

King Fahd University of Petroleum & Minerals Computer Engineering Dept

CSE 642 – Computer Systems
Performance

Term 091

Dr. Ashraf S. Hasan Mahmoud

Rm 22-148-3

Ext. 1724

Email: ashraf@kfupm.edu.sa

10/10/2009

Dr. Ashraf S. Hasan Mahmoud

1

Performance Evaluation In Telecommunications

- **Introduction to Networks**
- **Approaches to Performance Evaluation**
- **Queueing Models**
- **Computational Tools**

10/10/2009

Dr. Ashraf S. Hasan Mahmoud

2

The Telephone Network

- **Characteristics**
 - Alexander Graham Bell 1876
 - Two-way (full-duplex) connection
 - 4 kHz bandwidth
 - Local network (phone poles)
 - Switches
 - Long haul network (RF links, fiber, etc)
- **Data modems**
- **PBXs**
- **Fax machines**

10/10/2009

Dr. Ashraf S. Hasan Mahmoud

3

The (Phone) Local Network

- **The means by which your phone is connected to the telephone network**
- **Pairs of twisted 22- or 26- gauge wires**
- **Participate in internet revolution – ADSL technology**
 - Rates up in the Mb/s
- **CTV network – competitor?**
- **Wireless Local Loop – another competitor?**

10/10/2009

Dr. Ashraf S. Hasan Mahmoud

4

Long Haul Network

- **A network that carries traffic from one end office to another.**
 - Collection of interconnected links
- **Transmission media**
 - Twisted pairs
 - Coaxial cable
 - Fiber
 - Microwave
 - Etc.
- **Dominance of fiber**

10/10/2009

Dr. Ashraf S. Hasan Mahmoud

5

Switching

- **First manual switch developed in 1878**
- **First automatic switch 1892**
- **Circuit switching – till 1960s**
 - Call setup ~ 0.5 second
 - Call holding time ~ 3 minutes
- **Examples: ?**

10/10/2009

Dr. Ashraf S. Hasan Mahmoud

6

Switching – Newer Technologies

- **Packet Switching**
 - Digital bits (1s and 0s)
 - Store-and-forward
- **ATM**
 - Virtual circuits
- **ARPANET-based IP networks**
 - Best-effort service
 - Attempts to support QoS

10/10/2009

Dr. Ashraf S. Hasan Mahmoud

7

Network Protocols

- **OSI protocol structure**
 - Physical: transport of 0s and 1s
 - Data link: frame format, error control, etc.
 - Network: Routing, flow control
 - Transport: manage path flow over several links (end-to-end)
 - Session: call setup/termination – synch
 - Presentation: info format, encryption
 - Application: User functions (FTP, Telnet, etc.)

10/10/2009

Dr. Ashraf S. Hasan Mahmoud

8

Approaches to Performance Evaluation

- **Analysis**
 - E.g.: P_e in an AWGN channel, buffer overflow probability, etc.
 - Fast, accurate (exact)
 - Best for simple models
- **Simulation**
 - Model detailed model
 - Monte Carlo simulation – repeated trials to obtain a set of responses to random inputs
 - Simulation time/effort may be prohibitive
- **Prototyping**

10/10/2009

Dr. Ashraf S. Hasan Mahmoud

9

Queueing Models

- **Queueing Theory: Our primary analytic tool for this course**
- **Generic queueing model:**
 - Arrival Process
 - Storage Facility
 - Server
- **Wide range of applications**



10/10/2009

Dr. Ashraf S. Hasan Mahmoud

10

Queueing Models – History

- 1898, G. T. Blood, first analysis of telephone traffic
- 1909-1917, Agner Krarup Erlang, Erlang models (father of queueing theory)
 - Erlang B – loss systems
 - Erlang C – delay systems
- 1948, Kosten, prove PB is insensitive to distribution of service time
- Molina, Engset, and O'Dell, extension and refinement of Erlang models
- Pollacek-Kinchin, average delay in completing service in a system with Poisson arrivals
- 1951, Kendall, imbedded Markov chains

- **MATERIAL COVERD IN CHAPTERS 3, 5, and 6 of textbook**

10/10/2009

Dr. Ashraf S. Hasan Mahmoud

11

Packet Switching

- **Introduced to resolve deficiencies in voice-oriented telephone network**
 - Jackson-networks and their extensions– covered in chapter 4

- **Analysis pioneered by Kleinrock**
- **Applications:**
 - TDMA/FDMA capacity analysis
 - ALOHA
 - Etc.
- **MATERIAL covered in chapters 5 and 6**

10/10/2009

Dr. Ashraf S. Hasan Mahmoud

12

Packet Switching

- **Two main advancements**
 - Fiber optics communication (high speed links and $P_e \sim 0$)
 - VLSI (faster processing/switching)
- **New services appeared**
 - Each has its own characteristics and requirements
 - E.g. Real-time traffic and nonreal-time
- **Emphasis on quality of service (QoS) and congestion control (CC)**
 - ATM
 - QoS-based IP (DiffServ/Leaky bucket and IntServ/RSVP)
- **Analysis of leaky bucket and fluid models in Chapter 7**