Internet Quality of Service

Dr. Miled M. Tezeghdanti

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Introduction

- Internet currently provides one single class service
  - Best Effort Service
    - No assurances about delivery
  - Elastic Applications
    - Tolerate delays and losses
    - Can adapt to congestion
- Real-time Applications are inelastic
  - They do not tolerate delays
  - They do not tolerate jitter

Quality of Service Metrics

- Availability
- Delay
- Delay Variation (Jitter)
- Throughput (bandwidth)
- packet Loss Rate

Integrated Services

- RFC 1633
- Architecture for providing QoS guarantees to individual application sessions
- Resource Reservation
  - A session requiring QoS guarantees must first reserve suffient resources at each router on its path before transmitting its data
- Arriving session must:
  - must declare its QoS requirements using R-spec
  - characterize traffic it will send using T-spec
- A signaling protocol is needed to carry R-spec and T-spec to routers
  - RSVP: ReSerVation Protocol
- Router must determine whether or not it can admit the request
- Router must maintain per-flow state (allocated resources, QoS requests)

RSVP

- A signaling protocol for applications to reserve resources (link bandwith, buffer space)
  - Provide reservations for bandwidth in multicast trees
  - Receiver-oriented
  - Can reserve resources for heterogeneous receivers
- Sender sends a PATH message to the receiver specifying the characteristic of the traffic and QoS requirements
- Receiver responds with a RESV message to request resources for the flow
  - An intermediate router can reject or accept the request of the RESV message
  - A router may merge the reservation messages arriving from downstream

IntServ Service Models

- Guaranteed Service
  - Provide firm bounds on end-to-end packet queuing delays
  - provide bandwith guarantee
- Controlled Load Service
  - Provide the QoS closely approximating the QoS that the same flow would receive from an unloaded network element
  - A very high percentage of transmitted packets will be successfully delivered to the destination
  - A very high percentage of transmitted packets will experience a queuing delay close to 0

Differentiated Services

- RFC 2475
- Goal: provide the ability to handle different classes of traffic in different ways
- Scalable: simple functions in network core, relatively complex functions at network edge
- Flexible: don't define specific service classes, provide functional components to build service classes

DiffServ Architecture

- Edge Router
  - Packets are marked
  - The mark of a packet identifies the class of traffic to which the packet belongs
  - DSCP: Differentiated Service Code Point
  - ToS Field: 6 first bits (64 service classes)
- Core Router
  - packet forwarded to the next-hop according to the per-hop behavior (PHB)
  - PHB determines buffering and shceduling at the routers
  - Routers don't need to maintain states for individual flows

DiffServ Classes

- BE: Best Effort
  - DSCP: 000000
- AF: Assured Forwarding
  - Class 1 (AF11, AF12, AF13)
  - DSCP: (001010, 001100, 001110)
  - Class 2 (AF21, AF22, AF23)
  - DSCP: (010010, 010100, 010110)
  - Class 3 (AF31, AF32, AF33)
  - DSCP: (011010, 011100, 011110)
  - Class 4 (AF41, AF42, AF43)
  - DSCP: (100010, 100100, 100110)
- EF: Expedited Forwarding
  - DSCP: 101110

DiffServ Implementation

- Queue Management
  - RED, RIO
  - WRED
- Scheduling
  - FIFO
  - RR, WRR
  - WFQ, CB-WFQ