Better-than-best-effort: Int-serv, Diff-serv, RSVP, RTP

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- **Why better-than-best-effort Internet ?**
- **Support for multimedia apps: RTP, H.323, Integrated Services(int-serv), RSVP.**
- **Scalable differentiated services for ISPs: diff-serv**
- **Missing pieces: QoS routing, traffic engineering, policy management, pricing models**

RTP

- **RTP is the standard protocol for the transport of real-time data, including audio and video.**
- **RTP follows the application level framing (ALF) philosophy.**
  - **RTP specifies common app functions.**
  - **It is intended to be tailored through modifications and/or additions to the headers (spec'd in companion docs)**
- **RTP consists of a data and a control part. The latter is called RTCP.**
- **The data part of RTP is a thin protocol.**

RTCP

- RTCP provides support for real-time conferencing of groups of any size within an internet.
  - Eg: source identification and support for gateways like audio and video bridges as well as multicast-to-unicast translators.
  - It offers quality-of-service feedback from receivers to the multicast group & synchronization support for media streams.

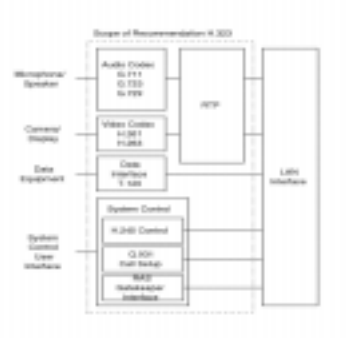
RTP (contd)

- RTP services: payload type identification, sequence numbering, timestamping, delivery monitoring, & optional mixing/translation. UDP for multiplexing and checksum services
- RTP does not provide: mechanisms to ensure quality-of-service, guarantee delivery or prevent out-of-order delivery or loss.
  - RTP sequence numbers allow receiver to reconstruct the sender's packet sequence, or to determine the proper location of a packet, eg, in video decoding, without necessarily decoding packets in sequence.

H.323

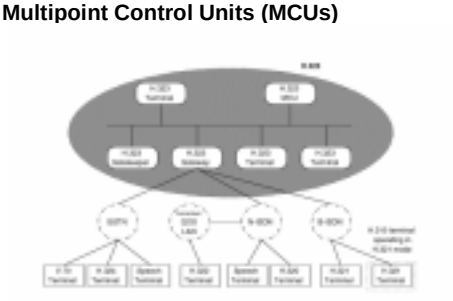
- H.323 is an ITU standard for multimedia communications over best-effort LANs.
- Part of larger set of standards (H.32X) for videoconferencing over data networks.
- H.323 includes both stand-alone devices and embedded personal computer technology as well as point-to-point and multipoint conferences.
- H.323 addresses call control, multimedia management, and bandwidth management as well as interfaces between LANs and other networks.

H.323 Architecture



H.323 (contd)

- **Terminals, Gateways, Gatekeepers, and Multipoint Control Units (MCUs)**



H.323 (contd)

- **Terminals: All terminals must support voice; video and data are optional.**
- **Gateway: an optional element which provides translation functions between H.323 conferencing endpoints (esp for ISDN, PSTN)**
- **Gatekeeper: most important component which provides call control services**
- **Multipoint Control Unit (MCU): supports conferences between three or more endpoints. Consists of a Multipoint Controller (MC) and Multipoint Processors (MP).**

Integrated Services (int-serv)

- Supplement Internet Architecture with:
  - 2 services: guaranteed (delay) service, controlled load service.
  - Resource reservation (signaling) protocol which carries a flowspec from the source and invokes admission control at routers.
  - Shaping at edge nodes combines with packet classification and scheduling/buffer management at routers to provide local delay and bandwidth guarantees.

RSVP

- A signaling protocol: creates and maintains distributed reservation state
- Multicast trees setup by routing protocols, not RSVP (unlike ATM signaling)
- Receiver-initiated: scales for multicast
- Soft-state: time out unless refreshed: robust.
- Latest paths discovered through "PATH" messages and used by RESV mesgs.
- Flowspec: specifies resource to be reserved
- Filterspec: packets which enjoy resvns
- Reservation styles: "wildcard", "fixed-filter", and "dynamic-filter".

Diff-serv motivations

- #1. *Economics* of ISPs (access and transit providers) dictates *need for service differentiation*
  - IP provides just a best effort service
  - TOS is used in a non-standard way, and could be redefined to be more useful
  - Work done in pricing aspects of SLAs did not fit into IP because of a lack of header bits
  - ISPs, not IETF, should define services
    - Some services could be end-to-end, but here IETF would standardize only building blocks

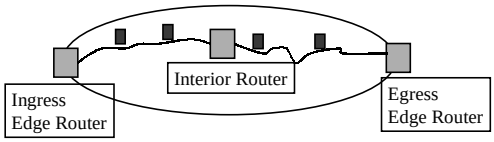
Diff-serv motivations (contd)

- #2. **Diffserv is a considered to be** *crucial building block* **to provide performance assurances** *in IP-based VPNs.*
  - **Other pieces: IPSEC (security & tunneling), L2TP (remote-access tunneling), and RSVP (QoS signaling)**
- #3. *Int-serv/RSVP does not scale*
  - **Diff-serv uses a limited set of "behavior aggregates (BA)"**
  - **Diffserv creates a separation between edge and core routers.**
    - **Move per-flow (possibly non-scalable) data path functions (or MF-classification) to edges.**
    - **Edge handles policy, contracting and billing.**
    - **Interiors may participate in signaling**

Diff-serv motivations (contd)

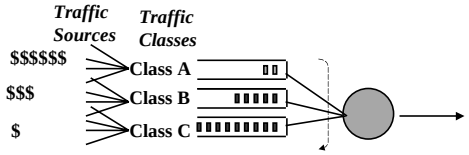
- *Diff-serv must work with IPv4.*
  - **Costs: incompatibility…**
    - **Redefining TOS octet.**
    - **Compatibility w/ RFC 791 (IP precedence)**
    - **New implementation of critical forwarding path as a "per-hop behavior"**
  - **Opportunities: leveraging Internet protocol base**
    - **Vendors: Opportunity for router upgrades**
    - **Small/medium-sized providers: economic necessity.**
    - **Large providers: view diff-serv as an intermediate solution to QoS while waiting for MPLS to integrate ATM, FR facilities and get traffic engineering features.**

Differentiated Services Model



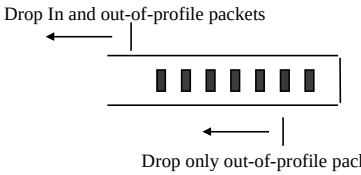
- *Network edge routers:* **traffic conditioning (policing, marking, dropping), SLA negotiation**
  - **Set values in DS-byte based upon negotiated service and observed traffic. Per-flow state.**
- *Interior routers:* **traffic classification and forwarding**
  - **Use DS-byte as index into forwarding table**

Mechanisms: Queuing, Scheduling



- **Use a few bits to indicate which queue (class) a packet goes into (also branded as CoS)**
- **High $$ users get into high priority queues, which are in turn less populated => lower delay and near-zero likelihood of packet drop**

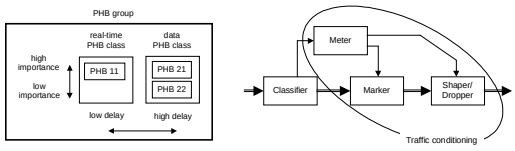
Mechanisms: priority drop



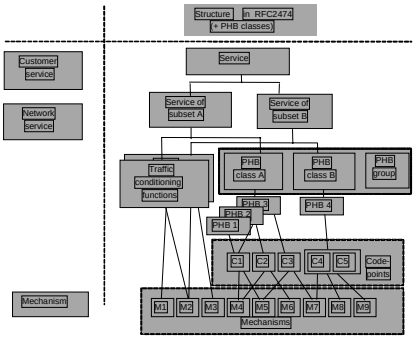
- **RIO: RED w/ preferentially drop of out-of-profile packets when a low threshold is crossed**
- Problem: *Denial-of-service attacks*. **Positive incentive for users to overdrive network by sending useless out-of-profile packets**

Diff-serv building blocks

- *Per-hop Behavior: (PHB)* **generalization of mechanisms applied to a flow in the forwarding path**
- *PHB Group:* **Inter-related PHBs used together to implement a service.**
- *Codepoints:* **Bit combinations in the DS-byte**
- *Mechanisms:* **low level impln of building blocks**
- *Traffic conditioners:* **markers, meters, shapers etc**

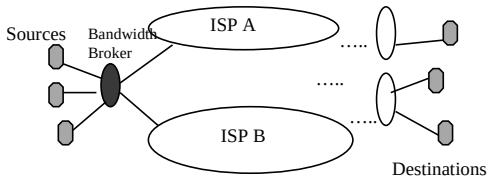


Relation between diff-serv blocks



Pricing architectures (future)

- **Model: Customers use bandwidth brokers to select** *short-term contracts* **from a set of service choices provided by possibly multiple providers.**
- **Providers advertise** *price per unit volume (P)* **of such service levels based upon the** *service class (S),* **a** *congestion-index(z)* **and expected** *demand elasticity (D).*



Missing pieces in diff-serv

- *Provisioning/policy/signaling:* **Assumed to be done using RSVP, COPS, SNMP, LDAP or over-engineering!**
- *Route pinning/multi-paths:* **extensions to OSPF, BGP, QoS routing**
- *Customer monitoring tools*: **??**
- *End-to-end services:* **combination of above pieces: eg: frame-relay emulation, virtual leased line etc**
- **Tools to prevent traffic based denial of service attacks**

Summary

- Real-time transport/middleware: RTP, H.323
- Integrated services: RSVP, 2 services, scheduling, admission control etc
- Diff-serv: edge-routers, core routers; DS byte marking and PHBs
- Missing pieces: routing support (MPLS), pricing models, policy management (COPS)