Quality of Service Architectures for Satellite Based Internet

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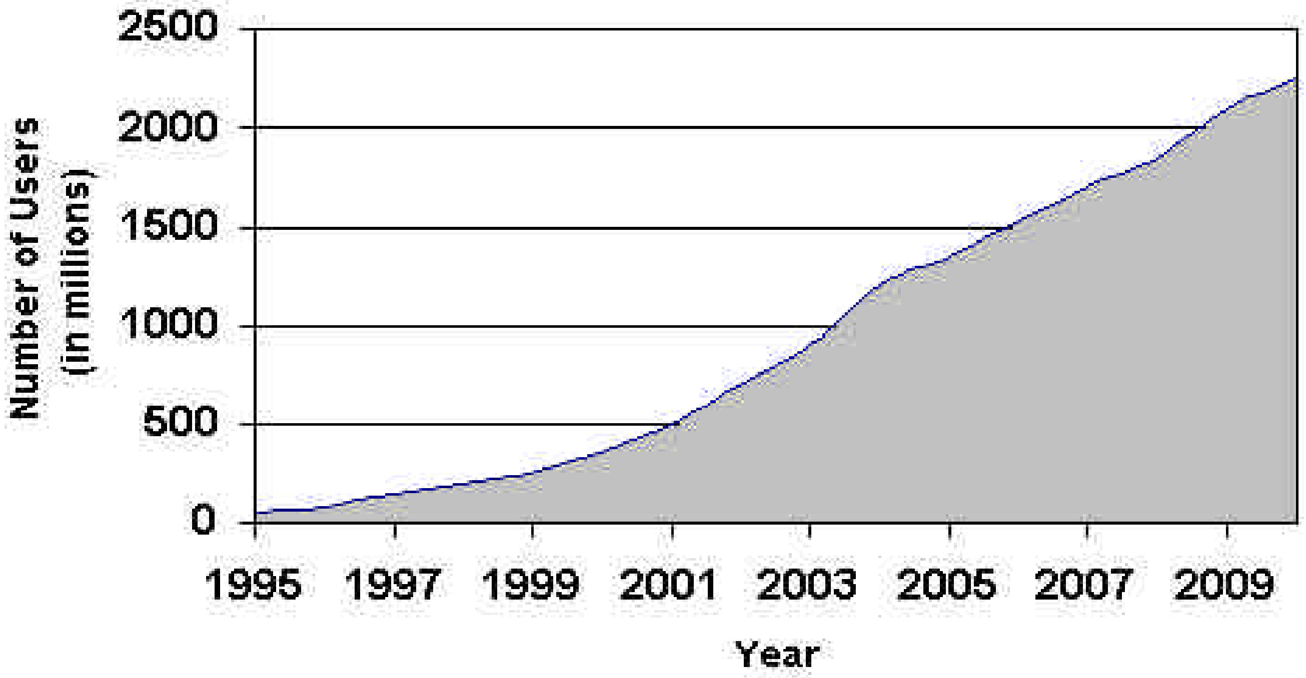
Outline

- Quality of Service Framework
- QoS Objectives
- Proposed Satellite IP QoS Architectures
- Return Channel Multiple Access
- Conclusions

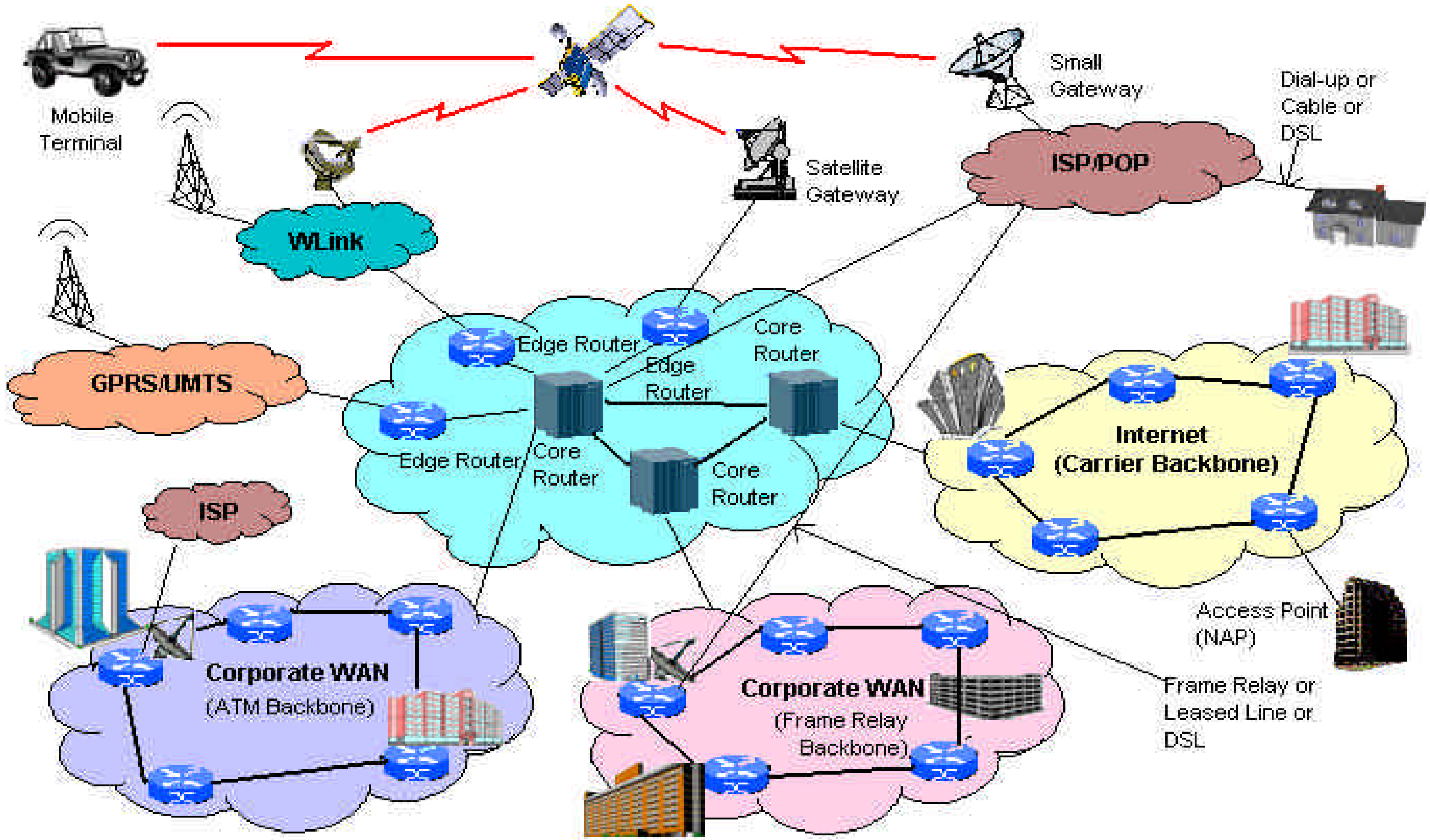
Internet Growth

- 75% of Traffic Web Based
- 3.6 million websites with 300-700 million web pages
- Traffic consists of 80 % data and 20 % voice with traffic growth of 100-1000% per year



Source: Nua Internet Surveys + vgc projections

Global Communication - A Scenario

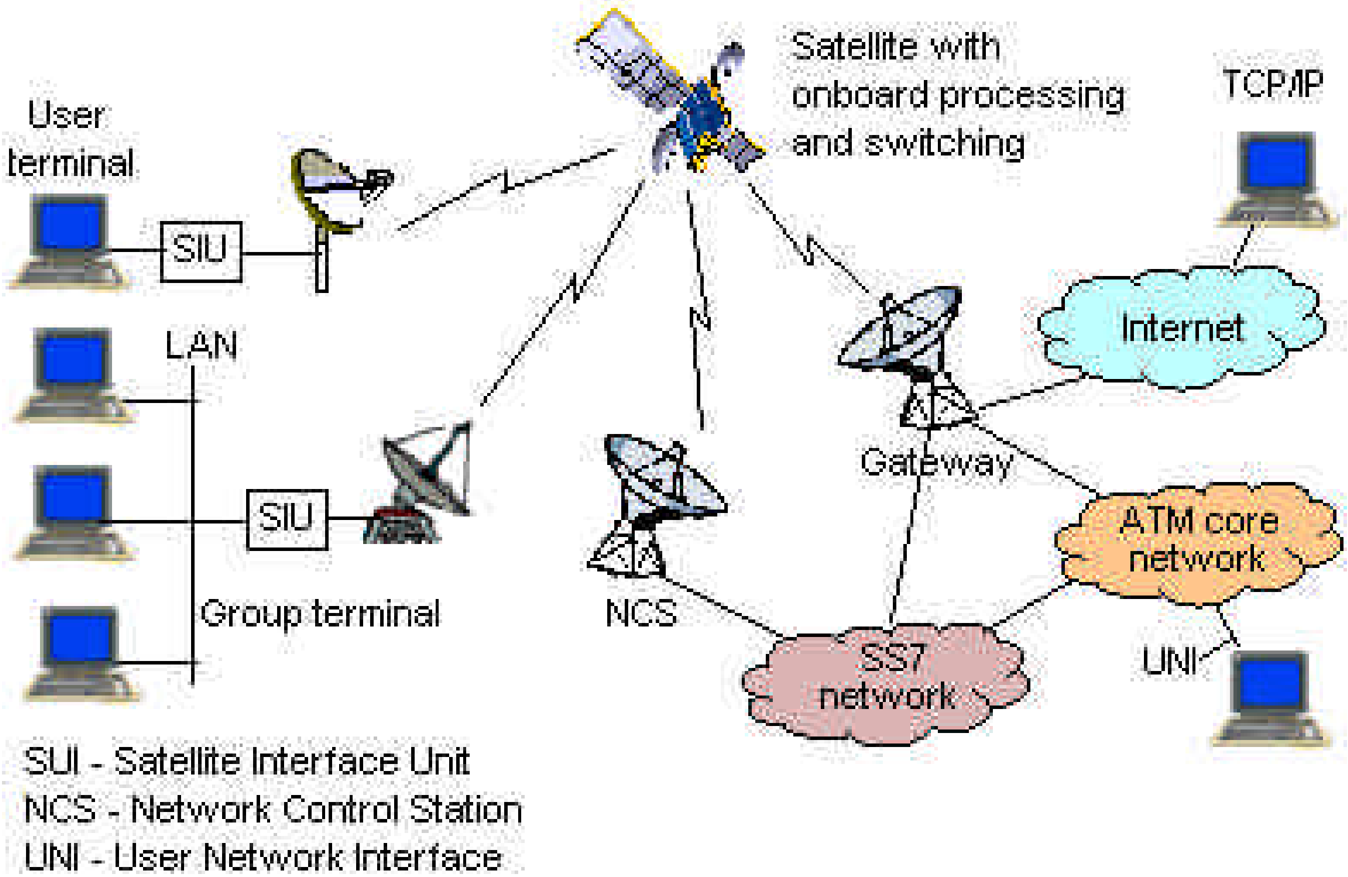


What is the role of satellites in providing broadband Internet access? And how to achieve?

Satellite Internet Access

- **Connectivity Network**: User-to–user connectivity via satellite onboard routing; avoids ground infrastructure complexity
- **Access Network**: Broadband interactive connectivity to the Internet
  - Forward link; network gateway to the user
  - Return link: user to network gateway
- **Satellite Architectural Options**
  - GSO vs.NGSO
  - Onboard processing
  - Onboard processing with ground based cell. ATM or fast packet switching
  - Onboard processing and onboard ATM or fast packet switching
  - Spot beam vs. wide area coverage beam

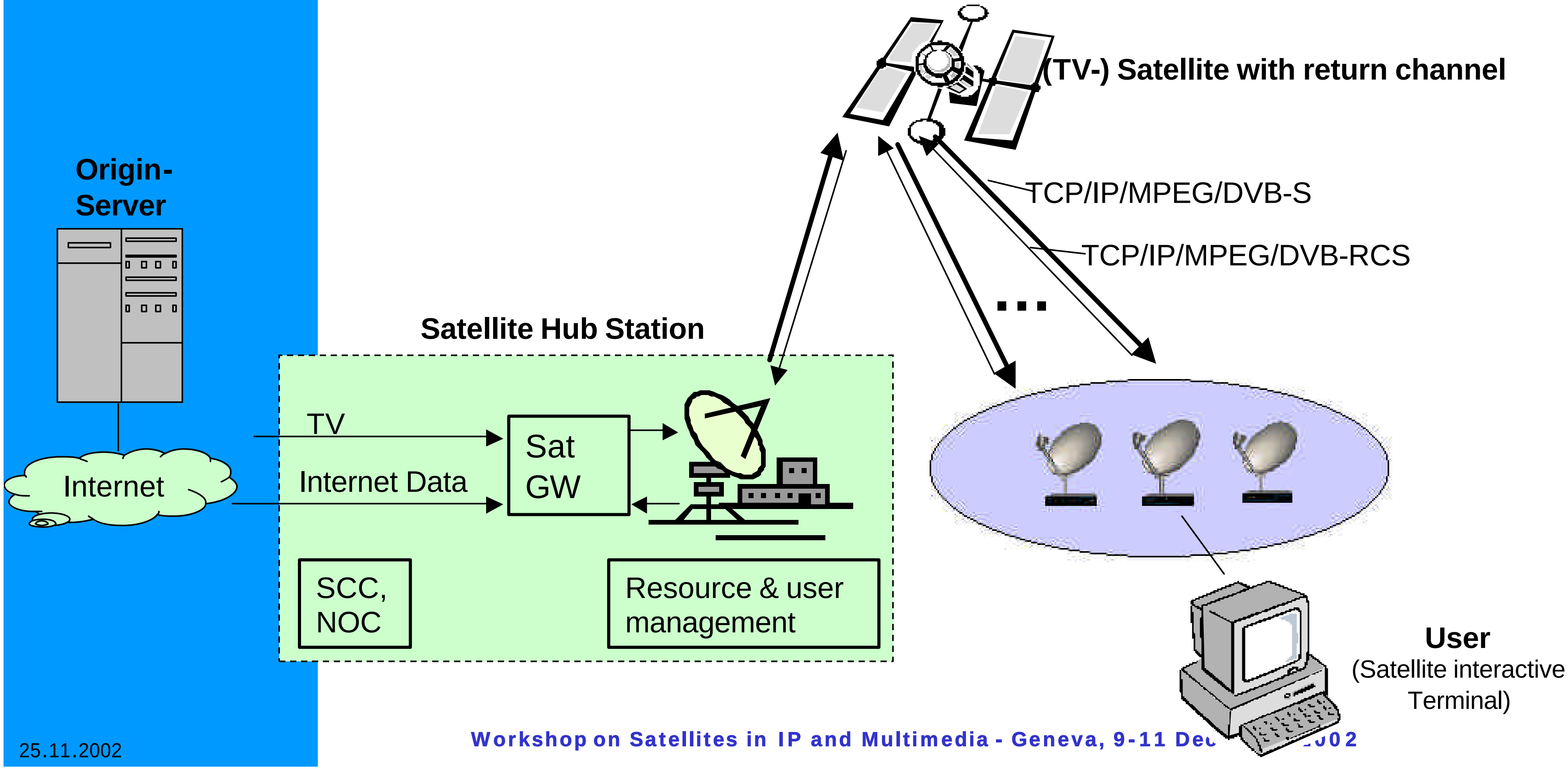
Broadband Satellite Network



- Protocol adaptation
- Fast packet switching or ATM-like switching
- Resource allocation, routing and management
- Connectivity to external networks

Digital Video Broadcasting (DVB) Satellite Network

- ETSI standard for transmission of digital television over cable and satellite.
- Modified to support packet transmission
- Standards exist for transmission of data and network management
- Uses a fixed length packet or cell of 188 bytes



What is Quality of Service (QoS)?

- Ability of a network element to have some level of assurance that its traffic and service requirements can be satisfied.

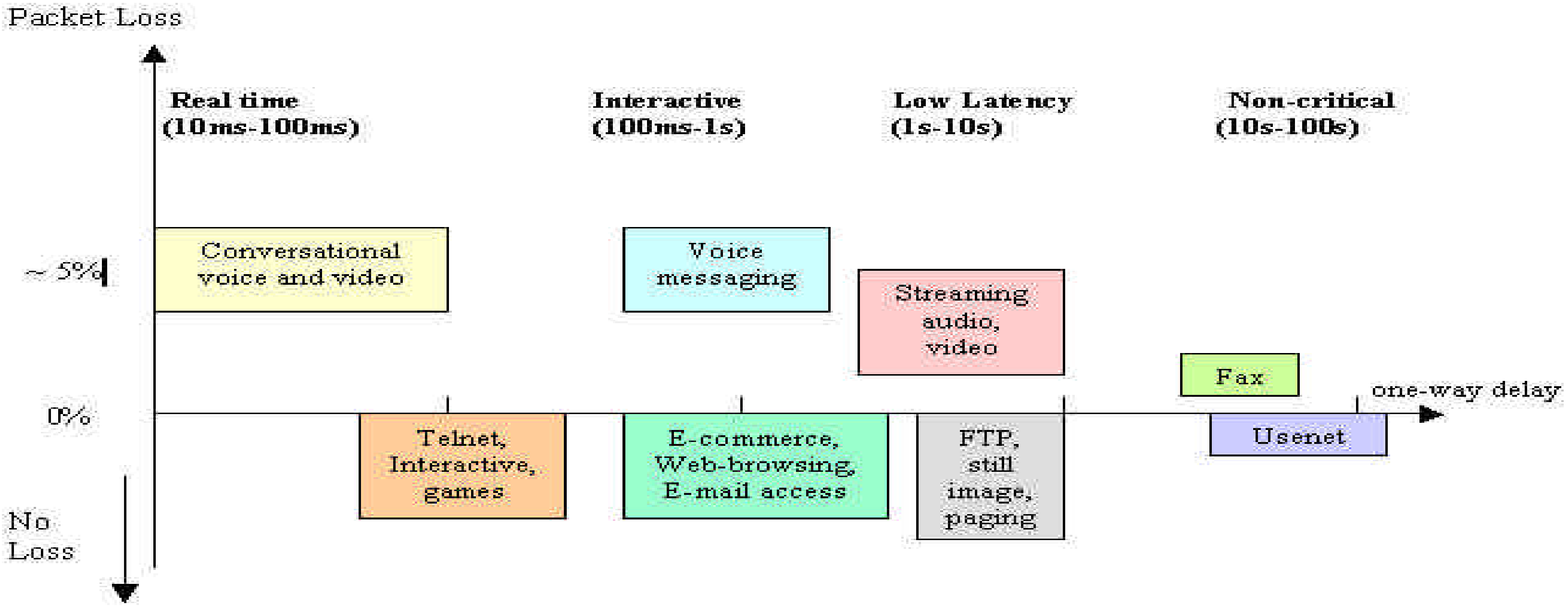
- Requires cooperation of all network layers and every network element

- ISO 8402 QoS definition
  - “the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs.”

- ITU-T Recommendation E.800 QoS definition
  - “the collective effect of service performance which determine the degree of satisfaction of a user of the service”

- ITU-T Recommendations on QoS
  - ITU-T I.350 and ITU-T Y.1540 - network performance and network interface-to-network interface QoS.
  - ITU-T Y.1541 - 6 classes of applications and application QoS objectives

QoS Requirements Example- ITU-T G.1010



- Throughput: Effective data rate
- Delay: Time taken to transport data from source to destination
- Delay Variation: Due to processing and queuing
- Packet loss: Due to congestion, error conditions, and link outages
- Reliability: Percentage of network availability

ITU-T Y.1541

Provisional IP QoS Class Definitions and Network Performance Objectives

Network Perfor-mance Para-meter	Nature of Network Performance Objective	Class 0	Class 1	Class 2	Class 3	Class 4	Class 5 (Unspecified)
IPTD	Upper bound on the mean IPTD	100 ms	400 ms	100 ms	400 ms	1 s	U
IPDV	Upper bound on $1-10^{-3}$ quantile of IPTD minus the minimum IPTD	50 ms	50 ms	U	U	U	U
IPLR	Upper bound on the packet loss probability	1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}	U
IPER	Upper bound	1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}	U

Satellite IP QoS – Fundamental Issues

- IP QoS architectures and objectives are influenced by proper selection of the following
  - **Services and applications**
  - **Transport layer protocols**
  - **Security algorithms**
  - **Flow and congestion control**
  - **Buffering and queue management - drop policies**
  - **Multicasting protocols**
  - **Routing and addressing schemes**
  - **Media Access Control protocols**
  - **Bandwidth allocation and bandwidth-on-demand algorithms**
  - **Interfaces, protocols, air interfaces**
  - **Interoperability networks and policies**
  - **Network control and management**

Network QoS Components

- Packet Processing
  - Classification, Queuing and Scheduling
  - Shaping, Policing. Marking
- Routing and Traffic Engineering
  - QoS Based Routing
  - Explicit Path Control (IP Tunnels, MPLS)
- Signaling
  - Network signaling
  - End System Signaling
- Policies, Authentication, Billing

QoS-Mechanisms for Terrestrial Networks

- **Integrated Services: IntServ**
  - End-to-End QoS guarantees for individual flows
  - End-to-End signaling of traffic parameters service type and QoS (RSVP)
  - Issues
    - Scalability Concern—Number of flows and per flow packet processing
    - Limited deployment of IntServ-aware applications
- **Differentiated Services: DiffServ**
  - Scalable solution on coarse QoS service class and simple packet forwarding
  - Service classes identified by DiffServ Code Points (DSCP) in packet header
  - Ingress nodes perform policing and masking, Egress nodes perform shaping—All nodes implement appropriate DiffServ Per-Hop Behaviors (PHB)

IntServ - RFC 2205, 2381

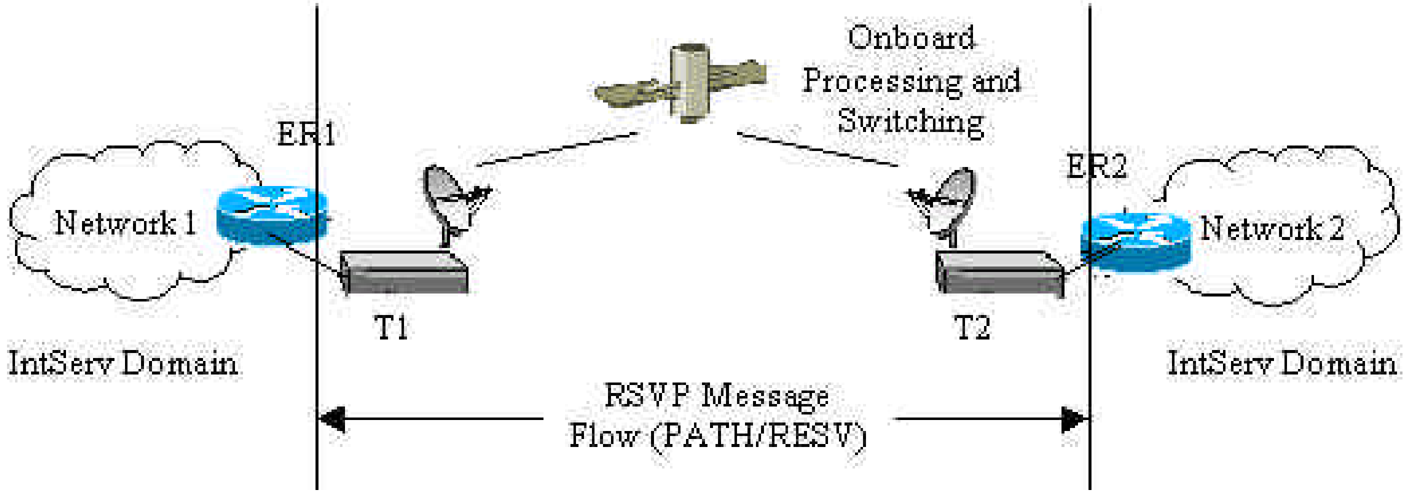
DiffServ - RFC 2474, 2475

QoS-Mechanisms for Terrestrial Networks Cont'd

- MultiProtocol Label Switching (MPLS)
  - Simplify Mechanisms of Packet Processing with Core Routers
  - Capability to Reduce Amount of Routing Information By Stream Merging
  - Capability to Produce an Efficient Tunneling Mechanism that can be Used for Traffic Engineering or VPNs
  - Packet Forwarding is based on "Labels" in MPLS Header
  - Label Switched Paths established by Signaling

MPLS - RFC 2702, 3031

Satellite QoS Architecture - IntServ

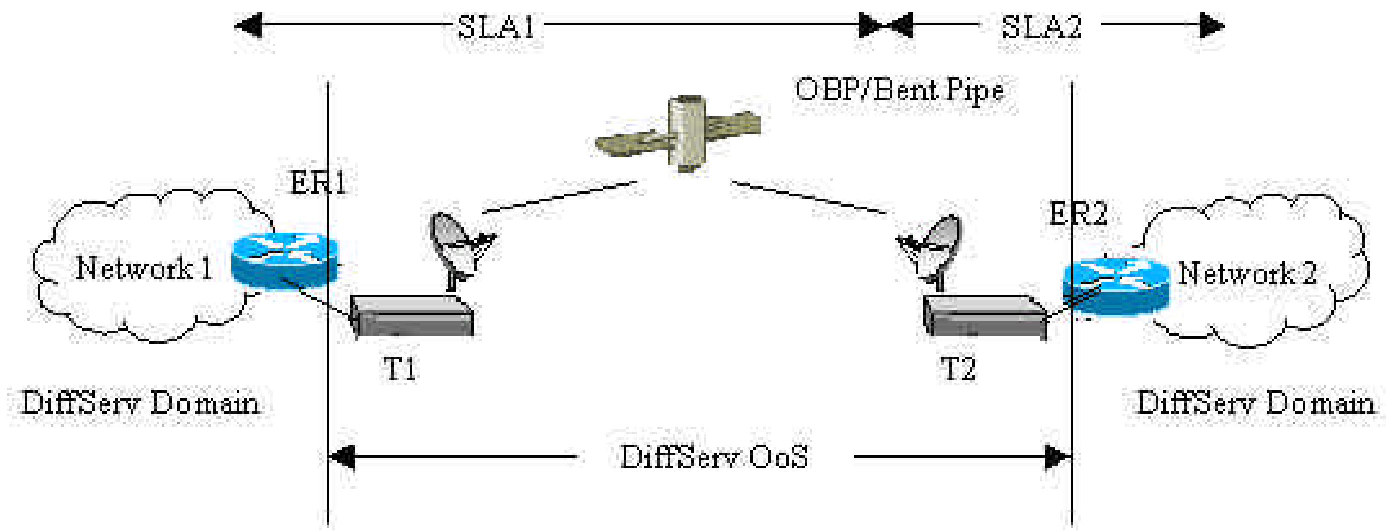


- Network 1 and network 2 support only IntServ.
- RSVP messages flow between network 1 and network 2.
- T1 and T2
  - RSVP aware to support end-to-end satellite IP QoS
  - process the PATH and RESV messages and perform admission control.
  - have to accept or reject RESV requests.
- Edge routers perform multi-field flow classifications, maintain flow state.

Feasible for satellites because packets bypass several terrestrial routers.

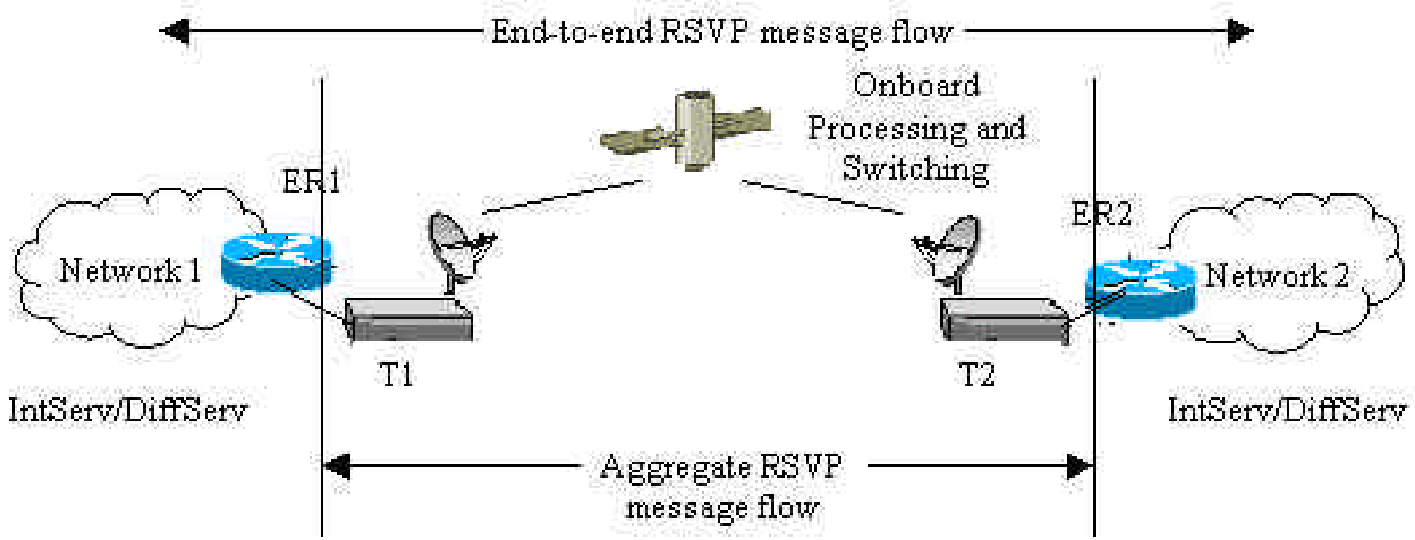
ITU-R 4B/086

Satellite QoS Architecture - DiffServ



- **Global satellite network**
  - End-to-end QoS achieved based on DiffServ at the access and core network
  - Assumed that a DiffServ SLA exists between network 1 and 2
  - T1 and T2 are also DiffServ capable and able to read the DSCPs in the packet headers
- **Access Satellite Network**
  - Network ISP and gateway support DiffServ
  - A DiffServ SLA1 exists between network 1 and gateway; SLA2 exists between gateway and ISP
  - Network 1 and ISP are not aware of each other's IP QoS
  - Network 1 and gateway are DiffServ capable

Satellite QoS Architecture - IntServ/DiffServ



- **Global Satellite Network**
  - Network 1 & 2 are IntServ capable and core network supports DiffServ
  - End-to-end RSVP messages flow between network 1 & 2
  - Aggregate RSVP messages flow between edge routers ER1 & ER2
  - End-to-end RSVP messages indicates that DSCP should be used for each flow
  - N1 & N2 must be DiffServ capable for flow classification and aggregate RSVP capable for signaling

These architectures must be evaluated for application QoS levels.

Return Channel Multiple Access

- TDMA-based DVB-RCS standard specifies bandwidth allocation mechanisms[(1)]
  - Continuous Rate Assignments (CRA)
  - Rate Based Dynamic Capacity (RBDC)
  - Volume Based Dynamic Capacity (VBDC)
  - Free Capacity Assignment (FCA)
- CDMA-based alternative[(2)]
  - Use of a unique code similar to Aloha reduces probability of collisions
  - Spread ALOHA One Code (SAOC) repeats the code or spread sequence every symbol
  - Spread ALOHA One Long Code (SALOC) uses single long code as long as the packet
  - Throughput performance analysis

(1) ETSI EN 301 790, v1.2.2 (2000-12)

(2) Kota S et.al (2002) Spread ALOHA Multiple Access for Broadband Satellite Return Channel. 20th AIAA ICSSC, Montreal, Canada, AIAA-2002-1918.

Conclusions

- QoS is a critical element for successful satellite broadband IP.
- Application specific QoS objectives are required for global and access satellite networks.
- Further analysis and tests for QoS architecture options for satellite IP must be performed.
- Liaison activities with other organizations e.g., ITU-T, IETF, ETSI and TIA.