Organisation of GSM International Roaming Tests

Version 8.0

27 Jan 2025

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1 General Description

1.1 Scope

The scope of this document is to define a methodology for testing, and maintaining in the presence of faults, the inter-Public Mobile Network (PMN) international roaming facility.

The structure for testing international roaming is recommended to follow a three -stage approach:

- Stage 1 – Interface self-certification testing for different protocols like MAP, CAMEL Application Part (CAP), IP, Diameter, GPRS Tunneling Protocol (GTP) and HTTP/2.
- Stage 2 - Exchange of numbering and addressing data, procedures for operation and maintenance, fault reporting, etc.
- Stage 3 - End-to-end functionality / capability performance testing.

Detailed description of stage 3 tests is provided in the IR.24, IR.25, IR.26, IR.27, IR.32, IR.35, IR.37, IR.38, IR.50, IR.53, IR.60, IR.62 , IR.63 and NG.143 documents. (See references in the front section of this document).

The purpose of breaking down the testing into stages is that Stage 1 requires completion by the PMN once only for each type and manufacturer of Network Entity: It can therefore be a very complex and thorough test.

Stage 3 must be repeated with each PMN and RHSP (Roaming Hub Service Provider) roaming relationship. It must therefore be a high-level functional test stage, and therefore be completed in a few man-hours.

In each of the following sections (section 2 to section 4), the different stages will be described with respect to their general contents, their applicability and their evolution to cope with new features of different protocols (i.e.: higher MAP versions, the introduction of Diameter and the incremental capabilities within HTTP/2, ...).

Section 5 gives a Summary of stages and responsibilities for international roaming tests. Requirements for re-testing are described in section 6.

1.2 References

These are GSMA permanent reference documents (PRD):

Ref	Document Number	Title
1	IR.21	GSM Association Roaming Database, Structure and Updating
2	IR.22	SCCP Signalling Aspects for Roaming
3	IR.24	End-to-End Functional Capability Specification for Inter-PLMN Roaming
4	IR.25	End-to-End Functional Capability Specification for Inter-PLMN Roaming (VoLTE)
5	IR.26	End-to-End Functional Capability Specification for Inter-PLMN Roaming (Addendum for Phase 2 Supplementary Services and Operator Determined Barring)
6	IR.27	Functional Capability Test Specification for Inter-PLMN Roaming (Phase 1 Data Services, Fax Services
9	IR.32	End-to-End Functional Capability Specification for Inter-PLMN CAMEL-Roaming
10	IR.35	End–to–End Functional Capability Test Specification for Inter-PLMN GPRS Roaming
11	IR.37	Guidelines and Testing for Optimal Routing - Service definition (Stage 1 Testing)
12	IR.38	LTE and EPC Roaming Testing
13	IR.50	2G/2.5G/3G Roaming
14	IR.53	MMS Inter-working Tests
15	IR.60	Prepaid Service Roaming Test
16	IR.62	End-to-End WLAN Roaming Test Cases
17	IR.85	IREG Hubbing Provider Data, Structure and Updating Procedures
18	NG.143	5G SA Roaming Testing

NOTE: The current testing documents could be found on

- gsma.com
- https://membergateway.sharepoint.com/

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1.3 Abbreviations

The following abbreviations are used:

Term	Definition
CAMEL	Customised Applications for Mobile networks using Enhanced Logic
CAP	CAMEL Application Part
GGSN	Gateway GPRS Support Node
GMSC	Gateway Mobile services Switching Centre
GPRS	Global Packet Radio Service

Term	Definition
GRX	GPRS Roaming eXchange
GTP	GPRS Tunnelling Protocol
HLR	Home Location Register, a MAP entity
HSS	Home Subscriber Server
IGP	International Gateway Point, a SCCP entity
IP	Internet Protocol
IPX	IP Packet eXchange. This is the whole group of interconnected IPX Provider's networks
ISC	International Switching Centre, an ISUP entity
ISDN	Integrated Services Digital Network
I-STP	International Signalling Transfer Point, a MTP entity
ISUP	ISDN User Part, a C7 protocol layer
LBO	Local Breakout
LTE	Long Term Evolution
MAP	Mobile Application Part, a C7 protocol layer
MME	Mobility Management Entity
MMS	Multimedia Messaging Service
MRVT	MTP Route Verification Test, defined in CCITT Q.753
MS	Mobile Station
MTP	Message Transfer Part, a C7 protocol layer
N-STP	National Signalling Transfer Point, a MTP entity
PDN	Packet Data Network
PGW	PDN Gateway
PMN	Public Mobile Network
RHSP	Roaming Hub Service Provider
SCCP	Signalling Connection Control Part, a C7 protocol layer
SCP	Service Control Point
SEPP	Security Edge Protection Proxy
SGSN	Serving GPRS Support Node
SGW	Serving Gateway
SOR	Support of Optimal Routing
SRVT	SCCP Route Verification Test, defined in CCITT Q.753
VMSC	Visited Mobile services Switching Centre; including the always collocated entities MSC Mobile services Switching Centre and VLR Visitor Location Register
VoLTE	Voice over LTE
VPMN	Visited PMN
WLAN	Wireless Local Area Network

2 Stage One

2.1 GSM

For GSM, a PMN operator achieves self-certification of the MAP interface by one of the following methods:

- Conformance testing, according to the international standard ISO DIS 9646. It is recommended to use the test cases described in CO.34.
- Acceptance testing, assuming that PMN operators will have the MAP interface proven as part of their final acceptance tests. Special attention must be paid to the conformance of the MAP-operations necessary for International Roaming.
- Compatibility testing between all combinations of different MAP implementations operational in the PMN.

Regarding Customised Applications for Mobile networks Enhanced Logic (CAMEL), it is recommended that before the start of inter-PMN testing of CAMEL functionality, each PMN has already achieved the following:

- CAMEL protocol level tests, to make sure, that CAMEL works properly in the own PMN.
- Practical experience of using CS-1, CS-2 Core- Intelligent Network Application Part (INAP) or CAMEL protocols within its own PMN. This practical experience should include the setting of MSC/SSP and/or CAMEL server data fill, the ability to analyse the CAP/INAP protocol and familiarity with the "test" service logic to be used in the CAMEL server.

2.2 GPRS

Regarding GPRS, it is recommended that before the start of inter-PMN testing of GPRS functionality, each PMN has already achieved the testing of IP-based protocol for GPRS (for example UDP, TCP, GTP, BGP, etc.), to make sure that GPRS works properly in the own PMN.

2.3 3G

Regarding 3G, it is recommended that before the start of inter PMN testing of 3G bearer functionality, each PMN has already achieved the testing of 3G bearer service like video call.

2.4 LTE

Regarding Long Term Evolution (LTE) for data roaming, it is recommended that before the start of inter PMN testing, that each PMN has already achieved the testing of all appropriate LTE bearers to ensure that the LTE data service is working correctly within its own PMN.

Furthermore all GPRS roaming exchange/ IP exchange (GRX/IPX) connectivity should be validated, recognising that LTE additionally uses GTPv2, and Diameter. It is anticipated that some PMNs may already have achieved much of this validation with GPRS and/or 3G originated traffic; If not, then self-certification or testing with an GRX/IPX provider of the necessary IP, BGP and GTP functionality should be undertaken.

Any self-testing should include the validation of GTP firewalls.

Regarding LTE for Voice over LTE (VoLTE) roaming, it is recommended that before the start of inter- PMN testing, each PMN has already achieved the testing of all appropriate LTE bearers, radio functionality, EPC functionality, IMS functionality and PSTN connectivity, using a LTE voice call. The purpose of this self-certification testing is to ensure that the VoLTE service is working correctly within its own PMN.

Stage 1 tests or a subset of tests shall be repeated according to each PMN specific needs whenever a relevant situation occurs:

- New category of Network Entity introduced in the network
- New manufacturer

2.5 5G SA

With 5G SA, roaming signalling (N32) is based on HTTP/2 between Security Edge Protection Proxies (SEPP).

Data sessions are controlled by signalling running also on N32, while data user plane is still using GTP-U.

For voice and SMS, IMS is still the technical enabler, using VoIMS and SMSoIP.

Note: Besides SMSoIP, also SMS over Non-Access Stratum (SMSoNAS) can be used. The latter does not rely on IMS.

Regarding 5G SA roaming, it is recommended that before the start of inter- PMN testing, each PMN has already achieved the testing of all appropriate 5G SA bearers, radio functionality, 5GS functionality, IMS functionality. The purpose of this self-certification testing is to ensure that the 5G SA service is working correctly within its own PMN.

2.6 Major software upgrade

Major software upgrade which affects MAP, CAP, IP, Diameter, GTP or HTTP/2 functionality.

3 Stage Two

Exchange of numbering and addressing data needs to take place between:

- PMN-A and PSTN-A, PMN-B and PSTN-B for circuit-related services,
- PMN-A and GRX-A/IPX-A, PMN-B and GRX-B/IPX-B for packet-switched services.

The international carriers/IPX service provider and RHSP should be brought into negotiations at this stage to ensure that the PMNs requirements can be met in an efficient and reliable manner.

It is anticipated that signalling traffic forecasts will be exchanged between the PMN and International Operators/RHSP to ensure sufficient capacity is available on the international routes to accommodate this increased signalling load. The issue of Message Transfer Part

(MTP) maintenance messages also needs to be addressed to ensure that a PMN nodal failure does not cause excessive loading to every signalling connection.

Before roaming takes place between two PMNs, covering procedures must be established for Operation and Maintenance, for example contact points for fault reporting and notification of planned works. There is also a requirement to include the local International carriers' and RHSP contact points. It is noted that these responsibilities may change from an initial set up phase to the ordinary operational phase.

Exchange of this data will be made in a centralized way under the responsibility of the GSMA in charge of the maintenance of PRDs and in particular of IR.21/IR 85, where the relevant information is contained.

The highest version of each MAP and CAP application context, which is supported in each PMN on the responding side, is indicated in IR.21/IR 85.

For LTE, additional information has been added to IR.21. The information in IR.21 contains the architectural options used by the PMN, and node information, including hostnames and IP addresses.

For 5G SA, additional information has been added to IR.21. The information in IR.21 contains the architectural options used by the PMN, and SEPP node information.

4 Stage Three

PMNs or RHSP shall perform end-to-end functionality tests. This section not only tests the functionality, but more importantly, the customer perception of roaming and its associated facilities.

References should be made to CONIG and SMG if unresolved problems are identified: it is mandatory that any test failure or discrepancy should be clarified against the procedures laid down in the CONIG documentation and GSM standards, for example: the CONIG output and the ETSI-SMG specifications are considered the base reference documents.

The tests are described in GSMA permanent reference documents (PRD).

They are split into several parts:

- Those related to location update/cancellation and telephony basic service (IR.24/IR.25).
- Those related to barring and call forwarding supplementary services (IR.24/IR.25).
- Those related to SMS MT/PP and SMS MO/PP basic services (IR.24/IR.25).
- Those related to phase 2 supplementary services and ODB (IR.26/IR25).
- Those related to circuit oriented (fax, asynchronous or synchronous), (audio ex-PMN or fully digital) data services (IR.27).
- Those related to CAMEL functionalities (IR.32).
- Those related to GPRS services (IR.35).
- Those related to Support 3G bearer capabilities (IR.50).
- Those related to Multimedia Messaging Service (IR.53).
- Those related to prepaid services (IR.60), based on CAMEL.
- Those related to Wireless LAN services (IR.62).

- Those related to LTE and EPC data services, CS Fallback and SMS over SGs (IR.38).
- Those related to 5G SA services (NG.143)

As a prerequisite, before VoLTE testing using IR.25 is performed, VPMN and HPMN must verify that Home Routing is fully supported as identified in IR.25.

Exchange of billing and accounting data can also be performed in conjunction with these tests if required for the testing.

Stage 3 tests or a subset of tests shall be periodically repeated according to each PMN specific needs whenever a relevant situation occurs.

Stage 3 tests shall be updated according to the additional needs of each new MAP and CAP Version.

The subset of test stage 3 which will be needed to be executed by the RHSP will be agreed bilaterally between the RHSP and the PMN. This agreement will define the executed test for

- Initial setup test
- Subsequent test
- Periodic test

5 Summary

Table 1 gives a summary of those stages, and their respective areas of responsibilities, for international roaming tests:

Stage	Activity	Responsibilities
1	MAP, CAP, IP, Diameter, GTP and HTTP/2 interface self-certification testing	PMN Operator
2	Exchange of numbering and addressing data, procedure for O-M, fault reporting, etc.	PMN-A/PSTN-A/RHSP A /PMN-B/PSTN-B/RHSP-B PMN-A/GRX-A/IPX-A PMN-B/GRX-B/IPX-B
3	End to end functional/capability performance testing	PMN-A PMN-B and involved RHSP.

Table 1 - Summary of Stages and Responsibilities

6 Re-Testing

6.1 Fault Management

It is recognized that maintenance actions must be performed as soon as possible when the international roaming service is failing. The international carriers, RHSP and the PMN operators share the responsibility of controlling the reliability of international roaming.

Each international carrier and RHSP shall be requested to monitor the signalling traffic in its own International Gateway Point (IGP), for example by counting the number of SCCP messages exchanged (emitted, received) with each foreign IGP. The number of SCCP messages exchanged with each national PMN operator should also be counted.

Each PMN operator should monitor the reliability of its own network acting as a VPMN, and consider that the partner PMN operators ensure the control of international roaming service to be provided to its HPMN subscribers. VPMN should take steps to notify HPMNs and RHSP of major service effective faults.

MTP and SCCP Route Verification Tests (MRVT, SRVT) as described in CCITT recommendation Q.753 appear to be a good means to detect routing and translation errors in MTP and SCCP. Unfortunately, it will take years until both functionalities are available in most networks. Until this time, a possible solution might be to perform all checks manually. As this method surely is time consuming, it should only be used in a limited number of cases (for example after occurrence of routing failures). Therefore, an agreement between the PMN and the PSTN carriers will be necessary.

If the international roaming service becomes faulty, and it becomes clear that the error is at the SCCP level of the signalling relation, the affected PMN or RHSP maintenance staff shall contact the maintenance staff of the next SCCP International Gateway Point. Depending on the access solution the two PMNs or RHSP are using (see IR.22) this means that the maintenance staff of:

- The IGP in the corresponding PMN, or,
- The IGP of the corresponding fixed network or
- The IGP of the corresponding RHSP

NOTE**:** This includes the affected PMNs/RHSP maintenance staff will have to make direct contact and will be responsible for the further action.

Regarding GPRS, a similar approach should be adopted in case of failure of the inter-PMN GPRS service. (Example: impossibility to query the "Root" DNS or to establish an IP dialog with the Home GGSN). The maintenance staff of the GRX and the affected PMNs maintenance staff will have to make direct contact and will be responsible for the further actions.

Regarding LTE (VoLTE and LTE data roaming), a similar approach should be adopted in case of failure of the inter PMN LTE service (VoLTE and LTE data roaming). The maintenance staff of the IPX and the affected PMNs maintenance staff will have to make direct contact and they will be responsible for the further actions.

The affected PMN/RHSP maintenance staff shall contact the maintenance staff of the next SCCP IGP/RHSP, which is responsible to contact the maintenance staff of the next SCCP node. If the error cannot be detected, this method will continue until, at least, the maintenance staff of the partner PMN/RHSP is contacted.

If the access solution is in a manner that one or more MTP-STPs are part of the SCCP relation and none of the carriers operating the SCCP nodes is responsible for operation of those STPs, also the maintenance staffs of all STP nodes will be contacted. This will be

done by the SCCP IGP node maintenance staff, which contacted its corresponding SCCP IGP node maintenance staff.

Regarding 5G SA, a similar approach should be adopted in case of failure of the inter PMN 5G SA service (VoIMS and 5G SA data roaming). The maintenance staff of the IPX and the affected PMNs maintenance staff will have to make direct contact and they will be responsible for the further actions.

6.2 Re-Testing after Network Changes

When operation is in course, it will be necessary to repeat subsets of the tests related with the above indicated stages, if a major upgrading is introduced in one of the two PMNs. The evaluation of the necessity of test repetitions is the responsibility of the involved VPMN operator. Examples of cases that can require test repetition are:

- Introduction of new mobility services, data services, supplementary services. All the tests associated to these new services must be performed as soon as possible after the launching of new roaming services provided by the VPMN operator to its own customers.
- Modification of addressing or numbering data.
- Change of the national numbering plan in a PMN country.
- Introduction of a new IPX proxy (i.e. STP, DRA, SEPP, …).
- Introduction of a new manufacturer for an existing node (STP, MSC, SGSN, MME, PGW, AMF, SMF/UPF, SEPP, …).
- Introduction of a new software release which involves major changes in a VPMN or HPMN node.

The VPMN operator shall define the appropriate subsets on a case-by-case basis.

6.3 Periodic Re-Testing

To check that international roaming is available continuously after the commercial opening of the service, periodic test repetition, not triggered by any special event, but for regular service control, shall be performed by the VPMN operator or the RHSP.

The VPMN operator or RHSP will set-up and connect calls periodically with test SIMs of each HPMN, currently located in the VPMN. This operation has to be performed weekly in each type of Network Node used (MSC, MME, AMF, ...) in the VPMN, twice if two types of HLR/HSS/UDM are used in the HPMN.

The selected test cases will depend of the operator policy and could be selected in the test PRD defined in stage Three (section 4).

Annex A Document Management

A.1 Document History

Version	Date	Brief Description of Change	Approval Authority	Editor / Company
Draft Issue:	May 91 to May 92	ER.D for IREG discussions		
3.0.0	3rd June 1992	Approved at MoU 20		
3.1.0	29th October 1993	CR#1		
3.2.0	1st September 1994	CR#2		
3.3.0	10 September 1995	CR#3		
3.4.0	23rd April 1996	CR#4		
3.4.1	17 February 1999	CR#5 Additional Annex for SCCP testing. Approved at Plenary 41		
3.5	18 August 2004	CR#6 References to CAMEL, GPRS, SOR, MMS and WLAN added. Reference to PRD TD.06 removed. Version control number reverts to a 2-element format.		
3.5	1 October 2005	Annual review, no changes.		
3.6	28 January 2009	Introduction of the roaming HUB test procedure		
4.0	1st April 2011	Submitted to IREG for approval	IREG#60 EMC	Philippe Erard Comfone Ltd
5.0	6th February 2012	Inclusion of CR 009 to IR.23	IREG#61 EMC	Philippe Erard Comfone Ltd
6.0	9th April 2013	Inclusion of IR.23 T1/CR1001	IREG#64 PSMC	Philippe Erard Comfone Ltd
6.1	9 Sept 2013	LTE and EPC Roaming Testing IR.38	IREG	Itsuma Tanaka (NTT Docomo)
7.0	24th September 2014	Inclusion of IR.23 CR1002	IREG#66 PSMC	Philippe Erard Comfone ltd
8.0	27/01/2025	CR1003 Update for 5G SA	NRG	Marc Balon Orange

Other Information

Type	Description
Document Owner	NRG
Editor / Company	Marc Balon - Orange

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