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Dynamic Admission Control Scheme with Resource Reservation

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ABSTRACT

As the number of Internet users increases most of the admission control schemes were not able to accommodate the end-user requirements. The Internet was originally designed to provide best effort service, in which the network doesn't guarantee anything. With the passage of the time customer expect the Internet to be able to provide various services such as Internet broadcasting, VoIP and multimedia service. There has been as increasing demand for the Internet to support Quality of Services (QoS) to satisfy service requirements. The problem is that Internet can't achieve the desired QoS and there is issues concerning scalability for any available QoS solutions. Most of the existing admission control schemes are suffering from end-to-end bound violation, un-responsive flows, no traffic matrix, congestion, service can't accommodate the arrival request, allocation of resources, because scheme can't perform dynamically and maximising the bandwidth utilisation. During the research I will propose Dynamic Admission scheme and provide viable solution, which can overcome the problems, faced by the existing admission control schemes. The proposed admission control scheme performs dynamically and adapts to the abnormal conditions, which controls and reduces end-to-end violation. The scheme estimates the network resources using the previous traffic pattern for each path and provides the bandwidth decrease mechanism to improve the bandwidth utilisation. The proposed admission control scheme maintains a core traffic load matrix, which has a link bandwidth information and periodically updates, this prevents congestion and also provide a mechanism to allocate resources to the specific links. To maximise the utilisation of the bandwidth algorithm of the proposed scheme provides the feature where the bandwidth can be increased or decreased as the traffic increases or reduces. This can maximise the bandwidth utilisation, controls the traffic congestion and reduces the end-to-end delay bound violation. Ingress router functions dynamically and restricts the flows, which are un-responsive and causes congestion.

Key Words: DA: Dynamic Admission; QoS (Quality of Services); UF: Unresponsive follows; BB: Bandwidth Broker; EAC: Egress admission control scheme; CA: Communication architecture; AC: Application-layer communication protocol; Client-server architecture

INTRODUCTION

The number of Internet users has grown steadily. In some countries more than half of the population uses the Internet regularly. In October 2001, the country with the highest rate usage was Sweden with more than 63% of the population having Internet access according to Nua Internet Surveys (Cruz, 2002). The Internet currently supports a best-effort connectivity service. There has been as increasing demand for the Internet to support Quality of Services (QoS) to satisfy service requirements from many emerging networking applications and yet to utilise the network resources efficiently. But the problem is that Internet can't achieve the desired QoS and there is issues concerning scalability for any available QoS solutions. If the network is not designed properly the Internet is not able to handle congestion conditions. This is because the Internet is un-aware of its internal network QoS states therefore it is not possible to provide QoS when the network state changes dynamically. The static mechanism can't cope with dynamic changes of input traffic and network topology since it reflects the network status per week or month (Braden *et al.,* 2004).

So the need of *Dynamic and Adaptive mechanism* is required, which can allocates the network resources using the previous traffic pattern to each path. Also a mechanism is required, which can allocate bandwidth to various paths dynamically and that can control delay bound violation by allocating the resources to those path, which are experiencing heavy traffic load. The bandwidth can be increased or decreased according to the traffic load pattern this will maximise the utilisation of the links. Also a scheme, which can guarantee and QoS (Quality of Service) to multimedia applications and handle the complex problem of un-responsive flows.

The paper is organised as follows. First of all Section II contains the working of proposed dynamic admission control scheme and how it will overcome the problems, which are faced by most of the admission control scheme. Section III contains the design and working of the proposed scheme, which is followed by the experiments in section IV. In section V there is critical analysis and discussion of these results.

Dynamic and adaptive admission control scheme. There has been a great growth of real-time multimedia applications in recent years. The proposed control scheme allocates and estimates the network resources using the previous traffic pattern for each path and provides the bandwidth decrease mechanism to improve the bandwidth utilisation. The edge nodes do not need communicates with the bandwidth broker if the reserved bandwidth for the path is sufficient to satisfy the flow request. This reduces the amount of extra un-necessary traffic, which was generated before and provides better QoS (Quality of Service). Also the proposed admission control scheme maintains a core traffic load matrix. It has link bandwidth information and periodically updates with the measured per-class link load. This mechanism prevents congestion. In proposed scheme bandwidth is allocated on-demand to each path and new flow is only accepted if the bandwidth can accommodate the traffic load. If the bandwidth can't accommodate traffic load then the flow is rejected until the traffic load becomes responsive and reduces data packets. Also the quality of service is much better, because there is less communication between the bandwidth broker and the nodes. To maximise the utilisation of the bandwidth the proposed scheme provides the feature, where the bandwidth can be increased or decreased as the traffic increases or reduces.

The proposed scheme allocates the network resources to the requested user flow properly according to the network situation. This mechanism can prevent congestion from transient violation. Ingress router works dynamically and provides fast reacting to the un-expected traffic pattern changes. To make the proposed scheme more efficient dynamic provisioning mechanism provides a specific quota or bandwidth resource allocations for each link. A quota is a "chunk" of bandwidth that is much larger than the average bandwidth requirement of typical flows based on the previous traffic pattern collected from the core traffic load matrix. Bandwidth is normally allocated on-demand to each path in units of quotas. The proposed scheme control and eliminates the flows, which are not responsive. Every flow at each link has a limited bandwidth to be utilized. In the proposed scheme a high-bandwidth flow is restricted, because it has been identified as un-responsive (a flow above the limited bandwidth) and it is later determined to be responding to congestion by reducing its arrival rate, then the restriction is removed.

Dynamic and adaptive admission control algorithm. In this section, I would like to describe the basic operation model and the algorithm of the proposed mechanism. The bandwidth broker initially allocates bandwidth to each path. The state of a path maintains the amount of bandwidth that has been allocated to the path. When a flow reservation set-up request along a path arrives, the ingress edge node only needs to check the corresponding path whether the amount of bandwidth allocated to the path is sufficient to satisfy the flow's request. The operation model of the proposed mechanism is shown in Fig. 1.

If the answer is positive, the flow request is accepted. Only when the allocated bandwidth of the path is less than the requested bandwidth, the ingress edge node requests the additional bandwidth to the bandwidth broker. The amount of the additional bandwidth is calculated in the ingress edge node based on the previous traffic pattern information. Therefore, this mechanism simplifies the bandwidth calculation in the bandwidth broker by limiting the resource management to the only path level. In the above Fig. 1 described an outline of the basic DA mechanism. A more formal and detailed description of the proposed scheme is presented by the pseudo-code in (Fig. 2, Fig. 3, Fig. 4 & Fig. 5).

Fig. 3 describes the admission control in the ingress edge node. If the reserved bandwidth is sufficient for new flow set-up request, the ingress edge node accepts the flow request. If not the ingress edge node computes the additional bandwidth considered to be needed in next period and requests bandwidth allocation to the bandwidth broker. The Ingress router is working Dynamically and updating the information quickly as and when it changes. The proposed scheme is not working as static mechanism, which is not able to update the changes. That additional bandwidth, *BWi + 1* denotes the amount of bandwidth that the ingress edge node will request to bandwidth broker in time *Ti + 1*, is estimated based the previous traffic pattern such as follows:

$$BW_{i+1} = \frac{UBW_i - UBW_{i-1}}{T_i - T_{i-1}} \cdot \Delta t \qquad (1)$$

Where,

Ti denotes the i-th additional bandwidth request time, *BWi* is the allocated bandwidth in time *Ti* and *UBWi* is the used bandwidth in time *Ti*. Also, *t* means that the average value of time interval from *Ti-1* to *Ti*. Through this *t*, we can reflect the previous traffic patterns to the next bandwidth allocation.

$$\Delta t = \frac{\sum_{k=0} T_k - T_{k-1}}{i-1} \qquad (2)$$

Fig. 4 describes the additional bandwidth allocation in bandwidth broker. In the case that the available bandwidth in each link along the path is sufficient to satisfy the requested additional bandwidth from the ingress edge node, the bandwidth broker will allocate *MAX_BW* or *min* to the ingress edge node as well as to each node in domain. Otherwise, the flow set-up request is rejected.

The proposed mechanism provides the bandwidth decrease algorithm to improve the bandwidth utilisation. The ingress edge node periodically checks the used bandwidth for the each path. If the current bandwidth is less than the previous used bandwidth, the ingress edge node decreases the amount of allocation bandwidth to the previous used bandwidth and informs this to bandwidth broker. The amount of decreasing bandwidth is such as Fig. 5. This mechanism is bandwidth utilisation and resources are used intelligently when and if they are required for any

Fig. 1. Proposed Mechanism Admission Control Scheme Model

(1) Initial Bandwidth Allocation; (2) Send the Request message to update bandwidth amount; (3) Reply to edge node through OK or NON-OK message; (4) If OK then changes the bandwidth for each node

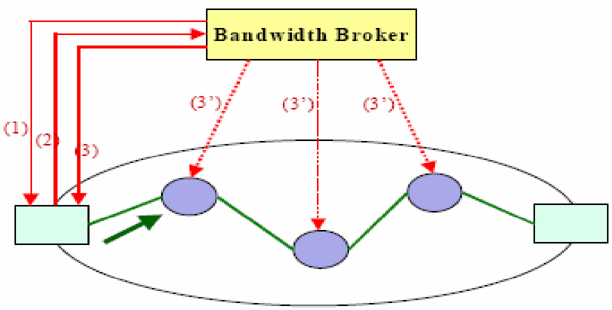


Fig. 2. Values Assigned to Different Variables

$p(s,d)$: A path from ingress edge node s to egress edge node d
$BW^{p(s,d)}$: Reserved bandwidth along the path
$UBW^{p(s,d)}$: Used bandwidth along the path
c : Requested bandwidth for a new call
a : Allocated bandwidth from BB
M : Initial bandwidth
$M`$: Additional required bandwidth to be used in next period
MAX_BW : Maximum requested bandwidth from edge node to BB
MIN_BW : Minimum requested bandwidth from edge node to BB
$Total\_BW$: Link capacity
$\sum UBW_i^{p(s,d)}$: Total used bandwidth along the path
min : The minimum available bandwidth among the links along the path

Fig. 3. Bandwidth Allocation for Proposed Admission Control Scheme

```
BW^p(s,d) = M
if  BW^p(s,d) >= UBW^p(s,d) + c   then
    UBW^p(s,d) += c
    return ACCEPT
else
    recompute M` = BW_(i+1) - BW_i
    MAX_BW = M`
    MIN_BW = UBW^p(s,d) + c - BW^p(s,d)
    if BB_Request(MAX_BW, MIN_BW) == OK then
        BW^p(s,d) = a                /* return value from BB */
        UBW^p(s,d) += c
        return ACCEPT
    else
        return REJECT
```

specific path, which is experiencing high volumes of data.

The proposed scheme addresses and resolves the problem of un-responsive flows. Un-responsive flows are flows that do not use end-to-end congestion control and in particular, that do not reduce their load on the network when subjected to packet drops. This un-responsive behavior can result in both un-fairness and congestion collapse for the Internet. The DA mechanism identifies the un-responsive flows by simply to verify that a high-bandwidth flow was responsive (i.e., its arrival rate decreases appropriately in response to an increased packet drop rate).

$$T \leq \frac{1.5\sqrt{2/3} * B}{R * \sqrt{P}}, \quad (3)$$

Equation (3) shows that for a TCP flow with persistent demand, if the long-term packet drop rate of the connection increases by a factor of x, then the arrival rate from the source should decrease by a factor of roughly (under root x). For example, if the long term packet drop rate increases by a factor of four, than the arrival rate should decrease by a factor of two. This suggests a test for identifying un-responsive flows if the drop rate is changing. If the steady state drop rate increases by a factor x and the presented load for a high-bandwidth flow does not decrease by a factor reasonably close to (under root x) or more, then the flow can be deemed not to be using control (un-responsive). Similarly, if the steady state drop rate increases by a factor x and the presented load for aggregated traffic does not decrease by a factor reasonably close to (under root x) or more, then either the mix of the aggregated traffic has changed, or the traffic as an aggregate is not using congestion control and can be categorized as un-responsive. The router should freely restrict the bandwidth of best-effort flows determined to be un-responsive in times of congestion. Such flows are "stealing" bandwidth from responsive TCP-friendly traffic and more importantly, increasing the danger of congestion collapse. Instead of applying the test passively by observing how the flow's arrival rate changes in response to changes in the packet drop rate another possibility would be to apply the test actively. Purposefully increasing the packet drop rate of a high bandwidth flow in times of congestion and observing whether the arrival rate of the flow on that link decreases appropriately could do this. Restrictions would be removed from an un-responsive flow only if, after an increased packet drop rate, its arrival rate returns to at most half of its arrival rate when it was restricted. This mechanism controls the un-responsive flow and eliminates the un-fairness caused by un-responsive flows. The overall effect is less congestion, every traffic load will have equal share and better QoS (Quality of Services).

Performance Evaluation

A. simulation model and results. In this section, I have conducted simulation to evaluate the performance of the proposed mechanism. I used the NS- 2 (Network Simulator-2) and the peer-to-peer simulation model such as Fig. 6. In this model, I defined three paths. Path 1 consists of node 1-4-5-6, path 2 is node 2-4-5-7 and path 3 is node 3-4-5-8. Therefore, the link 4-5 is the bottleneck link in the following network topology (Chimento, 2003).

Experiment dynamic adaptive admission control scheme. In order to study the performance of the proposed scheme, I performed various experiments each was building on the previous one. I changed the parameters to see the effects and gathered various critical results, which help me to conclude the effectiveness of Dynamic Adaptive

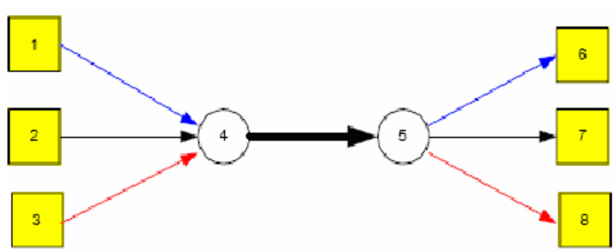
Fig. 4. Additional Bandwidth Allocation

search $min = Total\_BW - \Sigma\, UBW_l^{p(s,d)}$ for $l \in p(s,d)$
if $min >= MAX\_BW$ then
allocate MAX_BW
return OK
else if $min >= MIN\_BW$ then
allocate min
return OK
else
return Non-OK

Fig. 5. Bandwidth better Utilisation Model Bandwidth decreased when not Required

if $BW_i^{p(s,d)} == BW_{i-1}^{p(s,d)}$ then
if $UBW_i^{p(s,d)} < UBW_{i-1}^{p(s,d)}$ then
$BW_{i+1}^{p(s,d)} = UBW_{i-1}^{p(s,d)}$

Fig. 6. Simulation Model



admission control scheme. During my experiment I will compare the results of proposed Dynamic Admission control scheme with existing Egress Admission control Scheme. For the first experiment a simple topology was used with source sending data at 100 Mbps to the Ingress router initially. Then data is sent to the core router. The bandwidth link is 9 Mbps. Before the destination node data is passed from Egress router (Bernet *et al.,* 2003).

The following observations were made about experimental results listed in Table I. There was large amount of overbooking done but the admission control scheme has control the number of bookings according to the available bandwidth. For this reason outside bound delay violation in proposed admission control scheme occurred from the range of 4.0121% to 6.9211%, which is much lesser as compared to other admission control scheme So the DAS admission control scheme is letting-in a set number of admission requests, which can be accommodated by the admission control scheme without too much violation outside bound delay as compared to the Egress admission control scheme. It is clear from the table the number of flows, which are being admitted are increasing but the Dynamic admission control scheme algorithm are dropping the packets or they are being remarked for latter access to

Table I. DA Proposed Admission Control Scheme

Delay Request (msec)	No of Flows	Mean Delay	Max Delay	Outside Bound (%)
5	18	3.2323	48.2321	***4.0121***
10	18	3.3122	48.4343	***3.9032***
20	20	5.4541	51.3432	***3.5212***
30	20	6.1213	58.3232	***5.6732***
40	22	6.8322	65.5434	***6.2123***
50	23	7.3433	71.2323	***6.7812***
60	23	9.2323	89.1232	***6.9211***

Table II. DA Proposed Admission Control Scheme Increased in No of Flows Control

Delay Request (msec)	No of Flows	Mean Delay (msec)	Maximum Delay (msec)	%Outside Bound
5	20	3.5121	51.2323	4.2342
10	20	3.5721	51.7666	4.6542
20	20	5.8766	53.1212	4.8876

the bandwidth. If the arrival rate is more than the threshold then the packets will be dropped or remarked and will not be given the access to the network. Also mechanisms are in place in order to control congestion such as to identify un-responsive flow a test would be simply to verify that a high-bandwidth flow was responsive (i.e., its arrival rate decreases appropriately in response to an increased packet drop rate). This is helping to control the outside bound delay violation and equally distributing the bandwidth among the number of admission request. Also controlling the mean and maximum delay violation. The proposed scheme is working dynamically. As the number of flows increases the Outside Bound violation are controlled as compared to Egress admission control scheme. The Ingress router works dynamically. It checks the traffic flow and compares it to the available bandwidth. If require more bandwidth it accommodates the traffic load after getting more bandwidth more bandwidth broker. Also core load matrix plays an important role in order to control outside bound violation.

According to the critical analysis it is clear that as the delay request is increased the Outside bound delay violation reduced. It is shown clearly that with the delay request 5 (msec) the outside bound violation was 4.0121%, whereas when the delay request increased to 20 (msec) the outside bound delay was 3.9032. It was reduced. But as I continue to increase the delay request to 30, 40, 50 and 60 (msec) I viewed another critical point, which was the delay, bound violation start to increase as well. The outside bound violation on increase as 6.2132%, 6.7812%, 6.9211%. This shows that the system under lose parameter was not performing according to the desired standards. But if compared to the Egress admission control scheme the outside bound delay in DA control scheme is much less also the maximum delay of the proposed admission control scheme is between 48.2321 - 89.1232 (msec) as compared to 61 - 428 - 152.892 (msec) for Egress scheme.

This is only possible, because in Dynamic admission control scheme initially ingress router intercepts the packets.

Fig. 7. Call Blocking comparison between Proposed Admission and Egress Admission

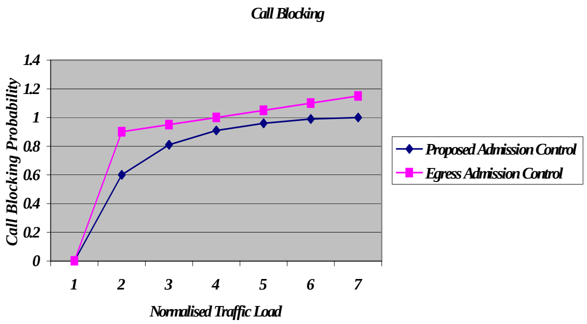


Fig. 8. Normalised Utilisation

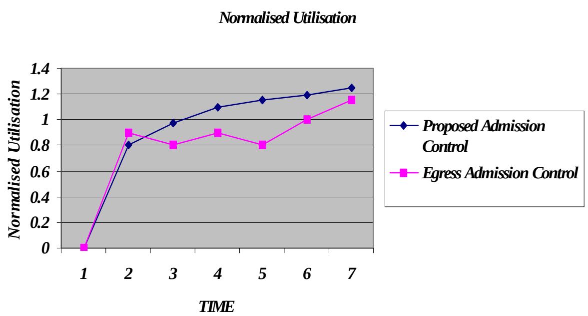
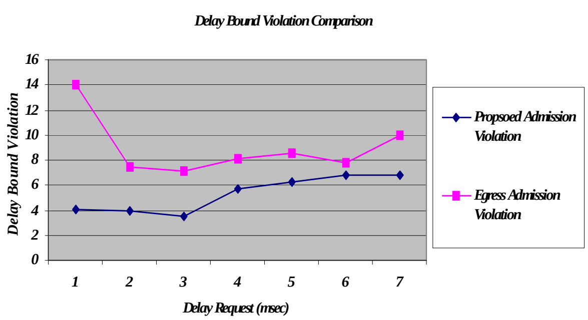


Fig. 9. Delay Bound Violation



If the requested rate is less than or equal to the amount of available bandwidth, the ingress router selects the flow to be a candidate for admission and transmits a message to the sender to start the probe traffic. If the available bandwidth is less than the requested rate, the ingress router sends a service denial message to the sender. The mechanism send the message to the bandwidth broker to allocate more bandwidth to that specific path, which is experiencing high traffic load. When bandwidth is allocated then the load is accepted. This helps to reduce the outside bound delay violation problem control the maximum delay and mean delay as well. In the proposed admission control scheme the mechanism is available if a high bandwidth flow is restricted, because it has been identified as un-responsive and it is later determined to be responding to congestion by reducing its arrival rate, then the restriction is removed. If the only tests deployed along a path were tests for responsiveness, this could give flows an incentive to start with an overly high initial bandwidth. Such a flow could then reduce its sending rate in response to congestion and still receive a larger share of the bandwidth than competing flows. The scheme work dynamically and changing information is updated in core load matrix very quickly.

Experiment No 2. In this experiment I just changed parameter and increased the number of flows being admitted as well as the peak rate and mean rate of traffic was increased to see how the admission control scheme reacts with more traffic. After the results, which were gathered I concluded that with peak rate and mean rate increased, outside bound delay increased slightly but not as much as compared to the Egress admission control scheme. Also mean delay and maximum delay is under control. This shows the proposed scheme reacts very well under large amount of traffic. The scheme is working very well, because it is successfully accommodated the extra traffic burden and un-responsive mechanism is providing fair and equal share to all traffic flows. Also the proposed admission control scheme verifies that a high-bandwidth flow was responsive (i.e., its arrival rate decreases appropriately in response to an increased packet drop rate). Also if compared with Egress admission control scheme it is clear that the outside bound delay is well in control and maximum delay is also less, which shows the Dynamic Admission control scheme is a much better option as compared to Egress admission control scheme under special or abnormal circumstances.

Less outside bound delay. Less Maximum delay/mean delay as compared to Egress admission control scheme.

Experiment No 4. The above figure shows that the proposed mechanism has less call blocking probability than Egress admission control mechanism even though high traffic loads. As the proposed mechanism adaptively conduct according to the status of call arriving it can accept more flows. Also the bandwidth broker allocates resources to the specific links. The proposed scheme allocates the network resources to the requested user flow properly according to the network situation. In the proposed scheme the mechanism has to provide fast reacting to the un-expected traffic pattern changes. The efficient network resource management mechanism of differentiated network is depended on that how ingress edge node can perform the distinct function according to service classes instead of simple operation in core node. The mechanism gathered immediately the traffic violation information of network by the bandwidth broker and feedback to ingress edge node. This mechanism reduces call blocking in the proposed admission control scheme.

Experiment 5. Moreover from the below Fig. 7, the experiments results clearly shows that normalised utilisation of the proposed mechanism is maintained to better performance value. On the opposite side the utilisation of Egress Admission control scheme is lower and more fluctuant than the proposed mechanism, because it cannot adapt to the variable input condition. In Dynamic Admission control scheme the high-bandwidth flow is restricted, because it has been identified as un-responsive and it is later determined to be responding to congestion by reducing its arrival rate, then the restriction is removed.

Experiment 7. The experiment clearly shows that the proposed admission control scheme (Dynamic Admission) works well and controls on delay bound violation. Whereas Egress admission control has a large amount of delay bound violation problem. The mechanism of the proposed admission control scheme controls on congestion and restrict extra traffic, which it can't accommodate. Also the mechanism controls the problem of un-responsive flow by restricting them until the flow becomes responsive.

DISCUSSION

Dynamic admission control scheme is a real solution to the problems, which are faced by the existing admission control schemes such as delay bound violation, congestion, no core load matrix, Ingress router not working dynamically, better utilisation of resources, services can't accommodate arrival request, maximise bandwidth utilisation and QoS (Quality of Services). The proposed scheme allocates the network resources to the requested user flow according to the network situation. This means that the algorithm has to provide fast reacting to the un-expected traffic pattern changes. The mechanism depends on how ingress edge node can perform the distinct functions according to service classes instead of simple operation in core node. The information should be gathered immediately the traffic violation information of network by the bandwidth broker and feedback to ingress edge node.

The proposed scheme allocates the network resource using the previous traffic pattern to each path and decreases the bandwidth if it is not used in some duration. Edge node doesn't need communication with the bandwidth broker if the allocated bandwidth for the path is sufficient to satisfy the flow request. Also the proposed scheme has mechanism to identify the un-responsive flows. The scheme stop the flow, which are un-responsive this prevents congestion, provide fair share to all traffic and provide better Quality of Services. The experiments results show the proposed scheme works well as compared to Egress Admission control scheme.

REFERENCES

Adler, H.M., 2004. 10 Gigabit/s Plattform fur das G-WiN betriebsbereit, DFN Mitteilungen, Heft 60

Awduche, D., 2003. Requirements for Traffic Engineering Over MPLS RFC 2702

Bernet, Y., R. Yavatkar, P. Ford, F. Baker and L. Zhang, 2003. *"A Framework for end-to-end QoS Combining RSVP/Intserv and Differentiated Services"*. Draft-bernet-intdiff-00.txt Internet Draft

Bianchi, G., A. Capone and Petrioli, 2002. "Throughput analysis of end-to-end measurement-based admission control in IP," *Proc. of INFOCOM*

Braden, R., L. Zhang, S. Berson, S. Herzog and S. Jamin, 2004. *"Resource Reservation Protocol (RSVP) - Version 1 Functional Specification"*. RFC 2205, Proposed Standard

Breslau, L., E. Knightly, S. Shenker, I. Stoica and H. Zhang, 2004. "Endpoint Admission Control: Architectural Issues and Performance." *Proc. of SIGCOMM*

Chimento, P.F., 2003. *QBONE Signalling Design Team: Final Report.* http://qos.internet2.edu/wg/documents-informational/20020709-chimento-etalqbone-signaling

Cruz, R.L., 2002. A Calculus for Network Delay, Part I: Network Elements in Isolation. *IEEE Transactions on Information Theory*, 37: 114–31

Nichols, K., V. Jacobson and L. Zhang, 2001. *"Two-bit Differentiated Services Architecture for the Internet"*. Internet RFC 2638

Blake, S., 2004. "*An Architecture for Differentiated Services*". Internet RFC 2475

Andrews, M. and L. Zhang, 2004. "Minimizing end-to-end delay in high-speed networks with a simple coordinated schedule," *In*: *Proc. IEEE INFOCOM*. New York

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