Lecture 04: Networking (continue)

**Distributed Systems**
Behzad Bordbar
School of Computer Science, University of Birmingham, UK

Recap

- Various types of Networks: LAN, WAN, MAN, WLAN, WMAN
- OSI layers and protocol
- Routing and RIP algorithm

Overview

- Routing and RIP (continue)
- Other protocols: Transport layer protocols (UDP, TCP)
- Mobile routing
- WLAN and its architectural issues
- Communication Service types:
  - connectionless communication (UDP)
  - connection-oriented communication (TCP)

RIP (continue)

- When a link fails, \(\text{cost}\) in the table is set to \(\infty\)
- Then, the cost in all table is set to \(\infty (1+\infty = \infty)\)
- 3 timers: periodic, expiration, Garbage collection
- RIP is
  - slow in convergence
  - But, most of the time system stables fast
- RIP 2 addresses some of the above issues and also Authentication and Multicasting (send packets to all other router.)

Congestion control

- When load on network high (80% capacity)
  - Packet queues long, links blocked
- Strategies to address the problem
  - Packet dropping
    - reliable of delivery at higher levels
    - Dropping some packets is better than others (MPEG)
  - Reduce rate of transmission
    - Nodes send choke packets (Ethernet)
    - Transmission control (TCP)
  - Transmit congestion information to each node
    - QoS guarantees (ATM)

Review of some Protocols

- IP: transfer datagram from one host to another
  - Unreliable best effort
  - only header checksum
- TCP and UDP
  - Main transport level protocols used by IP
- MobileIP
  - Connectivity for mobile devices, even in transit
  - Device retains single IP address
  - Re-routing by Home (HA) and Foreign Agents (FA)
  - Transparent
- Wireless LAN (IEEE 802.11)
  - Radio or infra-red communications
  - CSMA/CA based
IP

Internet Protocol is unreliable and connectionless
Best effort (no error checking or Ack)

Packets called Datagram have Header
- IP address of source and destination
- Containing version, Header Length (HLEN), length (Header +data) ...
- higher level protocol ?? (info encapsulated UDP, TCP, RIP2, ...
- header checksum
- Fragmentation
- Timestamp (IP address of the router + Universal time)

Not all exploited by all higher level protocols

Transport layer protocols

UDP (basic, used for some IP functions)
- uses IP address+port number
- no guarantee of delivery, optional checksum
- messages up to 64KB

TCP (more sophisticated, most IP functions)
- data stream abstraction, reliable delivery of all data
- messages divided into segments, sequence numbers
- sliding window, acknowledgement+retransmission
- buffering (with timeout for interactive applications)
- checksum (if no match segment dropped)
- Both are process-to-process communication

Communication service types

Connectionless: UDP
- ‘send and pray’ unreliable delivery
- efficient and easy to implement

Connection-oriented: TCP
- with basic reliability guarantees
- less efficient, memory and time overhead for error correction

Connection-oriented service

TCP (Transmission Control Protocol)
- establishes data stream connection to ensure reliable, in-sequence delivery
- error checking and reporting to both ends
- attempts to match speeds (timeouts, buffering)
- sliding window: state information includes
  - unacknowledged messages
  - message sequence numbers
  - flow control information (matching the speeds)
- Used e.g. for HTTP, FTP, SMTP on Internet.

Connectionless service

UDP (User Datagram Protocol)
- messages possibly lost, duplicated, delivered out of order, without telling the user
- maintains no state information, so cannot detect lost, duplicate or out-of-order messages
- each message contains source and destination address
- may discard corrupted messages due to no error correction (simple checksum) or congestion
- Used e.g. for DNS (Domain Name System) or RIP.

MobileIP

At home normal, when elsewhere mobile host:
- notifies HA before leaving
- informs FA, who allocates temporary care-of IP address & tells HA

Packets for mobile host:
- first packet routed to HA, encapsulated in MobileIP packet and sent to FA (tunnelling)
- FAunpacks MobileIP packet and sends to mobile host
- sender notified of the care-of address for future communications which can be direct via FA

Problems
- efficiency low, need to notify HA
MobileIP routing

- Sender
- Address of FA returned to sender
- First IP packet addressed to FA
- Subsequent IP packets tunneled to FA
- Mobile host MH
- Foreign agent FA
- Internet
- First IP packet tunneled to FA

Wireless LAN (802.11)

- Radio broadcast (fading strength, obstruction)
- Collision avoidance by
  - slot reservation mechanism by Request to Send (RTS) and Clear to Send (CTS)
  - stations in range pick up RTS/CTS and avoid transmission at the reserved times
  - collisions less likely than Ethernet since RTS/CTS short random back off period
- Problems
  - security (eavesdropping), use shared-key authentication

Wireless LAN configuration

- Laptop
- Radio obstruction
- PalmPc
- Mobile phone
- Access point
- Base station
- Wireless LAN
- LAN

Summary

- Routing and RIP, various timers
- IP
- Transport layer protocols (UDP, TCP)
- Mobile routing
- WLAN and its architectural issues
- Communication Service types:
  - Connectionless vs. Connection-oriented
- Further reading: end of chapter 3 p. 130

Exercises (Lectures 3,4):

- client sends a 200 byte request message to a service, which produces a response containing 5000 bytes. Estimate the total time to complete the request in each of the following cases, with the performance assumptions listed below:
  - i) Using connection less (datagram) communication (for example, UDP);
  - ii) Using connection-oriented communication (for example, TCP);
  - iii) The server process is in the same machine as the client.
  [Latency per packet (local or remote. incurred on both send and receive): 5 ms, Connection setup time (TCP only): 5 ms, Data transfer rate: 10 Mbps MTU: 1000 bytes Server request processing time: 2 ms Assume that the network is lightly loaded.]

Exercises:

- 3.2: The Internet is far too large for any router to hold routing information for all destinations. How does the Internet routing scheme deal with this issue?
- 3.6: Can we be sure that no two computers in the Internet have the same IP addresses?
- 3.7: Compare connection less (UDP) and connection-oriented (TCP) communication for the implementation of each of the following application-level or presentation-level protocols:
  - i) "remote terminal access (for example, Telnet); ii) file transfer (for example, FTP);
  - iii) user location (for example, rwho, finger); iv) information browsing (for example, HTTP); v) remote procedure call.