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SERIES Q: SWITCHING AND SIGNALLING

Testing specifications – Testing specifications for next generation networks

IMS/NGN performance benchmark – Part 1: Core concept

Recommendation ITU-T Q.3932.1

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Recommendation ITU-T Q.3932.1

IMS/NGN performance benchmark – Part 1: Core concept

Summary

Recommendation ITU-T Q.3932.1 provides the first part of a multi-part deliverable covering the IP multimedia subsystem (IMS)/next generation networks (NGN) performance benchmark, as identified below:

Part 1: Core concepts;

Part 2: Subsystem configurations and benchmarks;

Part 3: Traffic sets and traffic profiles;

Part 4: Reference load network quality parameters.

This Recommendation describes the performance benchmark methodology for the IMS based services multimedia telephony (MMTel), video telephony and IMS/PES. The terminology and concepts are described in Recommendation ITU-T Q.3930.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q.3932.1	2015-06-13	11	11.1002/1000/12495

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

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IMS/NGN Performance benchmark – Part 1: Core concept

1 Scope

Recommendation ITU-T Q.3932.1 provides the first part of a multi-part deliverable covering the IMS/NGN performance benchmark, as identified below:

Part 1: Core concepts;

Part 2: Subsystem configurations and benchmarks;

Part 3: Traffic sets and traffic profiles;

Part 4: Reference load network quality parameters.

The present Recommendation describes the performance benchmark methodology for the IMS based services MMTel, video telephony and IMS/PSTN emulation solution (PES). The terminology and concepts are described in [ITU-T Q.3930].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T P.56] Recommendation ITU-T P.56 (2011), *Objective measurement of active speech level*.

[ITU-T P.862] Recommendation ITU-T P.862 (2001), *Perceptual evaluation of speech quality (PESQ): An objective method for end-to-end speech quality assessment of narrow-band telephone networks and speech codecs*.

[ITU-T P.862.1] Recommendation ITU-T P.862.1 (2003), *Mapping function for transforming P.862 raw result scores to MOS-LQO*.

[ITU-T P.863] Recommendation ITU-T P.863 (2014), *Perceptual objective listening quality assessment*.

[ITU-T Q.3930] Recommendation ITU-T Q.3930 (2012), *Performance testing of distributed systems* – Concepts *and terminology.*

[ITU-T Q.3932.2] Recommendation ITU-T Q.3932.2 (2015), *IMS/NGN performance benchmark – Part 2: Subsystem configurations and benchmarks*.

[TS 101 563] ETSI TS 101 563 V.1.3.1 (2014), *Speech and multimedia Transmission Quality (STQ); IMS/PES/VoLTE exchange performance requirements*.

[TS 123 002] ETSI TS 123 002 (V11.6.0) (2013), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Network architecture (3GPP TS 23.002 version 11.6.0 Release 11).*

3 Definitions

3.1 Terms defined elsewhere

The IMS benchmarking definitions are described in [ITU-T Q.3930].

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 background load: Workload applied to a system under test (SUT) during a benchmark test, for the purpose of consuming SUT resources during a benchmark test and changing the traffic intensity at which the capacity of the SUT is reached.

3.2.2 benchmark report: Document generated at the conclusion of a test procedure containing the metrics measured during the execution of the test and/or computed from the data collected in the benchmark log.

3.2.3 benchmark test: Procedure by which a test system interacts with a system under test (SUT) to measure its behaviour and produce a benchmark report.

3.2.4 configuration: Specification of a subset of IMS/PES architectural elements and metrics for which collection of benchmark tests can be defined.

3.2.5 design objective (DO): Probabilistic model of delay and failure requirements for SUT, associated with a use case, specified by threshold values and probabilities for delay and scenario failure.

3.2.6 design objective capacity (DOC): Largest load a SUT can sustain while not exceeding design objectives (DOs) defined for a use case.

3.2.7 idle load: Load that is not dependent on the traffic or other external activities.

3.2.8 maximum capacity: maximum processor load that a processor can handle without rejecting new calls.

3.2.9 metric: Performance measurement of a system under test (SUT) reported in a benchmark report.

3.2.10 parameter: Attribute of a SUT, test system, system load, or traffic set whose value is set externally and prior to a benchmark test, and whose value affects the behaviour of the benchmark test.

3.2.11 processor load: Amount of time the processor executes work. It is normally expressed in percent.

NOTE – The processor load consists of idle load, traffic load and usage load.

3.2.12 reference call (RC): Basic ISDN user part (ISUP) to ISUP call connected through two media gateways (MGWs) in the same media gateway controller (MGC) domain.

3.2.13 session attempts per second (SAPS) increase amount: Increment by which the average SAPS changes between steps of a profile.

3.2.14 test parameters: Parameters whose values determine the behaviour of a benchmark test.

3.2.15 test procedure: Specification of the steps to be performed by a benchmark test.

3.2.16 test scenario: Specific path through a use case, whose implementation by a test system creates a system load.

3..217 test system: Collection of hardware and software which presents a system load to a system under test (SUT) and collects data on the SUT's performance, from which metrics can be computed.

3.2.18 traffic load: Load that results from handling traffic events that are directly related to calls.

NOTE – This load varies with the traffic intensity.

3.2.19 traffic-time profile: Evolution of the average scenario over a time interval.

3.2.20 traffic set: Mixture of traffic scenarios.

3.2.21 usage load: Load that is reserved for the administration's operation and maintenance activities during busy hour.

3.2.22 workload: Number of reference calls per second (RC/s).

NOTE – It is calculated by multiplying calls per second by its corresponding workload factor (WLF).

3.2.23 workload factor (WLF): Traffic load for different types of calls in relation to the traffic load of the reference call (ISUP call).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AGCF Access Gateway Control Function

BGCF Breakout Gateway Control Function

BYE BYE message

CN Core Network

CPU Central Processor Unit

CS Circuit Switched

CSCF Call Server Control Function

DO Design Objective

DOC Design Objective Capacity

ETH Ethernet

HSS Home Subscriber Server

FM Fault Management

IBCF Interconnection Border Control Function

II-NNI Inter-IMS Network to Network Interface

IM IP Multimedia

IMS IP Multimedia Subsystem

IP Internet Protocol

ISC IP multimedia Service Control

ISDN Integrated Service Digital Network

ISUP ISDN User Part

LCS Location Services

LRF Location Retrieval Function

MCS Modulation and Coding Scheme

MGC Media Gateway Controller

MGW Media Gateway

MHT Mean Holding Time

MME	Mobile Management Entity
MMTel	Multimedia Telephony
MRB	Media Resource Broker
MRF	Media Resource Function
MRFP	Media Resource Function Processor
NGN	Next Generation Networks
NNI	Network-to-Network Interface
PES	PSTN Emulation Solution
PESQ	Perceptual Evaluation of Speech Quality
POLQA	Perceptual Objective Listening Quality Assessment
POTS	Plain old telephone service
RC	Reference Call
RTP	Real-Time Protocol
SAPS	Session Attempts Per Second
S-CSCF	Serving CSCF
SIGTRAN	Steam Control Transmission Protocol
SIP	Session Initiation Protocol
SIP-I	a mapping from SIP to ISUP
SLF	Subscription Locator Function
SUA	SCCP-User Adaptation Layer
SUT	System Under Test
TA	Tones and Announcement
TDM	Time-division multiplexing
UDI	Unrestricted Digital Information
UDI/TA	Unrestricted Digital Information with tones and announcements
UE	User Equipment
VGW	Voice Gateway
WLF	Workload factor

5 Conventions

None.

6 Benchmark information model

In this clause, "benchmark information model" refers to the structure of the information elements that define the benchmark. This **information** model is depicted in Figure 1.

The information model consists of three primary elements: use cases, which describe the behaviour of an individual user, and which in turn define scenarios; benchmark tests, which generate a workload by aggregating the behaviour of individual scenarios in a controlled manner, and collect log files of measurements during the test; and benchmark test reports, which report metrics interpreted from the benchmark test log files.

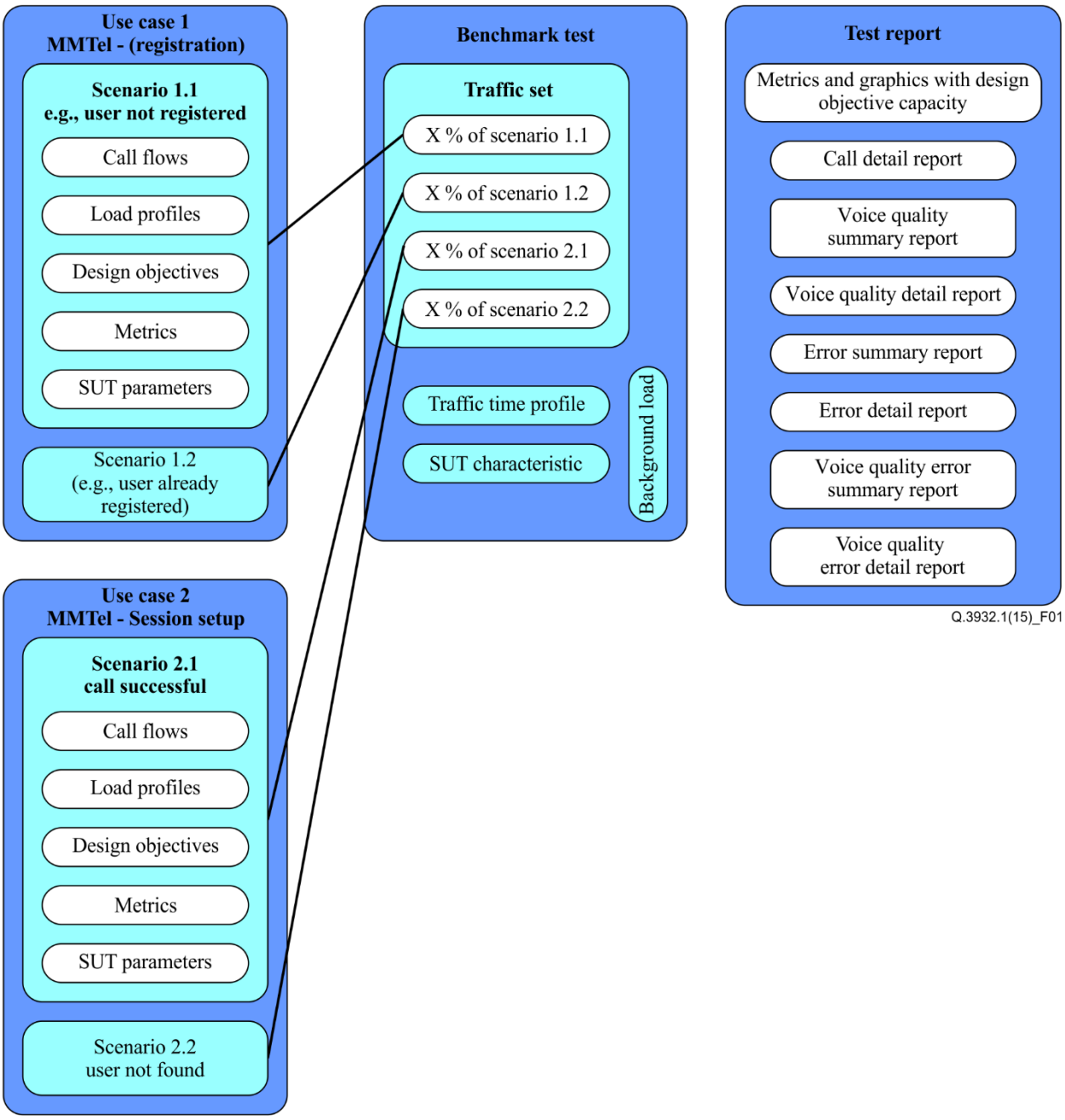


Figure 1 – IP multimedia subsystem (IMS) benchmark information model

6.1 Use case

The top level of the individual behavioural model is the use case. A use case describes: The goal that a user has in interacting with a system, the various actors (e.g., other users, network elements) that participate in the use case, the basic course of events that are carried out by the user and the SUT, the design objective (DO) of the use case, the possible outcomes that apply to the use case, and the metrics to be collected. The goal and actors of a use case are documented in narrative text and diagrams; the other elements are complex information elements, which are described in their respective clauses.

6.1.1 Call flow

The calls flows define the characteristic message flows, the tones and announcements (TAs) for a specific interface.

6.1.2 Load profile

To facilitate the calculation of processing capacity and the appropriate load profile, the concept of workload factor (WLF) has been defined based on the reference call (RC) for each combination of traffic case and traffic signalling interface. The RC is defined as a basic ISDN user part (ISUP) to ISUP call connected through two media gateways (MGWs) in the same domain.

Based on the WLFs for all different types of calls, the call intensities and the services used, one can express the total traffic load in an equivalent number of RCs per second.

The dimensioning of any type of network depends on a number of different parameters such as utilization per channel, calls per second, mean holding time (MHT), type of accesses being involved and type of services being requested.

6.1.3 Metrics

The metrics of a use case describe the measurements collected from the execution of a scenario attempt. Typical metrics include response times and message rates. If a scenario is selected for execution in a benchmark test, its metrics are collected. See clause 8 for more detail.

6.1.4 Use case outcomes

A use case outcome is a set of possible outcomes of the scenarios of a use case. An outcome may be simply "correct", it may reflect an error or failure condition, or it may reflect a correct behaviour that took an excessive amount of time to occur. An instance of a scenario that experiences an error, failure, or timeout outcome is referred to as an inadequately handled scenario attempt.

6.1.5 Scenarios and scenario attempts

A scenario is a trace of a path through a use case. It is analogous to "call attempt", but applies to all interactions within an IMS/PES network, different bearer and application interactions.

A scenario may succeed, fail, or succeed functionally.

The terms "scenario attempt" and "scenario attempts per second" are used in the present document in place of "call attempt" and "call attempts per second" because IMS is a transaction-oriented system with transactions of a variety of types traffic sets, and in the real world do not operate according to only one transaction type, so the more generalized term is necessary. It would be incorrect and misleading to attempt to report the capacity of a system in "call attempts per second", "registration attempts per second", etc., for system loads that were other than purely call attempts, registration attempts, etc.

6.1.6 Design objective (DO)

The DO describes the maximal acceptable rate handled scenario attempts for a use case.

6.1.7 Scenario

A scenario describes a single interaction sequence among the actors of a use case. It is documented by a set of preconditions on its actors (typically specified by parameter values). In the case of IMS/PES the scenario is defined as a set of different bearer capabilities (e.g., speech, 3.1 kHz audio, unrestricted digital information (UDI), unrestricted digital information with tones and announcements (UDI/TA)), services (fax, modem), or dial modes.

6.2 Benchmark test

A benchmark by definition measures the behaviour of a population of users. To accomplish this, the behaviours of individual users shall be aggregated into input traffic to the SUT. The input traffic shall be realistic, in the sense that a population of users would perform such actions in the real world, and in the sense that statistical variation in user behaviour is similar to statistical variation that would occur in the real world.

6.2.1 Traffic set

The traffic set is a collection of scenarios which are determined to be likely to co-occur in a real-world scenario. The scenarios do not need to come from the same use case. Within a traffic set, each scenario has an associated relative occurrence frequency, interpreted as the probability with which it would occur in the course of the test procedure.

6.2.2 Background load

Background load is a workload presented to the SUT in order to consume its resources. It may consist of a stream of traffic presented to the SUT by an external system apart from the test system; or it may be a workload presented to the processing elements, network, or storage subsystem of the SUT.

The purpose of background traffic is to make possible the measurement of a DOC in SUT when the capacity of the test system is insufficient to reach the DOC.

If a benchmark test is published in which background load is used, then the following requirements apply:

- the hardware used to generate the background load shall be fully specified. If the background load is generated by software running directly on the SUT, then the components of the SUT on which the background load is executed shall be fully specified;
- the software used to generate the background load shall be provided in source form, including makefiles and any other configuration files required to compile the software.

6.2.3 Traffic-time profile

The traffic-time profile is a function describing the average scenario attempt arrival rate as a function of elapsed time during a benchmark test. A traffic-time profile should be chosen in such a manner so that, for a given scenario attempt arrival rate, sufficient samples are generated that metrics can be collected with an appropriate confidence bound. The following call profiler traffic patterns are used today: saw tooth, blast, ramp, steady call rate, rolling blast and Poisson distribution. To get a realistic scenario, a combination of at least two scenarios is needed.

6.2.4 Test parameters

The benchmark test parameters are used to control the behaviour of the test script. The data elements required to configure the test system are listed in Table 1.

Table 1 is a non-exhaustive list of test parameters defined for the benchmark standard. The list is expected to grow over time, as additional subsystems and system configurations are developed.

Table 1 – Test parameters

Parameter	Description
Start time	Amount of time that a system load is presented to a SUT at the start of a test
Stop time	Amount of time that a system load is presented to a SUT at the end of a test

Table 1 – Test parameters

Parameter	Description
TotalProvisionedSubscribers	The number of simulated subscribers provisioned in the network
PercentSimulatedSubscriber	The average percentage of simulated subscribers
Simulated maximum simultaneous call legs	The number of simulated maximum simultaneous call legs
Traffic per subscriber	Traffic per subscriber; default value 0.1 Erlang
PX_PercentRegisteredSubscribers	The average percentage of simulated subscribers that are registered simultaneously
PX_PercentRoamingSubscribers	The average percentage of simulated subscribers that are roaming (i.e., registered in a non-local network)
PX_Simulated Subscriber Registration Parameters	Parameters and distributions of the probabilistic model of simulated subscriber operation
MHT	Mean holding time of a call; default value 110 seconds
Ringing time	Duration between (180 ringing and 200 OK INVITE) Default value 1-5 s
NoS	Number of subscribers originating traffic per subscriber
CAPS/BHCA	Call attempts per second/busy hour call attempts
WLF for call controller	The WLF for call controller for a specific configuration. Default value 1-3
WLF for gateway controller	The WLF for gateway controller for a specific configuration. Default value 1-3
WLF for MGW	The WLF for MGs for a specific configuration. Default value 1-3
Time-division multiplexing TDM trunks	Number of TDM trunks
Ethernet (ETH)	Number of ETH connections
Type of call	MMTel fixed access to MMTel fixed access
	Video telephony
	IMS/PES to IMS/PES
	MMTel fixed access to IMS/PES
Protocol call type and interfaces	SIP-I
	ISUP
	Steam control transmission protocol (SIGTRAN) (M2PA; M2UA; M3UA; SCCP-user adaptation layer (SUA))
	Session initiation protocol (SIP) inter-IMS network to network interface (II NNI) (Ici,Izi)
	SIP NNI (Mx Interface)
	Gm interface
MGCF/MGW/I-BCF/TrMGW performance tests	SIP-I to SIP-I
	SIP-I to ISUP
	SIP-I to network-to-network interface (NNI)
	NNI to NNI

Table 1 – Test parameters

Parameter	Description
	SIGTRAN to SIGTRAN (M2PA; M2UA; M3UA; SUA)
	ISUP (SIGTRAN) to NNI
Transport interfaces	Voice over LTE (VoLTE) (LTE-Uu, S1-U, S-11, S6a, S11, S5/S8, Rx, Gx, Mw, ISC and Ut interfaces)
	ETH
	xDSL
	Integrated services digital network (ISDN)
	Plain old telephone service (POTS) (Z)

6.3 Benchmark report

A test report is a document, with accompanying data files, that provides a full description of an execution of a benchmark test on a test system. The SUT and test system, as well as their parameters, are described in sufficient detail that an independent test site can replicate the test. The results of the test include: Data, represented as charts and data sets, depicting the behaviour of the SUT over the elapsed time of the test; reports of the relevant metrics that are conventionally used to compare benchmark results of differing SUTs; and a full description of other observations and exceptions noted during the test.

7 System under test (SUT)

The IMS performance benchmark covers benchmark tests for the video telephony and multimedia telephony (MMTel) fixed access – IMS/PES.

Figure 2 depicts the IMS reference architecture. The components of the architecture are the primary building blocks, which are either defined by the IMS standard, or defined by external standards and referenced by the IMS. The links between the primary building blocks represent reference points over which the building blocks communicate with each other.

The reference architecture is a logical architecture; no mapping of functional elements to hardware or software components is mandated. And conversely, IMS products as deployed in the real world do not factor neatly into the elements of the reference architecture, which complicates the process of comparing similar products with a benchmark.

The problem can be simplified by observing that there are classes of products which have common subsets of reference architecture elements. For classes defined in this manner, common sets of benchmarks can be defined. The classes defined in this manner are called IMSs, or simply subsystems, and are expected to grow over time, as the IMS marketplace becomes richer.

[ITU-T Q.3932.2], which is part of this multi-part deliverable, maintains a list and description of subsystems.

In order to proceed from a subsystem description to a benchmark test, a complete description of all aspects of the subsystem relevant to the performance of the benchmark shall be present; this is referred to as the system configuration, or SUT configuration. This description starts with an enumeration of the elements of the reference architecture and an enumeration of all reference points that are external to the subsystem (i.e., reference points between elements within the subsystem are "internal"). However, the configuration requires a specification of the hardware elements (e.g., servers, central processor units (CPUs), network configuration and bandwidth) and software elements (e.g., operating system, database system), because even though the metrics reported by the benchmark tests are

measured with respect to such metrics as total round-trip delay of messages and system capacity, the behaviour of IMSs is still an area of study and a thorough understanding of how CPU and network bandwidth utilization behaves during operation is of interest.

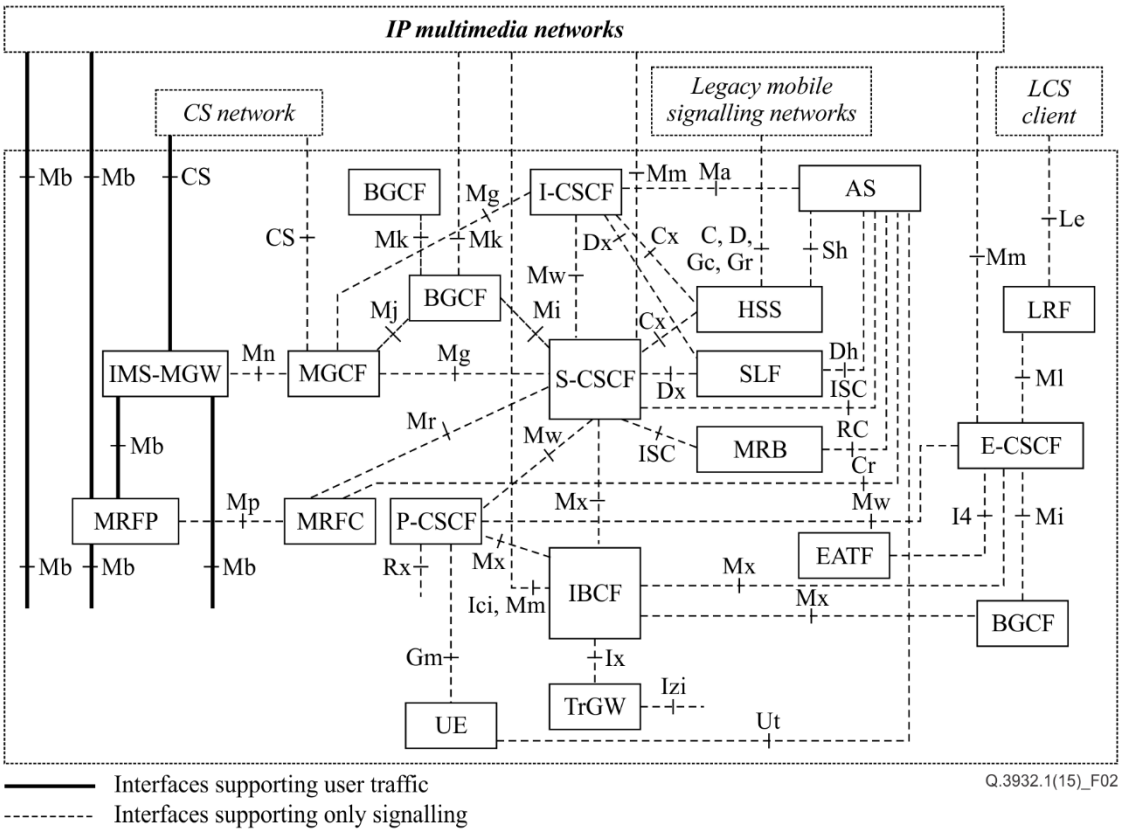
Figure 3 depicts the II NNI between two IP multimedia

(IM) core network (CN) subsystem networks.

Figure 4 depicts the IMS/LTE basic configuration.

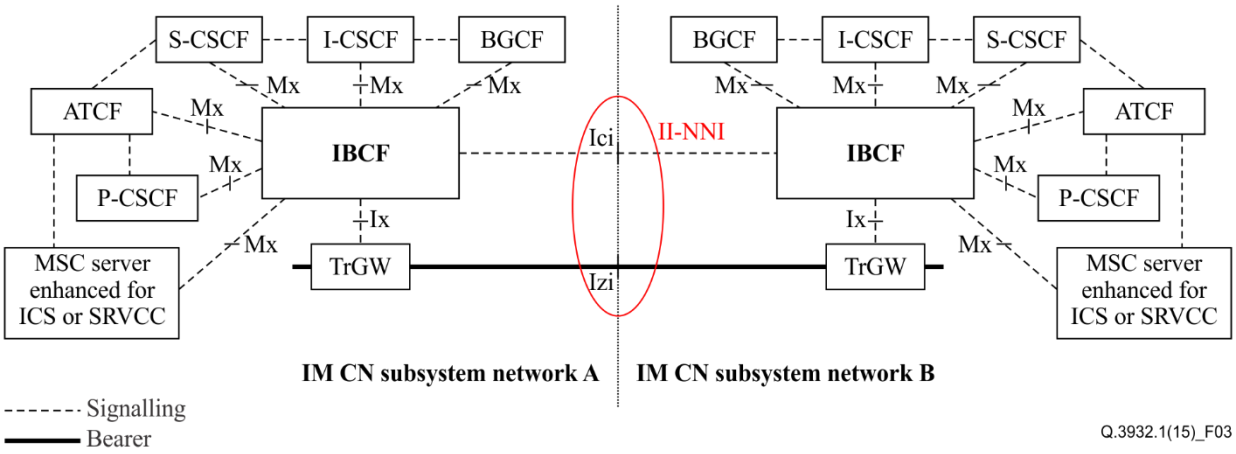
Figure 5 depicts the LTE end-to-end configuration.

Figure 6 depicts the access gateway control function (AGCF)/voice gateway (VGW) session processing model for IMS PES.



NOTE 1: The reference point CS (Circuit Switched) is not specified in the present document.
NOTE 2: The reference point I5 is not shown in this figure.

Figure 2 – Overview of IMS functional entities [ETSI TS 123 002]



NOTE: Interface (II-NNI) between two IM CN subsystem networks.

Figure 3 –II NNI between two IM CN subsystem networks

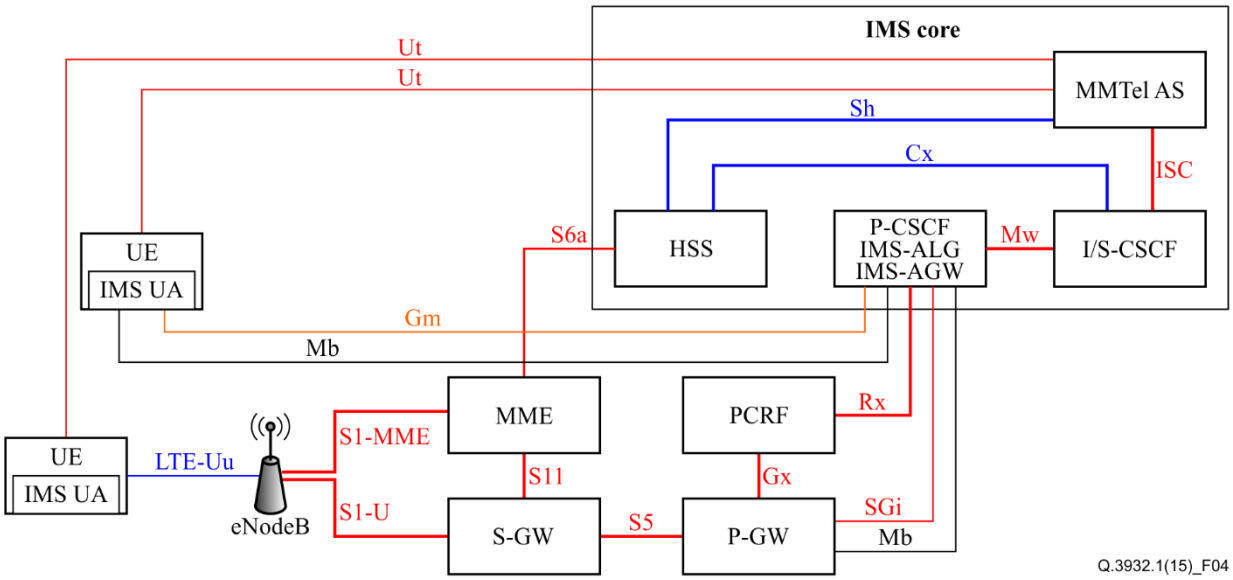


Figure 4 – IMS/LTE basic configuration

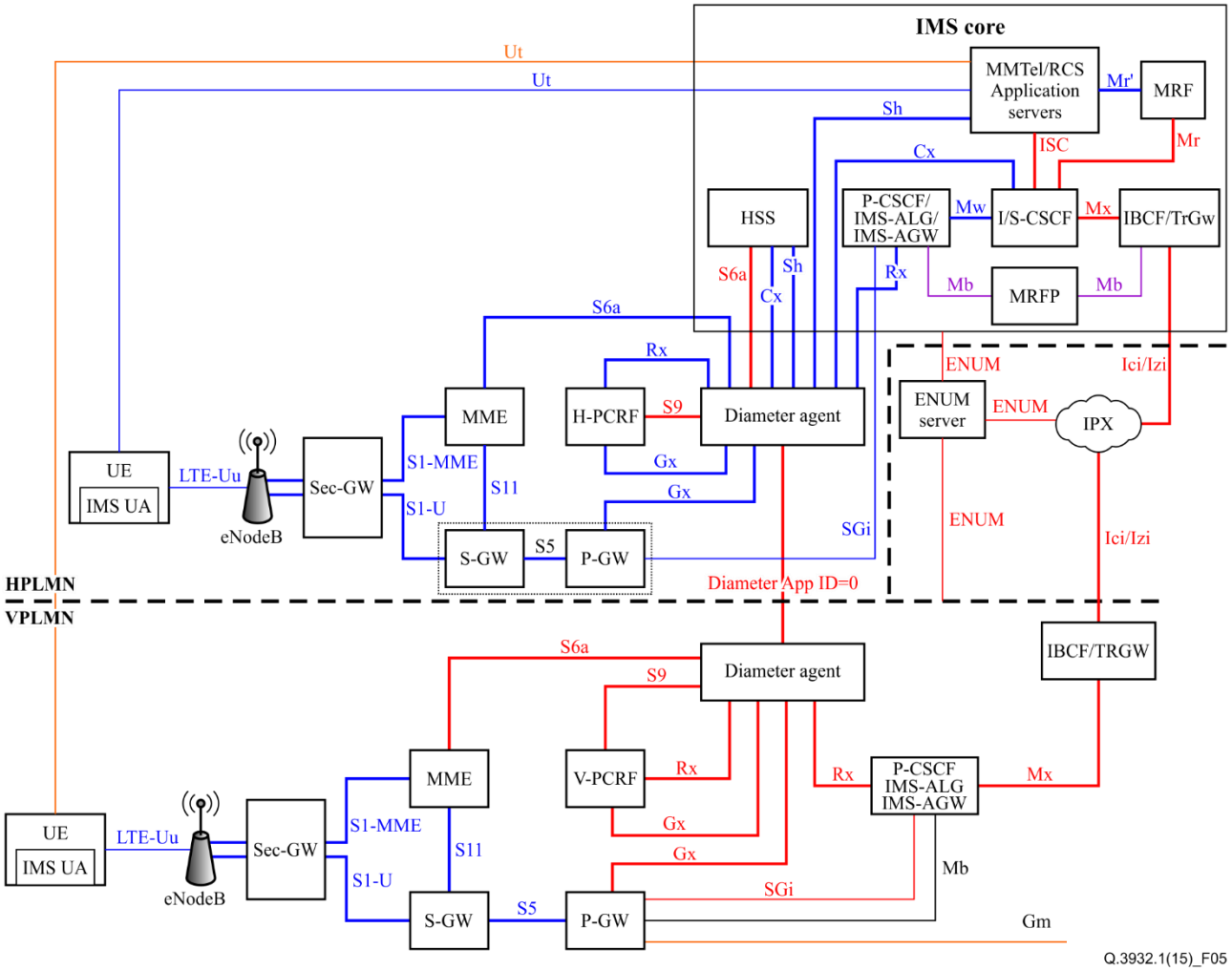


Figure 5 – LTE end-to-end configuration

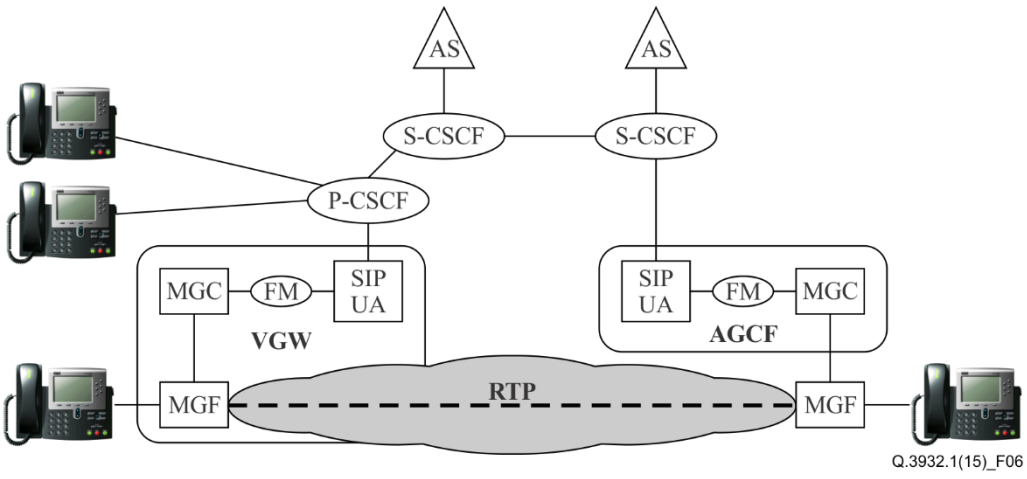


Figure 6 – AGCF/VGW session processing models

Creation of subscriber database

The subscriber database is the data set required to configure the SUT in order to execute a benchmark test. Using the same data, the test system should be able to generate correct traffic.

The present document does not try to specify a complete set, but rather just the subset that will ensure comparable results. All other provisioning information required for correct configuration of a SUT is to be set at the discretion of the SUT provider.

One requirement for a fair benchmark is that the input data is similar for all test-runs. In order for this to happen we have two choices:

a) provide a database for the subscriber base. However, because we have to ensure scalability for the benchmark, this solution is not feasible;

b) provide rules to generate this data and data generators. Algorithms using random generators will be avoided for data that could possibly influence the results.

8 Test system

The test system is used to generate the appropriate load on the SUT. The present document does not mandate any specific test system to be used, although the details of the test system shall be reported in the benchmark report.

The test system should have two main functions:

- traffic generation: the test system shall be able to execute use cases' scenarios following the traffic-time profile. It shall also be able to reproduce the appropriate traffic set (a mix of scenarios with a weight for each of them);
- network emulation: optionally, network characteristics on the different interfaces should be emulated by the test system.

9 Benchmark metrics examples

The metrics reported by a benchmark test are measured in real time during the execution of the test, or may be computed after completion of the test from event logs collected during the execution. Enclosed is a benchmark matrix based on [ETSI TS 101 563].

Table 2 – Benchmark metrics examples

Delay parameters	Description
Call request delay	Call request delay is defined as the interval from the instant at which the INVITE message has been received from the SIP subscriber until the 100 Trying from the SBC/P-CSCF is passed back to the subscriber
Alerting sending	Call request delay is defined as the interval from the instant at which the 180 Ringing is received from the terminating subscriber until the 180 Ringing is passed back to the originating subscriber
Call set up delay	The time interval starts when the digit collection function determines that the address information received in the INFO or subsequent INVITE message is sufficient for session initiation, and ends when the INVITE message on the Ic or terminating Gm interface has been sent
Through connection delay	The through connection delay is defined as the interval from the instant that the 200 OK message is received from the called user at the terminating Gm interface until the through connection is established and available for carrying traffic and the 200 OK message has been sent to the calling user on the originating Gm interface
Connection release delay	Connection release delay is defined as the interval from the instant when a BYE message (BYE) is received at the originating or terminating Gm interface until the instant when 200 OK is sent and a corresponding BYE is sent at the terminating or originating Gm interface respectively
Speech quality analysis	
Speech quality	[ITU-T P.862] and [ITU-T P.862.1]
	[ITU-T P.863]
Speech level – active level	[ITU-T P.56]
Speech level – peak	
Speech level – noise	
Speech level – signal to interval noise	

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