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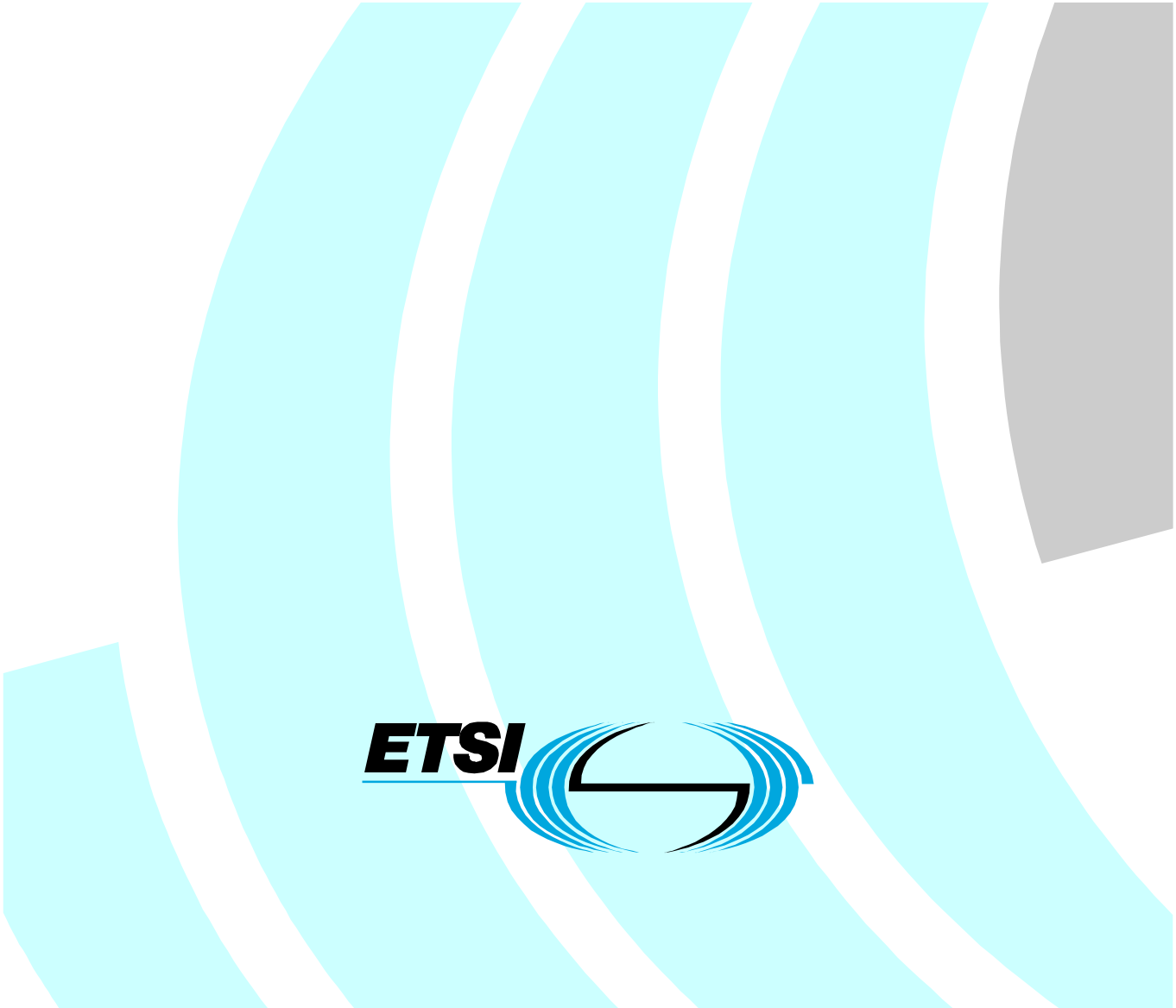
Technical Report

Methods for Testing and Specification (MTS)
IMS Network Integration Testing Infrastructure
Testing Methodology



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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Methods for Testing and Specification (MTS).

1 Scope

The present document describes a testing methodology for the functional qualification of the mobile network infrastructure for the IP Multimedia Subsystem (IMS) R5. The methodology proposed is concerned to the infrastructure and not to the IMS services, hence the analysis of the Application Servers interfaces is beyond the scope of the present document. General charging aspects will be also considered. For a checking of the IMS CN infrastructure it is suggested to test a series of reference scenarios analysing the corresponding signal messages regarding the internal interfaces of the involved nodes: IuPS, Gn, Mw, Gm, Go, Mi, Mj, Mk, Mg, Mn/Mc, Cx and Rf. Nodes and interfaces involved in each specific scenario constitute testing infrastructure. Ten configurations were shown in order to test procedures from part of Mobility management, Session setup, Session Control, Enhanced Multimedia Services and Charging. The different scenarios cover single operator, multiple operator and roaming configurations. Furthermore some are intended to test PLMN-PSTN interworking.

2 References

For the purposes of this Technical Report (TR), the following references apply:

[1] ETSI TS 123 060 (V5.6.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); General Packet Radio Service (GPRS) Service description; Stage 2 (3GPP TS 23.060)".

[2] ETSI TS 123 221 (V5.7.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Architectural requirements (3GPP TS 23.221)".

[3] ETSI TS 123 228 (V5.9.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); IP Multimedia Subsystem (IMS); Stage 2 (3GPP TS 23.228)".

[4] IETF RFC 3261 "SIP: Session Initiation Protocol".

[5] ETSI TS 124 229 (V5.5.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); IP Multimedia Call Control Protocol based on SIP and SDP; Stage 3 (3GPP TS 24.229)".

[6] ETSI TS 129 229 (V5.7.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Cx and Dx interfaces based on the Diameter protocol; Protocol details (3GPP TS 29.229)".

[7] ETSI TS 129 232 (V5.7.0): "Universal Mobile Telecommunications System (UMTS); Media Gateway Controller (MGC) - Media Gateway (MGW) interface; Stage 3 (3GPP TS 29.232)".

[8] ETSI TS 132 225 (V5.6.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Telecommunication management; Charging management; Charging data description for the IP Multimedia Subsystem (IMS) (3GPP TS 32.225)".

[9] ETSI TS 129 207 (V5.8.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Policy control over Go interface (3GPP TS 29.207)".

[10] ETSI ETR 193: "Methods for Testing and Specification (MTS); Network Integration Testing (NIT); Methodology aspects; Test Co-ordination Procedure (TCP) style guide".

[11] ETSI ETR 303: "Methods for Testing and Specification (MTS); Test Synchronization; Architectural reference; Test Synchronization Protocol 1 (TSP1) specification".

[12] ISO 9646 (all parts): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework".

[13] ISO/IEC 9646-3: "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 3: The Tree and Tabular Combined Notation (TTCN)".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3GPP	Third generation Partnership Project
BGCF	Break-out Gateway Control Function
CCF	Charging Collection Function
CN	Core Network
COPS	Common Open Policy Services
CS	Circuit Switched
CSCF	Call Session Control Function
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Server
GERAN	GSM/EDGE Radio Access Network
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
HSS	Home Subscriber Server
I-CSCF	Interrogating-CSCF
IETF	Internet Engineering Task Force
IM	IP Multimedia
IMS	IP Multimedia Subsystem
IP	Internet Protocol
ISDN	Integrated Service Digital Network
MGCF	Media Gateway Control Function
MGW	Media Gateway
MTS	Methods for Testing and Specification
NIT	Network Integration Testing
P-CSCF	Proxy-CSCF
PDF	Policy Decision Function
PDP	Packet Data Protocol
PEP	Policy Enforcement Point
PICS	Protocol Implementation Conformance Statement
PIXIT	Protocol Implementation eXtra Information for Testing
PLMN	Public Land Mobile Network
PS	Packet Switched
PSTN	Public Switched Telephone Network
QoS	Quality of Service
SBLP	Service-Based Local Policy
S-CSCF	Serving-CSCF
SDP	Session Description Protocol
SGW	Signaling Gateway Function
SIP	Session Initiation Protocol
TR	Technical Report
TTCN	Tree Tabular Combined Notation
UE	User Equipment
UMTS	Universal Mobile Telecommunication System
UT	Upper Tester
UTRAN	UMTS Terrestrial Radio Access Network

4 Introduction

4.1 Purpose

The present document is aimed at defining a Testing Methodology for the functional qualification of the mobile network infrastructure for the IP Multimedia Subsystem (IMS) R5. The purpose is to verify the procedures conformity to TS 123 228 [3] following up the introduction of a the new set of signalling and network bearer related network entities. The procedures that have been considered in the present document are:

- CSCF;
- Mobility Management;
- Session control and Session set-up;
- Enhanced Multimedia Services;
- QoS and Charging.

The methodology used foresees tests are carried out end-to-end, through the following phases: preparation of prerequisites - including build of specific test scenario -, execution of procedure and result verification through POs and PCOs. The different scenarios cover single operator, multiple operator and roaming configurations and some are intended to test PLMN-PSTN interworking. Nodes and interfaces involved in each specific scenario constitute testing infrastructure.

4.2 Validity

The purpose of the present document is to functionally verify the IMS R5 core network architecture. IP multimedia services are based on IETF defined session control capability using the PS domain to transport signalling and bearer traffic; they are independent of the CS domain although some network element may be common with it.

For a complete checking of the IMS CN it is necessary to test a series of reference scenarios analysing the corresponding signal messages regarding the internal interfaces of the involved nodes: IuPS, Gn, Mw, Gm, Go, Mi, Mj, Mk, Mg, Mn/Mc, Cx and Rf. However, there are interfaces that are not IP based used during interactions with the legacy network (i.e. GSM, PSTN, and ISDN). Their internal functions will be tested for proving the interoperability with the external IMS domain. For this reason, it is necessary to specify in each test the nodes and the interfaces involved; in other words the network configuration. The verification also envisages the production of traffic documentation.

The qualification of the other network elements and radio interface is beyond the scope of the present document.

4.3 IMS Architecture

The IMS CN subsystem combines the growth of the Internet with the growth in mobile communications, in fact it should enable the convergence of, and access to, voice, messaging, data and web-based technologies for the wireless user.

The IMS Architecture is basically based on the Packet Domain [1] and it has special entities devoted to interact with the external Circuit-Switched networks, as well as functional entities dedicated to signalling and transporting user's data and signalling. The figure 1 shows the IMS architecture including the Radio Access Network either GERAN or UTRAN [2].

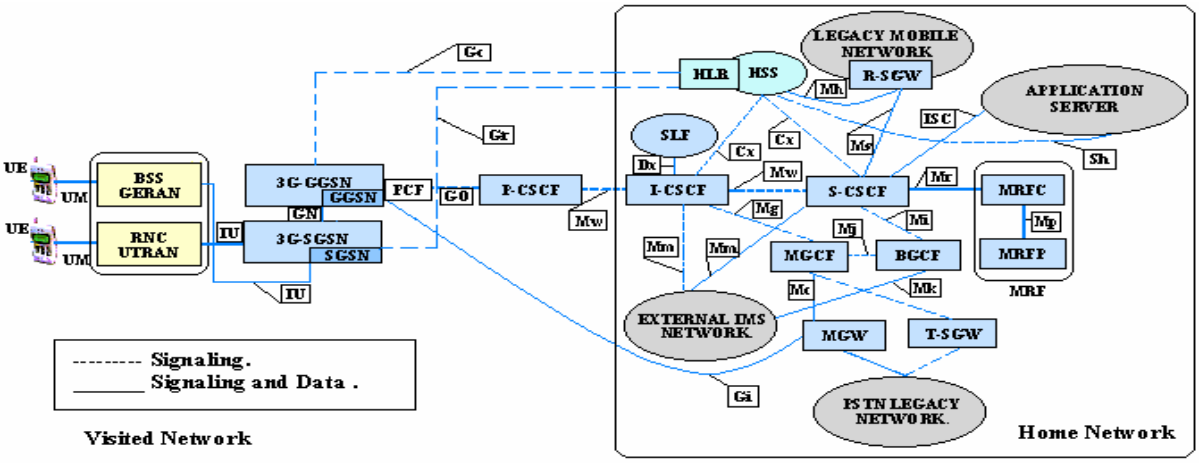

Figure 1: Architecture for IP multimedia service

5 IMS Network Integration Testing Methodology

5.1 Reasons for Network Integration Testing (NIT)

NIT is a testing methodology that is applicable to test and monitor the overall behaviour of complex telecommunication systems, typically based on distributed call processing and distributed architectures.

In particular, the NIT approach can be conveniently applied to verify the global functions of interconnected networks providing services based on IMS.

It is clear that NIT is different from conformance testing, the latter methodology being traditionally aimed at supporting verifications on a single product (a protocol, or a stack of protocols, but in any case on a well identified single "System Under Test").

Network operators are traditionally used to perform some "end-to-end testing" (a type of NIT testing, as we will see) before opening telecommunication services towards destinations served by other operators. Such tests are normally carried out by network operators on a bilateral voluntary basis before opening a bilateral (symmetric) traffic relation for the commercial service. From the technical point of view, the aim is to check the behaviour of a global telecommunication network (i.e. a set of interconnected sub-networks) from the point of view of the end users (the customers of each operator) which are "attached" to the borders of the network, at the user-to-network interfaces.

Sometimes the "borders" of the global network under test are not couples of user-to-network interfaces but are at two or more node-to-node interfaces. This is the case of a transit network (e.g. a core SS#7 network): in this case the term "node-to-node testing" is used (the term "point-to-point" testing is also used sometimes by the operators, the name "point" correctly reminding us the SS#7 terminology of "signalling points").

So the common "black box" approach of both cases (testing for the borders) is referred to using the term "Network Integration Testing" (NIT), which reflects the ability of different components of a "global" network, to work with a certain level of co-ordination and *integration* in order to be able to offer a given set of telecommunication services at the "global borders".

5.2 Overview of ISO 9646 [12] concepts and their applicability to NIT

5.2.1 Requirements

NIT Requirements have to be based not on a single set of reference specifications but on many, at least one for each interconnected sub-network, from which the compatibility requirements must be extracted.

5.2.2 PICS and PIXIT

A Protocol Implementation Conformance Statement (PICS) for NIT can be derived from the PICS of each reference specification.

A Protocol Implementation extra Information for Testing (PIXIT) can be derived from the PIXIT of each implementation.

5.2.3 NIT profile

A NIT profile can be derived from the PICS of different base standards or profiles. This allows the inclusion of a requirement list for the specific interworking under test.

5.2.4 Type of test

As the purpose of NIT is not to check the conformance of the network to the standard, but its functionality, that is to check how the information related to the establishment, usage and release of a call is carried between the network components, basic interconnection category is definitely in its scope.

The type of test for NIT is an open issue. In fact there could be other types of tests in NIT scope.

5.2.5 Test method

The chosen method for NIT is MPTM. In the case of End-to-End testing, an applicable method is MPTM without Upper Tester (UT) (see figure 2). In the case of the Node-to-Node testing, it is necessary to cause within the IUT some conditions necessary to continue the test. In this case an applicable method is MPTM with an UT (see figure 3).

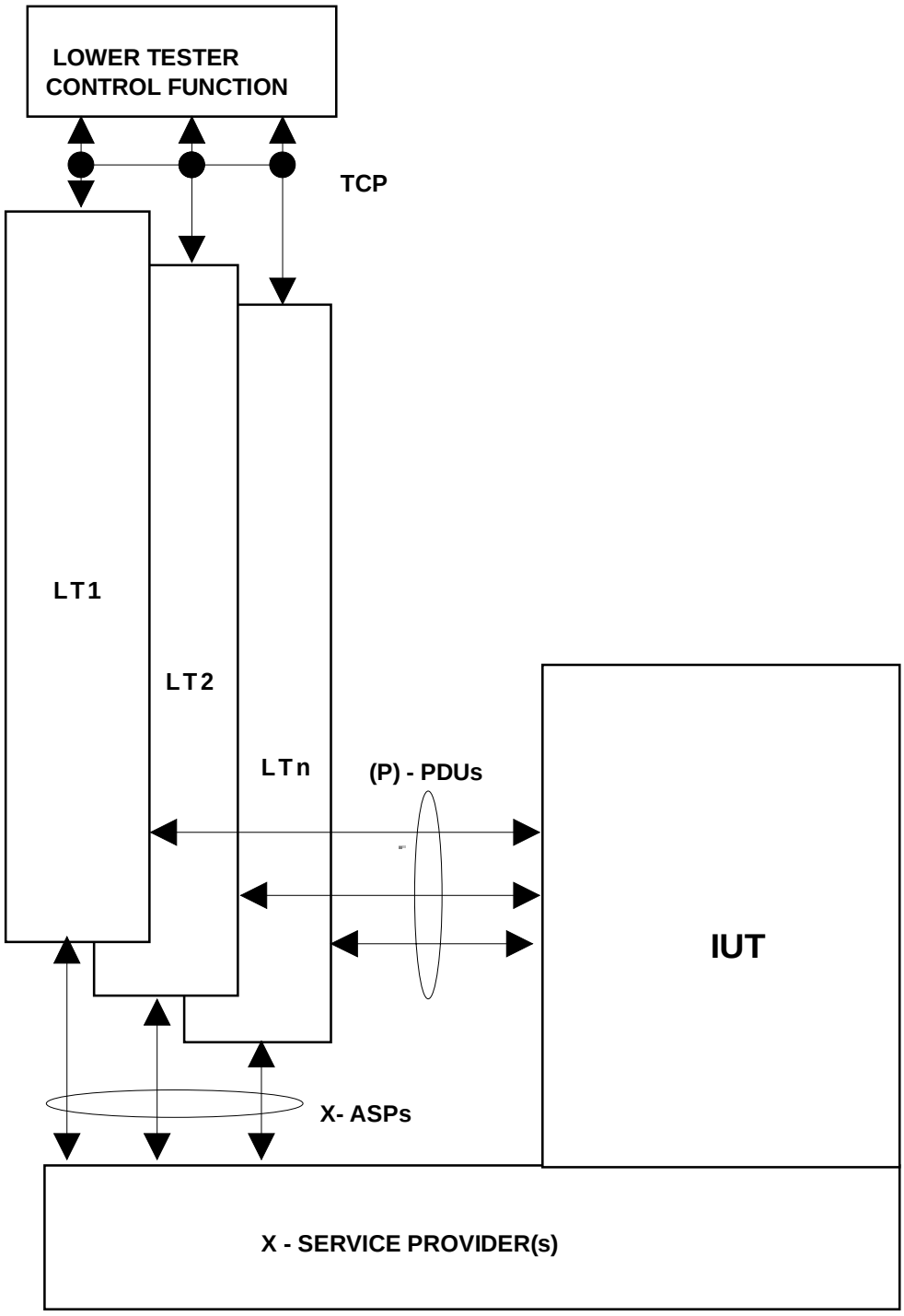

Figure 2: MPTM used for End-to-End testing

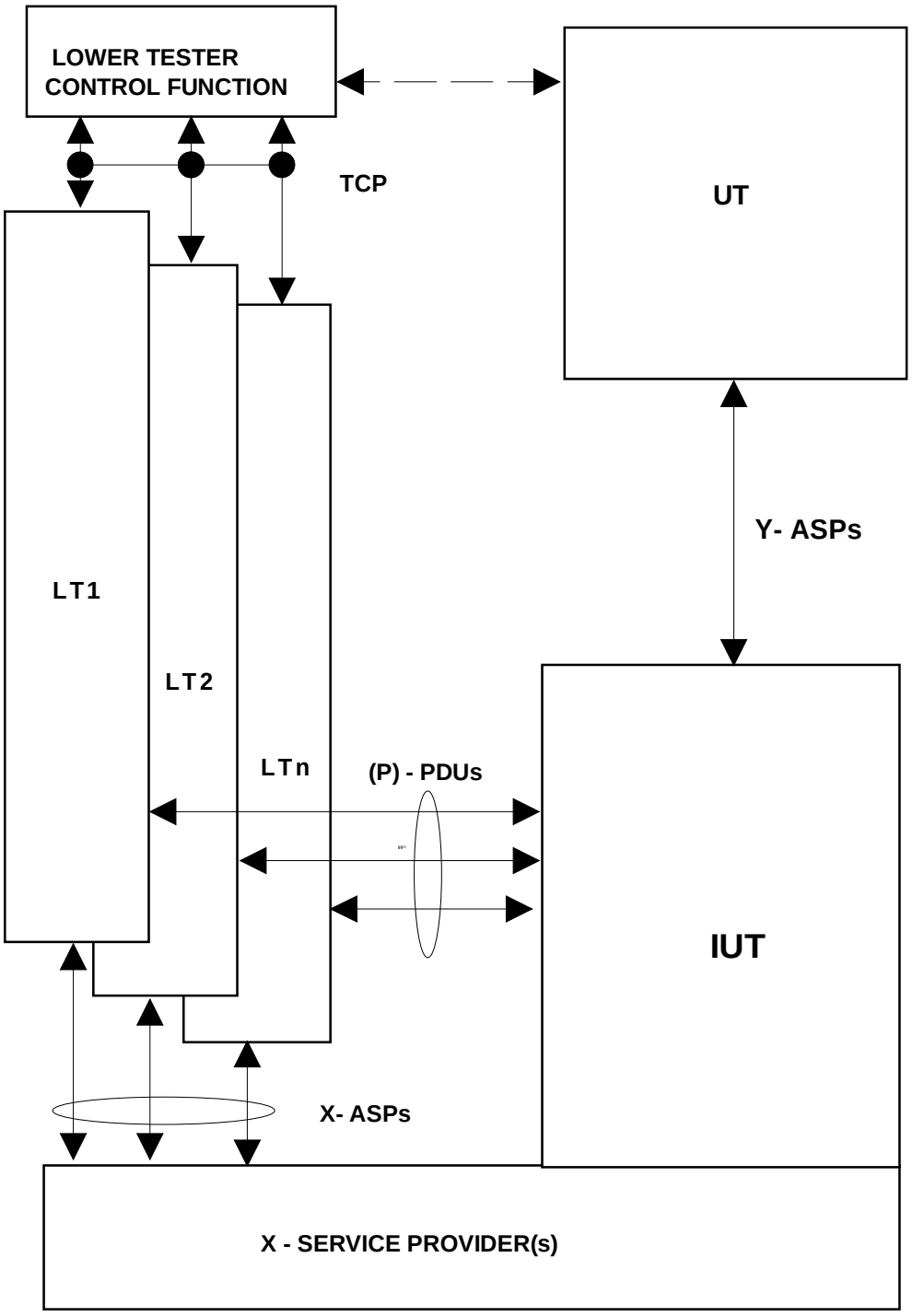

Figure 3: MPTM used for Node-to-Node testint

5.2.6 Test notation

The ATS designer should use a standard ized notation defined in ISO/IEC 9646-3 [13] (TTCN). In particular MPTM is used with "Concurrent TTCN" as specified in ISO/IEC 9646-3 [13]/AM1.

5.3 Functional tests

The methodology used foresees tests are carried out end-to-end, through the following phases:

- **preparation of prerequisites:** phase in which the various elements of the network must be suitably configured and brought to the envisaged test start condition. This phase may require work on the HSS as well as on the core-network nodes. It may also require insertion of suitable external measuring instruments (e.g. protocol analyser). The special requirements of each test will be specified through a minimal configuration given in the appendix;
- **execution of procedure:** phase in which the procedure to test the various functions is carried out by operating on the UE, as well as on the network elements;
- **result verification:** phase (overlapping with the previous one) to verify procedural correctness by monitoring the interfaces and logging network elements.

The tests in the present document are functional, that is to say aimed at verifying the system's capacity to perform a given function envisaged by the standard. The result verification phase essentially consists in analysing the messages exchanged on the interfaces involved and checking the effects obtained on the elements concerned. Each test is passed if they give the desired effects and if the messages exchanged are coherent with the service specifications. For failed tests, the severity of the problem should be estimated in relation to the consequences for both the user and the network.

Figure 4 presents the complete network configuration for executing the proposed tests. Some networks entities have been omitted only for clarity, but each proposed test explicitly indicates all network entities involved.

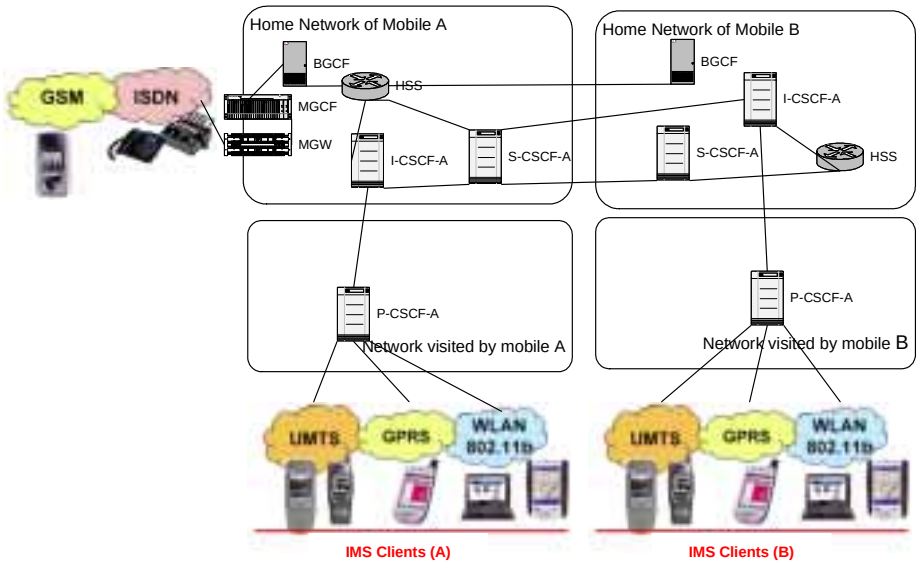

Figure 4: Basic network configuration to execute the performance test

Basic sessions between mobile users will usually involve two S-CSCFs (one S-CSCF for each) and one or more network operator. In case that a basic session is between a user and a PSTN endpoint, it involves a S-CSCF for the UE, a BGCF to select the PSTN gateway, and additionally an MGCF for the PSTN.

5.4 Test forms

This clause introduces the test forms envisaged. Each form consists of various fields that are briefly defined below:

OBJECTIVE: this field indicates the aim of the test, in other words, the function to be checked.

INTERFACES: this is a list of the interfaces involved in the test, the ones in bold type require analysis with a monitoring instrument during the test.

PRECONDITIONS: this describes the phases of preparation that have to be carried out to bring all elements of the system to the initial conditions necessary for performing the test.

PRIORITY: the importance given to performing the test compared to others.

PROCEDURE DESCRIPTION: this describes the sequence of actions to perform to solicit the function under test.

EXPECTED RESULTS: this describes the messages to check on the interfaces with the protocol analyser and the system element states to check.

NOTES: comments, explanations or suggestions about the test.

REFERENCES: the specifications and documents offering more information on problems with the test.

5.5 Network configurations

This clause illustrates the different system configurations necessary to carry a basic set of tests on the IMS architecture.

Exactly ten minimum configuration are provided in order to test procedures from part of Mobility management, Session setup, Session Control, Enhanced Multimedia Services and Charging. Moreover some of these configurations are intended to test network operator interoperability and PSTN interworking.

The following is the list of the proposed network configurations:

Home network for CSCF related procedures

Home network for Mobility Management procedures

Home and Visited network for Mobility Management procedures

Home network for Session control procedures and Enhanced Multimedia services

Home and Visited network for Session setup and control procedures

Home network for PSTN initiated session to IMS

Home network for IMS initiated session to PSTN

IMS originated session to PSTN from different operator

PSTN originated session to IMS from different operator

Home network for Charging tests.

All the involved interfaces are: PS domain interfaces, Gm (logical SIP interface between UE and CSCF), Mw, Mi, Mj, Mk, Mg (SIP interfaces [4] [5]), Cx (Diameter interface [6]), Mn or Mc (H.248 interfaces [7]), Rf (Diameter interface for charging [8]) and Go (COPS interface [9]) in case of implemented SBLP (service based local policy).

Every configuration differentiates from each other according to the network entity and the network interfaces involved in the scenarios, moreover only the signalling interface are shown.

5.5.1 Home network for CSCF related procedures

This configuration is intended to test only the P-CSCF discovery procedure that occurs before or as part of the PDP context activation procedure for IMS signalling.

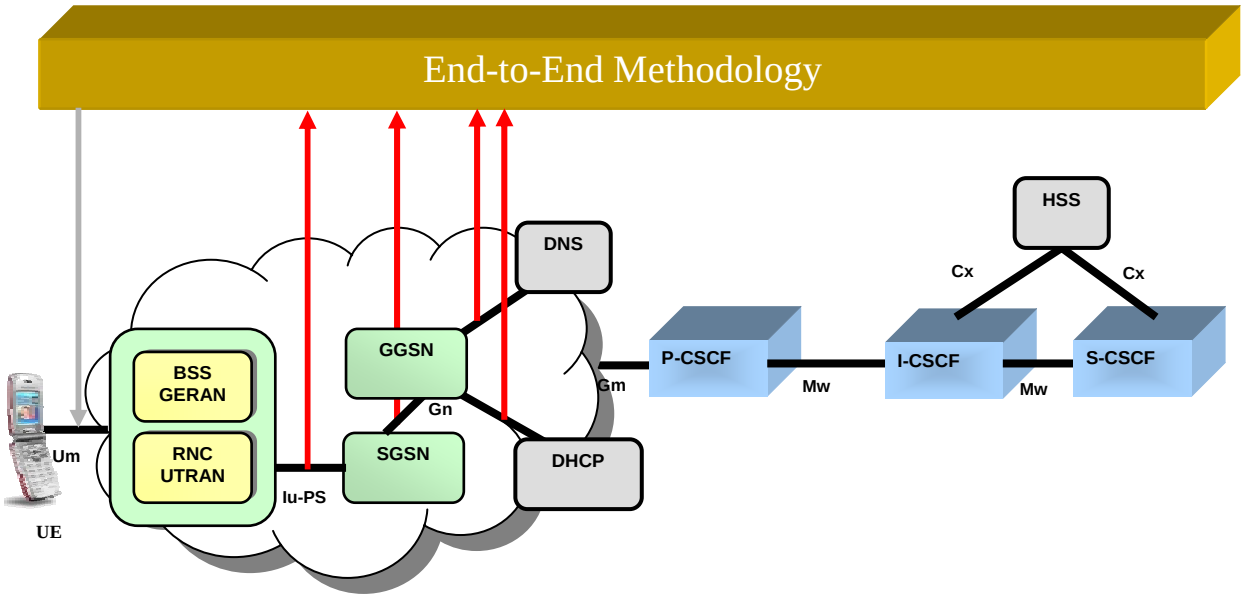

Figure 5: Configuration no. 1

In this configuration it is necessary to monitor the following interfaces: Iu-PS, Gn and the interface between GGSN and DHCP/DNS server in case the DHCP/DNS procedure for P-CSCF discovery occurs.

5.5.2 Home network for Mobility Management procedures

This configuration requires one IMS home network for testing Mobility Management procedures as Registration, Deregistration, Authentication, User subscription and some Network initiated procedures.

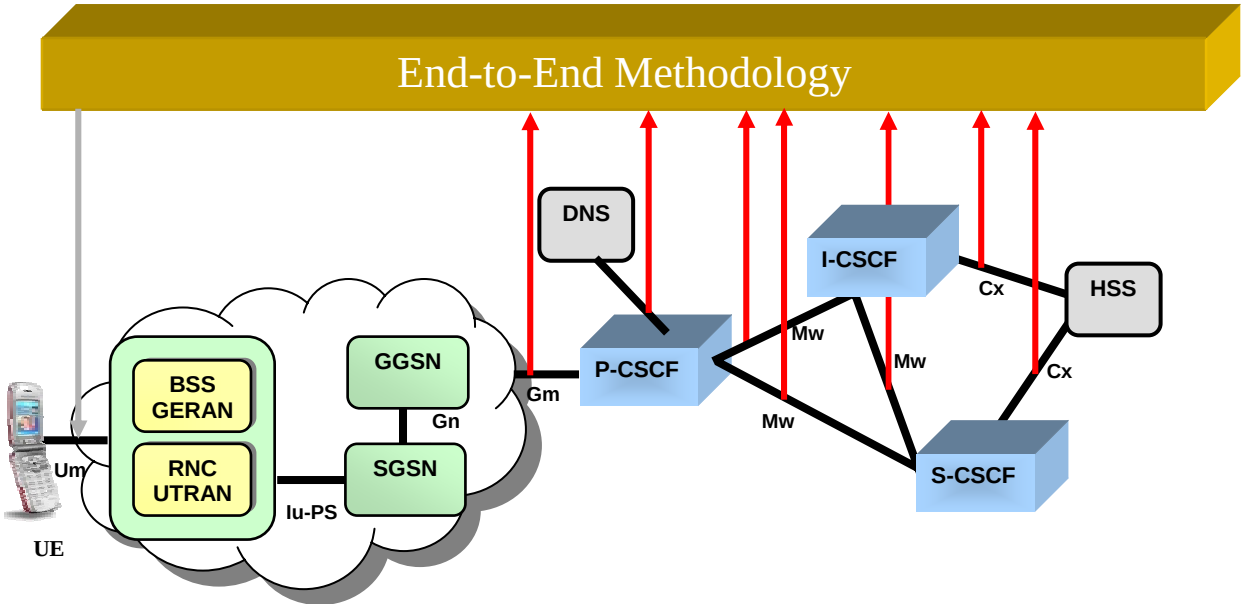

Figure 6: Configuration no. 2

To check the correctness of these procedures it is necessary to monitor the following interfaces: Gm, Mw and Cx as shown in the previous figure.

5.5.3 Home and Visited network for Mobility Management procedures

This configuration is intended to test the interoperability in case of mobility management procedures between different operators, so it requires a roaming user.

The procedures to check are the same indicated for the previous configuration as Registration, Deregistration, Authentication, User subscription, Network initiated procedures but it is also possible to test the unsuccessfull registration in case of user not allowed to roam.

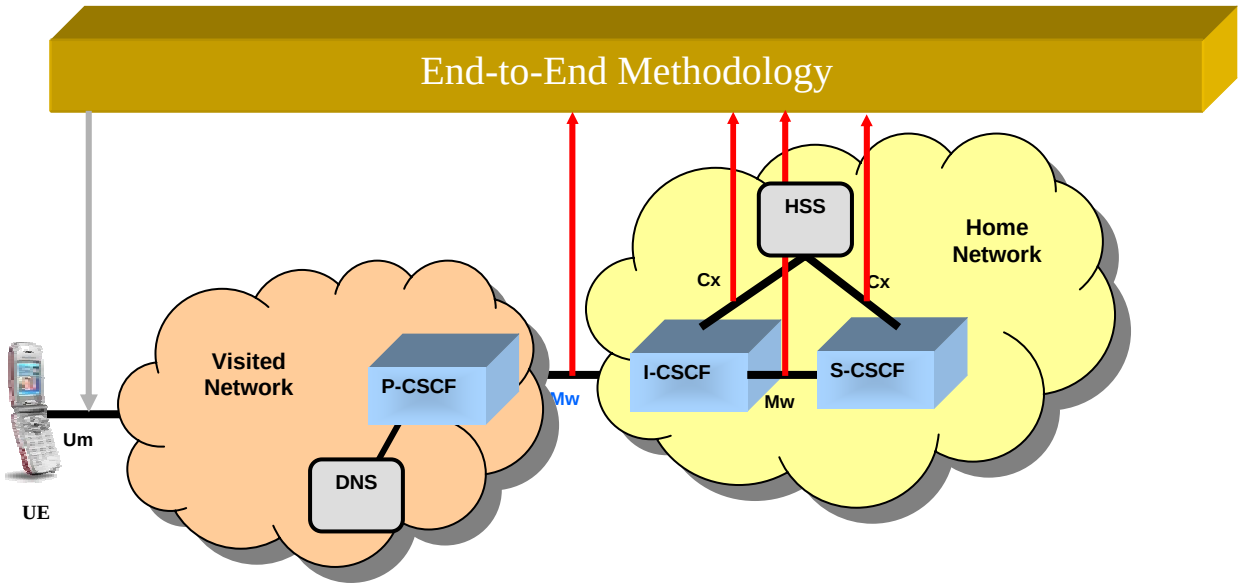

Figure 7: Configuration no. 3

To check the correctness of these procedures it is necessary to monitor the following interfaces: Mw and Cx as shown in the previous figure. Exactly with Mw interface between visited and home network, is intended the interfaces between P-CSCF visited and both the home network entity I-CSCF and S-CSCF.

5.5.4 Home network for Session control procedures and Enhanced Multimedia services

This configuration requires one IMS home network for testing session setup, session control and some enhanced multimedia services in case of user located in the same network.

In detail the procedures that are possible to test with this configuration are: Session initiation, Session Release, Network initiated release procedures, Unsuccessful session handling (as user busy, rejected session, user not registered or unreachable). It is also possible to check some Enhanced Multimedia services as session hold and resume, handling of privacy, codec and media flow negotiation, and in case of availability of three user it is also possible to check session redirection and session transfer procedures.

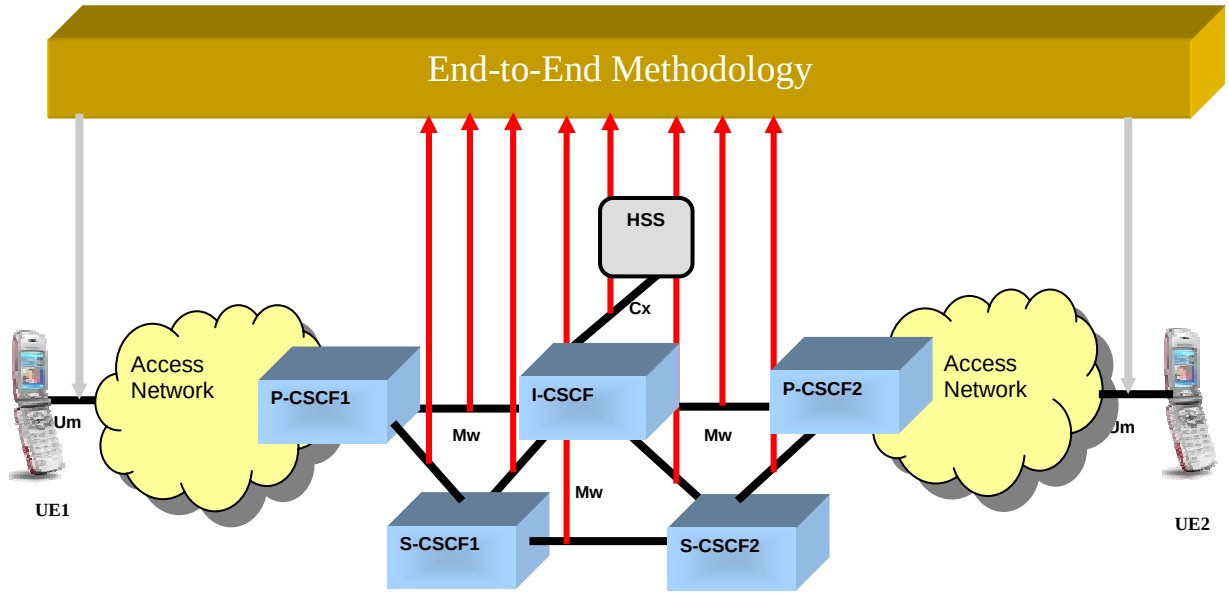

Figure 8: Configuration no. 4

To check the correctness of these procedures it is necessary to monitor the following interfaces: Mw and Cx as shown in the previous figure.

In order to check the end-to-end QoS signalling it is also necessary to monitor the messages exchange on the Go interface between GGSN, that acts as PEP (Policy Enforcement Point), and P-CSCF, that acts as PDF (Policy Decision Function). In this case it is assumed that the core network is DiffServ enabled and service based local policy decisions (SBLP) are taken by the PDF. The addition of the GPRS procedures in the access networks to the DiffServ enabled core network guarantees the end-to-end quality of service.

5.5.5 Home and Visited network for Session setup and control procedures

This configuration is intended to test the interoperability in case of session related procedures between different operators, so it requires users to belong to different networks.

The procedures to check are the same indicated for the previous configuration as Session initiation, Session Release, Network initiated release procedures, Unsuccessful session handling (as user busy, rejected session, user not registered or unreachable). It is also possible to check some Enhanced Multimedia services as session hold and resume, handling of privacy, codec and media flow negotiation, and in case of availability of three user is also possible to check session redirection and session transfer procedures.

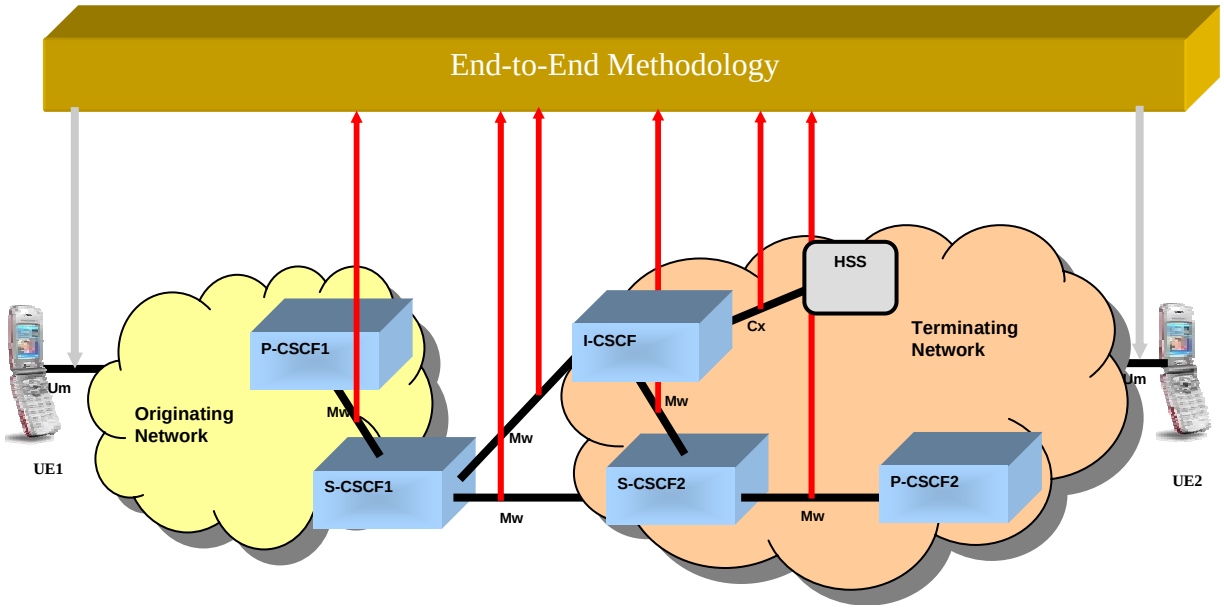

Figure 9: Configuration no. 5

To check the correctness of these procedures it is necessary to monitor the following interfaces: Mw and Cx. In this case some Mw interfaces are between entity that belong to different network operator as shown in the previous figure.

In order to check the end-to-end QoS signalling it is also necessary to monitor the messages exchange on the Go interface between GGSN, that acts as PEP (Policy Enforcement Point), and P-CSCF, that acts as PDF (Policy Decision Function). Int this case it is assumed that the core network is DiffServ enabled and service based local policy decisions (SBLP) are taken by the PDF. The addition of the GPRS procedures in the access networks to the DiffServ enabled core network guarantees the end-to-end quality of service.

5.5.6 Home network for PSTN initiated session to IMS

This configuration requires one home network operator provided with both CS and IMS domain for testing session related procedures including some enhanced multimedia services, in case of PSTN originating session.

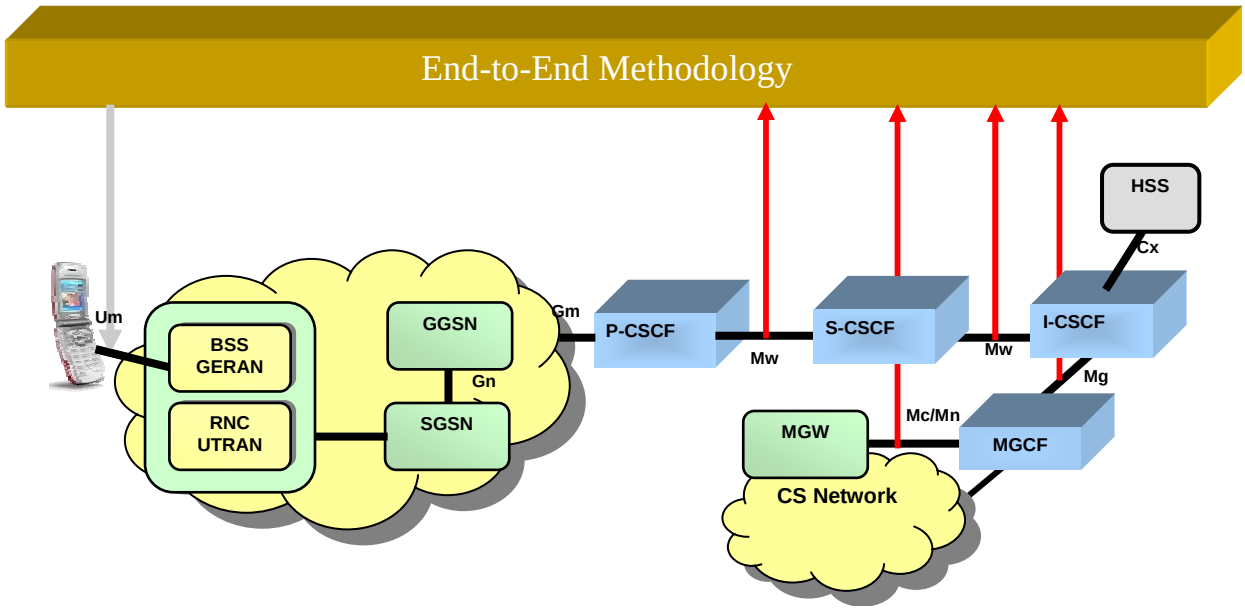

Figure 10: Configuration no. 6

To check the correctness of the session related procedures it is necessary to monitor the following interfaces: Gm, Mw, Mg, Cx and Mc or Mn (it depends on the MGW if it is located in the CS domain or in the IMS domain respectively).

In order to check the end-to-end QoS signalling it is also necessary to monitor the messages exchange on the Go interface between GGSN, that acts as PEP (Policy Enforcement Point), and P-CSCF, that acts as PDF (Policy Decision Function). Int this case it is assumed that the core network is DiffServ enabled and service based local policy decisions (SBLP) are taken by the PDF. The addition of the GPRS procedures in the access networks to the DiffServ enabled core network guarantees the end-to-end quality of service.

It is possible that this configuration requires a SGW to perform the call related signalling conversion to or from network transport in CS domain and network transport in IMS domain.

5.5.7 Home network for IMS initiated session to PSTN

This configuration requires one home network operator provided with both CS and IMS domain for testing session related procedures including some enhanced multimedia services, in case of IMS originating session.

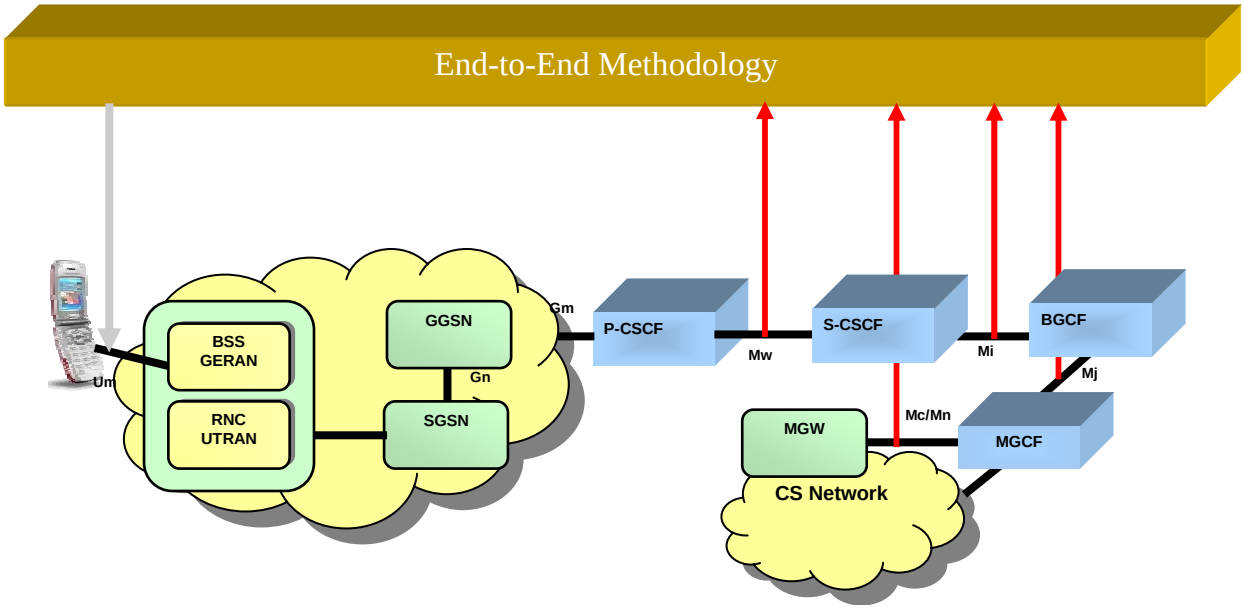

Figure 11: Configuration no. 7

To check the correctness of the session related procedures it is necessary to monitor the following interfaces: Gm, Mw, Mi, Mj and Mc or Mn (it depends on the MGW if it is located in the CS domain or in the IMS domain respectively).

In order to check the end-to-end QoS signalling it is also necessary to monitor the messages exchange on the Go interface between GGSN, that acts as PEP (Policy Enforcement Point), and P-CSCF, that acts as PDF (Policy Decision Function). In this case it is assumed that the core network is DiffServ enabled and service based local policy decisions (SBLP) are taken by the PDF. The addition of the GPRS procedures in the access networks to the DiffServ enabled core network guarantees the end-to-end quality of service.

It is possible that this configuration requires a SGW to perform the call related signalling conversion to or from network transport in CS domain and network transport in IMS domain.

5.5.8 IMS originated session to PSTN from different operator

This configuration is intended to test the interoperability between network operators in case of session related procedures originated by IMS to PSTN domain.

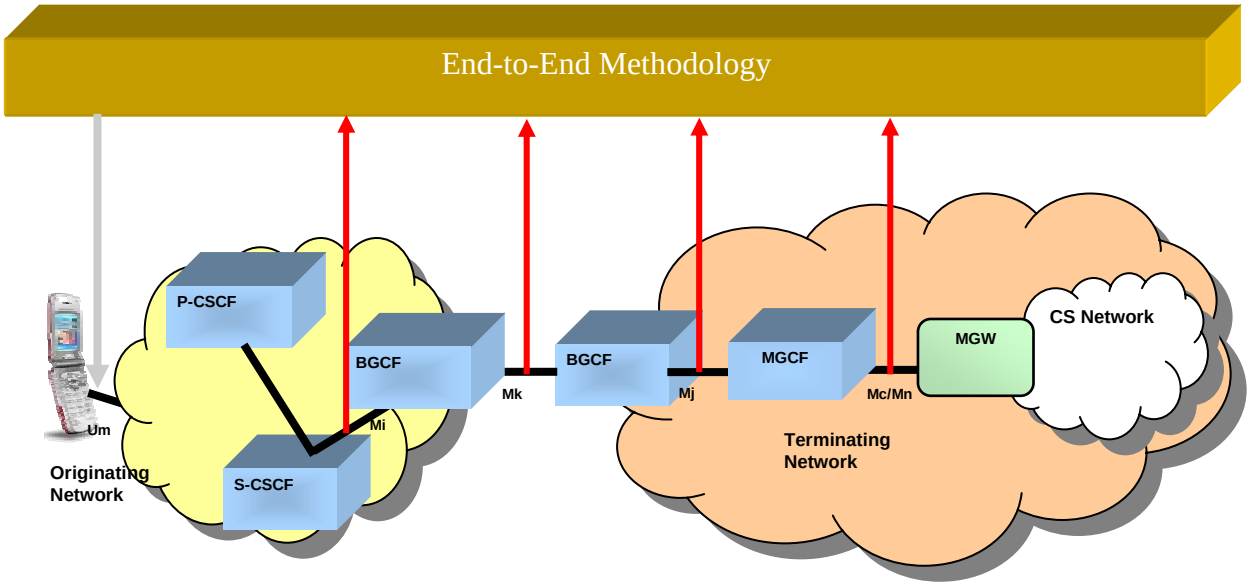

Figure 12: Configuration no. 8

To check the correctness of the session related procedures it is necessary to monitor the following interfaces: Mk, Mi, Mj and Mc or Mn it depends on the MGW if it is located in the CS domain or in the IMS domain respectively (both in the terminating network).

In order to check the end-to-end QoS signalling it is also necessary to monitor the messages exchange on the Go interface between GGSN, that acts as PEP (Policy Enforcement Point), and P-CSCF, that acts as PDF (Policy Decision Function). In this case it is assumed that the core network is DiffServ enabled and service based local policy decisions (SBLP) are taken by the PDF. The addition of the GPRS procedures in the access networks to the DiffServ enabled core network guarantees the end-to-end quality of service.

It is possible that this configuration requires a SGW in the terminating network to perform the call related signalling conversion to or from network transport in CS domain and network transport in IMS domain.

5.5.9 PSTN originated session to IMS from different operator

This configuration is intended to test the interoperability between network operators in case of session related procedures originated by PSTN to IMS domain.

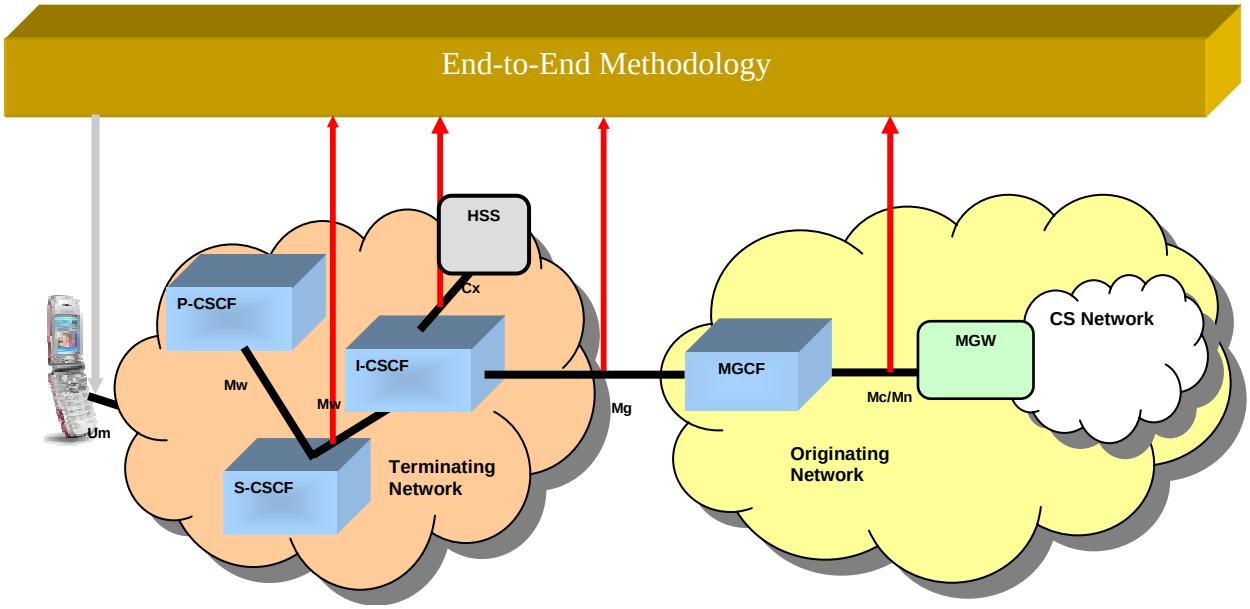

Figure 13: Configuration no. 9

To check the correctness of the session related procedures it is necessary to monitor the following interfaces: Mw, Mg, Cx and Mc or Mn it depends on the MGW if it is located in the CS domain or in the IMS domain respectively (both in the originating network).

In order to check the end-to-end QoS signalling it is also necessary to monitor the messages exchange on the Go interface between GGSN, that acts as PEP (Policy Enforcement Point), and P-CSCF, that acts as PDF (Policy Decision Function). In this case it is assumed that the core network is DiffServ enabled and service based local policy decisions (SBLP) are taken by the PDF. The addition of the GPRS procedures in the access networks to the DiffServ enabled core network guarantees the end-to-end quality of service.

It is possible that this configuration requires a SGW in the originating network to perform the call related signalling conversion to or from network transport in CS domain and network transport in IMS domain.

5.5.10 Home network for Charging tests

This configuration is intended to test the charging functionality in a single network operator.

To give a global vision of the charging architecture in the configuration are shown different networks, in this way it is possible to check the correct CDRs collection in case of mobile generated or mobile terminated session, in case of roaming user, and in case of interoperability between different operator. In any case the collection of CDRs is intended only in the network operator under test.

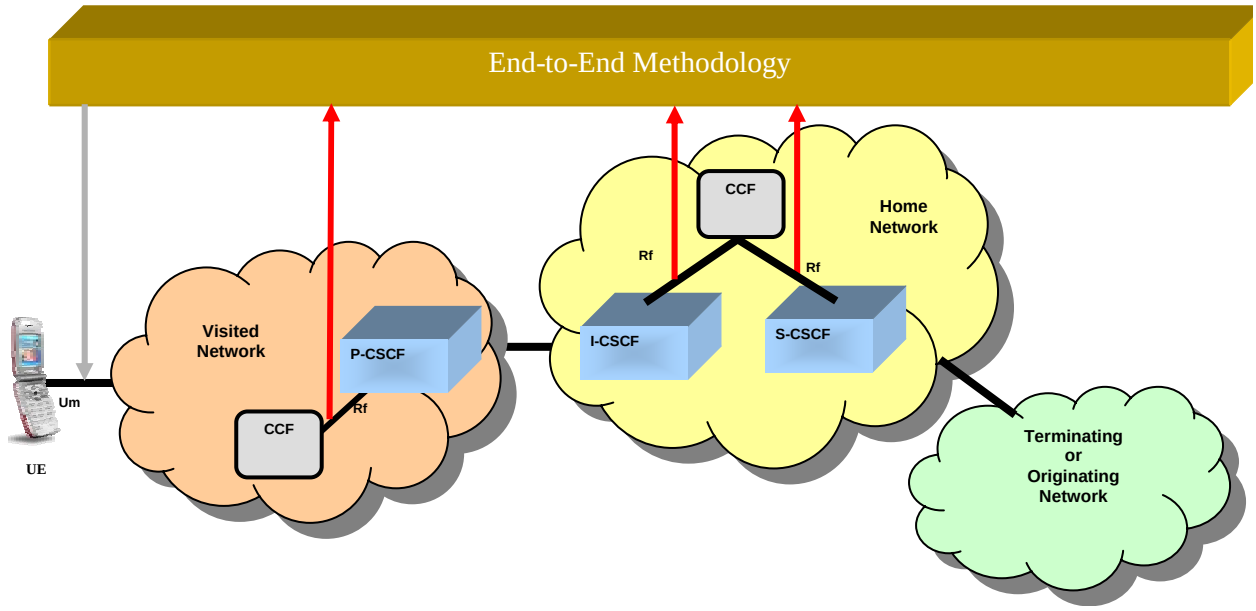

Figure 14: Configuration no. 10

To check the correctness of the CDRs generation and collection it is necessary to monitor the Rf interface between the CSCF entities and the CCF (Charging Collection Function).

History

Document history		
V1.1.1	April 2005	Publication