Adaptive Application-Level QoS Management Technique for Multimedia Traffic

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Introduction

- Internet Traffic
  - non real-time traffic [ftp, telnet, mail, snmp, …]
  - real-time traffic [VOD, AOD, …]
- Multimedia applications over TCP/IP-based Intranet or Internet have become popular
- Current Internet Service
  - Connectionless service in IP Layer
  - TCP/IP based Best-Effort routing scheme
  - data transmission using TCP or UDP
  - Flow, congestion control for only TCP packet
- Current network structure is not sufficient for real-time multimedia traffic.
  - can not use TCP flow & congestion control
  - no consideration about time-critical data delivery

Introduction

- How to cope with multimedia traffic on current best-effort based Internet?
- How to change current Internet to deal with real-time traffic well?
- How to guarantee Quality of Service (QoS) of multimedia traffic?
- How to support various requirements for multimedia data of end-users?

Related Work

- Change current Internet structure for QoS deployment
  - RSVP [RFC2205, RFC2208, RFC22096]
  - diffserv [RFC2474, RFC2475,...]
  - intserv [RFC2211, RFC2212, RFC2213]
  - traffic shaping and apply policy to network traffic
- The flow and congestion control for multimedia traffic on current TCP/IP based Internet
  - Recovery from Error Spread using Continuous Update (REACU) [NCSU]
  - Forward Error Correction (FEC)
- The above related work concentrates on network & transport layers, but our work concentrates above the transport layer

QoS for Multimedia Traffic

- Characteristics
  - constant bandwidth
  - soft real-time traffic with transmission time limit
  - capture, encode, compress, transmit [in sender part]
  - receive , decompress, decode, play out [in receiver part]
  - Different style of congestion and flow control is needed for these MM traffic.
- QoS evaluation factors in network level
  - delay, jitter, loss, throughput
- It is also important that Application-Level QoS parameter is guaranteed.

Problem

- There are various users' requirements for multimedia data quality. For example:
  - The size of video must be CIF form.
  - My audio must be radio quality and stereo.
- It is impossible to guarantee these application-level QoS in current distributed multimedia applications.
  - Constant bandwidth is not guaranteed to a single connection.
  - Flow and congestion control for multimedia traffic does not exist.
- How to guarantee the users' requirements and flow and congestion control for multimedia traffic on current internet environment?

⇨ Application-level QoS management is needed !

How to solve this problem

- Application-level QoS management system for distributed multimedia applications

- The Requirements of this system
  - can satisfy the user's various needs
  - can define the QoS parameter which can be changed by user
  - can guarantee the desired QoS in the current network environment
  - can use the network resources with other application fairly
  - can analysis the current network status and adapt properly to the situation

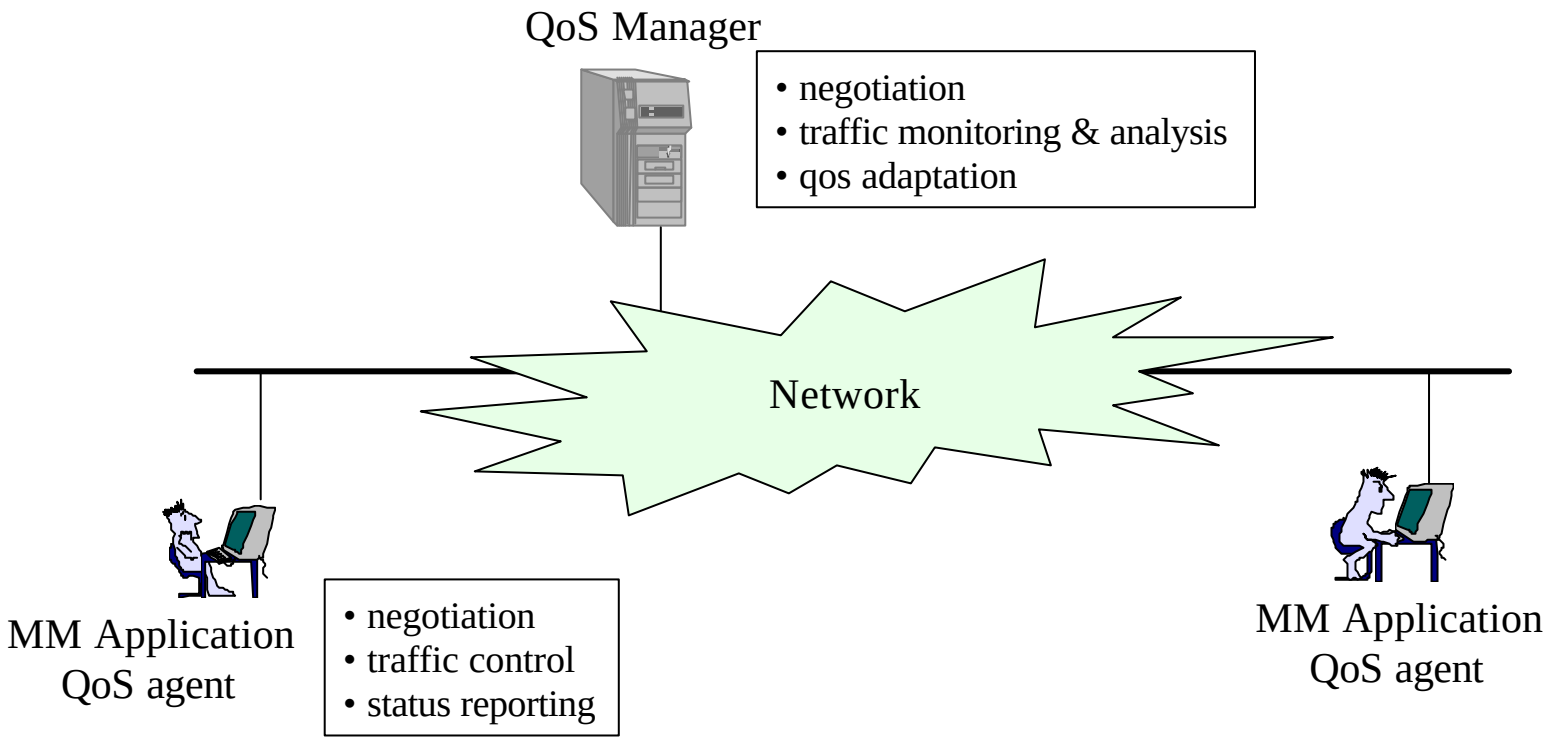
QoS Parameters at Application Level

- The variables which have an effect on the required network bandwidth
- Video
  - frame rate (frame/sec)
  - precision (bit/pixel)
  - resolution (pixel x pixel)
  - encoding/decoding method (Raw, H.261, H.263, CellB)
- Audio
  - sampling rate (Hz/sec)
  - channel (mono, stereo)
  - precision (bits/sample)
  - encoding method (PCM, ADPCM:G.721, G.723)

QoS Management Functions

- QoS negotiation
  - set application level QoS parameters.
- Multimedia Traffic Monitoring
  - monitor current QoS guaranteed rate by loss.
- QoS Adaptation
  - determine proper bandwidth for current application
  - change application-level QoS parameter

System Layout



QoS Negotiation

- Control sender's encoding method and bandwidth
- Initial negotiation
  - before stream transmission
  - with QoS parameter
  - by sender and receiver manually or by default set up value
- QoS re-negotiation
  - static negotiation
  - same as initial negotiation
  - during data transmission
  - by sender and receiver manually

MM Traffic Monitoring

- In Sender part
  - encoding rate
    - frame rate, sampling rate
  - transmission rate
- In Receiver part
  - latency (transmission delay)
  - transmission rate
  - loss rate / retransmission rate
  - delay-jitter
- monitoring protocol
  - real-time transport protocol (RTP/RTCP)
  - data transmission between sender and receiver using RTP.

QoS Adaptation

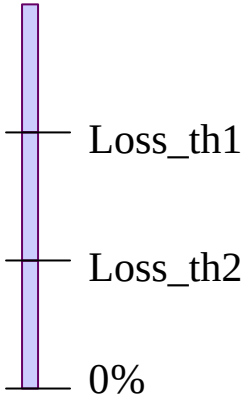
- QoS mapping between application level and network level
  - user level parameter
  - network level parameter [bandwidth, loss rate]
- QoS threshold
  - bandwidth threshold
  - loss threshold (Loss_th1, Loss_th2)
  - time(T_th)
- determine proper application-level parameters according to the current traffic status

QoS Adaptation Scheme

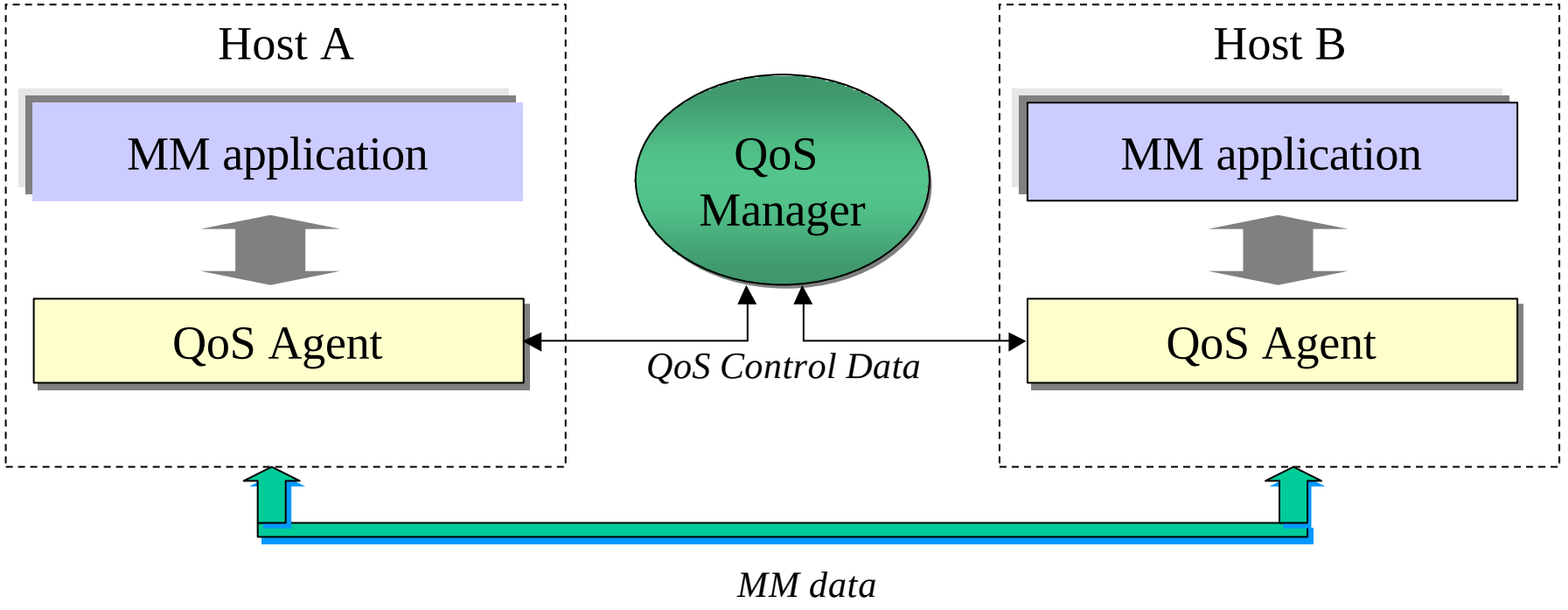
- Desired Bandwidth
  - $D_{audio} = A_s * A_c * A_p * A_e$
  - $D_{video} = V_f * V_p * V_r * V_e$
  - $D_{total} = D_{audio} + D_{video}$
- parameter priority in ascending order
  - video < audio
  - $V_f < V_p < V_r < V_e$, $A_s < A_c < A_p < A_e$

A_s : audio sampling rate
A_c : audio channel
A_p : audio precision
A_e : audio encoding method
V_f : video frame rate
V_r : video resolution
V_p : video precision
V_e : video encoding method
T_{trans} : transmission time

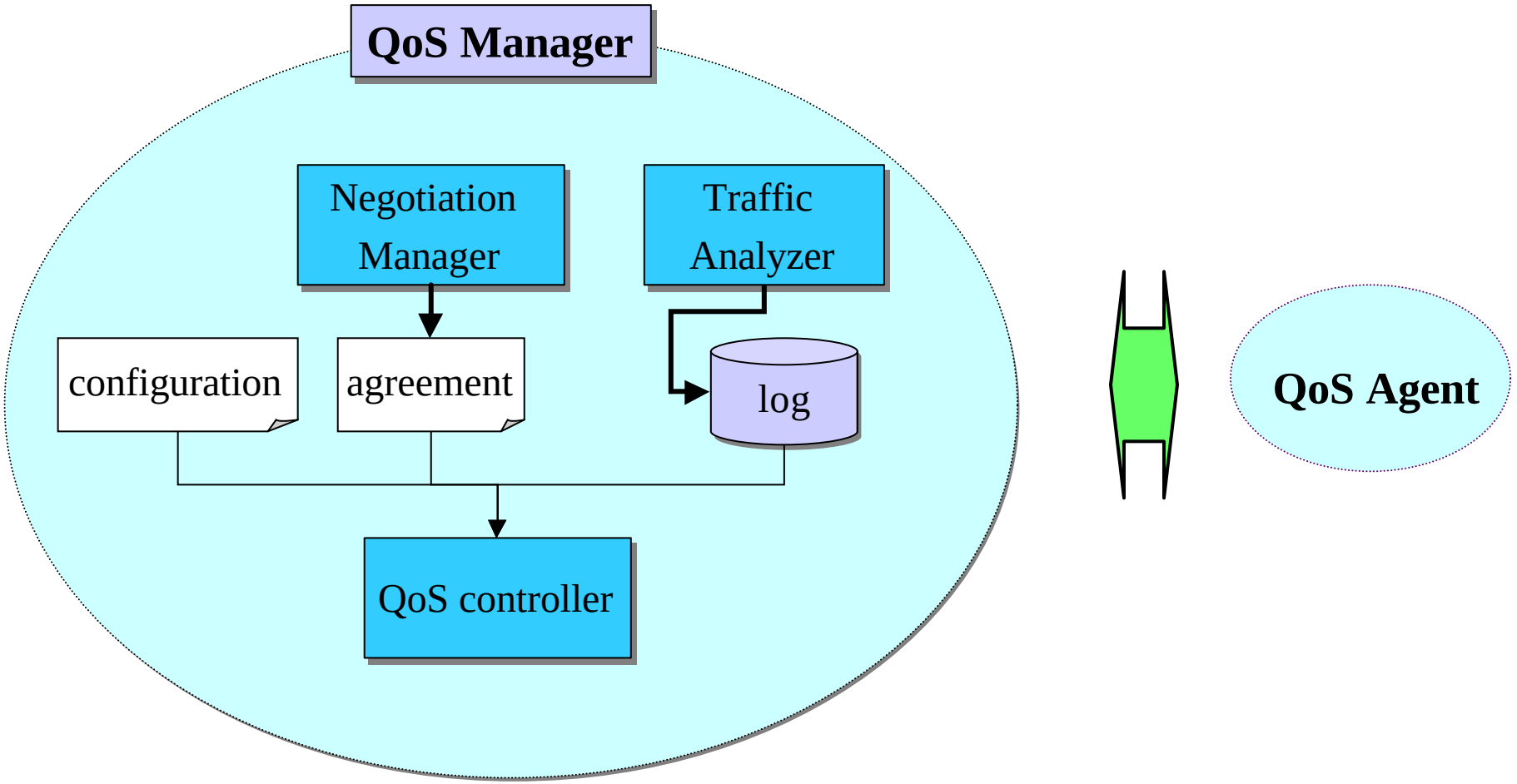
```
If ( Loss_c >= Loss_th1 )
        decrease bandwidth by assign a new value to a user parameter;
else if ( Loss_c <= Loss_th2 && Dcurrent < Dtotal && ? T > T_th)
        increase bandwidth by assign a new value to a user parameter;
else if (T_current > 0 && Loss_c >Loss_th2)
        T_start = 0;
```



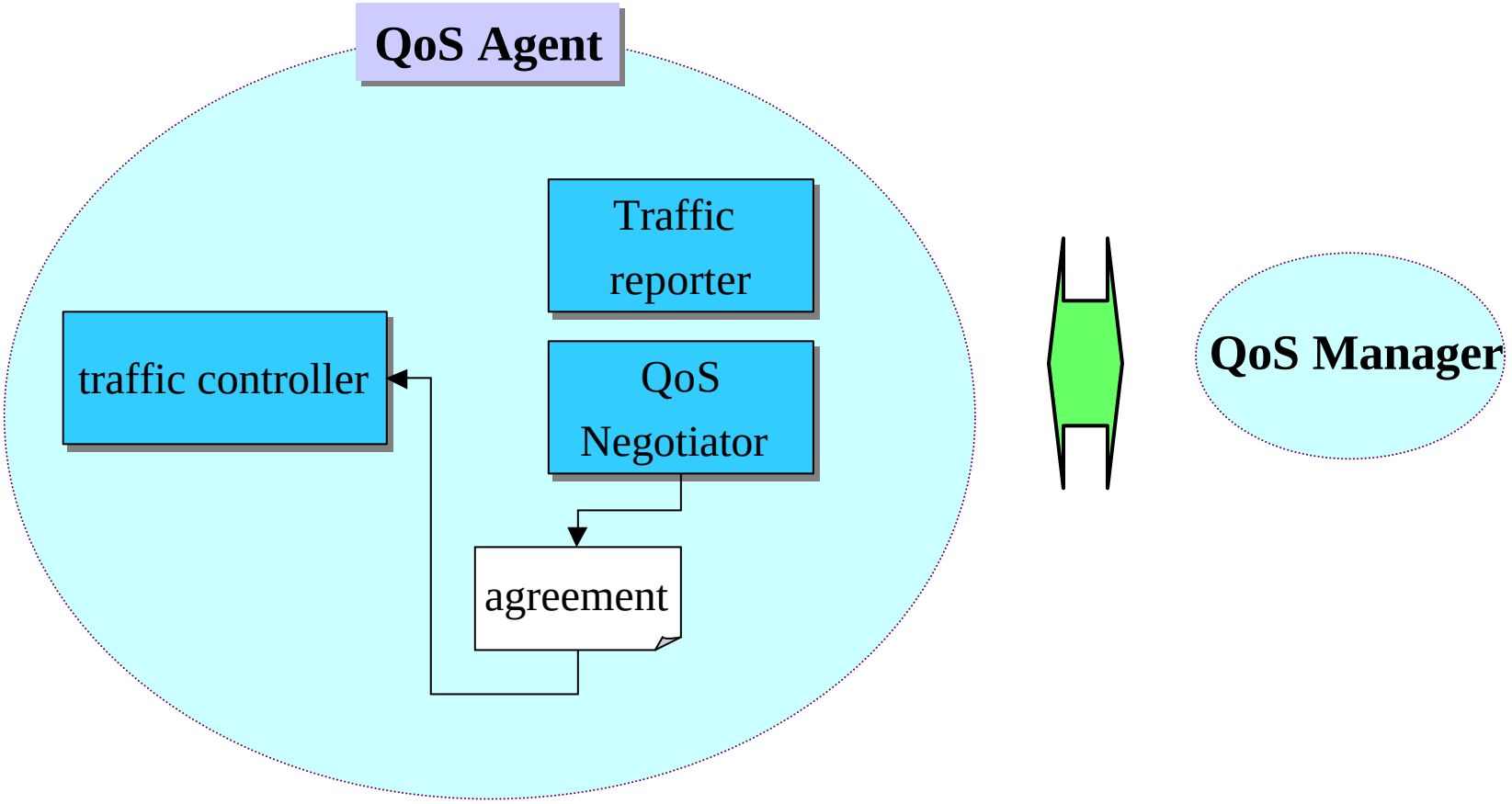
Management Architecture



QoS Manager


QoS Manager
Negotiation Manager
Traffic Analyzer
configuration
agreement
log
QoS controller
QoS Agent

QoS Agent

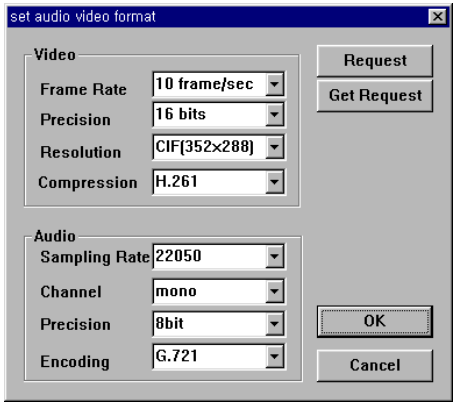

QoS Agent
Traffic reporter
traffic controller
QoS Negotiator
agreement
QoS Manager

Implementation

- Environment

	QoS Manager	*QoS Agent*
Machine type	Sun enterprise server 450	Pentium II 266MHz
Operating System	Solaris 2.6	Windows 95
CORBA	Orbix 2.3_MT solaris version	Orbix 2.3c windows version
Compiler	Sun C++ compiler 4.2	Visual C++ 6.0
Video capture card		Ospery-1000

- Implementation



QoS parameter setting

Video/Audio conferencing

Conclusion and Future Work

- A technique to support user's various requirements and congestion and flow control for multimedia traffic transmission.
- proposed an Adaptive Application-Level QoS Technique and Management System for Multimedia Traffic
  - QoS manager
  - QoS agent
  - Application-Level QoS parameter

- Future Work
  - determination of appropriate loss and time threshold by experimentation
  - transmission to more than two receivers.
  - Error recovery