Enhancing UPnP Quality of Service by Intelligent Access Point

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Abstract—**With the process of wireless local area networks (WLANs), the concept of digital home gradually plays an important role nowadays. For this reason, a standard called UPnP, one of the future trends, is proposed. UPnP provides many important functions, for example, active detection, zero-configuration, etc. The problems about the distribution of total bandwidth and QoS become more complicated since multiple services (e.g., Ftp, Streaming, VoIP) activate simultaneously. Under the architecture of UPnP QoS, we enhance and apply it to Intelligent Access Point (IAP) to redefine a new UPnP QoS architecture in our paper, and combine our UPnP QoS algorithm to proceed predation and distribution algorithm about the total bandwidth. In this paper, the IAP and users are permitted to do active detection and can adjust actively to get a better QoS. Finally, our simulation results reveal that the total bandwidth can be used in a more efficient way which means that out proposed scheme can always service more new coming users.**

Keywords- Universal Plug and Play (UPnP), digital home, active detection, zero-configuration, UPnP QoS.

I. INTRODUCTION

In recent years, lifestyle of human beings has enormously changing with the process of wireless communication which contains multiform and plentiful types of services. Home network is also one important issue in wireless LANs (WLANs). Under this global trend, Microsoft Cooperation promotes a standard called Universal Plug and Play (UPnP) [1], [5] ,[9], a standard interface of home networks [3]. To further develop web-based UPnP standard, several companies (e.g., CISCO, COMPAQ, D-Link, SONY) organized a forum called UPnP Forum [1] in 1999. In this way, all electric appliances that support UPnP can connect to each other and share resources without additional installation. Moreover, people could control electric appliances in digital home by zero-configuration [2]. By using XML and HTTP as its communication protocols, UPnP is compatible with any other platforms of networks. In UPnP QoS architecture, systems use streaming to transmit multimedia resources and how to distribute limited bandwidth is therefore the main point of our paper.

The rest of this paper is organized as followed. Section 2 represents relatively technical backgrounds, and Section 3 displays our QoS architecture and algorithm. Section 4 manifests results of the simulation and analysis, and Section 5 concludes this paper.

II. BACKGROUNDS

A. UPnP AV Architecture

As a standard for multimedia streaming in digital home, UPnP AV [7], [8] contains Media Server, Media Renderer, and AV Control Point in basic scenario. Media Server owns multimedia resources for users to play on Media Renderer. Users can select what media to play and which Media Renderer to play on by user interface of AV Control Point. All UPnP actions are sending by AV Control Point to set Media Server and Media Renderer. When the video contains are transmitted from Media Server to Media Renderer, the transmission protocols (e.g., HTTP, RTP, TCP/IP) and codecs (e.g., MPEG2, MPEG4, MP3, WMV) must be supported by both components. The relationship between Media Server, Media Renderer, and AV Control Point is shown in Fig.1.

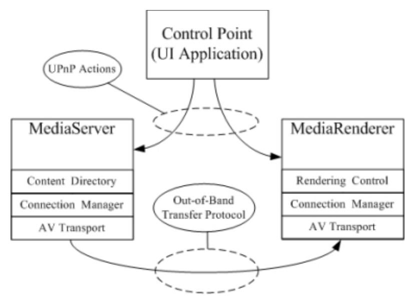

Fig.1. UPnP AV Architecture

B. UPnP QoS

In digital home, wireless networks will be the major medium for transmission, and the issues of QoS will be much more important in the future. UPnP forum brings up UPnP QoS architecture version 2.0 [2] in 2006 as shown in Fig.2. UPnP QoS architecture version 2.0 comprises three major parts: QoS Manager (QM), QoS Policy Holder (QPH), and QoS Device (QD). QM manages communications between Control Point (CP) and any other UPnP QoS components. QPH makes policies according to the classification of applications, and QDs are in charge of providing multimedia resources and managing QoS devices. While sending a Request QoS (1) to QM, CP produces a Traffic specification (Tspec) to QM at the same time. Next, QM sends a Traffic Descriptor (2) to QPH to get necessary information. Meanwhile, QM collects some QoS information from several devices that are currently transmitting data. QPH then replies Traffic Policy (3) to QM. Finally, QM adjusts all corresponding devices in terms of the received information. By the way, users are allowed to change and reset the policies in QPH according to their different demands.

III. IMPLEMENTING QOS ARCHITECTURE BASED ON IAP

First, the authors in [9] proposed an enhanced QoS Architecture which adds a “QoS Adapter” and a “Status Monitor” to monitor the data flows and adjust it dynamically. Next, the Status Monitor monitors the status of data flow and reports the status of network to QM periodically. Based on this report, the QoS statuses of each device are updated by the QM. Finally,

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we enhance the QoS Architecture [9], and focus on the method of how to distribute the total bandwidth of all appliances without partiality.

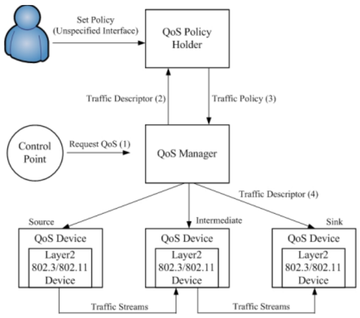

Fig.2. UPnP QoS Architecture

A. System Architecture

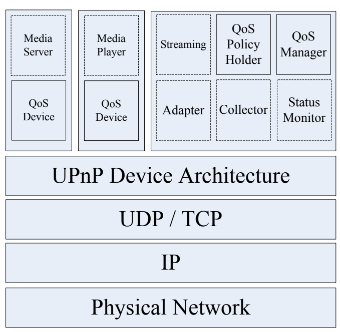

Fig.3. UPnP QoS Architecture Based on IAP.

In this paper, we add the UPnP QoS Architecture to wireless Access Point (AP), Media Server and Media Player, and the services are rearranged as shown in Fig.3. First, we attach four modules to a Intelligent AP (IAP), including "Streaming", "Status Monitor (SM)", "Adapter" and "Collector". In addition to the four new modules, both UPnP QoS QPH and QM are also standardized. Second, we assume that the Media Server and Media player can support the standard UPnP and become an UPnP Media Server and an UPnP Media Renderer.

B. Initializing Procedures for IAP

Before using the IAP, the following procedures for initialing the IAP are listed step by step as shown in Fig.4.

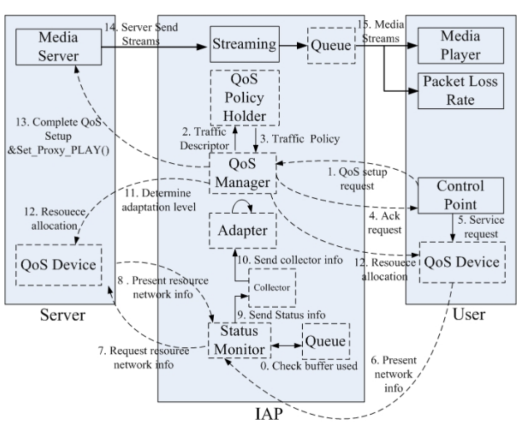

Fig.4. Initializing Procedures for IAP

C. Active Detections by IAP and Adjusting Procedures

After the Initializing Procedures, the IAP is allowed to serve users who request services. The details about how the IAP executes active detections and adjusts its internal settings are displayed as followed.

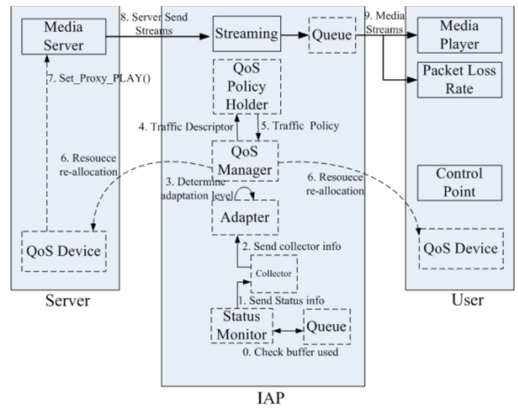

Fig.5. Active Detections by IAP and Adjusting Procedures

D. UPnP QoS Algorithm

Before entering this subsection, we first have to define whether the service request is successful or not. If a new service request comes, the server will determine its minimum bandwidth (Bmin) for transmission according to its service type and calculate the maximum time (Tmax) for completing this transmission. However, the bandwidth for transmission is not permanent constant, and the truly completed time (Treal) changes according to its current bandwidth for transmission (Breal). So, if the server judges that the new service request can be completed within Tmax, this service will be concluded as successful state and vice versa. Note that we replace the amount of transmission by 1.

$$T_{real} = 1/B_{real} \quad (1)$$

$$T_{max} = 1/B_{min} \quad (2)$$

Definition 1: ratio

The parameter ratio is used to represent the remnant bandwidth that can be distributed to other users. If the ratio is less than 1 (ration < 1), it means that there is still remnant bandwidth for a new user now. On the contrary, if the ratio is equal to 1 (ratio =1), it means that there is no remnant bandwidth for a new user currently. Under (1), (2) and (3), we can get (1-ratio) to determine the ratio that can be distributed to other user. Note that the ratio must be equal to or less than 1 (ratio <= 1), because B_{real} must be equal to or less than B_{min} to guarantee QoS.

$$ratio = T_{real}/T_{max} = B_{min}/B_{real} \quad (3)$$

Definition 2: Δx and ratio'

After our further considerations, the method in *Definition 1* will encounter one serious problem that users may feel the quality of image drop off instantly, because the bandwidth for current service is reduced to Bmin (Breal = Bmin) by predation algorithm (6). Under this reason, we propose a more appropriate method in (4). Based on (3), the purpose of ratio', the first term in (4), is to enlarge the value of ratio. With the newly proposed (4), the quality of image can be maintained because of the enlarged ratio (ratio'). Note that Δx can be adjusted randomly by the manager.

$$\text{ratio}' = \text{ratio} + (1 - \text{ratio})\Delta x \qquad (4)$$

Definition 3: A

When a new service request comes, the IAP can do predation algorithm (6) according to different service types. If a new service request for bandwidth is BW_{n+1}, the amount of predation proceeded by the IAP is based on the weights of different service types. For example, if BW_{n+1} = 10 Mbytes, W_f = 0.8 (the weight for ftp), and W_s = 0.2 (the weight for streaming), the IAP can recycle the bandwidth 8 and 2 Mbytes from ftp and streaming, respectively. Furthermore, in case that the recycled bandwidth is bigger than our expectation (BW_{n+1}), the A is adopted to adjust the amount of predation to a precise value of bandwidth.

$$A = (W \times BW_{n+1})/(1 - \text{ratio}') \times BW \qquad (5)$$

Definition 4: Predation algorism for UPnP QoS

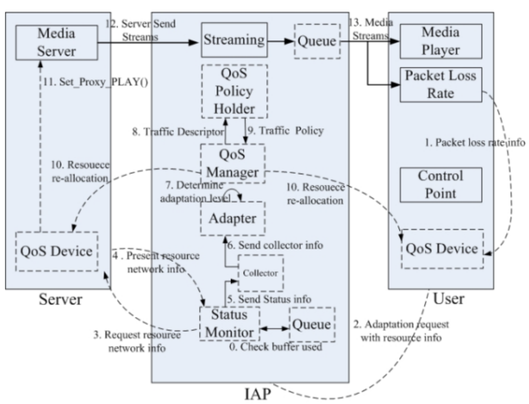

Fig.6. Active Detections by Users and Adjusting Procedures

From the discussions in *Definition 1* to *3*, we can obtain the predation algorithm for UPnP QoS. The index j represents different service types, and the index i stands for the members in each service type. The amount of predation can be adjusted by parameter A to a precise value of bandwidth BW_{n+1}.

$$BW_{n+1} = \sum_{j=1}^{m} \frac{A_j}{W_j} \sum_{i=1}^{n} (1 - \text{ratio}'_{ij}) \times BW_{ij} \qquad (6)$$

To exclude the worst situation, a service should be ended in a certain timeslot. When a service is finished, a reasonable mechanism is necessary to distribute the bandwidth again. For this reason, we add a collector in our UPnP QoS architecture to do this job as shown in Fig. 3. The collector can recycle the bandwidth that is released by some retired users, and the total amount is symbolized by $A_{iv}BW$. (7) is used to distribute $A_{iv}BW$ to different service types, and (8) is further used to distribute the bandwidth to all current members in different service types. Note the index j represents the different service types, and the index i stands for the members in each service type.

$$S_j = A_{iv} BW \times \left[W_j / \textstyle\sum_{j=1}^{n} W_j\right] \qquad (7)$$

$$S_i = S_j / n,\ i = 1, 2, 3, \ldots, n \qquad (8)$$

E. *Active Detections by Users and Adjusting Procedures*

In our system architecture, the IAP constantly activates our proposed algorithm to calculate and adjust the current distribution of bandwidth. To prevent unexpected situations, we must allow users to inform the IAP about the breakdown of QoS caused by the busyness of the IAP. The procedures about how users to inform the IAP are illustrated in Fig.6.

IV. Simulation Results and Analysis

100 service requests are generated randomly order by order and can be divided into three major service types: VoIP, Streaming, and Ftp. The section discusses the differences of QoS between with and without adding our UPnP QoS algorithm. Finally, we will describe and analyze the simulation results.

A. *Defining Environments and Paremeters*

IEEE 802.11 b standard is used to implement our wireless communication. We design our simulator using C language, and assume that the maximum bandwidth for transmission is 10 Mb/s. At the beginning, the simulator generates 100 service requests within three different service types: VoIP, Streaming, and Ftp. The appropriate threshold values for transmission are listed in TABLE I.

TABLE I. Threshold Values for Transmission

Service types	Threshold value
VoIP	64Kbps
Streaming	640Kbps to 4Mbps
Ftp	64Kbps to 1Mbps

B. *Simulation results and analysis*

The first benefit of our UPnP QoS algorithm is the decrease of the waiting time in each service request, because our mechanism allows more people to enter the environment of digital home synchronously. The most obvious difference between Fig.7 and 8 is that the waiting time is greatly reduced by using our method. The number of service in Fig.7 and 8 represents the joining service request within 1 to 100. Note that the waiting time means how many times each service request waits.

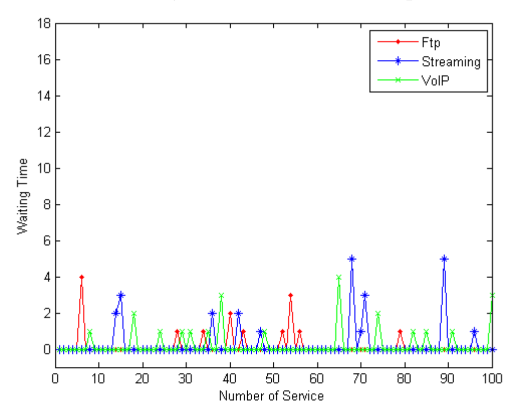

Fig.7. The simulation result of waiting time (without our method)

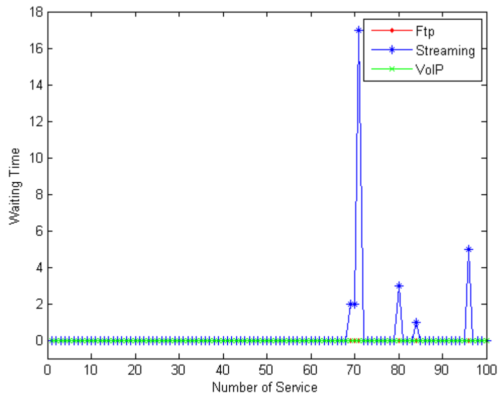

Fig.8. The simulation result of waiting time (with our method)

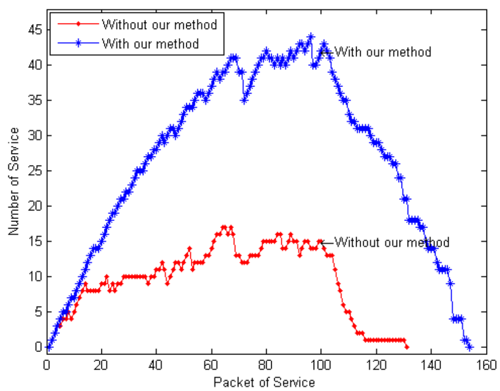

Fig.9. The comparison for numbers of service.

Fig.9 reveals the second benefit of our UPnP QoS algorithm: the total bandwidth can be utilized much more efficiently. We do not distribute our limited bandwidth to certain service requests, and more people certainly can join in the environment. In Fig. 9, the upper curve is much higher than the lower one, because the bandwidth can be recycled when this service is completed in the lower one. On the contrary, we can execute the predation algorithm to recycle the bandwidth that has been distributed to the currently proceeding services so that the IAP can serve more users all the time.

V. CONCLUSIONS

TABLE II. THE FAILED RATE (FR) BETWEEN TWO MTTHODS

	Ftp	VoIP	Streaming
Old method	8.57%	13.16%	25.93%
New method	0%	0%	18.52%

TABLE III. THE SUCCESSFUL RATE (SR) BETWEEN TWO METHODS

	Ftp	VoIP	Streaming
Old method	91.43%	86.84%	74.07%
New method	100%	100%	81.48%

We use TABLE II and III to conclude this paper. TABLE II and III list the Failed Rate (FR) and the Successful Rate (SR) to represent whether a new service request could get service from the IAP at certain time or not. With our method in section III, as given in TABLE II, we can get 100% SR in Ftp and VoIP and 18.52% in Streaming, because the environment achieves the maximum number of services. At that time, each service type uses its own threshold value for transmission as shown in TABLE I. In general, a new service request can only be accepted by the IAP when an ongoing service is ended. Thus, the sacrifice of Streaming is necessary. Finally, we can greatly decrease the waiting time to each service request and increase the total amount of service request, and the promotions of UPnP QoS are obvious in section IV.

VI. ACKNOWLEDGEMENT

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