» BEYOND IMAGINATION

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

MPLS: Status

- 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: Work in progress

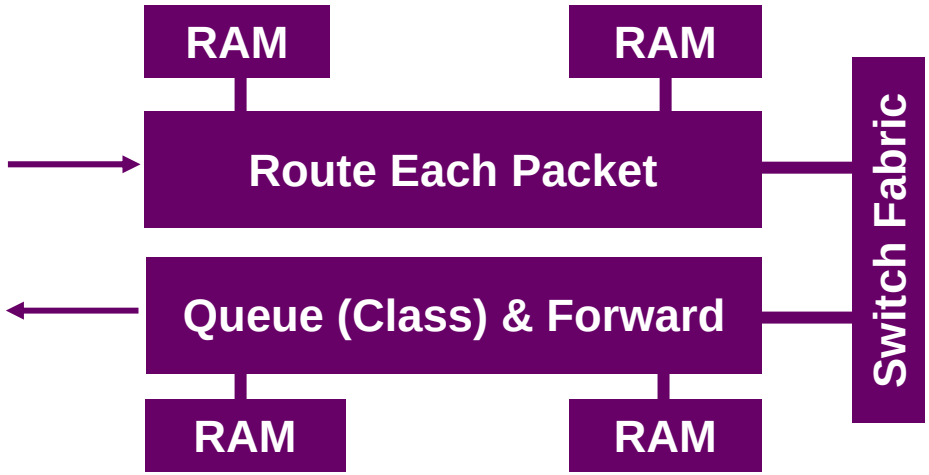
MPLS - a good technology, but some issues remain:

- **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

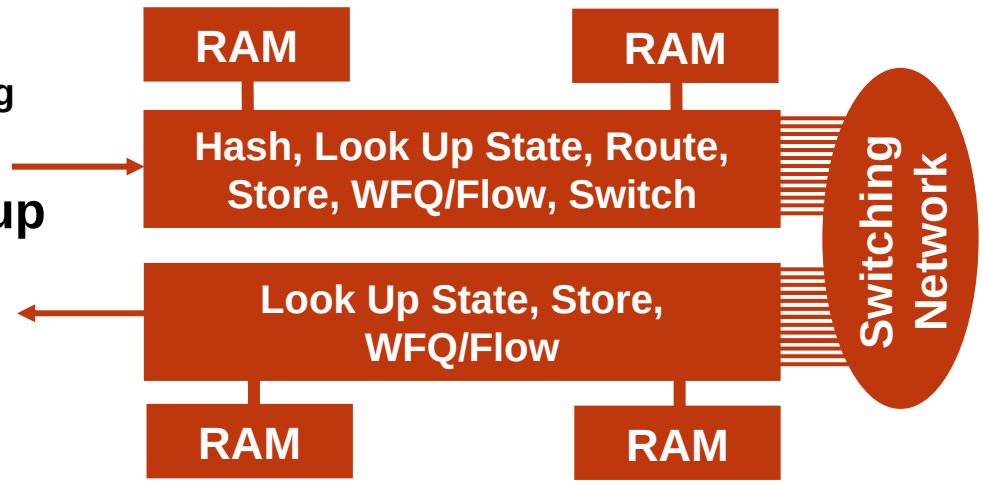
Conventional Router

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

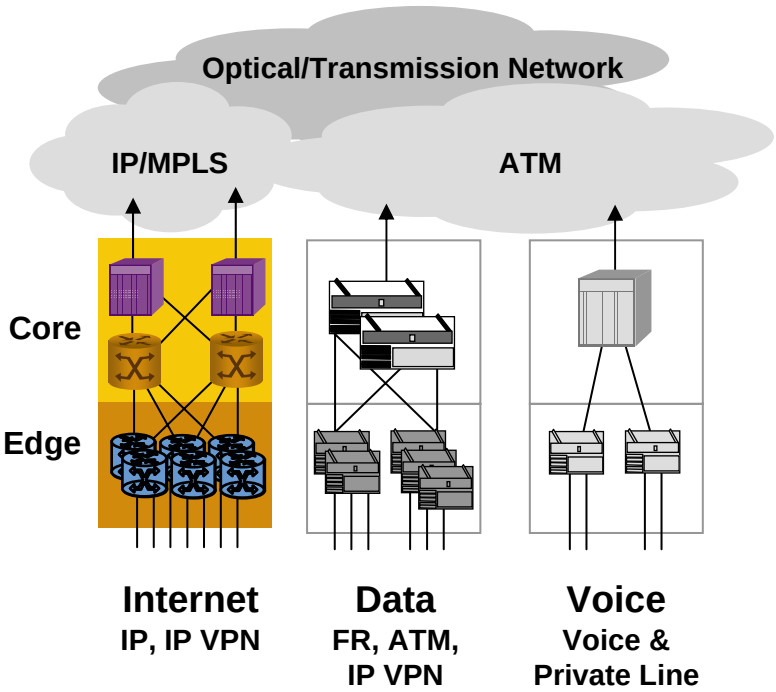
Requirement	Conventional Packet Routers	Flow Based Routers
Protect certain traffic types from others (voice vs. video, www vs. P2P, etc.)	No explicit differentiation of traffic types	Alternative congestion control schemes for high rate vs. low rate, responsive vs. unresponsive, long-lived vs. short lived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

Flow-Based Routing in an MPLS context

- **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**

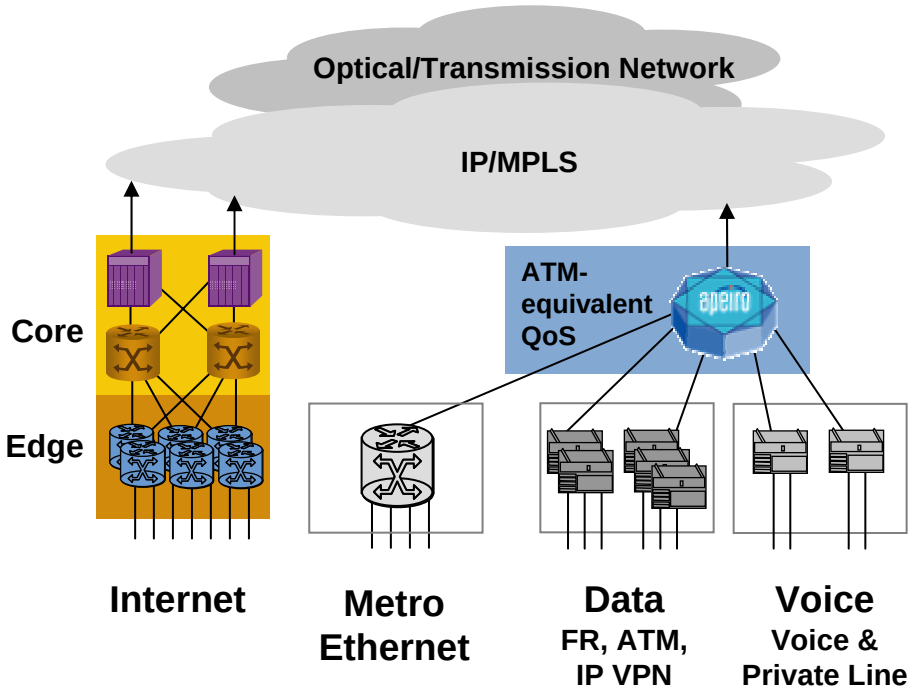
Application – Network Consolidation

Today



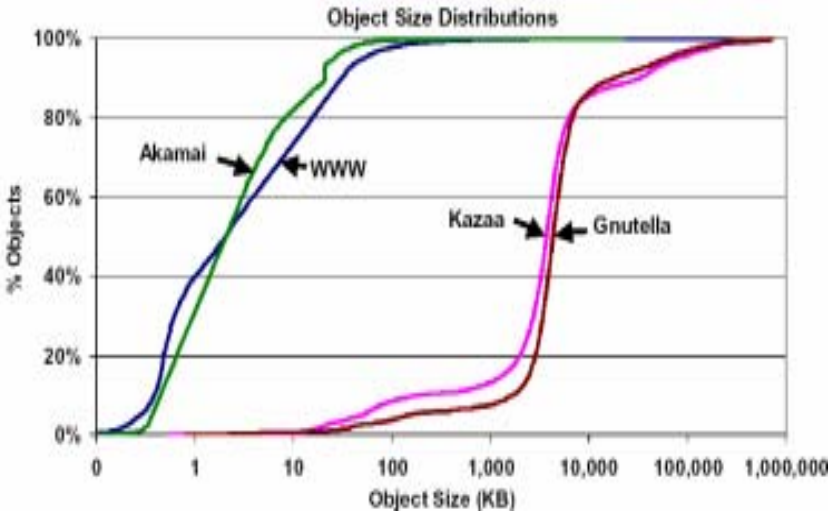
- Separate Frame and ATM overlay networks required for premium traffic

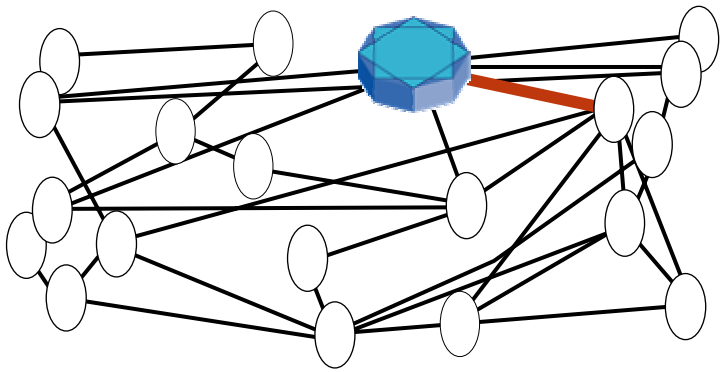
Apeiro-Enabled



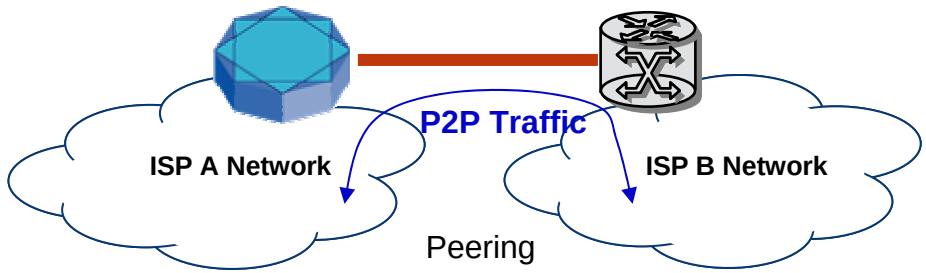
- ATM-like rate, performance & bandwidth guarantees allow subsuming of ATM and Frame traffic on a common IP backbone

Application – Controlling P2P Traffic





Isolated Congestion Points



Peering

- **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.**

Undersea Links

Conclusions

- **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**