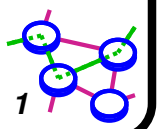
CS551
Differentiated Services (DiffServ)

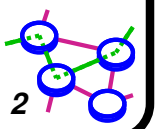
Bill Cheng

http://merlot.usc.edu/cs551-f12



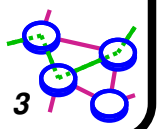
Key Ideas

- 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



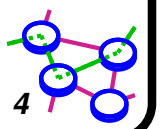
Service Differentiation

- 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



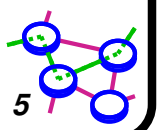
Types of Service

- **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 amout 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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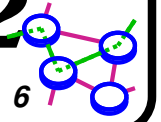
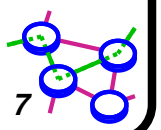


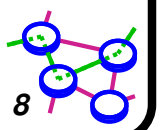
Premium vs. Assured Forwarding Behaviors

- ***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**



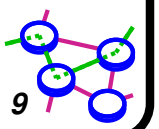
2-bit Differentiated Service

- 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

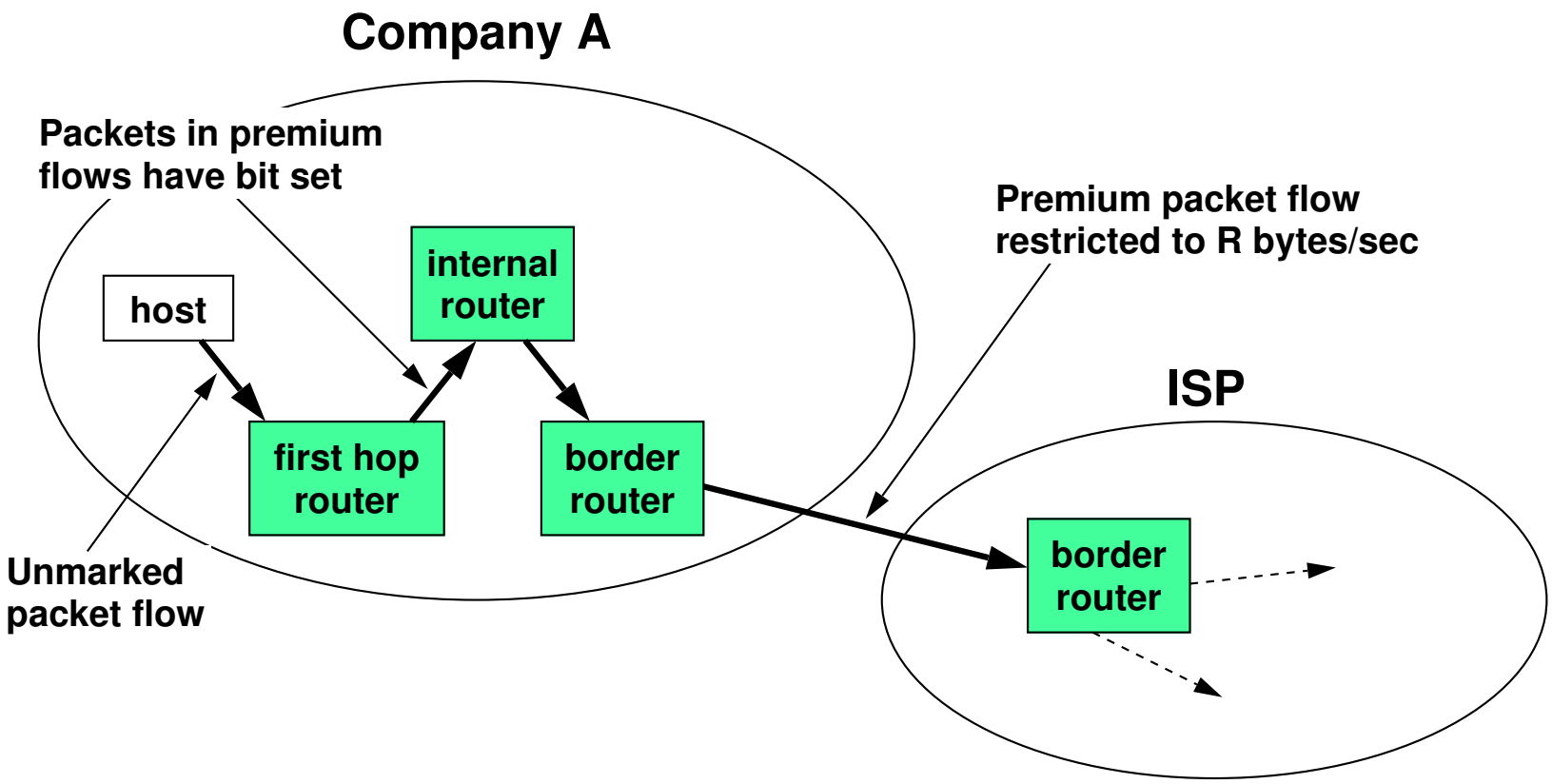


Premium Service

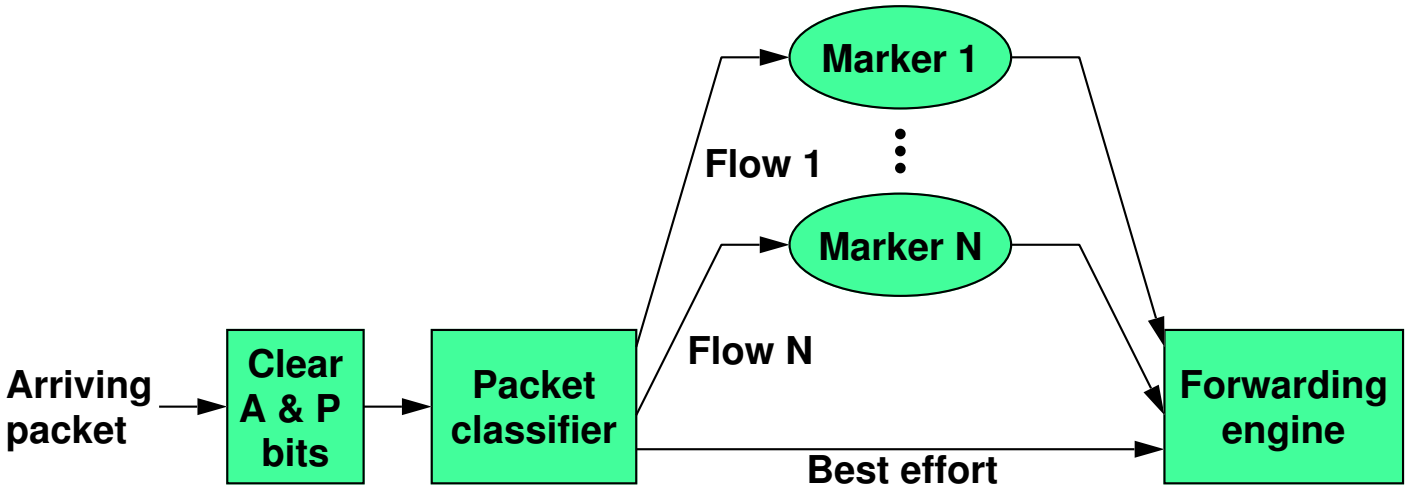
- User sends within profile, network commits to delivery with requested profile
- Simple forwarding: classify packet in one of two queues, use priority
- Shaping at trust boundaries only, using token bucket
- Signaling, admission control may get more elaborate, but still not end-to-end



Premium Traffic Flow



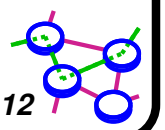
First-hop Router Input Functionality



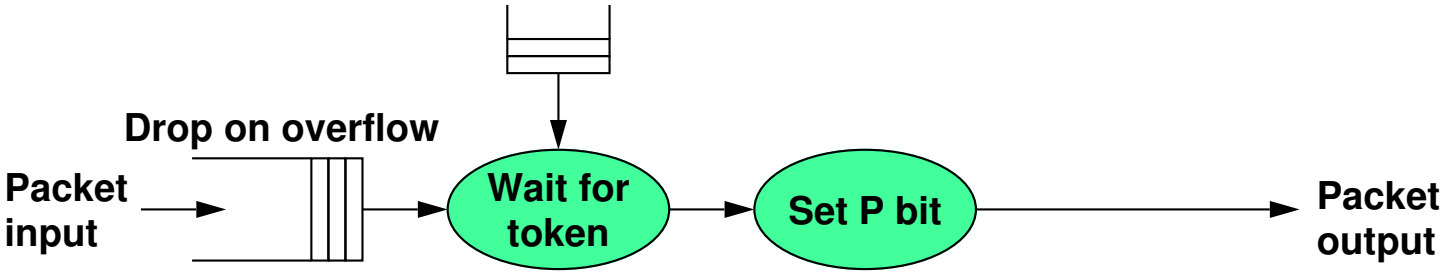
Markers: service class, rate, permissible burst size

Marker Function in Routers

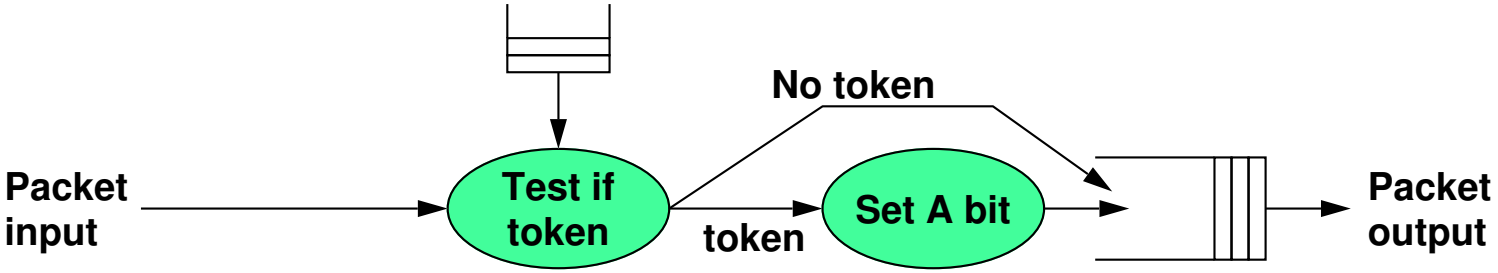
- First-hop routers have traffic profiles - they classify packets based on packet header
  - if no profile present, pass as best effort
  - if profile is for A:
    - mark packets *in* or *out* (*in*-profile packets with A, forward others unmarked)
  - if profile is for P:
    - delay or drop out-of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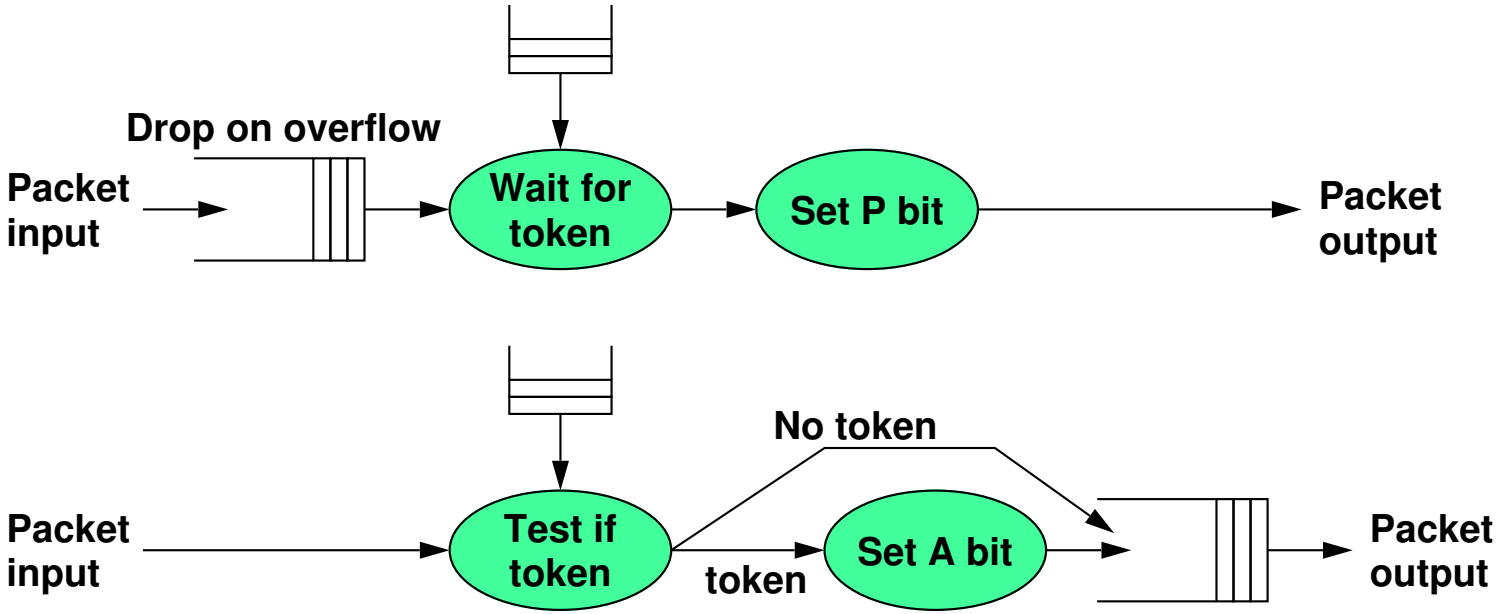
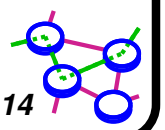
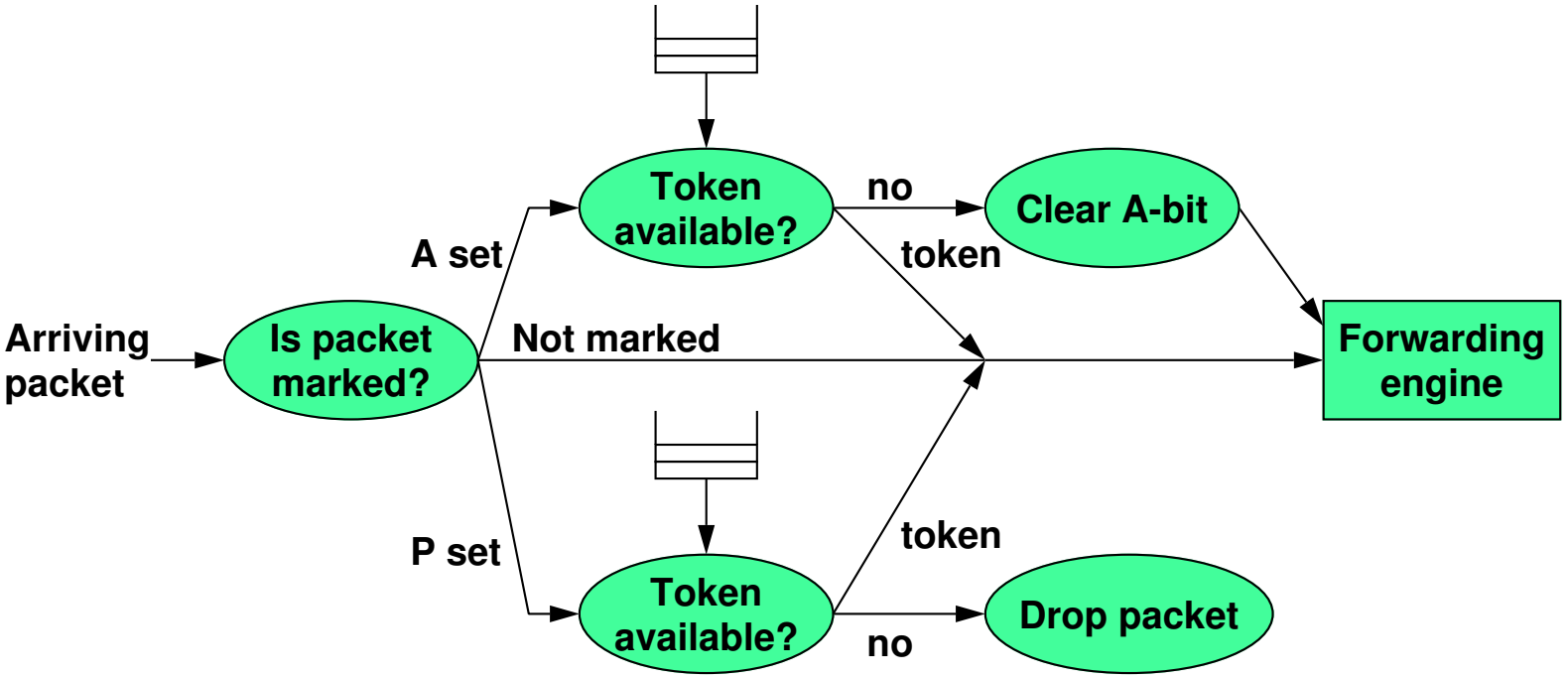


- if profile is for A:
  - mark packets *in* or *out* (*in*-profile packets with A, forward others unmarked)
- if no profile present, pass as best effort



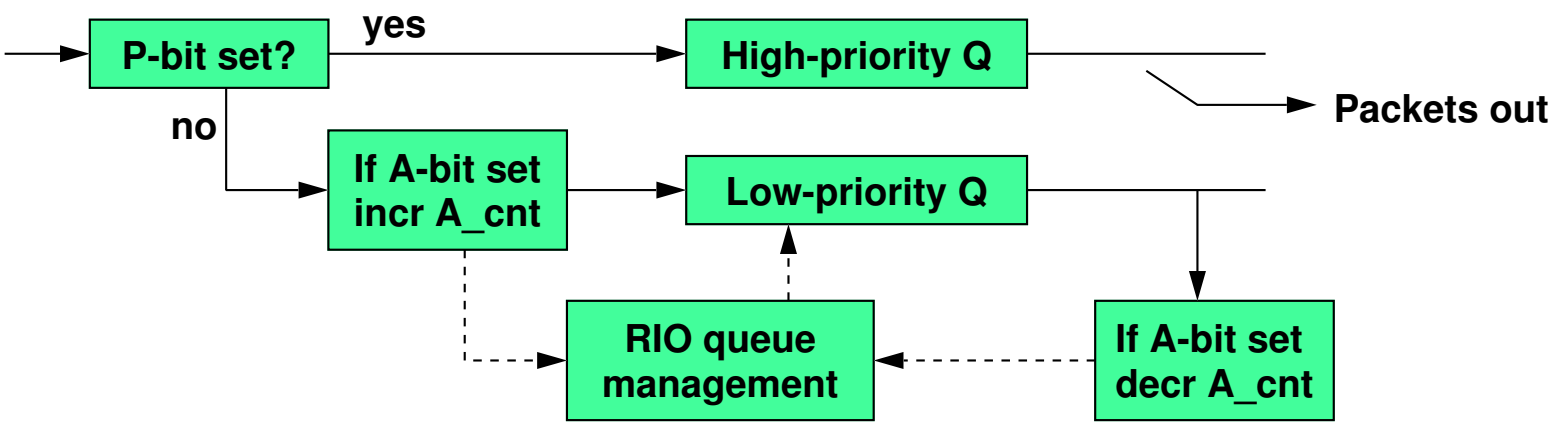
Border Router Input Interface Profile Meters



- At border routers profile meters test marked flows:
  - drop P packets out of profile
  - unmark A packets

Output Forwarding

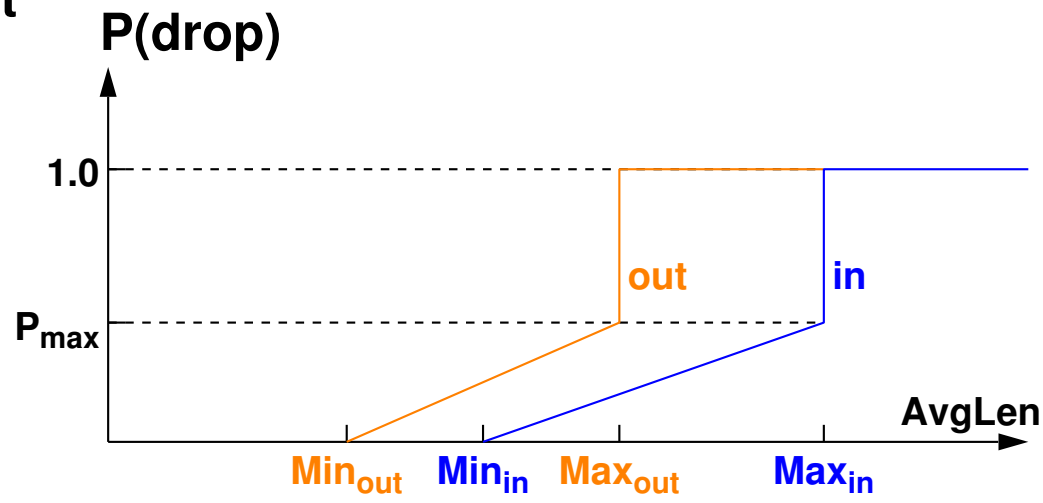
- 2 queues: P packets on higher priority queue
- Lower priority queue implements RED "In or Out" scheme (RIO) [Clark98a]

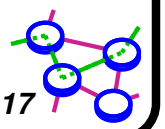


Red With In or Out (RIO)

[Clark98a]

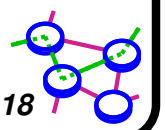
- For Assured Services
- Similar to RED, but with two separate probability curves
- Has two classes, "In" and "Out" (of profile)
- "Out" class has lower Minthresh, so packets are dropped from this class first
- As avg queue length increases, "in" packets are dropped
- More drop probability curves (WRED)





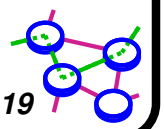
Per-hop Behaviors (PHBs)

- 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)

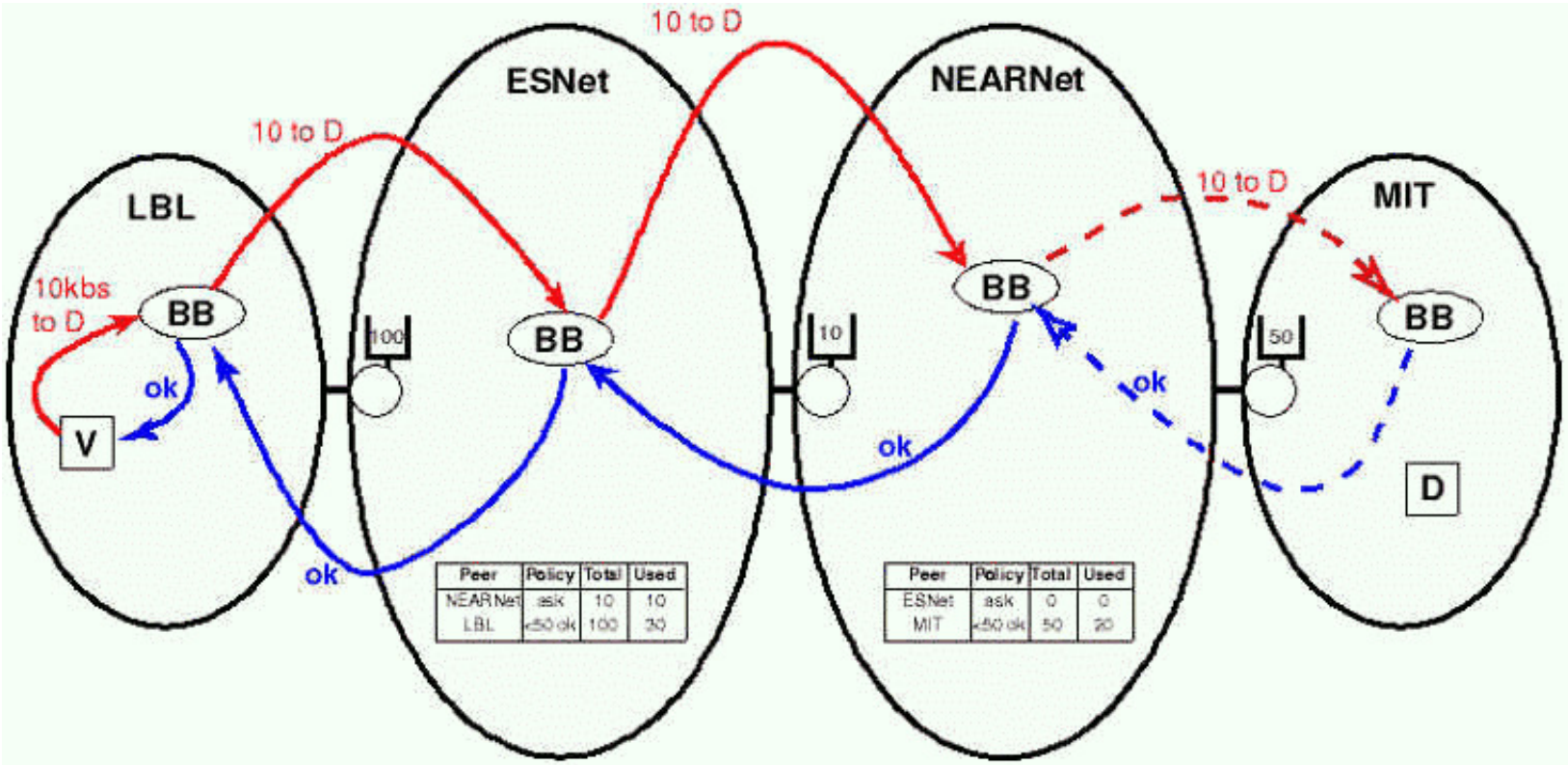


Signaling

- 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

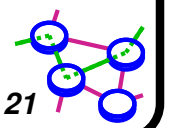


Signaling: BBs



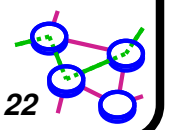
Diffserv vs. Intserv Summary

- 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