Differentiated Services for IP Networks

Thoughts on early DiffServ implementations.....

Where does DiffServ fit?

- Quality of Service has two components

IP Based Services

Applications

IP Layer Link Layers

DiffServ lives in the network layer

Recovery from packet loss, delay, jitter

Control of packet loss, delay, jitter
**End to end QoS: Edges, Routers, Links**

- End to End QoS depends on
  - Edge to Edge QoS
  - Router capabilities (e.g. DiffServ)
  - Link capabilities (e.g. ATM, MPLS/POS, Ethernet...)

**QoS: Protect some traffic from others**

<table>
<thead>
<tr>
<th>Class 1</th>
<th>Unused</th>
<th>...during Bursting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class N</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Multi-Queue Router**

<table>
<thead>
<tr>
<th>Class 1</th>
<th></th>
<th>Isolated Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class N</td>
<td></td>
<td>Multi-queue Routers Isolate Traffic Classes</td>
</tr>
<tr>
<td>Unused</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
How does DiffServ work?

- Simplify, simplify, simplify…

**Edge:** Multi-field classification, policing, marking

**Core:** DS field classification, policing, marking, queuing, scheduling

<table>
<thead>
<tr>
<th>ToS</th>
<th>Proto</th>
<th>Src</th>
<th>Dst</th>
<th>Src/Dst</th>
<th>Ports</th>
</tr>
</thead>
</table>

DSCP: differentiated services code-point
CU: currently unused

How does DiffServ work?

- Simplify, simplify, simplify…

**Edge:** Multi-field classification, policing, marking

**Core:** DS field classification, policing, marking, queuing, scheduling

Distributed behavior

- **Policing**
  - Ensure aggregate load on core routers stays within limits

- **Marking**
  - Allows distributed burst tolerance

![Token Bucket Metering](image)
Queue Management: Better RED than Dead?

- Random Early Detection (RED)
  - Statistical targeting of congestion-causing flows, without requiring multi-field classifier
  - Keeps average queue occupancy low
    - Assuming predominantly TCP-like traffic
  - Makes the most of limited per-packet context
  - Packets in same queue may receive different RED treatment based on DSCP marking (weighting)

Is DiffServ worth it?

- Sure, for a time

- It is part of evolution
  - Ease of core router implementation
  - Simple core router management
  - End to end QoS requires co-ordinated management of Edge router behaviors

- Better than Best Effort!

- Some providers aiming for trials and customers in 2000
**Will DiffServ be the only choice?**

- No
- Service providers have options
  - New gigabit multi-field classifiers and schedulers can be deployed in core too
  - Core routers with < 10 queues giving way to routers with thousands of queues
- Service offerings may be mixed
  - DS behaviors for some flow aggregates
  - Flow-specific service guarantees using end to end per-flow queues for other traffic
- MPLS may provide additional method for selecting per-hop behaviors
  - Use Label instead of DSCP

**DiffServ and VPNs**

- Virtual Private Networks require isolation
- Topological isolation - private routing
  - Do it now with IP tunnels
  - Do it soon with MPLS
- Temporal isolation?
  - Use any QoS mechanism on tunneling packet
- DiffServ can be applied to tunnel itself
  - Tunnel appears as link layer with predictable QoS characteristics
  - DS network doesn’t ‘see’ traffic being tunneled
  - Critical for private Service Level Agreements
*Last minute opinions*…..

Stuff I couldn’t put in print…. 