

Towards Service Differentiation on the Internet

from

**"New Internet and Networking Technologies and
Their Application on Computational Sciences",**

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and

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High-Performance Computing",**

tutorial given at HiPC 2004, Bangalore, India
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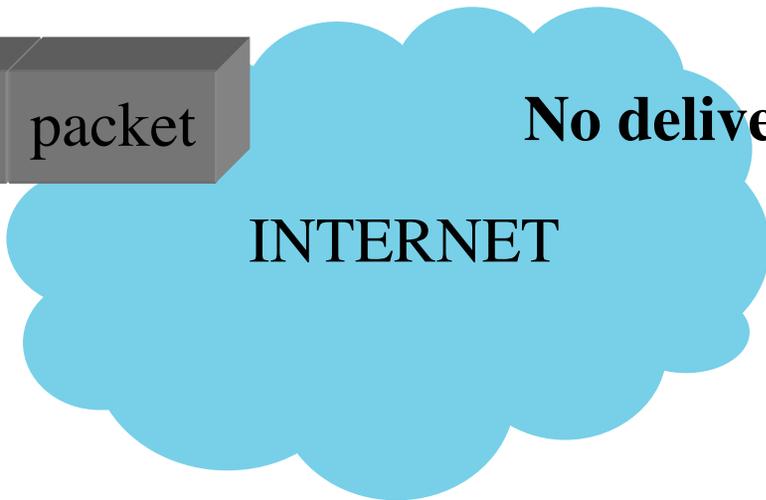
Limitations of the current Internet

- ❑ Bandwidth
 - ❑ Raw bandwidth is not a problem: DWDM
 - ❑ Provisioning bandwidth on demand is more problematic
- ❑ Latency
 - ❑ Mean latencies on Internet is about 80-160ms
 - ❑ Bounding latencies or ensuring lower latencies is a problem
- ❑ End-to-end performances
 - ❑ Links are getting faster and faster!
 - ❑ Why my FTP is still going so slow?
- ❑ Communication models
 - ❑ Only unicast communications are well-defined: UDP, TCP
 - ❑ Multi-parties communication models are slow to be deployed

Revisiting the *same service* *for all* paradigm

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No delivery guarantee



Enhancing the best-effort service



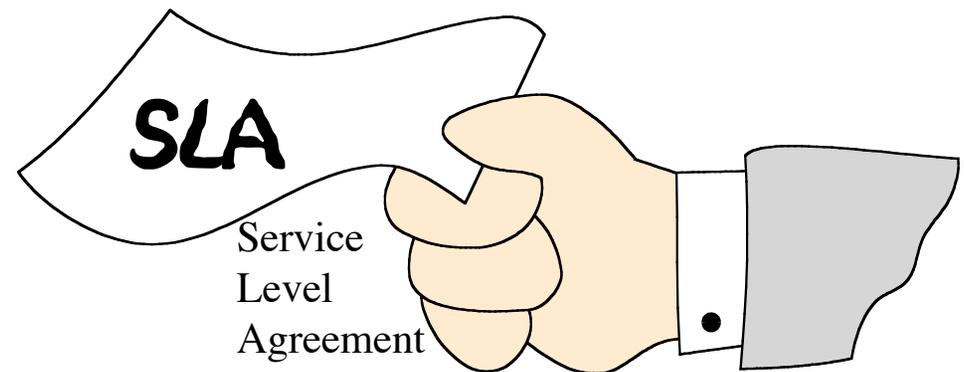
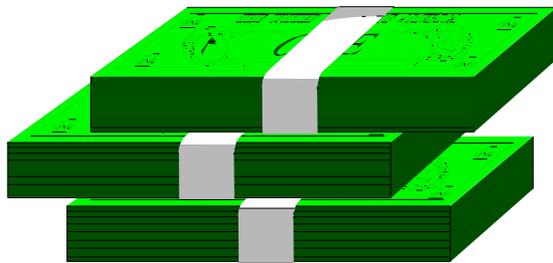
Introduce
Service Differentiation



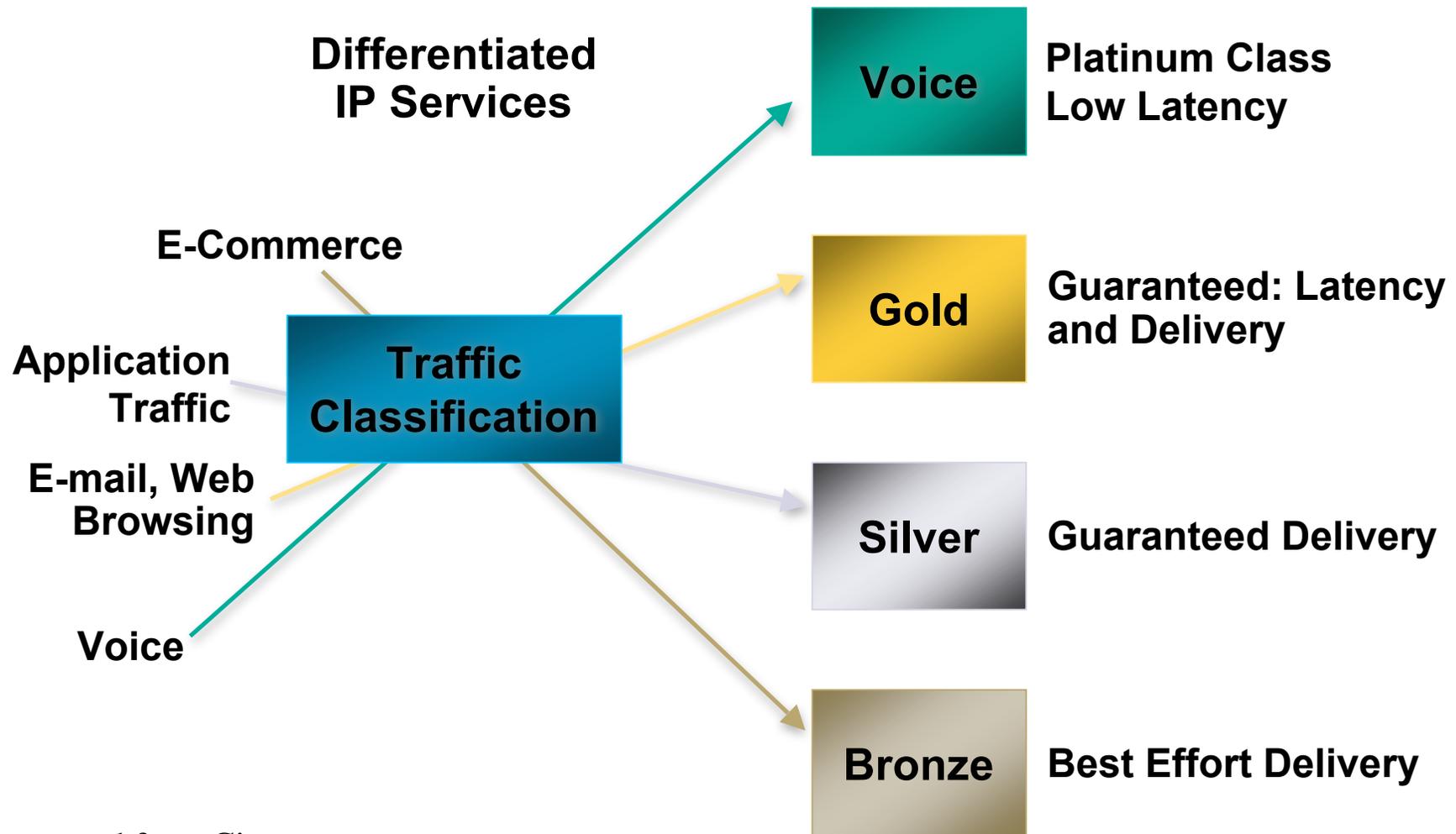
Service Differentiation

The real question is to choose which packets shall be dropped. The first definition of differential service is something like "not mine."
-- Christian Huitema

- ❑ Differentiated services provide a way to specify the relative priority of packets
- ❑ Some data is more important than other
- ❑ People who pay for better service get it!



Divide traffic into classes



Borrowed from Cisco

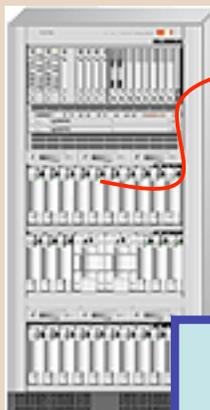
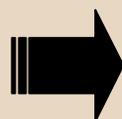
Design Goals/Challenges

- ❑ Ability to charge differently for different services
- ❑ No per flow state or per flow signaling
- ❑ All policy decisions made at network boundaries
 - ❑ Boundary routers implement policy decisions by tagging packets with appropriate priority tag
- ❑ Traffic policing at network boundaries
- ❑ Deploy incrementally, then evolve
 - ❑ Build simple system at first, expand if needed in future

IP implementation: DiffServ

RFC 2475

No per flow state in the core

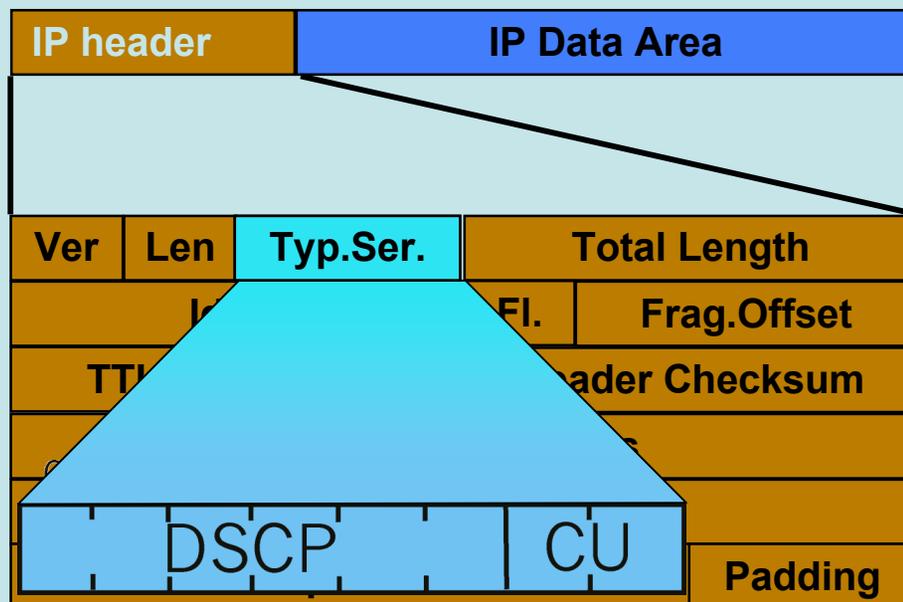
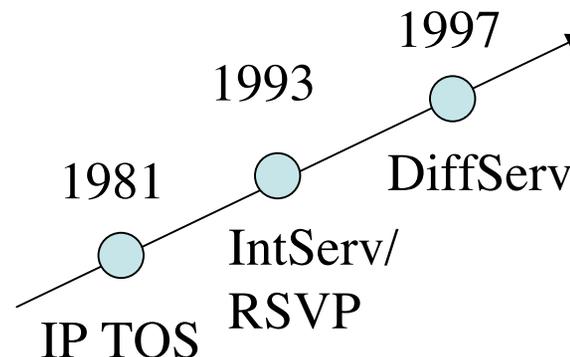


~~Flow 1
Flow 2
Flow 3
Flow 4
...~~

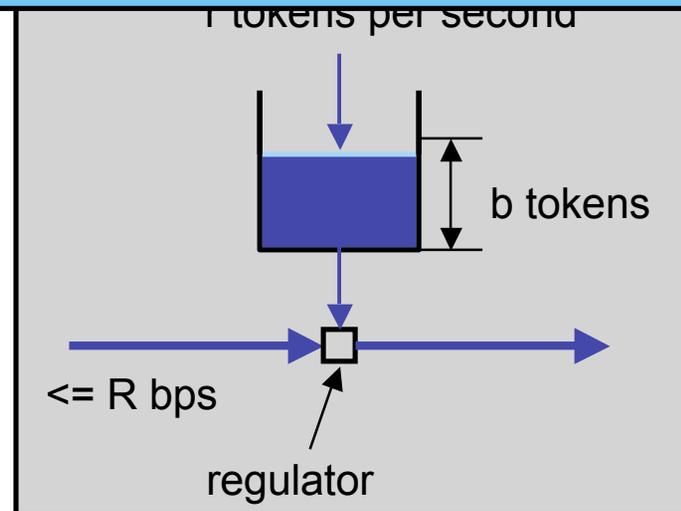
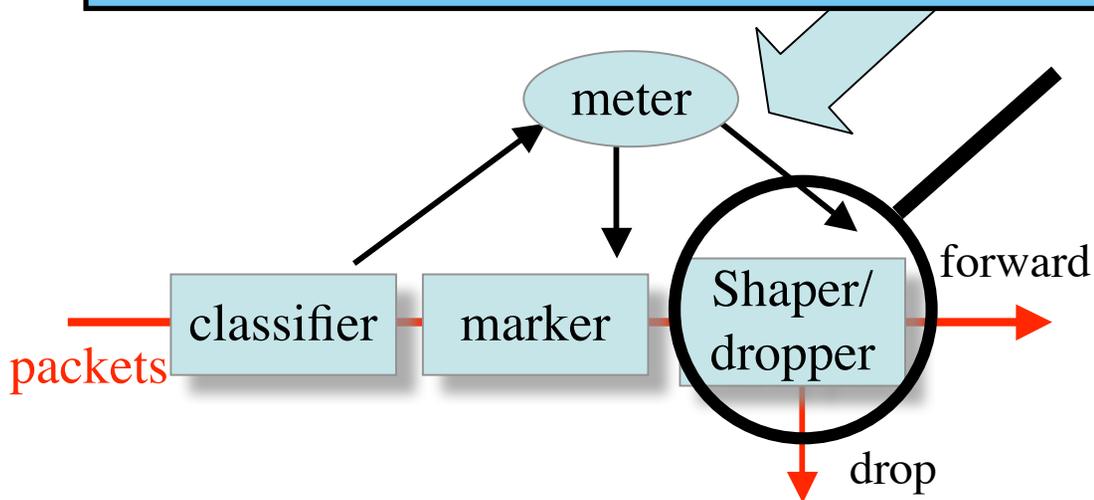
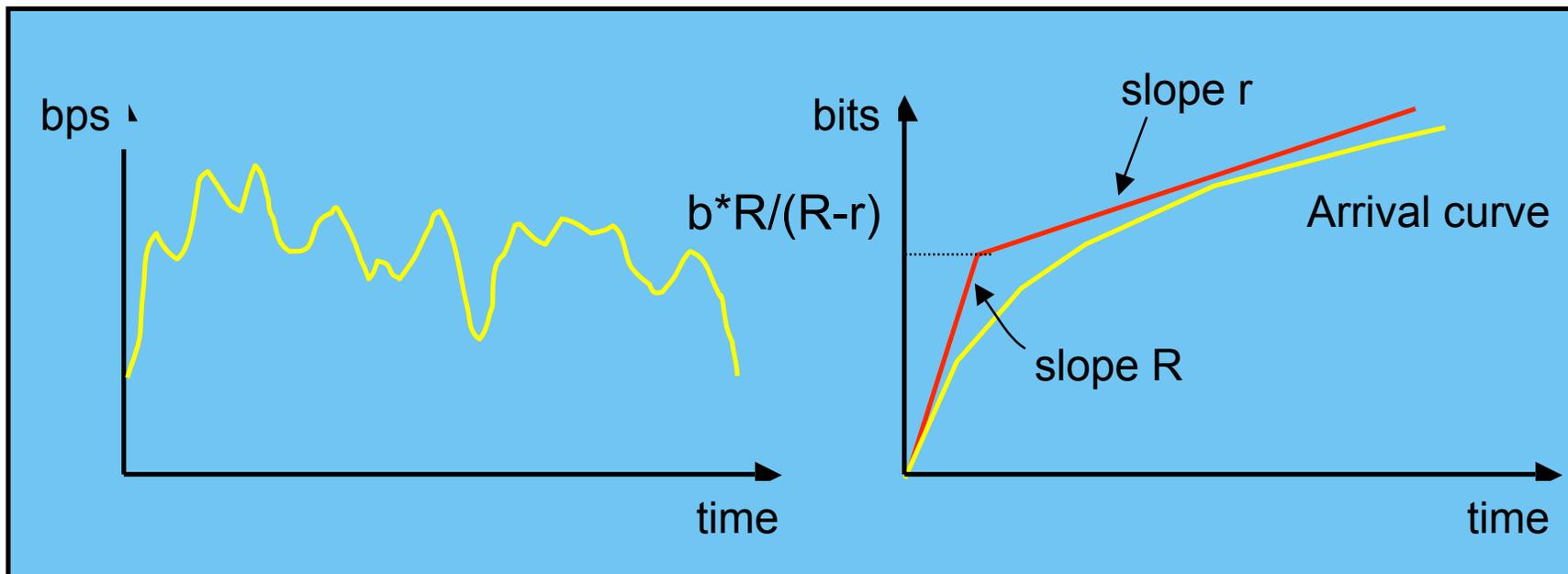
10Gbps=2.4Mpps
with 512-byte packets

**Stateful approaches
scalable
at gigabit rates**

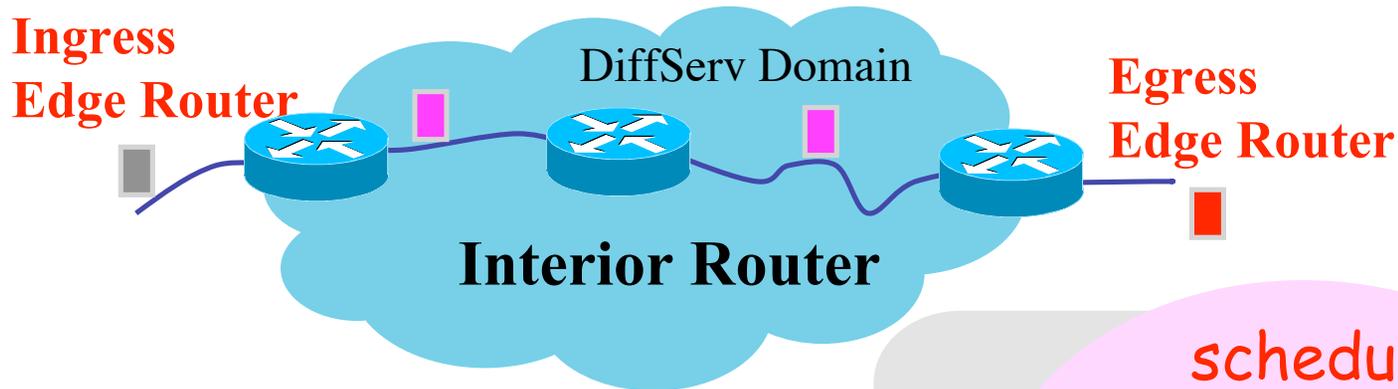
6 bits used for Differentiated Service Code Point (DSCP) and determine PHB that the packet will receive



Traffic Conditioning



Differentiated Architecture



Marking:

per-flow traffic management

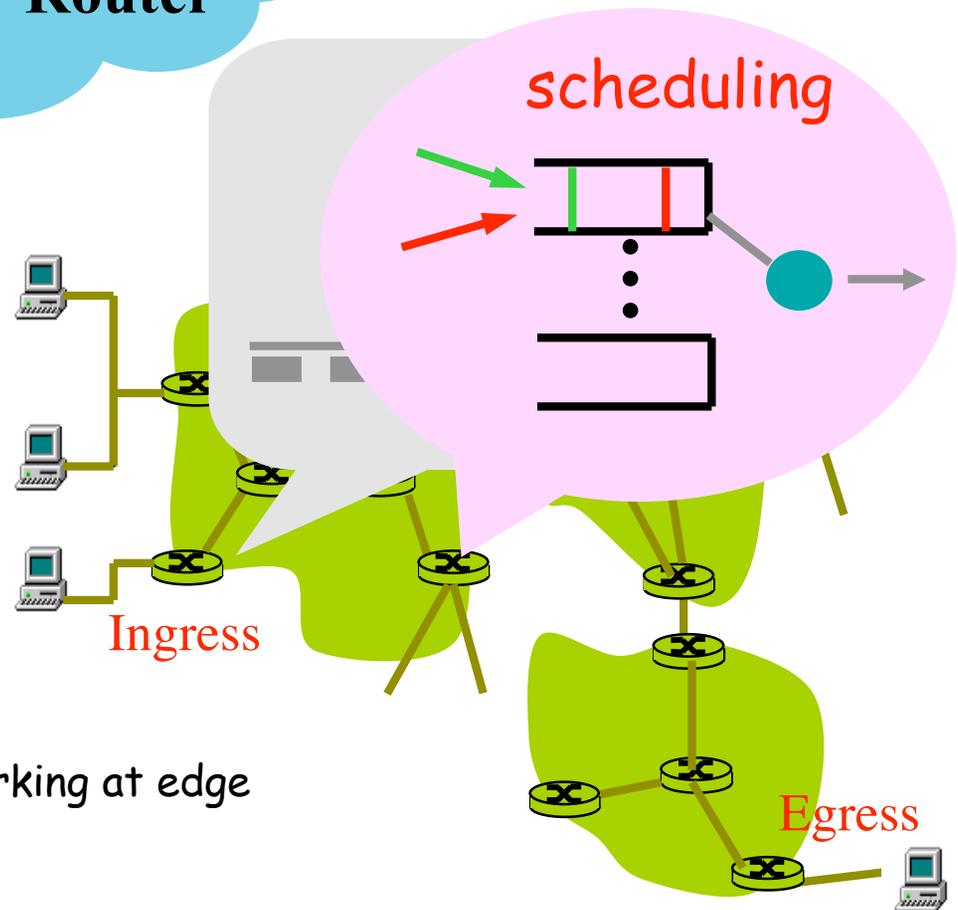
marks packets as in-profile and out-profile

Per-Hop-Behavior (PHB):

per class traffic management

buffering and scheduling based on marking at edge

preference given to in-profile packets



Pre-defined PHB

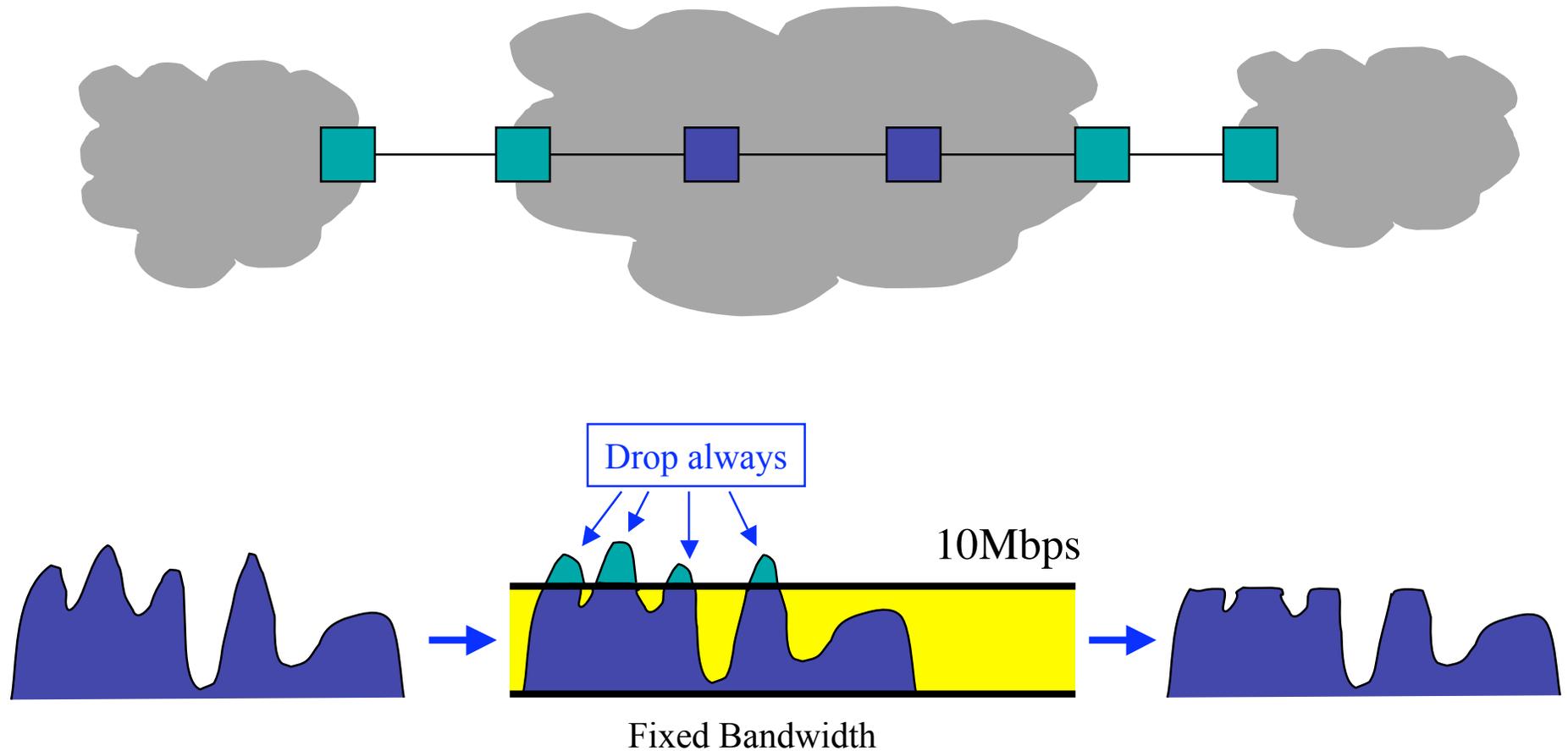
- ❑ Expedited Forwarding (EF, premium):

- ❑ departure rate of packets from a class equals or exceeds a specified rate (logical link with a minimum guaranteed rate)
- ❑ Emulates leased-line behavior

- ❑ Assured Forwarding (AF):

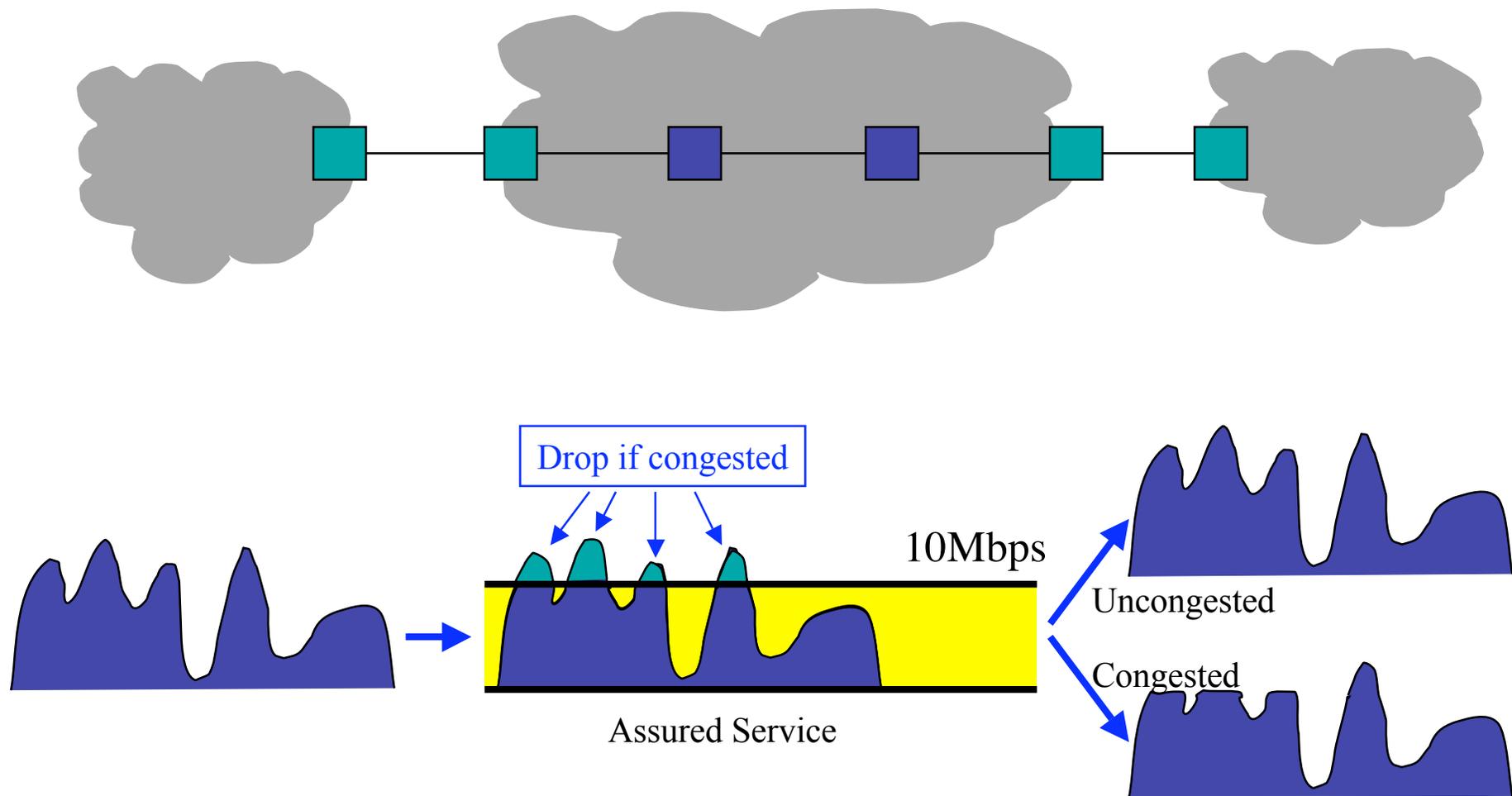
- ❑ 4 classes, each guaranteed a minimum amount of bandwidth and buffering; each with three drop preference partitions
- ❑ Emulates frame-relay behavior

Premium Service Example



source Gordon Schaffee

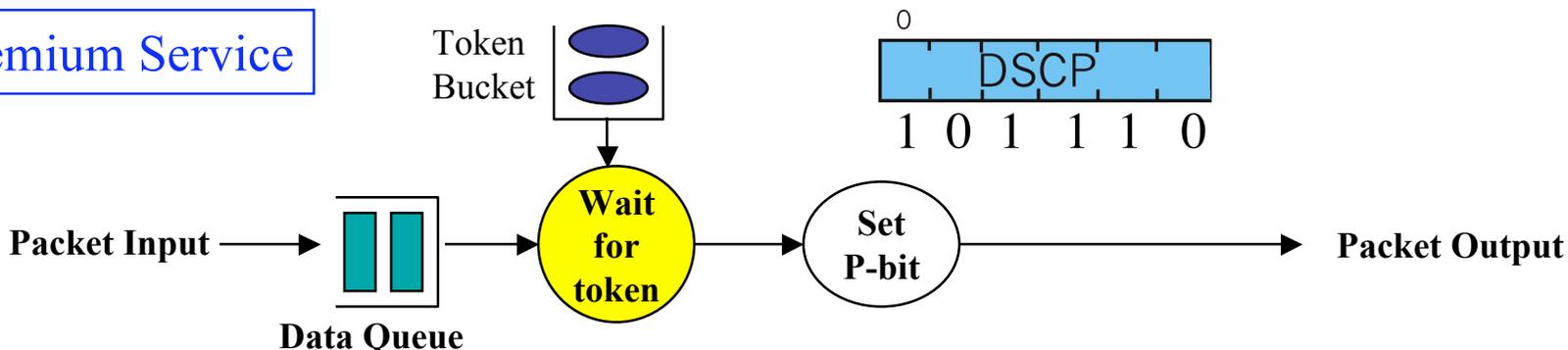
Assured Service Example



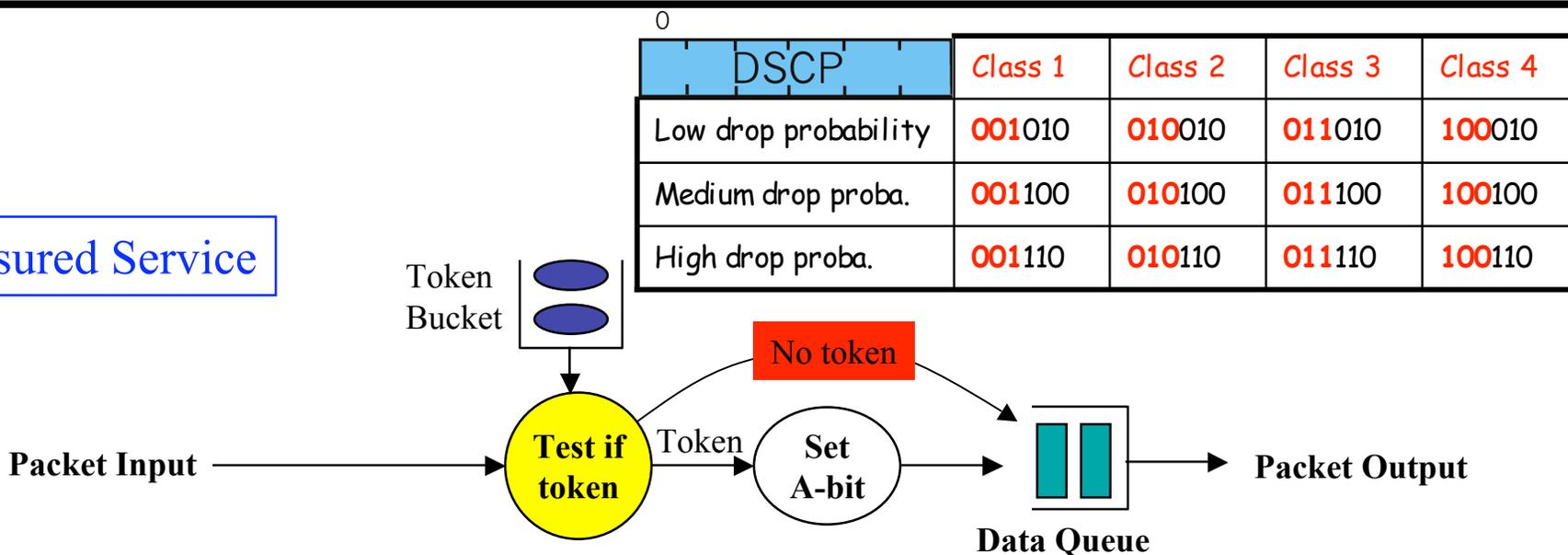
source Gordon Schaffee

Border Router Functionality

Premium Service

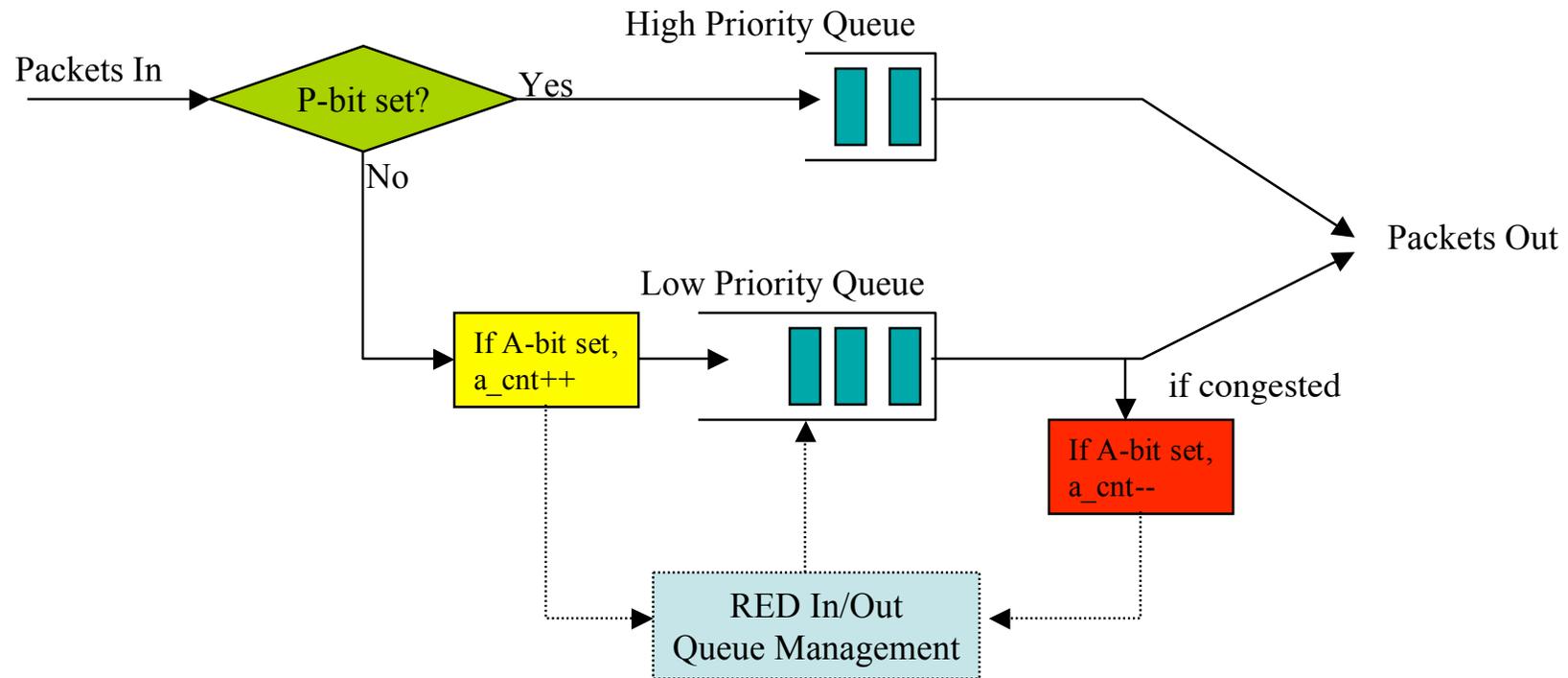


Assured Service



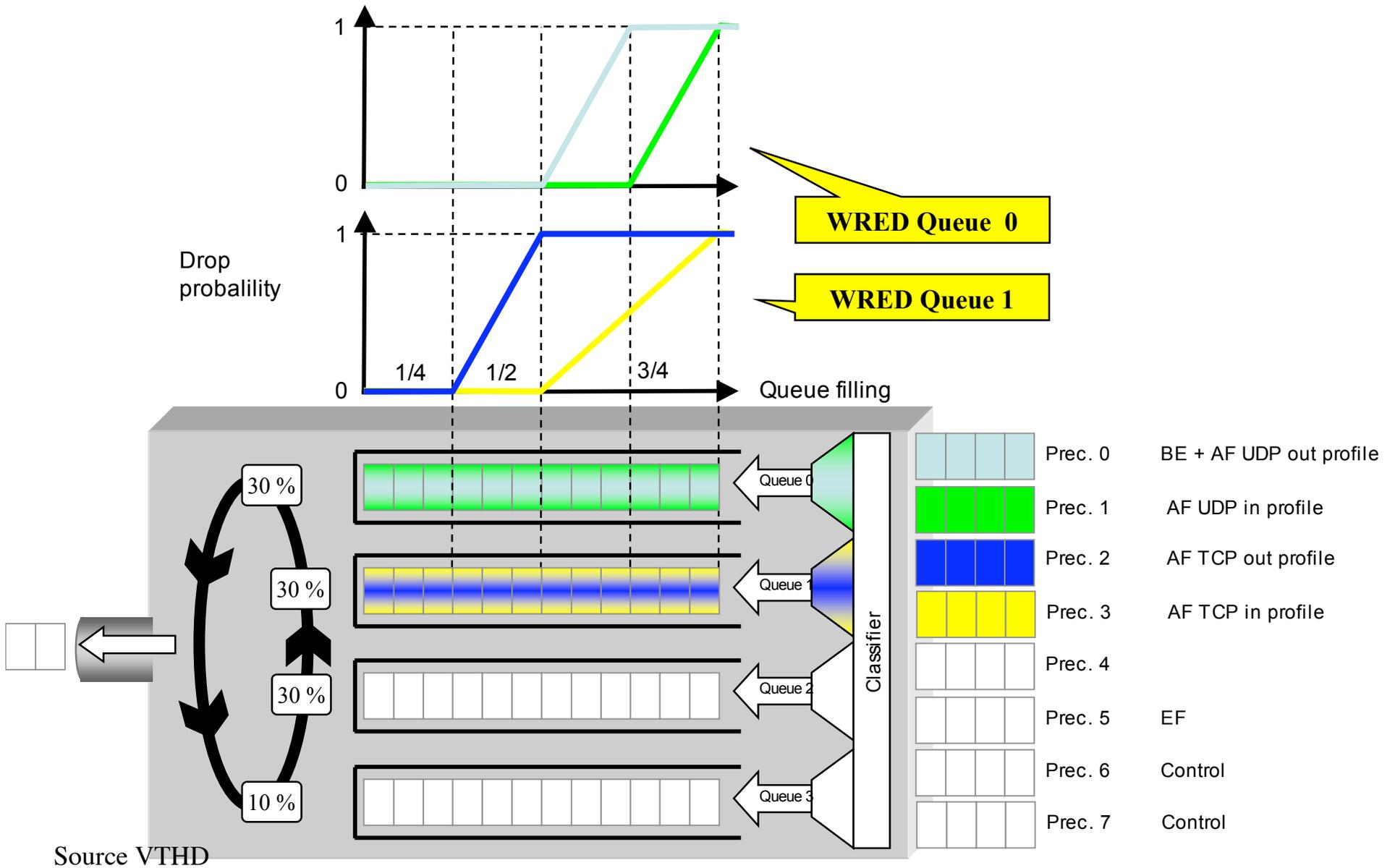
source Gordon Schaffee, modified by C. Pham

Internal Router Functionality

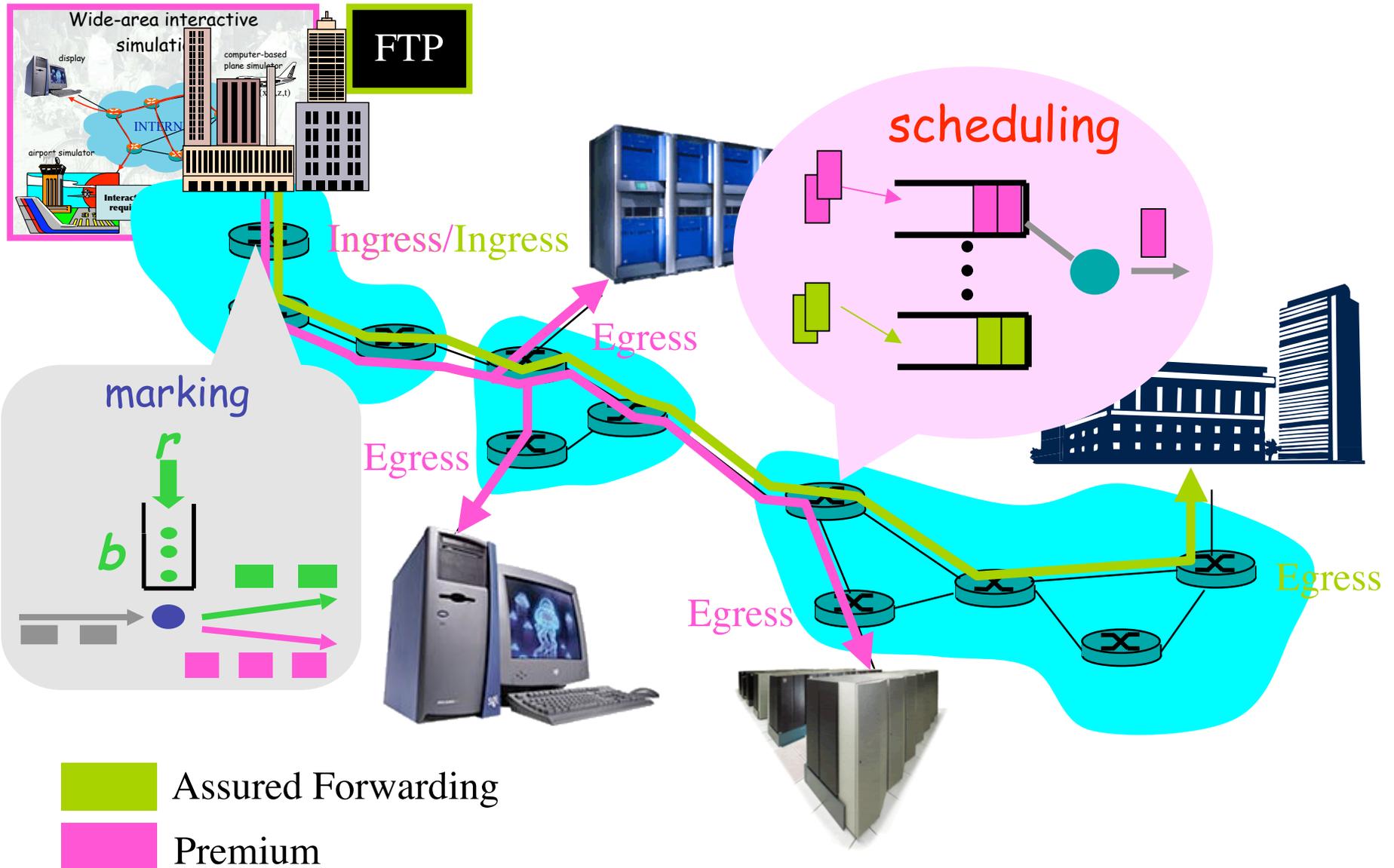


A DSCP codes aggregates, not individual flows
No state in the core
Should scale to millions of flows

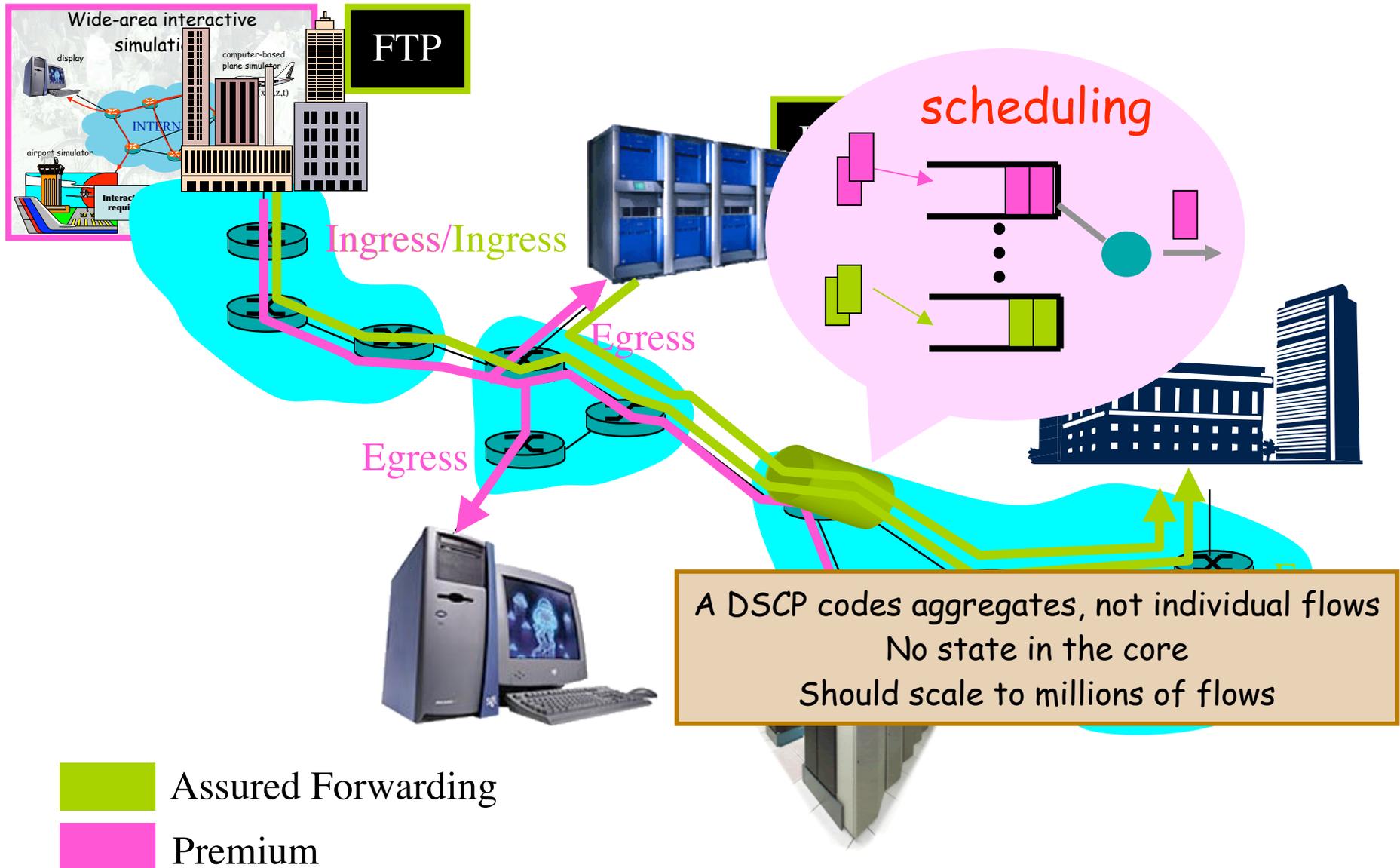
Practical realization



DiffServ in action



DiffServ in action (con't)



DiffServ in commercial products

- ❑ Most switch/router manufacturer (Cisco, Juniper, Procket...) have DiffServ implementations (and other advanced QoS features: WFQ, RED, WRED...) in their products for corporates, ISP, operators.