Multimedia Networking

Network Support for Multimedia Applications

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Protocols for Real Time Interactive Applications

- Differentiated Services (DiffServ)
- Per Connection Quality of Services Guarantees (IntServ)

Differentiated Services

Introduction

- Ability to handle different classes of traffic in different ways within the Internet in a scalable manner.
- Millions of simultaneous source-destination traffic flows may be present at a backbone router.
- Scalability is met by placing only simple functionality within the network core, with more complex control operations being implemented at the network's edge

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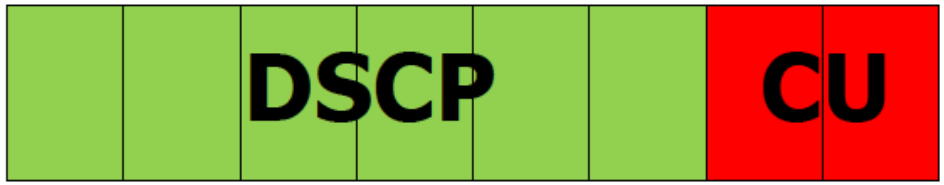
Differentiated Services
Functional Elements

- *Edge Functions*:
  - Packet classification
    - At the incoming edge of the network (that is, at either a Diffserv-capable host that generates traffic or at the first Diffserv-capable router that the traffic passes through), arriving packets are marked.
    - Differentiated Services (DS) field in IPv4 (Type of services) and IPv6 (Traffic class) header is set to some value.
    - DSCP: DiffServ Code Point (6 bits)
  - Traffic conditioning
    - Packet marking, metering, testing with contracted profile, shaping and dropping.



ToS byte in IPv4 header or TC byte in IPv6 header

Differentiated Services

Sub Functions

- Traffic Profile:
  - Some of the end-nodes have an upper bound on their sending rate
  - E.g. a limit on peak rate or burstiness of the packer flow
  - As long as the user sends packets into the network in a way that conforms to the negotiated traffic profile, the packets receive their priority marking and are forwarded along their route to the destination.
  - On the other hand, if the traffic profile is violated, out-of-profile packets might be marked differently, might be shaped (for example, delayed so that a maximum rate constraint would be observed), or might be dropped at the network edge

Differentiated Services

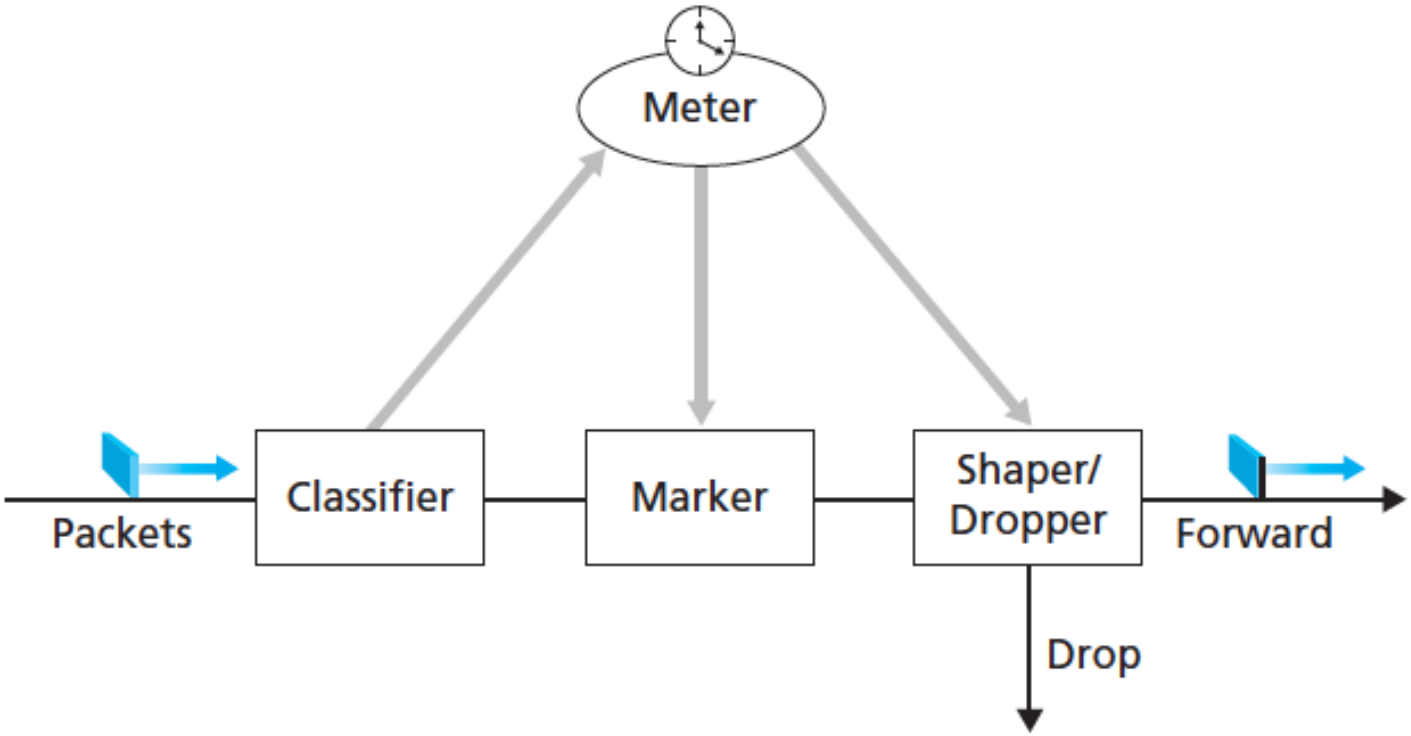
Sub Functions

- Metering Function:
  - It is to compare the incoming packet flow with the negotiated traffic profile and
  - To determine whether a packet is within the negotiated traffic profile.
  - The actual decision about whether to immediately remark, forward, delay, or drop a packet is a policy issue determined by the network administrator and is not specified in the Diffserv architecture.

Differentiated Services

Sub Functions

Traffic Conditioning at Edge Router



Differentiated Services

Functional Elements

- *Core Functioning:*
  - Forwarding
    - When a DS-marked packet arrives at a Diffserv capable router, the packet is forwarded onto its next hop according to the so-called per-hop behavior (PHB) associated with that packet's class.
    - The per-hop behavior influences how a router's buffers and link bandwidth are shared among the competing classes of traffic.
    - A crucial tenet of the Diffserv architecture is that a router's per-hop behavior will be based only on packet markings, that is, the class of traffic to which a packet belongs.

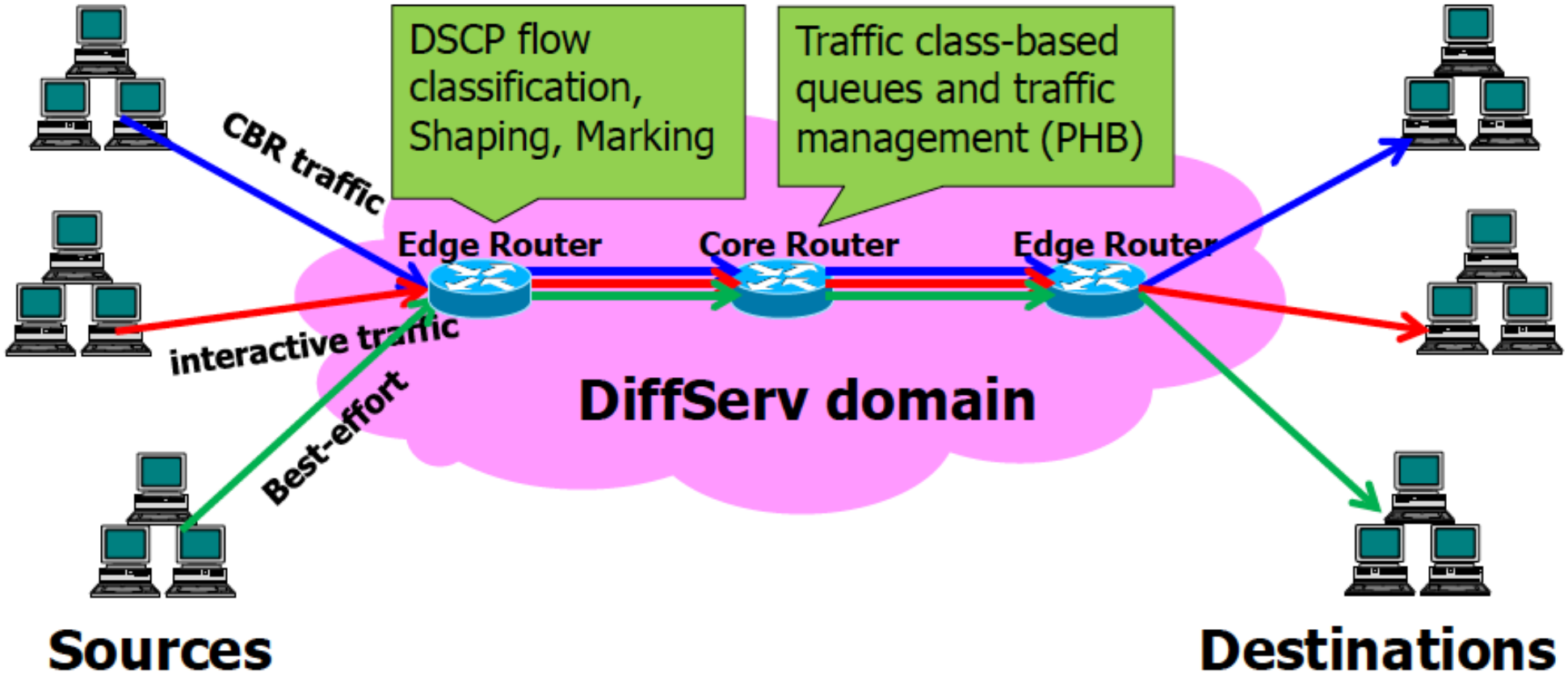
Differentiated Services

Sub Functions

- Per-hop behavior (PHB):
  - A PHB can result in different classes of traffic receiving different performance (that is, different externally observable forwarding behaviors).
  - While a PHB defines differences in performance (behavior) among classes, it does not mandate any particular mechanism for achieving these behaviors.
  - E.g, a PHB would not require that a particular packet-queuing discipline (for example, a priority queue versus a WFQ queue versus a FCFS queue) be used to achieve a particular behavior.
  - Differences in performance must be observable and hence measurable.

Differentiated Services

Functional Elements



Differentiated Services

Two PHBs

- *Expedited Forwarding PHB:*
  - The departure rate of a class of traffic from a router must equal or exceed a configured rate.
  - EF is supported by a specific queue at the router
- *Assured Forwarding PHB:*
  - Divides traffic into four classes
  - Each AF class will have its own queue at the router
  - Each AF class is guaranteed to be provided with some minimum amount of bandwidth and buffering such that
    - AF1 > AF2 >AF3 >AF4

Differentiated Services

End-End DiffServ

- In order to provide end-to-end Diffserv service:
  - All the ISPs between the end systems must not only provide this service, but most also cooperate and make settlements in order to offer end customers true end-to-end service.
- Second, if Diffserv were actually in place and the network ran at only moderate load:
  - Most of the time there would be no perceived difference between a best-effort service and a Diffserv.

Integrated Services

Per-connection Quality of Service (QoS) Gaurantee

- In DiffServ with proper network dimensioning, the highest class of service can:
  - Indeed achieve extremely low packet loss and delay—essentially circuit-like performance.
  - But can the network guarantee that an ongoing flow in a high-priority traffic class will continue to receive such service throughout the flow's duration using only the mechanisms that we have described so far?
  - It cannot
- Why additional network mechanisms and protocols are required for a hard service to individual connections.

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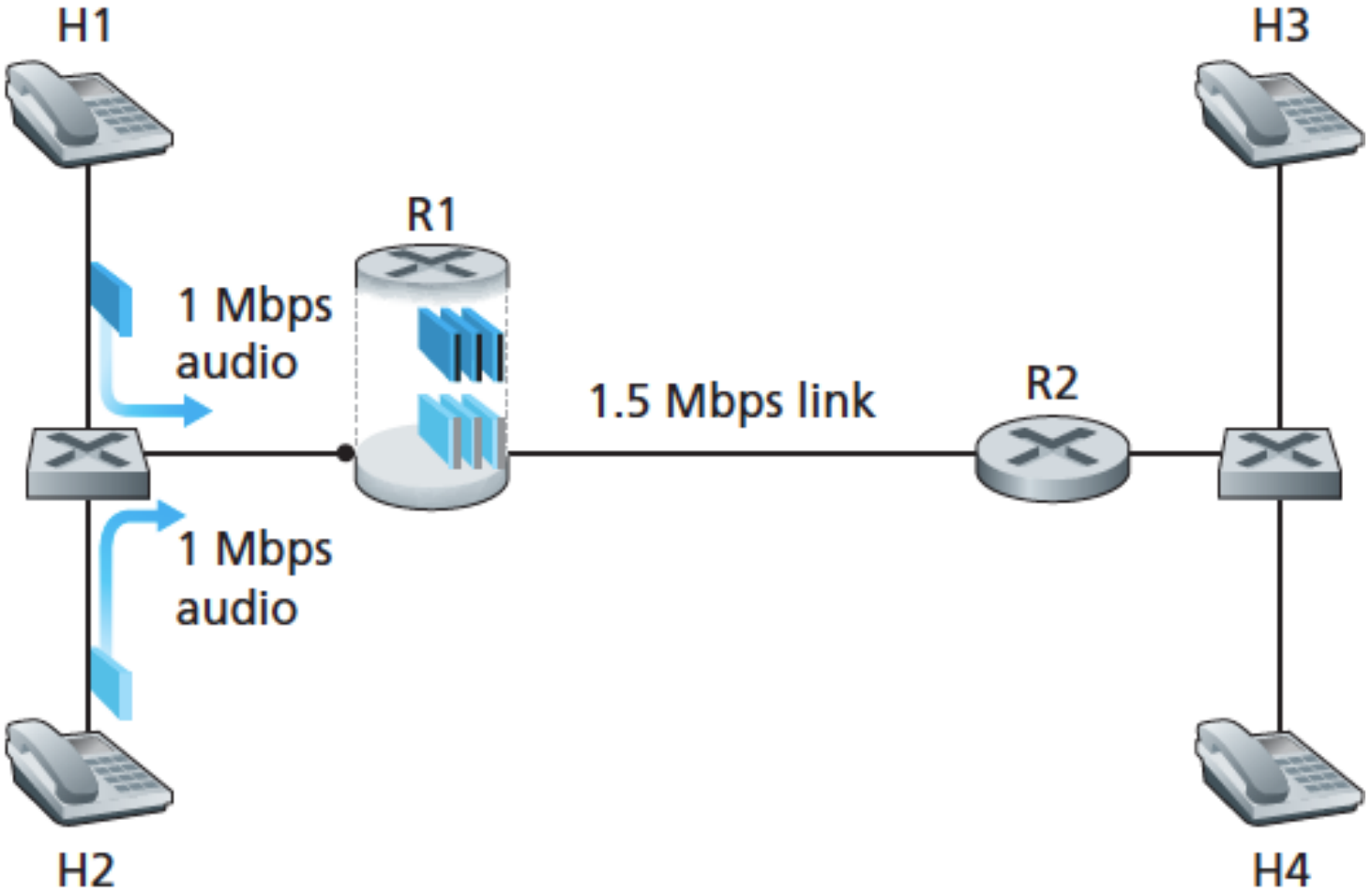
Integrated Services

Per-connection Quality of Service (QoS) Gaurantee



Integrated Services

Per-connection Quality of Service (QoS) Gaurantee

- Ex: Two audio applications
  - Each transmitting at 1Mbps
  - Sharing 1.5Mbps
  - Each is belonging from same class
  - The router will treat each similarly
  - Each traffic stream will loose 25% of its packets
  - It is unacceptable QoS, both applications are unusable.

Integrated Services

Per-connection Quality of Service (QoS) Gaurantee

- Ex: Two audio applications
  - Both the applications cannot be satisfied simultaneously
  - Question: How to resolve the problem?
  - Answer: One of the application flow be blocked [Telephone network is an example]
  - By explicitly admitting or blocking flows based on their resource requirements, the network can guarantee that admitted flows will be able to receive their requested QoS.
- Call Admission:
  - A flow declares about the resources it will need for a flow
  - The network either accepts or rejects the flow

Integrated Services

Per-connection Quality of Service (QoS) Gaurantee

- Ensuring an application flow gets its desired QoS
- Resource Reservation
  - To guarantee a call gets its desired QoS from a network, it must specify:
    - The resources that it needs (e.g. link bandwidth, buffers etc)
  - Once call reserves the resources; it has on demand access the the resources throughout its duration.
  - If a call reserves and receives a guarantee of x Mbps of link bandwidth, and never transmits at a rate greater than x , the call will see loss- and delay-free performance.

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Integrated Services

Per-connection Quality of Service (QoS) Gaurantee

- Ensuring an application flow gets its desired QoS
- Call Admission
  - Since resources are not infinite; the call application when asks for resources
    - The network accepts it, if resources are available.
    - Or blocks the call if there are not enough resources. In such a case the call application may try again and again until required resources are available (i.e. released by others).

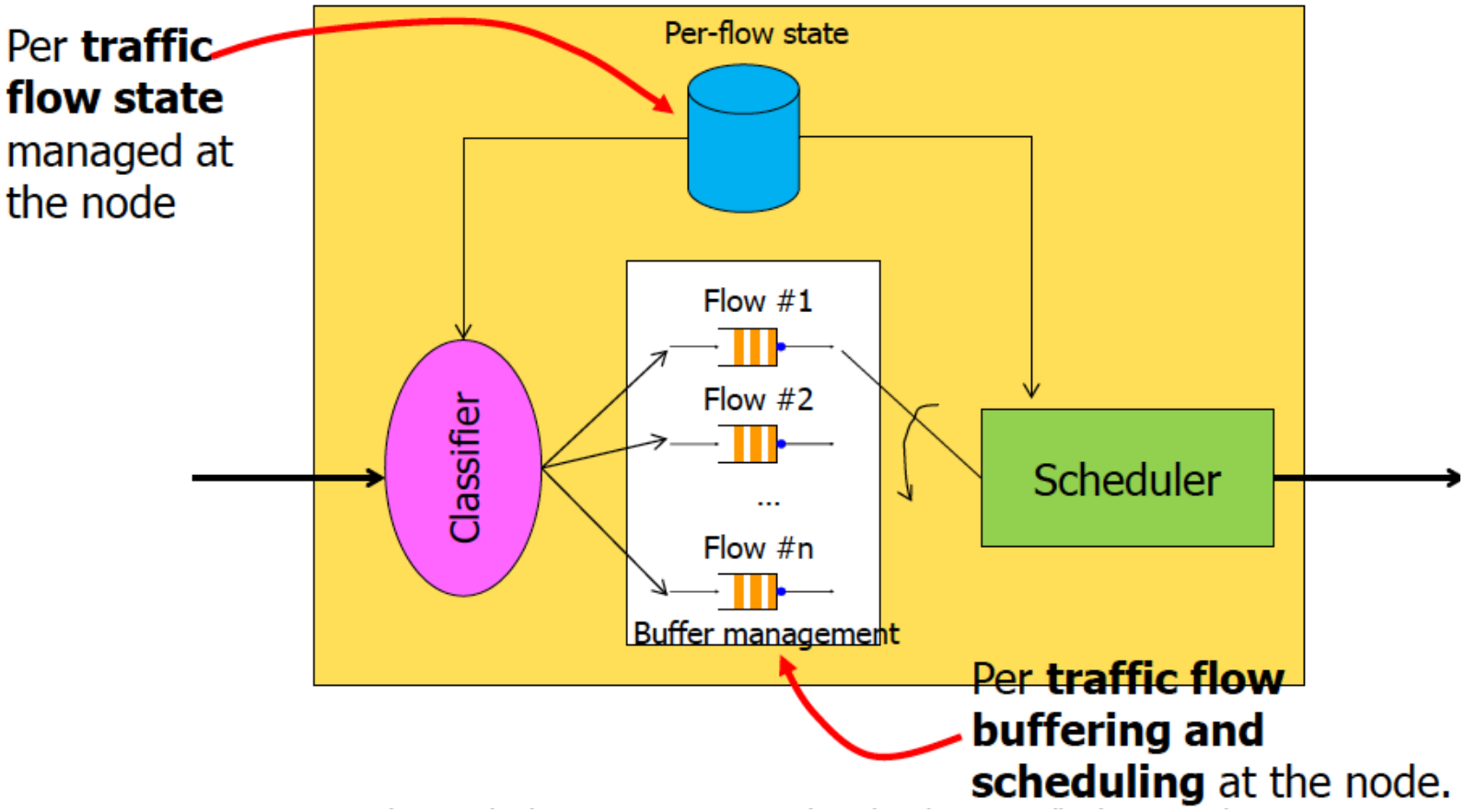
Integrated Services

Per-connection Quality of Service (QoS) Gaurantee

- Ensuring an application flow gets its desired QoS
- Call setup signaling:
  - A signaling protocol is needed to ensure
    - the per-hop allocation of local resources,
    - as well as the overall end-to-end decision of whether or not the call has been able to reserve sufficient resources at each and every router on the end-to-end path.
    - RSVP protocol is a call setup protocol,
    - In ATM network; Q2931b does this job

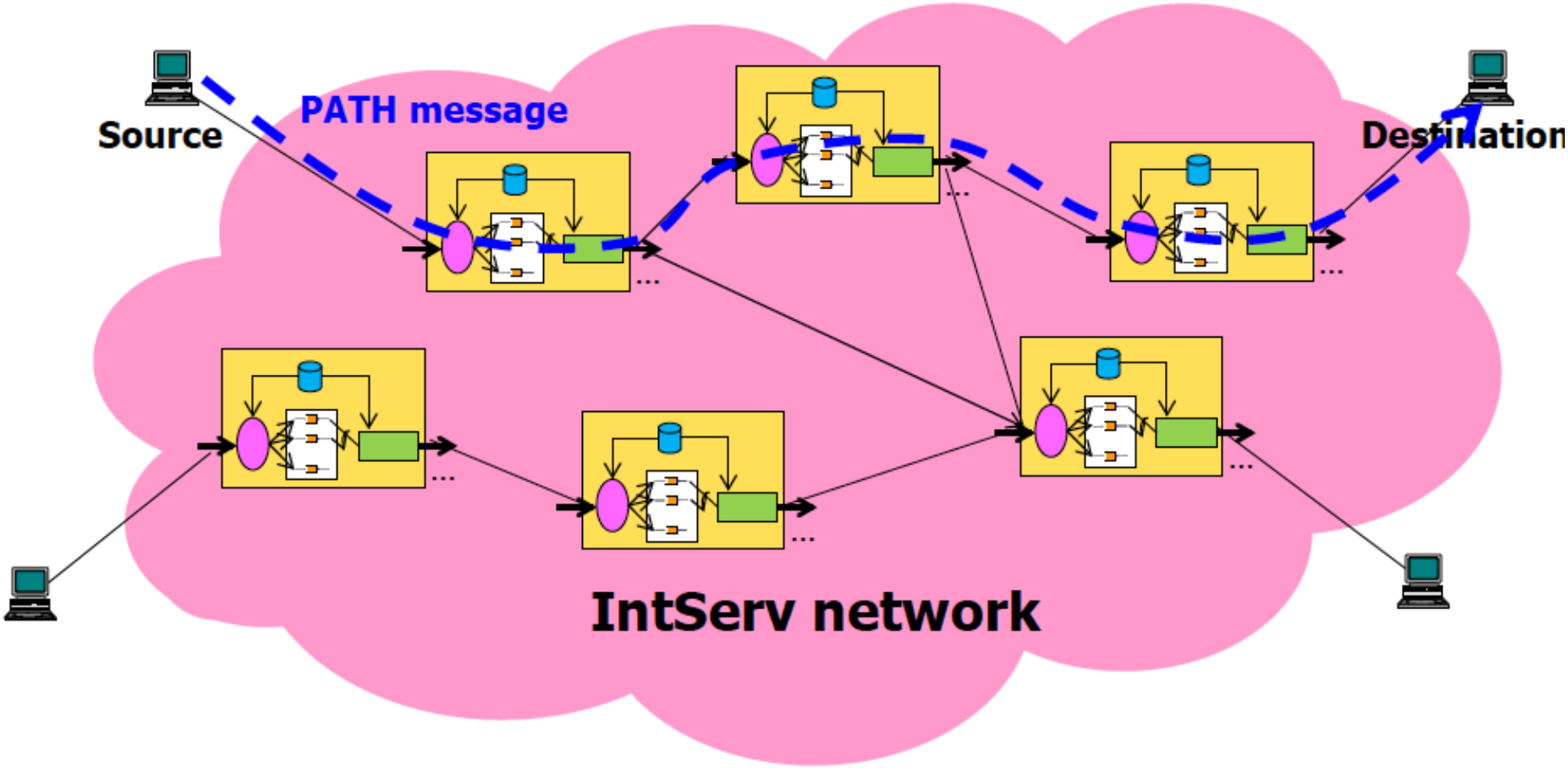
Integrated Services

Per-connection Quality of Service (QoS) Gaurantee



Integrated Services

Per-connection Quality of Service (QoS) Guarantee



Quality of Service (QoS) Guarantee

	Best-Effort	DiffServ	IntServ
Service	Connectivity No isolation No guarantees	Per-aggregation isolation Per-aggregation guarantee	Per-flow isolation Per-flow guarantee
Service Scope	End-to-end	Domain	End-to-end
Complexity	No set-up	Long term setup	Per-flow setup
Scalability	Highly scalable (nodes maintain only routing state)	Scalable (edge routers maintains per-aggregate state; core routers per-class state)	Not scalable (each router maintains per-flow state)

Multimedia Networking Summary

- Types of Data
  - *Audio*
    - Analog to Digital Conversion
    - Encoding Schemes
      - Pulse Code Modulation (Sampling, Quantization)
      - MP3 (Filters out unintelligible frequencies)
  - Video
    - Consist of Frames/ second
    - Each frame is an image
    - Compression/ Encoding
      - Exploits Spatial Redundancy (e.g. JPEG)
      - Exploits Temporal Redundancy (e.g. MPEG)

Multimedia Networking Summary

- Type of Applications
  - Streaming Stored Audio/video
    - UDP streaming
    - HTTP streaming (HTTP/TCP)
    - Adaptive HTTP streaming (HTTP/TCP)
  - Stream Live Audio/video
    - Multiple unicast IP
    - Multi-cast IP
    - Application layer P2P/ CDN
  - Conversational VoIP
    - RTP/UDP, TCP
    - FEC, Interleaving, Error Concealment
    - Playout Delay

Streaming

Interactivity

Continuity

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Multimedia Networking Summary

- Video/Audio Distribution
  - Content Delivery Network
  - Peer to Peer Network
- Conversational VoIP Protocols
  - Real-Time Protocol (RTP) for audio/video transfer
  - Real-Time Interactive Protocol (RTCP) for control messages
  - Session Initiation Protocol (Enables Conversational VoIP)
    - E-mail like addresses
    - Terminals
    - Proxy
    - Registrar
  - H.323
    - A suite of protocols
    - Terminals, Gatekeeper, MCU and Gateway

Multimedia Networking Summary

- Guarantee QoS
  - Best Effort Network
  - Multiple Classes
  - Per-connection QoS guarantee