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Telecommunications management network

Requirements for QoS/SLA management over the TMN X-interface for IP-based services

ITU-T Recommendation M.3341

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ITU-T Recommendation M.3341

Requirements for QoS/SLA management over the TMN X-interface for IP-based services

Summary

This Recommendation addresses end-to-end Quality of Service (QoS) information collection, aggregation and exchange between Service Customers, Service Providers and Network Operators. In the context of this Recommendation, Service Providers (SPs) include Telecom SPs, Internet SPs, Application SPs and Content SPs. Service Customers include end-Customers and other SPs. Functions and interfaces required to ensure end-to-end QoS classes are specified for the complete service life cycle.

Source

ITU-T Recommendation M.3341 was approved on 14 December 2003 by ITU-T Study Group 4 (2001-2004) under the ITU-T Recommendation A.8 procedure.

Keywords

End-to-end, IP, Management, Measurement Point, Network Operator, Observation, Quality of Service (QoS), Service Customer, Service Provider, X-interface.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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ITU-T Recommendation M.3341

Requirements for QoS/SLA management over the TMN X-interface for IP-based services

1 Scope

This Recommendation addresses end-to-end quality of service (QoS) information collection, aggregation and exchange between service customers, service providers and network operators for IP-based services. In the context of this Recommendation, service providers (SPs) include telecom SPs, Internet SPs, application SPs and content SPs. Service customers include end-customers and other SPs. Functions and interfaces required to manage end-to-end QoS are specified for the complete service life cycle. This Recommendation provides requirements in the form of use cases and preliminary information related to the analysis phase. This Recommendation also recognizes the business need to manage QoS across multiple SPs.

2 References

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

[1] ITU-T Recommendation G.1010 (2001), *End-user multimedia QoS categories*.

[2] ITU-T Recommendation M.1530 (1999), *Network maintenance information*.

[3] ITU-T Recommendation M.1532 (2000), *Network maintenance service performance agreement (MSPA)*.

[4] ITU-T Recommendation M.1535 (1996), *Principles for maintenance information to be exchanged at customer contact point (MICC)*.

[5] ITU-T Recommendation M.1537 (1997), *Definition of maintenance information to be exchanged at customer contact point (MICC)*.

[6] ITU-T Recommendation M.1539 (1999), *Management of the grade of network maintenance services at the maintenance service customer contact point (MSCC)*.

[7] ITU-T Recommendation M.2301 (2002), *Performance objectives and procedures for provisioning and maintenance of IP-based networks*.

[8] ITU-T Recommendation M.3010 (2000), *Principles for a telecommunications management network*.

[9] ITU-T Recommendation M.3020 (2000), *TMN Interface Specification Methodology*.

[10] ITU-T Recommendation M.3200 (1997), *TMN management services and telecommunications managed areas: overview*.

[11] ITU-T Recommendation M.3208.1 (1997), *TMN management services for dedicated and reconfigurable circuits network: Leased circuit services*.

[12] ITU-T Recommendation M.3350 (Draft) (2004), *TMN service management requirements for information interchange across the TMN X-interface to support provisioning of telecommunication capabilities for disaster relief operations and mitigation*.

[13] ITU-T Recommendation M.3400 (2000), *TMN management functions*.

[14] ITU-T Recommendation Q.822 (1994), *Stage 1, stage 2 and stage 3 description for the Q3 interface – Performance management*.

[15] ITU-T Recommendation X.730 (1992), *Information technology – Open Systems Interconnection – Systems Management: Object management function*.

[16] ITU-T Recommendation Y.1001 (2000), *IP framework – A framework for convergence of telecommunications network and IP network technologies*.

[17] ITU-T Recommendation Y.1221 (2002), *Traffic control and congestion control in IP-based networks*.

[18] ITU-T Recommendation Y.1540 (2002), *Internet protocol data communication service – IP packet transfer and availability performance parameters*.

[19] ITU-T Recommendation Y.1541 (2002), *Network performance objectives for IP-based services*.

[20] TeleManagement Forum GB 917 (2001), *SLA Management Handbook – GB 917, Ver. 1.5*.

[21] OMG Document formal/2003-03-01, *Unified Modeling Language (UML), Version 1.5*.

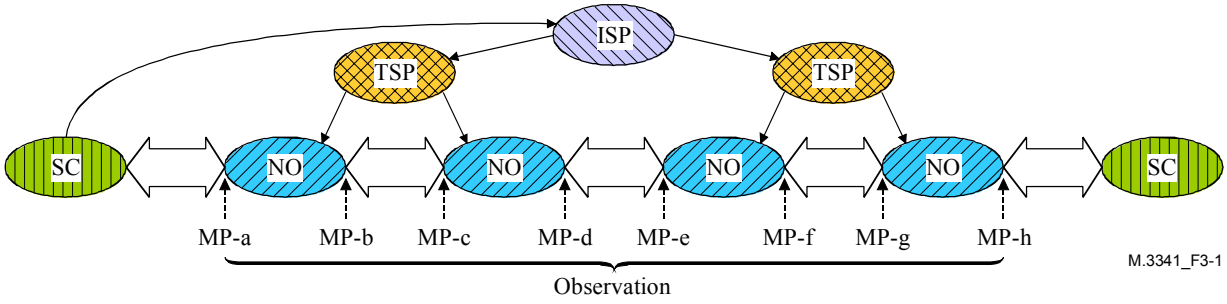
3 Terms and definitions

This Recommendation defines the following terms:

3.1 measurement point: The physical or logical point at which measurements can be made and to which the data obtained is related, e.g., a measurement point in a network or a step in the business process dependant upon the service life cycle. In the implementation phase of the service life cycle, it could be the time that an order is received by the service provider.

3.2 observation: An observation is used by the service customer to monitor the QoS of the telecommunication service provided to the SC by the SP. An observation is associated with exactly two measurement points.

3.3 end-to-end QoS: The QoS service level metrics relevant to the service being delivered as perceived by the SC.



MP Measurement Point

Figure 3-1/M.3341 – Measurement points and observation

Figure 3-1 shows an example of Measurement Points (MP) and an Observation (Ob) in a typical network. The Internet Service Provider (ISP) receives telecommunication services from two Telecommunication Service Providers (TSPs).

Network Operators (NOs) define the Measurement Points (MPs) at each end of their responsible part of the network. They have responsibilities to observe their part of the network. MP-a and MP-b

are defined at the ingress and egress of one NO's network. Likewise, MP-g and MP-h are defined at the ingress and egress of another NO's network.

Each TSP receives services from two Network Operators (NOs). TSPs have responsibilities to observe their part of the networks, in Figure 3-1, spanning across two NO's networks.

The ISP, which has a primary contract with the Service Customer (SC), has the responsibility to observe end-to-end QoS of the entire network, not merely a part of one TSP, and also has the responsibility to provide the observation data to SC. The SC is able to define an observation between the measurement points MP-a and MP-h. The observation provides QoS measurements from the ingress to the egress of the ISP's network regardless of the service providers or network operators involved.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations:

3GPP	Third Generation Partnership Project
C	Customer
ID	Identificator
IP	Internet Protocol
ISP	Internet Service Provider
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
MP	Measurement Point
NO	Network Operator
NP	Network Performance
Ob	Observation
OMG	Object Management Group
P	Provider
PM	Performance Management
QMS	QoS/SLA Management Service
QoS	Quality of Service
QoSMS	QoS management in a multi-service provider environment
SC	Service Customer
SLA	Service Level Agreement
SP	Service Provider
TMF	TeleManagement Forum
TMN	Telecommunications management network
TSP	Telecommunication Service Provider
VoIP	Voice over IP
XML	eXtensible Markup Language

5 Service life cycle and QoS

Management of QoS and associated SLAs require interaction between many telecom operations business processes and TMN management services as defined in ITU-T Rec. M.3200 and TMN management function sets as defined in ITU-T Rec. M.3400. In order to understand and analyse these interactions, there are at least five phases of the service life cycle that should be considered. These five phases are shown in Figure 5-1:

– Service product planning and development;
– Negotiation and sales of a service product;
– Implementation (configuration, provisioning and commissioning) of a service product;
– Operation and maintenance of a service product;
– Periodic assessment of the QoS of a service and whether it meets the SLA.

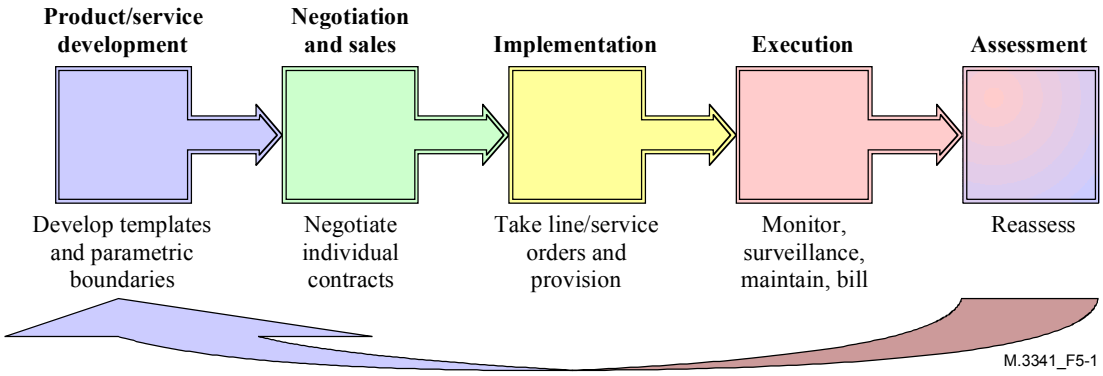


Figure 5-1/M.3341 – Service life cycle (Figure 5-1/GB917)

The following subclauses describe those aspects of each phase related to QoS and SLA management across the X-interface between two TMN domains, but not all of the aspects involved in each phase within a single TMN domain. Furthermore, in some cases e.g., leased circuit services, the negotiation and sales phase is sometimes split into two phases: pre-ordering and ordering. Descriptions of these five phases are described in detail in GB 917.

5.1 Service product planning and development

When planning and developing a service product, consideration must be given to a number of QoS and SLA aspects. In addition to the generic parameters there are technology-specific parameters. For example, in the case of IP-based services, these parameters and limits should be based on ITU-T Recs Y.1540, Y.1541 and M.2301. These Recommendations define QoS classes and the Network Performance (NP) parameters and limits designed to support certain applications e.g., VoIP, streaming video, etc. However, if the service is a pure packet delivery service, the QoS parameters and limits will be the same as the NP. Further information is given in 6.

5.2 Negotiation and sales

During this phase, the service provider must negotiate and agree with the customer technical details of specific instances of the service product offered. The QoS parameters and limits may be the same as those offered in the standard template or customized to a specific service instance. The format of conveying this information across the X-interface is outside the scope of this Recommendation, but it may well be XML in the case of eCommerce. However, the content should be defined according to the QoS parameters and limits specified in ITU-T Recommendations.

5.3 Implementation

Service implementation is the phase when the service is configured, activated (commissioned or brought into service) and operation begins. Detailed descriptions of the procedures for the "bringing into service" are contained in ITU-T Recs M.1530, M.1532, M.1535, M.1537, and M.1539. Many of these functions may be implemented via TMN management function sets defined in ITU-T Rec. M.3400 and procedures and performance limits defined in the M.2xxx-series Recommendations.

5.4 Execution

This phase covers all normal operations of the services and service instances covered by the SLA. This includes normal in-service monitoring and operation, real-time QoS reporting and service quality validation, and real-time SLA violation handling. The emphasis on real-time is deliberate because increasingly, the customer requires continuous monitoring, reporting and guarantees of QoS offered, especially in an eCommerce environment. Many ITU-T Recommendations in the M.2xxx-series and M.3xxx-series Recommendations cover the functions and procedures to be used in this phase.

5.5 Assessment

Assessment of QoS and SLA is scheduled during a single customer SLA contract period where the assessment is related to the delivered QoS against the SLA parameter values and limits, and the levels of customer satisfaction with the service product. This may include potential service improvement with possibly increased charges depending on market pricing, as well as responding to changing customer requirements. The QMS is relevant to this part of the assessment phase.

The second time-frame is related more to the service provider's internal overall quality goals, objectives and risk management and is considered out of the scope of this Recommendation.

6 QoS classes and traffic types

It is important to note that there is a distinct difference between the user/service QoS requirements defined in the SLA, and the network-level QoS/NP and QoS-enabling mechanisms. As mentioned in 5.1, QoS classes and the Network Performance (NP) parameters and limits designed to support certain applications e.g., VoIP, streaming video etc., are defined by ITU-T Rec. Y. 1541. Table 2/Y.1541 provides the mapping between QoS classes and traffic types (i.e., applications). Additional information may be found in ITU-T Rec. G.1010. GB 917 section 4.1.4 (NP/QoS Requirements and QoS Classes) gives additional explanation of the relationship between NP and QoS.

7 QMS functional requirements

7.1 QMS framework

An SP provides a telecommunication service[1] to an SC. An SLA is an agreement by the SP to provide a particular QoS (in terms of measurable parameters) to the SC pertaining to this telecommunication service. The QMS provides the SC with a flexible approach to monitoring (i.e., observing) the QoS associated with this telecommunication service on a continuous basis. QMS interactions occur over the TMN X-interface as shown on Figure 7-1.

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[1] The term "telecommunication service" is used throughout this clause in order to make a distinction from the "management service", however, the concepts portrayed in this clause are also applicable to other types of "services" that an SP might sell, i.e., those that may be provided by Internet SPs, Application SPs, and Content SPs.

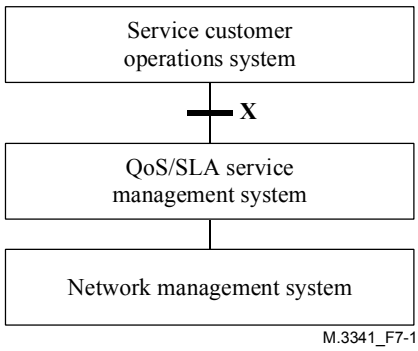

Figure 7-1/M.3341 – Reference interface

Note that the performance management functions found in ITU-T Rec. Q.822, are foundational to QMS. Many of the Q.822 concepts and detailed descriptions can be applied to QMS for the X-interface.

7.2 Basic requirements

The SP provides MPs from which the SC constructs Obs. Obs are used by the SC to monitor the QoS associated with the telecommunication service provided to the SC by the SP. At a minimum, MPs will be provided at the telecommunication service ingress and egress points. The SP may also choose to provide MPs at points intermediate to these as well. Each MP will have a fixed set of measurable PM parameters associated with it. When the SC constructs an Ob, the PM parameters that can be monitored via the Ob are those that are common to the MPs that are used to construct the Ob.

In terms of the performance management model found in ITU-T Rec. Q.822, the QMS Ob is considered to be a "monitored object" as shown on Figure 7-2. In this way, the detailed performance management functions and descriptions found in ITU-T Rec. Q.822 may be directly applied to the QMS X-interface.

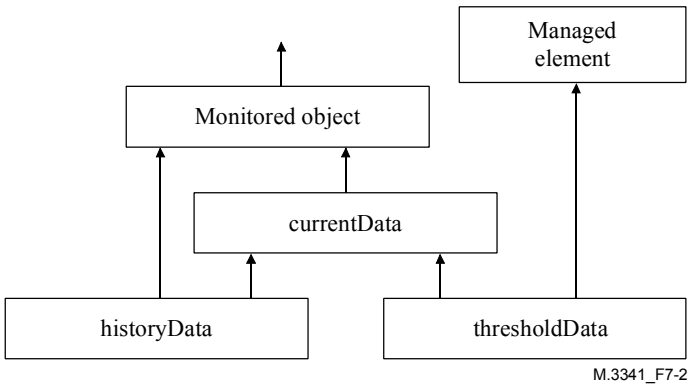

Figure 7-2/M.3341 – Naming hierarchy (Figure 3/Q.822)[2]

[2] The arrow between currentData and thresholdData is a defect in ITU-T Rec. Q.822 and should be removed. The thresholdDataId attribute within the currentData object is used to identify the relationship between the thresholdData object and currentData object.

7.2.1 Management interactions

Table 7-1 lists service management interactions that could be converted across the QMS interface between SCs and SPs. This is the TMN X-interface for service management as defined by M.3010. Those interactions that are defined in ITU-T Rec. Q.822 and are being applied to QMS at the X-interface are depicted using ***Bold Italic*** font.

Table 7-1/M.3341 – QoS/SLA management interactions across QMS interface

Initiator	QoS/SLA management interactions
Service Customer	Retrieve MPs Retrieve Obs Configure Ob (Note 1) ***Assign PM data collection interval*** (Note 2) ***Suspend/Resume PM data collection*** (Note 1) ***Reset PM data*** (Note 1) ***Assign PM history duration*** (Notes 1 and 2) ***Assign PM threshold (including severity)*** (Notes 1 and 2) ***Request PM data (current or history)***
Service Provider	Report MP configuration changes Report SP suspension of PM data collection ***Report PM threshold violation***
NOTE 1 – It is assumed that this action would be confirmed by the SP either via a response to the requested action or through the issuance of a report that the action took place. Since the original initiator of the action is the SC via its request, the potential issuance of a corresponding report by the SP is not listed separately as a "SP-initiated" interaction. NOTE 2 – Although not explicitly called out as separate functions in ITU-T Rec. Q.822, the ability to retrieve, i.e., "get" any of these data items (in addition to assigning, i.e., "setting" them) is implicitly supported within the Q.822 performance management model.	

7.2.2 Interactions initiated by service customer

The following provides a narrative description of requests initiated by the SC and sent across the X-interface to the SP for action:

a) **Retrieve MPs** – The SC queries the SP to find out what MPs are being provided corresponding to the telecommunication service that is being provided to the SC. The SC may also query for the detailed attribute values associated with a specific MP.

b) **Retrieve Obs** – The SC queries the SP to find out what Obs currently exist corresponding to the telecommunication service that is being provided to the SC. The SC may also query for the detailed attribute values associated with a specific Ob.

c) **Configure Ob** – The SC may create a new Ob or delete an existing Ob. In order to account for the case where the SC may want to cancel the creation of a new Ob, it is suggested that Obs be created in a "suspended" state, i.e., the Ob object gets created but does not perform any functionality until the SC performs the "resume PM data collection" function. Therefore, if the SC decides that the Ob creation should have been cancelled, the SC may simply delete this Ob object while it is in the "suspended" state, which in effect "cancels" the original creation request.

d) **Assign PM data collection interval** – The SC instructs the SP about the duration of the PM data collection interval for a given Ob or set of Obs. This information (i.e., the duration of the PM data collection interval) may also be queried from the SP by the SC.

e) **Suspend/Resume PM data collection** – The SC instructs the SP to suspend/resume the performance monitoring data collection activity for a given Ob or set of Obs.

f) **Reset PM data** – The SC instructs the SP to reset the performance monitoring counters for a given Ob or set of Obs.

g) **Assign PM history duration** – The SC instructs the SP to establish the duration during which to maintain a specific record of PM historical data. This information (i.e., the duration which to maintain a specific record of PM historical data) may also be queried from the SP by the SC.

h) **Assign PM threshold (including severity)** – The SC instructs the SP to establish the threshold criteria for PM data of a given Ob or set of Obs. Each threshold setting consists of the attribute identifier of the PM parameter, the threshold value and (optionally) the severity of the threshold-exceeding event. This information (i.e., the threshold criteria for PM data) may also be queried from the SP by the SC.

i) **Request PM data (current or history)** – The SC issues a spontaneous request to the SP for current or historical PM data information on a given Ob or set of Obs.

7.2.3 Management interactions initiated or provided by service provider

The following provides a narrative description of reports provided by the SP based upon the administered schedule or triggers. The reports are sent by the SP across the X-interface to the SC:

a) **Report MP configuration changes** – If the SP makes a change to the MPs provided to the SC, then the SP would send a report to the SC to inform them of such a change. The reported change could be the addition of a new MP, the deletion of an existing MP, or a change in the PM parameters that can be monitored from the MP.

b) **Report SP suspension of PM data collection** – In unusual circumstances (e.g., SP PM data collection system failure), it may be necessary for the SP to suspend PM data collection corresponding to an Ob that the SC has established without obtaining permission from the SC to do so. If the SP suspends PM data collection, then the SP would send a report to the SC to inform them of this event.

c) **Report PM threshold violation** – The SP informs the SC of a PM parameter threshold violation having occurred in a specific Ob.

7.3 Business level requirements (use cases)

Basic requirements (in text form) for QMS are provided in 7.2, 7.3 and 7.4 and identify the associated use cases with actor/role and resources. The goal of these clauses is to define system requirements for the QoS/SLA service management system shown on Figure 7-1. The requirements of the system under development, that is, what functionality must be provided by the system, is documented in a use case model that illustrates the system's intended functions (use cases), its surroundings (actors), and the relationships between the use cases and actors (use case diagrams). Note that actors are not part of the system – they represent anyone or anything that must interact with the system. Additional information on use case conventions may be found in OMG – *Unified Modeling Language, Version 1.5* (March 2003).

7.3.1 Actors

The only actor defined is that of the Service Customer (SC) as identified in Figure 7-1. The role of the SC actor is analogous to the role of the performance manager actor shown on Figure 7-3. Note that the use cases associated with the traffic manager actor (also shown on Figure 7-3) are currently beyond the scope of this Recommendation.

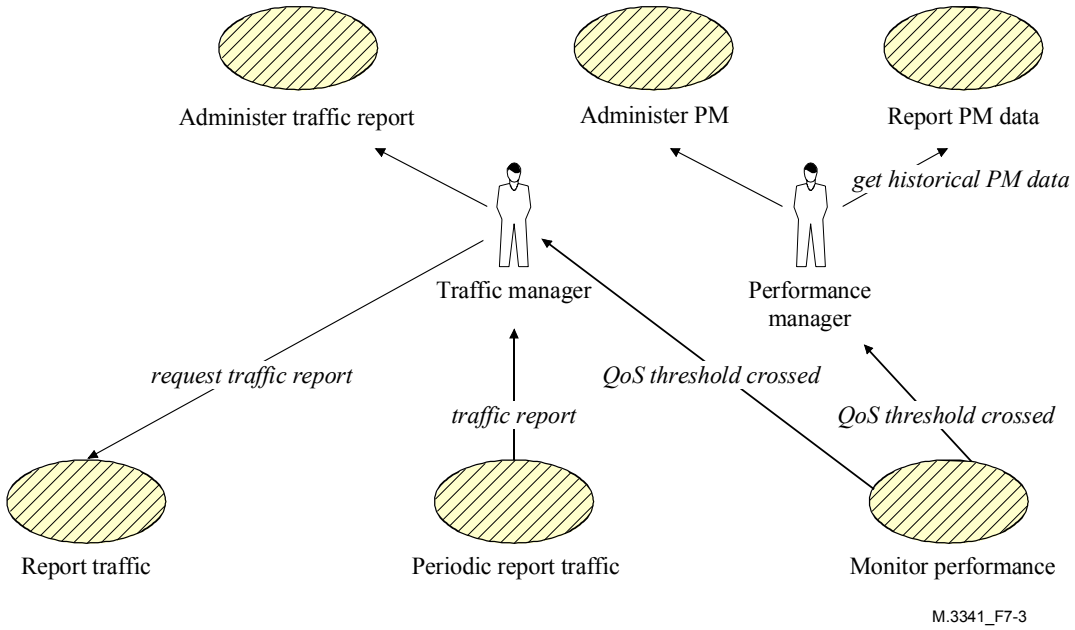

Figure 7-3/M.3341 – Use cases for performance measurement (Figure 1/Q.822.1)

The administer PM and report PM data use cases shown in Figure 7-3 have been expanded into more granular use cases and are shown on Figure 7-4. The monitor performance use case is expanded as shown on Figure 7-5.

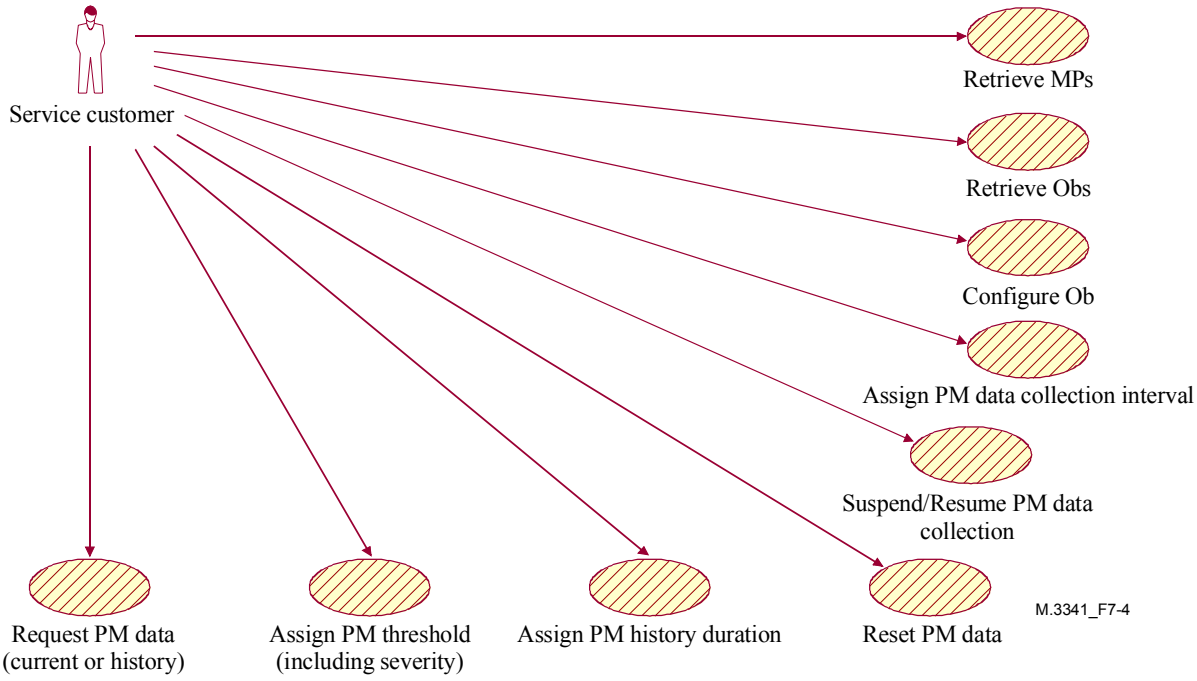

Figure 7-4/M.3341 – SC-initiated use cases

The use cases shown in Figure 7-4 are expansions of the high-level use cases called Administer PM and Report PM Data in Figure 7-3.

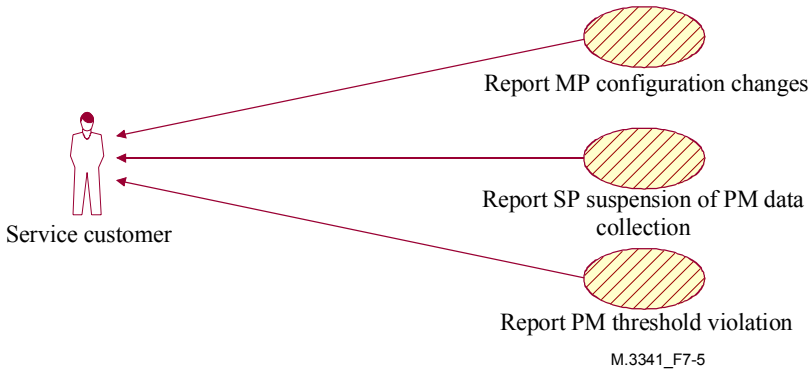

Figure 7-5/M.3341 – SP-initiated use cases

The use case shown in Figure 7-5 is an expansion of the high-level use case called Monitor Performance in Figure 7-3.

7.3.2 Telecommunication resources

The relevant resources required to support the use cases found in this clause are described in ITU-T Rec. M.2301. ITU-T Rec. M.2301 provides performance objectives and procedures for provisioning and maintenance of IP-based networks owned by different operators. This is regardless of the transport technology supporting the IP network and the higher layers to be implemented over IP.

7.3.3 High-level use case diagrams

This clause contains high-level use case diagrams that summarize the functionality and interfaces of the QoS/SLA service management system as shown in Figure 7-1. The use case diagrams are organized along the lines shown in Table 7-1, i.e., use cases initiated by the SC are depicted first followed by use cases initiated by the SP. In some cases there may be specific use cases mentioned on more than one high-level diagram. The reason for such duplication is to aid in completing the characterization of behaviour and functionality. Use case descriptions are provided in 7.4 for every use case pictured in these high-level diagrams.

7.4 Specification level requirements

This clause contains textual details for each of the use cases shown in the high-level use case diagrams of 7.3. The details are provided to clarify the roles of external actors and telecommunication resources and to refine the previous high-level use case diagrams to a specification level. Use case details include the following components:

Name	The name of the use case (matches all drawing names)
Summary	A summary of the use case's purpose and content
Actor(s)	The names of actors involved in the use case including role characteristic for each actor
Assumptions	A description of the environment providing a context for the use case
Pre-conditions	A list of all system and environmental conditions that must be true before the use case can be triggered
Begins when	The name of the single event that triggers the start of the use case
Description	The various tasks that make up the use case, not necessarily in sequence. The description should reference any reuse of TMN functionality
Ends when	The event(s) that signals that the use case has terminated

Exceptions	A summary list of all exception conditions and faults detected by the use case during its operation
Post-conditions	A list of all system and environmental conditions that must be true if the use case has terminated without internal error

7.4.1 Retrieve MPs

Name	Retrieve Measurement Points (MPs)
Summary	In order for an SC to fully utilize QMS, the SC needs to have knowledge of the MPs provided by the SP that are being made available to the SC to use as part of the QMS. For a given telecommunication service that is being provided by the SP to the SC, the SC queries the SP and the SP responds with a listing of all MPs available to the SC corresponding to that particular telecommunication service.
Actor(s)	Service Customer (SC)
Assumptions	Each telecommunication service that the SP provides to the SC will have a specific set of MPs corresponding to that service. The available set of MPs is fixed by the SP according to an SLA describing QMS capabilities that will be available to the SC.
Pre-conditions	The SP is providing a telecommunication service to the SC. The SP has established a specific set of MPs corresponding to this telecommunication service. The SP has agreed to provide QMS to the SC in accordance with a specific SLA.
Begins when	The SC issues a request to retrieve MPs.
Description	The SC issues a request to retrieve MPs associated with a specific telecommunication service. In the request, the SC must identify the specific instance of telecommunication service for which MP information is being requested. The SP responds with a listing of the names of all MPs corresponding to that particular instance of telecommunication service. Once the SC has knowledge of the MP names, the SC can also use the generic operations getAttributes and/or getAllAttributes defined in Annex C/M.3020 to find out more information about specific MPs (e.g., what parameters they are capable of measuring).
Ends when	The SP responds with a listing of the names of all MPs corresponding to the particular instance of telecommunication service.
Exceptions	Invalid telecommunication service instance ID
Post-conditions	The SC has knowledge of the MPs available corresponding to a particular instance of telecommunication service that can be used as part of the QMS.

7.4.2 Retrieve Obs

Name	Retrieve Observations (Obs)
Summary	The SC can create and delete Obs via the "Configure Obs" use case (see 7.4.3). In order for the SC to synchronize its view of what Obs currently exist (and/or the attributes associated with these Obs), the SC queries the SP to find out what Obs currently exist corresponding to a given telecommunication service.
Actor(s)	Service Customer (SC)
Assumptions	Obs are created, deleted, and modified by the SC via the "Configure Obs" use case (see 7.4.3).
Pre-conditions	The SP has agreed to provide QMS to the SC in accordance with a specific SLA.
Begins when	The SC issues a request to retrieve Obs.

Description	The SC issues a request to retrieve Obs associated with a specific telecommunication service. In the request, the SC must identify the specific instance of telecommunication service for which Ob information is being requested. The SP responds with a listing of the names of all Obs corresponding to that particular instance of telecommunication service. Note that a "null" response is allowed if no Obs currently exist for that specific instance of telecommunication service. Once the SC has knowledge of the Ob names, the SC can also use the generic operations getAttributes and/or getAllAttributes defined in Annex C/M.3020 to find out more information about specific Obs (e.g., what parameters they are measuring).
Ends when	The SP responds with a listing of all Obs corresponding to the particular instance of telecommunication service.
Exceptions	Invalid telecommunication service instance ID
Post-conditions	The SC has knowledge of the Obs that currently exist corresponding to a particular instance of telecommunication service.

7.4.3 Configure Ob

Name	Configure Observation (Ob)
Summary	The SC may create a new Ob or delete an existing Ob.
Actor(s)	Service Customer (SC)
Assumptions	In the context of QMS, each Ob instance is represented by a managed object. The SC needs to have the ability to create and delete Ob instances, and to examine the value of attributes of Ob instances. When an Ob object is created, a currentData object (contained by the Ob object) will also implicitly be created (see 7.2). The attributes of an Ob instance must identify (at a minimum) an ingress MP, an egress MP, the QoS parameter(s) being measured by the Ob, and whether the measurements are being made for unidirectional or bidirectional traffic. Once an Ob is created, its attribute values remain fixed for the duration of the Ob object instance lifetime (i.e., until the Ob is deleted).
Pre-conditions	The SP has agreed to provide QMS to the SC in accordance with a specific SLA. The SC has knowledge of the MPs available corresponding to a particular instance of telecommunication service that can be used as part of the QMS (see 7.4.1). The SC has knowledge of the Obs that currently exist corresponding to a particular instance of telecommunication service (see 7.4.2).
Begins when	The SC initiates a request to create or delete an Ob managed object.
Description	The following management service described in ITU-T Rec. X.730 applies to this use case: • the creation and deletion of managed objects This use case is satisfied by applying the management service procedures defined in ITU-T Rec. X.730 to the Ob managed object.
Ends when	The SP informs the SC that the request has been completed.
Exceptions	Defined by ITU-T Rec. X.730
Post-conditions	Depending on what the SC requested, the post-condition will either be the creation of a new Ob, or the deletion of an existing Ob.

7.4.4 Assign PM data collection interval

Name	Assign PM data collection interval
Summary	The SC instructs the SP about the duration of the PM data collection interval for a given Ob or set of Obs. This information (i.e., the duration of the PM data collection interval) may also be queried from the SP by the SC.
Actor(s)	Service Customer (SC)
Assumptions	As defined by ITU-T Rec. Q.822, a currentData managed object will be used to record the current performance data for monitoring purposes. Each Ob will contain a specific instance of the currentData managed object. The PM data collection interval is specified via the granularityTime attribute of the currentData object.
Pre-conditions	The SC has created and properly configured one or more Obs for a specific telecommunication service instance (see 7.4.3).
Begins when	The SC either requests the current value, or assigns a new value, for the PM data collection interval being used for a specific Ob (or set of Obs).
Description	The management service to support the "*assign PM data collection*" function is defined in ITU-T Rec. Q.822. This use case is satisfied by applying the Q.822 procedures to the currentData managed object contained by the Ob managed object.
Ends when	The SP informs the SC that the request has been completed.
Exceptions	None beyond those defined by ITU-T Rec. Q.822
Post-conditions	The SC will know the value of the PM data collection interval corresponding to the Ob and, if assigned by the SC in the request, the PM data collection interval will reflect this new assigned value.

7.4.5 Suspend/Resume PM data collection

Name	Suspend/Resume PM data collection
Summary	The SC instructs the SP to suspend/resume the performance monitoring data collection activity for a given Ob or set of Obs.
Actor(s)	Service Customer (SC)
Assumptions	As defined by ITU-T Rec. Q.822, a currentData managed object will be used to record the current performance data for monitoring purposes. Each Ob will contain a specific instance of the currentData managed object. PM data collection is suspended and resumed by modifying the value of the administrativeState attribute of the currentData object (i.e., attribute value of "locked" suspends PM data collection, and attribute value of "unlocked" resumes PM data collection).
Pre-conditions	The SC has created and properly configured one or more Obs for a specific telecommunication service instance (see 7.4.3).
Begins when	The SC issues a request to either suspend or resume PM data collection for a specific Ob (or set of Obs).
Description	The management service to support the "*suspend/resume PM data collection*" function is defined in ITU-T Rec. Q.822. This use case is satisfied by applying the Q.822 procedures to the currentData managed object contained by the Ob managed object.
Ends when	The SP informs the SC that the request has been completed.

Exceptions	• Exceptions defined by ITU-T Rec. Q.822 • Cannot resume due to SP-initiated suspend (see 7.4.11)
Post-conditions	As requested by the SC, PM data collection for the Ob will be suspended or resumed.

7.4.6 Reset PM data

Name	Reset PM data
Summary	The SC instructs the SP to reset the performance monitoring counters for a given Ob or set of Obs.
Actor(s)	Service Customer (SC)
Assumptions	As defined by ITU-T Rec. Q.822, a currentData managed object will be used to record the current performance data for monitoring purposes. Each Ob will contain a specific instance of the currentData managed object. A reset of PM data is accomplished by modifying the value of the counter attribute of the currentData object (i.e., setting the value to zero).
Pre-conditions	The SC has created and properly configured one or more Obs for a specific telecommunication service instance (see 7.4.3).
Begins when	The SC issues a request to reset PM data for a specific Ob (or set of Obs).
Description	The management service to support the "*reset PM data*" function is defined in ITU-T Rec. Q.822. This use case is satisfied by applying the Q.822 procedures to the currentData managed object contained by the Ob managed object.
Ends when	The SP informs the SC that the request has been completed.
Exceptions	None beyond those defined by ITU-T Rec. Q.822
Post-conditions	The PM data counter for the Ob (or set of Obs) is reset to zero.

7.4.7 Assign PM history duration

Name	Assign PM history duration
Summary	The SC instructs the SP to establish the duration during which to maintain a specific record of PM historical data. This information (i.e., the duration which to maintain a specific record of PM historical data) may also be queried from the SP by the SC.
Actor(s)	Service Customer (SC)
Assumptions	As defined by ITU-T Rec. Q.822, a currentData managed object will be used to record the current performance data for monitoring purposes. At the end of each PM data collection interval, a historyData object instance is created. Once the new historyData object is created, it will be retained for at least the duration equivalent to the number of intervals specified in the historyRetention attribute of the currentData object. Each Ob will contain a specific instance of the currentData managed object. The SC can assign PM history duration by modifying the value of the historyRetention attribute of the currentData object.
Pre-conditions	The SC has created and properly configured one or more Obs for a specific telecommunication service instance (see 7.4.3).
Begins when	The SC either requests the current value, or assigns a new value, for the PM history duration being used for a specific Ob.

Description	The management service to support the "*assign PM history duration*" function is defined in ITU-T Rec. Q.822. This use case is satisfied by applying the Q.822 procedures to the currentData managed object contained by the Ob managed object.
Ends when	The SP informs the SC that the request has been completed.
Exceptions	None beyond those defined by ITU-T Rec. Q.822
Post-conditions	The SC will know the value of the PM history duration corresponding to the Ob, and if assigned by the SC in the request, the PM history duration will reflect this new assigned value.

7.4.8 Assign PM threshold (including severity)

Name	Assign PM threshold (including severity)
Summary	The SC instructs the SP to establish the threshold criteria for PM data of a given Ob or set of Obs. Each threshold setting consists of the attribute identifier of the PM parameter, the threshold value and (optionally) the severity of the threshold-exceeding event. This information (i.e., the threshold criteria for PM data) may also be queried from the SP by the SC.
Actor(s)	Service Customer (SC)
Assumptions	As defined by ITU-T Rec. Q.822, a currentData managed object will be used to record the current performance data for monitoring purposes. Additionally, a thresholdData managed object will be identified by the thresholdDataId attribute of the currentData managed object and will provide values of the threshold settings for the PM parameters. Each Ob will contain a specific instance of the currentData managed object. The SC can assign PM threshold (including severity) data by modifying the value of the counterThresholdList attribute of the thresholdData object.
Pre-conditions	The SC has created and properly configured one or more Obs for a specific telecommunication service instance (see 7.4.3).
Begins when	The SC either requests the current value, or assigns a new value, for the PM threshold data (which includes severity of the threshold-exceeded event) being used for a specific Ob (or set of Obs).
Description	The management service to support the "*assign PM threshold*" function is defined in ITU-T Rec. Q.822. Severity is included as part of the PM threshold definition. This use case is satisfied by applying the Q.822 procedures to the thresholdData managed object contained by the currentData managed object contained by the Ob managed object.
Ends when	The SP informs the SC that the request has been completed.
Exceptions	None beyond those defined by ITU-T Rec. Q.822
Post-conditions	The SC will know the value of the PM threshold data (including severity) corresponding to the Ob, and if assigned by the SC in the request, the PM threshold data will reflect this new assigned value.

7.4.9 Request PM data (current or history)

Name	Request PM data (current or history)
Summary	The SC issues a spontaneous request to the SP for current or historical PM data information on a given Ob or set of Obs.
Actor(s)	Service Customer (SC)

Assumptions	As defined by ITU-T Rec. Q.822, a currentData managed object will be used to record the current performance data for monitoring purposes. At the end of each PM data collection interval, a historyData object instance is created. Once the new historyData object is created, it will be retained for at least the duration equivalent to the number of intervals specified in the historyRetention attribute of the currentData object. Each Ob will contain a specific instance of the currentData managed object and multiple instances of the historyData managed object. The SC can request PM data (current or history) by reading the attributes of the currentData and historyData managed objects.
Pre-conditions	The SC has created and properly configured one or more Obs for a specific telecommunication service instance (see 7.4.3).
Begins when	The SC issues a request for PM data (current or history) associated with a specific Ob (or set of Obs).
Description	The management service to support the "*request PM data*" function is defined in ITU-T Rec. Q.822. This function includes requests for current or historical PM data information. This use case is satisfied by applying the Q.822 procedures to the currentData and/or historyData managed object(s) contained by the Ob managed object.
Ends when	The SP informs the SC that the request has been completed.
Exceptions	None beyond those defined by ITU-T Rec. Q.822
Post-conditions	The SC is in receipt of the requested PM data (current or history).

7.4.10 Report MP configuration changes

Name	Report Measurement Point (MP) configuration changes
Summary	If the SP makes a change to the MPs provided to the SC, then the SP would send a report to the SC to inform them of such a change. The reported change could be the addition of a new MP, the deletion of an existing MP, or a change in the PM parameters that can be monitored from the MP.
Actor(s)	Service Customer (SC)
Assumptions	Each telecommunication service that the SP provides to the SC will have a specific set of MPs corresponding to that service. The available set of MPs is fixed by the SP, according to an SLA describing QMS capabilities that will be available to the SC. Once MPs have been established for a QMS being provided to a specific SC, configuration changes to these MPs would not normally be expected but may occur on an exceptional basis. Configuration changes to MPs that are currently in use for an Ob (i.e., the Ob ingress MP or the Ob egress MP) should not be allowed.
Pre-conditions	The SP is providing a telecommunication service to the SC. The SP has established a specific set of MPs corresponding to this telecommunication service. The SP has agreed to provide QMS to the SC in accordance with a specific SLA. An exceptional condition has occurred that necessitates a need for the SP to make a MP configuration change.
Begins when	The SP issues an MP configuration change report.

Description	The following management services described in ITU-T Rec. X.730 apply to this use case: • the reporting of creation and deletion of managed objects; • the reporting of changes to attribute values of managed objects. This use case is satisfied by applying the management service procedures defined in ITU-T Rec. X.730 to the MP managed object.
Ends when	The SC receives the MP configuration change report.
Exceptions	None beyond those defined by ITU-T Rec. X.730
Post-conditions	The SC is informed of the MP configuration change.

7.4.11 Report SP suspension of PM data collection

Name	Report Service Provider (SP) suspension of PM Data Collection
Summary	In unusual circumstances (e.g., SP PM data collection system failure), it may be necessary for the SP to suspend PM data collection corresponding to an Ob that the SC has established without obtaining permission from the SC to do so. If the SP suspends PM data collection, then the SP would send a report to the SC to inform them of this event.
Actor(s)	Service Customer (SC)
Assumptions	As defined by ITU-T Rec. Q.822, a currentData managed object will be used to record the current performance data for monitoring purposes. Each Ob will contain a specific instance of the currentData managed object. PM data collection is suspended by modifying the value of the administrativeState attribute of the currentData object to that of "locked".
Pre-conditions	An Ob and its contained currentData object are being used to collect PM data. The SP experiences an unusual condition (e.g., SP PM data collection system failure) that causes the SP to intervene and suspend PM data collection.
Begins when	The SP issues an SP suspension of PM data collection report.
Description	The following management service described in ITU-T Rec. X.730 applies to this use case: • the reporting of changes to attribute values of managed objects. This use case is satisfied by applying the management service procedures defined in ITU-T Rec. X.730 to the currentData object.
Ends when	The SC receives the SP suspension of PM data collection report.
Exceptions	Defined by ITU-T Rec. X.730
Post-conditions	The SC is informed of the SP suspension of PM data collection.

7.4.12 Report PM threshold violation

Name	Report PM threshold violation
Summary	The SP informs the SC of a PM parameter threshold violation having occurred in a specific Ob.
Actor(s)	Service Customer (SC)

Assumptions	As defined by ITU-T Rec. Q.822, a currentData managed object will be used to record the current performance data for monitoring purposes. Additionally, a thresholdData managed object will be contained by the currentData managed object and will provide the values of the threshold settings for the PM parameters. Each Ob will contain a specific instance of the currentData managed object. If any of the thresholds (defined in the contained thresholdData object) are violated, a Quality of Service (QoS) alarm notification is emitted by the currentData object.
Pre-conditions	The SC has created and properly configured one or more Obs for a specific telecommunication service instance (see 7.4.3).
Begins when	A threshold violation occurs corresponding to a specific Ob.
Description	The management service to support the "*report PM threshold violation*" function is defined in ITU-T Rec. Q.822. This use case is satisfied by applying the Q.822 procedures to the currentData managed object contained by the Ob managed object.
Ends when	The SC receives the PM threshold violation report.
Exceptions	None beyond those defined by ITU-T Rec. Q.822
Post-conditions	The SC is informed of the PM threshold violation.

8 Interface requirements

QoS is defined as the set of parameters which define the properties of media streams. The notion of QoS is different for the various system layers; e.g., the description of QoS at the application layer is usually at a higher level than that at the network layer of a communication system. The required QoS depends on various factors such as the used media (video, audio, etc.), the coding format used to encode the data, the application and the type of the application. For instance, the QoS of a videoconference is different from that of a video retrieval application, since the dialogue-mode communication of a conference requires a short delay which is not as important for playback applications.

Support for configurable, realizable and maintainable QoS is expected by numerous distributed applications. As such, it must necessarily be provided on an end-to-end basis from the source of data to the final perception of the data by the consuming user. This means that all hardware and software components involved in the overall tasks of the applications must provide appropriate methods and handle the data accordingly, from the local resources at the sender side via the transport system and networks, to the local resources at the receiving side. This applies to end-systems, servers and networks as well as to system software and applications.

Most of the participating resources are shared among users and various processes. One approach would be to (over-) design them based on peak demands such that no collisions between demands of different applications can ever occur. Then it would not be necessary to provide any resource management functionality. Yet, such a scenario would result in huge costs and low resource utilization and, hence, is typically not realizable. So, if we have limited resources, we may use filtering and scaling mechanisms, which adapt the generated workload to the available resources by changing the characteristics of the transmitted data stream, e.g., lowering the frame rate of a video stream. Yet, these techniques cannot offer a reliable, constant QoS during the run-time of an application. We believe that typical distributed computer systems still are, and will be so for a considerable amount of time, in the "window of scarcity". Thus, to provide a constant QoS during the run-time of an application, resource reservation and scheduling techniques must be applied.

There are still different perspectives on QoS as observed by service providers and service users whereby, for the former, efficiency of resource utilization is the focal point of QoS while, to the latter, the completeness of parameterization of the service is most important. These different

perspectives have led to different service models, which in the past did not allow for quantitative mappings between them. Hence, a goal to be strived for must be an integral view of QoS for both providers and users of a service. This can be achieved if both components are integrated into one system as, for example, when the operating system offers services to the applications like process scheduling, but has been very difficult when multiple parties have to cooperate, as in the case of a network services provider and an application program, which naturally pursue very different objectives. However, by using the QMS services as described in clause 7, an integral view of QoS for both providers and users of a service can be achieved, even in an environment that necessitates the cooperation of multiple parties. The specification for the interface requirements (i.e., the interface that QMS services will be carried across) is a subject of other ITU-T Recommendations.

QoS is inherently an end-to-end requirement since, for the user, the whole concept of QoS is only attractive if the presentation at the user interface satisfies his/her needs. This means that an overall approach to QoS provisioning is necessary. Another critical factor for establishing an efficient and effective interface for interchange of service and network management information between TMNs across the X-interface, is standardization of data elements that represent appropriate information associated with QoS. Standardized data elements for management information interchange need to be identified for application to QoS provisioning and management. In addition, specialized data elements may need to be defined and standardized that would apply uniquely to specialized application types (e.g., Telecommunication for Disaster Relief). The definition of the appropriate data elements to be conveyed using QMS services will be specified by other ITU-T Recommendations.

Annex A

QMS management scenarios

This annex describes multiple scenarios, which utilize the QoSMS to manage QoS in a multi-service provider environment. Figure A.1 is taken from Figure 3-1 and represents a mapping into the supply-chain model. P and C in the figure represent the role associations in the supply-chain model. P is the Provider role. C is the Customer role. The ISP acts in both a Provider (P) role and Customer (C) role. The ISP acts in the P role to the SC, and acts in the C role to the TSPs from which he acquires telecommunication services. Likewise, the TSP acts in the P role to the ISP, to which he supplies telecommunication services, and the C role to the NOs who in turn provide telecommunication services to the TSP.

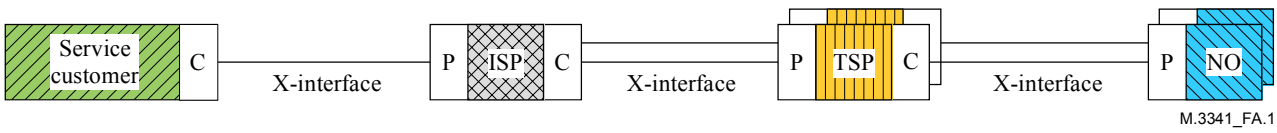

Figure A.1/M.3341 – X-interface generic model

While most QMS management scenarios may be inferred directly from the use cases described in clause 7, this annex describes additional QMS management scenarios that involve the combination of multiple use cases. These examples pertain to the implementation and execution phases of the service life cycle (see clause 5).

A.1 Implementation phase (service orders and provision)

Figure A.1 shows the relationships between peer entities in the supply-chain model. In this figure, the ISP provides an SLA to the SC. The TSP provides an SLA to the ISP and so on down the supply-chain. The ISP has a contract with the TSP whereby the TSP provides MPs into its own internal business processes. While the SP business process of the TSP is out of scope of this Recommendation, the announcement of MPs like:

- time stamp of receipt of order (acknowledgement of receipt of order),
- firm order commitment date (time),
- and the time service is actually provided,

provide MPs to the SC to enable the SC to measure the performance (QoS) of the SPs ordering and provisioning services. These MPs are typically predefined in the contract but may be prescribed by regulatory oversight. The SC is able to derive Obs by computing the time difference between the MPs and comparing these results with the SLA guarantees using the QMS defined in this Recommendation.

A.2 Execution phase (monitor, surveillance)

Two example scenarios are described for the execution phase.

A.2.1 Cancel an observation request

Looking at Figure 3-1 as an example, suppose that the ISP, acting as the QMS SC, requests the creation of an observation between MP-a and MP-c using the configure Ob use case (see 7.4.3) and the corresponding X.730 creation of managed object management service. Immediately after sending this creation request, the ISP realizes that a more meaningful observation would be between MP-a and MP-d.

Note that when an Ob object is created, a currentData object (contained by the Ob object) also gets implicitly created. It is recommended that when an Ob object and its corresponding currentData object are created, the initial value of the administrativeState attribute of the currentData object always be set to "locked", i.e., PM data collection for this Ob and its contained currentData object would not begin until a subsequent "resume PM data collection" was sent from the SC to the SP using the Suspend/Resume PM data collection use case (see 7.4.5).

Therefore, for the scenario described above, the SC may send a second request to create an observation, this time specifying that the observation occur between MP-a and MP-d. Since the SC never sent a "resume PM data collection" corresponding to the initial observation request, no PM data actually gets collected for this initial *incorrect* observation. The SC can then send a "resume PM data collection" corresponding to the second observation request (i.e., the *correct* one) and meaningful PM data collection begins. Finally, the SC can send a request to the SP to delete the initial *incorrect* observation using the configure Ob use case (see 7.4.3) and the corresponding X.730 deletion of managed object management service.

A.2.2 Modify parameters being monitored within an observation

As a continuation of the previous scenario, suppose that the ISP (i.e., the QMS SC) has been using the *correct* observation to collect PM data based on QoS parameters "x" and "y". Further, suppose that the QoS requirements for the SC's application change so that PM data based on QoS parameters "x" and "z" are now more relevant to the SC than PM data based on QoS parameters "x" and "y". Thus the SC would like its observation to continue between MP-a and MP-d, however, it would now like to collect QoS data in terms of parameters "x" and "z" rather than in terms of parameters "x" and "y". It is assumed that both MP-a and MP-d support PM data collection in terms of any or all of the QoS parameters "x", "y", and "z".

Note that according to the configure observation (Ob) use case (see 7.4.3), once an Ob managed object has been created, the attributes of the Ob object are fixed for the lifetime of the Ob object, i.e., they cannot be modified by the SC.

Therefore, for the scenario described above, the SC may send a request to create a new observation with attributes defined for monitoring QoS parameters "x" and "z". The SC can then send a "resume PM data collection" corresponding to this new observation and PM data collection in terms of QoS parameters "x" and "z" begins. Finally, the SC can send a "suspend PM data collection" request to the SP corresponding to the old Ob object so that PM data collection in terms of QoS parameters "x" and "y" ceases. Once a sufficient amount of PM history data has been established using the new observation, the SC may choose to delete the old Ob managed object (with attributes corresponding to QoS parameters "x" and "y") using the configure Ob use case (see 7.4.3) and the corresponding X.730 deletion of managed object management service.

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