Real-Time Communication

Real-Time and Embedded Systems (M)

Tutorial 6

Tutorial Outline

- Review of lectures
- Examples
- Q&A on programming assignment

Review of Lectures

- Modelling real-time communications
  - Traffic and network models
    - Models for host and network
    - Sources of delay and timing problems
  - Properties of networks
    - Throughput, delay and jitter
    - Clock skew
    - Congestion and loss
    - Packet timing graphs to visualise network behaviour
  - Examples
    - Controller area networks
    - Ethernet

Review of Lectures

- Real-time on IP networks
  - Timing properties of IP networks
    - Example network behaviour
    - Expected performance
  - Use of TCP/IP and UDP/IP for real-time traffic
    - TCP congestion control
    - Timeliness vs. reliability trade-off
  - Overview of RTP
  - Understanding that real-time on IP networks is limited to soft real-time, with flexible applications

Review of Lectures

- Quality of Service
  - Why enhanced service is needed
  - What is needed to support enhanced services
    - Queue discipline
    - Acceptance test
    - Signalling protocol
  - Two approaches to implementing priority queuing
    - Weighted Fair Queuing (WFQ)
    - Weighted Round Robin (WRR)
  - Brief pointer to RSVP

Key Learning Outcomes

- Understanding of the concepts of real-time communication
  - Sources of delay and jitter in a network
  - Characterising and bounding delay/jitter
- Understanding that some networks are engineered to provide predictable and schedulable communication; others are not
  - Limitations of non-controlled packet networks for real-time traffic
  - Advantages and disadvantages of enhanced quality of service (QoS) networks
    - Conceptual understanding of the algorithms used to provide enhanced QoS
    - Conceptual understanding how to implement enhanced QoS networks
- Ability to reason about real-time communications; use examples to demonstrate understanding

Examples

- You are deploying a real-time streaming audio application within an IP network. This comprises a proprietary server running on dedicated hardware, and a client running on a popular operating system. The server communicates with the clients using UDP/IP.
  - Testing of the application, you notice that the audio playback is frequently disrupted, with gaps occurring in the output and variations in quality. The vendor tells you the problem is due to your network. How and why might the behaviour of the network impact application performance?
  - Some routers in your network support WFQ. Can this be used to improve performance? Will it affect the other applications using the network?
  - The other routers in your network support WRR scheduling, but not WFQ. Can you use WRR scheduling to improve real-time audio performance?
  - How might the behaviour of flows traversing the network path using WRR scheduling differ from the performance of the traffic that traverses the path using WFQ? How might the load on the routers using WRR differ from the load on those using WFQ?

Q&A/Programming Assignment

- Any questions on lecture material?

- Should have been working on the programming assignment last week – any questions for clarification?