CS551
Differentiated Services (DiffServ)
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http://merlot.usc.edu/cs551-f12
Key Ideas

- Traffic classes instead of flows
- Forwarding behaviors instead of end-to-end service guarantees
  - Tune applications to network services rather than network services to applications
  - Discrete v.s. continuous space
- No resource reservation
- Somewhere between Best Effort and IntServ
Service Differentiation

Analogy:
- airline service, first class, coach, various restrictions on coach as a function of payment

Best-effort expected to make up bulk of traffic, but revenue from first class important to economic base (will pay for more plentiful bandwidth overall)

Not motivated by real-time but by economics and assurances
Types of Service

Premium service: (type P)
- admitted based on peak rate
- conservative, virtual wire services
- unused premium goes to best effort (subsidy!)

Assured service: (type A)
- based on expected capacity usage profiles
  - traffic unlikely to be dropped if user maintains profile
  - out-of-profile traffic marked
- traffic is *in* or *out* (of profile)
- police traffic to keep *in* within limits
- use provisioning and/or admission control to limit amount of *in*
- preferentially drop *out* traffic
Differences With Integrated Services

- No need for reservations: just mark packets
- Packet marking done at administrative boundaries before injecting packets into network
- Significant savings in signaling, much simpler overall
CS551
A Two-bit Differentiated Services Architecture
[Nichols99a]

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Premium vs. Assured Forwarding Behaviors

- **Premium** packets receive virtual circuit type of treatment
  - Appropriate for intolerant and rigid applications
- **Assured** packets receive "better than best effort" type of treatment
  - Appropriate for adaptive applications
2-bit Differentiated Service

- Precedence field encodes P & A type packets
- P packets are BW limited, shaped and queued at higher priority than ordinary best effort
- A packets treated preferentially with respect to dropping probability in the normal queue
- Leaf and border routers have input and output tasks - other routers just output
Premium Service

- User sends within profile, network commits to delivery with requested profile
- Simple forwarding: classify packet in one of two queues, use priority
- Shaping at trust boundaries only, using token bucket
- Signaling, admission control may get more elaborate, but still not end-to-end
Premium Traffic Flow

Company A

Packets in premium flows have bit set

Unmarked packet flow

host

first hop router

internal router

border router

Premium packet flow restricted to R bytes/sec

ISP

border router
First-hop Router Input Functionality

Markers: service class, rate, permissible burst size
Marker Function in Routers

First-hop routers have traffic profiles - they classify packets based on packet header:
- if no profile present, pass as best effort
- if profile is for A:
  - mark packets *in* or *out* (*in*-profile packets with A, forward others unmarked)
- if profile is for P:
  - delay or drop out-of-profile packets to *shape* into profile

Routers at administrative boundaries:
- must make sure traffic exchange agreements are met
Markers to Implement Two Different Services

- if profile is for P:
  - delay or drop out-of-profile packets to *shape* into profile

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Packet input → Wait for token → Set P bit → Packet output
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Packet input → Test if token

- No token

  - Set A bit

  → Packet output

Drop on overflow
```
Markers to Implement Two Different Services

- if profile is for A:
  - mark packets in or out (in-profile packets with A, forward others unmarked)
- if no profile present, pass as best effort
At border routers profile meters test marked flows:
- drop P packets out of profile
- unmark A packets
Output Forwarding

- 2 queues: P packets on higher priority queue
- Lower priority queue implements RED "In or Out" scheme (RIO) [Clark98a]

**Diagram:**
- P-bit set? -> High-priority Q
  - yes
  - If A-bit set incr A_cnt
  - no
  - If A-bit set decr A_cnt
- Low-priority Q
  - RIO queue management
- Packets out
Red With In or Out (RIO)

- For Assured Services
- Similar to RED, but with two separate probability curves
- Has two classes, "In" and "Out" (of profile)
- "Out" class has lower Minthresh, so packets are dropped from this class first
- As avg queue length increases, "in" packets are dropped
- More drop probability curves (WRED)

\[ P_{\text{drop}} \]

\[ P_{\text{max}} \]

\[ \text{AvgLen} \]

\[ \text{Min}_{\text{out}}, \text{Min}_{\text{in}}, \text{Max}_{\text{out}}, \text{Max}_{\text{in}} \]
Per-hop Behaviors (PHBs)

- Define behavior of individual routers rather than end-to-end services
  - there may be much more services than behaviors
- Multiple behaviors - need more than one bit in the header
- Six bits from IP tos field are taken for Diffserv code points (DSCP)
Signaling

Where?
- static (long-term):
  - done out-of-band
- dynamic:
  - from leaf to Bandwidth Broker
  - and from BB in one domain to another BB

How?
- not clear, but maybe RSVP
Signaling: BBs
Diffserv vs. Intserv Summary

- Resources to aggregated traffic, not flows
- Traffic policing at the edges, class forwarding in the core
- Define forwarding behaviors, not services
- Guarantees by provisioning and Service Level Agreements, not reservations
- Focus on single domain, not e2e (need BBs for e2e)
Open Issue: Inside or Outside the Network?

- Reservation based strategies can provide more varied QoS than feedback-based schemes

- Will this be the end of TCP?
  - highly unlikely
  - applications are established, heterogeneous networks, etc.

- Diffserv is middle ground: no intelligence v.s. high intelligence with Intserv

- Will we see a deployment? Jury is still out..
Discussions

Context
- a lot of people had been looking at Integrated Services
  - realizing that Integrated Services were unworkable

Discussion
- nice, implementable schemes
- no real driver for this
  - it’s worthwhile to note that when you build a network and put in services, people might find a way to use those
  - when the network is mature, need an economic driver to introduce new services