Note: HW 3 posted, due next Thursday.  4/17/12

Routing

Static: ETx, Ampath, Backpressure

Ad Hoc Networks: AODV, DSR, Barag Relay

ICMN: Epidemic Flooding, Spray & Wait

Intermittently Connected Mobile Networks with perfectly predictable encounters (e.g., buses/trains with deterministic schedule)

Given: a list of all encounters & their times in advance. Find the best (shortest delay) route from node A to B.
E.g. 4 nodes: A B C D

Encounter start time

A-B 1

B-C 2

A-C 4

A-B 7

A-B 7.5

A-D 8

C-D 8.2

Goal: given the list of encounters & times, compute the shortest delay path between any two nodes for a given starting time.

One possible algorithm:

- try every permutation

  e.g. A-B-C-D
       A-C-B-D

- for each find the shortest delay
  & pick shortest of all
Another approach:
- Use Dynamic Programming

A0
B0
C0
D0

A
B
C
D

(1,1) 
(1,1)
(1,1) 
(1,1)

\[ S(A, D) = \min_{t \in d(A)} \left( \frac{S(A, K) + S(K, D)}{\frac{t}{\alpha}, + \frac{s(K, D)}{\alpha}} \right) \]

E.g., to go from A to D, consider all nodes of A:

\[ S(A, D) = \min \left( \frac{S(A, K) + S(K, D)}{\frac{t}{\alpha}, + \frac{s(K, D)}{\alpha}} \right) \]
Optim 3:

- Do a "virtual" flood
- see when the destination gets the packet & trace it back
- this is the shortest delay path.

e.g. P gets the packet at some time t from C for the first time, it makes a reverse pointer to C, labelled with time too.
Phy     MAC     Ethernet     Transport

Functions of the Transport Layer

- Congestion control & flow control
- End to end reliability
- Multiplexing applications
  - Different on wireless networks vs. using ports

UDP on a wireless network needs no modification.

Reliability:
- Missing packets
- Out of order packets
  - Both typically detected using sequence numbers
  - By buffering at the transport layer, reordering, & then sending to application.
Missing plots at the end to end perspective can only be dealt with by source retransmissions.

\[ = \text{end to end acks} \text{acks are needed.} \]

Recall that we also typically use hop by hop ARQ & Ack's. In fact, this way we use ETX as the only metric.

Although in theory this should ensure even and to end reliability, in practice number of retransmission attempts are capped at some finite value, really in some type of link loss. (Also due to radio breaks).
Congestion Control turns out to be a bit more challenging in Wireless Networks.

Two parts to Congestion:

1. Arriving Traffic
2. Available Bandwidth

In communication networks, the net effect of congestion is increased end to end delays & packet loss.

Extreme solution: conservatively provision traffic for worst-case bandwidth availability.
Congestion control mechanisms must balance two conflicting objectives:
1. Avoid congestion
2. Maximize utilization

TCP: Transmission Control Protocol (for congestion control)
At its heart are two pieces:
1. Congestion detection
2. Response to congestion

Typically, 1: Loss detection via timeouts for ACK reception
2: Additive Increase Multiplicative Decrease
Idealized model:

Example:

$R_{\text{max}}$

Source

Max efficiency is $75\%$

Diagram