

Computer Networks

Edo Biagioni
esb@hawaii.edu

Overview

- Computer Networks
- Layered protocols
- IP routing
- Wireless ad-hoc networks

Computer Networks

- leverage a method of exchanging bits
- into a useful network
- that connects computers

How?

- provide levels of abstraction
- provide implementations for each abstraction
- support applications in what they need

protocols

a protocol

is an agreement about
the meaning of certain events
and the appropriate responses

Levels of abstraction

- exchanging bits
- exchanging packets (framing)
- larger networks (routing)
- reliable (or timely) data delivery (transport)
- secure data exchange
- application-specific communication

standard 7-layer model

- 7: application layer, including security
- 6, 5: presentation and session layers
- 4: transport (reliability)
- 3: network (internet)
- 2: data link (directly connected computers)
- 1: physical (electrical and timing)

benefits of layering

- The application doesn't have to concern itself with details handled on lower layers
- The layers don't have to know anything about the application
- Each layer needs to know very little about the layers above it and below it
- Each layer can be implemented and tested in isolation

drawbacks of layering

- harder to optimize
- hard to design truly independent layers: issues such as addressing are pervasive
- e.g. switch from IPv4 to IPv6 affects the applications as well as TCP/UDP

IP routing

- each packet carries a source and a destination address
- each host/router has one or more interfaces, each with its local address
- if the destination address matches the address of one of my interfaces, packet is for me
- otherwise, I must either drop it, or send it on one of my interfaces: forward the packet

IP routing table

- I could arrange my network so it is clear to which interface I should forward the packet
- or I could be flexible, and keep a list of destinations, and for each an interface
- this is the basic **routing table**:

| destination | interface | next hop | cost |
|-------------|-----------|----------|------|
| jim | left | anne | 5 |
| judy | right | andy | 2 |
| judy | left | anne | 4 |

routing table maintenance

- routing table should direct packets closer to their destination
- when the network changes, the routing table may also have to change
- doing this manually is time-consuming and error-prone, so:
- automatic routing table maintenance: routing protocols
- hierarchy aids in summarizing and reducing routing table size, routing protocol data

port numbers

- if IP decides a packet is for this host, it must select a recipient application (actually, a *socket*)
- TCP and UDP define a collection of port numbers, 0..65535
- typically a server listens on a given port number, e.g. port 80 for http
- firewalls may block specific port numbers for servers we should not be running

wireless ad-hoc networks

- computers are now small
- computers now have wireless networks
- an **infrastructure node** is a wireless node also wired to the internet
- can we do useful networking without infrastructure nodes?
- **ad-hoc** means neighbors simply forward each other's packets, without a fixed infrastructure

types of wireless ad-hoc networks

- mobile ad-hoc nets (MANETs): nodes are likely to move around, neighbors change over time
- wireless sensor networks (WSNs): nodes are very low power, may sleep and wake up
- mesh networks: cellular communication plus ad-hoc networking

challenges of wireless ad-hoc networks

- routes change relatively quickly, optimization may not be profitable
- applications: who needs a MANet? (VANet)
Are WSNs practical yet? (some of them are)
- lots of interference, large error rates and packet losses
- repeatable testing, realistic simulation, custom hardware

Wireless sensor networks

- potentially large networks (100's, 1000's, +)
- potentially very low energy per node
- low bit-rate traffic (temperature) to high bit-rate traffic (video)
- potentially long term deployments: reliability
- routing: most routes rarely change, but some change quickly (fixed-mobile)
- in-network processing is advantageous

Summary

- computer networks function by of agreement about what the bits mean: protocols
- layering takes a complex task and makes it manageable
- routing has a forwarding component (easy, fast) and a routing table maintenance component (complex, slow)
- wireless ad-hoc networks may enable many new products and applications

<http://www2.ics.hawaii.edu/~esb/>