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(3GPP TS 32.404 version 13.0.0 Release 13)

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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

The present document is part of a TS-family covering the 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Telecommunication management; as identified below:

32.401	Performance Management (PM); Concept and requirements
52.402	Performance Management (PM); Performance measurements – GSM
32.404	**Performance Management (PM); Performance measurements - Definitions and template**
32.405	Performance Management (PM); Performance measurements Universal Terrestrial Radio Access Network (UTRAN)
32.406	Performance Management (PM); Performance measurements Core Network (CN) Packet Switched (PS) domain
32.407	Performance Management (PM); Performance measurements Core Network (CN) Circuit Switched (CS) domain; UMTS and combined UMTS/GSM
32.408	Performance Management (PM); Performance measurements Teleservice
32.409	Performance Management (PM); Performance measurements IP Multimedia Subsystem (IMS)
32.425	Performance Management (PM); Performance measurements Evolved Universal Terrestrial Radio Access Network (E-UTRAN)
32.426	Performance Management (PM); Performance measurements Evolved Packet Core (EPC) network
32.452	Performance Management (PM); Performance measurements Home Node B (HNB) Subsystem HNS
32.453	Performance Management (PM); Performance measurements Home enhanced Node B (HeNB) Subsystem (HeNS)

The present document is part of a set of specifications, which describe the requirements and information model necessary for the standardised Operation, Administration and Maintenance (OA&M) of a multi-vendor PLMN system.

During the lifetime of a PLMN, its logical and physical configuration will undergo changes of varying degrees and frequencies in order to optimise the utilisation of the network resources. These changes will be executed through network configuration management activities and/or network engineering, see TS 32.600 [3].

Many of the activities involved in the daily operation and future network planning of a PLMN require data on which to base decisions. This data refers to the load carried by the network and the grade of service offered. In order to produce this data performance measurements are executed in the NEs, which comprise the network. The data can then be transferred to an external system, e.g. an Operations System (OS) in TMN terminology, for further evaluation. The purpose of the present document is to describe the mechanisms involved in the collection of the data and the definition of the data itself.

Annex B has been added to help in the definition of new performance measurements that can be submitted to 3GPP for potential adoption and inclusion in the present document. Annex B discusses a top-down performance measurement definition methodology that focuses on how the end-user of performance measurements can use the measurements.

1   Scope

The present document describes definitions and template related to the measurements for UMTS, GSM and LTE networks (and combined such networks).
TS 32.401 [1] describes Performance Management concepts and requirements.
The present document is valid for all measurement types provided by an implementation of a UMTS, GSM or LTE network (and combined such networks).
Vendor specific measurements types are not covered. Instead, these could be applied according to manufacturer's documentation.

Measurements related to "external" technologies (such as ATM or IP) as described by "external" standards bodies (e.g. ITU-T or IETF) shall only be referenced within this specification, wherever there is a need identified for the existence of such a reference.

The definition of the standard measurements is intended to result in comparability of measurement data produced in a multi-vendor network, for those measurement types that can be standardised across all vendors' implementations.

The structure of the present document is as follows:

- Header 1: Network Element (e.g. RNC related measurements);
- Header 2: Measurement function (e.g. soft handover measurements);
- Header 3: Measurements.

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. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1]   3GPP TS 32.401: "Telecommunication management; Performance Management (PM); Concept and requirements".

[2]   3GPP TS 52.402: "Telecommunication management; Performance Management (PM); Performance measurements - GSM".

[3]   3GPP TS 32.600: "Telecommunication management; Configuration Management (CM); Concept and high-level requirements".

[4]   Void.

[5]   3GPP TS 23.003: "Numbering, Addressing and Identification".

[6]   Void.

[7]   3GPP TS 32.632: "Telecommunication management; Configuration Management (CM); Core Network Resources Integration Reference Point (IRP): Network Resource Model (NRM)".

[8]   3GPP TS 32.642: "Telecommunication management; Configuration Management (CM); UTRAN network resources Integration Reference Point (IRP): Network Resource Model (NRM)".

[9]   3GPP TS 32.622: "Telecommunication management; Configuration Management (CM); Generic network resources Integration Reference Point (IRP): Network Resource Model (NRM)".

[10]   ITU-T Recommendation E.410: " International network management – General information".

[11]   3GPP TS 32.405: "Telecommunication management; Performance Management (PM); Performance measurements - Universal Terrestrial Radio Access Network (UTRAN)".

[12]   3GPP TS 32.406: "Telecommunication management; Performance Management (PM); Performance measurements - Core Network (CN) Packet Switched (PS) domain".

[13]   3GPP TS 32.407: "Telecommunication management; Performance Management (PM); Performance measurements - Core Network (CN) Circuit Switched (CS) domain; UMTS and combined UMTS/GSM

[14]   3GPP TS 32.408: "Telecommunication management; Performance Management (PM); Performance measurements - Teleservice".

[15]   3GPP TS 32.409: "Telecommunication management; Performance Management (PM); Performance measurements - IP Multimedia Subsystem (IMS)".

[16]   3GPP TS 32.425: "Telecommunication management; Performance Management (PM); Performance measurements Evolved Universal Terrestrial Radio Access Network (E-UTRAN)'.

[17]   3GPP TS 32.426: "Telecommunication management; Performance Management (PM); Performance measurements Evolved Packet Core (EPC) network'.

[18]   3GPP TS 32.452: "Telecommunication management; Performance Management (PM); Performance measurements Home Node B (HNB) Subsystem (HNS)'.

[19]   3GPP TS 32.453: "Telecommunication management; Performance Management (PM); Performance measurements Home enhanced Node B (HeNB) Subsystem (HeNS)'.

3   Definitions and template

3.1   Definitions

For the purposes of the present document, the following terms and definitions apply:

"*(n-1)* out of *n*" approach:

- The measurements result values generated by a NE can be obtained in a number of different ways. Therefore, the "*(n-1)* out of *n* approach" has been defined in order to avoid redundancy in the measurements.

- The "*(n-1)* out of *n* approach" allows a vendor to choose any (n-1) out of the n defined counters for implementation but some choices can offer more detailed information than others. The missing n[th] value can be calculated in post-processing.

- If multiple measurements are included in one template, then the applicability of the "(n-1) out of n" scenario are mentioned in template item A with the following sentence "The *n* measurement types defined in item E are subject to the "*(n-1)* out of *n* approach"*". The item D will specify the measurement result per measurement type specified in template item E.

- If the measurements that are applicable to the "*(n-1)* out of *n*" scenario are defined in separate templates, then they will be grouped together into a common clause of the TS, and the applicability of the approach will be mentioned in the clause that groups the measurements.

- Examples of measurements which are subject to the "*(n-1)* out of *n*" approach are provided in the annex A.

Measurement community

Several measurement communities are defined in the present document to identify the end users of system measurements. Each measurement should be defined to address the needs of at least one of   these user communities.

Six communities have been identified so far:

-        Network Operator's Business Community
-        Network Operator's Maintenance Community
-        Network Operator's Traffic Engineering Community
-        Network Operator's Customer Care Community
-        Equipment Vendor's Performance Modelling Community
-        Equipment Vendor's Development Engineering Community

A comprehensive description of measurement communities is provided in Annex B. The user communities names are a composite of the various terms used in the industry and might be subject to modification or refinement in future releases.

Measurement family

The measurement names are all beginning with a prefix containing the measurement family name (e.g. RAB.AttEstabCS.Conv, MM.AttGprsAttach). This family name identifies all measurements which relate to a given functionality and it may be used for measurement administration (see TS 32.401 [1]).

The measurement families for UMTS and combined GSM/UMTS networks are specified in TS 32.405 [11], TS 32.406 [12], TS 32.407 [13], TS 32.408 [14] and for IMS in TS 32.409 [15].
Measurement families for E-UTRAN are specified in TS 32.425 [16] and for EPC in TS 32.426 [17]. Measurement families for Home Node B (HNB) Subsystem (HNS) are defined in TS 32.452 [18] and for Home enhanced Node B (HeNB) Subsystem (HeNS) in TS.32.453 [19].

3.2   Abbreviations

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

3G	3rd Generation
3GPP	3G Partnership Project
ASN.1	Abstract Syntax Notation 1
ATM	Asynchronous Transfer Mode
BER	Basic Encoding Rules
CN	Core Network
DTD	Document Type Definition
EGQM	Enhanced Goal, Question, Metric
EM	(Network) Element Manager
EPC	Evolved Packet Core
EPS	Evolved Packet System
GSM	Global System for Mobile Communications
GQM	Goal, Question, Metric
IEEE	Institute of Electrical and Electronics Engineers, Inc.
Itf	Interface
ITU-T	International Telecommunication Union - Telecommunications Standardisation Sector
LTE	Long Term Evolution
NE	Network Element
NM	Network Manager
OA&M	Operation, Administration and Maintenance
OS	Operations System (EM, NM)
OSI	Open Systems Interconnection
PLMN	Public Land Mobile Network
PM	Performance Management
QoS	Quality of Service
RNC	Radio Network Controller
UMTS	Universal Mobile Telecommunications System
UTRAN	Universal Terrestrial Radio Access Network

You can find below a list of abbreviations used within the measurement types for field E of the measurement template (see subclause 3.3).

Att	Attempt(s,ed)
Conn	Connection
CS	Circuit switched

Conv	Conversational
Estab	Establish (ed,ment)
FDD	Frequency Division Duplex
HHO	Hard Handover
HO	Handover
Inter	Inter
Intra	Intra
Max	Maximum
MM	Mobility Management
Out	Outgoing
PS	Packet switched
RAB	Radio Access Bearer
RNC	RNC
RRC	Radio Resource Control
SGSN	SGSN
Sub	Subscriber
Succ	Success(es,ful)
UTRAN	UTRAN

Further measurement type abbreviations used for UMTS and combined GSM/UMTS networks are specified in TS 32.405 [11], TS 32.406 [12], TS 32.407 [13], TS 32.408 [14] and for IMS in TS 32.409 [15].
Measurement type abbreviations for E-UTRAN are specified in TS 32.425 [16] and for EPC in TS 32.426 [17].
Measurement type abbreviations for Home Node B (HNB) Subsystem (HNS) are defined in TS 32.452 [18] and for Home enhanced Node B (HeNB) Subsystem (HeNS) in TS.32.453 [19].

3.3 Measurement definition template

Following is the template used to describe the measurements contained in this subclause.

C.x.y. Measurement Name (clause header)

This is a descriptive name of the measurement type that is specified as clause C.x.y of the present document.

The measurement name shall be written in lower-case characters except abbreviations (e.g. RNC).

A measurement name can apply to one or more measurements. If the measurement name applies to several measurements then all fields of the template will take this into account.

Measurement names shall not exceed 64 characters in length and should be constrained to 32 characters maximum. Exceptions greater than 32 characters are allowed but should be kept to a minimum and only made where necessary.

a) Description

This subclause contains an explanation of the measurement operation.

b) Collection Method

This n contains the form in which this measurement data is obtained:

- **CC** (Cumulative Counter);

- **GAUGE** (dynamic variable), used when data being measured can vary up or down during the period of measurement;

- **DER** (Discrete Event Registration), when data related to a particular event are captured every n^{th} event is registered, where n can be 1 or larger;

- **SI** (Status Inspection) ;

- **TF** (Transparent Forwarding)**.**

c) Condition

This subclause contains the condition which causes the measurement result data to be updated;
This will be defined by identifying protocol related trigger events for starting and stopping measurement processes, or updating the current measurement result value. Where it is not possible to give a precise condition, then the conditional circumstances leading to the update are stated.

If a measurement is not available for FDD or TDD, then the measurement description shall contain a statement.

If a measurement is related to 'external' technologies, this subclause shall give a brief reference to other standard bodies.

d) Measurement Result (measured value(s), Units)

This subclause contains a description of expected result value(s) (e.g. a single integer value). If a measurement is related to 'external' technologies, this subclause shall also give a brief reference to other standard bodies.

The definition applies for each measurement result.

e) Measurement Type

This subclause contains a short form of the measurement name specified in the header, which is used to identify the measurement type in the result files.

The measurement names are dotted sequences of items. The sequence of elements identifying a measurement is organised from the general to the particular.

- The first item identifies the measurement family (e.g. HHO, RAB, SMS). Note that this family may also be used for measurement administration purpose.

- The second item identifies the name of the measurement itself, for which the following rules shall apply:

    - The second item of the measurement name can be divided into   <Operation>, <Reason/Result> and <Direction> (and in that order)

    - Examples of Operation can be Establishment, Release, and Modification

    - Examples of Reason/Result can be Attempt, Failure, Success, Throughput and Volume

    - Examples of Direction can be Incoming, Outgoing, Uplink and Downlink

- Depending on the measurement type, additional items may be present to specify subcounters (failure causes, traffic classes, min, max, avg, G, U ...). In case of multiple additional items, they are also represented as a dotted sequence of items. When available, the template will describe to which standard it is referring to for these additional items (e.g. cause, traffic class). Otherwise, the additional item semantics must be described in details in the present document.

    Standardised causes will be a number.   This number shall be derived according to which of the following rules applies:

- For the standardised causes with numeric values explicitly specified in the reference spefication, the subcounter name will be the number assigned to this cause in this reference specification.

- For the standardised causes without numeric values explicitly specified in the reference spefication, but where the causes are identified, the subcounter name shall be an number from 1 to n mapped in an incremental sequence to each of the specified causes following top down sequence in the order they are identified in the reference specification (e.g. RRC.ConnEstab.1, 1 idenfies the establishment cause 'Originating Conversational Call', see TS 25.331);

- For the standardised causes without numeric values explicitly specified in the reference spefication and the causes identified and the causes have been divided into different cause groups, the subcounter should be defined as the form of *"Cause group".Cause*, where:

    o the subcounter name of *"Cause group"* shall be an incremental number from 1 to n to identify each cause group specified in a top down sequence following the order they are identified in the reference specification,

    o the subcounter name of *cause* within this cause group shall be an incremental number from 1 to n to identify each cause within the group specified in a top down sequence following the order they are identified within the cause group in the reference specification (e.g. RLM.FailRLSetupIub.2.1, 2.1 indenfies the cause 'Transport resource unavailable' in the cause group 'Transport Layer Cause', see TS 25.433). Subcounter *"Cause group".sum* is permitted to indentify the aggregate of measurement values of all the causes within the cause group (e.g. RLM.FailRLSetupIub.1.sum, 1.sum identifies the aggregate of all the causes within the cause group 'Radio Network Layer Cause', see TS 25.433).

    The non standardised causes should be a string (e.g. RRC.ConnEstab.NoReply).

The set of values issued for a measurement does not depend on the associated collection method (CC, SI, Gauge, DER, TF). For instance, a gauge collected counter does not necessarily provide min, max, average values.

The vendor-specific UMTS and combined GSM/UMTS measurement names will all begin with the VS prefix.

In addition, it is recommended that a prefix is added for non-UMTS measurements:

- Q3 for Q3 measurements;

- MIB for IETF measurements (ATM, IP);

- OS for other standards measurements.

The 3GPP standardised measurements name must not commence with the above prefixes.

Examples of valid measurement names are:

- HO.PrepAtt

- SAEB.EstabSucc

- RRC.ConnEstabAtt.*Cause*
  where *Cause* identifies the failure cause.

Examples of valid measurement names for measurements defined before version 8.3.0 of the present document are:

- VS.HO.InterSGSNReject.NoResource;

- ATM. ATML.IngressCells;

- HHO.SuccOutIntraCell;

- MM.AttachedSubs.Max;

- RAB.EstabAttCS.Conversational;

- RRC.ConnEstab.*Cause*
  where *Cause* identifies the failure cause.

Abbreviations to be used within measurement types can be found in subclause 3.2 of the present document.

f) Measurement Object Class

This subclause describes the measured object class (e.g. UtranCell, RncFunction, SgsnFunction). The object class used for this purpose shall be in accordance with NRMs defined in any NRM IRPs, such as those defined in 3GPP TS 32.622 [9], TS 32.632 [7] and TS 32.642 [8].

For object classes currently not defined according to the above, the present document defines its own nomenclature (e.g. RA, LAC).

It is possible to use the same measurement name for a standardized measurement type implemented at a different object class level than the one defined in the Standard. The same measurement type can apply to one or more measurements for which all fields of the measurement template are the same except the clause f) "Measurement Object Class". For instance, a measurement which uses the same template as a given measurement type but relates to another or different object classes (e.g. UtranCell instead of UtranRelation, or RncFunction and UtranCell) shall have the same name.

g) Switching Technology

This subclause contains the Switching domain(s) this measurement is applicable to i.e. Circuit Switched and/or Packet Switched.

h) Generation

The generation determines if it concerns a GSM, UMTS, EPS, combined (GSM+UMTS+EPS) or IMS measurement.

- **GSM:** pure GSM measurement; it only counts GSM events. In a combined (GSM+UMTS+EPS) NE the count would be exactly the same as in a pure GSM NE. In a pure UMTS, pure EPS or combined UMTS and EPS NE this counter does not exist;

- **UMTS:** pure UMTS measurement; it only counts UMTS events. In a combined (GSM+UMTS+EPS) NE the count would be exactly the same as in a pure UMTS NE. In a pure GSM, pure EPS or combined GSM and EPS NE this counter does not exist;

- **EPS:** pure EPS measurement; it only counts EPS events. In a combined (GSM+UMTS+EPS) NE the count would be exactly the same as in a pure EPS NE. In a pure GSM, pure UTMS or combined GSM and UTMS NE this counter does not exist;

- **GSM/UMTS:** measurement applicable to both GSM and UMTS systems; in a combined (GSM+UMTS) NE separate subcounts for GSM and/or UMTS events can be obtained;

- **GSM/UMTS/EPS:** measurement applicable to GSM, UMTS and EPS systems; in a combined (GSM+UMTS+EPS) NE separate subcounts for GSM, and/or UMTS, and/or EPS events can be obtained;

- **Combined:** measurement applicable to combined GSM, UMTS and EPS systems, but regardless of whether the measured event occurred on the GSM, UMTS or EPS part of the system. This means that in a combined NE only one total (i.e. GSM+UMTS+EPS) count is obtained for the measured event.

The above aspects are also reflected in the measurement type name in template item E by adding a "G" to the GSM measurements, "U" to the UMTS measurements, "E" to the EPS measurements.

- **IMS**: measurement applicable to IMS.

NOTE: The 2G component of combined 2G/3G equipment may actually choose to implement GSM measurements according to the present document or TS 52.402 [2], based on GSM specifications.

i) Purpose

This optional clause aims at describing who will be using the measurement. It is proposed to indicate in this clause the targeted categories of users based on the measurement user communities described in Annex B.

When available, this clause provides additional information on the interest of the measurement but is however purely indicative.

3.4 Definition of private Object Classes

Private Object Classes are Object Classes which are needed for PM purposes, but that are not yet defined by CM.

3.4.1 RA

The Object Class RA (Routing Area) is needed to conduct measurements on RA level. For the purpose of the present document, the Routing Area should be encoded in the file format as the concatenation of the MCC, MNC, LAC and the RAC, in decimal notation. See further definition of Routing Area Identification in TS 23.003 [21]. Since LAC is a 2 byte number (00000-65535), 5 characters are needed in the moid PrintableString. Since RAC is a 1 byte number (000-255) 3 characters are needed in the moid PrintableString. MCC is 3 digits and MNC 2 or 3 digits. The concatenated moid PrintableString will always contain 14 characters. In the case where MNC has the length 2, a leading underscore character will be added.

a) EXAMPLE 1: LAC = Hexadecimal 4E20 = Decimal 20000;
RAC = Hexadecimal BE = Decimal 190; MCC = Decimal 046; MNC = Decimal 01
moid = "046_0120000190".

The Object Class RA (Routing Area) is needed to conduct measurements on RA level. For the purpose of the present document the Routing Area should be encoded in the file format as the concatenation of the LAC and the RAC, in decimal notation. Since LAC is a 2 byte number (00000-65535) 5 characters are needed in the moid PrintableString. Since RAC is a 1 byte number (000-255) 3 characters are needed in the moid PrintableString. Hence concatenated moid PrintableString will always contain 8 characters.

EXAMPLE 2: LAC = Hexadecimal 4E20 = Decimal 20000;
RAC = Hexadecimal BE = Decimal 190;
moid = "20000190".

3.4.2 MMS Relay/Server

The Object Class MMS Relay/Server is needed to conduct measurements on MMS Relay/Server level. No specific moid structure is defined for the MMS Relay/Server. The moid is a PrintableString which contains a maximum of 20 characters.

3.4.3 ObservedDestination

The Object Class ObservedDestination is needed to conduct measurements on ObservedDestination level.
For the purpose of the present document, the ObservedDestination could be country code, or/and an area code, or/and an exchange, or/and other location number, or/and a special service number) in decimal notation (ITU-T E.410 [10]).
The moid is a PrintableString which contains a maximum of 20 characters.

3.5   Management of per cause measurements

Per cause measurements may lead in certain cases to a lot of subcounters which will increase substantially the size of the measurement report file. Since all per cause measurements are not necessarily useful to the end-user, two options are possible for the management of the corresponding subcounters:

- support all the subcounters corresponding to the cause codes as defined in the 3GPP standards. In that case, the sum of all supported per cause measurements is equal to the total sum across all subcounters;

- support only a subset of the subcounters (allowed only if the cause codes are specified in 3GPP standards). In that case, the first value of the result sequence must be the total sum across all the cause codes as defined in 3GPP standards. This implies that all subcounters of a given measurement type appear as uninterrupted sequence in the result file. The keyword *.sum* placed behind the measurement type is used to identify the sum subcounter. The choice of the supported cause codes is manufacturer dependent.

3.6 Rule for generic measurements definition

The measurement definitions shall not be duplicated. Reference should be used instead.
If one measurement is needed in several places, there should be only one single definition with complete structure.
All other occurrences should make reference to the original one, whether they are in the same specification or not.

The measurements having the same definition of the following items are regarded as duplicated:

    a) Description
    b) Collection Method
    c) Condition
    d) Measurement Result (measured value(s), Units)
    f) Measurement Object Class

The duplicated occurrence shall make reference to the original occurrence in two ways.

    1. "Refer to <Clause number> for concrete definition"
       in the case where both occurrences are within the same specification.

    2. "Refer to <Specification number><Version Number><Clause number> for definition"
       in the case the occurrences are in different specifications.

For the differing measurement template items e), g), h), i) the difference shall be pointed out after the reference notice.
The presentation of the differing items should follow the same format as in the measurement template.

Annex A (informative):
Examples for "(n-1) out of n" approach

The measurements result values generated by a NE are often redundant, or the info contained in the measurement results can be obtained in a number of different ways.

The "(n-1) out of n" approach allows a vendor to implement a subset of 3GPP defined measurements, for example if there exists a relation (A+B=C) then any 2 out of 3 defined measurements A, B, C are sufficient information to calculate the third (n=3). In case there exists a relation (A+B+C=D), then any 3 out of the 4 would suffice, and the same kind of approach would be applicable.

A.1   Attempt/success/failure procedure measurements

Consider the number of attempts to start a specific procedure (e.g. RRC connection establishment). Some of these attempts will fail, some will be successful. Three different counters can be defined to measure these procedures: an attempt counter, a success counter, and a failure counter, but in fact only 2 may be provided, since we have the fixed relation (#success + #failure) = #attempt.

It is to be noted that all combinations do not provide the same level of details. For example, in the case only #attempt and #success are provided, it will not be possible to retrieve the detailed failure causes.

The three measurement types defined in clause 4.4 of TS 32.405 are subject to the "(n-1) out of n" approach with n=3:

- Attempted RRC connection establishments.
- Failed RRC connection establishments.
- Successful RRC connection establishments.

The "(n-1) out of n" approach is also applicable for more complex measurements split according to a specific criterion, e.g. Queuing. For example, the CS measurements described in clause 4.1 of TS 32.405 are subject to a 4 out of 5 approach:

- Attempted RAB establishments for CS domain.
- Successful RAB establishments without queuing for CS domain.
- Failed RAB establishments without queuing for CS domain.
- Successful RAB establishments with queuing for CS domain.
- Failed RAB establishments with queuing for CS domain.

Any of the five measurements can be calculated from the four others but all combinations will not provide the same level of details (e.g. failure causes).

A.2   GSM/UMTS combined measurements

With relation to the field H of the measurement template, a measurement indicated with GSM/UMTS is an example of the "(n-1) out of n" approach with n=3 since (GSM + UMTS) = Combined.

In that case, all concerned measurements are included in the same template but the vendor may provide only 2 subcounters out of 3.

The measurement described in subclause 4.6.1 of TS 32.406 is subject to the "(n-1) out of n" approach with n=3:

- SM.AttActPdpContext (attempted context activation procedures with no distinction between GSM and UMTS).
- SM.AttActPdpContext.G (attempted context activation procedures for GSM only).
- SM.AttActPdpContext.U (attempted context activation procedures for UMTS only).

A.3 Embedded "(n-1) out of n" approaches

It is also possible to combine the approaches described above. For example, the measurements described in subclause 4.5 of TS 32.406 are subject to the "(n-1) out of n" approach at two levels.

Firstly, measurements are split according to the CS/PS domain, for example:

- attempted CS SMS mobile originating;
- attempted PS SMS mobile originating;
- attempted SMS mobile originating;

where any of the three measurements can be calculated from the two others.

Secondly, each measurement provides 3 subcounters, for example for Attempted CS SMS mobile originating:

- SMS.AttMoCS;
- SMS.AttMoCS.G;
- SMS.AttMoCS.U;

where any of the three subcounters can be calculated from the two others.

Annex B (informative):
Top-Down Performance Measurement Definition Process

B.1   Scope of this annex

Performance measurements within wireless telecommunications networks are required in order to meet the needs of the diverse community of end-users of those measurements. New features develop, networks evolve and operating conditions change without sufficient consideration given to the measurements needed to keep the network running efficiently. While Equipment Vendors define measurements to satisfy their particular needs, other perspectives, especially the voice of the Network Operator, are sometimes lost during Equipment Vendor development processes. Similarly, Network Operators sometimes request measurements without fully understanding who will be using the data or what actions those people will take based on the collected data. A coherent, simple, top-down methodology for defining performance measurements is lacking in the telecommunications industry.

This annex proposes a methodology to handle the above problems. In particular, multiple user communities have been defined representing the end-users of system measurements. Performance goals and measurements are defined considering these same user communities. The definition includes identification of specific problem scenarios and corrective actions to be taken by the appropriate user community.

Measurements defined using this methodology can be contributed to 3GPP SA5 for potential adoption and inclusion in the present document. It is believed that this methodology will help reduce development costs for the Equipment Vendors and reduce operational costs for the Network Operators.

B.2   Overview

Performance measurements are important to the proper and efficient functioning of wireless telecommunications networks. They have numerous uses related to resource utilization, expansion planning, network optimisation, operating problem diagnosis and network availability monitoring. For the wireless telecommunications world, product performance measurements are necessary to support multiple communities of users.

In addition, once performance measurements are defined for a wireless telecommunication network they must be maintained. The evolution of a wireless telecommunication network for capacity increases and feature extensions leads to the evolution of the collected measurements. Performance measurements need to be added, modified and made obsolete from the overall measurement repository. These changes must be defined completely and accurately to meet the requirements of each community of users.

The development of a performance measurement life cycle process to oversee this need is proposed in this annex. The life cycle process addresses the multiple user communities whose perspectives are needed to supply the requirements for the performance measurements.

The proposed performance measurement life cycle process is a usage-based process. The basic Goal, Question, Metric (GQM) method is enhanced to define problem scenarios and corrective actions. These descriptions are not only used to filter out proposals for performance measurements that provide no defined benefit, but also support user community training in the use of the performance measurements.

The remainder of this annex is organised as follows.

-        Clause B.3 defines Measurement User Communities for wireless telecommunications.
-        Clause B.4 discusses the GQM and the Enhanced GQM methods.
-        Clause B.5 discusses the measurement life cycle process.
-        Clause B.6 provides conclusions.

B.3 Measurement User Communities

One objective of Performance Management as a functional subset of operations and maintenance processes is to define sets of measurements. Typical definition criteria revolve around measuring activity within the network in terms of volume, speed and accuracy. While this approach produces measurement data it does not completely address the needs and uses of the multiple consumers of network performance measurement information. The Enhanced GQM methodology extends the measurement definition criteria to better satisfy multiple groups with diverse needs for these measurements.

A qualitative judgement as to the efficacy of a Performance Management subsystem is how well served these different groups are by the measurements provided. To better understand these needs, five generic categories of users, outlined definitions and examples of their needs and requirements for measurements taken from their wireless telecommunications network are defined. These groups are referred to as measurement user communities. These six communities are:

1. Network Operator's Business Community
2. Network Operator's Maintenance Community
3. Network Operator's Traffic Engineering Community
4. Network Operator's Customer Care Community
5. Equipment Vendor's Performance Modelling Community
6. Equipment Vendor's Development Engineering Community

B.3.1 Network Operator Business Community

The first measurement user community is the Network Operator's Business Community. This community is defined under the assumption that the wireless telecommunications network is fully operational, adequately engineered for traffic load per quality of service definitions and in commercial service. The primary objective of this community is to guarantee the financial health and welfare of the Operating Company. They expect a properly configured wireless telecommunications network to supply the revenue per subscriber unit necessary to meet their financial goals.

An understanding of the elasticity of demand can help the Business Community maximize profits within their product pricing strategy as they alter prices according to various mixes of services. Typical measurements of interest to this community are those based on the actual volumes of calls completed by service type. This call volume information can lead to trends of usage over time. Correlation between price mix and call volumes can help to identify pricing strategies geared towards increasing revenue per subscriber unit.

B.3.2   Network Operator Maintenance Community

The second measurement user community is the Network Operator's Maintenance Community. This community is defined under the assumption that the wireless telecommunications network is less than fully operational, adequately engineered for traffic load per quality of service definitions and in commercial service. The primary objective of this community is to reduce Mean Time to Repair faults that occur within the network equipment of the Operating Company.

The baseline metric for this community is the availability of the network equipment, where availability is composed of the sum of scheduled and unscheduled outages to the network equipment. Unscheduled outages are influenced by the inherent hardware and software quality of the products provided to the operating company. While the Maintenance Community has no direct control over that quality, they do have control over the second component of scheduled outage, Mean Time to Repair.

Mean Time to Repair is influenced by the Mean Time to Detect a fault. This community of user's defines measurements that support detecting or predicting faults within the network equipment.

Measurements that support this community can come from places other than the network equipment, itself. Several Operating Companies have been observed building information systems based on the data provided by Call Detail Records and Billing Records. Correlation is sought within these data between call faults and location within the Network. Detection of these faults serves a dual purpose: it allows the Operating Company a view of performance at the level of their Network Operator (the subscriber) and it allows the Maintenance Community to target specific network equipment for repair.

B.3.3   Network Operator Traffic Engineering Community

The third measurement user community is the Network Operator's Traffic Engineering Community. This community is defined under the assumption that the wireless telecommunications network is fully operational, inadequately engineered for current or future traffic load per quality of service definitions and in commercial service. The primary objective of this community is to keep the capacity of the network equipment within 1) the Operating Company's design criteria for the quality of service based on growth of the subscriber base, 2) changes in usage patterns based on pricing strategies and 3) introduction of new services.

The baseline metric for this community is the trend in utilization of the network equipment. A fully instrumented network would allow the Operating Company to understand the trend in performance of their principle capital investment and any leased services. As these trends pass thresholds of performance, purchasing decisions or volume pricing discounts could be triggered.

B.3.4   Network Operator Customer Care Community

The fourth measurement user community is the Network Operator's Customer Care Community. This community is defined under the assumption that the wireless telecommunications network is fully operational, functioning at a less than optimal level resulting in end-user dissatisfaction and in commercial service. The primary objective of this community is interfacing with the end-user customers of offered services for the purpose of establishing and maintaining end-user customer satisfaction. This may include customer care responsibilities such as Customer Relationship Management (CRM), Service Level Agreement (SLA) management, quality of service (or QoS) management, etc.

This community is interested in defining measurements related to the end-user customer experience with the network Operator's offered services in the areas of CRM, SLA, QoS, problem reports, etc. Decisions on how to best handle customer dissatisfaction or how to keep customers from becoming dissatisfied are based on these types of measurements.

B.3.5 Equipment Vendor Performance Modelling Community

The fifth measurement user community is Equipment Vendor's Performance Modelling Community. This community is defined under the assumption that the wireless telecommunications network is fully operational, adequately engineered for traffic load per quality of service definitions and in some level of call capable service. The primary objective of this community is to guarantee that the models used during analysis and design phases conform to real-world observations of the network equipment of the Operating Company.

While this community is not within the Operating Company it still provides beneficial service to the Operating Company by managing the development of subsequent features that are in line with the actual performance characteristics of the network. Many decisions within the development life cycle depend on models developed prior to shipping the product. These models need to be calibrated to network performance once the product is released. Definition of measurements in concert with calibrating these models requires the direct involvement of the people developing the models.

The network that transports Network Management data often is the same network that carries call control traffic. Clearly, the knowledge of volume levels of this traffic during anomalous operating conditions is important in order to understand the total impact to call processing. This community would define measurements to allow the monitoring of this type of phenomena.

B.3.6   Equipment Vendor Development Engineering Community

The sixth measurement user community is Equipment Vendor's Development Engineering Community. This community is also defined under the assumption that the wireless telecommunications network is fully operational, adequately engineered for traffic load per Quality of Service or Service Level Agreement definitions and in commercial service. The primary objective of this community is to guarantee that the implementations of the designs conform to real-world observations of the network equipment of the Operating Company.

While this community also is not within the Operating Company, it still provides beneficial service to the Operating Company. The implementation of new algorithms carries some finite risk of performance in the Network Operator environment versus the lab environment. Many times simulators of network activity are developed to support the verification of these algorithms. These simulations need to be calibrated to network performance once the product is released. Definition of measurements in concert with calibrating these simulations requires the direct involvement of the people developing the simulations.

B.3.7   User Community Conclusion

The six measurement communities are broken into four Network Operator based groups and two Equipment Vendor groups. However, experience shows that the measurements defined for these groups are not mutually exclusive. Other groups may also use measurements needed by a particular group for the same or different purposes. Thus, the accurate definition of the measurements and how to use them is necessary to allow the Network Operator to properly combine these measurements into more complex analyses.

B.4 Enhanced GQM

The Goal, Question, Metric (GQM) method requires measurement user communities to help define goals and metrics. This clause first presents the standard GQM method and then presents an enhanced GQM method, which provides the measurement user communities a broader understanding of how metrics are used. The term 'Metric' in GQM means the same as 'measurement'.

B.4.1 GQM Methodology

Basili and Weiss [23] and others originally proposed the GQM method. This methodology provides a systematic approach for defining metrics that can be collected and analysed to determine whether or not a goal has been reached. This methodology was originally created for quality assurance of software development processes, but has been applied to other areas. GQM is comprised of the following three steps.

1. Identify and define **Goals** for a particular group;

2. Refine goals into quantifiable **Questions**;

3. Define **Metrics** that will answer the questions.

Goals are defined in terms of a **purpose** and a **perspective**. The purpose specifies the object to be analysed and why it will be analysed. The perspective specifies the relevant aspects of the object and which measurement user community is interested in the aspects.

Execution of the GQM methodology results in the formation of a GQM model. A GQM model contains the set of defined Goals, Questions and Metrics. A GQM model provides trace-ability from the goals to the associated metrics. Figure B.4.1.1 shows an example of a GQM model.
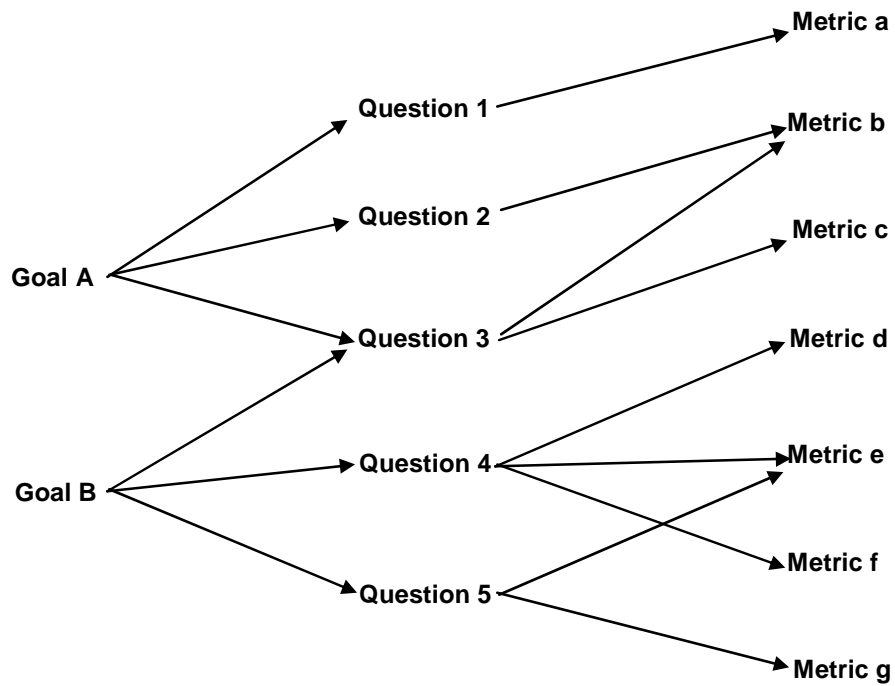
Figure B.4.1.1: GQM Model

GQM definition templates are often used to help produce consistent goal, question and/or metric definitions. An example of a Goal template is shown below:

Purpose: To (characterize evaluate, predict, motivate, etc.) the (process product model, metric, etc.) in order to (understand, assess, manage, engineer, learn, improve, etc.) it.
Example: To evaluate the system testing methodology in order to improve it.

Perspective: Examine the (cost, effectiveness, correctness, defects, changes, product metrics, reliability, etc.) from the point of view of the (developer, manager, Network Operator, corporate perspective, etc.).
Example: Examine the effectiveness from the developer's point of view.

B.4.2 Enhanced GQM (EGQM) Methodology

As it stands, the GQM methodology works well for defining metrics, but falls short in several areas. The original GQM methodology was enhanced to better fit within the wireless telecommunications industry for the following reasons:

a) Allow wireless measurement user communities to specify their needs at the beginning of the performance measurement life cycle rather than waiting for product to be delivered.

b) Allow wireless measurement user communities to understand what performance measurements are being designed for them in time to modify the associated collection, analysis and reporting processes.

c) Allow wireless measurement user communities to understand how they should analyse collected measurement data and what actions they should take when analysis has been completed.

d) Provide criteria for rejecting unnecessary goals, useless measurements, or measurements that can not be properly collected, analysed or understood.

e) Provide criteria for architecting metrics into the appropriate wireless network device (based on network traffic capacity, device CPU and memory capacity, data collection capabilities, etc.).

f) Allow for consistent measurement definition by providing Enhanced GQM model definition and measurement definition templates.

g) Help reduce development costs for Equipment Providers and reduce operational costs for the Network Operator.

The Enhanced GQM, or EGQM, methodology is comprised of the following four steps.

1. Identify and define measurement goals for a particular measurement user community;

2. Refine measurement goals into quantifiable problem scenarios;

3. Define measurements that will determine if the goal is being accomplished;

4. Define corrective actions.

EGQM's first and third steps are similar to GQM's first and third steps. EGQM's second step is different than GQM's second step in that it focuses on problem scenarios associated with the goal rather than on questions associated with the goal. Problem scenarios are descriptions of real world problems the measurement user community has or will experience. Each problem scenario represents a particular aspect of the associated goal. Problem scenarios include definitions of any formulas that will allow the measurement user community to analyse the problem scenario after metric data has been collected from the field. EGQM's fourth step is new. Corrective actions are descriptions of what the measurement user community should do based on analysis of metric data collected from the resulting wireless network.

Execution of the EGQM methodology results in the formation of an EGQM model. An EGQM model contains the set of defined goal, problem scenarios, metrics and corrective actions. An EGQM model also provides trace-ability from the goals to the associated corrective actions. Figure B.4.2.1 shows an example of an EGQM model.
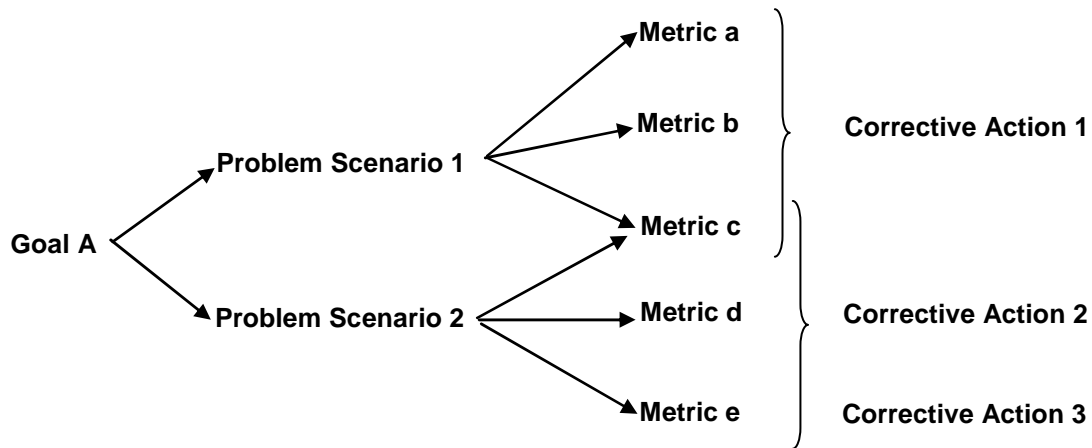
Figure B.4.2.1: EGQM Model

EGQM has definition templates for producing an EGQM model and for defining metrics. The EGQM model definition template is shown in Table B1. The EGQM metric definition template that is useful for 3GPP SA5 activities is defined in subclause 3.3 of the present document.

Table B.4.2.1: EGQM Model Definition Template

Goal	Provides the name of goal and non-ambiguous definition of what needs to be accomplished. Also provides the measurement user communities the goal is associated with.
Problem Scenario(s)	Provides a description of the problem scenario associated with the goal. Contains a description of how performance measurements will be used by the user in order to meet the goal.
Required Metric(s)	Provides a list of metrics required to assess the problem scenario to see if the goal is being accomplished.
Corrective Action(s)	Provides descriptions of actions the user can execute based on data collected from the wireless network. Contains descriptions of expected metric data values and how those values work with the Problem Scenarios definitions.

As described in clause B.3, six measurement user communities have been defined for the wireless telecommunications industries. EGQM supports all six communities. Representatives from each community participate in all four steps of the EGQM methodology. This allows user communities to specify exactly what they need and/or want and to know exactly how they will use the metrics before any software is developed. Participation in the EGQM process increases Network Operator satisfaction through early definition of operational practices (including corrective actions) and increases product knowledge within the Network Operator organization.

The EGQM model definition and metric definition templates provide the mechanism to reject unnecessary goals, useless metrics, or metrics that can't be properly collected or computed. Reasons for the rejection of a goal include the following:

a) Non-ambiguous goal definition could not be determined;

b) Problem scenarios could not be determined;

c) Definition of how performance measurement will be used within a problem scenario could not be determined;

d) Corrective actions could not be determined;

e) Metrics could not be defined to support problem scenario definitions;

f) Required metrics could not be architected into network devices for any of the following reasons:

1) Network device could not collect metric due to CPU utilization issues;

2) Network device could not collect and/or store metric due to memory issues;

3) Network could not support the uploading of measurement data from network devices to network manager;

4) Network manager could not collect and/or store measurement data due to memory issues.

B.5   Measurements Life Cycle Process

If the uses of performance measurements were confined to feature releases and occasional changes to those features, then EGQM would suffice. However, user community needs evolve, operating conditions change, performance models are validated, new services are introduced, etc. As these conditions change, performance measurements may need to change. Such considerations point to the need for a complete measurements life cycle model.

A simple life cycle model to handle performance measurement changes is depicted in Figure B.5.1. New performance measurement goal and metric definitions are provided through new features. These are made available with major releases.
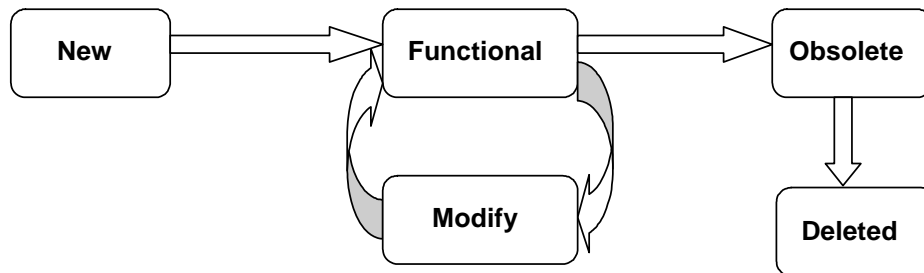

Figure B.5.1: Measurement Life Cycle

Performance measurements may need to be periodically reviewed. Goal and metric definition updates made during this process are generally instantiated at major releases. When metrics are no longer useful they can be made obsolete and eventually deleted. A waiting period between obsolescence and deletion allows user communities time to implement and test out new metrics and analyses that are meant to replace existing metrics and analyses.

B.6   Conclusion

In the past, definition of performance measurements of wireless telecommunications networks was focused mainly on satisfying the needs of the Equipment Vendor Performance Modelling and Development Engineering measurement user communities. The needs of the wireless telecommunications Network Operator were not always addressed. The Performance Measurement Definition process described in this annex addresses the needs of all measurements user communities. The process also provides additional benefits, including the following:

- Allow measurement communities to specify their needs up front.

- Allow measurement communities to prepare for and modify their measurement monitoring and reporting processes before product is released to them.

- Allow measurement communities to know what actions they need to perform when assessing collected measurements.

- Provides method for rejecting unrealistic goals and measurements.

- Provides method for best architecting measurements into network devices.

- Provides method for producing consistent measurement definitions.

- Provides method for managing measurements life cycle including measurement creation, modification and obsoletion.

The EGQM methodology may be used for:

- analyse and assess performance areas that are not well understood or are highly complex;

- non-straightforward cases where it is difficult to create useful measurement proposals;

- an understanding of real value is required before useful measurement proposals can be created;

- mine for missing measurements;

- mine for conflicting, overlapping, or existing measurements that are no longer useful.

In summary, the EGQM methodology may be used by any company to generate measurement definitions that can then be contributed to 3GPP SA5 for potential inclusion in the present document.

Annex C (informative): Change history

Change history								
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Cat	Old	New
Mar 2006	SA_31	SP-060107	--	--	Split of 32.403-710 into four new TSs 32.404, 32.405, 32.406, 32.408. Submitted to TSG SA #31 for Approval.	--	1.0.0	7.0.0
Jun 2006	SA_32	SP-060260	0001	--	Add features to the template to adapt ATM/IP PM definitions	B	7.0.0	7.1.0
Jun 2006	SA_32	SP-060260	0002	--	Add IMS domain into measurement definition template	B	7.0.0	7.1.0
Dec 2006	SA_34	SP-060725	0003	--	Allow different object classes using same measurement type in measurement template	B	7.1.0	7.2.0
Jun 2007	SA_36	SP-070276	0004	--	Add rule for subcounter naming of standardised causes without numeric value	F	7.2.0	7.3.0
Sep 2007	SA_37	SP-070613	0005	--	Change Routing Area to RA in private object class definition	F	7.3.0	7.4.0
Dec 2007	SA_38	SP-070742	0006	--	Add private Object Class ObservedDestination - Align with 32.407	C	7.4.0	8.0.0
Mar 2008	SP-39	SP-080069	0007	--	Add rule for generic measurement definition	C	8.0.0	8.1.0
Sep 2008	SP-41	SP-080465	0008	--	Add EPS into the performance measurement definition template in 32.404	B	8.1.0	8.2.0
Dec 2008	SP-42	SP-080846	0009	--	Enhancement of the measurement naming rules in the measurements definition template.	B	8.2.0	8.3.0
Sep-2009	SP-45	SP-090534	0010	--	Add missing NRMs into scope of Performance Measurements template	F	8.3.0	8.4.0
Dec 2009	-	-	-	-	Update to Rel-9 version (MCC)	--	8.4.0	9.0.0
Mar 2011	-	-	-	-	Update to Rel-10 version (MCC)	--	9.0.0	10.0.0
Sep 2011	SP-53	SP-110526	0011	--	Add missing references to performance measurements TSs and remove obsolete references. Add missing text referring to LTE.	F	10.0.0	10.1.0
2012-09	-	-	-	-	Update to Rel-11 version (MCC)		10.1.0	**11.0.0**
2014-10	-	-	-	-	Update to Rel-12 version (MCC)		11.0.0	**12.0.0**
2015-12	SP-70	SP-150690	0012	1	Add a new collection method – TF to the measurement definition template	B	12.0.0	**13.0.0**

History

Document history		
V13.0.0	January 2016	Publication