Teaching

CL

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0.1 Digital Communication II

Lecturers: Jon Crowcroft, Dr I.A.Pratt (`jon.crowcroft@cl.cam.ac.uk` `ian.pratt@cl.cam.ac.uk`)

No. of lectures: 16, or so
Prerequisite course: Digital Communication I
This course is a prerequisite for Security (Part II).

Aims

This course aims to provide a detailed understanding of how computer networks operate, through the examples of the Internet, and presents ways to build such systems. It also covers a selection of topics which relate to recent trends in digital communications systems. The material falls roughly into two halves: Protocols, and Technologies/Performance.

Lectures

- **Introduction.** Course overview. Abstraction, layering. The OSI reference model. JAC
- **The Internet: IP.** IP overview/review. Networking in Unix: structures, buffering, sockets, network interfaces. IP addresses and (simple) routing. Subnetting. IP checksum. Fragmentation. JAC
- **The Internet: routing.** ROADS and CIDR. Terminology: AS, IGP, EGP. Routing protocols: distance vector *versus* link state. Examples: RIP, OSPF. AS routing: I-BGP/E-BGP, metrics. JAC
- **The Internet: UDP, TCP** TCP operation, state transitions. Handling loss: acks and retransmissions. Estimating RTT. Basic congestion control. Improving things: TCP vegas, SACKs, ECN. [JAC, 2 lectures]
- **The Internet: The Linux Implementation.** Networking in Linux: structures, buffering, sockets, network interfaces. IP addresses and (simple) forwarding. Subnetting. IP checksum. Fragmentation. JAC
- **The Internet: network resource management.** Differentiated and Integrated Services. Signaling (RSVP) and Admission Control, Forwarding and Scheduling, Policing and Shaping. The future. JAC
- **The Internet: Applications, Multimedia, NFS & HTTP** RTP operation, Playout adaption; RPC & Network File Systems; HTTP, HTTP 1.1 - making it all work JAC

- **The Internet: multicast and QoS routing.** Other TCP details. Internet multicast model. Applications. Basic implementation. Refinements. JAC

- **Pricing and other Miscellany.** Model and motivation. Practical considerations. The future. JAC

- **ATM case study** Multiplexing and virtual circuits. Signalling. ATM Adaption Layers. Quality of Service CBR, VBR, ABR. IAP

- **Wide Area Networks.** Fibre Technology. Long-haul link design. Dense Wave Division Multiplexing. Sonet/SDH. MPLS. Packet over SONET. Optical switching. IAP

- **Access Networks.** Cable Modems. xDSL. Fixed wireless. Satellite. Firewalls and Network Address Translation. IAP

- **Local Area Networks and System Area Networks.** Fast/Gigabit Ethernet. Optimising latency. Host interface design. User-space protocol processing. IAP

- **Additional Topics.** To be announced. IAP+

Objectives

At the end of the course students should be able to

- enumerate and explain the layers of the OSI reference model
- compare and contrast connectionless and connection-oriented networks
- explain how IP routing works
- describe the components of the Internet resource management system
- describe how and why TCP attempts to handle congestion in the network

Recommended books

Srinivsan Keshav. (1997). *An Engineering Approach to Computer Networking*. Addison-Wesley Pub Co; (1st ed.); ISBN: 0201634422

Alternative to Keshav: Bruce S. Davie & Larry L. Peterson & David Clark (1999). *Computer Networks: A Systems Approach.* Morgan Kaufmann Publishers (2nd ed.); ISBN: 1558605142

W. Richard Stevenes (1994) *TCP/IP Illustrated, Volume 1: The Protocols.* Addison-Wesley Pub Co, (1st ed.); ISBN: 0201633469

Alternative to Stevens: Douglas Comer (2000). *Internetworking with TCP/IP Vol. I: Principles, Protocols, and Architecture* Prentice Hall (4th ed.); ISBN: 0130183806

Backround: Balachander Krishnamurthy & Jennifer Rexford (2001) *Web Protocols and Practice: HTTP/1.1, Networking Protocols, Caching, and Traffic Measurement.* Addison-Wesley Pub Co (1st ed.); ISBN: 0201710889