TELE302 Network Design

Lecture 1 - Introduction

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Lecture Outline

Course Overview

- Guidelines for network design – systems approach
- Performance analysis using queueing models
- Network simulations
- Topology design
- Security design
- Wireless networking: challenges and solutions

The Team

- Lecturers:
  - A/Prof. Jeremiah Deng
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    - jeremiah.deng@otago.ac.nz
  - Guest lecturers
    - t.b.d.
- Tutor:
  - Sepideh Zareei (sepideh.zareei@postgrad.otago.ac.nz)
- Class Reps
  - Raise your hand?

Resources

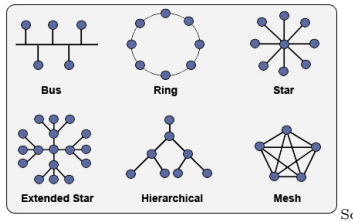
- Course website `www.telecom.otago.ac.nz/tele302/` for general information
- Piazza site for resources and discussion forums - `https://piazza.com/otago.ac.nz/semester22015/tele302/home`
- Recommended Textbooks
  - M. Harchol-Balter, *Performance Modeling and Design of Computer Systems*, Cambridge, 2013.
  - P. Oppenheimer, *Top-Down Network Design*, CISCO Press, 2004/2011. (Ebook available from UO Library)
  - J. McCabe, *Network Analysis, Architecture, and Design*, Morgan Kaufmann, 2010. (Ebook available from UO Library)
- Other material
  - D. Bertsekas and R. Gallager, *Data Networks*, 2^{nd} Ed., Prentice-Hall, 1992.
  - Supplementary readings on course website

Assessment Package

- Internal assessment total: 50%
  - 5 Labs, $5 \times 2\%$
  - 3 Assignments (incl. Project), 35%
  - Presentation, 5%
- Final exam: 50%
- Tips for getting good marks:
  - Attend *every* lecture
  - Complete *all* the labs and assignments
  - An open mind willing to try new things
  - Ask questions
  - Grab bonus marks (?)

What is a Network?

- A set of processing nodes connected by communication links.
  - Many topologies:



Source: learn-networking.com

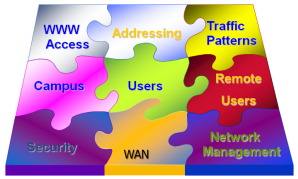
- Many types of communication media:
  - Wired: twisted pair, coaxial cable, fiber optic cable
  - Wireless: radio, light, satellites

What is a Network ...?

- Runs a certain kind of *technology*: Ethernet, ATM, SMDS, Frame Relay etc.
- May deal with *internetworking* with other networks
- Enables sharing of information and resources.
  - Interaction between parties
  - Interaction occurs on a *protocol* stack (such as TCP/IP) of several layers.
  - Various types of *applications*
  - Applications are used by different *users*
  - Size matters

Networking Issues

- LAN, MAN, WAN and beyond
- Technologies: Ethernet, ADSL, ATM, WiFi, WiMAX, 4G ...
- Internetworking
- Mobile networking
- Applications
- Service quality
- Management and Security
- Finance
- Regulations and policies
- Implementation, outsourcing, maintenance



Application Characteristics

Applications	Msg length	Msg arrival	Delay need	Reliability need
Interactive terminals	Short	Low	Moderate	Very high
File transfer	Very long	Very low	Very low	Very high
Hi-res graphics	Very long	Moderate	High	Low
VoIP	Very short	Very High	High	Low

Network Design: Mission Impossible?

Response speed

Cost

Reliability

Business growth

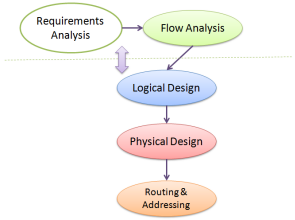
Interpersonal relationship

What Was Network Design

- Traditionally based on a set of general rules
  - "80/20"
  - "Bridge when you can, route when you must"
  - Can't deal with *scalability* & *complexity*
- Focused on capacity planning
  - No consideration in delay optimization
  - No guarantee of service quality
  - Lack of redundancy

The Systems Approach

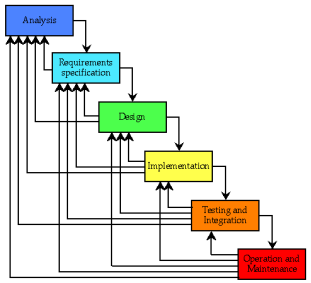
- A top-down approach that integrates two *iterative* phases: Analysis & Design
- Analysis phase:
  - Requirements analysis: business goals and constraints, services requirements
  - Flow analysis: flow specifications development and mapping
- Design phase:
  - Logical design: technology choices, interconnection, management and security
  - Physical design: devices and equipment choice and placement, cabling
  - Routing & addressing



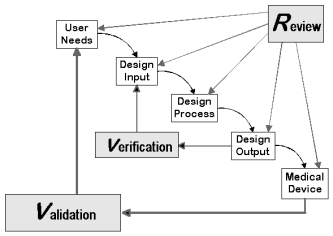
Analysis and Design Processes

- Set and achieve goals
  - Maximizing performance
  - Minimizing cost
- Optimization with trade-offs
  - Performance analysis or simulation
  - Recognizing trade-offs
  - No single 'best' answer
- Hierarchies
  - Provide structure in the network
- Redundancy
  - Provides availability & reliability

Systems Approach Elsewhere: "Waterfall Models"



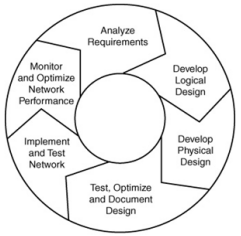
Software development



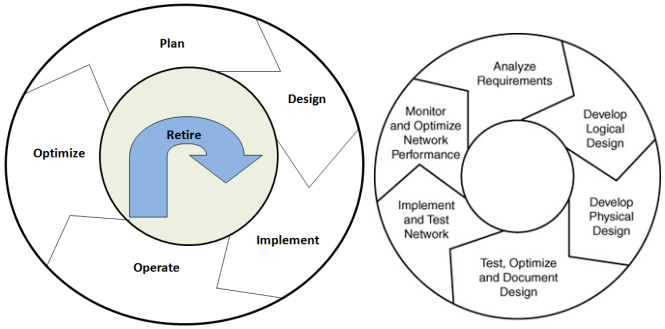
Medical devices

"Top-Down" Design Phases (Oppenheimer)

- Analyze requirements.
  - Collect user data.
  - Analyze future requirements.
- Develop the logical design.
  - Topology, addressing, naming, routing, security & management planning.
- Develop the physical design.
  - Choose technologies, devices, cable; chose service providers.
- Test, optimize, and document the design
  - Implement a test plan, build a prototype and document your work with a design proposal.
- Can be a painstaking *iterative* process.



The "PDIOO" Network Life Cycle



Spot the difference?

General Design Approaches

- **Heuristic** – by using various principles and algorithms
- **Exact** – by working out mathematical solutions based on linear programming etc., minimizing certain cost functions
- **Simulation** – often used when no exact analytical form exists. Experiments are conducted on simplified models to see the performance of network

Not Just 'Rocket Science'

Greek $\tau\epsilon\chi$: stands for art and technology

The *Art* of Network Design

- Communication with users
- Technology choices and migration
- Relations to business goals

The *Science* of Network Design

- Understanding of network technologies
- Analysis of capacity, redundancy, delay

According to a scientist / artist

"Science is knowledge which we understand so well that we can teach it to a computer; and if we don't fully understand something, it is an art to deal with it. "
Computer programming is an art, because it applies accumulated knowledge to the world, because it requires skill and ingenuity, and especially because it produces objects of beauty. "

– Donald Knuth

Review Questions

- Explain the top-down systems approach in network design.
- Name a few challenges of network design in today's ICT settings.
- Where and why is testing embedded in the network life cycle?
- What are the three general approaches for network desgin?

Readings

- Available at the Piazza site, under "Resources"
- Readings are *examinable* in the final ☺
- Pricilla Oppenheimer, "Analyzing Business Goals and Constraints of Network Design", TDND Chapter 1
  - Also available from CISCO.com
- Van Slyke, Sections 1 & 2
- Coming next: **Network Services**