Internet Quality of Service

CSE 791

Fall 1999

What does QoS Mean?

- Three things people talk about:
  - latency: how "long" is the pipe
  - bandwidth: how "big" is the pipe
  - jitter rate: how "smooth" is the pipe
- Each constraint has different impact on communication

Who Wants QoS?

- People with streaming data
  - voice over IP
  - video over IP (remember video on demand?)
  - multimedia (e.g. games)
- People buying service from a backbone ISP
  - intranets for large corporations
  - resellers of service to those in category 1

Latency

- Remember, light takes ~1/30 second (33 msec) for a round trip of the USA
- That's an absolute bound that we can't beat
- Many applications are happy with RTT in the hundreds of milliseconds
  - 200 msec is the "magic number" for interactive games.

Bandwidth

- We can gang together (aggregate) routes to get more bandwidth
- Various speeds:
  - T1/DS-1: 1.544 Mbps
  - T3/DS-3: 45 Mbps (30 x T1)
  - OC-3c: 155 Mbps (our link off campus)
  - OC-12: 622 Mpbs (the vBNS/Internet II)
  - OC-24: 1.2 Gbps (same as Myrinet)

Jitter

- Van Jacobsen: all delay in the internet is due to congestion.
- Jitter is unpredictable delay (we want packets to arrive at a steady rate).
- Congestion happens when routers get overloaded; queues grow, packets are dropped.
- Solution: buffering at end, packet metering

QoS in Networks

- LAN: ATM is the only option
- WAN: ATM core provides that option
  - but this doesn't help for TCP/IP traffic
- What can we do for TCP/IP traffic?
  - take what we know from ATM and try to use it for TCP/IP.

QoS in the LAN: ATM

- ATM = Asynchronous Transfer Mode
- Based on small, fixed-sized packets called "cells" (5 + 48 = 53 octets)
- No link-by-link error or flow control
  - recoil in horror: "What? No flow control?"
- Basic concepts:
  - virtual channel
  - virtual path

Virtual Channels and Paths

- Virtual Channel:
  - set up between two end users
  - variable rate of packets are switched along this route
  - all communication must have a VC
- Virtual Path
  - group of VC with the same endpoints

ATM QoS Parameters

- Speed
  - Peak Cell Rate (PCR)
    - maximum at which cells will be sent
  - Sustained Cell Rate (SCR)
    - long-term average cell rate
  - Minimum Cell Rate (MCR)
    - minimum acceptable cell rate
- Variation
  - Cell Delay Variation Tolerance (CVDT)
    - maximum acceptable jitter
- Measured by Receiver
  - Cell Loss Ratio (CLR)
    - percentage lost or late
  - Cell Transfer Delay (CTD)
    - mean and max latency
  - Cell Delay Variation (CDV)
    - variance in delivery times

ATM Levels of Service

- Constant Bit Rate (CBR)
  - acts like copper wire or fiber
  - no flow control
  - useful for real-time audio & video
  - Example: T1 circuit
- Variable Bit Rate (VBR)
  - Real-Time VBR
    - useful for videoconferencing
  - Non-Real-Time VBR
    - small delay is ok, but deliver ASAP
    - e.g. multimedia e-mail
- Available Bit Rate (ABR)
  - Variable bandwidth
  - "I need minimum of 5 Mbps, and as much as 10 Mbps"
  - E.g. browsing the web
- Unspecified Bit Rate (UBR)
  - whatever's left
  - best-effort delivery, no promises
  - like IP delivery over ATM

What Have We Learned?

- Different classes of service seems like a good model.
- The TCP/IP protocol suite is excellent for inter-process communication.
- How can we get levels of service into TCP/IP?

QoS in TCP/IP

- RSVP
  - ReServation reserVation Protocol
- IntServ
  - Integrated Services
- DiffServ
  - Differentiated Services
- MPLS
  - Multi-Protocol Label Switching

RSVP

- Path of guaranteed bandwidth
- Reservations are on per-flow basis
- Assumes fixed endpoints
- Simplex channels
- Flows are set up by the receiver
  - receiving process requests QoS from host
  - request is propagated “upstream” to sender
  - combines with multicast trees for single-source, multiple receiver data

IntServ

- Integrated Services through a single network
  - video, voice, regular data
- Based on setting up flows with predetermined QoS attributes
- Uses RSVP to set up flows
- Provides end-to-end QoS guarantees
- Requires RSVP everywhere

DiffServ

- Differentiated Services
- Really a “Class of Service” (COS) approach
- Use the TCP/IP Type of Service field; renamed to the DS field
- 64 different classes of service
- Routers make all decisions on a per-hop basis (not per flow!)

IntServ vs. DiffServ

- IntServ provides end-to-end assurances
- Based on concept of flows
- Good for delivering data “to the core”

- DiffServ provides per-hop assurances
- Based on individual links
- Good for use “inside the core”

IntServ and DiffServ

- Egress and Ingress routers: points at which packets leave and enter a particular network
- Between networks we need SLA
- Can do traffic policing/traffic shaping at borders (make sure incoming/outgoing traffic conforms to agreement).

IntServ and DiffServ

- Both IntServ and DiffServ are “level 3” or “layer 3” technologies
- Refers to routing support in the OSI reference model.
- But what can we do with lower level (layer 2) support at the network?

802.1p

- IEEE standard 802 specifies Ethernet
- Various standards for plain Ethernet, Fast Ethernet, and Gigabit Ethernet
- 802.1p specifies type-of-service fields for Ethernet LANs, letting us do something like DiffServ in the small.

MPLS

- MPLS: Multi-Protocol Label Switching
- Spans layer 2 and layer 3
- One can set up flows through the network (a la’ RSVP) and assign a label to them
- All packets for that route are *marked*
- Routing is done quickly based on labels (markings)

IntServ