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Information technology – UPnP Device Architecture – Part 11-1: Quality of Service Device Control Protocol – Level 2 – Quality of Service Architecture



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Part 11-1: Quality of Service Device Control Protocol – Level 2 – Quality of Service Architecture

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This International Standard has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the second title page.

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UPnP Device Architecture 1.0	ISO/IEC 29341-1
UPnP Basic:1 Device	ISO/IEC 29341-2
UPnP AV Architecture:1	ISO/IEC 29341-3-1
UPnP MediaRenderer:1 Device	ISO/IEC 29341-3-2
UPnP MediaServer:1 Device	ISO/IEC 29341-3-3
UPnP AVTransport:1 Service	ISO/IEC 29341-3-10
UPnP ConnectionManager:1 Service	ISO/IEC 29341-3-11
UPnP ContentDirectory:1 Service	ISO/IEC 29341-3-12
UPnP RenderingControl:1 Service	ISO/IEC 29341-3-13
UPnP MediaRenderer:2 Device	ISO/IEC 29341-4-2
UPnP MediaServer:2 Device	ISO/IEC 29341-4-3
UPnP AV Datastructure Template:1	ISO/IEC 29341-4-4
UPnP AVTransport:2 Service	ISO/IEC 29341-4-10
UPnP ConnectionManager:2 Service	ISO/IEC 29341-4-11
UPnP ContentDirectory:2 Service	ISO/IEC 29341-4-12
UPnP RenderingControl:2 Service	ISO/IEC 29341-4-13
UPnP ScheduledRecording:1	ISO/IEC 29341-4-14
UPnP DigitalSecurityCamera:1 Device	ISO/IEC 29341-5-1
UPnP DigitalSecurityCameraMotionImage:1 Service	ISO/IEC 29341-5-10
UPnP DigitalSecurityCameraSettings:1 Service	ISO/IEC 29341-5-11
UPnP DigitalSecurityCameraStillImage:1 Service	ISO/IEC 29341-5-12
UPnP HVAC_System:1 Device	ISO/IEC 29341-6-1
UPnP HVAC_ZoneThermostat:1 Device	ISO/IEC 29341-6-2
UPnP ControlValve:1 Service	ISO/IEC 29341-6-10
UPnP HVAC_FanOperatingMode:1 Service	ISO/IEC 29341-6-11
UPnP FanSpeed:1 Service	ISO/IEC 29341-6-12
UPnP HouseStatus:1 Service	ISO/IEC 29341-6-13
UPnP HVAC_SetpointSchedule:1 Service	ISO/IEC 29341-6-14
UPnP TemperatureSensor:1 Service	ISO/IEC 29341-6-15
UPnP TemperatureSetpoint:1 Service	ISO/IEC 29341-6-16
UPnP HVAC_UserOperatingMode:1 Service	ISO/IEC 29341-6-17
UPnP BinaryLight:1 Device	ISO/IEC 29341-7-1
UPnP DimmableLight:1 Device	ISO/IEC 29341-7-2
UPnP Dimming:1 Service	ISO/IEC 29341-7-10
UPnP SwitchPower:1 Service	ISO/IEC 29341-7-11
UPnP InternetGatewayDevice:1 Device	ISO/IEC 29341-8-1
UPnP LANDevice:1 Device	ISO/IEC 29341-8-2
UPnP WANDevice:1 Device	ISO/IEC 29341-8-3
UPnP WANConnectionDevice:1 Device	ISO/IEC 29341-8-4
UPnP WLANAccessPointDevice:1 Device	ISO/IEC 29341-8-5
UPnP LANHostConfigManagement:1 Service	ISO/IEC 29341-8-10
UPnP Layer3Forwarding:1 Service	ISO/IEC 29341-8-11
UPnP LinkAuthentication:1 Service	ISO/IEC 29341-8-12
UPnP RadiusClient:1 Service	ISO/IEC 29341-8-13
UPnP WANCableLinkConfig:1 Service	ISO/IEC 29341-8-14
UPnP WANCommonInterfaceConfig:1 Service	ISO/IEC 29341-8-15
UPnP WANDSLLinkConfig:1 Service	ISO/IEC 29341-8-16
UPnP WANEthernetLinkConfig:1 Service	ISO/IEC 29341-8-17
UPnP WANIPConnection:1 Service	ISO/IEC 29341-8-18
UPnP WANPOTSLinkConfig:1 Service	ISO/IEC 29341-8-19
UPnP WANPPPConnection:1 Service	ISO/IEC 29341-8-20
UPnP WLANConfiguration:1 Service	ISO/IEC 29341-8-21
UPnP Printer:1 Device	ISO/IEC 29341-9-1
UPnP Scanner:1.0 Device	ISO/IEC 29341-9-2
UPnP ExternalActivity:1 Service	ISO/IEC 29341-9-10
UPnP Feeder:1.0 Service	ISO/IEC 29341-9-11
UPnP PrintBasic:1 Service	ISO/IEC 29341-9-12
UPnP Scan:1 Service	ISO/IEC 29341-9-13
UPnP QoS Architecture:1.0	ISO/IEC 29341-10-1
UPnP QosDevice:1 Service	ISO/IEC 29341-10-10
UPnP QosManager:1 Service	ISO/IEC 29341-10-11
UPnP QosPolicyHolder:1 Service	ISO/IEC 29341-10-12
UPnP QoS Architecture:2	ISO/IEC 29341-11-1
UPnP QOS v2 Schema Files	ISO/IEC 29341-11-2

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UPnP Document Title	ISO/IEC 29341 Part
UPnP QosDevice:2 Service	ISO/IEC 29341-11-10
UPnP QosManager:2 Service	ISO/IEC 29341-11-11
UPnP QosPolicyHolder:2 Service	ISO/IEC 29341-11-12
UPnP RemoteUIClientDevice:1 Device	ISO/IEC 29341-12-1
UPnP RemoteUIServerDevice:1 Device	ISO/IEC 29341-12-2
UPnP RemoteUIClient:1 Service	ISO/IEC 29341-12-10
UPnP RemoteUIServer:1 Service	ISO/IEC 29341-12-11
UPnP DeviceSecurity:1 Service	ISO/IEC 29341-13-10
UPnP SecurityConsole:1 Service	ISO/IEC 29341-13-11

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1. Glossary

Access Domain

A set of LAN or MAN stations together with interconnecting data transmission media and related equipment (e.g., connectors, repeaters), in which the LAN or MAN stations use the same MAC protocol to establish the sequence of stations that are in temporary control of the shared transmission media.

Access Priority

The Access Priority is a parameter that indicates the priority handling when accessing the communication resource. The range of access priorities is defined by the layer 2 networking technology.

AV Control Point

A Control Point that is used in an AV scenario and utilizes UPnP AV.

Best Effort

Best effort is a service of the Internet Protocol; i.e. it makes almost no guarantees about a packet other than attempting to transmit it. At the destination, the packet may arrive damaged, it may be out of order (compared to other packets sent between the same hosts), it may be duplicated, or it may be dropped entirely. If reliability is needed, it is provided by upper level protocols transported using IP.

With the introduction of IEEE 802.1D priority tagging the priority associated with untagged packets is also called "Best Effort".

Bridge

A functional unit that interconnects two or more LANs that use the same Data Link layer protocols above the MAC sublayer, but can use different MAC protocols

Hub

A device, with two or more physical ports, that forwards all traffic received on any individual port to all other ports. This device is also referred to as a “repeater”. In a home network, a hub connects networks segments of the same physical medium.

IGD

Internet Gateway Device: a border device that physically connects the Home Network with a WAN. This device performs routing. QoS mechanisms associated with routing are not addressed by this architecture; the IGD may present a QosDevice interface on the Home Network.

Intermediate Device

An intermediate device is physically connected between the Source and Sink device data flow. There may be more than one intermediate device in the Source to Sink connection.

Path

A path is the physical course that traffic will flow on from source to sink. For UPnP QoS, a path must reside within a single IP subnet, but a path may comprise multiple segments.

Packet Priority

The Packet Priority is a layer 2 parameter that indicates the priority handling requested by the originating service. Typically this parameter is part of a packet header and indicates the relative importance of the packet compared to other packets. It is used to differentiate packets to determine which are given preferential access to the communication medium. This parameter is typically mapped to an Access Priority value supported by the network device.

Policy Management

A function that makes decisions on the traffic streams allowed to use network resources.

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Prioritized Services

Prioritized services refer to a general methodology for providing QoS by differentiating traffic. Messages types are grouped by order of importance and assigned a priority. Message types assigned a higher priority are given preferential access to the communications medium.

Quality of Service (QoS)

The term QoS refers to a broad collection of networking capabilities and techniques. The goal of QoS is to improve the user experience of a network's ability to deliver predictable results for sensitive applications such as audio, video, and voice applications. Elements of network performance within the scope of QoS often include bandwidth (throughput), latency (delay), and error rate. There are two broad classes of QoS: data reliability and temporal reliability. Each makes different demands on network technologies. This architecture is primarily concerned with delivering temporal reliability

Router

A device, with two or more physical ports, that makes port to port traffic forwarding decisions based on layer 3 information (source and destination IP addresses).

Segment

A segment refers to a section of a network that shares a common physical medium. The boundaries of a network segment are established by devices capable of regulating the flow of traffic into and out of the segment. This includes routers, bridges, hubs, switches, and adapters (e.g., PCI, PCCard, or USB NICs). With particular relevance to UPnP QoS, a segment is typically a physically distinct portion of a larger network that is in turn defined logically by devices residing on a common IP subnet.

Sink Device

A Sink device provides media data receiving, playback, storage, or rendering capabilities. Some examples include TV monitors, Stereo and Home Theaters, PDAs, Wireless Monitors, DVD Recorders, and Printers.

Source Device

A Source device provides media transmission and data sourcing capabilities. Examples include STBs, PVRs, PCs, Music Servers, Broadcast Tuners and Video Imaging Capture Devices. A source device acts as the source of a traffic stream, regardless of other functions on the device.

Subnet

Subnet as defined in IETF RFC 3927 [RFC3927].

Traffic Class

The Traffic Class indicates the kind of traffic in the traffic stream. The Traffic Class is used to distinguish, for example, audio from video. The distinction is at the application layer and the Traffic Class is mapped into the applicable layer 2 representations for the technology bearing the stream. An example is the mapping in IEEE 802.1D, Annex G.

Traffic Identifier (TID)

A Traffic Identifier is a set of information that uniquely identifies a set of data packets as belonging to a traffic stream. This information is typically used by a packet classifier function to associate a Traffic Specification's QoS contract to the service provided to the Traffic stream. Other technologies may refer to this as a Filter Spec (RFC2205) or Traffic Classifier (IEEE 802.11e).

Traffic Specification (TSPEC)

A Traffic Specification contains a set of parameters that define the characteristics of the traffic stream. The TSPEC may be used to define the operating requirement for carrying the traffic stream and may define the operation of the packet scheduling function.

Traffic Stream (TS)

Traffic Stream is a unidirectional flow of data that originates at a source device and terminates at one or more sink device(s).

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2. Introduction

This architecture document describes the motivation, use and interaction of the three services that comprise the UPnP QoS Framework:

- QosDevice
- QosPolicyHolder
- QosManager

It should be noted that while UPnP QoS defines three services (listed above), it does not define a new device type.

Since Quality of Service issues need to be solved for multiple usage scenarios, it is expected that vendors may use any UPnP device as a container for the services defined by UPnP QoS. The Control Points and QoS Management Entities must look for UPnP QoS Services embedded in all UPnP device types.

The UPnP QoS Framework is compliant with the UPnP Device Architecture version 1.0.

2.1. Referenced Specifications

Unless explicitly stated otherwise herein, implementation of the mandatory provisions of any standard referenced by this specification shall be mandatory for compliance with this specification.

[Annex_G] – IEEE 802.1D-2004, Annex G, *IEEE Standard for Information technology - Telecommunications and information exchange between systems - IEEE standard for local and metropolitan area networks - Common specifications - Media access control (MAC) Bridges*, 2004.

[XML] – *Extensible Markup Language (XML) 1.0 (Second Edition)*, T. Bray, J.Paoli, C. M. Sperberg-McQueen, E Maler, eds. W3C Recommendations, 6 October 2000.

[QM] – UPnP QosManager:2 Service Document:

[QD] – UPnP QosDevice:2 Service Document:

[QPH] – UPnP QosPolicyHolder:2 Service Document:

[AV] – UPnP AV Architecture Document V0.83

[DEVICE] - *UPnP Device Architecture, version 1.0*.

[DSCP] - IETF RFC 2474, *Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers*, K. Nichols, Cisco Systems, S. Blake, Torrent Networking Technologies, F. Baker, Cisco Systems, D.Black, EMC Corporation, December 1998.

[RFC3927] IETF RFC 3927, Dynamic Configuration of IPv4 Link-Local Addresses.

[RFC3339] – *Date and Time on the Internet: Timestamps*, G. Klyne, July 2002.
http://www.ietf.org/rfc/rfc3339.txt

[RFC2474] - Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers.
http://www.ietf.org/rfc/rfc2474.txt

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3. Architecture Overview

This version of the architecture document only describes prioritized QoS. UPnP QoS architecture defines 3 services. These are the QosPolicyHolder[QPH] Service[QPH] , QosManager[QM] Service[QM] and QosDevice[QD] Service[QD] . All three are shown in the following figure. The numbers in parenthesis indicate the order of the QoS actions.

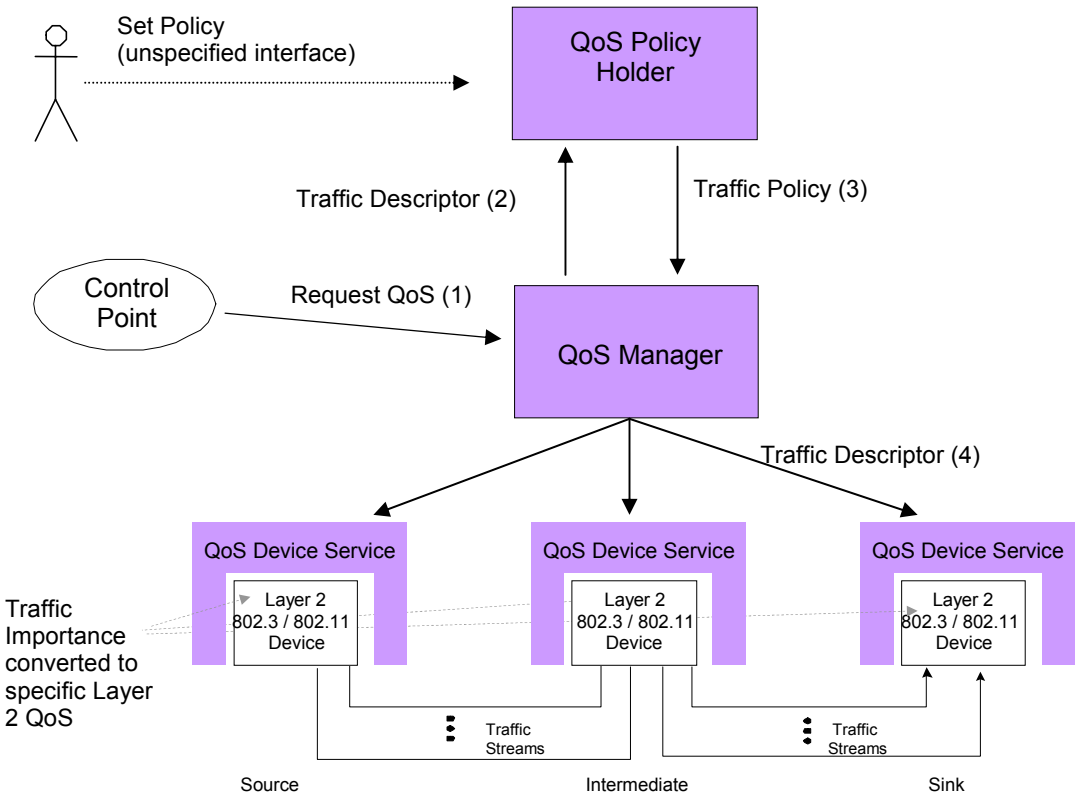

Figure 1 – UPnP QoS Architecture Overview

The following describes an overall architecture of the QoS subsystem and the interaction between various components. To illustrate the relationships of various QoS components, an example scenario with a simple sequence of setup steps is described below. The detailed operations are described in section 5.

In this scenario, a Control Point application is assumed to have the knowledge of source, sink and content to be streamed, along with the content's Tspec. The Control Point constructs a TrafficDescriptor structure and requests a QosManager in the network to setup QoS for a traffic stream (step 1). The Control Point may optionally indicate the QosPolicyHolder service of its choice when calling the QosManager service. The QosManager component, acting as a Control Point (often referred to as QoS Management Entity), requests the QosPolicyHolder service (step 2) to provide appropriate policy for the traffic stream described by the TrafficDescriptor (step 3). Based on this policy, the QosManager configures the QosDevice(s) for handling the new traffic stream (step 4).

The QosPolicyHolder Service provides traffic policy for the network on which it resides. It can be used to set the relative importance of a traffic stream by returning a TrafficImportanceNumber and a UserImportanceNumber (these are elements of TrafficPolicy). The TrafficImportanceNumber in turn, is conveyed to QosDevice(s) by the QosManager and is used by the QosDevice to derive the technology specific layer 2 access priority. For Parameterized Services, the allocation of resources for QoS instances, by a QosDevice, is determined by the UserImportanceNumber. The mechanisms for setting up parameterized QoS are not defined in this version of UPnP QoS architecture.

The QosManager communicates with the QosPolicyHolder , to get the TrafficImportanceNumber (part of TrafficPolicy) for the requested traffic stream (described by the traffic descriptor). The Control Point may select a QosPolicyHolder that the QosManager must use. If the Control Point does not specify a QosPolicyHolder, then the QosManager searches for all QosPolicyHolder instances on the network. If there are zero or more than one

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QosPolicyHolder instances on the network, then the QosManager applies a default policy based on the TrafficClass supplied by the Control Point. However, if the QosManager finds exactly one QosPolicyHolder on the network and the Control Point has not selected any QosPolicyHolder then the QosManager queries that QosPolicyHolder for traffic policy.

Additionally, the QosManager may perform admission control for a traffic stream on behalf of a QosDevice, if the "AdmissionPolicy" attribute is set to "enabled" by the QosPolicyHolder. If admission control is performed, the UserImportanceNumber is used to determine the relative importance of the traffic streams (see Section 4.1.2.) otherwise this parameter must be ignored.

Fundamentally, UPnP QoS operates on a traffic stream that flows between two or more devices. A traffic stream is viewed as a uni-directional flow from a source device to a sink device, possibly passing through intermediate devices. The QosDevice Service exists within one or more devices to receive and apply the TrafficImportanceNumber (e.g., implied access priority) for a traffic stream.

The internal mechanism used by the QosDevice for applying the TrafficImportanceNumber is not defined by UPnP. For a prioritized environment, it is envisioned that either an application on the source QosDevice directly tags the packets to be transmitted or there is a classifier function in the QosDevice that examines and tags packets.

It should be noted that a fundamental assumption for UPnP QoS is that every device on the home network will be on the same IP subnet. Therefore routing between devices in the Home Network is out of scope for UPnP QoS.

This section is meant as a brief overview of the UPnP QoS Architecture. The following section will explain the motivation behind UPnP QoS. It also introduces some key concepts and terms that will be explored in the following sections of this document.

3.1. Motivation

3.1.1. Policy-based QoS

Policy-based QoS provides a way to allocate network resources, e.g., network bandwidth, according to a set of defined preferences. It provides criteria for resolving conflicts when applications simultaneously compete for the resources. Policy is the basis for responding to questions such as these:

- Who and what can access which resources on the network?
- What is the highest importance traffic or application that is in use, what is the lowest importance traffic, and what levels of traffic are in between?

A policy-based QoS system allows an individual or entity to define rules, based on these types of questions and to manage them in the context of the policy system. These rules are then applied to network resources and requests based upon a set of pre-defined criteria and/or conditions such as network address, application type and/or bandwidth needs and availability.

UPnP QoS is a policy-based QoS system. The QosPolicyHolder Service, in particular, provides a mechanism for enabling or disabling Admission Policy [3.2.2] for the entire network and for classifying traffic according to information provided in the request for QoS for a particular traffic stream. The type of information is provided in the Traffic Descriptor includes, among other items, traffic class (best-effort, video, voice, etc.), the source and destination network IP addresses for the stream, and the protocol, application name, username, etc. Whenever a request for QoS is made, it is forwarded to the QosPolicyHolder Service (if present) by the QosManager Service. The QosPolicyHolder Service then examines the information provided in the request and returns the importance, in the form of a TrafficPolicy that shall be given to the traffic stream.

There were several goals taken into account in the design of the UPnP QoS Architecture and in particular the QosPolicyHolder Service. These included:

1. Consistent and predictable classification of a traffic stream.
2. Allow for flexibility in QosPolicyHolder implementation, to meet the diverse needs of applications and requirements.

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3.2. Key Concepts

3.2.1. Admission Control

Admission control is the procedure followed to permit the instantiation of a traffic stream at any of the following QoS capable devices: a source, zero or more intermediate devices on a traffic stream's path, or a sink. This procedure is based on a device's resources and is a go/no-go decision for a single traffic stream instantiation request. The decision is made based on the instantaneous state of the device. The procedure may be executed by the QosManager or the QosDevice, depending on the device's advertised capabilities. In the UPnP QoS version 2.0 Specification, QosDevice Admission Control is not supported.

3.2.2. Admission Policy

Admission Policy is the procedure followed by the QosManager, which is responsible for managing the end to end instantiation of a traffic flow. This procedure uses policy information, obtained from the QosPolicyHolder Service, to determine the continuing viability of existing end to end traffic instances. If policy permits, existing end-to-end traffic stream instances may be modified or de-committed by the managing entity (QosManager), in order to allow the instantiation of the prospective traffic flow. The policy information used for making decisions is AdmissionPolicy, UserImportanceNumber and TrafficImportanceNumber.

3.2.3. Traffic Descriptor

The TrafficDescriptor is composed of a TrafficId and other pertinent information that must be provided by the Control Point. It is the representation of a traffic stream for purposes of providing QoS. Once the QosPolicyHolder returns a policy, or if the QoS Management Entity uses a default policy, this policy information is placed into the TrafficDescriptor by the QosManager before setting up QoS on each QosDevice. This information in the TrafficDescriptor may later be used for diagnostic purposes. The QosDevice service must store the traffic descriptors of the traffics that have been successfully set up.

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4. UPnP QoS Services

4.1. QosPolicyHolder Service

4.1.1. Role

The UPnP QosPolicyHolder Service is a repository of QoS policies for Home Network. These QoS Policies can be configured by the user or a third party on behalf of the user to indicate the treatment of traffic on the Home Network. The QosPolicyHolder Service provides a UPnP-defined interface for a QosManager to access the Home Network QoS policies. The Policy within the QosPolicyHolder Service is populated in a non-specified manner that is out of scope for the UPnP QoS specifications. For example, methods such as an HTML GUI or other vendor dependent applications may be used.

The main function of this service is to judiciously allocate the use of traffic importance numbers by applications so that traffic importance levels are not overused. In a prioritized system the traffic importance number is mapped into a priority and if a given priority were overused, it would essentially loose differentiation. QosPolicyHolder also provides additional information[QPH] to identify the source of the QoS policy.

4.1.2. Traffic Stream QoS Policy Description

The QoS traffic policy consists of three QoS-specific elements, namely *AdmissionPolicy* (a Boolean value), *TrafficImportanceNumber* (an integer in the range of 0-7), and *UserImportanceNumber* (an integer in the range of 0-255). In addition, QosPolicyHolder also provides 4 optional parameters (*PolicyHolderId, PolicyLastModified, PolicyModifyingUserName, PolicyHolderConfigUrl*) that are used for identifying the source of the QoS policy.

If a QosPolicyHolder administrator chooses to set AdmissionPolicy (enabled/disabled) to “enabled”, the QosManager enforces admission policy for the traffic streams being setup.

The *TrafficImportanceNumber* indicates a traffic stream’s relative importance priority as described in Section 3.1.

The *UserImportanceNumber* will be used by the QosManager as the basis for admission policy decisions when the network resources are saturated. The UserImportanceNumber allows the QosManager to admit new requests or revoke previous requests so that the traffic streams with higher UserImportanceNumber are accommodated first. This value allows users the ability to fine tune their preferences for particular types of traffic streams that otherwise might have had the same TrafficImportanceNumber. The UserImportanceNumber value is applicable only when A*dmissionPolicy* is “enabled”. The value of 255 indicates highest importance and the value 0 indicates lowest importance. In the case where two or more traffic streams have the same UserImportanceNumber value, a first come first serve policy is applied to them.

The *PolicyHolderId* uniquely identifies the QosPolicyHolder in the home network. *PolicyLastModified* indicates when the policy was last modified, while the *PolicyModifyingUserName* identifies the home user or other entity that modified the policy last time. *PolicyHolderConfigUrl* points to the policy configuration page of the device

The QosPolicyHolder Service provides an interface to retrieve the QoS policy for a given traffic stream, described by the TrafficDescriptor. Although the UPnP QoS 1.0 architecture only allows a single policy holder in the home network, the 2.0 version allows the existence of multiple policy holders. The Control Point optionally supplies a QosPolicyHolder of its choice to the QosManager. The behavior of QosManager (version 1.0 or 2.0 when the Control Point does not select a QosPolicyHolder), when there are multiple or zero QosPolicyHolder Services in the home network, is described in section 4.2 (QoS Manager).

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4.2. QoS Manager

4.2.1. Role

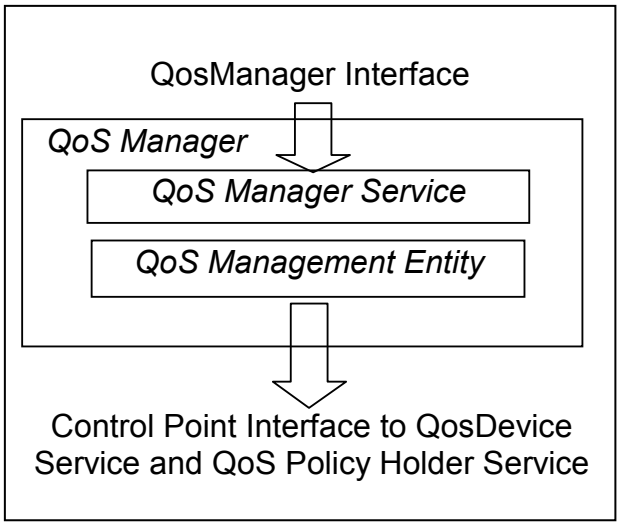

Figure 2 – QoS Manager function and interfaces

The QoS Manager function is an essential part of the UPnP QoS architecture. This function is a combination of a QosManager Service and a QoS Management Entity as shown in Figure 2. The QoS Management Entity provides Control Point functionality that discovers and controls QosDevice services and the QosPolicyHolder Services running on the network. The QoS Management Entity is responsible for requesting and releasing the QoS assigned to various network traffic streams. The interface between the QoS Management Entity and the QosManager Service is device dependent and not defined by the UPnP QoS specifications.

In the remainder of the document the term "QosManager" may be used to refer to the QosManager Service or the QoS Management Entity or the collective functionality.

4.2.2. Behavior

When a QosManager completes setting up QoS for a traffic stream, the traffic related information is stored in the QosDevice(s) on the traffic stream's path (source, intermediate, and/or sink). All QosDevice(s) in the network path will store the traffic descriptor (more details are provided in the QosDevice Service section). Consequently, any QosManager can query the QosDevice(s) and determine the state of a traffic stream.

A Control Point will request the QosManager Service to setup QoS by providing a TrafficDescriptor. The Control Point may optionally indicate to the QosManager, a QosPolicyHolder of its choice in the TrafficDescriptor structure. The QosManager service will retrieve admission and traffic QoS policy from the designated (if specified) or default QosPolicyHolder Service and, possibly after determining the network path, will setup all appropriate QosDevice services.

The QosManager service provides an interface (RequestTrafficQos action) for a Control Point to request QoS for a traffic stream identified by a TrafficDescriptor. The QosManager service will return the TrafficDescriptor (in addition to other parameters) which will contain additional information such as the Tspec that is currently active. If the QosManager is not successful, then it returns a corresponding error code.

4.2.3. Dealing with Policy

The QosManager interacts with the QosPolicyHolder Service in the following ways to deal with policy.

- If the Control Point specifies a QosPolicyHolder then the QosManager must use it. If the Control Point selected QosPolicyHolder does not exist, then the QosManager must return an error.
- If the Control Point does not specify a QosPolicyHolder then

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- If there is one QosPolicyHolder Service on the network it must be used as the source of policy information.
- If there is more than one QosPolicyHolder service on the network, then the QosManager must use the default policy described in [QM]
- If there are no QosPolicyHolder services on the network, then the QosManager must use the default policy described in [QM] .

After completing the action RequestTrafficQoS, the QosManager will also return the number of QosPolicyHolder instances (in addition to other return parameters) that are visible to the QosManager (irrespective of whether a specific QosPolicyHolder was selected by the Control Point or not).

4.2.4. QoS Update

In order to update the QoS for a traffic stream the QosManager will have to release the QoS for that traffic stream first and then setup QoS again for the requested traffic descriptor.

4.3. QosDevice Service

4.3.1. Role

The QosDevice service is a function typically implemented in a QoS capable source, sink or intermediate network device. A QosDevice service is responsible for managing the device's network resources for traffic streams and returning the state of the device.

4.3.2. Behavior

The QosDevice Service provides an interface for Control Points to execute actions on the device to setup QoS for traffic streams, to query the QoS capabilities and state of the QosDevice, and to register for events that the QosDevice generates. Typically, a QoS Management Entity acts as a Control Point for QosDevice Service. The QosDevice may optionally provide per interface rotameter observations.

An UPnP QosDevice will expose its static QoS capabilities through the GetQosDeviceCapabilities interface action. The static capabilities include type of native QoS support, such as: "Prioritized", "Parameterized", or "BestEffort". In the current UPnP QoS Specifications, "Parameterized" QoS is not supported. Other capabilities include maximum PHY bandwidth, network technology type, MAC address, InterfaceId and AdmissionControlSupported. In the current UPnP QoS Specifications, AdmissionControlSupported shall not be enabled.

The run time QoS state of the QosDevice is exposed through the GetQosState action. Since the QosManager is stateless and all of the traffic streams' related information is stored in each QosDevice on a traffic stream's path, the GetQosState interface provides information about its currently active traffic streams by returning a list of active TrafficDescriptor structures.

The SetupTrafficQos action of the QosDevice service allows the QoS Management entity to setup QoS associated with a particular traffic stream. The ReleaseTrafficQos action of the QosDevice service allows the Management entity to release QoS associated with a particular traffic stream. If the QoS Management entity is updating the existing QoS associated with a traffic stream, it first calls the ReleaseTrafficQos action, followed by the SetupTrafficQos action.

The topology information associated with the QosDevice (specifically its MAC table entries) is exposed via the GetPathInformation action. The GetQosDeviceInfo action allows the QosDevice to expose the port number and protocol associated with a particular traffic stream.

A QosDevice optionally collects information about network flows (rotameter) from its interfaces. Specifically, for each active interface on a QosDevice, one of two embodiments may be implemented. In the first embodiment, the QosDevice keeps a single traffic counter for each device directly attached to that interface. The counter for each attached device is used for traffic sent to and received from the device. Alternatively, in the second embodiment, the QosDevice keeps separate counters for each implemented priority queue (rather than a single

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counter representing all queues) for each device directly attached to that interface. The rotameter allows for both embodiments as some devices may not be capable of counting traffic per-priority-queue for each device attached to the interface.

These counters are useful for diagnostic purposes, i.e. ascertaining which device(s) on the network are most active (sending or receiving the most data), and therefore likely candidates for causing congestion. Because no distinction is made between bits sent or received in each counter, other UPnP QoS methods must be used to ascertain the source (versus the sink) of traffic (this can be done by simply querying the QosDevice for active TrafficDescriptor instances).

If a Control Point is interested in querying these rotameter observations, it must first configure the service using the ConfigureRotameterObseration action, then subsequently (e.g. a user initiated diagnostic session) request one or more observations using the GetRotameterInformation action. Importantly, the rotameter service must be configured well before observations are requested (otherwise there won't be sufficient data to provide diagnostic value).

4.3.3. Setup Traffic QoS

The QosManager uses the TrafficDescriptor and calls the SetupTrafficQos action on the QosDevice service to set up QoS for the traffic stream identified by the TrafficId in the traffic descriptor.

4.3.4. Traffic Admission Control

In response to the action GetTrafficPolicy, the QosPolicyHolder returns the admission policy for the home network in the AdmissionPolicy state variable. If the value of the state variable is "enabled", the QosManager may perform end-to-end network-wide admission control in an implementation specific manner. The QosManager uses the associated UserImportanceNumber to reject or allocate new traffic streams and/or revoke existing traffic streams. If the value of the AdmissionPolicy state variable is "disabled", the QosManager must pass the traffic stream's TrafficImportanceNumber to the relevant QosDevice(s). Device level admission control is not part of this version of UPnP QoS specification. The QosDevice parameter AdmissionControlSupported is specified for future extensions to this specification.

4.3.5. Path Information

The QosDevice service provides an interface to provide information regarding its neighboring devices that are reachable through each of its active interfaces. This information is useful for a QosManager service to correctly detect the network segment topology.

4.3.6. Events

The QosDevice service may optionally implement two events, namely PathInformation and TrafficStreamUpdate. When there is a change in PathInformation, the QosDevice will issue an event and send the updated PathInformation variable in the body of the event. Any time a SetupTrafficQos or ReleaseTrafficQos action is invoked; the QosDevice will issue an event and send the updated TrafficStreamUpdate variable in the body of the event. Both these events should be moderated to avoid flooding the network with repeated events.

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5. System Operation

An overview of the operational flow of UPnP QoS control messages is given below, more detailed information is provided in the related subsections.

1. Initiation of the QoS Setup for a traffic stream – The QosManager requires a minimum set[2] of information from a Control Point to perform the QoS setup. The method used to gather this information for different usage environments is described in the initiation process.

2. Determination of Policy for the traffic stream – The QosManager will determine the appropriate policy by requesting this information from the QosPolicyHolder service. If the Control Point does not select a QosPolicyHolder or if a unique QosPolicyHolder does not exist, then default policy applies.

3. Determination of QosDevice Services that should be configured – Based on the source and destination information for the traffic stream the QoS Management Entity will determine which QosDevice Services will play a role in the transport of the traffic stream.

4. Configuration of QosDevice – the QoS Management Entity will interact with each applicable QosDevice to setup QoS for the traffic stream on the device. The device's setup will depend on the capabilities of the device and could include setting of packet handling priorities, other setup functions, and possibly in future versions of UPnP QoS - QosDevice-based admission control.

5. Feedback of the results of the QoS setup to the Control Point invoking the QosManager – the success or failure of setup is provided to allow user feedback or other possible corrective actions.

5.1. Initiation of QoS Setup

The Control Point may first select a QosManager Service. Control Points that do not select a QosManager Service, must implement or provide a QoS Management Entity. There may be zero or more QosManager Services in the home network. These are known through standard UPnP discovery methods. The method for selection of the QosManager is outside the scope of the UPnP QoS specification.

When a QosManager Service is selected, its operation is triggered through the RequestTrafficQoS action. This provides the QosManager with a (partially complete) TrafficDescriptor. Upon completion of the action, the QosManager returns the TrafficHandle, NumPolicyHolders and (an updated) TrafficDescriptor to the Control Point.

- The TrafficHandle is a unique identifier associated with that TrafficDescriptor to be used in all future interactions.

- The NumPolicyHolders value indicates the number of QosPolicyHolder Services that are available in the network. This value is significant only if the Control Point did not choose a QosPolicyHolder in the input TrafficDescriptor. A value other than "1" indicates that the default policies have been used by the QosManager. A value of "1" indicates that the policy provided by the Control Point selected QosPolicyHolder Service has been used or that exactly one QosPolicyHolder was found on the network.

The information provided in the TrafficDescriptor by the Control Point and the related process steps are described in the following subsections. A generic process for any Control Point is described. However, since streaming in UPnP-AV is out-of-band in the specific case of an independent AV Control Point such a requester of QoS may not know all details of the specific traffic stream for which QoS is requested. The UPnP-QoS services add specific support to deal with this case by allowing an AV Control Point to supply an incomplete TrafficId and providing means for the QosManager to complete the TrafficId.

5.1.1. Integrated Control Point

In the case of an integrated Control Point (a Control Point that is located in an endpoint), the UPnP QoS architecture requires that Control Point to manage the binding between the traffic stream and the

[2] see the Traffic Descriptor Matrix in QosManager Service document [QM] for examples

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TrafficDescriptor. This means that the invocation of the QosManager is done by a Control Point that has knowledge of the setup of the transport method (for example, TCP or UDP which is out of band to UPnP QoS). It must be able to provide the QosManager with the complete TrafficId information and the Tspec.

The integrated Control Point is present in the following applications:

- UPnP AV Services, two box model

In the two box model there is a Media Server device (MSD) and a Media Server Control Point. The device that hosts the Media Server Control Point (MSCP) is the initiator of the QoS setup. The MSCP will locate content on the MSD, retrieve its URI and start playback. The initiation of QoS Setup can be done before or after the establishment of the traffic stream from the server.

- Generic case (not UPnP AV services)

Any application is able to initiate the QoS setup as long as it can provide the information needed by the QosManager Service.

5.1.2. Independent AV Control Point

The AV Control Point case refers to the situation where there is an AV Control Point that is not co-resident with the Media Render device (MRD). This is referred to typically as the three box model. For further information refer to the UPnP-AV architecture [AV]

In the three box model case, the AV Control Point initiating the RequestTrafficQos action on the QosManager may be unaware of the complete TrafficId. Information such as the port numbers may be unknown to the AV Control Point. The QosManager uses the QosDevice action, GetQosDeviceInfo to query the appropriate QosDevice for the port numbers on the basis of an (incomplete) TrafficDescriptor. When the MediaServerConnectionId and MediaRendererConnectionId are provided, these may be used by the QosDevice to correctly identify the connection.

The QosManager action *RequestTrafficQos* offers the ability to take an ordered list of Tspecs and have the QosManager select the most-preferred Tspec that can be supported by the network conditions. However in practice, use of this capability is limited due to the fact that the complete TrafficId may not be known before the setup of the transport session or may not be the same for all Tspecs. Since the port numbers are typically independent from the URI and known in the devices that setup the transport's connection, it is possible for the QosManager to have sufficient TrafficId information to complete the QoS setup process via the GetQosDeviceInfo action on the MediaRenderer and MediaServer. In this version of the QoS architecture the use of this feature is restricted to cases where the port numbers are consistent between different Tspecs. Finally the AV Control Point is responsible for ensuring that the URI corresponding to the selected Tspec is selected via SetAVTransportURI.

5.1.3. Determination of TrafficId

The initiation of QoS with RequestTrafficQos can be done before or after full knowledge of the TrafficId is available. A summary of the issues in each of these cases is outlined below.

- Before establishment of the Traffic Stream

In this case, only a minimum amount of TrafficId information (source and destination IP addresses) may be available to the Control Point initiating the QoS request. Before the traffic stream is established, the port numbers and protocol are typically not known, so only the source and destination IP addresses can be provided. This approach has the advantage of setting up of the QoS for the traffic stream before the traffic stream begins. This means that if there are insufficient resources on the network for the stream, this state can be determined before the content is streamed and unsatisfactory performance is observed by the user. The Control Point can then take corrective measures. A disadvantage of this approach is the need for a longer setup process.

- After establishment of the Traffic Stream

In this case the full TrafficId information is provided, consisting of source and destination IP addresses and port numbers as well as protocol. This has the advantage of simplifying the setup process but has the disadvantage of having the traffic stream start without having QoS applied to it in the network

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The preferred approach is for the full set of TrafficId information to be provided based on the establishment of the traffic stream but before the start of the transfer. This ability to do this is dependent on the transport protocol and its use by the application.

5.1.4. Creation of Optional Traffic Specification (Tspec)

The Control Point is responsible for providing the optional content dependent Traffic Specification (Tspec) parameters to the QosManager. These parameters define the performance characteristics desired as seen by the application receiving the content. The generation of the Tspec parameters is left to the Control Point but the UPnP QoS framework provides a standard method for the parameters to be stored in Content Directory Service of the UPnP Media Server. This information can be used in the case where the UPnP AV services are used, otherwise it is up to the Control Point to derive and provide this information.

A summary of the options available for generation of the Tspec parameters is provided below:

- Retrieved from CDS[3] – the resource element in CDS may provide a set of Tspec parameters. This is the preferred method for traffic specification creation if this information is available.
- MIME-type and other info in CDS – the MIME-type element that is part of the ProtocolInfo and properties such as res@bitrate can be used to derive the TSPEC parameters.
- Derived from the content itself – retrieval of the content itself can be used to determine the Tspec parameters. However this requires the intelligence to understand the content, although this will be typical for rendering devices.
- Application dependent – an application or protocol may provide other means for deriving this information.

5.2. Determination of Policy for the Traffic Stream

The QosManager uses the TrafficDescriptor information to determine policy for the traffic stream. The QosManager must use the QosPolicyHolder supplied by the Control Point. If the Control Point does not provide a QosPolicyHolder, then the QosManager must do the following:

- Search for all QosPolicyHolder services on the network.
- If it finds only one QosPolicyHolder then use it to obtain TrafficPolicy.
- If it finds zero or multiple QosPolicyHolder Services then it must apply default policies based on TrafficClass.

5.2.1. QosPolicyHolder Service

The QosManager must use the GetTrafficPolicy action of the QosPolicyHolder Service to retrieve the policy for the traffic stream defined by the information in the TrafficDescriptor. The QosPolicyHolder Service will provide several pieces of information such as TrafficImportanceNumber, UserImportanceNumber, AdmissionPolicy and some optional information. Further definition of these parameters is provided in section 4.1.2 of this document. The use of these parameters in the traffic stream setup process is described briefly:

- AdmissionPolicy determines if end-to-end admission control is used in the home network.
- TrafficImportanceNumber this parameter is used to determine the packet priority value(in a prioritized case) for the traffic stream. The QoS Manager's QoS Management Entity must provide it to the QosDevice Services, to allow tagging of the packets appropriately.
- UserImportanceNumber provides a relative rating of the traffic stream's user importance compared to that of the other traffic streams. Its value must be used by the QosManager to determine the traffic streams that are allowed on the network in the case where there are insufficient resources. It is only used in the case when

[3] CDS: Content Directory Service

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AdmissionPolicy is enabled. When used, the QosManager must compare the UserImportanceNumber values of the new traffic stream to that of the existing streams and modify network resource allocation to allow the traffic streams with the highest UserImportanceNumber. In the case where the UserImportanceNumber is the same, a first come first serve approach is used to determine which streams get the network resources.

- PolicyHolderId is a value that uniquely identifies a network device implementing the QosPolicyHolder service. This value informs the QosManager which QosPolicyHolder to query for a TrafficPolicy. The value must be of the following form:

  uuid:<UUID>:urn:upnp-org:serviceId:<SERVICEID>

  for example:

  uuid:0000481030110c68f9480:urn:upnp-org:serviceId:QosPolicyHolder-2a

  UUID: The UDN of the QosPolicyHolder service not including the prefix “uuid:”

  SERVICEID: The serviceId of the QosPolicyHolder service not including the prefix “urn:upnp-org:serviceId:”

- PolicyLastModified is an RFC3339 compliant string [RFC3339] that identifies the date/time when the policy on a QosPolicyHolder device was last modified (policy modification is out-of-scope to UPnP). This optional field, if present, shall identify the wall clock time when a policy is added or altered. It is recognized that device clocks may not be synchronized. This field is valuable for implementations to provide diagnostic information to the end user.

- PolicyModifyingUserName is a string that identifies the user who last changed the policy (policy modification is out-of-scope to UPnP). This optional field, if present, must be <= 64 UTF-8 characters. At present this specification does not define the semantics for this field. Examples include, “Dad”, “Jimmy”, etc. This field is valuable for implementations to provide diagnostic information to the end user.

- PolicyHolderConfigUrl is an optional string containing the URL on the device that provides the QosPolicyHolder service. If the device provides the URL, containing "HTTP" or "HTTPS" as the <protocol>, for its configuration, then the Control Point may retrieve a page using the provided URL to allow a user to configure the policy holder (the configuration method is out-of-scope). The host portion of the URL must be in dotted-decimal IP address form, e.g. "http://10.0.0.131/ config_policy.html".

  URL Format: <protocol>:// <host> [:<port>] [<path> [? <query>]]

5.2.2. Default Policy

The following default policy must be used by the QosManager in the following cases:

- where there is no QosPolicyHolder Service and the Control Point did not specify a Policy Holder to use
- more than one QosPolicyHolder Service exists on the network and the Control Point did not specify a Policy Holder to use.

The default value for AdmissionPolicy is “enabled” state.

The TrafficImportanceNumber default is based on the TrafficClass. This default mapping of Traffic Class to TrafficImportanceNumber is defined in the QosManager Service document. If the TrafficDescriptor does not contain a valid TrafficClass then the QosManager Service must treat that traffic stream as traffic class type “Other”.

The default UserImportanceNumber is 0, the lowest value.

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5.3. Determination of QosDevice Services that should be configured

To setup QoS for the traffic stream, the QosManager may determine the devices that are directly involved in the transport of the traffic stream and the type of QoS setup that is required. Determination of the devices is done via a path discovery mechanism that may include use of QD[4]:GetPathInformation.

5.3.1. Path Determination (Optional)

The QosManager may use the TrafficId information together with the response from QD:GetPathInformation received from each QosDevice Service to determine which devices are on the path. This information may also be used to determine the applicable network interfaces.

1. The QosManager first determines the Source and Sink QosDevice services by comparing the Source and Sink IP address in the TrafficId to the IP addresses of all discovered QosDevice Services available on the network.
2. The QoS Manager may then find the intermediate devices by:
    a. Looking up the MAC addresses corresponding to the Source and Destination IP addresses in the Traffic ID
    b. Getting the QD:GetPathInformation structure from every QosDevice Service available.
    c. Comparing the MAC addresses from the TrafficId and the DeviceReachableMacs in the QD:GetPathInformation Structures until the path is determined.

5.3.2. Setup Capabilities Determination

The QosManager uses the information in the previous step to determine the network capabilities for each device and interface on the path.

1. The QosManager uses the QD:GetQosDeviceCapabilities action on each device on the path. This returns the QosDeviceQosCapabilities XML structure.
2. The capabilities of each interface are extracted by matching the <InterfaceId> value to corresponding values in the QosDeviceCapabilities XML structure. The following information is provided:
    - **TechnologyType**: Provide an indication of the networking technology type (e.g., 802.11, 802.3, etc)
    - **AdmissionControlSupported**: This field indicates whether the interface on the device is capable of performing the device level admission control function.
    - **NativeQos**: Indicates if the interface support prioritized or best efforts QoS.
    - **MaxPhyRate**: indicates the maximum PHY rate of the interface.
    - **ChannelInformation:** for wireless networking technologies indicates the channel on which the network is operating.

5.4. Configuration of QoS Devices

The configuration of the QosDevices is controlled by the QoS Management Entity. Depending on the particular requirements of the traffic stream and capabilities of the QoS Devices on the path of the traffic stream, the QoS Management Entity can choose the appropriate setup. Some of the typical strategies that it may employ are described here.

[4] QD: QosDevice Service

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5.4.1. Priority Setup Strategy

For most networks, configuring the traffic stream source device with the appropriate packet priority (TrafficImportanceNumber) is sufficient for setup of QoS. Intermediate devices should also be configured with the traffic stream's TrafficDescriptor. Upon successful completion of SetupTrafficQos, source devices implementing the QosDevice service must prioritize the traffic, associated with the TrafficId, according to the TrafficImportanceNumber (hence PacketTaggingSupported="Yes") on their output interfaces. Intermediate devices implementing the QosDevice service with PacketTaggingSupported="Yes" must prioritize the traffic associated with the TrafficId according to the TrafficImportanceNumber on their output interfaces irrespective of incoming traffic priority. After the traffic stream is set, the QosDevice implementation must not alter any of the elements of the TrafficDescriptor structure.

5.4.2. Admission Control Strategy

If the AdmissionPolicy flag is "enabled" then the QosManager must perform network-wide admission control of the traffic streams.

Device-level admission control is not supported in UPnP QoS Version 2.0.

5.4.3. Traffic Observation Strategy

The UPnP QoS 2.0 provides mechanisms for QoS Management Entities to configure QosDevices to collect traffic pattern information on a per link basis. The QosDevice may further classify this information on a per priority basis as well. This can be useful to detect congestion points on the network as well as which traffic streams or sources are causing the congestion.

5.5. Run time Operation

5.5.1. Lease Management

TrafficDescriptor optionally includes 'Lease Time' for the QoS resources allocated to the traffic stream. It is up to the QosDevice service to enforce this constraint. If the QosManager intends to update the lease time of the traffic stream (TrafficLeaseTime), then it requests a complete new traffic stream setup process again after it has released the QoS resources.

5.5.2. Traffic revocation

A Control Point may revoke a traffic stream by calling QM:ReleaseTrafficQos with the appropriate TrafficHandle. The QosDevice will update the QoS state after releasing the traffic stream. After the traffic revocation the device must release all its QoS resources allocated to that traffic.

5.5.3. Violation of TSPEC

Traffic Streams are not policed in this version of the UPnP QoS Framework.

5.5.4. The Use of Traffic Descriptor

Traffic Descriptor is an XML structure that is exchanged during the run time QoS negotiation described above. For details about how this structure is populated and used, please refer to QosManager Service description document, Annex A.

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5.6. Relationship to other UPnP Services and non UPnP Traffic Streams

5.6.1. UPnP IGD

UPnP QoS is seen as a complementary service that may be added to an IGD. While the IGD is concerned primarily with LAN to WAN connectivity, the UPnP QoS service allows it to participate within the local network for QoS on traffic streams it terminates for the Wide Area or for streams that may pass through any of its local interfaces. For example, it could be an intermediate QoS device for traffic stream that flows from a Wireless AP to a physical Ethernet interface or between two physical Ethernet interfaces. For streams that come from a LAN client that are destined for the WAN, or vice-versa, it can be a sink or source device.

To participate in UPnP QoS, the IGD need only implement the QosDevice service. A vendor implementing an IGD may choose to also implement a QosManager and QosPolicyHolder.

In the case of a scenario where the traffic either originates or terminates on the WAN (i.e. WAN-to-LAN or LAN-to-WAN traffic) the QosBoundarySourceAddress and QosBoundaryDestinationAddress fields of TrafficDescriptor may be used. These values may be used by the QosManager for such tasks as path determination. In such a scenario, the Traffic Identifier field of TrafficDescriptor enumerates the real source / destination IP address of the stream (whether it is on the LAN or the WAN). In case where the traffic originates on the WAN and ends up on the LAN, the Control Point will specify the QosBoundarySourceAddress as the IP address of the IGD. In case where the traffic originates on the LAN and ends up on the WAN, the Control Point will specify the QosBoundaryDestinationAddress as the IP address of the IGD.

5.6.2. Legacy Devices

Legacy devices cannot be discovered nor managed via UPnP QoS. They may however, be able to process a Layer 2 priority that has been set by a QosDevice Service.

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6. Prioritized QoS

6.1. Management of Packet Priorities

The QoS Management Entity communicates TrafficImportanceNumber consistent with the QoS Policy being used. The following diagram depicts the sequence of messaging for the setting up QoS for a given traffic stream.

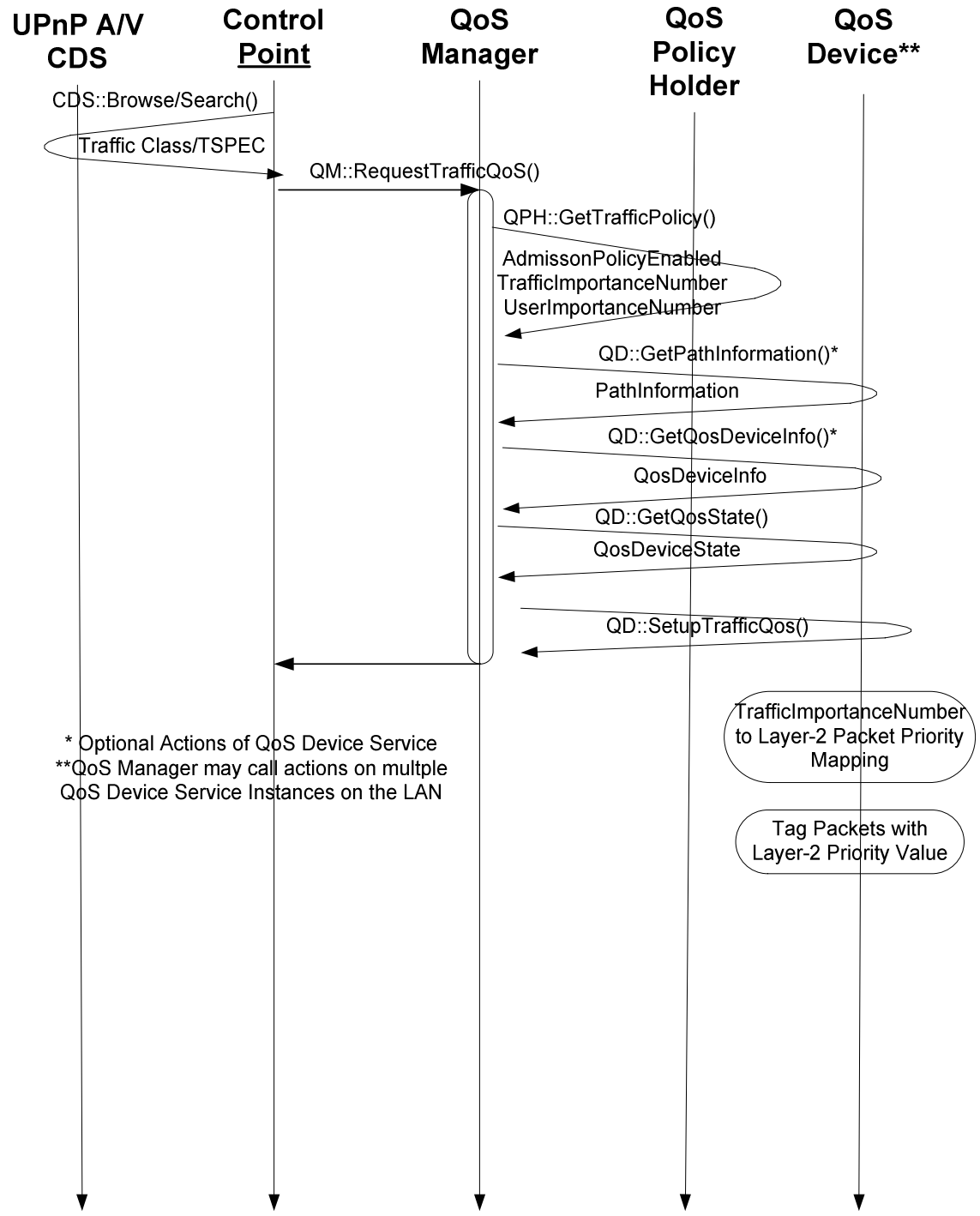

Figure 3 – Packet Priority Determination Flow

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The packet priority value used on a particular traffic stream is derived from the TrafficImportanceNumber. The packet priority value can be provided by any device (based on TrafficId) on the path of the traffic stream although it is typically required at the source device. This allows the packet tag to be assigned the correct priority value that is carried through the full path of the packet through the network.

The mapping of the TrafficImportanceNumber to the priority tag value used for the layer-2 network is not defined by the UPnP QoS Framework. This is dependent on the particular layer-2 technology type used. The TrafficImportanceNumber has been defined to be consistent with the IEEE 802.1D, Annex G, so it is expected to be a one-to-one mapping from the TrafficImportanceNumber to the packet tag value.

The TrafficImportanceNumber is determined by the QosPolicyHolder service. Based on Traffic Class and other information available in the traffic descriptor the QosPolicyHolder service provides the TrafficImportanceNumber. In the case where the QosPolicyHolder Service cannot be used, default policies are defined that must be used by the QosManager.

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7. Usage of Tspec

A Traffic Specification (Tspec) contains a set of parameters that define the characteristics of the traffic stream. When a Control Point requests QoS for a traffic stream, that stream is described in the Tspec it submits. This information is then used by the various UPnP QoS entities (Manager, Policy Holder and Device) to determine the proper handling for the stream. As such, the Tspec is a fundamental artifact for QoS within the UPnP framework and should always be submitted with as much information as is known at the time.

There are essentially two scenarios when using a Tspec: Those that involve UPnP AV traffic streams and the general case for non AV streams. As such the Tspec itself contains fields that are common to both scenarios and those that are specific to AV. Both scenarios are described further below.

General Scenario

The General scenario involves establishing QoS for non UPnP AV traffic streams. In this situation, the traffic stream is described in the Tspec using the TrafficClass that most closely matches the traffic stream. AV specific portions of the Tspec are not required.

UPnP AV Scenario

The AV Scenario involves establishing QoS for UPnP AV traffic streams. Like the General case, the TrafficClass of the Tspec should be properly recorded. In addition, several other fields (AVTransportURI and AVTransportInstanceID) can be filled in by a Control Point. In a UPnP AV scenario, this information is extracted from the Content Directory Service of the Media Server. In the Content Directory Service, a Tspec is represented either as a string containing escaped XML structure, or an URI pointing to the escaped XML structure. A UPnP AV Control Point uses CDS:Browse and/or CDS:Search action calls to acquire the Tspec(s) associated with the content.

The following example describes the Tspec in CDS and the use of indirection through a URI in CDS. We assume the normal UPnP name spaces are in effect and that an appropriate namespace q: is defined somewhere and is in effect for this example.

```
<item>
      …
       <res protocolInfo="http-get:*:video/mpeg:*"
      tspec="&lt;TrafficClass&gt;AV&lt;/TrafficClass&gt" …>
            http://1.2.3.4/file-highres.mpg
      </res>
       <res protocolInfo="http-get:*:video/mpeg:*"
      tspec="http://1.2.3.4/med-res-tspec" …>
            http://1.2.3.4/file-highres.mpg
      </res>
      <res protocolInfo="http-get:*:video/mpeg:*"
      tspec="&lt;TrafficClass&gt;AV&lt;/TrafficClass&gt" …>
            http://1.2.3.4/file-lowres.mpg
      </res>
</item>
```

The length of the Tspec string in CDS is bounded by the UPnP AV specification and for longer Tspec strings indirection through a URI can be used. A sample contents of http://1.2.3.4/med-res-tspec is:

```
&lt;TrafficClass&gt;AV&lt;/TrafficClass&gt;
```

Note that the file must contain escaped XML.

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Annex A
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Layer 2 Implementation Guidelines

A.1 IEEE 802.1D, Annex G

Devices that support IEEE 802.1D, Annex G priority scheme must convert the UPnP Traffic Importance Number to the appropriate VLAN tag. The following mapping table must be used. Note that this table is used for tagging; for the queuing and buffer management when dealing with less than 8 queues, the behavior is specified by IEEE 802.1D.

QoS Traffic Importance Number	VLAN / IEEE 802.1Q priority
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7

Processing of received frames should be done in accordance with the IEEE 802.1q specification.

A.2 HomePlug

HomePlug defines four priority levels at layer 2. These levels, from highest to lowest priority, are: CA3, CA2, CA1 and CA0. It is recommended that the mapping of the QoS Traffic Importance number to a HomePlug priority be done using IEEE 802.1D Annex G. Based on this the four HomePlug Priorities, the following table of mappings can be applied.

QoS Traffic Importance Number	HomePlug Priority
0	CA1
1	CA0
2	CA0
3	CA1
4	CA2
5	CA2
6	CA3
7	CA3

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A.3 HPNA

HPNA defines eight priority levels. These are from highest to lowest, 7-0. It is recommended that the mapping of the QoS Traffic Importance number to a HPNA priority be done using IEEE 802.1D Annex G, Using that section and the eight priorities, the following table of mappings can be applied.

QoS Traffic Importance Number	HPNA Priority
2	0
1	1
0	*2*
3	3
4	4
5	5
6	6
7	7

A.4 DSCP

A QosDevice implementing DSCP[RFC2474] tagging must use the following mapping table.

QoS Traffic Importance Number	DSCP priority
0	0x00
1	0x08
2	0x10
3	0x18
4	0x20
5	0x28
6	0x30
7	0x38

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Annex B
(normative)

XML Namespaces

Most of Action arguments in UPnP QoS are XML documents. Every XML document is described by an XSD description which is listed in the respective service documents. For example, the formal XML schema definition for the UPnP QosPolicyHolder service namespace is:
"http://www.upnp.org/schemas/TrafficPolicy.xsd" and is located at
"http://www.upnp.org/schemas/qos/TrafficPolicy-v2.xsd".

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns="http://www.upnp.org/schemas/TrafficPolicy.xsd"
  targetNamespace="http://www.upnp.org/schemas/TrafficPolicy.xsd"
  elementFormDefault="qualified"
  attributeFormDefault="unqualified"
  id="TrafficPolicy.xsd">
  <xs:annotation>
    <xs:documentation>
      This is for version 2.0 of the UPnP QoS specification.
      Copyright 2004-2006 Contributing Members of the UPnP Forum. All rights reserved.
      Schema Location: "http://www.upnp.org/schemas/qos/TrafficPolicy-v2.xsd"
   </xs:documentation>
  </xs:annotation>
  <xs:element name="TrafficPolicy" type="TrafficPolicyType"/>
  <xs:complexType name="TrafficPolicyType">
    <xs:sequence>
      <xs:element name="AdmissionPolicy">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:enumeration value="Disabled"/>
            <xs:enumeration value="Enabled"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name="TrafficImportanceNumber">
        <xs:simpleType>
          <xs:restriction base="xs:nonNegativeInteger">
            <xs:maxInclusive value="7"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name="UserImportanceNumber" minOccurs="0">
        <xs:simpleType>
          <xs:restriction base="xs:nonNegativeInteger">
            <xs:maxInclusive value="255"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name="v2" type="v2ExtensionType" minOccurs="0"/>
      <!-- allow any element except those from (v1) target namespace -->
      <xs:choice minOccurs="0" maxOccurs="unbounded">
        <xs:any namespace="##other" processContents="lax"/>
        <xs:any namespace="##local" processContents="lax"/>
      </xs:choice>
    </xs:sequence>
  </xs:complexType>
  <xs:complexType name="v2ExtensionType">
    <xs:sequence>
      <xs:element name="PolicyHolderId" type="xs:string" minOccurs="0"/>
      <xs:element name="PolicyLastModified" type="xs:string" minOccurs="0"/>
      <xs:element name="PolicyModifyingUserName" type="xs:string" minOccurs="0"/>
      <xs:element name="PolicyHolderConfigUrl" type="xs:string" minOccurs="0"/>
      <xs:element name="v3" type="v3ExtensionType" minOccurs="0"/>
      <!-- allow any element except those from (v2) target namespace -->
      <xs:choice minOccurs="0" maxOccurs="unbounded">
        <xs:any namespace="##other" processContents="lax"/>
        <xs:any namespace="##local" processContents="lax"/>
      </xs:choice>
    </xs:sequence>
    <xs:anyAttribute/>
  </xs:complexType>
  <xs:complexType name="v3ExtensionType">
    <xs:sequence>
```

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```
      <xs:any namespace="##targetNamespace" processContents="lax" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute/>
  </xs:complexType>
</xs:schema>
```

In order to avoid name space collisions between different versions of UPnP QoS, the version tags such as V2, and V3 are used. It is envisioned that all tags at the root level by default belong to Version 1 until explicitly identified by vendor specific tags such as "prv" as in the following example:

```
<?xml version="1.0" encoding="UTF-8"?>
<TrafficDescriptor
  xmlns="http://www.upnp.org/schemas/TrafficDescriptorv1.xsd"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:prv="http://myPrivate.com"
  xmlns:prv2="http://myPrivate2.com"
  xsi:schemaLocation="http://www.upnp.org/schemas/TrafficDescriptorv1.xsd
  http://www.upnp.org/schemas/qos/TrafficDescriptor-v2.xsd">

    <!-- prv and prv2 are for illustration purpose only to show how vendor specific namespaces
could be added -->
  <TrafficHandle>kiwin1</TrafficHandle>
  <TrafficId>
    <SourceAddress>
      <Ipv4>192.168.1.50</Ipv4>
    </SourceAddress>
    <SourcePort>23</SourcePort>
    <DestinationAddress>
      <Ipv4>192.168.1.53</Ipv4>
    </DestinationAddress>
    <DestinationPort>23</DestinationPort>
    <IpProtocol>1</IpProtocol>
    <v2TrafficId>
      <v3TrafficId>
        <Whatever>whatever</Whatever>
      </v3TrafficId>
      <prv2:MyPrivate2>whatever</prv2:MyPrivate2>
    </v2TrafficId>
    <prv:MyPrivate1>whatever</prv:MyPrivate1>
  </TrafficId>
  <AvailableOrderedTspecList>
    <Tspec>
      <TspecIndex>300</TspecIndex>
      <TrafficClass>AV</TrafficClass>
    </Tspec>
    <Tspec>
      <TspecIndex>2</TspecIndex>
      <TrafficClass>Audio</TrafficClass>
      <v2TrafficSpecification>
        <v3TrafficSpecification>
          <Whatever>whatever</Whatever>
        </v3TrafficSpecification>
        <prv2:MyPrivate2>whatever</prv2:MyPrivate2>
      </v2TrafficSpecification>
      <prv:MyPrivate1>whatever</prv:MyPrivate1>
    </Tspec>
  </AvailableOrderedTspecList>
  <ActiveTspecIndex>300</ActiveTspecIndex>
  <TrafficImportanceNumber>5</TrafficImportanceNumber>
  <v2>
    <v3>
      <Whatever>whatever</Whatever>
    </v3>
    <prv2:MyPrivate2>whatever</prv2:MyPrivate2>
  </v2>
  <prv:MyPrivate1>whatever</prv:MyPrivate1>
  <OptionalPolicyParams>
    <CpName>Amy's CP</CpName>
    <v2OptionalParams>
      <v3OptionalParams>
        <Whatever>whatever</Whatever>
      </v3OptionalParams>
      <prv2:MyPrivate2>whatever</prv2:MyPrivate2>
    </v2OptionalParams>
    <prv:MyPrivate1>whatever</prv:MyPrivate1>
  </OptionalPolicyParams>
</TrafficDescriptor>
```

Similarly all the tags under V2 are expected to be in the namespace of QoS2.0 and so on. All vendor specific tags must be clearly identified by their respective name space definitions. The "Whatever" tag mentioned under

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V3 is an example of a specific element in the name space of V3, while the elements “MyPrivate1” and “MyPrivate2” belong to the namespaces prv1 and prv2 respectively.

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