



A Preferred Service Architecture for Payload Data Flows

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Outline

- Best Effort Service Overview
- Application Requirements
- Quality of Service Mechanisms
- Quality of Service Architectures
- Conclusion - Mission Benefits
- Next Steps



Best Effort Service

- Traditional Internet architecture is “Best Effort”
 - The network puts forth its best effort to forward packets to their destinations in order and without loss
 - All packets are treated the same by the network, regardless of source, destination, or content
- Sometimes best effort isn’t good enough
 - Packets may be dropped due to link congestion, lack of space in the router queue, node or link failures
 - Packets originally transmitted as a steady stream may be received as bursts of packets with irregular arrival times
 - No distinction between “more important” and “less important” traffic
- Different ways developed to cope with these problems
 - TCP takes care of reliability and in-order delivery for a given flow, but at a cost of timeliness
 - Virtual circuit service addresses the link congestion problem, but bandwidth earmarked for a given flow can be wasted if that flow is not using its full allocation



Application Requirements

- Voice
 - May be a live or pre-recorded stream, one-way or bidirectional
 - One-way voice is tolerant of high latency, but intolerant of high jitter
 - Live, two-way voice is less tolerant of high latency (e.g., no real-time phone calls to Mars)
 - Some packet loss is acceptable if it reduces overall jitter
 - Must receive at least a (codec-dependent) minimum amount of bandwidth
- Video
 - Similar characteristics to voice, except video can be more intolerant of packet loss
 - Also higher bandwidth requirements



Application Requirements

- Bulk file transfer
 - Generally tolerant of high latency and jitter, but intolerant of packet loss.
 - Generally high bandwidth requirements
- Instrument command and control
 - Generally lower bandwidth requirements than video and (possibly) voice, but intolerant of packet loss or out-of-order delivery
 - May also have tight latency requirements, but more tolerant of jitter



Quality of Service

- Traffic from all of these applications is multiplexed over a shared set of links
- Solution to provide each application with its required service – Quality of Service (QoS)
 - Allows different types of traffic to receive unequal treatment on the network
- Most often implemented at the network layer, although link-layer QoS is also common



QoS Mechanisms

- Classification
 - Segregating traffic into different classes, which will receive different treatment
 - Traffic can be classified according to fields in the TCP/IP headers
 - Source/Destination IP, port, protocol
 - IP TOS byte
- Queuing
 - Implementing a queue for each traffic class
 - Parameters: number of queues, queue size, discard policy (e.g., drop-tail, random early detection, etc)
- Scheduling
 - Servicing the set of queues according to some priority scheme
 - Common choices: weighted fair queuing, weighted round-robin



QoS Mechanisms

- **Shaping**
 - “Smoothing out” burstiness in incoming traffic
 - Common mechanisms - leaky bucket, token bucket
- **Marking**
 - Identifying traffic that does/does not conform to a specified traffic profile
 - Downstream elements may choose to allow or discard marked traffic
- **Policing**
 - Discarding packets that do not conform to the traffic profile
 - No further questions...



QoS Architectures

- Integrated Services (IntServ)
 - Provides End-to-end QoS control
 - Applications request to reserve resources from the network, and each router along the path between source and destination signal whether the reservation can be supported
 - Operates on a per-flow basis
 - ReSerVation Protocol (RSVP) - Reservation signaling and negotiation protocol
 - PATH messages from sender to receiver say what the sender wants
 - RESV messages from receiver to sender say what the sender can get
 - Drawbacks
 - Complexity of architecture
 - Each router must keep per-flow state
 - Requires symmetric links



QoS Architectures

- Differentiated Services (DiffServ)
 - Traffic is classified into groups labeled with given DiffServ codepoints (DSCPs), indicated in the IP TOS byte
 - Each DSCP specifies a particular per-hop behavior (PHB) to be experienced by the associated traffic
 - PHBs can specify queue management mechanisms, service policies
 - Common PHBs:
 - Expedited Forwarding (EF) - Packets must be serviced at least as fast as they arrive
 - Assured Forwarding (AF) - Less stringent, specifies queue management and drop precedence
 - Advantages:
 - Simplified architecture
 - Routers need only maintain configuration state about each PHB, instead of each flow



QoS Architectures

- **Multi-Protocol Label Switching (MPLS)**
 - Generalization of the Virtual Circuit model - Construct fixed paths through the routing infrastructure
 - Allows arbitrary paths to be constructed to better share load over links
 - MPLS paths need not be the shortest path
 - IP packets are encapsulated in MPLS frames, which indicate the Label-switched path (LSP) that the frame should follow



Putting Everything Together

- Space-based networks will include multiple IP routing nodes connected via RF links
- Can implement QoS features at each (on-board) router
- DiffServ offers simplicity
- Can use MPLS to drive some traffic (e.g., file transfers) traffic to longer but higher-bandwidth paths
- Payload data can be labeled on ingress to router, then scheduled for transmission on the outgoing link
- Different PHBs for voice, video, command and control, and file transfers



Mission Benefits

- Multiple classes of traffic can receive the service they require over a unified network
- Protects mission-critical traffic from being starved of network resources by non-critical traffic
- Scalable architecture
 - Multiple on-board data sources may receive preferential treatment from an on-board router
 - Data from multiple missions may receive preferential treatment by routers in a common backbone infrastructure using the same mechanisms

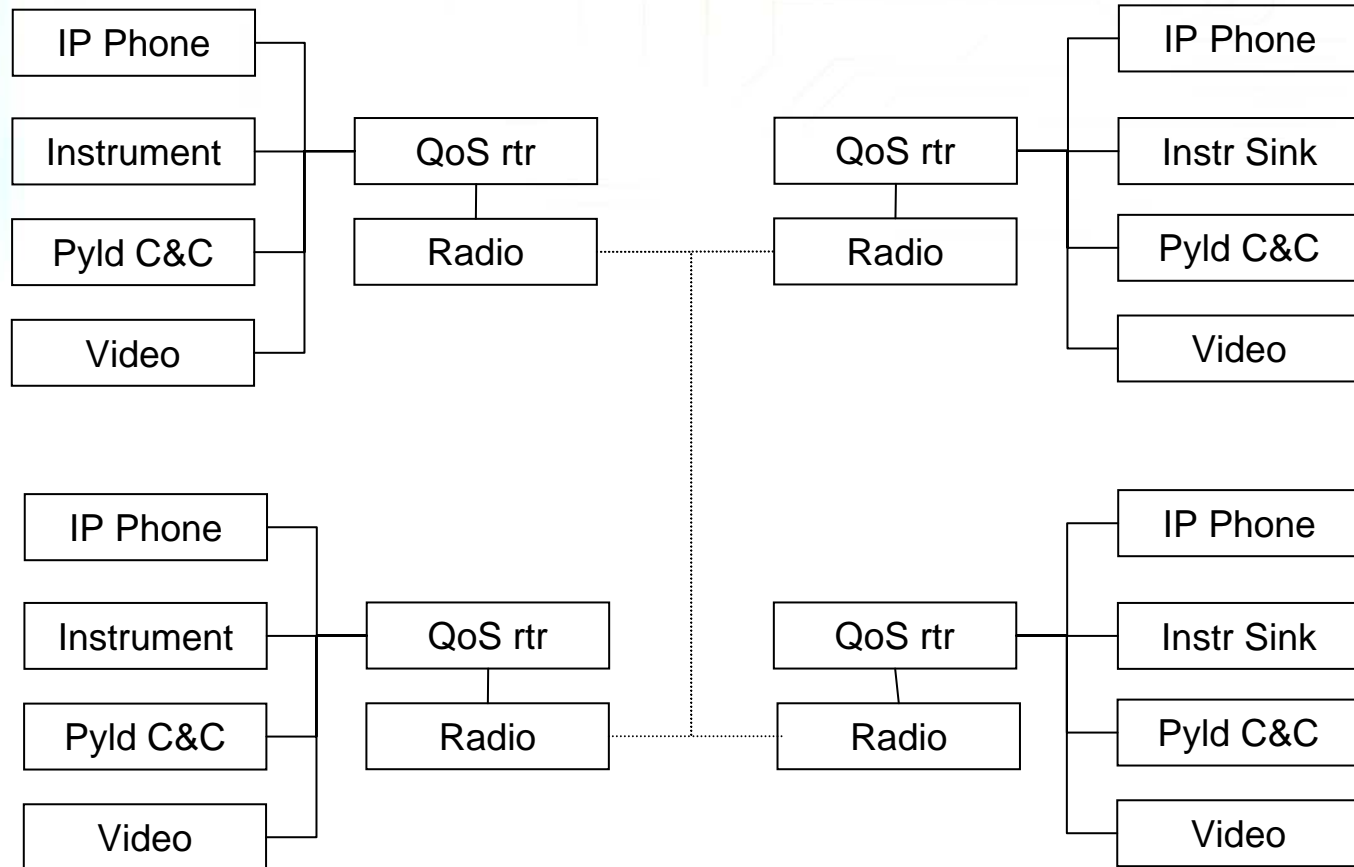


Next Steps

- Empirical study - Implementation of basic QoS architecture in laboratory emulated space environment
 - Linux QoS routers atop SDR-based RF links
- Characterization of application performance under various QoS configurations to determine optimal parameters



Next Steps





A Very Leaky Bucket

