocol
SIP-I	SIP with encapsulated ISUP

Term	Definitions
SP	Service Provider. A business entity entering into a contractual relationship with IPX Provider(s) which offers services to final users providing termination (origin and destination) for IP services traffic. Thus, “service provider” includes MNOs, FNOs (for example, fixed broadband operators and NGNs), ISPs, ASPs and similar entities.
TET	Test Execution Team
UE	User Equipment
USSD	Unstructured Supplementary Service Data
UTC	Universal Co-ordinated Time
UUS	User to User Signalling (on ISDN)

1.4 Document Cross-References

Document	Name
[1]	IR.83 SIP-I Interworking Description
[2]	IR.87 SIP-I Test Cases
[3]	IR.34 Inter-Service Provider IP Backbone Guidelines
[4]	AA.80 Agreement for IP Packet eXchange (IPX) Services
[5]	IR.40 Guidelines for IPv4 Addressing and AS Numbering for GRX/IPX Network Infrastructure and User Terminals
[6]	IR.67 DNS Guidelines for Operators
[7]	AA.81 Packet Voice Interconnection Service Schedule to AA80
[8]	AA.82 SMS Service Schedule to AA80
[9]	AA.83 MMS Service Schedule to AA80
[10]	ITU-T Q.1912.5 Interworking between Session Initiation Protocol (SIP) and Bearer Independent Call Control Protocol or ISDN User Part
[11]	ITU-T G.711 Pulse Code Modulation of Voice Frequencies

2 About IPX Testing

2.1 Who Should Execute IPX Tests and Why?

IPX is open to any potential player in the delivery of IP services: fixed and mobile networks service providers, carriers and ISPs. Inherent in this is the assumption that all IPX connections will conform with the IPX technical and commercial specifications. Executing IPX tests enables the development of IPX capabilities and the evaluation of IPX as an IP interconnection model of choice.

Wholesale Carriers who execute IPX tests will develop an understanding of IPX based on practical experience. These IPX capabilities will enable the development of IPX products and services.

As an example those service providers that have implemented (or are planning to implement) soft-switch/MSC server type core networks will realise the benefit of investment by establishing a physical SIP-I compliant interconnect interface between the IP core and an IPX provider.

2.2 Partnering

A typical test group will consist of two or more service providers (SP) at the ends of the end-to-end service delivery chain and either one or two IPX providers (IPXP) acting as intermediary carriers.

Figure 1 illustrates the possible partner configurations, whereby the possible bilateral configurations are;

SP A > IPXP A < SP B

SP A > IPXP A >< IPXP B < SP C

SP C > IPXP B >< IPXP A < SP B

The multilateral configuration would include all three SPs and both IPXPs.

Figure 1: Example Configuration of Test Partners

Your choice of test partners should be dictated in accordance with normal strategic and tactical decision factors. Carriers interested in providing IPX services are encouraged to discuss the opportunity to execute IPX tests with service provider clients. Service providers can provide an opportunity for their carrier partners to implement IPX early by partnering with them in IPX tests.

Liaison with numerous prospective parties is recommended to identify partnering opportunities. Once partnerships are agreed upon in intent, a test execution team (TET) should be formed, comprised of functional experts from each organisation. The TET should design, plan and execute IPX tests in accordance with the instructions in this document and project management best practices.

Test partners are expected work in a cooperative fashion and provide mutual support to ensure that testing is executed in accordance to the agreed plan. TET members should be possessed of the necessary skills to design, plan and execute the tests. Skills will include network knowledge, GRX/IPX connectivity, data networking, CDR capture and processing, inter-connect billing and project management. Each party should identify an individual Test Manager, responsible for overall trial execution.

It is essential that TET principals share a common language. As all the test documentation is prepared in English, it is recommended that the TET principals are conversant in English.

It is recommended that at least some of the early TET meetings are face-to-face. This fosters good interrelationships within the TET and makes later remote communications much easier.

3 Designing IPX Testing

It is necessary for all parties to agree the extent of the testing to be executed. The TET should define and agree the test specifications. Detailed service requirements and features to be tested should be identified. The test infrastructure, including participant specific and collective design features and test equipment to be used, must be designed in detail. A plan for implementation of the test infrastructure must be agreed between the test partners and executed in a coordinated and orderly manner. The Infrastructure build will require specific configurations and interconnection of test participants.

The following factors should be evaluated and specified.

3.1 Service Options

Any service can be tested in IPX testing. After test partners have agreed on the service(s) to be tested, the service options and features should be identified to determine the test requirements. A sample feature list for SIP-I based packet voice service (PVI) is illustrated in Figure 2.

Protocol Specification	ITU-T Q.1912.5 Profile C; International ISUP encapsulation
Codec	G.711
Call establishment	A and B party establishment Ring tone generation Abnormal conditions, clean handling of – calling busy subscriber, clearing before completion
Call clearing	Normal cases A and B. Abnormal cases – confirm clean handling with appropriate user indications
Supplementary Services	CLIP; CLIR; CFU; CFB; CFNRy; CFNRc; Call Hold; Call Waiting; Closed User Group, UUS; Call Complete to Busy Subscriber; Multiparty; Multicall; COLP; COLR
Charging	Generate CDRs to determine duration of open media channel and identify expected event labels and cause codes.
Packetisation Period	20ms for G.711
DTMF	In-band transport (G.711).
Echo Cancellation	None
IPX Protocol Interworking	None

Figure 2: Sample Service Feature List (PVI)

A number of IPX service schedules are predefined [7, 8, 9] and these should be referred to in a selection of service options.

3.2 Test Equipment

Participant specific and collective design requirements should be identified and incorporated into a detailed infrastructure design.

Service providers should choose handsets or terminals in common use in their network.

Related servers/platforms to the service to be tested, such as Soft switch and/or MSC-S for SIP-I related tests, must have connectivity to IPX, as described in IR.34

Support should be made available from the corresponding vendors.

4 Test Planning

4.1 Coordination

It is necessary for all parties to exchange contact and configuration in advance of testing. This will facilitate communication between test teams and easy test equipment configuration. A template is available to facilitate information exchange.

A test schedule should be defined in consideration of availability of TET members, particularly for test execution stage, when immediate liaison between test personnel will be necessary. When planning, ensure that the staff and resources are available at the same time. Staff vacations, national holidays, working hours and time zones must all be taken into account. Ensure that other test resources such as platform and laboratory time are booked in accordance with the test schedule.

A plan for implementation of the test infrastructure must be agreed between the test partners.

Instant Messenger (IM) is a useful communications tool during for pre-testing and testing. Aside from being a cheap and easy international method of communication, the immediacy of IM in coordination, is very beneficial.

One method that has been used in trials to alleviate coordination is the use of ‘loopback’ numbers at the edge of the IPX network. This allows testers to verify call origination/termination independently of other trial participants. This method is particularly useful when there is a significant time zone difference between test teams.

4.2 Preparations

A number of pre-conditions and assumptions apply to all test cases and these are indicated in IR.87 IPX Test Cases [2].

Some test cases require specific configurations so IR.87 IPX Test Cases [2] should be studied in detail. Service related guideline PRD(s) such as IR.83 for SIP-I should be also studied in detail.

IPX offers 3 interconnection modes IPX Transport, IPX Service Transit and IPX Service Hub. These are defined in AA.80, however, a brief explanation is given here. IPX Transport mode describes interconnection using IPX and its QoS capability, but not requiring cascade billing, or the services of an IPX Proxy. IPX Service Transit and IPX Service Hub modes describe

use of an IPX proxy and CDR production to enable service-based charging. If an IPX Proxy is to be used, it should be configured in accordance with IR.34 [3] specifications. SPs should have the option of routing the media plane through the IPX Proxy and it is expected that most, if not all, SPs will choose this option.

Firewalls will need to be configured to allow signalling (such as SIP-I) and media (such as RTP) traffic from originating and terminating service providers.

If cascade billing tests are to be performed billing CDRs will need to be captured at originating MSC-S, terminating MSC-S and the IPX Proxy nodes traversed. CDR timestamps will need to be NTP synchronised. Also, CDRs should be converted to a commonly agreed format, with a commonly agreed naming convention. This will enable easy interpretation, to determine test success. Figure 3 indicates where the CDRs should be generated.

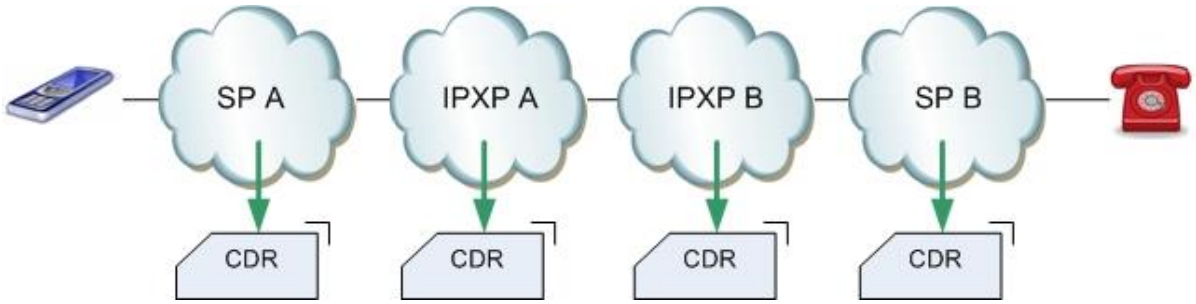

Figure 3: CDR Generation Points

IR.40 Guidelines for IPv4 Addressing and AS Numbering for GRX/IPX Network Infrastructure and User Terminals [5] and IR.67 DNS Guidelines for Operators [6] should be referred to the design of addressing and domain name definition for the IPX tests.

5 Testing

Test personnel should take a copy of test document such as IR.87 SIP-I Interworking Test Cases [2] and make modifications to conform with the agreed scope of testing. The resulting document should be used as a worksheet, thus, as tests are conducted, the worksheet can be annotated with marks and comments. After testing, this document will form the basis of management reporting (See section 6). Figure 4 illustrates an annotated test case related to SIP-I interworking testing.

Ref # TC-601b (Ref # in IPX PCI Project was PVI601b)	Call from B to A using NB-AMR, B releases call		
Test Purpose:	To verify that narrow band AMR codec can be used.		
Test preconditions:	NB-AMR selected as codec.		
Step	Test description	Verdict	
		Pass	Fail
1	Initiate new call from User B to the address of User A		
2	Accept call at User A		
3	*Can speech from User A be heard and understood at User B during 60 sec?*	Yes	No
4	*Can speech from User B be heard and understood at User A during 60 sec?*	Yes	No
5	Clear call at User B		
6	*Is call setup related signalling handled correctly between MSC-Ss?*	Yes	No
7	*Is call release related signalling handled correctly between MSC-Ss?*	Yes	No
8	*Is CDR created correctly in each network entity?*	Yes	No
9	*Does the CDR contain correct information about the codec used?*	Yes	No
10	*Was NB-AMR used during the call?*	Yes	No
11	*Is ptime 20ms possible to use with this codec?*	Yes	No
Overall result: Full Pass / Partial Pass / Failed			
General observations or specific explanations in the case of partial pass or failed test:			
Incompliance of 3GPP TS 29.163 AMR implementation in Vendor A. Action is to alert Vendor A.			

Figure 4: Annotated Test Case Worksheet

It is suggested that while running the voice tests the signalling will be monitored to make sure that SIP messages are being delivered correctly. During the testing process, it can be assumed that handling the call setup correctly means that user plane starts flowing and the signalling traffic ends as it should. Similarly, it can be assumed that handling the call release correctly means that user plane is terminated and CDRs are written correctly.

It is assumed that during testing process the signalling messages of successful tests are not analysed in detail. However, detailed analysis can be done after the test execution by each participant. In case of issues or signalling anomalies, the signalling flows will be compared to the reference signalling figures.

When faults occur, a fault report (with Ethereal capture) should be sent to vendor support, after both directions have been tested. If a fault is detected in both directions, both service providers should make fault reports together with a common fault title. Otherwise, the corresponding service provider should only make fault report to vendor.

In case of single test case/step fails:

Fault report (with Wireshark (Ethereal) capture) will be sent to vendor after both directions have been tested. If fault is detected in both directions, both service providers should make fault reports together with common unique tag (i.e. GSMA IPX PCI SIP-I Trial) in title. Otherwise, the corresponding service provider should only make fault report to vendor.

Too much time should not be spent for initial fault analysis

For each test case a trace using Wireshark (Ethereal) should be made to enable verification and fault analysis after execution. Verification will include analysis of route headers to verify path taken. Each test pair should agree on file naming practises so that test case traces can be matched later on. The filename should include participant names, direction of TC, identification of TC execution try and date. For example:

<A party>_<B party>_<test case number>_<source>_<attempt>_<date>

6 Management Reporting

GSMA aims to advance the general evolution of IPX and SIP-I interoperability. IPX Test Execution Instructions and related documents have been prepared by GSMA for the common good. To this end, test participants are requested to submit management report to GSMA, so that the IPX body of knowledge can be further evolved. Your recommendations on improvements to IPX Test Execution Instructions and related documents will be especially valued. All GSMA PRDs are managed using formal and structured change management processes and RFCs will be handled accordingly.

IPX Test Reports are not published as a matter of course however, IPX test participants are requested to mark any confidential information as “confidential information” and this will be treated in accordance with instructions.

A template reporting format is available, should you choose to report IPX test results.

Reports from each participating SP and IPXP should be merged and reconciled into a final report for the management of each organisation.

Annex A SIP-I interworking Description

There is growing interest from SPs to deploy SIP-I based voice interworking between using 3GPP specified MSC-S nodes in an IP based architecture instead of the current TDM based solutions. Therefore there is a need to for common recommendations ensuring that interworking with SIP-I takes place smoothly. These recommendations are captured in a separate PRD: IR.83

SIP-I Interworking Description [1], which describes how the SIP-I (SIP with encapsulated ISUP) is utilized in the IPX environment.

The document defines a generic SIP-I profile to be used for the Packet Voice Interworking over the IPX between different mobile SPs, in order to minimise the number of interoperability issues caused by different implementation and deployment solutions.

Annex B Test Cases

All IPX features are within scope. Some test cases are pre-defined however, each party can develop additional test cases as desired. An example of defined test cased and a template for creation of addition test cases can be found in IR.87 SIP-I Interworking Test Cases [2].

Annex C Test Participant Information Template

A template spreadsheet is available to ensure that key contact and technical information is made available promptly and shared amongst test partners.

IR86_AnnexD_IPX_Test_Participants_Info

Annex D Results Capture Template

A template spreadsheet is available to provide for easy collation of overall test results.

IR86_AnnexE_Test_
Results_Template.xls

Annex E Management Report Template

A report document could be compiled by each participating SP and IPXP. The IPX test documentation has been designed to enable easy capture of test output for reporting purposes.

Test personnel should take a copy of IR.87 SIP-I Interworking Test Cases [2] and make modifications as desired, for example, add additional test cases. The resulting document should be used as a worksheet, thus, as tests are conducted, the worksheet can be annotated with marks and comments. Annotations should be transferred to the Test Results spreadsheet. If the person compiling the management report is in receipt of these two sources, management reporting is a straightforward task. Figure 5 illustrates the channelling of information into management report.

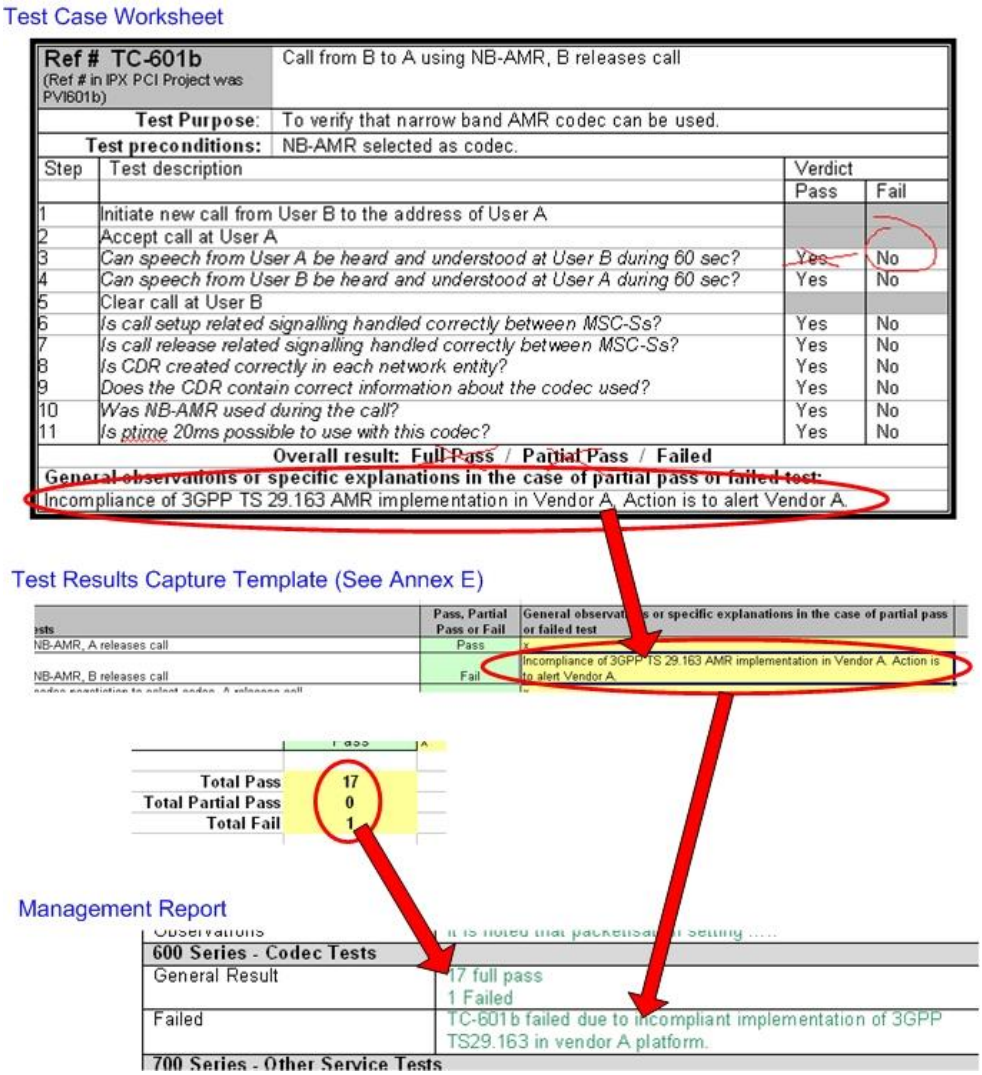

Figure 5: Information channeled to management report.

The following management report format is suggested. Example text (green) is given along with an indication of the source for the specific information (blue).

Executive Summary

SP A, IPXP A, IPXP B and SP B have executed IPX tests to <purpose>. It is concluded that <conclusions>.

Purpose

The purpose of the tests is to evaluate the technical and commercial implications of IPX interconnection.

Note any additional or participant specific purposes, for example “to advance our own IPX capabilities”, “to gain experience”, “to prepare for commercial services”.

Test Configuration

A description of test functionality and configuration including details of equipment used and network diagrams. This information should be sourced in the test design section of the test plan.

What Was Tested

A summary description of what was tested including a list of the test cases executed.

Voice Call Tests, 24 test cases (TC-101a to TC-111b)

Supplementary Services Tests, 21 test cases (TC-201a to TC-211b)

CDR validation Tests , 8 test cases (TC-301a to TC-304b)

Voice Quality Test, 1 test case (TC-401)

Codec Tests, 18 test cases (TC-501a to TC-509b)

IPX Specific Tests, 17 test cases (TC-1001 to TC-1017)

TC-403, a modification to TC-401.

Own developed test cases TC-1101a and TC-1101b.

Results of Tests

Example format

100 Series - Voice Call Tests	
General result	24 full pass
200 Series - Supplementary Services Tests	
General result	20 full pass 1 partial pass
Partial pass	TC-nnn particlly passed because
300 Series - CDR Validation Tests	
General Result	8 full pass
400 Series - Voice Quality Tests	
General Result	Pass with observations
Observations	It is noted that packetisation setting …..
500 Series - Codec Tests	
General Result	17 full pass 1 Failed
Failed	TC-501b failed due to incompliant implementation of 3GPP TS29.163 in vendor A platform.
1000 Series - IPX Specific Tests	
General Result	17 full pass, 4 with observations
Observations	TC was interesting because ….
600 Series - Other Service Tests	
General Result	600 Series not executed.
Own Tests	
TC-403 modified T-401	Full pass
TC-1101a	Full pass
TC-1101b	Full pass

Observations

Note any interesting observations, for example, issues that were resolved within the trial and do not necessarily give rise to follow-up work.

This information should be sourced from the testing worksheet.

Conclusions

Conclusions should be drawn in consideration of overall results and observations. What worked, what did not work and what could be made to work?

Recommendations

Note any recommendations, for example, to own organization, test partners, vendors, SDOs or to GSMA, to improve IPX Test Execution Instructions.

Issues for further study

Issues for further study are a subset of the observations. What is the issue, what is the action arising and who is responsible for the action?

Annex F Details of Any Modifications to Test Cases

Ref # TC-503	Voice quality test with modifications				
Test Purpose:	Similar to TC-501 but ……				
Test preconditions:	<Test preconditions>				
- Step	- Test description			- Verdict	
-	-	- Pass		- Fail	
- 1	<Step 1>	-		-	
- 2	<observed effect>	- Yes		- No	

Annex G Details of Own Developed Test Cases.

Ref # TC-508a	Our own test A to B				
Test Purpose:	Our own purpose…				
Test preconditions:	<Test preconditions>				
- Step	- Test description			- Verdict	
-	-	- Pass		- Fail	
- 1	<Step 1>	-		-	
- 2	<observed effect>	- Yes		- No	

Ref # TC-508b	Our own test B to A				
Test Purpose:	Our own purpose…				
Test preconditions:	<Test preconditions>				
- Step	- Test description			- Verdict	
-	-	- Pass		- Fail	
- 1	<Step 1>	-		-	
- 2	<observed effect>	- Yes		- No	

Annex H Test Results Capture Template

The completed TEST RESULTS CAPTURE TEMPLATE spreadsheet.

Annex I Confidential Information

Any confidential information should be marked as “confidential information”.

Annex J Document Management

J.1 Document History

Version	Date	Brief Description of Change	Approval Authority	Editor / Company
0.1	20/04/09	First version for IREG		
1.0	12/06/2009	Approval of document		Niclas Svahnström / TeliaSonera

Other Information

Type	Description
Document Owner	IREG
Editor / Company	