Looking Back and Looking Forward

Jim Kurose
U. Massachusetts/Amherst

Where's the $
Where have we come from?

- 10 years ago: IP versus ATM
- since then:
  - QOS
  - network calculi
  - intserv diffserv
  - signaling: RSVP
  - high speed routers
  - WWW protocols, caching
  - CDNs
  - streaming
  - LRD traffic
  - power laws
  - TCP, closed loop control
  - multicast
  - measurement
  - active networking
  - traceback, DDoS
  - BGP pathologies
  - VoIP, SIP
  - IP-over-*
  - ......

The definition of success is in the eyes of beholder
Challenge: scale, complexity

- growing gap between:
  - scale, complexity, heterogeneity of networks
  - ability to capture (measure), model (abstract), and ultimately understand their behavior

- some successes: performance!
  - closed-loop TCP models
  - large scale fluid models, simulation
Challenge: on beyond data plane performance

- **Q:** is performance really the major roadblock?
  - “robustness”
  - “complexity of control”
  - maintainability
  - evolvability

  the “……ities”

- **Fundamental advances here are hard!**
  - “efficiency” not the most important measure
  - little/no past work
  - metrics and models still to be defined
Example: soft state control

- conventional wisdom: “soft-state is robust, less complex than hard-state signaling”
  - really?
  - how to define “robustness”?
  - how to define “complexity”?

- posing/answering such a question is:
  - **hard**: no well-accepted models, paradigms
  - **easy**: little/no past research
  - **important**: a fundamental question
Choosing problems

- Look to industry: manageability a key concern
  - *models* needed to reason about network behavior
  - *measurement* needed to understand current behavior
  - increasing *complexity*
    - McKeown: by some measures IP already more complex, still less reliable, than telephone net

- “applications rule”
  - sensors nets, wireless/mobility
  - publish/subscribe architectures
  - application overlay networks
  - games, VR
Summary: advice to students

- *lots* of successes to be proud of!
  - definition of success in eyes of beholder
- *lots* of interesting unanswered questions
  - fundamental questions with large half life (thinking outside the box)
  - “on beyond performance”: the “…ities”
- applications, applications, applications
Questions

- why so little biodiversity in research areas?
- why aren’t there more Jim Roberts?
- all the action at the application level?
- QoS, multicast within provider’s network?