On Enhancing Diffserv Architecture by Dynamic Policy Provisioning Using Network Feedback

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Abstract: This article describes an approach to improve IP packet marking entering a Diffserv domain through dynamic policy provisioning and network feedback signaling. Traffic entering the network is dynamically tagged based on network congestion information reported by real-time resource monitoring and feedback alerts. This allows dynamic reallocation and management of resources based on current network state and applications QoS requirements.

We present an algorithm dealing with video traffic and we enhance our architecture by using meta-policies which are stored locally in the edge router of the Diffserv network. Therefore, video traffic can be marked with different PHB when entering the network. An evaluation of dynamic policy provisioning using a Java COPS and a Linux based network is also presented and evaluated over an experimental testbed.

Key words: MetaPolicy, COPS, QoS, IP Diffserv

1. INTRODUCTION

This article describes a dynamic IP Diffserv resource allocation model that relies on COPS (Common Open Policy Service) as signaling protocol [1]. While the current Diffserv configuration is static and doesn't change frequently our proposal is

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based on network resource monitoring and reporting information from the network to build a reactive system by executing automatic and real-time reconfiguration. The configuration may concern essentially dynamic IP packet marking/remarking. Our model is applied to video traffic that make use of available bandwidth through source bit rate adaptation.

To enhance this model, we have proposed in [2] a new approach to handle dynamically out-of-profile traffic when entering the Diffserv domain by regarding network state. In this architecture, out-of-profile traffic is treated differently each time i.e. accepted, remarked or dropped dynamically. We propose to extend this idea by marking user traffic dynamically by adding conditional actions to the system which will be executed asynchronously based on the reception of a triggering condition by the management system.

The reminder of the article is as follow; Section 2 describes the proposed resource management model. Performance evaluation and results analysis are presented in Section 3. Finally, we conclude in Section 4.

2. DYNAMIC POLICY PROVISIONING USING NETWORK FEEDBACK SIGNALING

2.1 Resource Monitoring and Network Feedback

In this paper, we focus on QoS measurement, essentially bandwidth usage related metrics. This measurement system is protocol independent and media independent to ensure both portability and commonality in the measurements and allow dynamic network resource and QoS management.

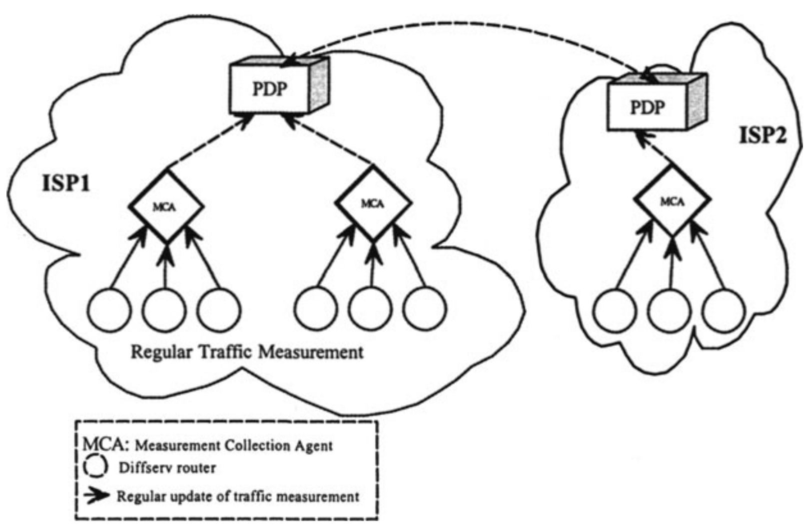

Figure 1: Hierarchical aggregation of traffic measurements

Figure 1 illustrates how hierarchical measurement estimates the traffic matrix for a large Internet Service Provider (ISP). Each router performs a passive monitoring of incoming traffic (i.e. BW_{ij}: bandwidth usage for router i in its interface j). Through regular update each router provides a partial view of the network. MCA (Measurement Collection Agent) aggregate this partial measurement the result is given to the PDP. PDP aggregates all the measurement into a matrix that gives the PDP a global status of the network and can generate feedback from the network.

2.2 Dynamic Policy Provisioning

The idea of dynamic policy provisioning is to enable edge router to mark the incoming traffic (in a Diffserv domain) differently each time and according to network states. The network state is obtained from the PDP feedback. The steps involved in this processes is detailed in **Figure 2** and are explained in the following:

Step 1: When edge router is started, its PEP requests all meta-policy concerning Diffserv QoS Management (filtering, class and queuing discipline) and installs theirs. All incoming traffics are marked according to the pre-installed rules. The meta-policies are stored and processed locally by the edge router, independent of their semantics, thus making the model more efficient, scalable, distributed and robust [3].

Step 2: PDP periodically receives an aggregate of bandwidth measurement which gives him a global network state. When the PDP detects a significant change in the amount of available bandwidth, it triggers an external event reported to the PEP indicating that a particular condition is satisfied.

Step 3: Meta-Policies are already pushed in step 1, this allows a considerable reduction of the amount of traffic exchanged between PDP and PEP. In this step, only a particular condition is provisioned to the PEP. The PEP takes the decision locally by updating a particular filtering.

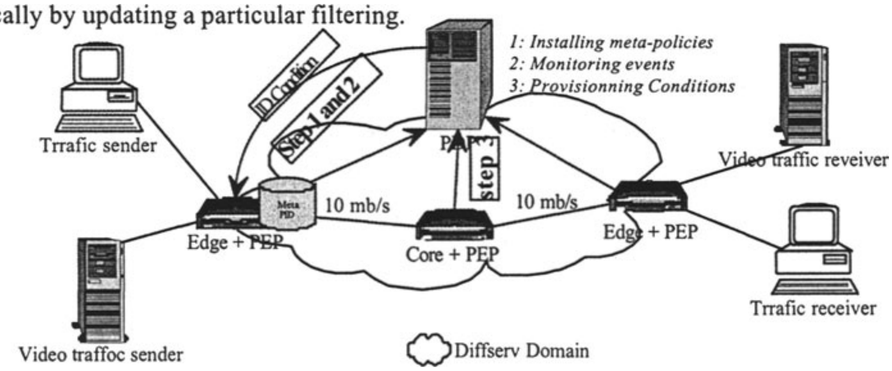

Figure 2: Dynamic Policy Provisioning

2.3 QoS Management Model

We have configured a **Meta-PIB** (Meta-Policy Information Base) that is described in **Table 1**.

The condition parameters are evaluated in the PDP and sent to the PEP. The decision is taken locally in the PEP according to meta-policies. We have sent a video traffic which can be in-profile or out-of-profile.

Id	Condition	Action
1	NetworkUnderLoad	• **Accept** video out-of-profile traffic • **Mark** in and out of profile video traffic with **Gold** PHB
2	NormalNetworkLoad	• **Mark** out-of-profile video traffic with **Silver** PHB • **Mark** in-of-profile video traffic with **Gold** PHB
3	NetworkCongestion	• **Drop** out-of-profile Traffic • **Mark** in-of-profile video traffic with **Bronze** PHB.

Table 1: Meta-policies dealing with video traffic

The parameters ***NetworkUnderLoad***, ***NormalNetworkLoad*** and ***NetworkCongestion*** represent the feedback from the network. They are evaluated according to network congestion of a bottleneck path. Two thresholds of congestion (*min_th* and *max_th*) determine whether the bottleneck link traffic path is in congestion or not.

The PDP receives periodically aggregated measurement of the bandwidth usage from network monitors. The monitoring information concerns essentially the bandwidth usage of each link in the network. After this, the PDP calculates a shaped value of the bandwidth usage using **EWMA** (Exponentially Weighted Moving Average). Path status is determined from the value of EWMA and is triggered to the PEP when a serious change is detected according to this algorithm.

```
Initialization:
Start Bandwidth Monitor Mi for each Router i to calculate the
available bandwidth BWi
Lambda ← 0.2    // Fixed value for historical data
X ←50% link capacity    // Initial value of EWMA
int ID ← 2 ; // we suppose that the network is in normal laod
int oldID;
Loop:
BW ← max(BW1, BW2, …,BWi) ; //EWMA available bandwidth X  ;
X ←  (1-lambda) * BW + lambda * X ;
oldID← ID;  // we save the value of the ID
if ( X < Min_th )then {ID ← 1   //i.e. NetworkUnderLoad= true}
else if (Min_th <= X &&  X < Max_th )then {ID ← 2;   //i.e.
   NormalNetworkLoad=true}
else {ID ← 3;//i.e.   NetworkCongestion=true}
End.
if (oldID != ID ) then {  Send to the Edge router a COPS Decision
in form of Named Decision Data (Provisioning) with the value of
the current Condition ID  }
```

3. PERFORMANCE EVALUATION

We used an experimental network testbed which is depicted in **Figure 2** to test the Dynamic Policy Provisioning System. User transmits a customized traffic (video traffic) across an IP Differentiated Services network. The network is composed of Diffserv capable routers: two edge routers and one core router connected through 10 Mb/s Ethernet links.

The network is load using *n* IP traffic generator. Background traffic is composed of 1024 bytes length UDP packet (including IP and UDP headers) according to a Poisson distribution with parameter packet/s that gives 1Mbit/s per traffic generator. In our test, and since our Ethernet links are 10 Mbit/s, we choose $n=5$, $n=7$ *and* $n=10$ in order to test different network conditions. Each source can be either ON or OFF state according to an exponentially distributed ON/OFF process with an average of 1 second.

Traffic policy is performed with a token bucket with the following parameters: *r=600Kbit/s* and $b=2K$. This means that video traffic must not exceed 600Kbit/s otherwise it will be considered as out-of-profile traffic.

For testing, we transmit a high quality MPEG-2 video stream to measure system reactions. **Figure 3** depicts the MPEG-2 video source bit rate. The average rate of this video is about 800Kbit/s and the peak rate is about 1.4Mbit/s. Video traffic is not conform to the traffic specification, and the exceed traffic is considered out-of-profile. Edge router marks the video traffic according to the dynamic policy provisioning.

The bottleneck link is loaded differently each time. **Figure 4** shows the network load during the experimental time period of 180s. The curves present the traffic sent from the *n* traffic generators to the receivers. This measure has been taken from the ingress interface of the core router. During the first 60 second there are only $n=5$ sources on/off. From 60 to 120 second there are $n=8$ sources and in the last 60 second (from 120s to 180s) the number of the source are $n=10$. Each source can be either ON or OFF.The PDP makes the decision according to the smoothing value of the bandwidth usage (i.e. EWMA). This decision is an identifier of the policy that the PEP must install. The following values Min_th=4Mbit and Max_th=7Mbit determine whether the video path is in congestion or not. Events sent from the PDP to the edge router doing the marking are listed **Table 2**. Each event is time stamped.

Time (Second)	(Policy ID)
0	Id=1
53	Id=2
54	Id=1
56	Id=2
127	Id=3
139	Id=2
140	Id=3
142	Id=2
144	Id=3
177	Id=2
179	Id=1

Table 2: List of policies event sent by the PDP to the edge router

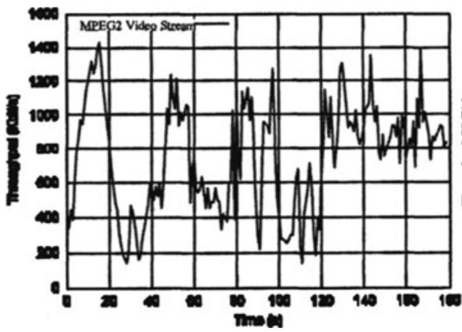

Figure 3: MPEG-2 Video Source Bit Rate

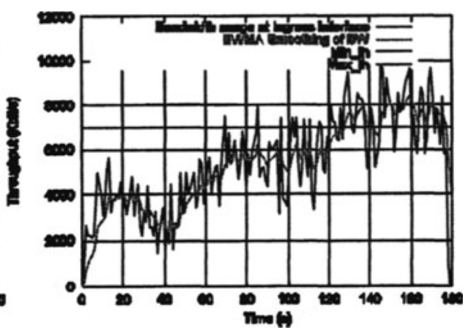

Figure 4: bandwidth usage in bottleneck link

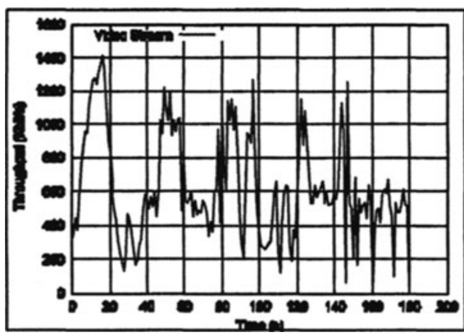

Figure 5: Received MPEG-2 video Traffic

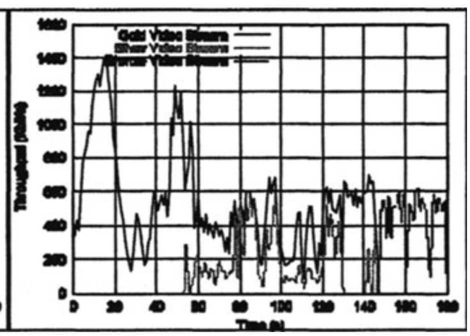

Figure 6: Different PHB Color

Figure 5 shows the video traffic received at the end-user terminal and **Figure 6** gives the PHB color assignment to IP packet video traffic when entering the domain.

4. CONCLUSION

We proposed an efficient and simple approach for IP packet marking in Diffserv networks. The proposed model is based on real-time resource monitoring and feedback signals from network components. IP Traffic entering the network is dynamically and automatically tagged with differing PHB according to resource network availability and application QoS requirements.

REFERENCE

[1] D. Durham, Ed, J. Boyle, R. Cohen, S. Herzog, R. Rajan,w, A. Sastry "RFC 2748: The COPS (Common Open Policy Service) Protocol" January 2000.

[2] T. Ahmed, A. Mehaoua, R. Boutaba "Dynamic QoS Adaptation using COPS and Network Monitoring Feedback" in IFIP/IEEE 4th MMNS'02, Santa Barbara, CA. October 2002.

[3] A. Polyrakis, R. Boutaba "The Meta-policy information Base" IEEE Network Magazine, Vol 16. N°2, April 2002.