Extending UPnP QoS Standard for Reducing Response Delay in Multimedia Home Networks

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Introduction

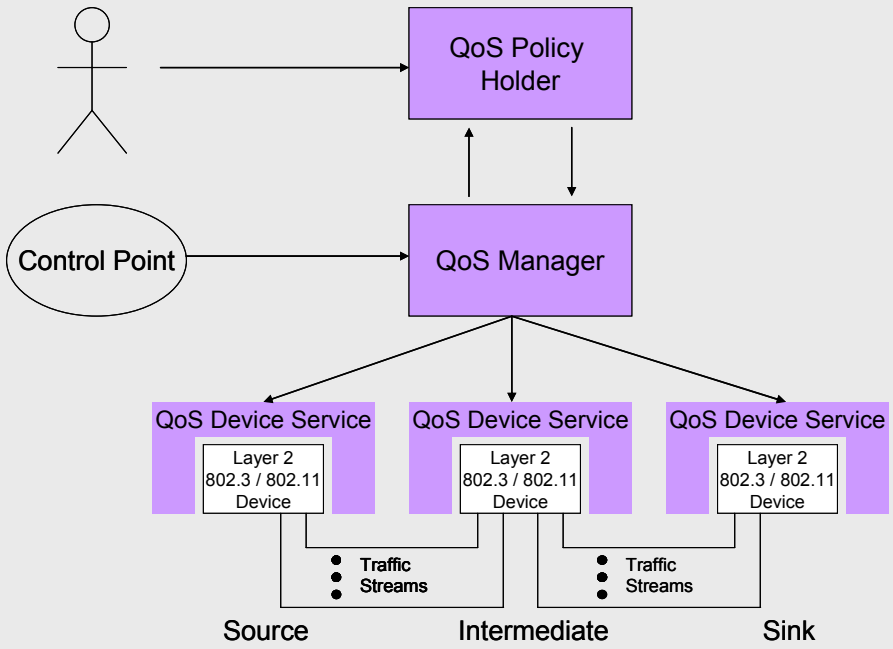
- Number of mobile multimedia devices is growing.
  - UPnP manages the heterogeneity and plug and play features
    - UPnP Audiovisual Architecture
    - UPnP Quality of Service Architecture
- QoS subsystem looks to ensure the next requirements
  - Transparency to the final user
  - Quality of content reproduction (functionality)
  - QoE (efficiency).
- The actual UPnP QoS subsystem doesn't have into account the efficiency issues
- To extend the actual UPnP QoS standard in order to:
  - Ensure the accuracy within the taken decisions
  - Improve the throughput of the actual initiatives

Objectives

- QoS subsystem that extends the UPnP QoS Architecture
  - Compatible with the UPnP standard
  - Highlighted issues
    - Persistence mechanism
    - Admission control modes
    - Relevant information retrieval mechanism
- To improve the QoE reducing the negotiation delay
  - Avoiding the redundant information interchange
  - Using stored information about the network topology and capabilities
- To check the developed subsystem features

State of the Art.

- UPnP QoS Architecture
  - Standardizes the AV flows quality management
  - Architecture based on three entities:
    - **QoS Manager**: Manages the QoS provisioning for a certain traffic
    - **QoS Policy Holder**: Stores the QoS policies applied to the AV flows
    - **QoS Device**: Provides information about the state and capabilities of a device
  - Constraints:
    - QoS supported within LAN
    - Non status persistence

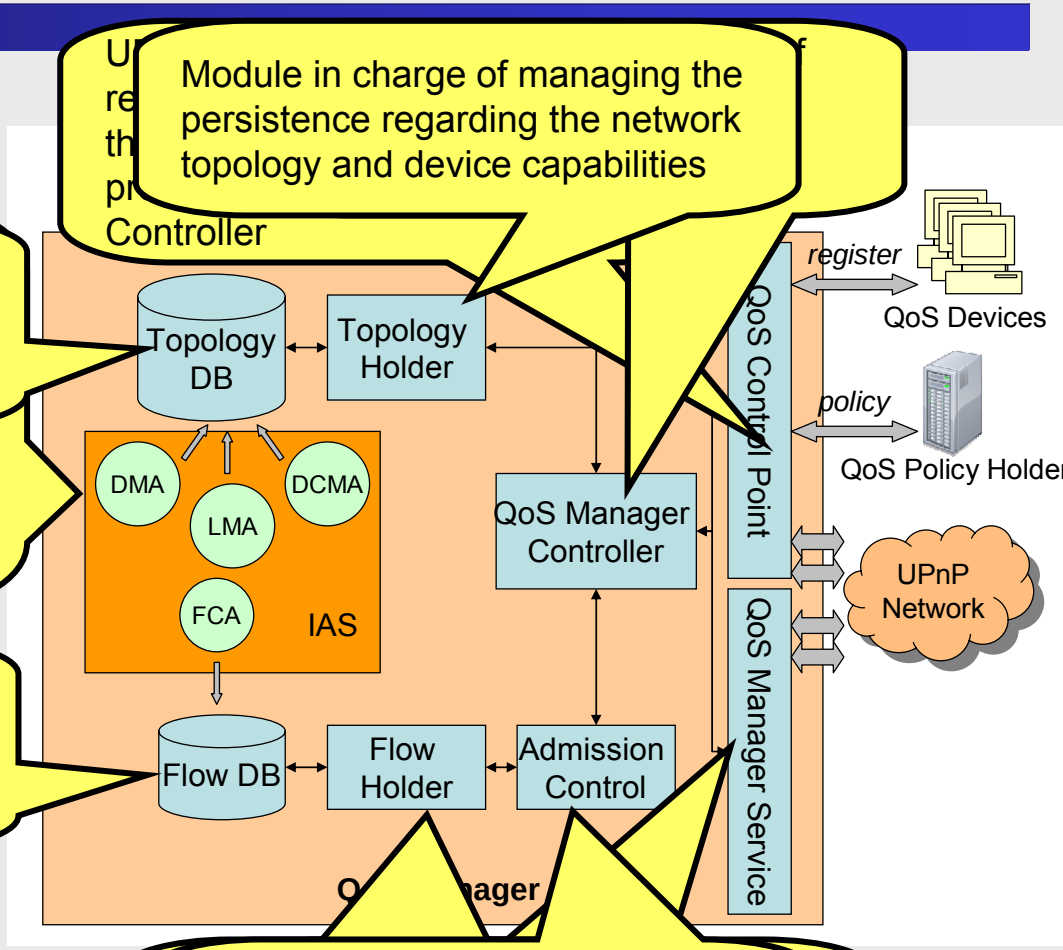


QoS Extension of the UPnP Standard.

- Modularity is the main guideline for the deployed model
- Centralized storage of the local network capabilities and topology
- “Information Agent Subsystem” (IAS) to maintain the consistence in the stored information
- Several operation modes have been defined
  - Device information retrieval mechanism
  - Actuators involved in admission control tasks
- Architecture extension focused on:
  - QoS Devices
  - QoS Policy Holder
  - QoS Manager

QoS Extension of the UPnP Standard. Architecture Extension (I)

- QoS Manager
  - Standard Components



Information about the network topology, device capabilities and previously calculated routes

- LMA : Link between devices
- DCMA : Device capabilities
- FCA : Flows within the LAN

Information about the registered flows within the LAN

- DDBB
  - Topology Data Base
  - Flows Data Base

Module in charge of deciding whether a flow can be reserved or not, having into account the input information

QoS Extension of the UPnP Standard. Architecture Extension (II)

- QoS Device
  - Additional eventualization mechanism to inform about the last successfully completed action
    - 'Request', 'Release' and 'Update' actions
    - New eventing state variable : 'TrafficState'
    - 'getQosState' action returns similar information
- QoS Policy Holder
  - Additional functionality that allows the QoS Manager to obtain more than one QoS policy
  - Improvements
    - Saves processing time
    - Reduces the channel load

QoS Extension of the UPnP Standard. Operational Modes

- Describe several configurations of the QoS subsystem.
  - Compatibility to the UPnP QoS v2 specification
  - Adapting to the home network environment
  - Improving the throughput in determinate use cases
- Persistence system
  - Local
    - Makes use of the stored information
  - Remote
    - DDBB disabled
- Admissions Control
  - Hybrid
    - Responsibility shared between QoS Manager and Devices
    - The QoS manager takes the first decision
    - The QoS Devices corroborate it
  - Distributed
    - Admission control done by the QoS devices
  - Centralized
    - Flows admission only focused on the QoS Manager
- IAS (Information retrieval mechanism)
  - Event-based
  - Polling mode
  - Mix mode

Extended Model evaluation. Methodology

- Evaluation scenario
  - Various devices with QoS capabilities ('QoS Devices')
  - One 'QoS Manager'
  - One 'QoS Policy Holder'
  - Local Area Network
- Efficiency measured by the response time and compared with **UPnP QoS standard** (#1)
- Five use cases
- Issues evaluated
  - Persistence Mechanism
  - Admission Control Modes

	Configuration modes	***Description***
1	**Persistence System:** Remote **IAS:** Polling mode **AC:** Hybrid	*UPnP QoS Standard*
2	**Persistence System:** Local **IAS:** Polling mode **AC:** Hybrid	*Fully compatible with the QoS UPnP standard.*
3	**Persistence System:** Local **IAS**: Event-based **AC:** Hybrid	*Complete extended model* *Hybrid admission control*
4	**Persistence System:** Local **IAS**: Event-based **AC:** Centralized	*Complete extended model* *Centralized admission control*
5	**Persistence System:** Local **IAS**: Event-based **AC**: Distributed	*Complete extended model* *Distributed admission control*

Extended Model evaluation. Results

- Persistence Mechanism (#1, #2, #3)
  - Noticeable improvement of the response time
  - Information retrieval mechanism
    - Polling mode
      - Compatible with UPnP QoS Standard
      - Additional requests done in order to retrieve the Device capabilities
      - Mayor a.r.t
    - Event-bases mode
      - Database totally consistent
      - Mayor efficiency improvement

Configuration	a.r.t. (ms)	e.i. (%)
#1 (reference configuration)	1400	-
#2	1196	14%
#3	554	60%
#4	99	92%
#5	714	45%

- Admission Control (#1, #3, #4, #5)
  - Centralized
    - Best results
    - Vulnerable to inconsistencies into de DDBB (Refuse or Accept)
  - Hybrid
    - Improves the vulnerability but it can refuse viable flows
    - Efficiency reduction
  - Distributed
    - ↑ Robustness ↔ ↓ Efficiency

Conclusions and Future Works

- The usability of multimedia services mainly depends on:
  - The integration features of a multimedia infrastructure
  - The propagation and access to services
  - The ability to establish a QoS connection
- Modular model which extends the current UPnP QoS standard and improves the QoE
- The centralized storage paradigm allows:
  - To create new operational modes to adapt the QoS System to a determinate environment
  - To improve the throughput compared to the UPnP standard
- Future works
  - To maintain the control of the streams' priorities
  - End-to-End QoS management support

Questions?