Agregando Calidad de Servicio a las Redes de Educación e Investigación

CUDI
Reunión de Primavera 2003 Ensenada

Roosevelt Ferreira
Juniper Networks
Agenda

- DiffServ QoS Architecture
- Edge CoS/ QoS Strategies
- Core CoS/ QoS Strategies (IP/ MPLS)
Agenda

- DiffServ QoS Architecture
- Edge CoS/ QoS Strategies
- Core CoS/ QoS Strategies (IP/ MPLS)
The Need for QoS

Applications in use on the Internet are changing:
- Voice
- Video
- Traditional Data

New service levels required:
- Better than best effort
- Assured Experience
Differentiated Services Network Components

- Customer Network
- Edge Device
- Core Routers
- Peer DiffServ Domain
- BA Classifier
  Per Hop Behavior
DiffServ Router Requirements

- Multiple Traffic Classes
  - IETF DiffServ PHBs: Traffic Classes
    - Assured Forwarding (AF: RFC 2597)
    - Expedited Forwarding (EF: RFC 2598)
  - Configurable Buffer Management for each traffic class
    - Best Effort
    - Low Loss: more buffers and/or bandwidth
    - Low Latency: strict priority with rate limiting
    - Low Latency & Low Jitter: strict priority with traffic shaping
Edge Device

- Multifield Classification
- DSCP Marking
- Flow Policing
- Traffic Shaping
BA Classifier Per Hop Behavior

- Expedited Forwarding (EF)
  Minimizes Delay and Jitter
  Provide Highest Level QoS
  Out of Profile Traffic is Dropped
- Assured Forwarding (AF)
  Better than Best Effort routing
  Different drop precedence per class
  Out of Profile Traffic may be demoted in class or drop precedence
Generic QoS Management Tasks

- Divide Traffic into Multiple Classes
- Premium
- Assured
- Best Effort

- Class-Based Queueing and Scheduling
- Weight-Round Robin
- Strict Priority

- Traffic Management
- Policing and Shaping
- RED/WRED

- MPLS-Based Quality of Service
- Traffic Engineering
- Traffic Protection
Agenda

- DiffServ QoS Architecture
- Edge CoS/ QoS Strategies
- Core CoS/ QoS Strategies
Edge QoS Management Tasks

- **Packet Classification**
  - Identify flows based on L2/L3/L4 information
  - Each flow is associated with a traffic class

- **Token-bucket-based policing**
  - Configurable parameters:
    - Sustained Rate
    - Maximum Burst Size
    - Exceeding traffic is either marked or dropped

- **Egress Buffer Management**
  - Buffer size and characteristics are determined according to delay budget for traffic class

- **Transmission Scheduling (Queueing Discipline)**
  - According to traffic class
  - Strict Priority or Weighted Round-Robin
Edge Router Requirements

Campus Network

- VoIP
- Video
- Real Time
- Bulk Transfers
- GRID Computing
- Best Effort

Classify / Mark
Policing
Assign Traffic Class
Queue Management (Buffer)
Transmission Scheduling
Wire Speed Performance
QoS Requirement

- Only as good as the weakest link
- Each hop must:
  - Route at Wire Speed, even under load
  - Route at Wire Speed while classifying packets
  - Continue to route at wire speed while also queuing packets for different services
Agenda

- DiffServ QoS Architecture
- Edge CoS/QoS Strategies
- Core CoS/QoS Strategies (IP/MPLS)
Core QoS Architecture

- Policing / CAC
- ToS/ EXP/ DSCP marking
- DSCP classification
- DiffServ EF/ AF PHBs
- SPQ queuing
- Scalable end-to-end QoS signaling (RSVP-TE)
- Traffic Protection with Fast restoration via MPLS Fast Reroute (FRR) – sub-50ms LSP protection
End-to-End Requirements for Delay

- Application processing delay (packet formation), $T_f =$ low ms to sub-ms
- Packet switching delay, $T_{sf} \approx 10 \mu s$ per hop
- Serialization delay, $S_i = \text{bits/ link rate} \times \text{number of hops}$
- Propagation delay, $P_i = 1\text{ ms/100 mile}$
- Queuing delay, $Q_{max}$ variable

$$D_{total} = T_f + T_{sf} + \sum_{i \in \text{path}} (S_i + P_i) + Q_{max}$$
CoS – Class of Service

- CoS is the preferential treatment of packets with certain characteristics
  - Define which packets get treated preferentially
- IPv4 packets
  - ToS/DCSP field can be used for CoS
  - ToS/DCSP values can be mapped to CoS mechanisms
- MPLS packets
  - EXP bits can be used for CoS
  - Mapping to ToS/DSCH bits
- All routers in a network must support CoS setting for applications to fully benefit
Classification/Marking

- DSCP
  - For IP packets, the entire 6-bit DSCP field is used to map into queuing and drop priority
- Flexible MPLS mapping
  - For MPLS packets, there is a mapping function between the EXP/COS field and queuing and drop priority
Generic QoS – Packet Processing

- Classification Marking Policing
- Queue Selection & Buffer Control
- Priority Queue
- Precedence/Exp/DSCP bits set

Gold VOIP Silver

VOIP Gold Silver Best Effort

WRR RED
(W)RED

- Time averaging
  - When indexing into the drop profiles queue length, a time-averaged queue length is used

<table>
<thead>
<tr>
<th>PLP/TCP=</th>
<th>0,0</th>
<th>0,1</th>
<th>1,0</th>
<th>1,1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pointer</td>
<td>Pointer</td>
<td>Pointer</td>
<td>Pointer</td>
<td></td>
</tr>
<tr>
<td>Pointer</td>
<td>Pointer</td>
<td>Pointer</td>
<td>Pointer</td>
<td></td>
</tr>
<tr>
<td>Pointer</td>
<td>Pointer</td>
<td>Pointer</td>
<td>Pointer</td>
<td></td>
</tr>
<tr>
<td>Pointer</td>
<td>Pointer</td>
<td>Pointer</td>
<td>Pointer</td>
<td></td>
</tr>
</tbody>
</table>
MPLS Traffic Engineering

- How it Works
  - RSVP establishes dedicated LSP for VoIP
  - Signalling includes Bandwidth Requirements and Protection Options
- Protection
  - Primary LSP
  - Secondary LSP
  - LSP Fast-Reroute
- Network Topology
  - Possibility of assigning links dedicated to specific traffic classes (Premium)
  - Premium LSPs have higher priority for LSP establishment and re-route in the event of link failure
CoS/QoS Configurable Components

**BA Classifier**
- Set FC/PLP/TCP from IP precedence/IP DSCP/MPLS EXP/IEEE 802.1p
- Forwarding Override Classification

**MF Classifier**
- Set/override FC/PLP from Firewall filter

**Forwarding**
- Override Classification

**Scheduling**
- Queue Sched.
- Policy: WRR/priority
- Queue quantum

**Receive**
- Forwarding = next-hop, PLP

**Transmit**
- Marker
  - IFL+FC+PLP = IP Precedence
  - IP DSCP
  - MPLS EXP
  - IEEE 802.1p
- RED
  - FC+PLP+TCP = drop profile
- Marker
  - IFL+FC+PLP = IP Precedence
  - IP DSCP
  - MPLS EXP
  - IEEE 802.1p