Adaptation of Collaborative Applications for Network Quality Variation

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Outline

- Introduction
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  - Quality of service
  - Collaborative environment
- Effect of partial resource reservation – An Experiment
- An architecture for exporting network awareness to support application adaptation
- Enhancing NetMeeting with network awareness
- Conclusions

Deployed Military Headquarters

- Information and Communication Technology
  - Enable new level of collaboration and communication to battlefield
- Information Systems in headquarters
  - Essential part of military operations
  - Critical capability to collect, process, and distribute relevant date to remote locations
  - Allow military force to gain battlefield situation awareness

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The Challenges

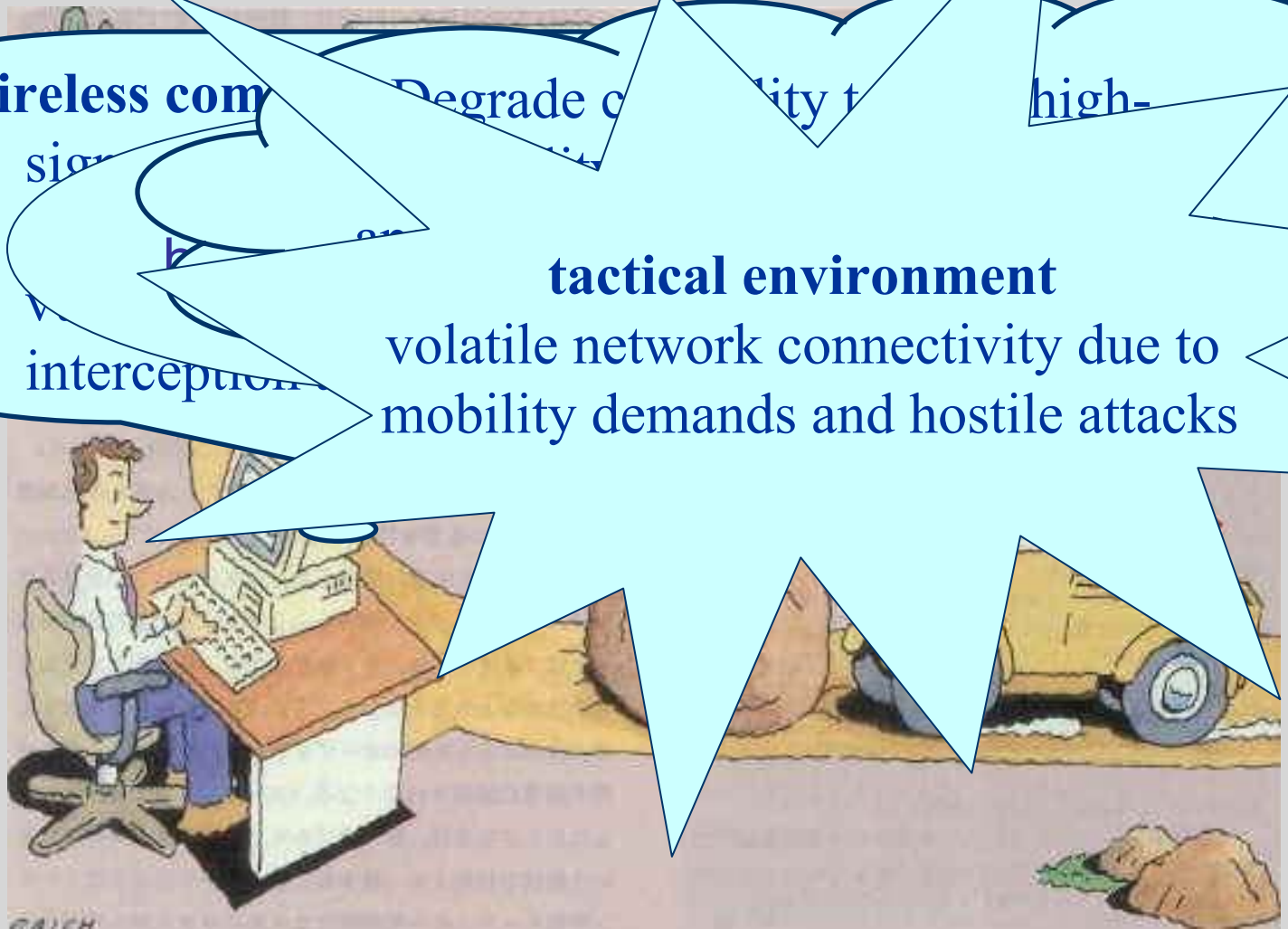
Wireless com

- sig
- interception

Degrade c ity t high-

tactical environment

volatile network connectivity due to mobility demands and hostile attacks



Quality of Service

- Network requirement to guarantee performance and stability of application
  - imposes bounds and limits (end-to-end delay, data rate, error rate and their variances)
- Conventional Data loss recovery schemes
  - Go-Back-N ARQ, Selective Repeat ARQ
  - Solve problem at data link layer but greater variations in delay
  - Can hardly satisfy requirement of real-time traffic

QoS at Network Layer

- Integrated Services (IntServ)
  - manage network resources using resource reservation and admission control for individual data flows
- Differentiated Services (DiffServ)
  - classify individual IP packets with similar QoS requirements into service categories
- Network layer QoS mechanisms
  - to deal with congestion loss and queuing effects
  - Not to deal with packet loss due to link errors

Dynamic Environment

- Network dynamics attributed to variable link characteristics and node movement
- Network topology changes due to node movement
- Variable demands on network resources by end-system applications
- Frequent traffic pattern shift due to periodic mission re-assignments
- Need a system that can adapt to dynamic network conditions

Collaborative Environment

- Provide integrated audio, video, document, data and application sharing
- Often developed for moderately capable networks
- Key aspect is establishing common ground by sharing information through any media
- Lack of significant differences on quality (audio only, or both video and audio)
- Similar information effectiveness (voice, collaborative tool, or both)
- Feasible to exploit any channels for information sharing (eg video downgrade to voice or email)

Effect of Partial Resource Reservation

- Guarantee service assumes every router supports resource reservation
- Large-scale network (eg Internet)
  - Support for QoS not always available
  - Those not supporting resource reservation simply ignore QoS requests or reroute packets
  - Cannot guarantee end-to-end quality service based entirely on resource reservation approach

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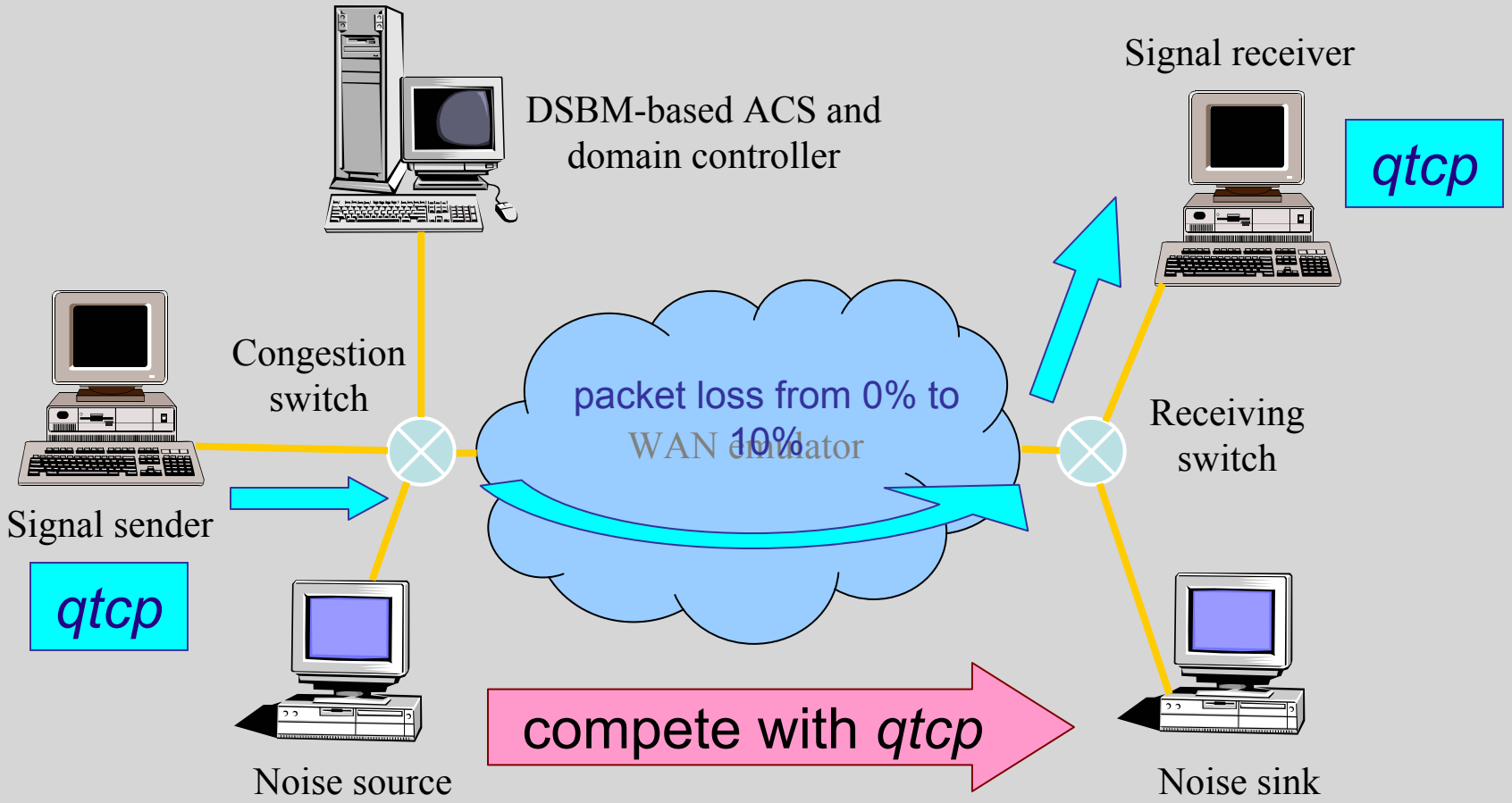
An Experiment



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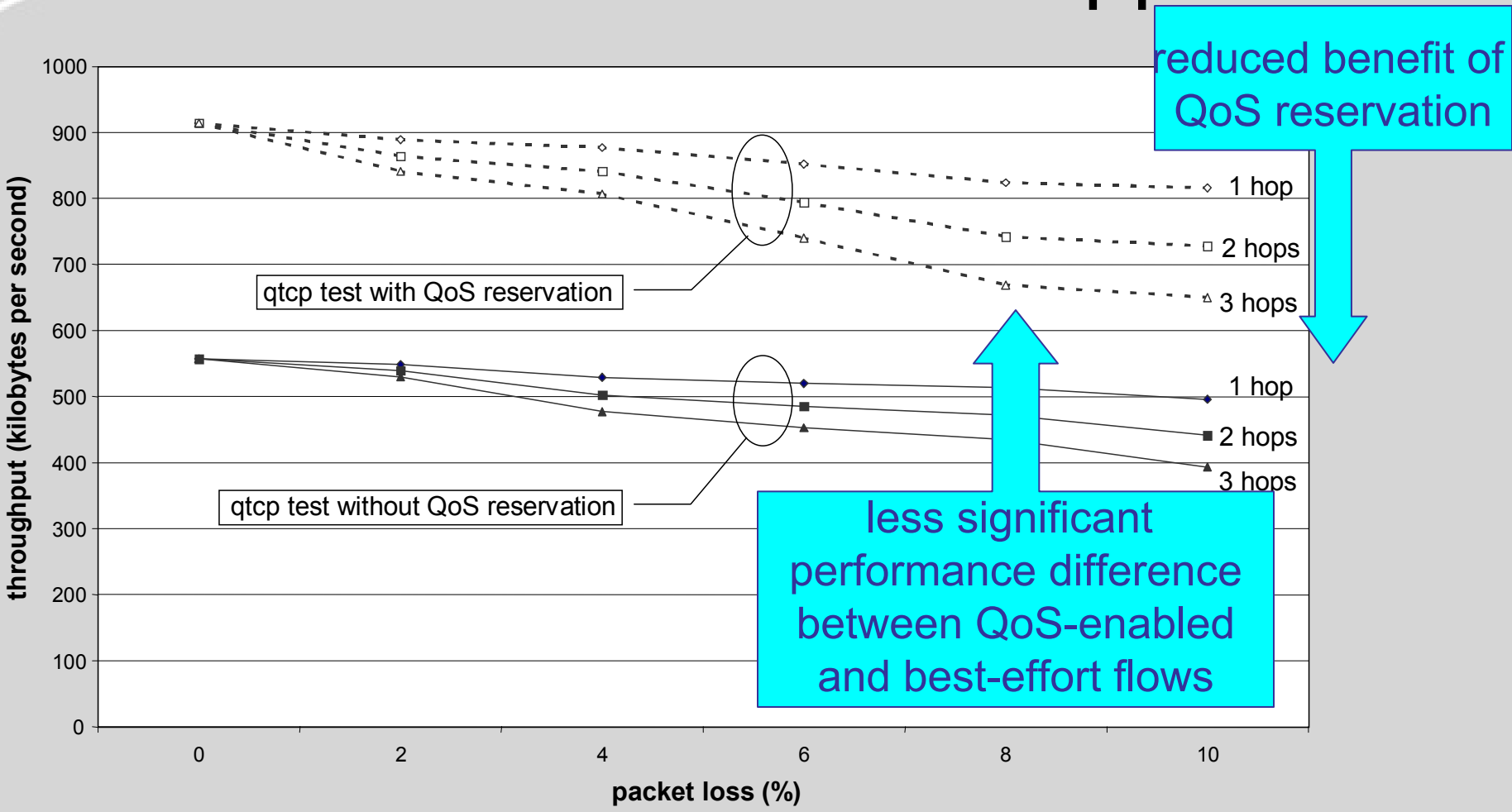
Effect of Partial QoS Support



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An Architecture for Exporting Network Awareness

- Notify applications of changes in network state
- Applications to dynamically upgrade or gracefully degrade in response
- Network detection and adaptation strategies implemented in middleware
  - Reusability by other applications
  - Separation of concern between functional and environment-specific aspects
  - Achieve application portability by encapsulating platform peculiarities

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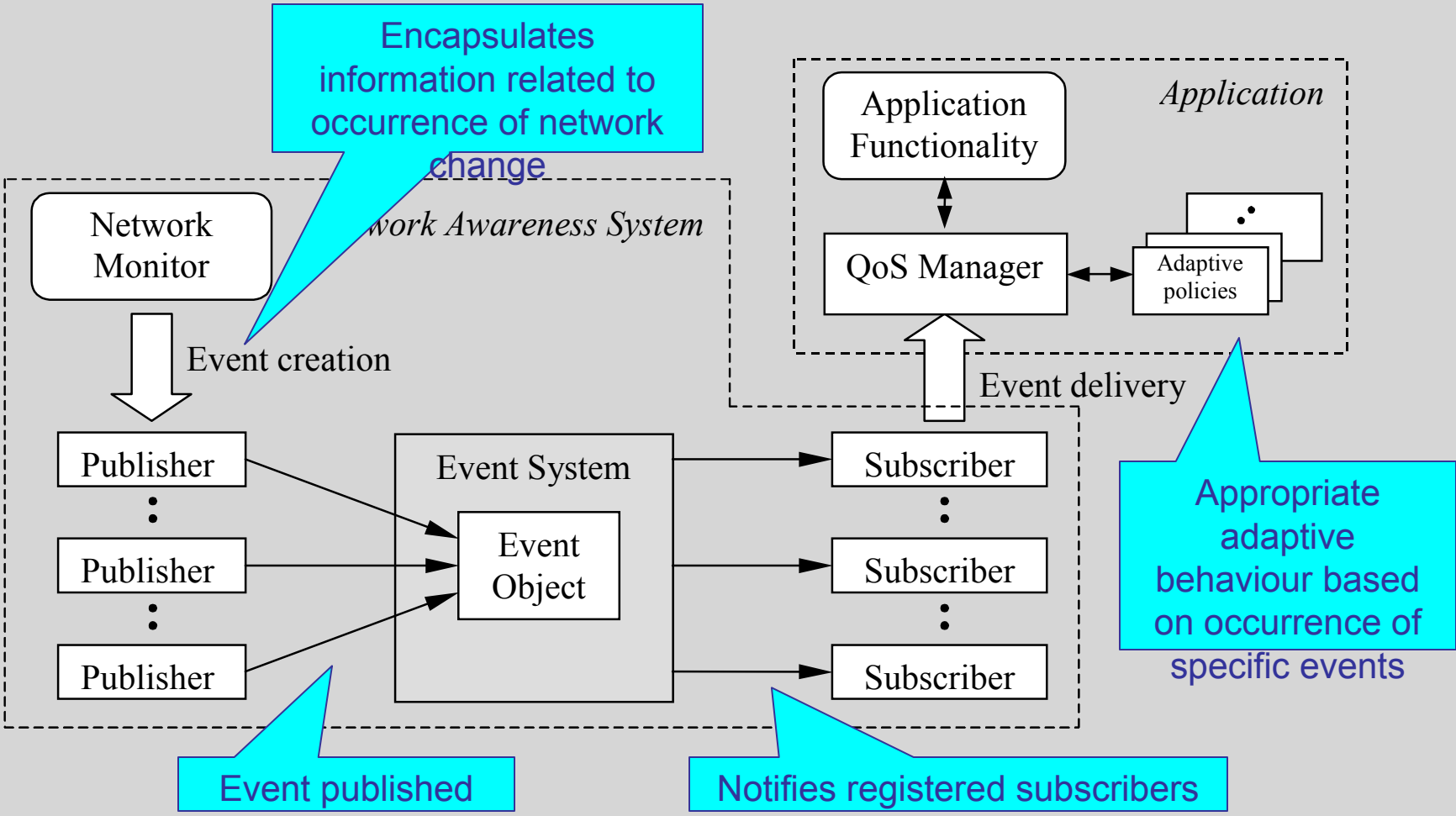
Event Delivery Framework



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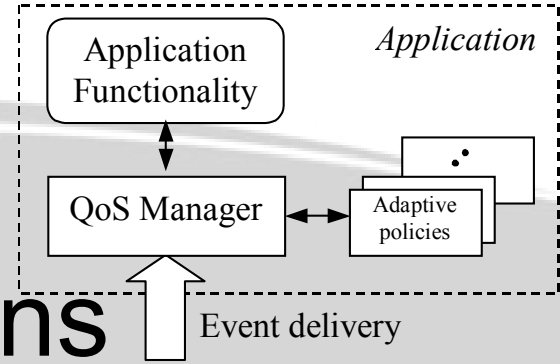

Adaptive Applications

- Network awareness facilitates development of adaptive applications
- Adaptive application able to operate at different operating points during its lifetime
- Performance sensitivities determine what adaptation algorithm is most appropriate
- QoS Manager to dynamically configure functionalities to match available resources according to user-defined policies

Network Monitor

- Individual modules to conduct measurement of network conditions
- Records statistics such as latency, available bandwidth (or throughput), and round trip time (RTT)
- Numerous useful network-monitoring tools
  - *Ping* to measure point-to-point RTT
  - *Iperf* to calculate throughput and to measure packet loss

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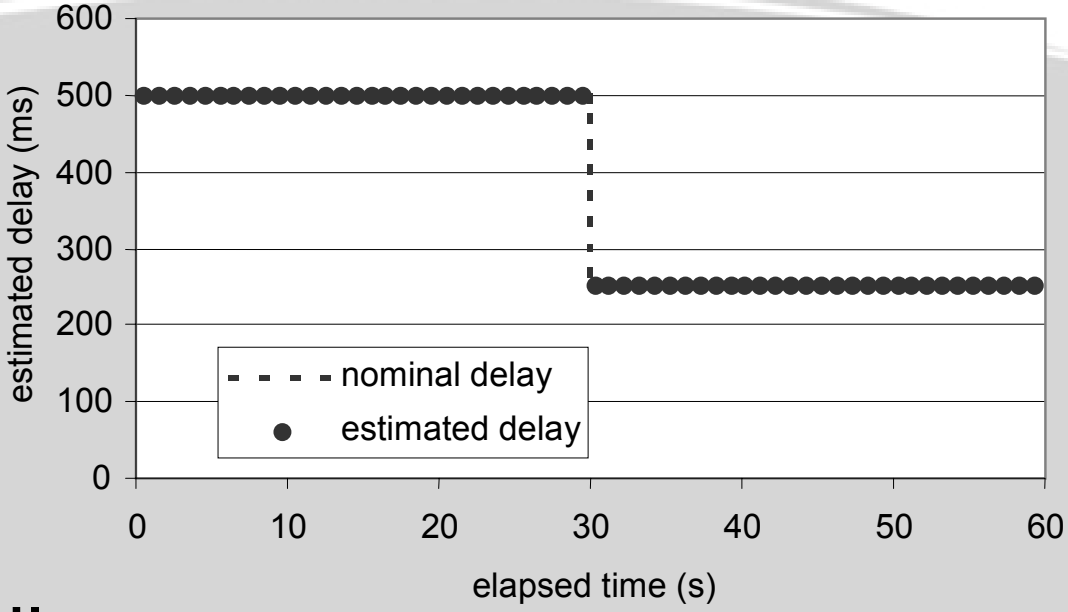
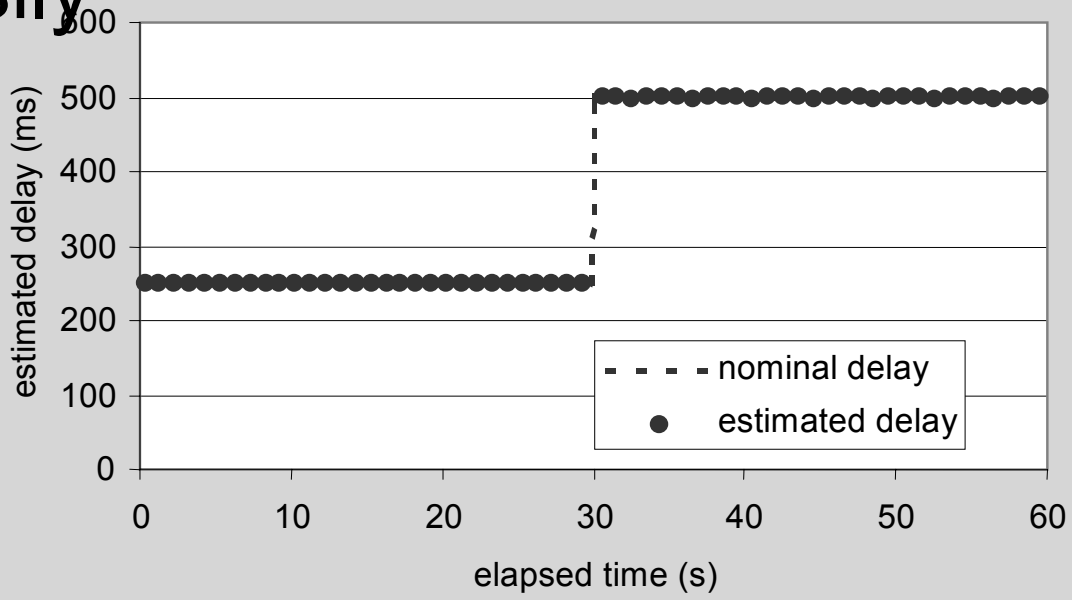
Detecting Delay

- increases and decreases are easily detectable





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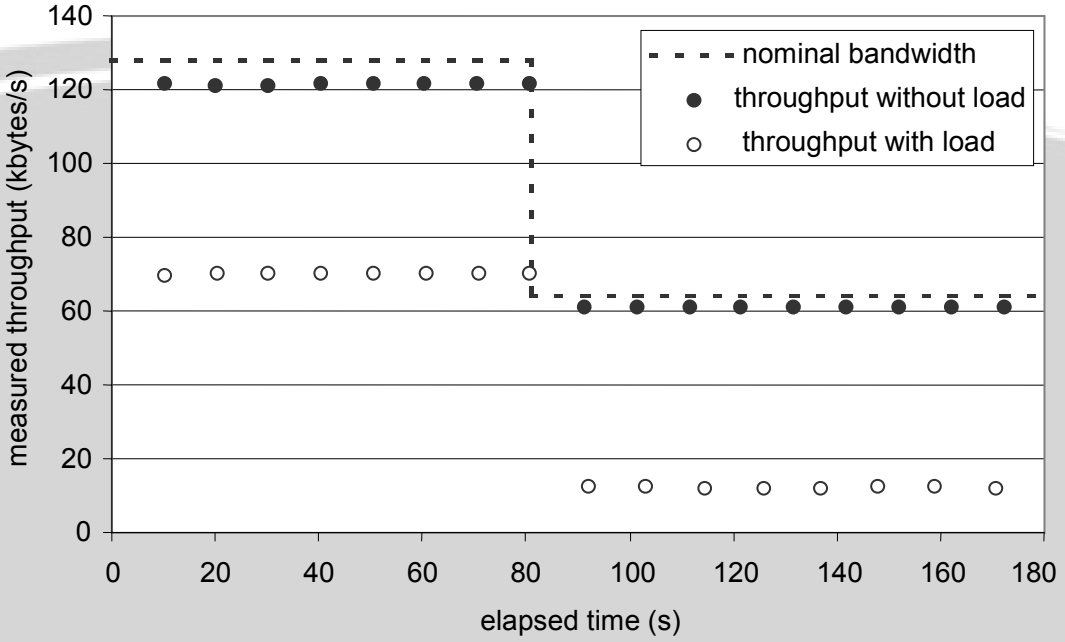
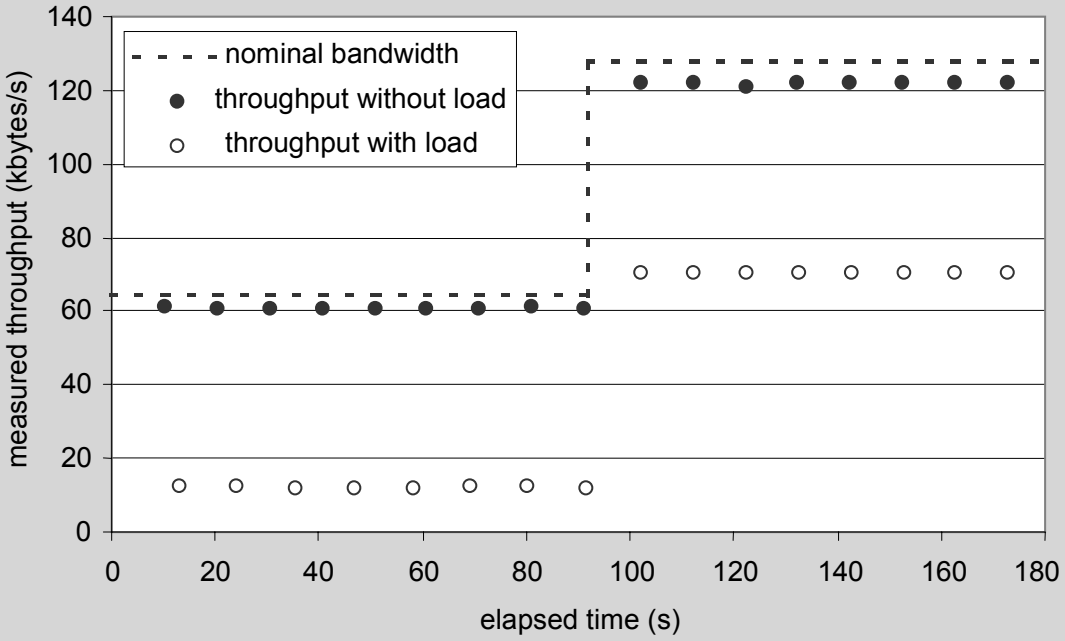
Detecting Throughput

- Able to observe changes in available bandwidth
- increases and decreases are detectable





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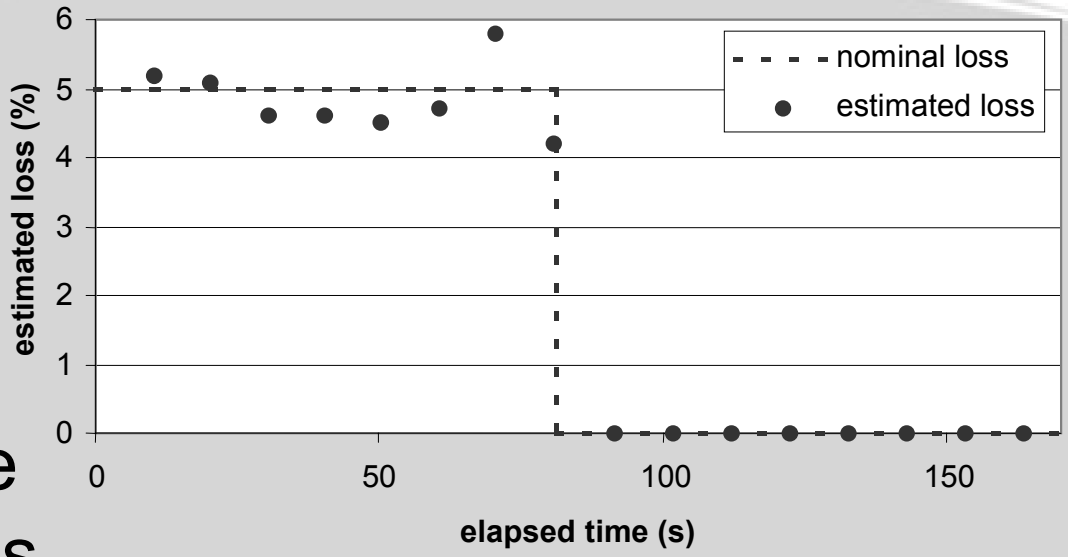
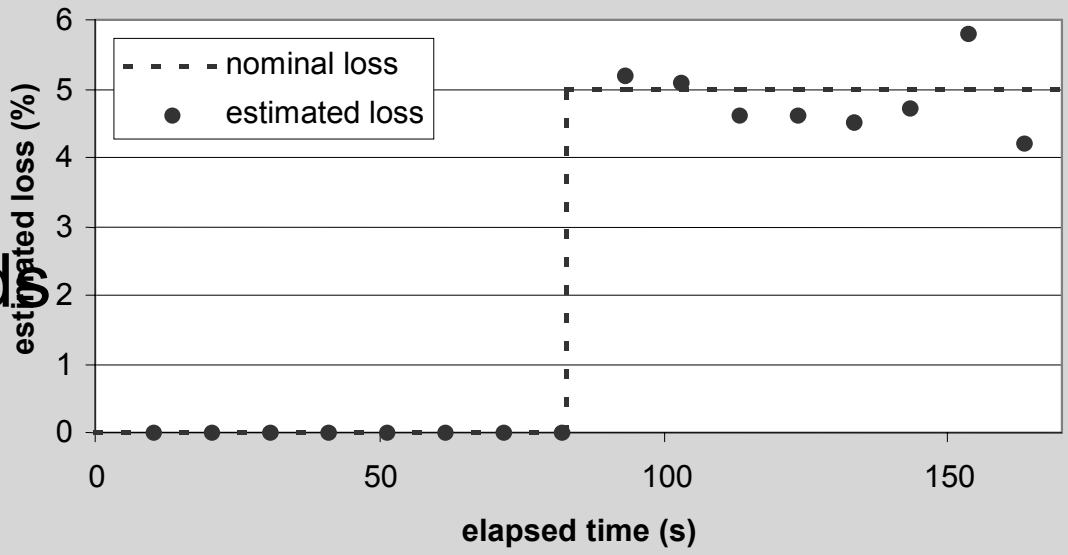
Detecting Packet Loss

- Reasonable estimate in detecting increases and decreases in packet loss
- Better estimate at expense of overheads and turnaround time





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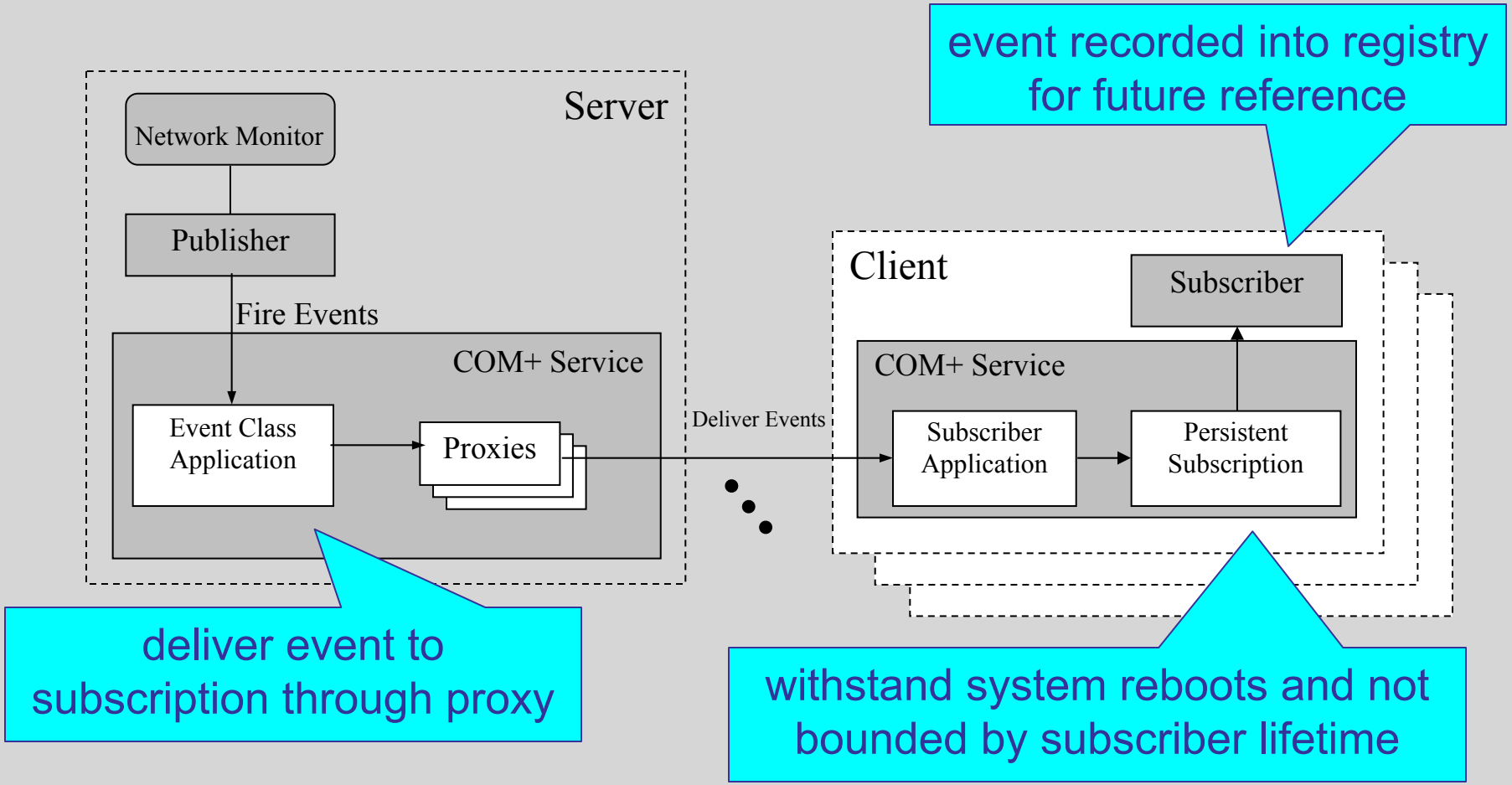
Implementation Details



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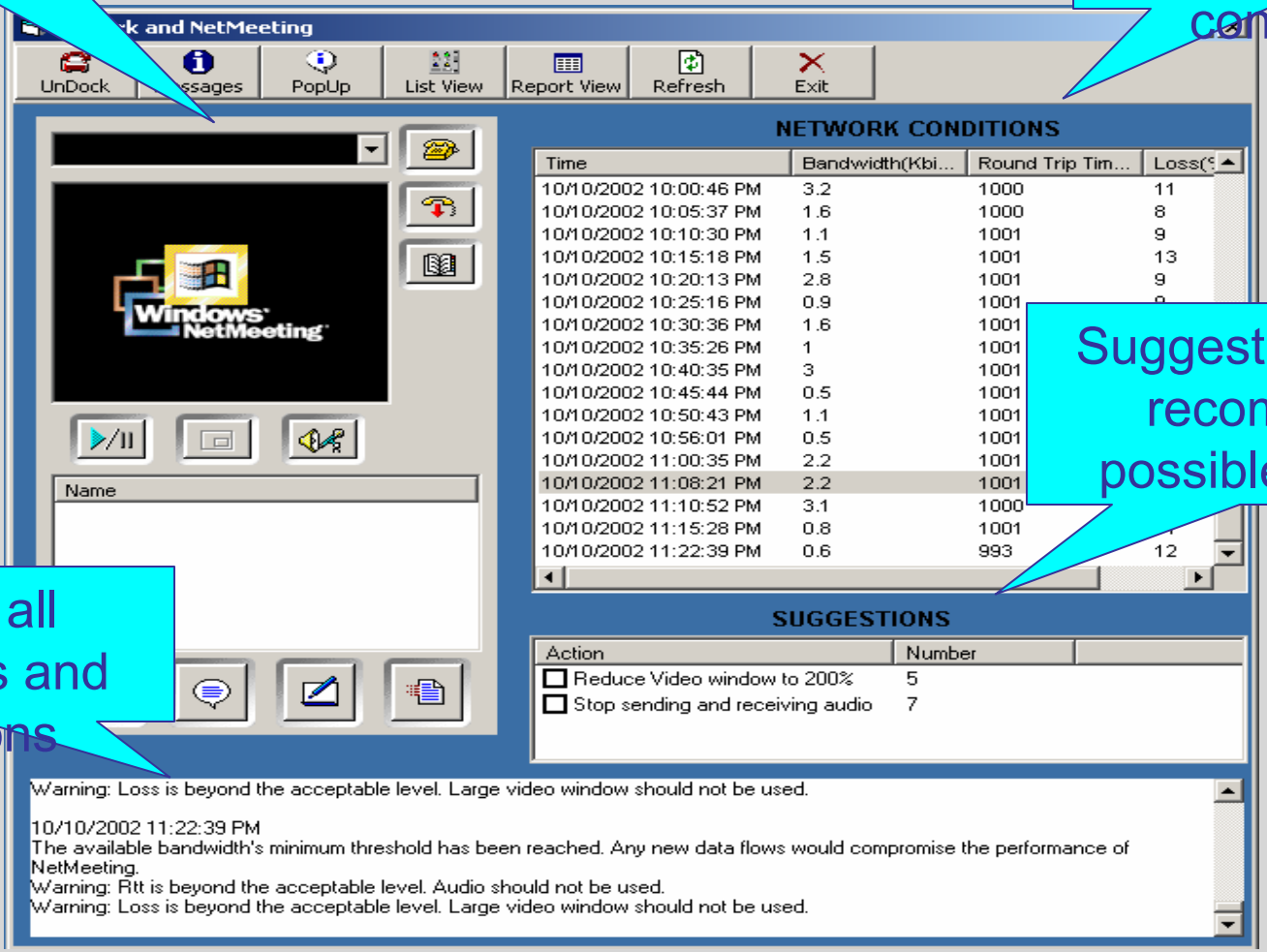
ActiveX Control NetMeeting

ListView to display network conditions

Suggestion box to recommend possible actions

Record all messages and conditions



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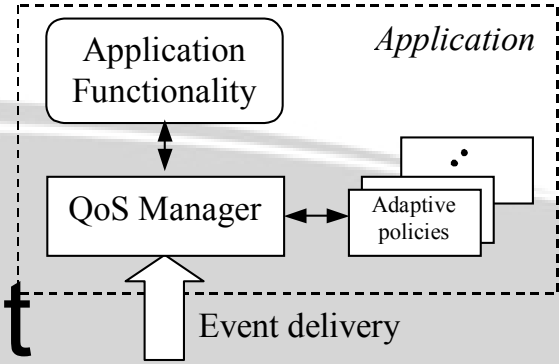
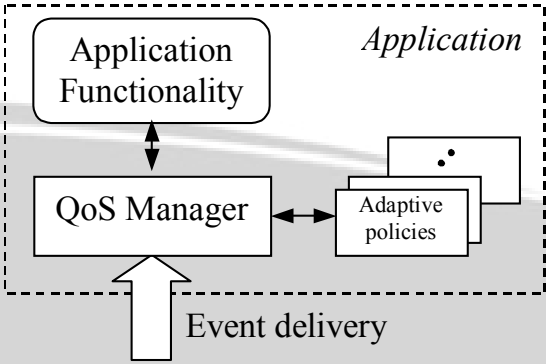


QoS Management

- QoS Manager
  - Receives information about network conditions
  - Consults adaptive policies
  - Advises NetMeeting users to take particular actions
  - Helps achieves robust operation through adaptive self-configuration
- Drawback of dynamic applications
  - Information overload to users
  - Better use intelligent agent to mesh with the way user works



Adaptive Policies

- Capture optimal modes of operation for any environmental conditions and user requirements
- Versatile user preferences for usage monitoring and application configuration
- Timing parameters of interactive applications more important than packet loss
- Video is supplementary medium in video conferencing

Conclusions

- Platform-independent event delivery framework to facilitate adaptation in unpredictable environment
  - Collaborative applications and users made aware of changing network conditions
  - Application functionality and adaptation conceptually separate from network awareness
  - Insufficient bandwidth for video conferencing
    - gracefully downgraded to voice, or
    - message conversation to keep collaboration going
- Proactive adaptation in response to poor and variable network quality
- Users help prevent further network deterioration