King Fahd University of Petroleum & Minerals Computer Engineering Dept

CSE 642 – Computer Systems Performance

Term 041

Dr. Ashraf S. Hasan Mahmoud

Rm 22-148-3

Ext. 1724

Email: ashraf@ccse.kfupm.edu.sa

Performance Evaluation In Telecommunications

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

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

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?**

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**

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: ?**

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**

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.)**

Approaches to Performance Evaluation

- **Analysis**
  - **E.g.: Pe 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**

Queueing Models

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

- **Wide range of applications**
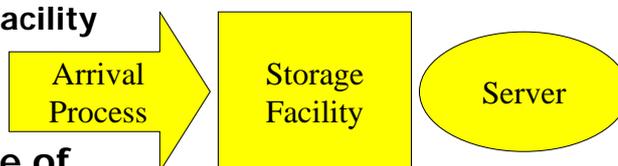
Queueing Models – History

- 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

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**