INTERNATIONAL TELECOMMUNICATION UNION

TELECOMMUNICATION STANDARDIZATION SECTOR

STUDY PERIOD 2001-2004

STUDY GROUP 13

TD 24 Rev. 1 (WP 2/13)

English only

Question(s): 16/13 Geneva, 3 - 12 February 2004

TEMPORARY DOCUMENT

Source: Editor

Title: Revised version 2 of Y.123.qos

This is the new revised version of Y.123.qos based on the meeting results and drafting discussion of Q.16/13 during the SG 13 meeting held from 3 to 12 Feb in 2004.

The new revision is based on Rev.1 in TD24 which has been reviewed and accepted as preliminary text for further discussion.

Based on D490 from NTT, a new section 9 is created to describe several simplified operational scenarios for flexibility and gradual deployment.

Based on D520 from USA, the following changes are made for covering several possible implementation scenarios and for clarity.

(1) Session control protocol is included in the reference model for clarity.

(2) To cover out-of-path and in-path signalling cases and to address different implementation cases, access resource control function (ARCF) is separated from any physical node, which is logically independent function in the figure. In implementation scenarios, SCF and ARCF may be integrated into the same or different physical node. Considering scalability and security, ARCF may be physically independent from any session control node and packet forwarding node.

(3) Some text are changed or added for clarity about that the same QoS mechanisms are used for connectionless services with QoS requirements as are used for connection-oriented services.

(4) As for the in-path QoS control implementation case (like Intserv with RSVP, RSVP-TE or CR-LDP), it could be viewed as both SCF (note that the term SCF is being used in 2 different senses – QoS signalling control and session control signalling) and RCF are integrated into packet forwarding nodes in distributed way. Reserving an absolute QoS path for an application flow, that may contains any kind of application data, could be viewed as a particular kind of connection-oriented service. However, that is not the focus of this new recommendation.

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ITU-T Draft Recommendation Y.123.qos Rev.2

A QOS ARCHITECTURE FOR ETHERNET-BASED IP ACCESS NETWORK

1 Scope

This Recommendation provides a QoS architecture for Ethernet-based IP access network. It specifies a layered reference model and methods for support of QoS in Ethernet-based IP access network as well as the associated protocol requirements.

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.

[Y.1221] ITU-T Recommendation Y.1221 (2002), *IP Packet Transfer Performance Objectives*

[Y.1540] ITU-T Recommendation Y.1540 (1999), *IP Packet Transfer and Availability Performance Parameters*

[Y.1541] ITU-T Recommendation Y.1541 (2002), *IP Packet Transfer Performance Objectives*

[G.1000] ITU-T G.1000 (2001), *Communications Quality of Service: A framework and definitions*

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

[I.350] ITU-T I.350 (1993), *General aspects of quality of service and network performance in digital networks, including ISDNs*

[802.1p] IEEE std 802.1p (published in 802.1D-1998), *Traffic Class Expediting and Dynamic Multicast Filtering*

3 Definitions

This Recommendation defines the following terms:

IP flow:

Session:

4 Abbreviations

IETF	Internet Engineering Task Force
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
QoS	Quality of Service
SLA	Service Level Agreement
ER	Edge Router
BAS	Broadband Access Server
IMD	Intermediate Device
CPN	Customer Premises Network

CPE	Customer Premises Equipment
NTRD	Network Topology and Resource Database
IP	Internet Protocol
MAC	Media Access Control
AN	Access Node
SCF	Service Control Function
ARCF	Access Resource Control Function
RCF	Resource Control Function
DSLAM	Digital Subscriber Line Access Multiplexer
VoIP	Voice over IP

5 Reference model for support of QoS in Ethernet-based IP access network

Figure 1 illustrates the reference model for support of QoS in Ethernet-based IP access Network.

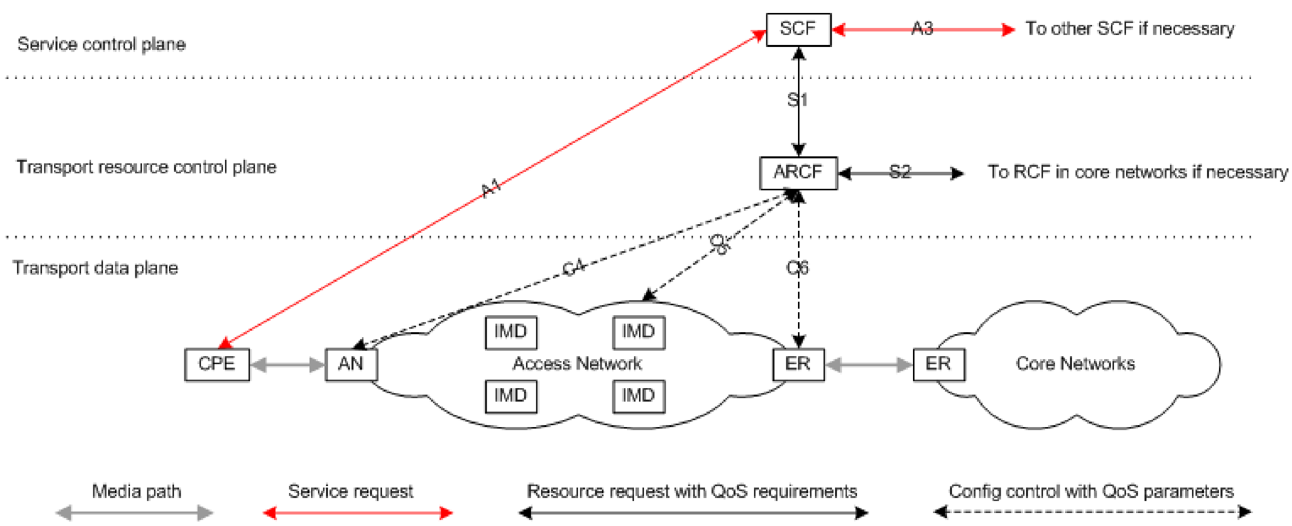

Figure 1 Reference model for support of QoS in Ethernet-based IP access Network

The reference model consists of three planes: Service control plane, Transport resource control plane and Transport data plane.

Service control plane comprises service control function (SCF) dealing with service requests, which decides the QoS requirements of each service flow and then sends the resource request to access resource control function (ARCF). As such SCF is service specific and may be realized in softswitches, streaming media servers, voice gateway, video on demand servers and the like, SCF is logically independent function that may be a stand-alone box or a function module integrated into other equipment.

Transport resource control plane comprises access resource control functions (ARCF) in access networks and resource control functions in core networks. ARCF deals with resource requests containing specific QoS requirements for IP flows, which makes admission control, route determination and resource allocation based on network resource status and SLA/policy. ARCF is also logically independent function that may be a stand-alone box or a function module integrated into other equipment.

IP Access network is an Ethernet-based Layer 2 network, which includes three types of device: ER, AN and IMD.

ER (Edge Router): The device in IP-based access network acts as the unique egress device that connects IP-based access network to backbone network; it is a Layer 3 device. Generally, it is a BAS (Broadband Access Server) or a router.

AN (Access Node): The network device in IP access network directly connects to customer terminals. Generally, it is a Layer 2 switch or an IP DSLAM (Digital Subscriber Line Access Multiplexer).

IMD (Intermediate Device): All the other devices in an IP-based access network, except the ER and CED. Generally, it is a Layer 2 switch.

CPE (Customer Premises Equipment) is device in CPN (Customer Premises Network). It generally is a customer terminal, e.g. Ethernet phone or Media Gateway. If CPN is composed of Layer 2 switches and customer terminals, CPN should forward customer packets without congestion, so as to ensure QoS of customer flows in CPN.

6 Requirements for support of QoS in Ethernet-based IP access network

There are two broad categories of IP flows: 1) the service flows that are associated with some form of service control procedure using a protocol such as SIP or H.323, and 2) the other service flows without any service control procedure.

Reserving an QoS path through path-decoupled or path-coupled signalling for an micro-flow or a traffic aggregate, that may contains any kind of application data, is viewed as a particular kind of connection-oriented service. If through path-coupled signalling, it can be viewed as both SCF (note that the term SCF is being used in 2 different senses – QoS signalling control and session control signalling) and RCF are integrated into packet forwarding nodes in distributed way. However, that's not the focus of this recommendation.

Before a connection-oriented service flow is classified on the AN, the flow must be identified at first. The flow is generally described by the IP 5-tuple or other protocol fields. Since a lot of IP service port numbers are determined through dynamic negotiation by the service control function, it is very difficult for layer 2 network devices to dynamically identify all of happening flows. Static configuration at per-flow level is unpractical. Only after the service control function informs the network layer of the flow description, can the problem be effectively solved. Meanwhile, the QoS parameters of the service flow are determined by the service control function too. Hence, it is also necessary for the service control function to inform the network layer of the QoS parameters of the service flow.

To make use efficiently of network resource, the resource must be allocated dynamically, that is, network resource is allocated to service flows during service period and released after service period. Admission control should be done before resource allocation.

For strictly guaranteeing QoS of connection-oriented services and real-time services in IP access network, the following requirements should be also met.

1) Network topology and resource status collection;

2) Resource request with specific QoS requirements;

3) Admission control and Resource allocation;

4) Configuration control with specific QoS parameters;

5) Service flow identification, classification and marking;

6) Packet forwarding on the basis of Ethernet-layer priorities defined in IEEE 802.1p.

For relatively guaranteeing QoS of connectionless services in IP access network, the same QoS mechanisms can be used. SLA negotiation between customer and provider is viewed as a static and manual service request for data delivery quality, and network administrators serve as SCF. Flow identification, classification and marking may be done only based on SLA/policy management. Packets are also forwarded on the basis of Ethernet-layer priorities defined in IEEE 802.1p. Considering automation and security of SLA management, maybe a path-decoupled signaling protocol needs to be developed for dynamic SLA negotiation and policy decision.

7 Key mechanisms for support of QoS in Ethernet-based IP access network

To meet the above requirements, it is necessary to define the associated key QoS mechanisms that can be applied in the reference model depicted in Figure 1.

7.1 Network topology and resource status collection

Topology and resource status of Ethernet-based IP access network can be obtained by means of static configuration or dynamic collection with a protocol. The configured or collected information is stored in network topology and resource database (NTRD), which is generally maintained on ARCF. Flow admission control, route determination and resource allocation are implemented on the basis of network topology and resource database and SLA/policy.

7.2 Admission control and resource allocation

This section introduces the procedure of admission control, which is illustrated in the Figure 2.

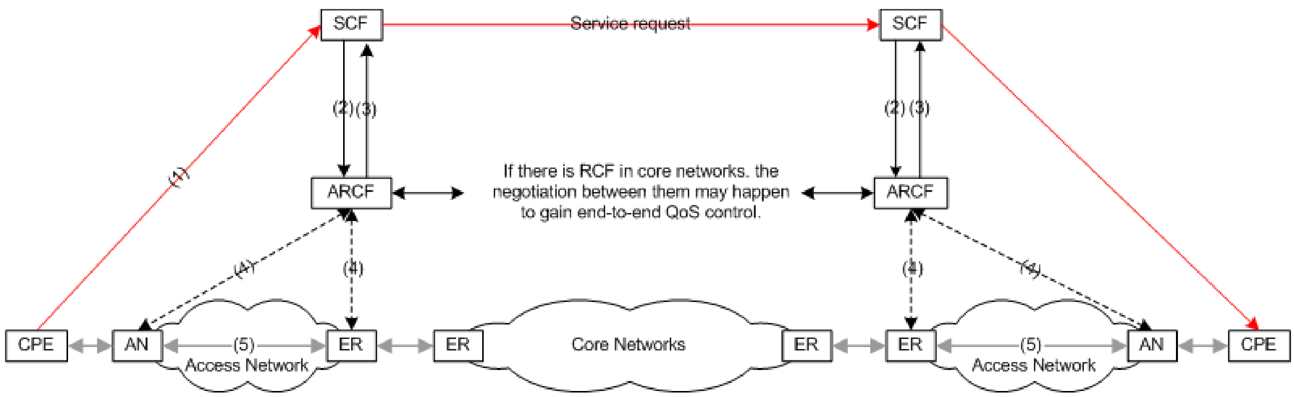

Figure 2 Admission control in Ethernet-based IP access Network

(1) Service Request. A terminal or application gateway/server sends a service request to SCF through a signalling protocol (e.g. SIP or H.323). A resource request is triggered by the service request. Service requests are various and application-specific.

(2) Resource Request with specific QoS requirements. SCF sends a resource request containing the parameters such as the IP address of the customer terminal, flow description, bandwidth demand and priority to ARCF. .

(3) Admission Control and Resource Allocation. ARCF finds the path of a flow according to the NTRD and IP address of the source terminal, and judges whether or not there is enough network resource for the flow access. If there is, ARCF sends an access admission response to SCF and

marks this part of resource as occupied in network topology and resource database; if there is not, the access is denied and the admission control procedure terminates.

(4) QoS Parameters Configuration. ARCF sends the flow description, bandwidth and priority of 802.1p to AN. If the service flow is bi-directional, ARCF should also configure flow description, bandwidth limitation and priority of the flow to ER. Flow description includes IP 5-tuple information or other protocol field parameters

(5) Flow Identification, Classification, Marking and Forwarding. AN identifies a service flow according to flow description, classifies the flow packets, limits the bandwidth of the flow, marks and forwards packets according to priority. The intermediate devices forward packets according to priority too. The unidentified packets are forwarded as best-effort traffic. If a service flow is bi-directional, ER performs same processes with AN.

7.3 Resource release

This section introduces the procedures for resource release as illustrated in the Figure 3.

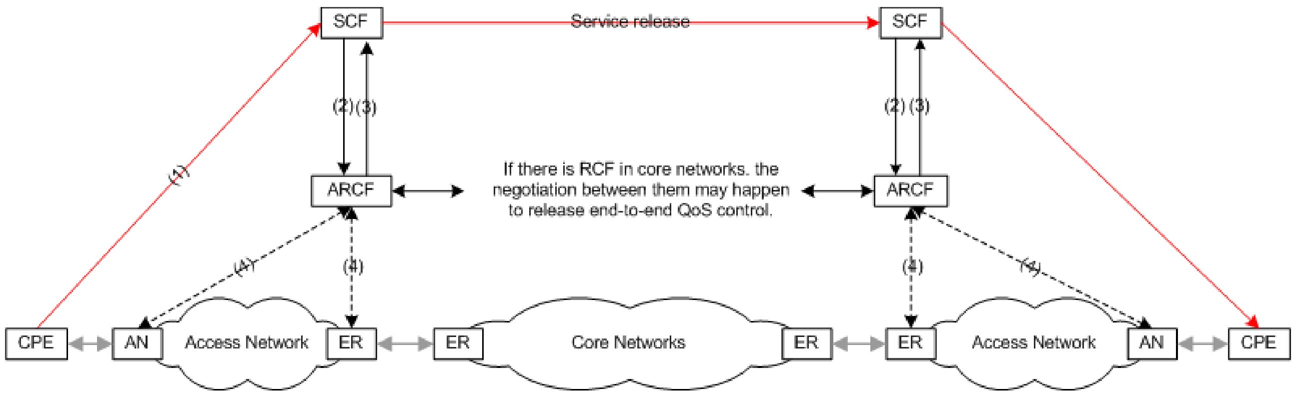

Figure 3 The Resource Release procedure in Ethernet-based IP access Network

(1) Service Release Request. A terminal or application gateway/server sends a service release request to SCF. A resource release request is triggered by the service release.

(2) Resource Release Request. SCF sends a resource release request containing the parameters of the IP address of the source terminal and flow description to ARCF.

(3) Resource Release. The resource occupied by the flow is marked as idle in network topology and resource database, and then an acknowledgement is sent to SCF.

(4) Removal of QoS Parameters Configuration. A message containing flow description is sent to AN, and then the device removes the identification and classification of the flow. The flow is regarded as best-effort traffic. If the service flow is bi-directional, ER performs the same processes with AN.

8 Protocol requirements

8.1 Protocol used for topology and network resource status collection

Network topology and resource status collection is the basis for making flow route determination, admission control and resource allocation.

For automation and accuracy, a protocol is preferable and used by the edge router or ARCF to dynamically collect link layer topology and resource status. This protocol should meet the following requirements.

(1) It must work in link layer.

Usually IP access networks are layer 2 switching network, especially if Ethernet-based. Only home gateway and edge router are IP-capable. The intermediate devices (such as DSLAM and layer 2 Ethernet switch) in access network work in link-layer.

So if edge router (or a physically independent access resource control function entity) wants to accurately make path determination for a flow passing through the access network, it must know the details of link layer topology, link capability and link using status. Only knowing layer 3 IP-subnet information is not enough, because the LAN connection between switches is transparent to IP layer.

(2) It should be able to timely and accurately track link layer topology changes and conditions.

It is so easy to build and change a layer 2 network that is really just a matter of plugging in cables.

(3) It should have neighbour discovery function.

Each node periodically advertises its own system and link layer port information via neighbour discovery messages to its adjacent nodes as needed. At the same time, it stores the received advertising information from the adjacent into its cache or MIBs.

The major information includes the chasis ID, port ID, port description, system name, system description, system capabilities, management address, and other organizationally specific extension information. Such as the spanning tree state, the speed and the full/half-duplex state of each port should also be advertised and discovered.

(4) It should have topology collection function.

Although SNMP could be used to collect the neighbour discovery information from each node, it is suitable for management but not for real-time control.

Topology collection request message and response message should be defined, by which a master device (BAS or layer-3 switch) can collect the entire link layer topology and resource status of the Ethernet access network. In addition, the master device may also provide an external interface for ARCF and network management system to obtain the entire network information.

The details of the protocol are included as Annex A.

8.2 Protocol used between SCF and ARCF

SCF sends a resource request containing the IP address of the customer terminal, flow description and QoS parameters to ARCF. ARCF then sends a response to admit or deny the access of the service flow. So a protocol needs to be used for signalling between SCF and ARCF. If necessary, it also can be used for signalling between ARCF and RCF in core networks to gain end-to-end QoS control.

The interface between service control plane and transport resource control plane is very important. Since a lot of IP service port numbers are determined through dynamic negotiation in the service control plane, if without the information from SCF, it is very difficult for layer 2 network devices by themselves to dynamically identify all of happening flows. Static configuration at per-flow level is unpractical. Only after SCF informs the transport layer of the flow description, can the problem be effectively solved. Meanwhile, it will be beneficial to service charging that the QoS parameters of the service flow are determined by the service control plane. Hence, it is necessary for the service layer to inform transport layer of the QoS requirement parameters of an application/service flow.

This protocol should support the following functions.

(1) Allow SCF to initiate a resource allocation request to ARCF for an IP service flow

According to the resource allocation request with specific QoS requirements, ARCF allocates the network resource for the IP service flow.

A resource allocation request shall include the main parameters as follows.

Flow ID: The unique ID number for an IP service flow.

Flow description: The 5-tuple information of an IP service flow, including source address, source port, destination address, destination port, protocol type.

QoS parameters: QoS requirements of an IP service flow, including service type, bandwidth, priority, delay, jitter, loss rate, MTU, direction and etc.

(2) Allow SCF to send ARCF a resource modification request for an IP service flow

For some kinds of services, it may be necessary to modify the QoS requirement at anytime during the run-time of a service flow. According to the resource modification request, ARCF modifies the bandwidth and priority allocated at the last time. Many times modification is allowed.

A bandwidth modification request shall include the main parameters as follows.

Flow ID:

Flow description:

QoS parameters:

(3) Allow ARCF to send SCF an acceptance response for a resource allocation request or a resource modification request

Upon succeeding in the resource allocation or modification, ARCF shall send an acceptance response to SCF.

An acceptance response shall include the main parameters as follows.

Flow ID:

Flow description:

Accepted QoS parameters:

(4) Allow ARCF to send SCF a rejection response for a resource allocation request or a bandwidth modification request

Upon failing to meet a resource request or a bandwidth modification request, ARCF shall send a rejection response to SCF.

A rejection response shall include the main parameters as follows.

Flow ID:

Rejection causes code:

(5) Allow SCF to initiate a resource release request to ARCF for an IP service flow

When a service flow is terminated, SCF shall initiate a resource release request to ARCF. According to the resource release request, ARCF takes back the allocated resource and sends back a resource release confirmation to SCF.

A resource release request or confirmation shall include the main parameters as follows.

Flow ID:

Release cause code:

(6) Allow SCF to send ARCF a resource allocation status query for an IP service flow

In case of any change of network resource status (e.g. a link or virtual connection is no longer available due to failure), SCF should be allowed to query ARCF the resource allocation status for an IP service flow.

A resource allocation status query shall include the main parameters as follows.

Flow ID:

(7) Allow ARCF to send SCF a resource allocation status report for an IP service flow

In case of any change of network resource status (e.g. a link or virtual connection is no longer available due to failure), ARCF should be allowed to report the resource allocation status to SCF for an IP service flow.

A resource allocation status report shall include the main parameters as follows.

Flow ID:

Current status: Normal or Exceptional.

The details of the protocol are included as Annex B.

8.3 Protocol used between ARCF and ER/AN

When a service flow is admitted, ARCF informs ER and/or AN of flow description, priority and bandwidth limitation parameters. When releasing service connection, ARCF informs ER and/or AN to remove the flow identification and mark, and then the flow is regarded as best-effort. So a protocol needs to be used for signalling between ARCF and ER/AN.

This protocol should support the following functions.

(1) Allow ARCF to instruct ER/AN to perform the flow identification and specified QoS treatment for an IP service flow

According to a resource allocation request from SCF, ARCF makes resource admission control, routing control, forwarding priority control and media resource control for the service flow. To implement the above control, ARCF must send a QoS perform instruction to ER/AN to modify their QoS configuration and behaviours.

A QoS perform instruction shall include the main parameters as follows.

Flow ID:

Flow Description:

QoS parameters:

(2) Allow ARCF to instruct ER/AN to modify the specified QoS treatment for an IP service flow

According to a resource modification request from SCF, ARCF modifies the resource allocation for the service flow during its run-time. To implement the above modification, ARCF must send a QoS modification instruction to ER/AN to modify their QoS configuration and behaviours.

A QoS perform instruction shall include the main parameters as follows.

Flow ID:

Flow Description:

QoS parameters:

(3) Allow ARCF to instruct ER/AN to cancel the specified QoS treatment for an IP service flow

According to a resource release request from SCF, ARCF takes back the resource allocated for the service flow. To implement the release, ARCF shall send a QoS cancel instruction to ER/AN to modify their QoS configuration and behaviours. And ER/AN shall send back a QoS cancel confirmation to ARCF.

A QoS cancel instruction or confirmation shall include the main parameters as follows.

Flow ID:

Cancel cause code:

(4) Allow ER/AN to send ARCF a QoS control response for a QoS perform/modification instruction

A QoS control response shall include the main parameters as follows.

Flow ID:

Execution result: OK or Fail.

The details of the protocol are included as Annex C.

9 Operation scenarios

For operational flexibility and gradual deployment, the mechanism is slightly restrictive in terms of admission control. There are some access network operation scenarios for which simplified admission control could work.

Let's assume that all IP flows are forwarded through the Edge Router. Then the access network looks like a star topology consisting of pipes between ER and each AN.

Scenario 1: If we assume that the bandwidth per pipe is reserved and guaranteed, we do not have to care about the topology of the access network, and admission control can be simplified. For example, ARCF can perform admission control based on the reserved bandwidth for the user (i.e. the pipe), the total bandwidth of the existing connections over the pipe, and the bandwidth of the newly requested connection.

Scenario 2: If we assume that the bottleneck of the bandwidth is limited, such as the link between the Edge Router and the first L2 switch, we do not have to care about the resources of other links in the access network, and again admission control can be simplified. For example, ARCF can perform admission control based on the provisioned bandwidth for such bottleneck link, the total bandwidth of the existing connection over the link, and the bandwidth of the newly requested connection.

10 Annex A

The definition of the protocol used for topology and network resource status collection.

This protocol must work in link layer. To be developed.

Editor’s note:

After carefully comparison, Q16/13 felt that IEEE802.1ab is most possible to be used for this purpose, although the following two requirements cannot be met by the current version of IEEE802.1ab.

(1) Only 8 types of basic TLV set are defined. That is, only 8 types of information about a device are advertised. It’s enough for collecting layer-2 topology, but not enough for collecting layer-2

resource status. Such as the spanning tree state, the speed and the full/half-duplex state of a port should also be advertised and collected.

(2) NMS collects the layer-2 connection information from the MIBs of each device via SNMP. And it pieces them together to form the physical topology of the whole network. However, in Y.123.qos, it's the edge router that needs to collect the link layer topology and resource status of the whole IP access network. But for edge router, collecting information via the slow and unreliable SNMP query and trap is not a good approach. If IEEE802.1ab defined topology request and response messages for a gateway router directly collecting layer 2 information of the subnet, it would be better.

Q16/13 decided to firstly send the above two extra requirements to IEEE802.1 group for action. The Q16/13 subsequent action depends on the response from IEEE802.1 group.

11 Annex B

The definition of the protocol used between SCF and ARCF..

To be developed.

Editor's notes:

Because Q8/SG11 is studying QoS signalling requirements, Q16/13 decided to firstly send this protocol requirement to Q8/SG11 for action. The Q16/13 subsequent action depends on the response from Q8/SG11.

12 Annex C

The definition of the protocol used between ARCF and ER/AN.

To be developed.

Editor's notes:

Because Q8/SG11 is studying QoS signalling requirements, Q16/13 decided to firstly send this protocol requirement to Q8/SG11 for action. The Q16/13 subsequent action depends on the response from Q8/SG11.

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