CS544
Computer Networks

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Class 1 Slides

Spring 2011-2012

Tonight's Topics

- Overview of class
- Review Syllabus
- Review WebCT/BBVista
- Major topics:
  - Protocols (definitions, characteristics of a good protocol)
  - Common themes & layering
  - Major architecture models (OSI, TCP/IP, ATM)
  - The Big Picture

Goals of class

- To learn computer networks (obviously!)
- But to understand "the nature of the beast" – understand all networks because we understand conceptually how they have to work.
- Understand what a protocol really is and how it solves a problem.
- Also to understand how protocols get created and evolve.
- To understand the effects of computer networks and their effects on us.

Threads of class

- Many different parts to class
  - Lecture
    - Discuss computer networks (exams)
    - Discussion of "Big Picture" (other areas and how they interact with computer networks)
  - Online (WebCT/BBVista)
    - Discussions / Sample questions
    - Semester Projects (Groups of 4 assigned randomly)
    - Exams are individual!

Blackboard/WebCT overview

- Announcements
- Assignments
- Assessments (exams)
- Calendar
- Discussions / Chat (Group based)
- Chat (Lecture Chat room)
- Web Links
- Interaction:
  - Can email in Blackboard, but you have to login
  - It's better to email me at Michael.Kain@Unisys.com.
- Syllabus (go over)

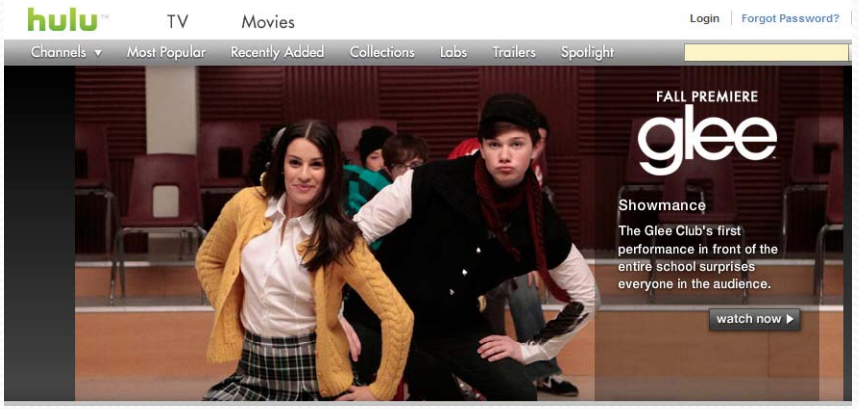
Groups

- Semester projects (2) will be done in groups of 4 (to be assigned in approximately Week 3)
  - Protocol design (due in Week 6)
  - Protocol implementation (due in Week 10)
- Reasons:
  - Part of protocols are tradeoffs between different viewpoints
  - Can do larger, more meaningful assignments with groups
  - That's the way life/work is.
- Please be proactive – vote a leader for each project and let us know if there are any issues.
- You get to influence everyone on your group's semester grade (10% of semester grade)

Internet change going on

- Many things changing the way that we think of computer networking
  - Social Networking
  - Wireless Communications
  - Others
- Many are rethinking the models and protocols of the current Internet – looking at the future Internet
- Protocols are the heart of any social or computer networking concepts.

What is a computer network?



A network

- Something used to share information.
- Two requirements:
  1. A link exists to transport digital data (binary)
  2. Both sides have agreed on the methods and structure to transfer the data (the protocol)
- Examples: Phone conversation, Sneakernet, others?

Networks around us

- So introduce yourself to the person next to you
  - (those watching via the web, use someone close by)
- How did you know what to do?
- How did you learn this?
  - Written down
  - Learned
  - Other?

How about telling a story?

- How is it the same?
- How is it different?
- Story has definite parts: Beginning, Middle, Climax, End (can pick other parts)
- Many more messages than introducing yourself.

How about transferring a file?

- What's similar?
- What's different?
- How can I describe it?

How about FTP?

- Has parts to its conversation
- Definite messages that each side understands.
- So how do we define this?
- Are there common ideas?

Protocol

- The heart of the network is the PROTOCOL
- Similar to many things that you already use
  - Telephone conversation
  - Ordering food
  - Introducing yourself to someone
  - "What time is it?"
- Definition:

  Defines the messages sent and received and the actions that are performed when messages and network events are received.

Why study protocols?

- Networks are made up of protocols
- Even as networks change, protocols and protocol concepts will stay the same
  - 10 years from now
  - 20 years from now
  - 20-30 years ago
- So, we'll look at protocols, where networks have been and going, and use protocols to understand it all.
- Protocol = "conversation"

A good protocol has:

- Well defined messages (content and delineation)
- Protocol state (not application state) and transitions = Deterministic Finite Automata (DFA)
- Other areas:
  - Extensibility
  - Performance
  - Migration / integration (old or competing protocols)
  - May have some concept of time (timeout for reliability)
  - Security
  - TRUST (more today than older protocols)
    - why?

Protocol state

- State of the "conversation" between peer(s)
  - GREETING
  - OPEN
- Not the application state!
  - Golden rule: If something is local (like "Waiting on disk" or "calculate answer") and doesn't involve sending something – then it's application state.
  - All protocol state changes are caused by messages or events
  - Some protocols do not have state – any guesses?
- How do we represent?

What is a DFA?

- Deterministic Finite Automata (also known as a Finite State Machine)
  - Graphical representation of a protocol where:
    - The nodes are the states of the protocol
    - The directed edges are messages sent or received, or events which happen in the protocol

DFAs

- Can be small (one node) which shows a stateless protocol (for example, HTTP)
- Can be large (many nodes and many transitions), which shows a stateful protocol
- Define the protocol and its operation.
- Show PROTOCOL STATE and transitions, not APPLICATION STATE.

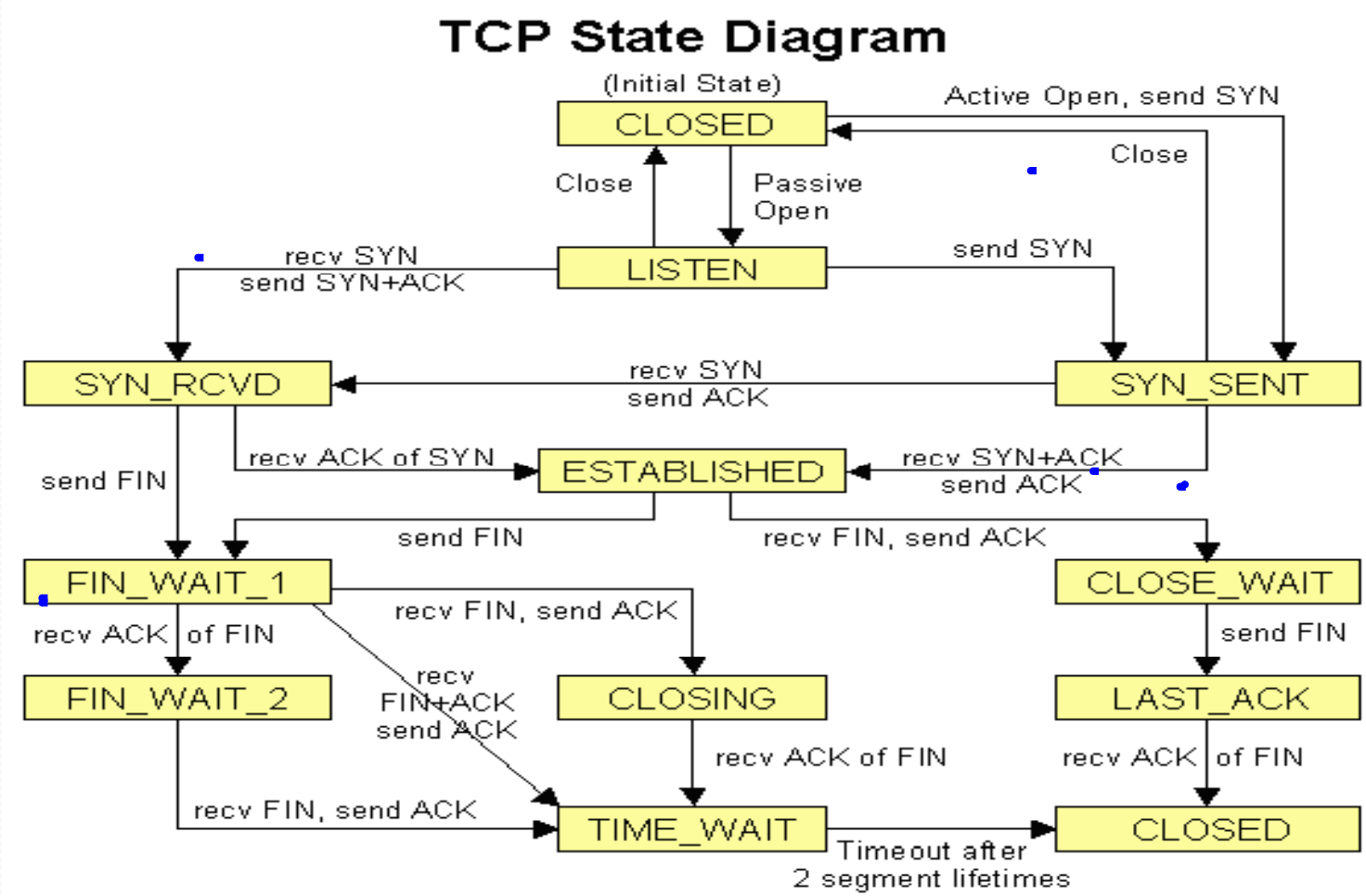
A simple DFA

- Door protocol

Another simple DFA

- Waiter protocol

A complicated DFA (TCP)



http://world.std.com/~franl/tcp-state-diagram.gif

How specific do we have to be?

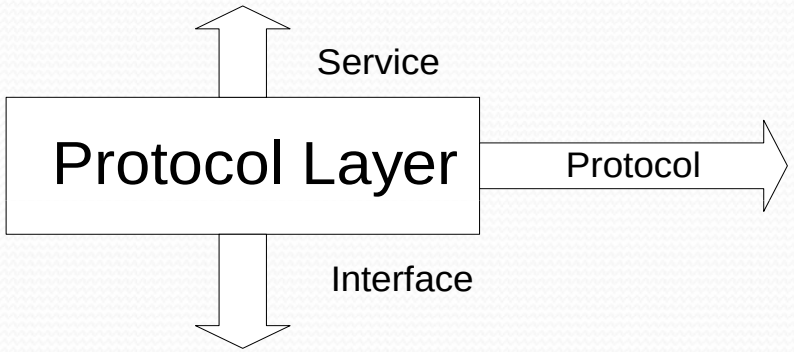
- Ambiguity in the protocol – how is it handled?
  - Messages
  - Transitions
- Must be very, very, specific.

How many protocols?

- So, how many protocols do we have in computer networking?
  - One?
  - More than one?
- How do we solve the problem of one computer talking to another?

Layering

- Why layers?
  - Concentrate similar functions together
  - Presents a "building block" approach to networks
  - Allows "Mix & Match" of boxes
- Concepts of service, interface, and protocol



Layering - continued

- Sublayers – Layers can be broken down into sublayers if functions can be grouped
- Acronyms:
  - Service Access Point (SAP)
  - Protocol Data Unit (PDU)
    - Frame = Link Layer PDU
    - Packet = Network PDU
    - Segment = Transport PDU

Common themes

- Common functions which occur at multiple layers:
  - Addressing
  - Connection Control (connection used or not)
  - Ordered Delivery
  - Segmentation & Reassembly
  - PDU (message) definition
  - Error Detection / Correction
  - Flow Control
  - Multiplexing (more than one lower or upper service)

The big themes

- Security!
  - Not just encrypting the data
  1. Data Integrity
  2. Confidentiality
  3. Access Control
  4. Availability (Service)
  5. Authentication
  6. Non-Repudiation
- Quality of Service (QoS):
  - What you get out of a protocol (not just the network layer)
  - How do you describe this?

The networking models

- The 3 major models:
  - OSI Basic Reference Model
  - TCP/IP
  - Asynchronous Transfer Mode (ATM)
- Others: BNA (Unisys), SNA (IBM), DecNet (HP), AppleTalk, etc……..
  - Show poster

OSI Basic Reference Model

- Application Layer
- Presentation Layer
- Session Layer
- Transport Layer
- Network Layer
- Data Link Layer
- Physical Layer

TCP/IP Reference Model

- Application Layer (HTTP, FTP, SMTP, POP3, etc.)
- Transport Layer (TCP, UDP, SCTP, DCCP, etc.)
- Internetworking Layer (IPv4, IPv6)
- Link Layer (Ethernet, Wireless, ATM, 3G/4G)
- Physical Layer (these two are sometimes together as the Host-to-Network Layer or NIC Layer)
- Transport Layer Security sublayer added later (SSL)

ATM Reference Model

- ATM Adaptation Layer
  - Convergence Sublayer (CS)
  - Segmentation and Reassembly Sublayer (SAR)
- ATM Layer
- Physical Layer (PHY)
  - Transmission Convergence sublayer (TC)
  - Physical Medium Dependent sublayer (PMD)
- User and Management planes

ATM Reference Model

- Heart of this model is 53 byte “cell” (the PDU of the physical layer)
  - 5 bytes of header
  - 48 bytes of data

Reference Models

- Which one is better?
- We see that we don't have one agreed protocol, but a layered set of protocols (one per layer or sublayer)
- What will the future Internet use?
  - TCP/IP?
  - Something different?

Protocol stacks

- How do we link the stack together?
- Usually a reference in the PDU header which is set on the way down the stack for use on the way up the stack on the other side
- Wireshark example

How do we define protocols?

- Anyone can define protocols
- Internet protocols are standardized by the Internet Engineering Task Force (http://www.ietf.org/)
- Define RFC (Request for Comments)
- Goes through draft phases, review phases (more than once) and may finally be approved (some never get there)
- Includes problem statement, performance, related works in addition to major parts of a protocol.

What about security of protocols?

- Is the strength of the DFA a part of its security?
  - Fuzzing
    - Random
    - Non-adaptive
    - Adaptive
- How can we assure that a remote person adheres to the protocol?
- What about the implementation?

The Big Picture

- Technology doesn't really drive network design, new protocols, etc.
- Influences and is influenced by:
  - Social / Society (changes the way we communicate & persona)
    - Facebook / Twitter / LinkedIn / Foursquare
    - "Googling" / Wikipedia / online information
    - Online games
    - Are we more or less "connected"?

The Big Picture, part 2

- Business (information & distribution)
  - Net Neutrality
  - Content management (DRM)
  - Can find lots of private information leaked onto web (Wikileaks)
  - Trust in information, though? (Cluetrain Manefesto, wikipedia)
- Legal / Criminal (tracking the bad guys!)
  - Hacking (Jurisidiction)
  - Internet Law, precedents, and case studies
  - Policies, Laws
- And these overlap. How about online school?
- Many, many articles (at least one per day)

Tonight – The Internet as a Utility?

- Discuss now and on WebCT.
- Should everyone be able to get to the Internet like we have water and electricity?
- Should it be regulated by the Federal Government?
- Any differences with what it is now?

For next week

- Login to WebCT/BBVista
  - Make sure that you can all get in
  - Discuss what you want to get out of this course.
  - Start to think about a protocol that you'll want to analyze.
  - Start thinking about what problem that you'll solve by a protocol that you and your group will design.
  - Read sample questions on WebCT and think about answers (not to be turned in).
- Read (chapters in syllabus)
  - Forouzan (textbook)
  - Spinroot (online)