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

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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

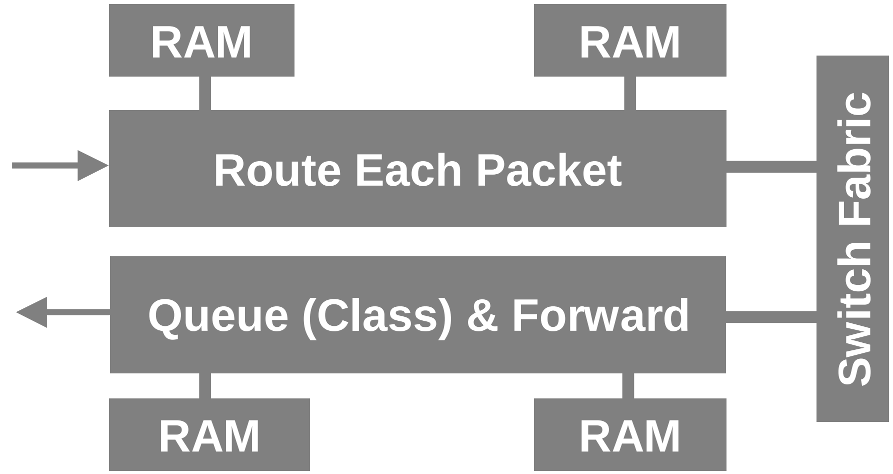
- **Network engineering techniques (TE) are static but operators need extremely fast traffic driven complementary techniques for service provisioning**
- **Session management is decoupled and resource greedy. Need extremely fast flexible setup.**
- **QoS guarantees/reservations are still elusive, Intserv 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

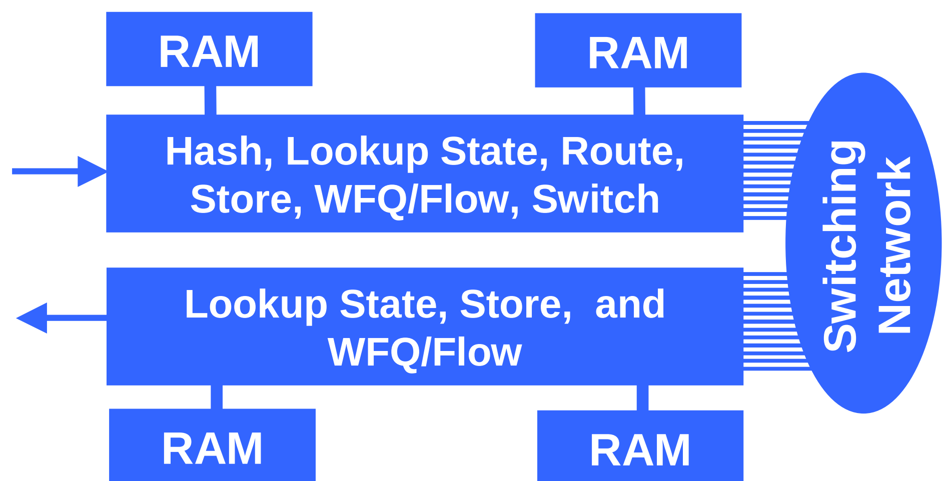
Conventional Router

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



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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

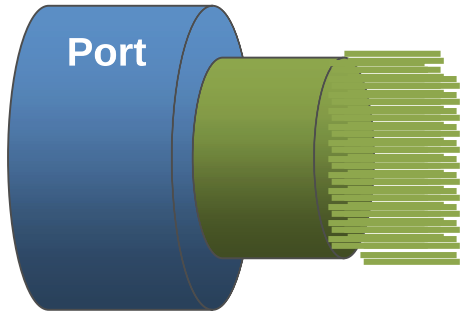
- **Guarantee (weighted) fairness between TCP flows**
- **Congestion control based on “granular per flow control “abusive” concept”**
- **Ensure virtually zero-loss for certain types of traffic (e.g. TDM emulated circuit)**

Flow-based congestion control schemes allow

- **Differentiation between service providers**
- **Definition of new services**

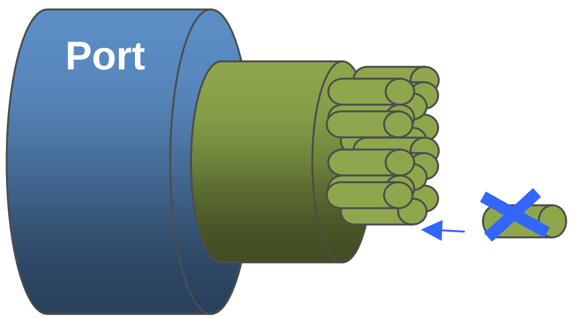
Example: Flow-based Connection Admission Control

Without CAC



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

With CAC



New UDP/TCP flows rejected

- 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

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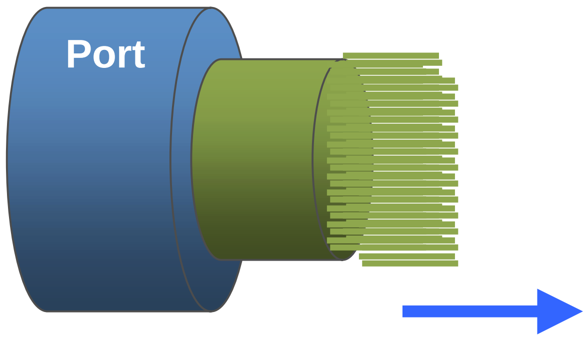
Example: Flow-based Shaping/Policing

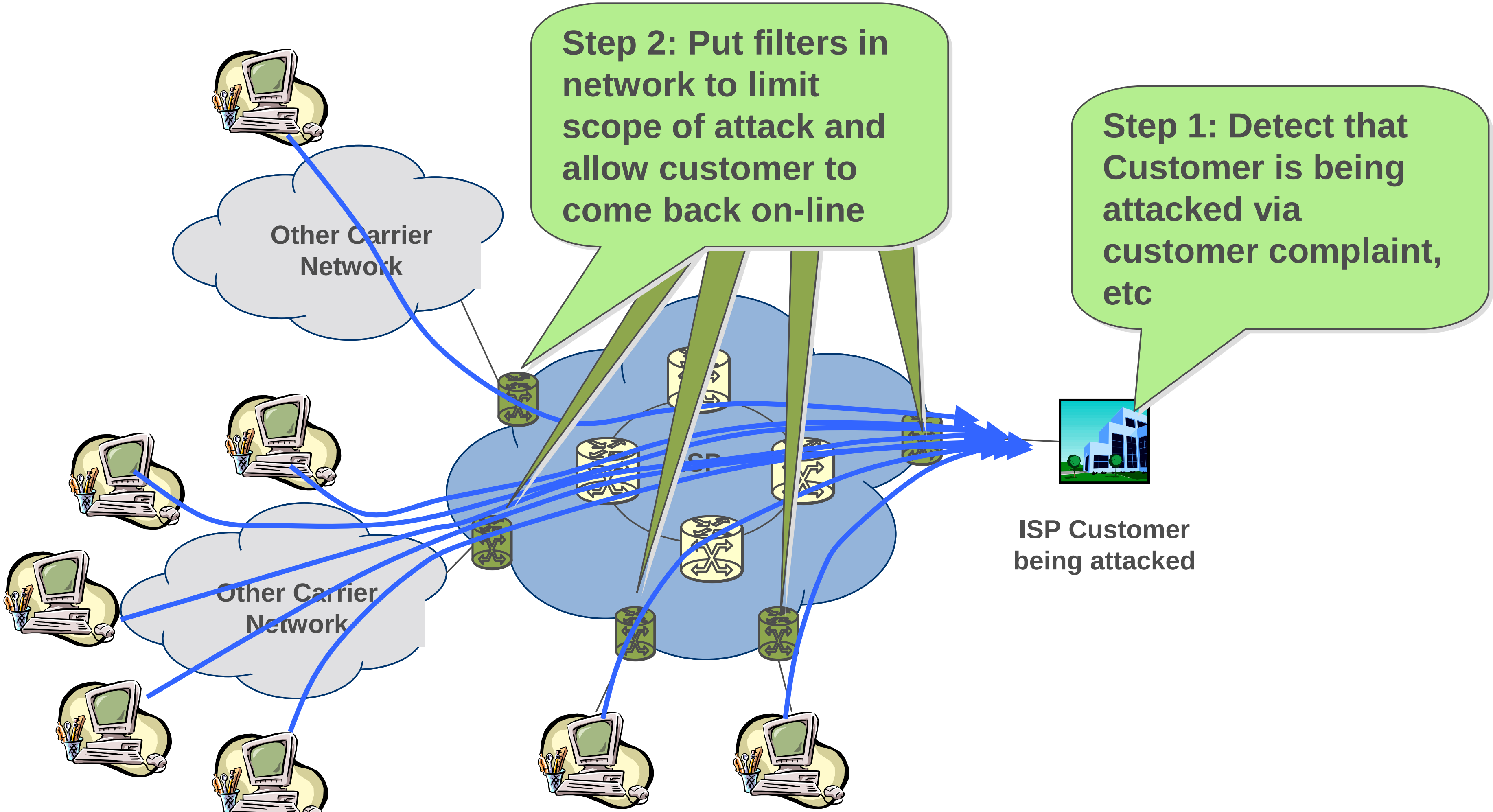


Flows are shaped/policed based on requirements

- ***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**

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**

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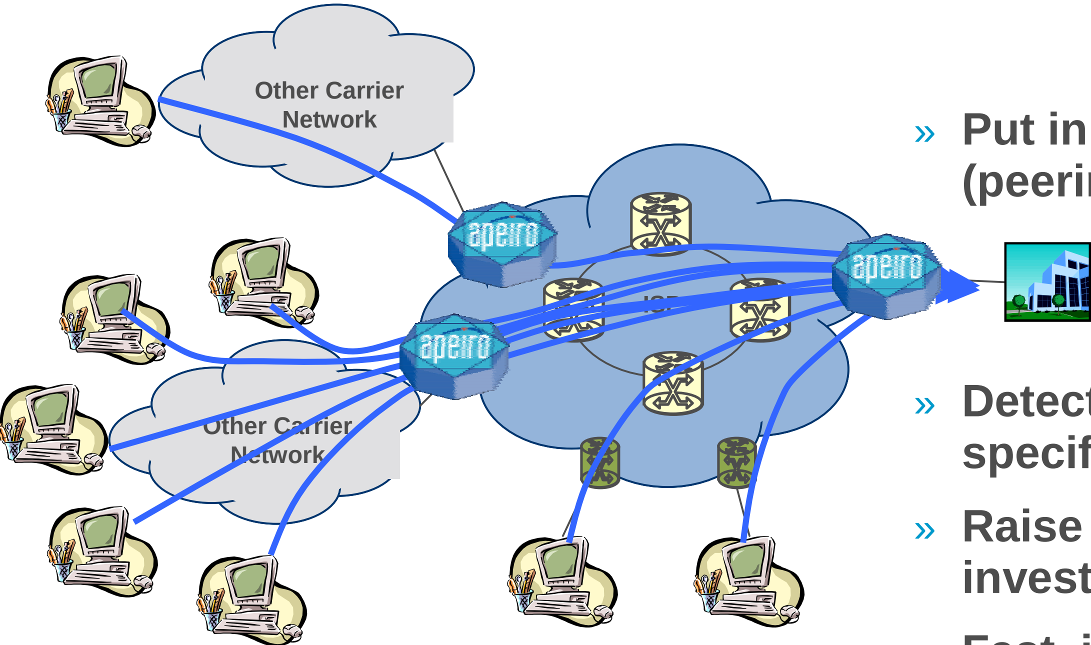
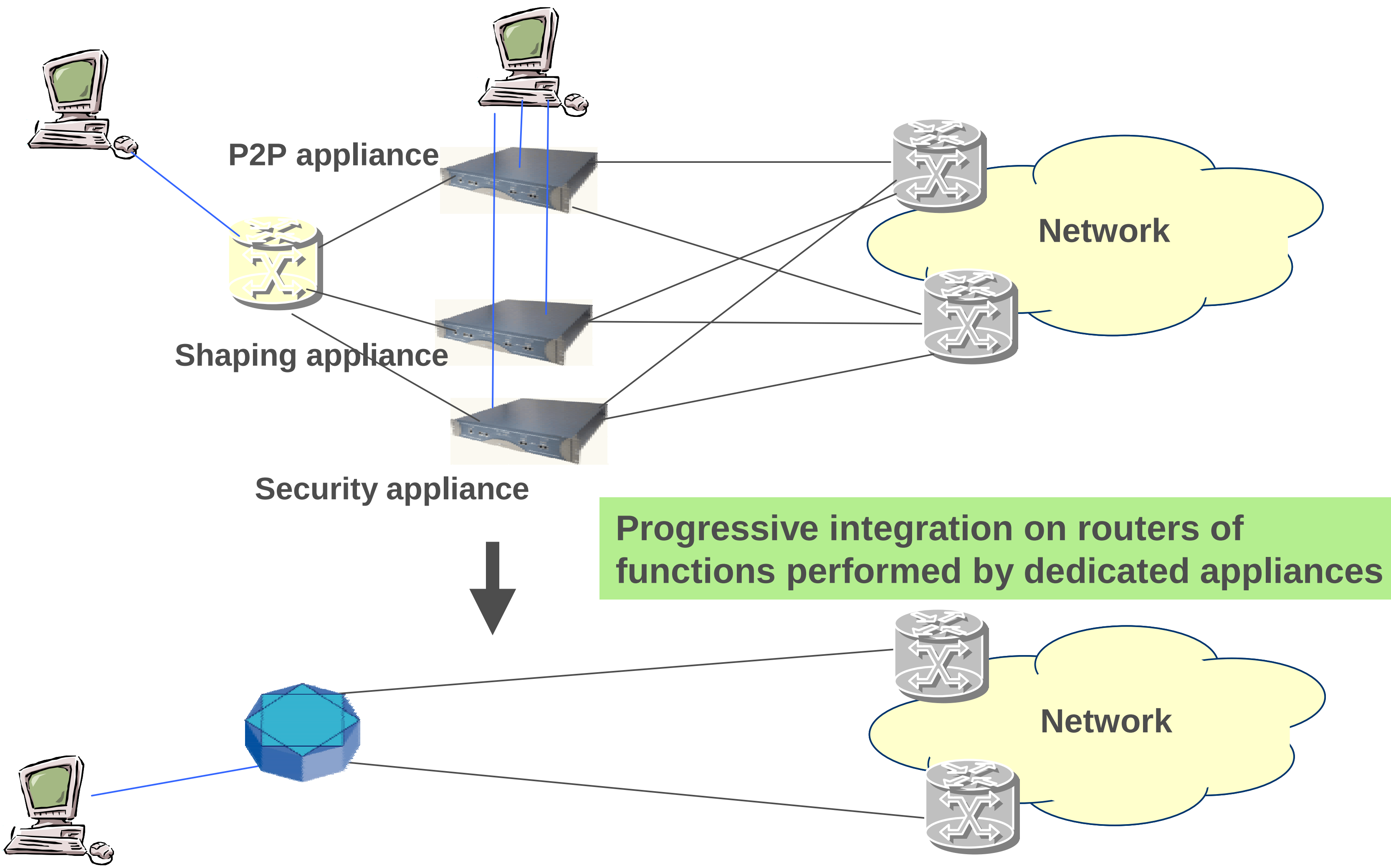
Example: Flow-based DDOS Prevention



- 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



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