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Contents

Foreword

This Technical Specification (TS) 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:

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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; Performance Management (PM), as identified below:

> **TS 32.401:**   "**Concept and requirements**";
>
> TS 52.402:   "Performance measurements - GSM";
>
> TS 32.403:   "Performance measurements UMTS and combined UMTS/GSM".

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 GSM or UMTS PLMN.

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 GSM TS 12.06 [9] and 3GPP TS 32. 600 [3].

Many of the activities involved in the daily operation and future network planning of a PLMN network 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 and its companion parts 2 and 3 is to describe the mechanisms involved in the collection of the data and the definition of the data itself.

1 Scope

The present document describes the requirements for the management of performance measurements and the collection of performance measurement result data across GSM and UMTS networks. It defines the administration of measurement schedules by the Network Element Manager (EM), the generation of measurement results in the Network Elements (NEs) and the transfer of these results to one or more Operations Systems, i.e. EM(s) and/or Network Manager(s) (NM(s)).

The basic Performance Management concept that the present document is built upon is described in clause 4. The requirements how an EM administers the performance measurements and how the results can be collected are defined in detail in clause 5. Annex A specifies the file format for the bulk transfer of performance measurement results to the NM, while annex B discusses the file transfer procedure utilised on that interface. A set of measurements available for collection by NEs are described in TS 52.402 for GSM and in TS 32.403 for UMTS and combined UMTS/GSM systems, effort has been made to ensure consistency in the definition of measurements between different NEs and generations.

The following is beyond the scope of the present document, and therefore the present document does not describe:

- the formal definition of the interface that the EM uses to administer performance measurements in the NEs;

- the formal definition of the interface that the EM uses to collect measurement results from the NEs;

- how the data, once accumulated and collected, could or should be processed, stored, or presented to an end user;

- the information which may be obtained through the collection and processing of call or event related records which have been produced by the NEs primarily for the purpose of raising bills and other charges.

The management requirements have been derived from existing telecommunications operations experience. The management definitions were then derived from other standardisation work so as to minimise the re-invention factor. References are given as appropriate.

The objectives of this standardisation are:

- to provide the descriptions for a standard set of measurements;

- to produce a common description of the management technique for measurement administration and result accumulation; and

- to define a method for the bulk transmission of measurement results across a management interface.

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

As far as possible, existing standardisation in the area of Performance Management has been re-used and enhanced where particular requirements, peculiar to the mobile telephony environment, have been recognised.

The present document considers all the above aspects of Performance Management for a GSM and UMTS network and its NEs defined in the core Technical Specifications. However, only those aspects which are specific to a GSM/UMTS system and particular to wireless network operation are included in the present document.

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, edition number, version number, etc.) 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 32.101: "Telecommunication management; Principles and high level requirements".

[2]   3GPP TS 32.102: "Telecommunication management; Architecture".

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

[4]   3GPP TS 25.442: "UTRAN Implementation Specific O&M Transport".

[5]   ITU-T Recommendation E.880: "Field data collection and evaluation on the performance of equipment, networks and services".

[6]   ITU-T Recommendation X.731: "Information technology - Open Systems Interconnection - Systems Management: State management function".

[7]   ISO 8571: "Information processing systems - Open Systems Interconnection - File Transfer, Access and Management".

[8]   GSM 12.04: "Digital cellular telecommunications system (Phase 2+) (GSM); Performance data measurements".

[9]   GSM 12.06: "Digital cellular telecommunications system (Phase 2+) GSM network configuration management".

[10]   3GPP TS 32.300: "Telecommunication management; Configuration Management (CM); Name convention for Managed Objects".

[11]   3GPP TS 32.302: "Telecommunication management; Configuration Management (CM); Notification Integration Reference Point (IRP): Information Service".

[12]   3GPP TS 32.111-1: "Telecommunication management; Fault Management; Part 1: 3G fault management requirements".

[13] - [19]   Void.

[20]   3GPP TR 32.800: "Telecommunication management; Management level procedures and interaction with UTRAN".

[21]   3GPP TS 32.111-2: "Telecommunication management; Fault Management; Part 2: Alarm Integration Reference Point (IRP): Information service".

[22]   3GPP TS 52.402: "Telecommunication management; Performance Management (PM); Performance measurements - GSM".

[23]   3GPP TS 32.403: "Telecommunication management; Performance Management (PM); Performance measurements - UMTS and combined UMTS/GSM".

[24]   3GPP TS 32.622: "Telecommunication management; Configuration Management (CM); Generic network resources Integration Reference Point (IRP): Network Resource Model (NRM)".

[25]   W3C REC-xml-20001006: "Extensible Markup Language (XML) 1.0 (Second Edition)".

[26]   W3C REC-xmlschema-0-20010502: "XML Schema Part 0: Primer".

[27]   W3C REC-xmlschema-1-20010502: "XML Schema Part 1: Structures".

[28]   W3C REC-xmlschema-2-20010502: "XML Schema Part 2: Datatypes".

[29]   ITU-T Recommendation X.680: "Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation".

[30]   ISO8601:2000(E) Data elements and interchange formats – Information interchange – Representation of dates and times".

3   Definitions and abbreviations

3.1   Definitions

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

network Element Manager (EM): provides a package of end-user functions for management of a set of closely related types of Network Elements. These functions can be divided into two main categories:

- Element Management Functions for management of Network Elements on an individual basis. These are basically the same functions as supported by the corresponding local terminals.

- Sub-Network Management Functions that are related to a network model for a set of Network Elements constituting a clearly defined sub-network, which may include relations between the Network Elements. This model enables additional functions on the sub-network level (typically in the areas of network topology presentation, alarm correlation, service impact analysis and circuit provisioning).

Network Manager (NM): provides a package of end-user functions with the responsibility for the management of a network, mainly as supported by the EM(s) but it may also involve direct access to the Network Elements. All communication with the network is based on open and well-standardised interfaces supporting management of multi-vendor and multi-technology Network Elements.

Operations System (OS): generic management system, independent of its location level within the management hierarchy

3.2   Abbreviations

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

3G	3rd Generation
AGCH	Access Grant Channel
APN	Access Point Name
ASN.1	Abstract Syntax Notation 1
AuC	Authentication Centre
BER	Basic Encoding Rules
BSC	Base Station Controller
BSS	Base Station System
BSSAP	BSS Application Part
BTS	Base Transceiver Station
CBCH	Cell Broadcast Channel
CCCH	Common Control Channel
DCCH	Dedicated Control Channel
DCN	Data Communication Network
DTD	Document Type Definition
EIR	Equipment Identity Register
EM	(Network) Element Manager
FACCH	Fast Associated Control Channel
FTAM	File Transfer Access and Management

FTP	File Transfer Protocol
GGSN	Gateway GPRS Service Node
GMSC	Gateway Mobile Services Switching Centre
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
GSN	GPRS Service Node
HLR	Home Location Register
HO	Handover
HPLMN	Home PLMN
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
ISDN	Integrated Service Digital Network
ISO	International Standards Organisation
Itf	Interface
LLC	Logical Link Control
LR	Location Register
MS	Mobile Station
MSC	Mobile Services Switching Centre
MSRN	Mobile Subscriber Roaming Number
MTP	Message Transfer Part
NE	Network Element
NM	Network Manager
NSS	Network Sub System (including EIR, HLR, SMS-IWMSC, MSC and VLR)
OA&M	Operation, Administration and Maintenance
OACSU	Off-Air Call Set Up
OS	Operations System (EM, NM)
OSI	Open Systems Interconnection
PCCCH	Packet Common Control Channel
PCCH	Packet Paging Channel
PCH	Paging Channel
PLMN	Public Land Mobile Network
PM	Performance Management
PTCH	Packet Traffic Channel
PVLR	Previous VLR
QoS	Quality of Service
RACH	Random Access Channel
Rec.	Recommendation
RF	Radio Frequency
RNC	Radio Network Controller
RR	Radio Resource
RXLEV	Reception Level
RXQUAL	Reception Quality
SACCH	Slow Associated Control Channel
SCCP	(ITU-T) Signalling Connection Control Part
SDCCH	Stand alone Dedicated Control Channel
SGSN	Serving GPRS Service Node
SMS-IWMSC	Short Message Service Inter Working MSC
SNDCP	Sub Network Dependency Control Protocol
SS	Supplementary Service
TCAP	(ITU-T) Transaction Capabilities Application Part
TCH	Traffic Channel
TFTP	Trivial FTP
TMN	Telecommunications Management Network
TMSI	Temporary Mobile Subscriber Identity
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
UTRAN	Universal Terrestrial Radio Access Network
VLR	Visitors Location Register

4 Concept

Any evaluation of PLMN-system behaviour will require performance data collected and recorded by its NEs according to a schedule established by the EM. This aspect of the management environment is termed Performance Management. The purpose of any Performance Management activity is to collect data, which can be used to verify the physical and logical configuration of the network and to locate potential problems as early as possible. The type of data to be collected is defined by the equivalent measurements (refer to TS 52.402 [22] and TS 32.403 [23]). The present document concentrates on the requirements of GSM and UMTS telecom management to produce this data. Any management actions performed at the OSs subsequently to analyse the performance data are not considered in the present document.

Data is required to be produced by the NEs to support the following areas of performance evaluation:

- traffic levels within the network, including the level of both the user traffic and the signalling traffic (clause 4.1.1);

- verification of the network configuration (clause 4.1.2);

- resource access measurements (clause 4.1.3);

- Quality of Service (e.g. delays during call set-up, packet throughput, etc) (clause 4.1.4); and

- resource availability (e.g. the recording of begin and end times of service unavailability) (clause 4.1.5).

The production of the measurement result data by the NEs also needs to be administered by the EM. Several phases of administration of performance measurements can be distinguished:

- the management of the performance measurement collection process (clause 4.2.1);

- the generation of performance measurement results (clause 4.2.2);

- the local storage of measurement results in the NE (clause 4.2.3);

- the transfer of measurement results from the NE to an OS (EM and/or NM) (clause 4.2.4); and

- the storage, preparation and presentation of results to the operating personnel (clause 4.2.5).

In respect to the evaluation of the results produced by the measurements the following has to be considered:

- to understand the nature of the results received from the network (clause 4.3.1);

- to assure the reliability and accuracy of the measurement results (clause 4.3.2);

- to ensure comparable measurement results for the same measurements being performed in equipment from different vendors (clause 4.3.3);

- the ability to identify the results in the management systems: with respect to the measurement jobs by the EM, and with respect to the measurement types and measured resources by the NM (clause 4.3.4); and

- to take into account that, in a set of n correlated measurements, any (n-1) out of the defined n measurements may be provided by the network (clause 4.3.5).

Performance measurements may also be used to supervise operator defined threshold values and generate alarms upon exceeding the thresholds (clause 4.4).

The following clauses provide further background on the performance measurement concept that is applicable to GSM and UMTS networks. Although any implementation of GSM or UMTS network elements shall adopt the concept described below, not all of the text - due to its conceptual nature - is usable to actually determine compliance of the equipment. In these cases, more strictly specified requirements, against which conformance shall be proven, are found in clause 5 of the present document.

4.1   Measurement result data requirements

This clause describes the typical requirements for performance data to be produced by the NEs, which comprise a GSM or UMTS network. It is important to note that an actual measurement value collected from the network may be used to satisfy requirements in more than one category of measurement described below.

4.1.1   Traffic measurements

Traffic measurements provide the data from which, among other uses, the planning and operation of the network can be carried out.

The types of traffic evaluations for which PLMN specific measurements may be used include:

- traffic load on the radio or core network interfaces (signalling and user traffic);

- usage of resources within the network nodes;

- user activation and use of supplementary services, etc.

Examples of measured values may include:

- pages per location area per hour;

- busy hour call attempts per BSC, RNC, MSC;

- handovers per BSC/RNC per hour, etc.

4.1.2   Network configuration evaluation

Once a network plan, or changes to a network plan, have been implemented it is important to be able to evaluate the effectiveness of the plan or planned changes. Typically, the measurements required to support this activity indicate the traffic levels with particular relevance to the way the traffic uses the network.

4.1.3   Resource access

For accurate evaluation of resource access, each measurement result would need to be produced for regular time intervals across the network, or for a comparable part of the network.

4.1.4   Quality of Service (QoS)

The user of a PLMN views the provided service from outside the network. That perception can be described in observed QoS terms. QoS can indicate the network performance expected to be experienced by the user. For further detail see ITU-T Recommendation E.880 [5].

The QoS parameters applied by the network to specific user services may also be relevant to determine the charges levied towards the user for the provision of those services.

4.1.5   Resource availability

The availability performance is dependent on the defined objectives, i.e. the availability performance activities carried out during the different phases of the life cycle of the system, and on the physical and administrative conditions. For further detail see ITU-T Recommendation E.880 [5].

4.2   Measurement administration

The range of measurements which will be available from the NEs are expected to cover all of the requirements described in clause 4.1. However, not all of these measurements will be required all of the time, from every occurrence, of every relevant NE. Therefore, it is necessary to administer the measurements so as to determine which measurement types, on which measured resources, at which times, are to be executed. With a highly distributed network like a GSM

or UMTS mobile telecommunication system it is also necessary to gather the measurement result data so as to perform consistent analysis of the results and to evaluate the interactions between the NEs.

This clause describes the requirements for the various areas of administration of measurements.

4.2.1   Measurement job administration

Measurement jobs, i.e. the processes which are executed in the NEs in order to accumulate measurement result data and assemble it for collection and/or inspection, will need to be scheduled by the EM for the period or periods for which gathering of data shall be performed.

The administration of measurement jobs by the EM comprises the following actions:

1) Create/delete a measurement job. This action implies the instantiation respectively deletion of a measurement collection process within the network.

2) Modifying a measurement job, i.e. changing the parameters (specifically the schedule) of a measurement job that has been previously created.

3) Definition of measurement job scheduling. This action defines the period or periods during which the measurement job is configured to collect performance data.

4) Specification of the measurement types to be contained in the job, e.g. "number of GPRS attach attempts". In GSM, the measurement jobs are administered by individual measurement types, which are specified in TS 52.402 [22]. In UMTS, the measurement jobs may be administered per individual measurement type or per measurement family, which comprises a collection of related measurement types. The measurement types and families for UMTS and combined GSM/UMTS networks are specified in TS 32.403 [23].

5) Identification of the measured resources, i.e. the NEs (e.g. MSC, NodeB) or NE components (e.g. trunkgroups, radio channels, transceivers) to which the measurement types or measurement families, specified in the measurement job, pertain.

6) Suspend/resume a measurement job. The "suspend" action inhibits the collection of measurement result data by a measurement job, regardless of its schedule, without deleting it. The "resume" action will re-enable measurement result data collection according to the measurement job schedule.

7) Setting up any necessary requirements for the reporting and routing of results to one or more OSs (EM and/or NM).

8) Retrieval of information related to measurement jobs, i.e. view the current measurement job definition.

A measurement job is thus characterised by a set of measurement types and/or measurement families which all pertain to the same set of measured resources and share the same schedule. Typically a large number of measurement jobs will run simultaneously within the NEs comprising the PLMN, and one or more EM is involved in the administration of those measurement jobs. In order for the operator to manage this large number of measurement jobs effectively and efficiently, it is necessary that the administration functions in the EM can not only deal with individual measurements on individual NEs, but also scope the execution environment across the measured resources, and apply an additional filter to the resources/NEs selected by the measurement scope. The scoping and filtering of the measurement(s) shall then be automatically adapted if measured resources that match the selection criteria are added or removed.

There are several instances of this "plug&measure" feature:

1) execute the same (set of) measurement type(s) on a set of identical resources within a single NE. An example of this is to measure the average bit error rate on all channels in a cell, or all channels of the cell that match the filter criterion;

2) execute the same (set of) measurement type(s) on a set of identical NEs or resources according to the hierarchical structure of the network. Examples of this are to measure the average bit rate on all Iu_{PS} links of the same U-MSC or to measure inter-cell handovers for all cells attached to the same BSC;

3) execute the same (set of) measurement type(s) across all resources/NEs of the same type that belong to a specific administrative domain. An example of this is to measure the call set-up failure rate in all cells located in a certain city, or otherwise defined geographical area (this may be a combination of scope and filter), or within the responsibility area of system operator number 2.

The definition of those administrative, or management, domains may be part of either the measurement job administration functions or the CM functions provided by the EM. The functionality of scoping and filtering of measurements within the same NE may either be distributed across the NE and the EM (e.g. EM creates a single measurement job with scope and filter, and NE determines the measured resources that match the selection criteria), or it may be realised solely in the EM (EM determines measured resources from the scope and filter specified by the system operator, and multiple measurement jobs will be created), according to implementation choice.

4.2.2 Measurement result generation

Each measurement job will be collecting result data at a particular frequency, known as the granularity period of the measurement job. At the end of the granularity period a scheduled result report is generated for each measurement job that is actively collecting performance measurement result data, i.e. for all the measurement types and measured resources covered by the job.

The measurement result data can be collected in each NE of the network in a number of ways:

- cumulative incremental counters triggered by the occurrence of the measured event;

- status inspection (i.e. a mechanism for high frequency sampling of internal counters at pre-defined rates);

- gauges (i.e. high tide mark, low tide mark);

- discrete event registration, where data related to a particular event is captured.

These are described in the following clauses.

Cumulative counter: The NE maintains a running count of the event being counted. The counter is reset to a well-defined value (usually "0") at the beginning of each granularity period.

Status inspection: Network elements maintain internal counts for resource management purposes. These counts are read at a predetermined rate, the rate is usually based upon the expected rate of change of the count value. Status inspection measurements shall be reset at the beginning of the granularity period and will only have a valid result at the end of the granularity period.

Gauge: Gauges represent dynamic variables that may change in either direction. Gauges can be integer or real valued. If a gauge is required to produce low and high tide marks for a granularity period (e.g. minimum and maximum call duration), then it shall be reinitialised at the beginning of each granularity period. If a gauge is required to produce a consecutive readout over multiple granularity periods (e.g. cabinet temperature), then it shall only be reinitialised at the start of a recording interval (see definition of "recording interval" in clause 5.2.1.2).

Discrete Event Registration: This is a measurement of a specified event where every Nth event would be taken into account. The value of N is dependent on the frequency of occurrence of the event being measured. Discrete event registration measurements shall be reset at the beginning of each granularity period and will only have a valid result at the end of the granularity period.

4.2.3 Local storage of results at the NE/EM

It is necessary for the NE to retain measurement result data it has produced until they have been sent to, or retrieved by, the destination OS(s). Depending on implementation and configuration details, e.g. the transfer method, the number and type (EM/NM) of the destination OS(s), this data will be retained at the NE under the control of the destination OS(s), or solely under the control of the EM. The storage capacity and the duration for which the data will be retained at the NE will be Operator and implementation dependent.

If the measurement result data are routed to an NM via the EM, then it is necessary for the EM to retain the data at least until they have been successfully transferred to the NM. The storage capacity and the duration for which the data will be retained at the EM are Operator and implementation dependent.

4.2.4 Measurement result transfer

Measurement results produced by the NEs are transferred to an external OS for storage, post-processing, and presentation to the system operator for further evaluation. In a network with more than one OS (e.g. EM and NM) the data may be required by several OSs. It is therefore necessary to support the possibility for multiple destinations for the transfer of measurement result data.

From the NE to the EM, the results of the measurement jobs can be forwarded in either of two standard ways:

1) the scheduled result reports, generated by the measurement jobs executing in the NE, can be sent to the EM as soon as they are available (notifications);

2) the reports can be stored in the NE (files) and transferred to or retrieved by the EM when required.

From the network to the NM, measurement results can be forwarded via a bulk transfer (i.e. file-based) interface. It is an implementation option whether this interface to the NM resides in the EM or in the NEs.

It should be noted that, depending on an Operator's needs, measurement results may have to be transferred to the EM only, the NM only, or both. Depending on a vendor's implementation, measurement results may be transferred to the NM directly from the NE or via the EM. This implies that not all of the result transfer options described above have to be implemented in all cases.

4.2.5 Performance data presentation

The performance data user interface presentation, including the storage and preparation of the data in the OS(s), is outside the scope of the present document.

4.3 Measurement type definitions

This clause looks at the requirements for the definition of the individual measurement types.

4.3.1 Nature of the result

The measurement types defined for the GSM and UMTS systems have to be collected in the NEs. As each NE has its own role to play in the provision of the mobile service then each will have a different perspective on the performance of the network. The measurement type definitions shall, therefore, contain a description of the intended result of the measurement in terms of what is being measured. Appropriate information is included in the measurement type definition templates, see 3GPP TS 52.402 and 3GPP TS 32.403.

4.3.2 Perceived accuracy

The accuracy of measurements can be seen in three ways:

- whether the result produced represents all occurrences of the defined event;

- whether related measurements produced for the same period refer to the same events; or

- whether a measurement result refers to the whole or part of a granularity period.

Representation of all occurrences: the definition of a measurement needs to accurately reflect which types of events are to be included in the collection of the data. If a general event or procedure description can be characterised by several sub-types then the measurement definition will have to be precise as to which sub-types are included or specifically excluded from that measurement. Depending on the measurement definition, it may prove more acceptable to count the event or procedure by causes, e.g. successful termination, unsuccessful termination for all reasons. If the definition of a measurement refers to specific failure causes then care shall be taken to assess whether all causes are included - the sum of which can provide the total number of failures - or whether a count of the total is defined as well as for the specific causes. This is particularly important if not all of the causes are supported by an implementation, or if not all of the causes are requested in the measurement job definition.

Same period for the same two events: consider two events being counted which refer to the same resource allocation procedure, falling on either side of a granularity period boundary. I.e. the attempt is counted in one period while the termination is counted in the subsequent period. This will lead to discrepancies appearing in the actual figures when trying to compare attempt and termination counts for the same period. In order to avoid this discrepancy, implementations shall ensure that the termination of a procedure started within a given granularity period shall be captured within the measurement results for that same period, even if the termination of the procedure falls within the next granularity period.

Measurement collection periods: a typical measurement collection period can be interrupted by system events.

These interruptions can be one or more of the following:

- failure of the measured network resource;

- failure of the procedure being measured, e.g. location update;

- resource only becomes available after the measurement period has commenced;

- procedure only becomes available after the measurement period has commenced.

Any such interruption implies that the affected measurement result is incomplete, and in extreme circumstances, no result reports at all can be generated. In these cases the measurement result shall highlight such interruptions to indicate that the result is suspect. Any actions to be taken subsequently with regards to the usefulness of the data will depend on the circumstances and the requirements of individual Operators.

4.3.3 Comparability of measurement result data

In a multi-vendor network it is important to know that measurement result data produced by equipment from one supplier is equivalent to the measurement result data being produced by the equivalent equipment from another supplier. This is particularly important when analysing data across the whole network. The measurement type definitions (in 3GPP TS 52.402 and 3GPP TS 32.403) shall therefore use a common understanding of the events being measured (e.g. by relating to protocol messages) so as to produce comparable results.

4.3.4 Measurement identification

In complex networks it is easy to generate large amounts of performance data. For the administration of the measurement jobs, and for the attribution of result data to the correct measurements, it is essential for the EM that all measurement result data is recognisable in respect of each request made. For post-processing of the measurement results in the NM, it is essential that measurement results can be attributed to the correct measurement types and NEs/measured resources.

As all the required information to distinguish the measurement results for each request, already exists in the definition of the request, it makes sense to use this information, rather than create anything new. The information, which can be used to distinguish requests from each others may be e.g. NE name, measurement type, granularity period, or a combination of these. NE names defined within the realm of CM (3GPP TS 32. 600 [3] and the associated network resource model in other 32.6xx TSs) shall be reused. For the measurement job administration in the EM, it is also possible to use measurement job ids, or other implementation specific parameters that identify the measurements.

4.3.5 (n-1) out of n approach

The measurement result values generated by a NE can be obtained in a number of different ways. For example, measurements can be defined to provide the number of attempts for a certain procedure plus the number of failures and the number of successes, where the sum of the successes and failures equals the number of attempts. This means that actually any 2 of the above 3 measurements provide the same information. Therefore, an approach has been adopted in the present document and its companions, 3GPP TS 52.402 [22] and 3GPP TS 32.403 [23], to allow a vendor to choose any (n-1) out of the n defined counters for implementation (2 out of 3 in the above example). The benefit of this approach is to avoid redundancy in the measurement implementation, while at the same time leaving freedom for implementation of the measurements in the network elements. As all n result values of the measurement results are relevant for system operators, the missing n^{th} value shall be calculated by post-processing running on the NM.

It is important to note, however, that, depending on the measurement type definition, some implementation choices can offer more detailed information than others. For example, if per-cause failure measurements are specified, then the implementation of the "attempts" and "successes" measurements still allows post-processing to calculate the number of failures, but per cause information can not be derived. Therefore, in this case, the failure measurement should always be implemented, while there is still freedom to choose the "attempts" or the "successes" measurement as the other one to be implemented. The "failure" measurement should still be capable of delivering a total value, if not all failure causes are supported or if the results are not requested for (all of) the failure causes in the set-up of the measurement job.

Note that the principal problem, described above, also exists for measurements where sub-types are specified.

4.4 Performance alarms

Instead of, or in addition to, generating regular scheduled result reports, measurements may be administered in a way so as to supervise operator-defined thresholds. The thresholds are set when instantiating the measurements, and alarms are generated when the threshold value is crossed. These performance alarms are generated instead of, or in addition to, the generation of the scheduled result reports, as configured by the system operator. In UMTS, the alarms are sent to the OS via the Alarm IRP specified in TS 32.111 [21]. In GSM, according to implementation choice, the alarms are sent either via the Alarm IRP or via the Q3 interface specified in the GSM 12.xx series of specifications. Depending on the nature of the measurement (cumulative counter, status inspection, gauge, discrete event registration), the observed value, which is checked against the threshold, can only be derived at the end of a granularity period (status inspection and discrete event registration), and may have to be reset at the beginning of a new granularity period (cf. clause 4.2.2).

A GSM or UMTS NE may also generate threshold alarms based on system-internal supervision of counters and their threshold values. Neither the threshold nor the counters can be administered, but they depend on internal system behaviour, defined by implementation. As the present document only specifies results and alarms based on manageable performance measurements, the system internal threshold alarms explained above are outside the scope of the present document and are solely within the realms of Fault Management.

5 Functional requirements

5.1 Introduction

This clause describes all basic functions to allow the system operator to have measurement data collected by the NEs and to forward the results to one or more OS(s), i.e. EM and/or NM. All functions are gathered to provide the system operator with the means to administer, plan, execute measurements and to store and evaluate the measurement results.

Building on the concept established in clause 4 of the present document, the following clauses further specify the requirements that all standard GSM and UMTS implementations shall comply to.

5.2 Basic functions

The Performance Management concept as applicable in the present document is based on the general framework for 3G-telecom management defined in 3GPP TS 32.101 [1] and 3GPP TS 32.102 [2]. A particular feature of this general framework is the existence of the fully standardised interface labelled "Itf-N", that connects the network with the Network Manager (NM). In the context of Performance Management, Itf-N can be used for:

-   the transfer of files containing performance measurement result data generated in the network;

-   the emission of "performance alarms" (notifications).

It should be pointed out that, on the network side, Itf-N may be implemented either in the NEs or in the EM, according to vendor choice.

As an example, figure 1 outlines this concept in the context of the UTRAN.

As the O&M functions for NodeB are partitioned into Logical and Implementation Specific O&M (see 3GPP TR 32.800 [20]), it should be understood that the functionalities described in the present document are completely within the scope of Implementation Specific O&M. This implies that no information pertaining to measurement administration and result transfer, as described here, is exchanged between the RNC and NodeB via the Iub interface. Such information may, however, be sent or received by the NodeB over the Iub physical bearer, see 3GPP TS 25.442 [4].
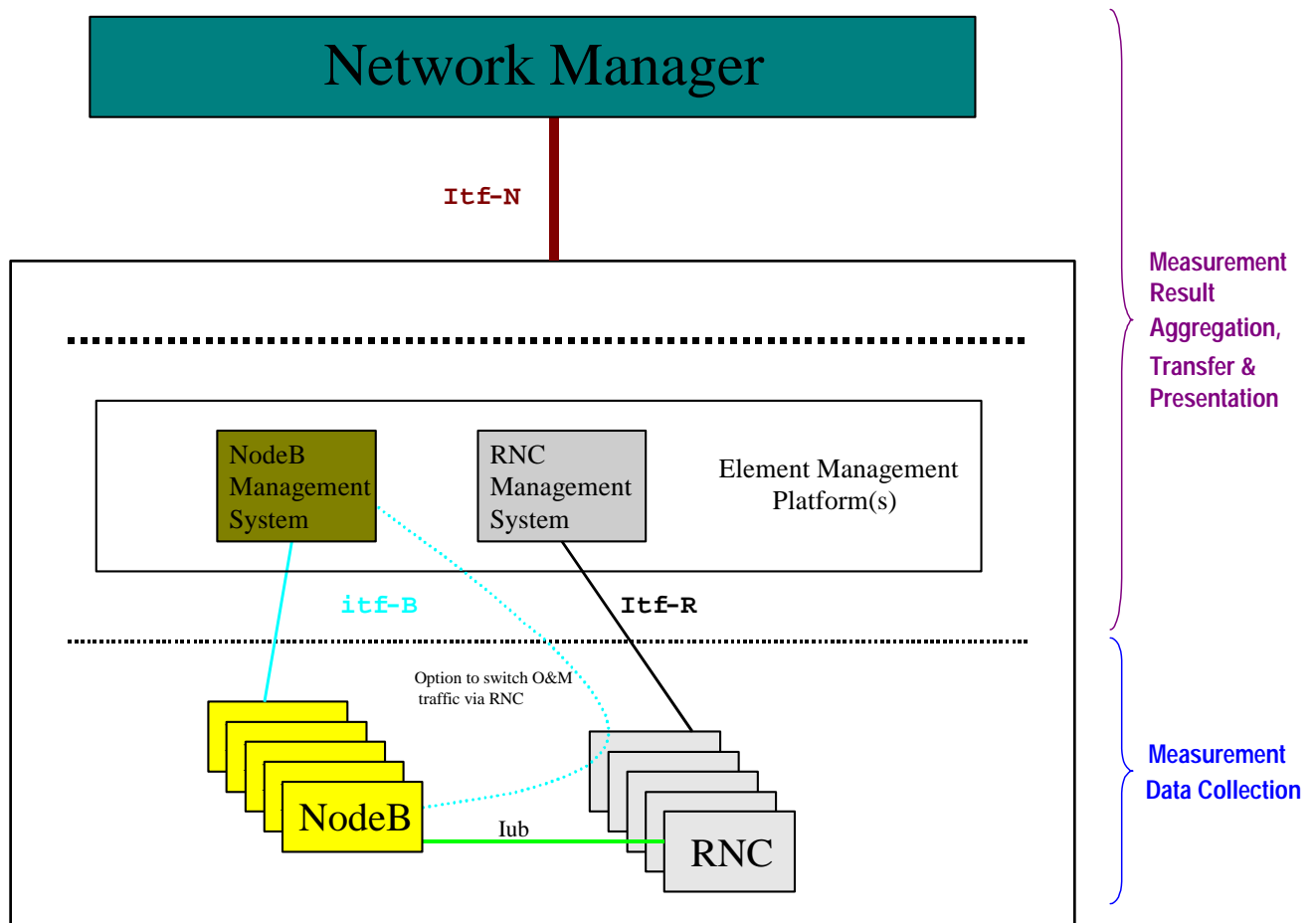
Figure 1: UTRAN Performance management concept

The basic requirement from an NE for measurements is to collect data according to the definition of the measurement jobs and to provide results to at least one OS (EM and/or NM). The data collected in the NE shall be made available for collection by or transfer to the OS(s) according to the schedule defined by the measurement job parameters. The NE shall be able to supply the result data at least to the NM if the Itf-N is implemented in the NEs, result provision from the NE to the EM is optional in this case. The NE shall be able to provide the result data to the EM if the Itf-N is implemented in the EM.

The EM shall be able to administer the measurements, e.g. create/delete measurement jobs and define their schedules. If the measurement results are transferred from the NEs to the EM, then the EM can control:

- the immediate ("real time") transfer of scheduled reports from the NE to the EM;

- the storage of scheduled reports in the NE; and

- deferred retrieval by the EM of scheduled reports stored in the NE.

In GSM, the optional Q3 interface specified in 3GPP TS 52.402 [22] can be used to perform these functions, while in UMTS, they are executed through a proprietary interface. Depending on the implementation option chosen for the Itf-N, the EM and/or NM may be involved in the control of the measurement result transfer to the NM.

The basic functions of the NM are beyond the scope of the present document. However, any NM that supports the network functions as described here must provide the NM side of the Itf-N, and the ability to handle the measurement result data that it receives, according to the file format(s) specified in the present document. The measurement result data may then be used in its original form or post-processed according to the system operator requirements. It is further anticipated that NM systems will have sophisticated functions for the management, preparation and presentation of the measurement result data in various forms.

The following clause summarises the measurement administration functions required in GSM and UMTS networks. They are then specified in more detail in clauses 5.x below.

(Performance) measurement administration functions allow the system operator, using functions of the EM, to determine measurement data collection in the network and forwarding of the results to one or more OS(s).

(Performance) measurement administration functions cover:

1) measurement data collection requirements:

   - **measurement types.** Corresponds to the measurements as defined in 3GPP TS 52.402 [22] and 3GPP TS 32.403 [23], respectively, or defined by other standards bodies, or manufacturer defined measurement types;

   - **measured network resources.** The resource(s) to which the measurement types shall be applied have to be specified, e.g. one or more NodeB(s);

   - **measurement recording**, consisting of periods of time at which the NE is collecting (that is, making available in the NE) measurement data.

2) measurement reporting requirements:

   - this allows the system operator to specify the measurement related information to be reported, if required (e.g. omitting zero valued counts).. The frequency at which scheduled result reports shall be generated also has to be defined, if it may deviate from the granularity period. Particular functions, which exceed the requirements set out in the present document, are provided if the optional Q3 interface specified in 3GPP TS 52.402 [22] is implemented for GSM.

3) measurement result transfer requirements:

   - The result transfer requirements in the present document are limited to the file based Itf-N, used to forward the measurement results to the NM. If ItF-N is implemented in the EM, then measurement results can be transferred from the NE to the EM, and/or they are stored locally in the NE and can be retrieved when required. If Itf-N is implemented in the NEs, then the PM result files are sent directly from the NE to the NM, involving control by the EM as required, The EM shall support all administration functions necessary to fulfil the above result transfer requirement.;

   - measurement results can be stored in the network (NEs or EM, depending on implementation option chosen for Itf-N) for retrieval by the NM when required.

A (performance) measurement job, covers the measurement data collection as described in point 1 above. If the Q3 interface for GSM is implemented, it also covers the measurement reporting requirements, as described in point 2 above. In UMTS, the reporting requirements may be covered by the measurement job, or they may be administered per NE, per management domain, or per EM, as chosen by the vendor. It is up to the implementation whether requirements for the result transfer or the local storage of results are specified within the measurement job, particularly since the use of standard protocols, such as FTP, is foreseen.

A measurement job can be created, modified, displayed or deleted by the EM. In addition, measurement job activities in the NE can be suspended and resumed on request of the EM.

The system operator shall specify the required measurement parameters upon initiation of a measurement job. These parameters consist of, among others, recording schedule, granularity, and measurement type(s), as listed above.

A standard set of measurements that generate the required data is defined in 3GPP TS 52.402 [22] for GSM and 3GPP TS 32.403 [23] for UMTS and combined GSM/UMTS systems. However, a significant number of additional measurements is expected from real implementations. These will mainly consist of measurements for the underlying technologies, which are not 3G specific, such as ATM or IP, but is also due to specific vendor implementations. While the NM interface (Itf-N) for result transfer of both standard and non-standard measurements is fully standardised in annexes A and B of the present document, the interface between EM and NE is only standardised in functional terms. In UMTS, implementation details of this interface are vendor specific. In GSM, it may be implementation specific or implemented in compliance with the OSI interface specified in 3GPP TS 52.402.

5.3 Plug & Measure

To be completed in a later Release.

5.4 Measurement jobs

Measurement jobs may be only visible at the (proprietary) interface between the EM and the NE. Measurement job administration functions in the EM may hide the measurement jobs from the user interface by providing higher levels of abstraction for the benefit of ease of use.

When defining a measurement job, the following aspects have to be considered.

5.4.1 Measurement job characteristics

5.4.1.1 Measurement types

Every measurement job consists of one or more measurement types (as defined in annex C), for which it collects measurement data. The measurement type(s) contained in a job may apply to one or more network resources of the same type, e.g. a measurement job may be related to one or several NodeB(s). A measurement job will only produce results for the measurement type(s) it contains.

5.4.1.2 Measurement sub-types

Many of the measurement types specified for GSM and UMTS networks produce single result values, i.e. the measurement is characterised by a single measurement type as specified in TS 52.402 [22] or TS 32.403 [23]. In other cases, however, the event or procedure being measured can be characterised by several sub-types, or, depending on the measurement definition, by several causes, e.g. successful termination of a procedure and unsuccessful termination for all failure causes. As far as a measurement type is defined to capture per cause information of the event or procedure being measured, the causes and cause codes are specified in "other" 3GPP TSs, i.e. in the TS defining the procedure being measured and not in TS 52.402 [22] or TS 32.403 [23]. In other cases, the sub-types are specified in the measurement type definitions in TS 52.402 [22] and TS 32.403 [23]. For UMTS and combined UMTS/GSM systems, this information is described in detail in the measurement definition templates, see TS 32.403 [23].

Per cause measurements, where the causes are defined in the 3GPP TS that specifies the procedure or event being measured, may lead in certain cases to a huge number of measurement sub-types which will increase substantially the size of the measurement result file. Since not all per cause measurements may be useful for the system operator, two options are possible for the management of the corresponding measurement sub-types:

- support all the sub-types corresponding to the cause codes defined in the 3GPP TS that specifies the procedure or event being measured. In that case, the sum over the result values of all supported per cause measurements is equal to the total sum across all defined sub-types, and therefore no sum value shall be provided in the measurement result files.

- support only a subset of the causes (allowed only if the cause codes are specified in "other" 3GPP TSs). In that case, the first value of the result sequence in the measurement result files must be the total sum across all the sub-types as defined in the "other" 3GPP TS, which may then be different from the sum over the result values of the supported sub-types. The keyword *.sum* placed behind the measurement type is used to identify the sum subtype.

If the definition of a measurement refers to specific failure causes or other sub-types then care shall be taken to assess which causes or sub-types are included. The choice of the supported causes/sub-types in the above cases is manufacturer dependent. Measurement job administration in the EM may also allow the system operators to select the

sub-types of the measurement types that make up the measurement job, otherwise all sub-types supported by an implementation are included.

5.4.1.3 Measurement schedule

The measurement schedule specifies the time frames during which the measurement job will be active. The measurement job is active as soon as the starttime - if supplied in the schedule - is reached. The system shall support a job starttime of up to at least 30 days from the job creation date. If no starttime is provided, the measurement job shall become active immediately. The measurement job remains active until the stoptime - if supplied in the schedule - is reached. If no job stoptime is specified the measurement job will run indefinitely and can only be stopped by EM intervention, i.e. by deleting or suspending the measurement job.

The time frame defined by the measurement schedule may contain one or more recording intervals. These recording intervals may repeat on a daily and/or weekly basis and specify the time periods during which the measurement data is collected within the NE. A recording interval is identified by an interval starttime and an interval endtime, which lie between 00.00 and 24.00 hours, aligned on granularity period boundaries. Thus the length of a recording interval will be a multiple of the granularity period. For a single measurement type it shall be possible to specify several measurement jobs with different recording intervals as long as these intervals do not overlap. If it is required that a measurement type be observed by multiple measurement jobs with overlapping schedules then the system shall support multiple instances of that measurement type.

5.4.1.4 Granularity period

The granularity period is the time between the initiation of two successive gatherings of measurement data. Valid values for the granularity period are 5 minutes, 15 minutes, 30 minutes, 1 hour. The minimum granularity period is 5 minutes in most cases, but for some measurements it may only make sense to collect data in a larger granularity period. The granularity period shall be synchronised on the full hour, but its value is not required to be changeable during the lifetime of the job.

5.4.1.5 Measurement reporting

Each measurement job running on an NE produces scheduled measurement reports at the end of each granularity period, and contains the information as requested by the system operator. This information consists of:

- an identification of the measurement job that generated the report;

- an identification of the involved measurement type(s) and the measured network resource(s) (e.g. NodeB);

- a time stamp, referring to the end of the granularity period;

- for each measurement type, the result value(s) and an indication of the validity of the result value(s);

- an indication if the scan is not complete, and the reason why the scan could not be completed.

The exact layout of the measurement result reports generated by the NEs may be vendor specific. For the result file transfer to the NM via Itf-N, however, annex A of the present document defines in detail which information of the report is included in the result files, as well as the file format. Clause 5.4.2 specifies how these reports can be transferred to the destination EM and/or NM.

5.4.1.6 Illustration of the measurement scheduling principles

The diagram below gives an example of a NE which runs a measurement job, with a 15 minute granularity period, that has a recording interval start and end time, respectively, of 12:00 and 14:00.
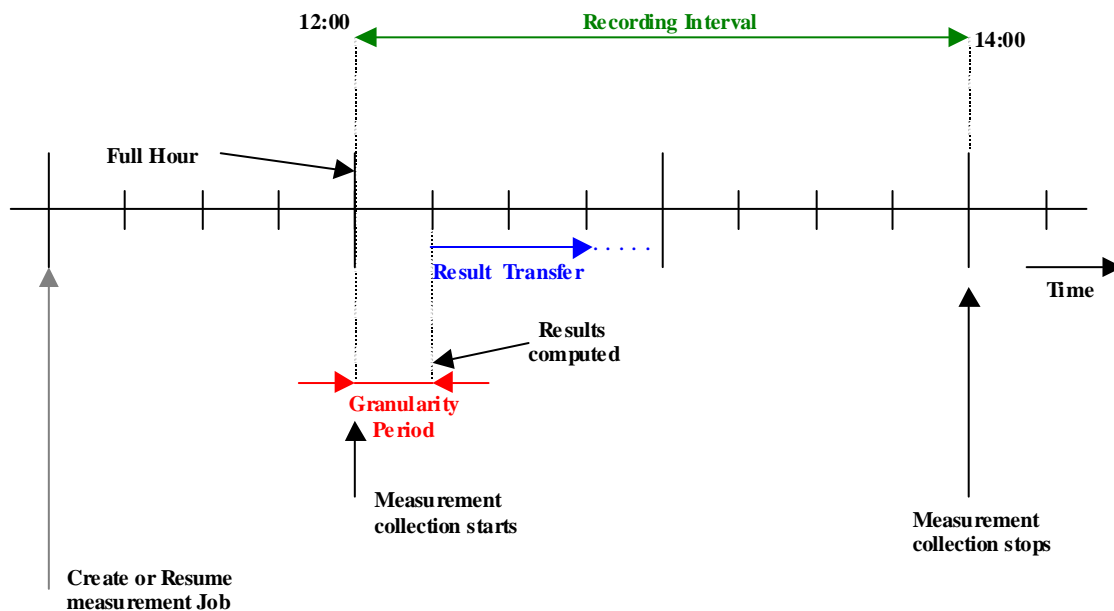
Figure 2

- At 12:00 the measurement job starts collecting data for its defined measurements.

- At 12:15, and every 15 minutes during the Recording Interval, the results for the measurements will be computed from the data gathered over the previous 15 minutes, and measurement reporting occurs as specified in clause 5.3.1.4.

- Beginning at 12:15, the results for the expired granularity periods may be sent to a destination OS.

- At 14:00 the measurement job activity is terminated for this recording interval.

5.4.2 Measurement job state and status attributes

According to the OSI systems management concept, the state of a resource is reflected in indicators (attributes). Status attributes are provided to qualify these state attributes. Full details are provided in ITU-T Recommendation X.731 [6]. As for a measurement job, the following information is provided:

Administrative state: The administrative state attribute allows the system operator to permit or prohibit administratively the execution of the measurement job (suspend/resume).

Operational state: The operational state attribute reflects the operability of the measurement job.

Availability status: The availability status attribute denotes particular conditions applicable to the measurement job. It indicates:

- whether or not the measurement job is collecting measurement data according to its schedule;

- if, for whatever reason, some of the requested measurement data cannot be collected by the measurement job, in particular whether the measurement schedule inhibits the collection of measurement data.

It should be noted that the application of OSI state and status attributes within the 3G-measurement concept does not enforce the provision of an OSI interface for measurement administration.

5.4.3 Measurement job administration

Measurement jobs can be administered by the EM according to the following stipulations.

Creating a measurement job: On creation of a measurement job, all information has to be supplied in order to collect the required data from the selected network resources as specified by the measurement job characteristics (see clause 5.2.1).

Modifying a measurement job: In general, the modification of measurement job parameters may be requested by the EM during the lifetime of a measurement job when the job is suspended (explained below).

Displaying a measurement job: The system operator shall be able to get a list of all measurements that are currently defined, together with all available actual information as stored in the NE. This information consists of the data that is supplied on creation/modification and the actual state and status information of the measurement job.

Deleting a measurement job: A measurement job is automatically deleted by the system when it reaches the job endtime and all scheduled measurement reports have been generated. A created measurement job can also be deleted by manual intervention at any time. When deleted, the measurement process associated with the job is stopped, and all allocated resources are freed.

Suspending/resuming a measurement job: On normal operation, the measurement job collects measurement data within the NE according to the actual values of the measurement job parameters. However, the system operator may decide for some reason to discard temporarily the collection of measurement data (e.g. in case of system overload or congestion, measurement results not used,...). The system operator therefore is able to suspend a defined measurement job at any time, using the Administrative State. This implies that the measurement job definition remains in the system, but that no measurement gathering activities are performed for this job. When the measurement job is resumed, measurement data collection is started again at the next granularity period within the measurement schedule.

5.5 Measurement results

5.5.1 Measurement result characteristics

During its specified recording intervals, each measurement job produces a result at the end of the granularity period if it is not suspended. Annex C provides for each measurement type that is specified within the present document a description of the expected measurement result.

Measurement results for all measurements of a particular measurement job are gathered in a single report at the end of the granularity period. The report may contain - in addition to the specific measurement results - fixed information, which is global for all measurement results associated with that measurement job, such as an identification of the involved network resources and a time stamp referring to the time at which the NE started collecting the measurement results. If measurement results are sent to the EM then the exact format may be vendor specific. For details about the standard file format for the transfer of measurement results to the NM via Itf-N see annex A of the present document.

Once the result reports have been generated, they shall be stored locally within the NE if so requested by the EM/system operator. The storage capacity and duration as well as the method how the data may be deleted from the NE will be implementation dependent.

If some or all of the requested measurement data cannot be collected by a measurement job (administrative state = locked, operational state = disabled, see clause 5.2.2), this shall be indicated in the measurement report, cf. clause 5.2.1.4. In extreme cases, no report at all can be generated by the measurement job. This means that the destination of the result report (EM and/or NM) shall be capable of coping with missing or incomplete measurement reports.

5.5.2   Transfer of measurement results

During the recording intervals specified for a measurement job, scheduled measurement reports are generated at the end of each granularity period if the measurement job is not suspended. These reports can be transferred to the EM in either of two ways:

   1) immediate notifications:

      - the reports are automatically forwarded to the EM at the end of the granularity period.

   2) deferred retrieval:

      - the reports are stored locally in the NE, where they can be retrieved when required.

For each individual report, the transfer of measurement results in either one or both ways is to be established by the system operator, i.e. under the control of the EM. The actual control of the result transfer and the mechanisms applied may be implementation specific.

Each implementation shall support a file transfer facility to an external OS (i.e. not supplied by the NE vendor), such as an NM. This facility shall be implemented using either the FTAM ISO 8751 [7] or (T)FTP protocol. This interface may be located either in the NEs or the EM, as chosen by the vendor. As a result, it may not at all be necessary to transfer measurement result reports to the EM, if:

   - the NM interface is implemented in the NEs, and

   - the Operator chooses to post-process measurement results only in the NM.

Details of the file format to be used on the NM interface can be found in annex A of the present document. The measurement report file conventions and transfer procedure are specified in annex B.

The results of the measurement job can be forwarded to the EM in either of two standard ways:

   1) the scheduled result reports generated by the NE (notifications) can be sent to the EM as soon as they are available;

   2) the reports can be stored in the NE (files) and transferred to or retrieved by the EM when required.

It shall be possible for the EM to specify the details for its result retrieval as a part of the measurement administration.

Measurement results can be forwarded to the NM via a bulk transfer interface. It is an implementation option whether this interface resides in the EM or the NEs. Depending on the implementation, the control of the bulk transfer of measurement results to the NM may involve the EM and/or the NM. See annex B for details.

In a network with more than one OS (e.g. EM and NM) the data produced may be required by several OSs. It is therefore necessary to support the possibility for multiple destinations for transfer of data.

All scenarios for the result transfer, as far as they are relevant for standardisation of 3G systems, are defined above. It should be noted that, depending on an Operator's needs, measurement results may have to be transferred to the EM only, the NM only, or both. Depending on a vendor's implementation, measurement results may be transferred to the NM directly from the NE or via the EM. This implies that not all of the result transfer options described above shall be implemented in all cases, however, those procedures that are implemented shall comply with the present document. A detailed specification of the measurement result transfer to the NM can be found in annex B of the present document.

5.6   Usage of Alarm IRP for performance alarms

Performance alarms allow Network Operators to be quickly informed of significant PM-related events. Authorized users can (a) set the measurement thresholds and (b) define the characteristics of related performance alarm notifications (e.g. perceivedSeverity). Crossing of thresholds shall result in the emission of a performance alarm notification. The configuration and management of thresholds and alarm notification are outside the scope of this document.

Performance alarms may be defined against any managed object supporting measurement definitions, e.g. UtranCell, SgsnFunction. The source object of the performance alarm shall be the source object instance of the measurement that caused the alarm. Upon threshold crossing, the subscribed users (i.e. Notification IRP Managers) shall be notified via

the Alarm IRP and Notification IRP. The Alarm IRP and Notification IRP are described in TS 32.111-2 [21] and TS 32.302 [11].

All parameters of the alarm notification as described in TS 32.111-2 can be used for performance alarms. This information shall be provided by the PM application as the user of the Alarm IRP, with respect to at least the event type, probable cause, perceived severity, and thresholdinfo, plus all other user supplied mandatory parameters of the alarm notification.The parameter thresholdinfo shall be present for all performance alarm notifications and shall contain information pertinent to the context in which the performance alarm was triggered.

The thresholdinfo parameter shall provide the following information:

> The identifier of the measurement which crossed the threshold.

> The value of the measurement.

> The threshold crossing direction (up or down).

> The threshold value (if hysteresis thresholds are supported, both raise and clear trigger values are provided).

Once a performance alarm has been raised, it can be managed as other kinds of alarms, e.g., acknowledged, unacknowledged or annotated. Performance alarms may not be cleared manually (i.e., via the ADMC [automatic detection and manual clearing], see 3GPP TS 32.111-1: "3G Fault Management" [12]). Performance alarms shall be cleared when the threshold is crossed in the opposite direction to the one that triggers the alarm.

Annex A (normative):
Measurement Report File Format

This annex describes the format of measurement result files that can be transferred from the network (NEs or EM) to the NM. Three alternative format definitions are specified, one using ASN.1 (see ITU-T Recommendation X.680 [29]) with binary encoding (BER), the two others applying XML (see [25]), which is ASCII based. Of the two alternative XML format definitions, one is based on DTD, while the other is based on XML schema (see [26], [27] and [28]). Each 3G-system implementation complying with the present document shall support at least one of the three alternatives.

NOTE: It is not intended to have the DTD based XML format from Release 6 onwards defined as one of the alternate valid file formats for measurement result files.

Both the ASN.1 and XML file format definitions implement the measurement result structure and parameters defined in clauses 5.2 and 5.3 of the present document, except from the measurement job id, which is only needed to correlate measurement result reports with measurement jobs within the area of measurement administration (see clause 5.2.1.4). The three defined file format definitions correspond to each other (except with some minor XML specific optimisations). This implies that the value ranges and size constraints defined in the ASN.1 definition shall also be valid for implementations of the XML format definition. From that perspective, the three format definitions can be regarded as three different instances of the same single format.

The following conditions have been considered in defining this file format:

- Since the files are transferred via a machine-machine interface, the files applying the format definitions should be machine readable using standard tools.

- The file format should be independent of the data transfer protocol used to carry the file from one system to another.

- The file format should be generic across 3G systems.

- The file format should be flexible enough to include all possible measurement types, i.e. those specified within annex C as well as measurements defined within other standards bodies, or vendor specific measurement types.

- The file format should not impose any dependency between granularity periods for the generation of measurement results and file upload cycles for the file transfer from the network to the NM.

- The file format should be flexible enough to support both the NE-based and the EM-based approaches, as discussed in annex B, clause B.1.1 of the present document.

- The file format should be usable for other interfaces than Itf-N if required. The measurement file header could be augmented to indicate this other usage, however this would be a non-standard extension. In the ASN.1 file format definition, this is accommodated by the use of the ellipse notation. XML allows such additions through extra DTDs, provided by the definer of the non-standard extension.

A.1 Parameter description and mapping table

Table A.1 maps the tags defined in the ASN.1 file format definition to those used in the XML file format definitions, DTD based and XML schema based. It also provides an explanation of the individual parameters. The XML tags defined in the DTD (see clause A.3.1) have been kept as short as possible in order to minimise the size of the XML measurement result files. XML tag attributes are useful where data values bind tightly to its parent element. They have been used where appropriate.

Table A.1 Mapping of ASN.1 Measurement Report File Format tags to XML tags

ASN.1 Tag	DTD based XML tag	XML schema based XML tag	Description
MeasDataCollection	mdc	measCollecFile	This is the top-level tag, which identifies the file as a collection of measurement data. The file content is made up of a header ("measFileHeader"), the collection of measurement result items ("measData"), and a measurement file footer ("measFileFooter").
measFileHeader	mfh	fileHeader	This is the measurement result file header to be inserted in each file. It includes a version indicator, the name, type and vendor name of the sending network node, and a time stamp ("collectionBeginTime").
measData	md	measData	The "measData" construct represents the sequence of zero or more measurement result items contained in the file. It can be empty in case no measurement data can be provided. The individual "measData" elements can appear in any order. Each "measData" element contains the name of the NE ("nEId") and the list of measurement results pertaining to that NE ("measInfo").
measFileFooter	mff	fileFooter	The measurement result file footer to be inserted in each file. It includes a time stamp, which refers to the end of the overall measurement collection interval that is covered by the collected measurement results being stored in this file.
fileFormatVersion	ffv	fileHeader fileFormatVersion	This parameter identifies the file format version applied by the sender. The format version defined in the present document shall be the abridged number and version of this 3GPP document (see below) for XML formats and the ASN.1 format alike. The abridged number and version of a 3GPP document is constructed from its version specific full reference "3GPP […] (yyyy-mm)" by: - removing the leading "3GPP TS" - removing everything including and after the version third digit, representing editorial only changes, together with its preceding dot character - from the resulting string, removing leading and trailing white space, replacing every multi character white space by a single space character and changing the case of all characters to uppercase.
senderName	sn	fileHeader dnPrefix and fileSender localDn	The senderName uniquely identifies the NE or EM that assembled this measurement file by its Distinguished Name (DN), according to the definitions in 3GPP TS 32.300 [10]. In the case of the NE-based approach, it is identical to the sender's "nEDistinguishedName". For ASN.1 and DTD based XML format, the string may be empty (i.e. string size =0) in case the DN is not configured in the sender. For the XML schema based XML format, the DN is split into the DN prefix and the Local DN (LDN) (see 3GPP TS 32.300 [10]). XML attribute specification "dnPrefix" may be absent in case the DN prefix is not configured in the sender. XML attribute specification "localDn" may be absent in case the LDN is not configured in the sender.
senderType	st	fileSender elementType	This is a user configurable identifier of the type of network node that generated the file, e.g. NodeB, EM, SGSN. The string may be empty (i.e. string size =0) in case the "senderType" is not configured in the sender. For the XML schema based XML format, XML attribute specification "elementType" may be absent in case the "senderType" is not configured in the sender.
vendorName	vn	fileHeader vendorName	The "vendorName" identifies the vendor of the equipment that provided the measurement file. The string may be empty (i.e. string size =0) if the "vendorName" is not configured in the sender. For the XML schema based XML format, XML attribute specification "vendorName" may be absent in case the "vendorName" is not configured in the sender.

ASN.1 Tag	DTD based XML tag	XML schema based XML tag	Description
collectionBeginTime	cbt	measCollec beginTime	The "collectionBeginTime" is a time stamp that refers to the start of the first measurement collection interval (granularity period) that is covered by the collected measurement results that are stored in this file.
nEId	neid	managedElement	The unique identification of the NE in the system. It includes the user name ("nEUserName"), the distinguished name ("nEDistinguishedName") and the software version ("nESoftwareVersion") of the NE.
nEUserName	neun	managedElement userLabel	This is the user definable name ("userLabel") defined for the NE in 3GPP TS 32.622 [24]. The string may be empty (i.e. string size =0) if the "nEUserName" is not configured in the CM applications. For the XML schema based XML format, XML attribute specification "userLabel" may be absent in case the "nEUserName" is not configured in the CM applications.
nEDistinguishedName	nedn	fileHeader dnPrefix and managedElement localDn	This is the Distinguished Name (DN) defined for the NE in 3GPP TS 32.300 [10]. It is unique across an operator's 3G network. The string may be empty (i.e. string size =0) if the "nEDistinguishedName" is not configured in the CM applications. For the XML schema based XML format, the DN is split into the DN prefix and the Local DN (LDN) (see 3GPP TS 32.300 [10]). XML attribute specification "localDn" may be absent in case the LDN is not configured in the CM applications.
nESoftwareVersion	nesw	managedElement swVersion	This is the software version ("swVersion") defined for the NE in 3GPP TS 32.622 [24]. This is an optional parameter which allows post-processing systems to take care of vendor specific measurements modified between software versions. For the XML schema based XML format, XML attribute specification "swVersion" may be absent in case the "nESoftwareVersion" is not configured in the CM applications.
measInfo	mi	measInfo	The sequence of measurements, values and related information. It includes a list of measurement types ("measTypes") and the corresponding results ("measValues"), together with the time stamp ("measTimeStamp") and granularity period ("granularityPeriod") pertaining to these measurements.
measTimeStamp	mts	granPeriod endTime	Time stamp referring to the end of the granularity period.
granularityPeriod	gp	granPeriod duration	Granularity period of the measurement(s) in seconds. For the XML schema based XML format, the value of XML attribute specification "duration" shall use the truncated representation "PTnS" (see [28]).
measTypes	mt	measTypes or measType	This is the list of measurement types for which the following, analogous list of measurement values ("measValues") pertains. The GSM only measurement types are defined in TS 52.402 [22]. The measurement types for UMTS and combined UMTS/GSM implementations are specified in TS 32.403 [23]. For the XML schema based XML format, depending on sender's choice for optional positioning presence, either XML element "measTypes" or XML elements "measType" will be used.
measValues	mv	measValue	This parameter contains the list of measurement results for the resource being measured, e.g. trunk, cell. It includes an identifier of the resource ("measObjInstId"), the list of measurement result values ("measResults") and a flag that indicates whether the data is reliable ("suspectFlag").

ASN.1 Tag	DTD based XML tag	XML schema based XML tag	Description
measObjInstId	moid	measValue measObjLdn	The "measObjInstId" field contains the local distinguished name (LDN) of the measured object within the scope defined by the "nEDistinguishedName" (see 3GPP TS 32.300 [10]). The concatenation of the "nEDistinguishedName" and the "measObjInstId" yields the DN of the measured object. The "measObjInstId" is therefore empty if the "nEDistinguishedName" already specifies completely the DN of the measured object, which is the case for all measurements specified on NE level. For example, if the measured object is a "ManagedElement" representing RNC "RNC-Gbg-1", then the "nEDistinguishedName" will be for instance "DC=a1.companyNN.com,SubNetwork=1,IRPAgent=1,SubNetwork=CountryNN,MeContext=MEC-Gbg-1,ManagedElement=RNC-Gbg-1", and the "measObjInstId" will be empty. On the other hand, if the measured object is a "UtranCell" representing cell "Gbg-997" managed by that RNC, then the "nEDistinguishedName" will be for instance the same as above, i.e. "DC=a1.companyNN.com,SubNetwork=1,IRPAgent=1,SubNetwork=CountryNN,MeContext=MEC-Gbg-1,ManagedElement=RNC-Gbg-1", and the "measObjInstId" will be for instance "RncFunction=RF-1,UtranCell=Gbg-997". The class of the "measObjInstId" is defined in item F of each measurement definition template.
measResults	r	measResults or r	This parameter contains the sequence of result values for the observed measurement types. The "measResults" sequence shall have the same number of elements, which follow the same order as the measTypes sequence. Normal values are INTEGERs and REALs. The NULL value is reserved to indicate that the measurement item is not applicable or could not be retrieved for the object instance. For the XML schema based XML format, depending on sender's choice for optional positioning presence, either XML element "measResults" or XML elements "r" will be used.
suspectFlag	sf	suspect	Used as an indication of quality of the scanned data. FALSE in the case of reliable data, TRUE if not reliable. The default value is "FALSE", in case the suspect flag has its default value it may be omitted.
timeStamp	ts	measCollec endTime	This tag carries the time stamp that refers to the end of the measurement collection interval (granularity period) that is covered by the collected measurement results that are stored in this file. The minimum required information within timestamp is year, month, day, hour, minute, and second.
Not Required	mt p	measType p	An optional positioning XML attribute specification of XML elements "mt" (DTD based) and "measType" (XML schema based), used to identify a measurement type for the purpose of correlation to a result. The value of this XML attribute specification is expected to be a non-zero, non-negative integer value that is unique for each instance of XML element "mt" or "measType" that is contained within the measurement data collection file.
Not Required	r p	r p	An optional positioning XML attribute specification of XML element "r", used to correlate a result to a measurement type. The value of this XML attribute specification should match the value of XML attribute specification "p" of corresponding XML element "mt" " (DTD based) or "measType" (XML schema based).

The measInfo contains the sequence of measurements, values and related information, in a table-oriented structure. A graphical representation of this structure, together with an ASN.1 and a XML example, can be found in annex C.

The representation of all timestamps in PM files shall follow the representations allowed by the ISO 8601 [30]. The precise format for timestamp representation shall be determined by the technology used for encoding the PM file (e.g. ASN.1, XML DTD, XML Schema). The choice of technology should ensure that this representation is derived from ISO 8601 [30]. Based on the representation used, the timestamp shall refer to either UTC time or local time or local time with offset from UTC.

At least for those measurement types that are re-used from non-3GPP standards (e.g. IP, ATM), it is required that the measType be operator definable. This is necessary to allow the operator to harmonise the numbering between different vendors' systems where appropriate. Through this harmonisation, it can be assured that identical measurements always carry the same measType value, which is required by the post-processing system. This requirement will eventually be reflected in TS 52.402 [22] and TS 32.403 [23], which specify the performance measurements for GSM (TS 52.402 [22]) and UMTS and combined UMTS/GSM systems (TS 32.403 [23]).

A.2 ASN.1 file format definition

For ASN.1 formatted files, BER encoding rules shall apply. Embedded comments are integral parts of the standard format; i.e. any implementation-claiming conformance to this annex shall also conform to the comments.

```
PM-File-Description
DEFINITIONS AUTOMATIC TAGS::= BEGIN
MeasDataCollection::= SEQUENCE
    {
    measFileHeader  MeasFileHeader,
    measData    SEQUENCE OF MeasData,
    measFileFooter  MeasFileFooter
    }

MeasFileHeader::= SEQUENCE
    {
    fileFormatVersion   PrintableString (SIZE (0..15)),
    senderName  PrintableString (SIZE (0..400)),
    senderType  SenderType,
    vendorName  PrintableString (SIZE (0..32)),
    collectionBeginTime TimeStamp,
    ...
    }
-- The sole purpose of the ellipse notation used in the file header is to facilitate inter-release
compatibility, vendor specific additions are not allowed in implementations claiming conformance to
the TS.  However, it is acknowledged that this feature does enable the use of non-standard
extensions to the file header without loosing compatibility to the file format specified in the
present document.

SenderType::= PrintableString (SIZE (0..8))

TimeStamp::= GeneralizedTime

MeasData::= SEQUENCE
    {
    nEId        NEId,
    measInfo        SEQUENCE OF MeasInfo
    }

NEId::= SEQUENCE
    {
    nEUserName      PrintableString (SIZE (0..64)),
    nEDistinguishedName     PrintableString (SIZE (0..400)),
    nESoftwareVersion       PrintableString (SIZE (0..64)) OPTIONAL
    }

MeasInfo::= SEQUENCE
    {
    measTimeStamp       TimeStamp,
    granularityPeriod       INTEGER,
    measTypes       SEQUENCE OF MeasType,
    measValues      SEQUENCE OF MeasValue
    }

MeasType::= PrintableString (SIZE (1..64))
MeasValue::= SEQUENCE
    {
    measObjInstId       MeasObjInstId,
    measResults     SEQUENCE OF MeasResult,
    suspectFlag     BOOLEAN DEFAULT FALSE
    }

MeasObjInstId::= PrintableString (SIZE (0..400))

-- The size of the concatenated MeasObjInstId and neDistinguishedName must not exceed 400.
```

```
MeasResult::= CHOICE
    {
        iValue  INTEGER,
        rValue  REAL,
        noValue NULL,
        ...
    }

--  Normal values are INTEGERs and REALs.  The NULL value is reserved to indicate that the
measurement item is not applicable or could not be retrieved for the object instance.  The sole
purpose of the ellipse notation used in the MeasResult choice is to facilitate inter-release
compatibility in case the choice needs to be extended in future releases.

MeasFileFooter::= TimeStamp
END
```

A.3   DTD based XML file format definition

The character encoding shall be a subset of UTF-8. The characters in the ASN.1 type PrintableString are allowed, i.e.:

- A-Z;

- a-z;

- 0-9;

- <space> ' ( ) + , - . / : = ?'.

For encoding of the information content, XML (see Extensible Markup Language (XML) 1.0, W3C Recommendation 10-Feb-98) will be used. The XML **document type definition** contains the mark-up declarations that provide a grammar for the measurement file format. This grammar is known as a Document Type Definition (DTD).
The DTD to be used is defined below. The type definitions and constraints for data types and values defined in the ASN.1 format, such as string sizes, shall implicitly be applied to the XML result files also. The representation of the timestamps within the XML file shall follow the "GeneralizedTime" ASN.1 type.

```
<!-- MeasDataCollection.dtd version 2.0-->
<?xml version="1.0" encoding="UTF-8"?>
<!ELEMENT mdc (mfh , md*, mff )>
<!ELEMENT mfh (ffv, sn, st, vn, cbt) >
<!ELEMENT md (neid , mi*)>
<!ELEMENT neid (neun, nedn, nesw?)>
<!ELEMENT mi (mts,gp, mt*, mv*)>
<!ELEMENT mv (moid , r*, sf? )>
<!ELEMENT mff (ts)>
<!ELEMENT ts (#PCDATA)>
<!ELEMENT sf (#PCDATA)>
<!ELEMENT r (#PCDATA)>
<!ATTLIST r p CDATA "">
<!ELEMENT mt (#PCDATA)>
<!ATTLIST mt p CDATA "">
<!ELEMENT moid (#PCDATA)>
<!ELEMENT gp (#PCDATA)>
<!ELEMENT mts (#PCDATA)>
<!ELEMENT nedn (#PCDATA)>
<!ELEMENT neun (#PCDATA)>
<!ELEMENT nesw (#PCDATA)>
<!ELEMENT cbt (#PCDATA)>
<!ELEMENT vn (#PCDATA)>
<!ELEMENT st (#PCDATA)>
<!ELEMENT sn (#PCDATA)>
<!ELEMENT ffv (#PCDATA)>

<!-- end of MeasDataCollection.dtd -->
```

The number of Measurement Result tags (r) per observed object instance tags (moid) shall always equal the number of Measurement Types (mt) tags. In case the result is a REAL value the decimal separator shall be ".". In case the result is "NULL" then the "r" mark-up shall be empty.

The following header shall be used in actual XML measurement result files (cf. annex D for an example):

```
<?xml version="1.0" encoding="UTF-8"?>
```

```
<?xml-stylesheet type="text/xsl" href="MeasDataCollection.xsl" ?>
<!DOCTYPE mdc SYSTEM "MeasDataCollection.dtd" >
<mdc xmlns:HTML="http://www.w3.org/TR/REC-xml">
```

- - Line 1: xml version number 1 shall be used.

- - The reference to an XSL (Extensible Stylesheet Language) or CSS (Cascading Style Sheet) file in line 2 of the header is optional. It may be configured by the operator to be inserted for the purpose of presenting the XML file in a web browser GUI. It is up to the receiver of the file to decide on the usage of this stylesheet reference, e.g. ignore it if not needed or choosing a configured default if no style sheet reference is supplied in the file.

- - Line 4: A reference to the W3C Recommendation web page for XML.

    Quick guide to XML notation: ? zero or one occurrence
    + one or more occurrences
    * zero or more occurrences
    #PCDATA parsed character data

A.4 XML schema based XML file format definition

A.4.1 Measurement collection data file XML diagram

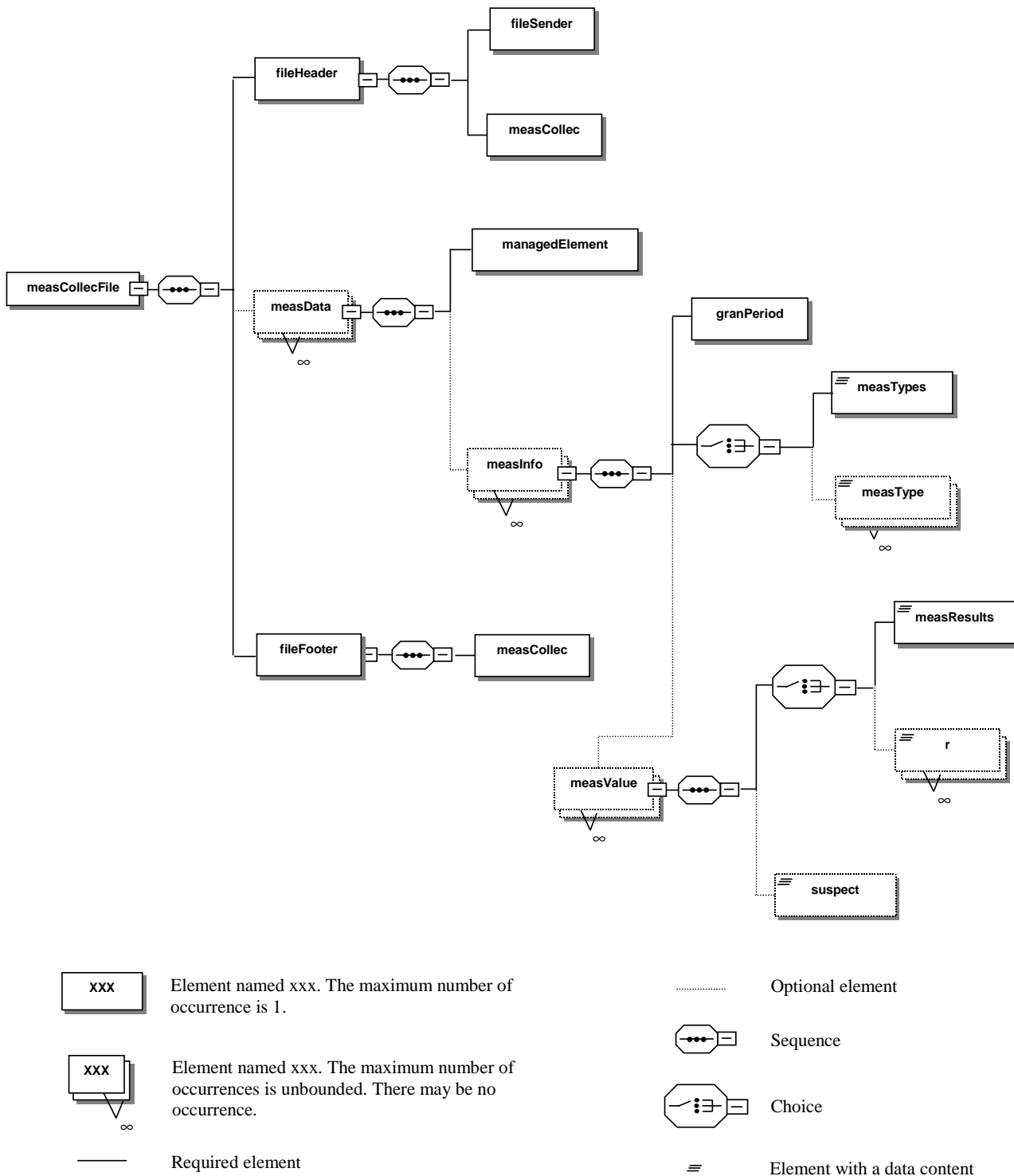Figure A.1 describes the XML element structure of the measurement collection data file:

Figure A.1: XML diagram of the measurement collection data file

A.4.2   Measurement collection data file XML schema

The following XML schema measCollec.xsd is the schema for measurement collection data XML files:

```xml
<?xml version="1.0" encoding="UTF-8"?>

<!--
  3GPP TS 32.401 PM Concept and Requirements
  Measurement collection data file XML schema
  measCollec.xsd
-->

<schema
  targetNamespace=
"http://www.3gpp.org/ftp/specs/latest/rel-5/32_series/32401-540.zip#measCollec"
  elementFormDefault="qualified"
  xmlns="http://www.w3.org/2001/XMLSchema"
  xmlns:mc=
"http://www.3gpp.org/ftp/specs/latest/rel-5/32_series/32401-540.zip#measCollec"
>

  <!-- Measurement collection data file root XML element -->

  <element name="measCollecFile">
    <complexType>
      <sequence>
        <element name="fileHeader">
          <complexType>
            <sequence>
              <element name="fileSender">
                <complexType>
                  <attribute name="localDn" type="string" use="optional"/>
                  <attribute name="elementType" type="string" use="optional"/>
                </complexType>
              </element>
              <element name="measCollec">
                <complexType>
                  <attribute name="beginTime" type="dateTime" use="required"/>
                </complexType>
              </element>
            </sequence>
            <attribute name="fileFormatVersion" type="string" use="required"/>
            <attribute name="vendorName" type="string" use="optional"/>
            <attribute name="dnPrefix" type="string" use="optional"/>
          </complexType>
        </element>
        <element name="measData" minOccurs="0" maxOccurs="unbounded">
          <complexType>
            <sequence>
              <element name="managedElement">
                <complexType>
                  <attribute name="localDn" type="string" use="optional"/>
                  <attribute name="userLabel" type="string" use="optional"/>
                  <attribute name="swVersion" type="string" use="optional"/>
                </complexType>
              </element>
              <element name="measInfo" minOccurs="0" maxOccurs="unbounded">
                <complexType>
                  <sequence>
                    <element name="granPeriod">
                      <complexType>
                        <attribute
```

```
                                name="duration"
                                type="duration"
                                use="required"
                              />
                              <attribute
                                name="endTime"
                                type="dateTime"
                                use="required"
                              />
                          </complexType>
                        </element>
                        <choice>
                          <element name="measTypes">
                            <simpleType>
                              <list itemType="Name"/>
                            </simpleType>
                          </element>
                          <element name="measType"
                                   minOccurs="0" maxOccurs="unbounded">
                            <complexType>
                              <simpleContent>
                                <extension base="Name">
                                  <attribute name="p"
                                              type="positiveInteger" use="required"/>
                                </extension>
                              </simpleContent>
                            </complexType>
                          </element>
                        </choice>
                        <element name="measValue"
                                 minOccurs="0" maxOccurs="unbounded">
                          <complexType>
                            <sequence>
                              <choice>
                                <element name="measResults">
                                  <simpleType>
                                    <list itemType="mc:measResultType"/>
                                  </simpleType>
                                </element>
                                <element name="r"
                                         minOccurs="0" maxOccurs="unbounded">
                                  <complexType>
                                    <simpleContent>
                                      <extension base="mc:measResultType">
                                        <attribute name="p" type="positiveInteger"
                                                              use="required"/>
                                      </extension>
                                    </simpleContent>
                                  </complexType>
                                </element>
                              </choice>
                              <element name="suspect" type="boolean" minOccurs="0"/>
                            </sequence>
                            <attribute name="measObjLdn"
                                       type="string" use="required"/>
                          </complexType>
                        </element>
                      </sequence>
                  </complexType>
                </element>
              </sequence>
          </complexType>
      </element>
```

ETSI

```
            <element name="fileFooter">
              <complexType>
                <sequence>
                  <element name="measCollec">
                    <complexType>
                      <attribute name="endTime" type="dateTime" use="required"/>
                    </complexType>
                  </element>
                </sequence>
              </complexType>
            </element>
          </sequence>
        </complexType>
      </element>

      <simpleType name="measResultType">
        <union memberTypes="decimal">
          <simpleType>
            <restriction base="string">
              <enumeration value="NIL"/>
            </restriction>
          </simpleType>
        </union>
      </simpleType>

    </schema>
```

A.4.3   Measurement collection data file XML header

The following header shall be used in actual XML measurement result files (cf. annex D for examples):

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="MeasDataCollection.xsl"?>
<measCollecFile
  xmlns=
"http://www.3gpp.org/ftp/specs/latest/rel-5/32_series/32401-540.zip#measCollec"
>
```

Annex B (normative):
Measurement Report File Conventions and Transfer Procedure

This annex describes the conventions how files containing performance measurement results are generated in the network (EM or NEs) and the procedure to transfer these files from the network to the NM.

B.1   Conventions

The following clauses define conventions for the generation and the naming of measurement-result files.

B.1.1   File generation

Since vendors may choose to implement the NM interface either in the NEs or the EM, the measurement result files for collection by the NM (push or pull transfer mechanism) may be provided by the NEs or the EM. Note that within one 3G network both possibilities may occur, since NEs of different types may use either one of the two possible approaches (NE based or EM based). This is particularly true in a multi-vendor network.

The procedures for the transfer of the files to the NM from either the NE or the EM are described in clause B.2.

B.1.1.1   NE based approach

The NE shall generate one file immediately at the end of each granularity period. This file shall contain all measurement results produced by the NE within that granularity period. For example, if a NodeB runs 10 measurements with a granularity period of 15 minutes and 5 measurements with a granularity period of 5 minutes, then it shall generate one file containing 10 results every 15 minutes, and one file containing 5 measurement results every 5 minutes.

In the event of two or more granularity periods coming to an end at the same time, the NE shall generate one file per granularity period. Hence in the above example, the NodeB shall generate 2 files – one containing 10 results (15min granularity period) and the other containing 5 measurement results (5min granularity period), when the end time of the granularity periods coincide.

The NE and the granularity period shall be identified both in the file name and the file contents. NE identifiers (names) used for the files shall be in accordance with the NE naming conventions defined in 3GPP TS 32.300 [10]. The file shall be available for transfer to or collection by the NM as soon as all applicable results have been assembled.

Each NE is responsible for the generation and maintenance of the files pertaining to its own measurements (i.e. the measurements it executes). In particular, this implies that the RNC is not involved in the generation, provision or transfer of measurement result files of its controlled NodeBs, i.e. for the measurements defined for the NodeB in the present document, no results will be sent via the Iub interface. (Note that NodeB measurement results may be routed across the same physical interface as Iub, see 3GPP TS 25.442 [4] for details).

B.1.1.2   EM based approach

This approach requires that measurement results be forwarded to the EM according to the mechanisms described in clause 4.2.4 of the present document. The EM may choose to provide measurement result files as described above for the NEs, however, additional flexibility may be offered. For example, measurement results from several granularity periods and/ or several NEs could be written into one single file. These NEs may be determined based on network hierarchy (e.g. all NodeBs controlled by the same RNC, all NEs controlled by the same EM), or management domains configured by the system operator (e.g. NodeBs belonging to a certain (management or geographical) area). In case such rules are applied by the EM for the routing of measurement results to specific files then they shall be operator configurable. If results from more than one NE are contained in a file, the NE identifier used for the file shall be the EM name as defined in 3GPP TS 32.300 [10], or a domain name configured by the system operator. If results from more than one granularity period are contained in the file then the beginning of the first and the end of the last granularity period shall be indicated in the file name.

The file shall be made available for transfer to or collection by the NM as soon as all applicable results have been assembled.

B.1.2 File naming

The following convention shall be applied for measurement result file naming:

<Type><Startdate>.<Starttime>-[<Enddate>.]<Endtime>_[<UniqueId>][_-_<RC>]

1) The Type field indicates if the file contains measurement results for single or multiple NEs and/or granularity periods, where:

   - "A" means single NE, single granularity period;

   - "B" indicates multiple NEs, single granularity period;

   - "C" signifies single NE, multiple granularity periods;

   - "D" stands for multiple NEs, multiple granularity periods.

Note that files generated by the NEs will always have the Type field set to "A".

2) The Startdate field indicates the date when the granularity period began if the Type field is set to A or B. If the Type field is either "C" or "D" then Startdate contains the date when the first granularity period of the measurement results contained in the file started. The Startdate field is of the form YYYYMMDD, where:

   - YYYY is the year in four-digit notation;

   - MM is the month in two digit notation (01 - 12);

   - DD is the day in two digit notation (01 - 31).

3) The Starttime field indicates the time when the granularity period began if the Type field is set to A or B. If the Type field is either "C" or "D" then Starttime contains the time when the first granularity period of the measurement results contained in the file began. The Starttime field is of the form HHMMshhmm, where:

   - HH is the two digit hour of the day (local time), based on 24 hour clock (00 - 23);

   - MM is the two digit minute of the hour (local time), possible values are 00, 05, 10, 15, 20, 25, 30, 35, 40, 45, 50, and 55;

   - s is the sign of the local time differential from UTC (+ or -), in case the time differential to UTC is 0 then the sign may be arbitrarily set to "+" or "-";

   - hh is the two digit number of hours of the local time differential from UTC (00-23);

   - mm is the two digit number of minutes of the local time differential from UTC (00-59).

4) The Enddate field shall only be included if the Type field is set to "C" or "D", i.e. measurement results for multiple granularity periods are contained in the file. It identifies the date when the last granularity period of these measurements ended, and its structure corresponds to the Startdate field.

5) The Endtime field indicates the time when the granularity period ended if the Type field is set to A or B. If the Type field is either "C" or "D" then Endtime contains the time when the last granularity period of the measurement results contained in the file ended. Its structure corresponds to the Starttime field, however, the allowed values for the minute of the hour are 05, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, and 00.

6) UniqueId. This is the name of the NE, EM or domain, as defined in clauses B.1.1.1 and B.1.1.2 (e.g. a distinguishedName). The field may be omitted only if the distinguishedName is not available from the CM applications.

7) The RC parameter is a running count, starting with the value of "1", and shall be appended only if the filename is otherwise not unique, i.e. more than one file is generated and all other parameters of the file name are identical. Therefore it may only be used by the EM, since the described situation can not occur with NE generated files.

Note that the delimiter for this field, _-_, is an underscore character (_), followed by a minus character (-), followed by an underscore character (_).

Some examples describing file naming convention:

1) file name: A20000626.2315+0200-2330+0200_NodeBId,
   meaning: file produced by NodeB <NodeBId> on June 26, 2000, granularity period 15 minutes from 23:15 local to 23:30 local, with a time differential of +2 hours against UTC.

2) file name: B20021224.1700-1130-1705-1130_EMId,
   meaning: file containing results for multiple NEs, produced by EM <EMId> on December 24, 2002, granularity period 5 minutes from 17:00 local to 17:05 local, with a time differential of –11:30 hours against UTC.

3) file name: D20050907.1030+0000-20050909.1500+0000_DomainId_-_2,
   meaning: file containing results for NEs belonging to domain <DomainId>, start of first granularity period 07 September 2005, 10:30 local, end of last granularity period 09 September 2005, 15:00 local, with a time differential of 0 against UTC. This file is produced by the EM managing the domain, and it is the second file for this domain/granularity periods combination.

B.2.   File transfer procedure

Both push (i.e. triggered by the NE) and pull (triggered by the OS) transfer modes shall be supported on the NM interface. Implementation specific means may be employed for the administration and control of the file transfer, concerning:

- the time of the transfer (in push mode);

- the routing of the transfer to one or more OS(s) (in push mode);

- the storage/deletion of the files in the NE, particularly when the EM based approach is chosen (cf. clause B.1.1.1).

Measurement result files shall be retained by the file generator (i.e. NE or EM) at least until they have been successfully transferred to or collected by the NM. The storage capacity and the duration for which the data can be retained at the NE or the EM will be Operator and implementation dependent.

The file transfer procedure implemented in the system (NE or EM) shall ensure that no data can get lost under normal operating conditions. The procedure shall also ensure that the files will be deleted after successful transfer to the NM. Depending on the exact implementation of the procedure, the NM may be responsible for deleting those files, or older files will be eventually overwritten by new ones by the file generator in a round robin fashion.

Each implementation shall support all primitives of the selected protocol (e.g. put file, get file, inspect directory contents, delete file) which are needed by the NM. These primitives depend on the details of the procedure, as defined by the manufacturer.

Annex C (informative):
The table oriented file format structure

Measurement Items (counters) are typically grouped according functionality (cf. GSM 12.04 [8] Measurement Function). The term "measured object class" is used to identify such a group. The file format is based on the fact that the measurements are always collected in sets of one functional group.

The measInfo contains the sequence of measurements, values and related information, in a table-oriented structure. It includes a list of measurement types ("measTypes") and the corresponding values ("measValues"), together with the time stamp ("measTimeStamp") and granularity period ("granularityPeriod") pertaining to these measurements. Whenever one of these 4 elements changes, then a new measInfo sequence is started. If the "measTypes" change, then also the "measValues" change, because these elements are connected in the following way: the "measTypes" correspond to a specific measurement object (NE, trunk, cell, …), of which one or more instances can exist inside the NE.

Hence for one set of "measTypes", there can be one or more sets of "measValues", according to the "measObjInstId".

The above is best explained with an example: consider the CELL measurement function (GSM 12.04 [8]). Then the measured object class is Cell. The measInfo contains a "header" line defining which measurements related to Cell are collected (measTypes), and in which order. The subsequent "data" lines will then contain the values of the measurements for each specific cell, which is measured, one data line per cell (measValues).

This format will generate a kind of table with as column headings the measurement names, and in the rows the corresponding measurement values per measured instance.

C.1 Graphical representation of the table structure

For clarity, the table in the example below only contains the measTypes and measValues (and suspectFlag), not the granularityPeriod and the measTimeStamp.

	attTCHSeizures	succTCHSeizures	attImmediateAssignProcs	succImmediateAssignProcs	
cell=997	234	345	567	789	false
cell=998	890	901	123	234	false
cell=999	456	567	678	789	false

C.2 Example of ASN.1 Measurement Report File

For readability, a kind of pseudo ASN.1 was used in stead of the BER encoding.

```
MeasDataCollection ::= {
    measFileHeader  {
        fileFormatVersion ::= "32.401 V5.0",
        senderName ::=
"DC=a1.companyNN.com,SubNetwork=1,IRPAgent=1,SubNetwork=CountryNN,MeContext=MEC-Gbg-
1,ManagedElement=RNC-Gbg-1" ,
        senderType  ::= "RNC",
        vendorName  ::= "Company NN",
        collectionBeginTime  ::= 20000301140000
        },
    measData   {
        nEId {
            nEUserName  ::= "RNC Telecomville",
            nEDistinguishedName  ::=
"DC=a1.companyNN.com,SubNetwork=1,IRPAgent=1,SubNetwork=CountryNN,MeContext=MEC-Gbg-
1,ManagedElement=RNC-Gbg-1",
            nESoftwareVersion  ::= "2.1"
        },
        measInfo {
            measTimeStamp ::= 20000301141430,
            granularityPeriod ::= 900,
            measTypes  {
 "attTCHSeizures", "succTCHSeizures", "attImmediateAssignProcs", "succImmediateAssignProcs"
```

```
},
            measValues {
                   {
measObjInstId ::= "RncFunction=RF-1,UtranCell=Gbg-997",
measResults { iValue ::= 234, iValue ::= 345, iValue ::= 567, iValue ::= 789},
suspectFlag ::= FALSE
},
                   {
measObjInstId ::= "RncFunction=RF-1,UtranCell=Gbg-998",
measResults { iValue ::= 890, iValue ::= 901, iValue ::= 123, iValue ::= 234},
suspectFlag ::= FALSE
},
                   {
measObjInstId ::= "RncFunction=RF-1,UtranCell=Gbg-999",
measResults { iValue ::= 456, iValue ::= 567, iValue ::= 678, iValue ::= 789},
suspectFlag ::= TRUE
}
}
        }
},
    measFileFooter ::= 20000301141500
}
```

C.3 Example of DTD based XML Measurement Report File

The following is an example of a DTD based XML measurement report file without use of optional positioning attributes on measurement types and results:

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="MeasDataCollection.xsl"?>
<!DOCTYPE mdc SYSTEM "MeasDataCollection.dtd">
<mdc>
  <mfh>
    <ffv>32.401 V5.0</ffv>
    <sn>DC=a1.companyNN.com,SubNetwork=1,IRPAgent=1,SubNetwork=CountryNN,MeContext=MEC-Gbg-
1,ManagedElement=RNC-Gbg-1</sn>
    <st>RNC</st>
    <vn>Company NN</vn>
    <cbt>20000301140000</cbt>
  </mfh>
  <md>
    <neid>
      <neun>RNC Telecomville</neun>
      <nedn>DC=a1.companyNN.com,SubNetwork=1,IRPAgent=1,SubNetwork=CountryNN,MeContext=MEC-Gbg-
1,ManagedElement=RNC-Gbg-1</nedn>
    </neid>
    <mi>
      <mts>20000301141430</mts>
      <gp>900</gp>
      <mt>attTCHSeizures</mt>
      <mt>succTCHSeizures</mt>
      <mt>attImmediateAssignProcs</mt>
      <mt>succImmediateAssignProcs</mt>
      <mv>
        <moid>RncFunction=RF-1,UtranCell=Gbg-997</moid>
        <r>234</r>
        <r>345</r>
        <r>567</r>
        <r>789</r>
      </mv>
      <mv>
        <moid>RncFunction=RF-1,UtranCell=Gbg-998</moid>
        <r>890</r>
        <r>901</r>
        <r>123</r>
        <r>234</r>
      </mv>
      <mv>
        <moid>RncFunction=RF-1,UtranCell=Gbg-999</moid>
        <r>456</r>
        <r>567</r>
        <r>678</r>
```

```
       <r>789</r>
       <sf>TRUE</sf>
     </mv>
   </mi>
 </md>
 <mff>
   <ts>20000301141500</ts>
 </mff>
</mdc>
```

The following is an example of a DTD based XML measurement report file with use of optional positioning attributes on measurement types and results:

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="MeasDataCollection.xsl"?>
<!DOCTYPE mdc SYSTEM "MeasDataCollection.dtd">
<mdc>
  <mfh>
    <ffv>32.401 V5.0</ffv>
    <sn>DC=a1.companyNN.com,SubNetwork=1,IRPAgent=1,SubNetwork=CountryNN,MeContext=MEC-Gbg-
1,ManagedElement=RNC-Gbg-1</sn>
    <st>RNC</st>
    <vn>Company NN</vn>
    <cbt>20000301140000</cbt>
  </mfh>
  <md>
    <neid>
      <neun>RNC Telecomville</neun>
      <nedn>DC=a1.companyNN.com,SubNetwork=1,IRPAgent=1,SubNetwork=CountryNN,MeContext=MEC-Gbg-
1,ManagedElement=RNC-Gbg-1</nedn>
    </neid>
    <mi>
      <mts>20000301141430</mts>
      <gp>900</gp>
      <mt p="1">attTCHSeizures</mt>
      <mt p="2">succTCHSeizures</mt>
      <mt p="3">attImmediateAssignProcs</mt>
      <mt p="4">succImmediateAssignProcs</mt>
      <mv>
        <moid>RncFunction=RF-1,UtranCell=Gbg-997</moid>
        <r p="1">234</r>
        <r p="2">345</r>
        <r p="3">567</r>
        <r p="4">789</r>
      </mv>
      <mv>
        <moid>RncFunction=RF-1,UtranCell=Gbg-998</moid>
        <r p="1">890</r>
        <r p="2">901</r>
        <r p="3">123</r>
        <r p="4">234</r>
      </mv>
      <mv>
        <moid>RncFunction=RF-1,UtranCell=Gbg-999</moid>
        <r p="1">456</r>
        <r p="2">567</r>
        <r p="3">678</r>
        <r p="4">789</r>
        <sf>TRUE</sf>
      </mv>
    </mi>
  </md>
  <mff>
    <ts>20000301141500</ts>
  </mff>
</mdc>
```

C.4 Example of XML schema based XML Measurement Report File

The following is an example of a XML schema based XML measurement report file without use of optional positioning attributes on measurement types and results:

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="MeasDataCollection.xsl"?>
<measCollecFile
  xmlns="http://www.3gpp.org/ftp/specs/latest/rel-5/32_series/32401-540.zip#measCollec">
  <fileHeader fileFormatVersion="32.401 V5.0"
              vendorName="Company NN"
              dnPrefix="DC=a1.companyNN.com,SubNetwork=1,IRPAgent=1">
    <fileSender
      localDn="SubNetwork=CountryNN,MeContext=MEC-Gbg-1,ManagedElement=RNC-Gbg-1"
      elementType="RNC"/>
    <measCollec beginTime="2000-03-01T14:00:00+02:00"/>
  </fileHeader>
  <measData>
    <managedElement
      localDn="SubNetwork=CountryNN,MeContext=MEC-Gbg-1,ManagedElement=RNC-Gbg-1"
      userLabel="RNC Telecomville"/>
    <measInfo>
      <granPeriod duration="PT900S" endTime="2000-03-01T14:14:30+02:00"/>
      <measTypes>attTCHSeizures succTCHSeizures attImmediateAssignProcs
succImmediateAssignProcs</measTypes>
      <measValue measObjLdn="RncFunction=RF-1,UtranCell=Gbg-997">
        <measResults>234 345 567 789</measResults>
      </measValue>
      <measValue measObjLdn="RncFunction=RF-1,UtranCell=Gbg-998">
        <measResults>890 901 123 234</measResults>
      </measValue>
      <measValue measObjLdn="RncFunction=RF-1,UtranCell=Gbg-999">
        <measResults>456 567 678 789</measResults>
        <suspect>true</suspect>
      </measValue>
    </measInfo>
  </measData>
  <fileFooter>
    <measCollec endTime="2000-03-01T14:15:00+02:00"/>
  </fileFooter>
</measCollecFile>
```

The following is an example of a XML schema based XML measurement report file with use of optional positioning attributes on measurement types and results:

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="MeasDataCollection.xsl"?>
<measCollecFile
  xmlns="http://www.3gpp.org/ftp/specs/latest/rel-5/32_series/32401-540.zip#measCollec">
  <fileHeader fileFormatVersion="32.401 V5.0"
              vendorName="Company NN"
              dnPrefix="DC=a1.companyNN.com,SubNetwork=1,IRPAgent=1">
    <fileSender
      localDn="SubNetwork=CountryNN,MeContext=MEC-Gbg-1,ManagedElement=RNC-Gbg-1"
      elementType="RNC"/>
    <measCollec beginTime="2000-03-01T14:00:00+02:00"/>
  </fileHeader>
  <measData>
    <managedElement
      localDn="SubNetwork=CountryNN,MeContext=MEC-Gbg-1,ManagedElement=RNC-Gbg-1"
      userLabel="RNC Telecomville"/>
    <measInfo>
      <granPeriod duration="PT900S" endTime="2000-03-01T14:14:30+02:00"/>
      <measType p="1">attTCHSeizures</measType>
      <measType p="2">succTCHSeizures</measType>
      <measType p="3">attImmediateAssignProcs</measType>
      <measType p="4">succImmediateAssignProcs</measType>
      <measValue measObjLdn="RncFunction=RF-1,UtranCell=Gbg-997">
        <r p="1">234</r>
        <r p="2">345</r>
        <r p="3">567</r>
        <r p="4">789</r>
```

```
        </measValue>
        <measValue measObjLdn="RncFunction=RF-1,UtranCell=Gbg-998">
          <r p="1">890</r>
          <r p="2">901</r>
          <r p="3">123</r>
          <r p="4">234</r>
        </measValue>
        <measValue measObjLdn="RncFunction=RF-1,UtranCell=Gbg-999">
          <r p="1">456</r>
          <r p="2">567</r>
          <r p="3">678</r>
          <r p="4">789</r>
          <suspect>true</suspect>
        </measValue>
      </measInfo>
  </measData>
  <fileFooter>
    <measCollec endTime="2000-03-01T14:15:00+02:00"/>
  </fileFooter>
</measCollecFile>
```

Annex D (informative): Change history

Change history								
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
June 2001	SA_12	SP-010237	--	--	Submitted to TSG SA #12 for Information.	--	1.0.0
June 2001	--	--	--	--	MCC editorials	1.0.0	1.0.1
Sep 2001	SA_13	SP-010467	--	--	Submitted to TSG SA #13 for Approval	2.0.0	4.0.0
Dec 2001	SA_14	SP-010638	001	--	Correction of declaration in XML header	4.0.0	4.1.0
Mar 2002	SA_15	--	--	--	Automatic upgrade to Rel-5 (no Rel-5 CR)	4.1.0	5.0.0
Sep 2002	SA_17	SP-020502	003	--	Description of Alarm IRP usage for performance alarms	5.0.0	5.1.0
Sep 2002	SA_17	SP-020502	004	--	Addition of measurement file XML schema and miscellaneous alignments with CM	5.0.0	5.1.0
Jun 2003	SA_20	SP-030291	006	--	Clarification of NE file generation behaviour in case of multiple granularity periods	5.1.0	5.2.0
Jun 2003	SA_20	SP-030291	008		Correction of Measurement Result File Name Definition for alignment with Windows based systems	5.1.0	5.2.0
Jun 2004	SA_24	SP-040265	014	--	Correction in requirement for granularity periods	5.2.0	5.3.0
Sep 2004	SA_25	SP-040572	017	--	Correction of measObjInstId and measType length limitations in the Measurement Report File Format	5.3.0	5.4.0
Mar 2004	SA_27	SP-050040	023	--	Resolve ambiguity in the format for timestamps in PM files	5.4.0	5.5.0

History

Document history		
V5.0.0	March 2002	Publication
V5.1.0	September 2002	Publication
V5.2.0	June 2003	Publication
V5.3.0	June 2004	Publication
V5.4.0	September 2004	Publication
V5.5.0	March 2005	Publication