

Teaching Networking For Fun And Profit

(Curricula and Labs)

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Undergraduate Courses (Breadth)

- Understand vocabulary and concepts
- Be able to state purpose and function of fundamental hardware and software components
- Know the role of protocols
- Be able to write programs that use computer networks
- Typical courses
 - Overview (everything from wires to applications)
 - Intro to Internetworking (TCP/IP)
 - Network Programming (sockets & middleware)
 - Intro to Network System Design (implementation of packet processing systems)

Graduate Course (Complete Mastery)

- Understand the design and implementation of protocols
- Be able to build correct and efficient system components
- Know how to architect large-scale networks
- Be able to discuss tradeoffs and limitations
- Typical courses
 - Internetworking (all the details)
 - Network System Design (engineering tradeoffs, network processors)
 - Seminars on latest topics (e.g., optical networks, wireless, web technologies, etc.)

Labs

- Motivation
 - Absolutely essential: students learn by doing
 - Reinforce concepts presented in class
 - Give students concrete understanding of details
 - Keep courses tied to reality
- Equipment
 - Doesn't have to be the latest/fastest
 - Any lab is better than no lab (but simulation isn't sufficient)
 - Show me your equipment and I'll show you experiments

Equipment In Comer's Labs†

- Undergraduate Lab
 - 20 workstations with extra NICs that students can connect to private hub / switch
- Graduate Lab
 - 24 front-end workstations on gigabit ethernet
 - 85 (downloadable) back-end systems
 - 22 network processors
 - Miscellaneous equipment for experiments
 - * VLAN switches and hubs
 - * IP routers
 - * Load balancer

†Thanks to: Intel, IBM, Cisco, Agere, AT&T, and others.

Front-End Systems In The Xinu Lab



Back-End Systems In The Xinu Lab

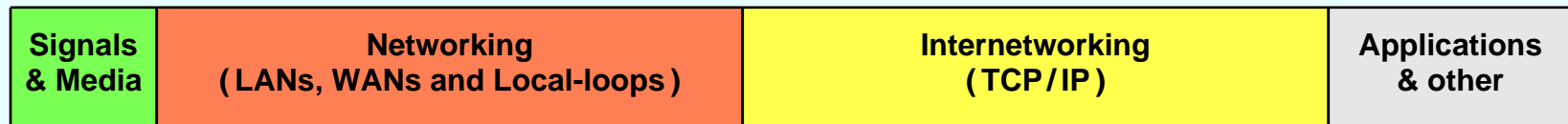


Example Undergraduate Lab Exercises

- Network programming
 - Build client and server using simplified API
 - Build a concurrent web server that supports server-side scripting using sockets
- Measurement
 - Compare throughput of 10/100 Mbps networks under load
 - Compare throughput of hub and switch
- Protocols
 - Capture and reassemble IP fragments
 - Trace a TCP connection and extract data

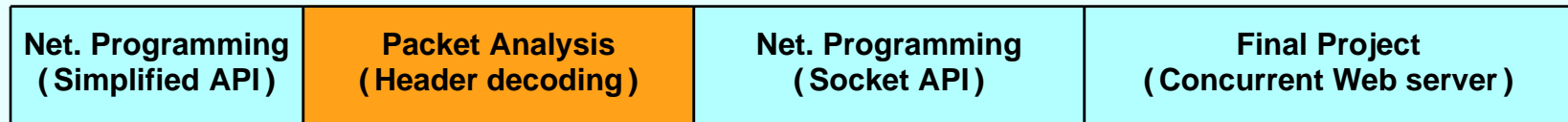
Example Timeline For Undergrad Overview Course And Lab

Course



————— *TIME* —————>

Lab



Example Graduate Lab Exercises (Team Projects)

- Design and implement a software-based IP router
 - Required protocols: IP, ICMP, UDP, and ARP
 - Student's choice of multicast, NAT, SNMP...
- Design and implement a high speed IPsec box using network processors
- Design and implement a voice service over IP

Awards For Undergrad Network Curricula

- Bronze
 - One course focused on irrelevant mathematics
- Silver
 - One course about real networks and internets
- Gold
 - One course about real networks and internets with a hands-on lab
- Platinum
 - Two or more courses about real networks, each with a hands-on lab



Questions?