ETSI TS 102 250-3 V1.2.1 (2004-03)

Technical Specification

Speech Processing, Transmission and Quality Aspects (STQ); QoS aspects for popular services in GSM and 3G networks; Part 3: Typical procedures for Quality of Service measurement equipment

ETSI

Reference

RTS/STQ-00054

Keywords

3G, GSM, network, QoS, service, speech

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Speech Processing, Transmission and Quality Aspects (STQ).

The present document is part 3 of a multi-part deliverable covering the QoS aspects for popular services in GSM and 3G networks, as identified below:

Part 1:   "Identification of Quality of Service aspects";

Part 2:   "Definition of Quality of Service parameters and their computation";

Part 3:   "Typical procedures for Quality of Service measurement equipment";

Part 4:   "Requirements for Quality of Service measurement equipment";

Part 5:   "Definition of typical measurement profiles";

Part 6:   "Post processing and statistical methods".

Part 1 identifies QoS aspects for popular services in GSM and 3G networks. For each service chosen QoS indicators are listed. They are considered to be suitable for the quantitatively characterization of the dominant technical QoS aspects as experienced from the end-customer perspective.

Part 2 defines QoS parameters and their computation for popular services in GSM and 3G networks. The technical QoS indicators, listed in part 1, are the basis for the parameter set chosen. The parameter definition is split into two parts: the abstract definition and the generic description of the measurement method with the respective trigger points. Only measurement methods not dependent on any infrastructure provided are described in the present document. The harmonized definitions given in the present document are considered as the prerequisites for comparison of QoS measurements and measurement results.

Part 3 describes typical procedures used for QoS measurements over GSM, along with settings and parameters for such measurements.

Part 4 defines the minimum requirements of QoS measurement equipment for GSM and 3G networks in the way that the values and trigger-points needed to compute the QoS parameter as defined in part 2 can be measured following the procedures defined in part 3. Test-equipment fulfilling the specified minimum requirements, will allow to perform the proposed measurements in a reliable and reproducible way.

Part 5 specifies test profiles which are required to enable benchmarking of different GSM or 3G networks both within and outside national boundaries. It is necessary to have these profiles so that when a specific set of tests are carried out then customers are comparing "like for like" performance.

Part 6 describes procedures to be used for statistical calculations in the field of QoS measurement of GSM and 3G networks using probing systems.

Introduction

All the defined quality of service parameters and their computations are based on field measurements. That indicates that the measurements were made from customers point of view (full End-to-end perspective, taking into account the needs of testing).

It is assumed that the end customer can handle his mobile and the services he wants to use (operability is not evaluated at this time). For the purpose of measurement it is assumed that:

- the service is available and not barred for any reason;

- routing is defined correctly without errors; and

- the target subscriber equipment is ready to answer the call.

Voice quality values measured should only be employed by calls ended successfully for statistical analysis.

However, measured values from calls ended unsuccessfully (e.g. dropped) should be available for additional evaluations and therefore, must be stored.

Further preconditions may apply when reasonable.

1 Scope

The present document describes typical procedures used for QoS measurements on mobile communication networks, e.g. GSM or UMTS, along with settings and parameters for such measurements.

Where possible existing ITU-T or ETSI definition are referenced. In some cases ITU-T or ETSI definitions do not exist or are considered as too generic, then a more service and mobile network specific definition is chosen.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

[1]   ITU-T Recommendation P.56: "Objective measurement of active speech level".

[2]   ETSI TS 102 250-1: "Speech Processing, Transmission and Quality Aspects (STQ); QoS aspects for popular services in GSM and 3G networks; Part 1: Identification of Quality of Service aspects".

3 Abbreviations

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

APN	Access Point Name
DND	Do Not Disturb
DNS	Domain Name Server
FTP	File Transfer Protocol
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
HTTP	Hyper Text Transfer Protocol
IP	Internet Protocol
MO	Mobile Originated
MOS	Mean Opinion Score
MT	Mobile Terminated
MTU	Maximum Transmission Unit
PABX	Private Automatic Branch eXchange
PC	Personal Computer
PDP	Packet Data Protocol
PDU	Packet Data Unit
POP3	Post Office Protocol version 3
QoS	Quality of Service
SMPT	Simple Mail Protocol Transfer
SMS	Short Message Service
SMSC	Short Message Service Centre
TCP/IP	Transmission Control Protocol/Internet Protocol
UDP	User Datagram Protocol
URL	Uniform Resource Locator
WAP	Wireless Application Protocol

4   Goal of measurement

The goal of measurements described in the present document is to assess the network under test for its quality parameters as defined in TS 102 250-1 [2]. This is, to determine the network quality for the respective transactions from subscribers view.

5   General aspects for all types of services

5.1   Set-up and control

Measurements should be conducted in a way that user behaviour is emulated, with a number of parameters under control of the measurement equipment.

The test case design (configuration and user profile) - to the degree necessary to fully reproduce the test - shall be part of the report.

It is assumed that for all types of services under test, a testcase consists of a number of single identical transactions. The measurement equipment and control must ensure that the starting conditions are the same for each transaction. This includes, among other things, that pause times are sufficiently long that the equipment is in a stable (idle) state again. The parameter "guard time" sets a minimum value for the pause between transactions.

It is assumed that the measurement is performed by a mobile measurement unit; depending on type of measurement, other equipment connected to the fixed network is added.

6   Telephony measurements

6.1   General aspects

Void.

6.2   Speech telephony

Void.

6.3   Video telephony

6.3.1   Measurement set-up and control

The basic transaction for speech testing is equivalent to a single call to a counterpart extension.

To ensure comparability and statistical validity of transactions, the following outer conditions need to be constant throughout a test case:

- Call counterpart: This includes the type of equipment (dedicated unit, automatic reply with taped message, etc.). It is assumed that the call partner is typically a fixed-network type extension to avoid uncertainties related to a second mobile connection.

- Call timing including behaviour in case of dropped calls: For reasons of comparability in density, it is required that all call attempts which form part of the statistics must follow a constant time pattern. Additional call attempts must not affect the pattern of the statistically relevant call attempts (see figure 1).
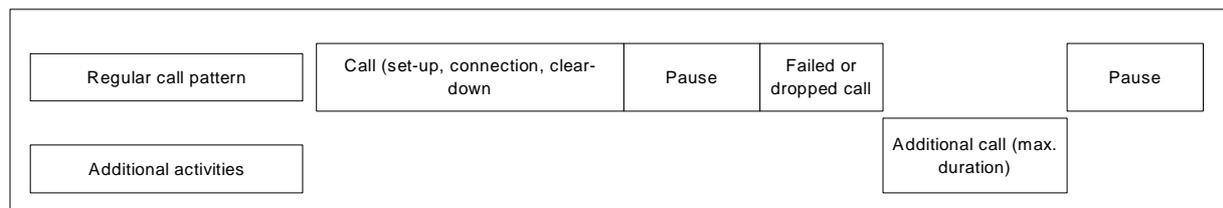
Regular call pattern	Call (set-up, connection, clear-down	Pause	Failed or dropped call		Pause
Additional activities				Additional call (max. duration)	

Figure 1

Figure 2 shows the overall structure and set of parameters as an overview.

Test Case

Repeat	Control	Call type Time-out setting	Audio data flow	Dropped Call behaviour	
	Parameters	Call number Codec settings	Call Duration		Guard time
	Sequence	**Call set-up**	**Call Connect**	**Call clear-down**	**Pause**
	QoS Values	Network accessibility Service Accessibility Set-up time	Speech Quality and audio verification	Call Completion Rate	
	[Other values]	e.g. Signalling pattern	e.g. (GSM) RxQual, FER	e.g. Signalling pattern	

Figure 2

The measurement equipment and control must ensure that the starting conditions are the same for each individual transaction. This includes, among other things, that pause times are sufficiently long that the corresponding call has been cleared down completely and that the equipment is in a stable (idle) state again. The parameter "guard time" sets a minimum value for the pause between calls.

Clause 6.1.1 discusses the call transaction structure in more detail.

6.3.2   Call Types

The call type is either Mobile Originated (MO) or Mobile Terminated (MT).

Basically, it is assumed that once a connection has been established, for further measurements it does not matter which side has triggered it. Therefore, the audio data flow parameter will not be logically linked to the call type.

6.3.3   Call transaction phases
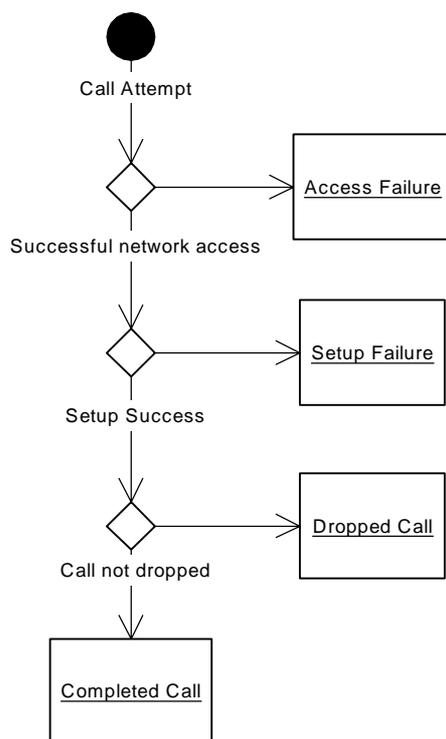
6.3.3.1   Call set-up

For call set-up assessment beyond QoS data acquisition, typically a state model driven by Layer 3 information combined with information from the call control engine is being used. This state model may also be used to determine timing information for each phase.

A typical state model allows for more detailed information about the outcome of a call attempt. The following terms are defined:

- Access Failure: Network access failed.

- Setup Failure: Network access was reached, but the call did not reach the state of an usable two-way end-to-end connection. This shall be verified by a procedure based on audio test transmissions within a given time window. If within this time window no audio connection can be verified, the setup attempt shall be considered to be failed and the call attempt be terminated.

A call attempt which leads to an usable connection is termed an Setup Success. Call setup times shall, however, be determined from the logical event indicating a connection so the connection-verification method will not influence the measurement.

This leads to the following decision tree for the outcome of a call (figure 3 includes the end-of-call cases).

Figure 3

The following QoS objects are determined from the call set-up phase.

6.3.3.1.1 Service accessibility

This is a "try/success" counter type object. A try is recorded when a call attempt has been made. A success is recorded when a Setup Success is detected.

6.3.3.1.2 Setup time

This is a "time" type object. Start corresponds to the respective "try" trigger point of the Service Accessibility object (see clause 6.1.2.1.1). Stop trigger point is set by the event indicating logical connection.

6.3.3.2 Call connect

The call connect phase starts when the connection has been established fully, defined by the success condition of call set-up.

Audio flow direction is an inner parameter for a transaction. Basically, all combinations of uplink/downlink dynamics are possible:

- Uplink only.

- Downlink only.

- Conversational (alternating uplink and downlink). This is the recommended standard testing mode. Other testing modes are considered to be used only for special purposes.

- "Duplex" (uplink and downlink audio simultaneously).

Only calls with a valid two-way end-to-end audio connection shall be considered for speech quality assessment (valid calls). To make sure an audio connection is valid, it is assumed that an appropriate kind of data analysis on audio flow is performed (see ITU-T Recommendation P.56 [1]).

A non-valid call shall be treated like a dropped call, with a modifier indicating this particular cause.

The following QoS objects are determined from the call connect phase.

6.3.3.2.1 Speech quality

For speech quality assessment, data is generated at the receiving end. For downlink speech, data storage is therefore straightforward; speech assessment data is simply included with other data items making up the result file. For uplink speech, at some point in time results have to be integrated with the rest of the data.

For assessing speech quality of complete transmitted speech samples, at least the following methods are possible:

- real-time assessment (streaming mode), where the speech quality assessment algorithm continuously outputs MOS data items;

- "offline" assessment, where speech is first recorded in some way and later being processed.

Data processing must make sure that only such speech quality data is used which lies inside the "connection active" time window and is in line with one of the two different speech quality parameters.

6.3.3.2.2 Call completion rate

A call is considered to be completed when it is active until the measurement equipment actively ends it.

A call which ends prematurely is termed a dropped call.

A call is active only as long as both sides consider it to be active. A call is therefore considered to be dropped if either side detects a dropped call.

The call completion rate is computed as a try/success type object, where a try is recorded upon Setup Success, and a call success is counted when the measurement unit determines that the call has not dropped.

6.3.3.3 Call clear-down

The call clear-down phase is the transition between the connected state and the idle state. No QoS parameters referring to call clear-down have been defined. Typically, measurement equipment will, however, record Layer 3 sequences which can be used to determine specific information about clear-down.

6.3.3.4 Pause

This phase is intended to give the mobile and the network time to reach its neutral state again, so the next transaction starts having the same conditions as the one before. For current GSM equipment, a pause time of at least 15 s (guard time) is recommended.

However, this duration may be adjusted to local conditions or special testing goals, but this must be reported.

If the pause duration is too short, side effects may occur, resulting in all kinds of transient effects and distortions in measurement data. It should be made certain that all the QoS parameters to be measured are not affected by the pause time.

7 SMS measurements

7.1 General aspects

7.1.1 SMS

Void.

7.1.2 General aspects of SMS measurement

The basic transaction for SMS testing is equivalent to transmission of a single SMS.

Typically, user SMS are being sent either from some fixed-network source to a mobile (SMS mobile terminated, SMS-MT), or from one mobile to another (SMS mobile originated, SMS MO, with regard to mobile-based testing). However, uplink SMS testing with a two-mobile setup may cause additional uncertainty due to coverage and signalling effects in the destination mobile. Basically, there are two recommended methods of testing:

a) using a destination mobile in a fixed location with virtually 100 % transfer probability. Part of the measurement procedure should be cyclical reference checks to assure reception quality respectively to create baseline data; or

b) using a fixed-network destination such as a large account SMS server which is accessed by suitable means from a fixed-network location.

In all cases, testing methodology requires that measurement data are being collected in at least two locations and need to be integrated before the final QoS evaluation can be made.

There are two modes form SMS transmission:

a) text mode;

b) PDU mode.

Basically, these modes should be equivalent including options available. In practice, mode support are mobile-dependent.

For each SMS, a "lifetime" can be set after which a SMS is deleted in the SMSC. While in PDU mode, this parameter is part of the parameter structure, in text mode it is set in the mobile, which may not be supported by all mobile types. This leads to the recommendation that PDU mode should be used.

To ensure comparability and statistical validity of transactions, the following outer conditions need to be constant throughout a test case:

- SMS mode.

- Call counterpart.

- SMSC being used.

- Call timing including behaviour in case of delivery failure to the network.

For reasons of comparability in density, it is required that all SMS sending attempts which form part of the statistics must follow a constant time pattern. Additional SMS sending attempts e.g. in the case of failure of delivery to the network must not affect the pattern of the statistically relevant call attempts.

SMS being sent from either side should contain information enabling validity and integrity checking during evaluation. The recommended minimum set includes:

- signature assuring that only test system SMS are being considered;

- sequence number for SMS delivery timing.

If required, a test SMS may contain additional data (padding) to obtain SMS with a length assumed to be typical for a particular network.

Proposed: If required, more powerful means of ensuring that only SMS generated by the test system can be added. For example, the SMS may contain a code which is created from checksum content and a seed value delivered by the receiving side. This ensures that even if a static signature is duplicated by operational errors or malfunction of other test systems, the system will be robust against it.

Further for general design of SMS testing, communication between the mobile testing system and its stationary counterpart is required to ensure certain starting conditions:

- Prior to actual testing, the SMS storage of the MS should be cleared to exclude SMS delivery failure due to memory shortage.

- The stationary side should start sending SMS only after a "go" from the mobile side, ensuring that no transient effects occur.

Since SMS is a store-and-forward service, SMS loss rate needs precise definition. From the user's point of view, there is expectation that a SMS is delivered within a certain time window. Even if technically an outstanding SMS may be delivered later, it should be considered lost anyway. This leads to the problem of over-aged SMS which may disturb subsequent measurements. Suitable means of eliminating such effects should be taken, e.g. setting a reasonable SMS lifetime, and using unique sequence numbering in a way to prevent aforementioned effects.

7.2   Testing modes

7.2.1   SMS-MT

7.2.1.1   Event flow

For this type of testing, SMS are being generated at a constant rate by the stationary side.

All SMS received which have not been generated by the stationary side shall be ignored for quality assessment.

For reception behaviour, two modes exist; it is mobile-dependent which modes are supported.

a)   On SMS reception, the mobile generates an indication message (CMTI message) on its data connection to the PC. The actual SMS can then be requested by a command.

b)   The mobile outputs the SMS directly on its data connection to the PC.

From control and trigger point accuracy considerations, mode a) is preferred.

7.2.1.2   Specific QoS objects

- Network accessibility.

- SMS delivery time to network.

7.2.2   SMS-MO

7.2.2.1   Event flow

For this type of testing, SMS are being generated at a constant rate by the mobile side, plus eventual extra SMS in case of failure of delivery to the network.

7.2.2.2   Specific QoS objects

SMS acquisition time (from paging to getting the SMS).

7.3   Common QoS objects

These objects are being determined for MO and MT, but need to be treated "by direction" anyway.

SMS end-to-end delivery time.

SMS fail rate (lost SMS with respect to a given time window).

SMS duplicate rate.

Probability that a SMS has more than zero bit errors (assuming the worst case, i.e. that even a single bit error makes the SMS useless for the subscriber).

Probability that SMS are being received which have been sent by others (during our tests, we found that such effects exist; this surely needs some discussion).

7.3.1   MMS

Void.

8   Data measurements

In the following clauses, data measurements for internet-related services are described. While process of obtaining a connection is different between Circuit-switched and Packet-switched access, there are many similarities for the actual data transfer phase.

8.1   Common aspects

8.1.1   Target for data access

The following categories of servers are distinguished, it is assumed that data service access is made to a server or entity within the general internet domain:

- Third-party content in the public internet. We will term this type of counterpart A-Servers.

- Accounts on internet servers which are under control of the testing system or under control of testing personnel (e.g. web domains assigned for testing purposes). This type of counterpart shall be termed B-Servers.

- Special servers not reachable via public internet (e.g. in the GGSN domain), or equipped with additional instrumentation e.g. for IP-level tracing or non-internet capabilities (e.g. UDP testing). This type of counterpart shall be termed C-Servers.

Access to a particular type of server will be termed using the same letter, e.g. A-access for access to an A-server.

It is assumed that A-servers are generally outside the sphere of control of testing systems, in particular, no baseline information for load or other conditions is obtainable. In case of B-servers and C-servers, such control may exist, but will typically be limited in some way due to IP-security reasons, in particular if IP access occurs intra-network.

Typically, when testing internet services, availability may depend on influences other than those under test, and performance will be affected by third-party traffic. Meaningful tests therefore shall contain appropriate measures to exclude such effects from QoS assessment, or make sure that all networks under test are affected the same way. It is assumed that such tests are performed by fixed network units. Suggested methods are:

- Cyclical availability checks on target servers or domains.

- Cyclical access-time tests.

It is assumed that for services where login is required, accounts used by the test system are valid, give positive login, and are good for full access to all activities forming the test.

   NOTE: This covers read/write privileges and directory-access rights e.g. for FTP).

User's point of view typically includes assumptions of a time the user is ready to wait before an action is considered to be failed. At the same time, IP service access typically goes with timeout windows at several levels., e.g. for in activity over a certain period of time. Test design must combine these two aspects to a reasonable, technically feasible set of parameters.

8.1.2   Test data content

When using web content (web sites or single pages) for testing, it must be taken into account that such content will typically change frequently (e.g. content of popular web portals) and therefore performance tests may give varying results over time. Test design must ensure that such effects are excluded from QoS assessment. Preferably, standardized and constant web content shall be used.

The degree of control a testing system has further depends on the type of service.

With E-Mail and FTP (assuming appropriate access privileges), data content can be determined exactly (e.g. by uploading files to be downloaded as part of subsequent tests.

8.1.3   Outer conditions to be kept constant for testing

To ensure comparability and statistical validity of transactions, the following outer conditions need to be constant throughout a test case:

- DNS used (by network).

- APN and other initial settings.

- Target URL, or server IP address.

- Account being used (where appropriate).

Access timing including behaviour in case of failure to obtain IP access. For reasons of comparability in density, it is required that all access attempts which form part of the statistics must follow a constant time pattern. Additional attempts e.g. in the case of network or service unavailability must not affect the pattern of the statistically relevant access attempts.

Further for general design, the following service-dependent measures shall be taken:

- FTP: For download tests, it must be assured that the file to be downloaded is actually available on the server. For upload tests, it must be assured that no storage-size limitations prevent successful upload.

- E-Mail: Proper authentication must be assured. For download tests, it must be assured that the mails to form download traffic are actually present on the server. For upload tests, it must be assured that no storage-size limitations prevent successful upload.

8.1.4   Definition of transaction

The basic transaction for data services testing consists of network access followed by a single data transaction such as:

- downloading or uploading a single FTP file of given size;

- downloading a web site for a given URL response of given structure;

- downloading or uploading a given number of e-mails of given size.

It is understood that basic access procedures such as server login shall not be considered as part of a transaction.

8.1.5   Assessing transactions

From user's perspective, outcome of a transaction can either be:

- Success: The intended transaction has been completed.

- Session loss: Network or IP connection has been lost before completing the transaction.

In case of session loss, the testing system shall indicate which of the possible principal causes occurred for the purpose of deciding of the network under test is to be blamed or not:

- Loss of radio connection.

- Loss of basic IP connection. If DNS access is still possible after a session loss, it is assumed that basic IP connection is still intact.

- Loss of internet access: If access to another domain or server is still possible, it shall be assumed that basic internet.

- Loss of connection to the server.

8.2   Circuit switched

A typical CSD data access consists of the following phases:

Connection set-up	Session access	DNS access	Domain access	Data transfer

Connection set-up: Setting up the basic network dial-up connection. Successful connection set-up results in a network connection usable for service access.

Session access: Access and authentication procedure for basic internet access. Successful access is assumed when a temporary IP address good for data transactions has been assigned to the testing system.

DNS access: Obtaining an IP address from a URL (web site name, server name). Successful DNS access is assumed when an IP address has been obtained from a given, valid URL.

Domain access: This is the actual internet access as seen from the user's perspective. For testing purposes, a successful domain access can be assumed when communication with the target server has been proved. The respective action will depend on the service under test.

Data transfer: In this phase, actual user-data flow occurs (file or mail upload or download). Depending on service, there may be several repetitions of domain access-data transfer phases.

8.3 Packet switched (GPRS)

A typical CSD data access consists of the following phases:

Network access	Session access	DNS access	Domain access	Data transfer

Network access: Obtaining basic network access ability. In GPRS, this is the Attach to the network.

Session access: Access and authentication procedure for basic internet access. Successful access is assumed when a useful PDP context (with IP address other than 0.0.0.0) has been assigned by the network.

DNS access: Obtaining an IP address from a URL (web site name, server name). Successful DNS access is assumed when an IP address has been obtained from a given, valid URL.

Domain access: This is the actual internet access as seen from the user's perspective. For testing purposes, a successful domain access can be assumed when communication with the target server has been proved. The respective action will depend on the service under test.

Data transfer: In this phase, actual user-data flow occurs (file or mail upload or download). Depending on service, there may be several repetitions of domain access-data transfer phases.

Typically, in GPRS longer periods of inactivity can occur with the session still intact. On the other hand, it must be taken into account that a useful PDP context is indicated by the system, which is in fact not useful. Therefore, testing shall include cyclical "lifecheck" measures. A possible method are ICMP pings to the DNS, not if such pings are blocked by the network, DND accesses with dummy URL. Due to possible URL/IP address storage, it must be assured that actual DNS access takes place.

9 Information to be logged for reproducibility of measurements

The following information elements need to be logged in order to ensure reproducibility and comparability of tests.

9.1 Speech measurements

- Call counterpart type (e.g. public telephone network, PABX).

9.2 SMS measurements

- SMSC used.

- Notification mode used for incoming SMS.

9.3 Data measurements

- Operating system (type and version).

- MTU size.

- Logical location of server (public internet, GGSN, etc.) with respect to effects possibly created by other traffic.

- Maximum server throughput inbound and outbound, per session response per connection.

- Type of access (IP address vs. URL).

- DNS used.

9.3.1   HTTP

- Type of browser used (including version number/build). For test-system browsers, maximum number of parallel socket connections.

- Reference web site used (structure, size of documents etc.).

9.3.2   FTP

- Type of FTP client used.

- Protocol used (TCP/IP or UDP).

9.3.3   E-mail (SMPT/POP3)

- Type of e-mail client used (including version number/build). For test-system clients, maximum number of parallel socket connections.

- Authentication mode used.

9.3.4   WAP

- Gateway.

- Type of access (text, binary connection-oriented, binary connectionless).

9.3.5   UDP

- Block size uplink/downlink.

- Stream rate uplink/downlink.

History

Document history		
V1.1.1	October 2003	Publication
V1.2.1	March 2004	Publication