

Lecture 28

CS625: Advanced Computer Networks
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<http://www.cse.iitk.ac.in/users/braman/courses/cs625-fall2003/outline.html>

Topics for Today

- Modeling wide-area traffic [PF95]
- TCP evaluation guidelines [AF99]
- *Scribe for today?*

Recall: Poisson, Exponential

- **Poisson**: used to model the number of event arrivals within a time interval
- Arrivals are **independent** of one another (no history; no memory)
- Poisson inter-arrival times are **exponentially** distributed
- Poisson is good for modeling user generated events

What/How to Model?

- Connection arrival
- Packet arrival
- Number/size of packets (bytes in connection)
- For: Telnet, FTP, NNTP, SMTP, HTTP, Video/Audio (RTP)
- This lecture: [PF95]
- Methodology:
 - Collect traces
 - "Fit" into model (plot graph, statistical tests)

TCP Connection Inter-Arrivals

- 24-hour pattern
- Model as constant-rate Poisson within 1-hour intervals, or 10-min intervals
- Telnet/FTP connection arrivals modeled well this way
- Not others, importantly HTTP (or WWW)

Packet Inter-Arrivals

- Telnet
 - Exponential model does not fit well
 - Pareto distribution is a better fit
 - Captures bursty behaviour
- FTPDATA
 - Exponential model does not work here as well
 - Data bytes follow a very **heavy-tailed** distribution

Evaluation of TCP

- Scenario: want to evaluate some modification to TCP, or a router scheduling mechanism
- Lots of subtleties in TCP performance
- Which TCP features to choose while evaluating?
 - Those in widespread implementation
 - Those in "many" OS implementations
 - Experimental
- Simulation or Implementation-based?

Which TCP Features to Choose?

- Basic Congestion Control
- Extension for high performance
 - Window size > 64KB, PAWS, Timestamps
- SACK
- Delayed ACKs
- Nagle algorithm: combine bits of application data into single larger TCP segment
- Larger initial windows (3-4)
- Explicit Congestion Notification (ECN)

Simulation-Based Evaluation

- ✓ Quickly test out your idea
- ✓ Small resource requirement
- ✓ Can create many scenarios easily
- ✓ Examine wide variety of traces
- ✓ Repeatability
- ✓ Different from real implementation
- ✓ Non-network events not modeled
- ✓ Cross-traffic modeling is difficult

Implementation-Based Evaluation

- Testbed, emulation, or live Internet tests
- Testbed ==> controlled conditions
- Emulation ==> also model some limited Internet behaviour
- Live Internet tests ==> realistic
 - But hard to setup, control, or repeat

Concluding Remarks

- Usually a combination of experiments is best
- Further parameters:
 - Choose window size carefully – so that the network is the bottleneck
 - Which application to use? FTP? HTTP?

Further Topics

- More on Internet measurement
- Traffic engineering; MPLS