Network Architectures for Emerging Services

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Convergence: Dimensions Revisited

- **Link Layer (ATM/FR/Ethernet over IP/MPLS – Pseudo Wire)**
- **Telecom / DataCom (VOIP)**
  - Changing revenue and SLA models
- **Broadcasting / Telecom (VIDoIP,)**
  - SLA well known
- **Wireline / Wireless (3,4,5G, 802.11/16)**
  - Revenue model very different
- **Overlay / Content Optimized networks (dynamic content, P2P distribution)**
  - Content owners drive

Different industries colliding and melding – better or equivalent service at lower cost
Convergence: Operator Requirements

» Advanced traffic measurements
  ▪ For statistics and load/traffic matrix estimation
  ▪ For traffic characterization

» Sophisticated traffic management for SLAs via
  ▪ Per-customer/service traffic shaping, policing
  ▪ Efficient congestion control and efficient fairness models

» Traffic-aware routing & efficient load balancing
  ▪ For network utilization
  ▪ For efficient restoration

» Dynamic ephemeral network models
  ▪ P2P distribution services
  ▪ On the fly provisioning

» Control of OPEX and CAPEX models
  ▪ within a rapidly changing service delivery and network management paradigm

» Preventive security models
  ▪ For fast reaction to denial of service attacks

create requirements for fast, fine-grained flow classification and accounting, challenging present-day IP router architectures
IP Packet Routing Still has Challenges

- Network engineering techniques (TE) are static but operators need extremely fast traffic driven complementary techniques for service provisioning.
- Session management is decoupled and resource greedy. Need extremely fast flexible setup.
- QoS guarantees/reservations are still elusive, Intserv did not scale. Class based Diffserv requires optimization - economics of static manual provisioning.
- Current nodal Congestion & QoS schemes are not optimized for real-time multi-services traffic with stringent requirements such as broadcast TV, encrypted video, etc.
- Limited inline preventive security and threat prevention models.
- Little room for service differentiation between carriers on QoS.

Next generation of routing/switching architectures with enhanced nodal behavior will have to overcome these issues.
Flow-based Routing: The Technology

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

Flow-based Router
1. Hash for flow identification
   • 2M flows/s and 6M flows per 10 Gig
   • Flexible definition of flows: IP flows, PWoMPLS flows, IPoMPLS flows
2. Create “soft” state or look up
   • Route, switch, filters, stats
3. Per-flow QoS behavior
   • Leverage flow state for advanced QoS
   • Shape, police, CAC, congestion control
3 Flow Routing: QoS and Network Benefits

- Customized congestion control schemes
- Extremely simple operations and management paradigm
- Flexible connection admission control (CAC)
- Advanced shaping/policing schemes
- Guaranteeing services → network scalability
- Next evolutionary steps towards routers with integrated traffic control capabilities

State → Intelligence → Improved nodal behavior → Enhanced network services at lower cost
Example: Customized Congestion Control

- Providers can select & enforce explicit congestion control policies
  (responsive vs. unresponsive, high rate vs. low rate, short lived vs. long lived, P2P vs web, “legal” vs “illegal” content )
- Flow routers leverage state information to characterize traffic flows
  - Can enforce specified congestion control policies
- Providers can decide on different control policies based on their requirements

Examples
- Guarantee (weighted) fairness between TCP flows
- Congestion control based on “granular per flow control “abusive” concept”
- Ensure virtually zero-loss for certain types of traffic (e.g. TDM emulated circuit)

Flow-based congestion control schemes allow
- Differentiation between service providers
- Definition of new services
Example: Flow-based Connection Admission Control

Without CAC

- All flows allowed into a class
- wRED on class congestion
- Many flows affected - poor service lack of determinism

With CAC

- New flows CACed
- Preserves integrity of existing flows, no performance degradation
- Enables ON/OFF service model

CAC for flows helps to improve overall network performance
Example: Flow-based Shaping/Policing

- **Shaping** aims at changing characteristics of input stream to produce an output stream with required characteristics
  - Benefits for the end users, and
  - For the downstream network

- **Policing** aims at enforcing traffic contracts

- Flow routing allows shaping and policing of desired flows

Flows are shaped/policed based on requirements

Ability to shape/police at the *flow level* allows new service definitions and improves network behavior
Example: General Protection Strategy and Issues

**Issue:** By time attack is detected, it is already too late – customer is impacted!!!

**Need:** DDOS Prevention Mechanism
Example: Flow-based DDOS Prevention

» Put in specific focal points for DOS attacks (peering point, customer access, etc)

» Detect anomalies in traffic flows on specific router without exporting data

» Raise alarms to operator for immediate investigation

» Fast, inexpensive way to detect attack before customer is impacted

» Increases value of appliance solutions if these already exist

Possible only with Flow-based Routers that use intelligent awareness of traffic heuristics which can be operator defined
Future Evolution: Towards High IQ Routers

- P2P appliance
- Shaping appliance
- Security appliance

Progressive integration on routers of functions performed by dedicated appliances

Shift from speeds/feeds to more intelligence on routers
Emerging Services Need Router Technologies to Evolve

» Flow-based routing enhances IP routers nodal behavior, fully interoperable with existing technologies

» Flow State Technology has benefits today – a new resources management model

» Provides additional benefits by leveraging flow state and integrating into the router model – optimized for network and service convergence

» Potential to change service providers’ networking and business models