Flow-Based Routing: Towards New QoS Models

Dr. Riad Hartani
Caspian Networks
Agenda

- MPLS: status and ongoing work items
- Flow-based routing – the technology
- Flow-based routing benefits
  - Overall technology benefits
  - Specific benefits in an MPLS environment
- Flow-based routing: application examples
- Conclusions
A packet-based transport platform:
- For IP Internet traffic
- For private IP traffic (L3 VPN)
- For multi-services traffic (ATM / FR / Ethernet / TDM and L2 VPN)

Used jointly with Diffserv to provide QoS

Being augmented with dynamic restoration schemes and various OAM functionalities
MPLS - a good technology, but some issues remain:

- Traffic engineering is good for long term timescales, but need complementary techniques for short term variations
- Additional design complexity (and hence cost) in the network
- No QoS guarantees yet, even with Diffserv!
- Remaining scalability issues (e.g. #LSPs, MBGP RR, Restoration, etc.)
- Not an end-to-end solution – and not designed to be so
- Little room for differentiation between service providers, when it comes to QoS
Flow-Based Routing: The Technology

**Conventional Router**
1. Route each packet
2. Switch to output
3. Class-based QoS

**Flow Router**
1. Hash for flow identification
   - 2M flows/s and 6M flows per 10 Gig
   - Flexible definition of flows
2. Create “soft” state or look up
   - Route, switch, filters, stats
3. Per-flow QoS behavior
Flow-Based Routing Overall Benefits

- **Network-level**
  - Novel congestion control and QoS schemes
    - Improved DiffServ model with enhanced Per Hop Behavior
    - Scalable IntServ model – Nodal behavior only
    - Or ... an alternative/evolution of existing IP networks
  - Optimized for Per-flow dynamic statistics collection
  - Router based preventive security (IDS/DOS)
  - Efficient flow based load balancing and dynamic flow aware routing

- **Node-level**
  - Packet processing I/O scaling
  - Switch fabric scaling and intra-switch load balancing schemes
## Flow-Based Routing QoS-Specific Benefits

<table>
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<tr>
<th>Requirement</th>
<th>Conventional Packet Routers</th>
<th>Flow Based Routers</th>
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<tbody>
<tr>
<td>Protect certain traffic types from others (voice vs. video, www vs. P2P, etc.)</td>
<td>No explicit differentiation of traffic types</td>
<td>Alternative congestion control schemes for high rate vs. low rate, responsive vs. unresponsive, long-lived vs. short lived flows, etc.</td>
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<td>Enable ON/OFF service model</td>
<td>Performance degradation under congestion</td>
<td>› CAC for UDP flows</td>
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<td>› Per-flow pre-emption capabilities</td>
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<td>Optimize network good-put &amp; user response time</td>
<td>Limited</td>
<td>› CAC for TCP flows</td>
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<td>› Alternative congestion control schemes</td>
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<td>Tight jitter and guaranteed QoS for real-time applications</td>
<td>Jitter increases with utilization and hop counts</td>
<td>› CAC for flows with guarantees</td>
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<td>› Guaranteed QoS capabilities (policing/shaping) for low, constant jitter even at high utilization</td>
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<tr>
<td>Network simplification (cost reduction)</td>
<td>Manual traffic engineering</td>
<td>Increased node intelligence: dynamic resource management and granular statistics collection</td>
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Two deployment options

- LSP is the flow
  - State per LSP: scheduling / shaping / policing per LSP

- The flow is what is carried within the LSP: IP flows or pseudo-Wire flows
  - Intra-LSP visibility: dual state per-flow and per-LSP

Benefits

- Granular and deterministic QoS (both for the E-LSP and L-LSP models)
- Simplified traffic engineering by increasing node level intelligence
- More scalable deployments in terms of # LSPs
- More opportunity for service differentiation leveraging state information
**Application – Network Consolidation**

### Today

- **Optical/Transmission Network**
  - IP/MPLS
  - ATM

- **Core**
  - Internet (IP, IP VPN)
  - Data (FR, ATM, IP VPN)
  - Voice (Voice & Private Line)

- **Edge**

### Apeiro-Enabled

- **Optical/Transmission Network**
  - IP/MPLS

- **Core**
  - Internet (IP, IP VPN)
  - Metro Ethernet

- **Edge**
  - Data (FR, ATM, IP VPN)
  - Voice (Voice & Private Line)

- **ATM**
  - ATM-like rate, performance & bandwidth guarantees allow subsuming of ATM and Frame traffic on a common IP backbone

- **Separate Frame and ATM overlay networks required for premium traffic**
• Traffic rates, flow lengths and traffic per flow potentially used to identify P2P traffic
• Provides customized control behavior under congestion
• Leads to optimized ROI when it comes to expensive peering links, etc.
Flow-based routing is a new paradigm that combines the best of packet/circuit switching – fits within a native IP network or an MPLS network.

Technology has obvious benefits today – a new IP QoS model.

Technology also has other not-so-obvious benefits.

Most importantly, technology has potential of changing service providers’ business models.