IP

Lecture 11:

Operating Systems and Networks

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recap

- processes communicating same machine: shared object and pipe
- Need network to communicate across machines
- Different type of network
- Modes of transmission (circuit switching and packet switching)
- protocols: (well-known set of rules and formats to be used for communication between processes to perform a given task)
- OSI view [most layers interacting with layer below or above]

Contents

- IP
- Datagram
- Routing protocol RIP1
- other IP protocols
- ping traceroute….

IP

- TP: transmission mechanism used by TCP and UDP
- uses other protocols ARP, RARP, ICMP …
- Best effort delivery (post office in Romeo): Unreliable and connectionless protocol
- No error checking or tracking
- Datagrams can be lost for various reasons
- noise converting a 0 to 1
- Congested router might drop packages
- loop because of bad networking and datagram times out
- broken link
- IP must be paired with another protocol to become reliable

Datagram

- packets in IP: two parts Header and data

Header (20-60 bytes)

- version (4bits) IPv4
- HLEN: Header Length (4bits) (0…15 multiple of 4)
- service type (8bits)(priority, throughput, delay
- Total length (16bits) 65535 bytes
- …
- Time to live (8bits) how many hops can go
- protocol (8bits)

Datagram

- Header checksum (16 bits)
- Source IP address
- Destination IP address

Body

How can I see the packets?

At home… not here!!!!

tcpdump or wireshark (windump on windows)

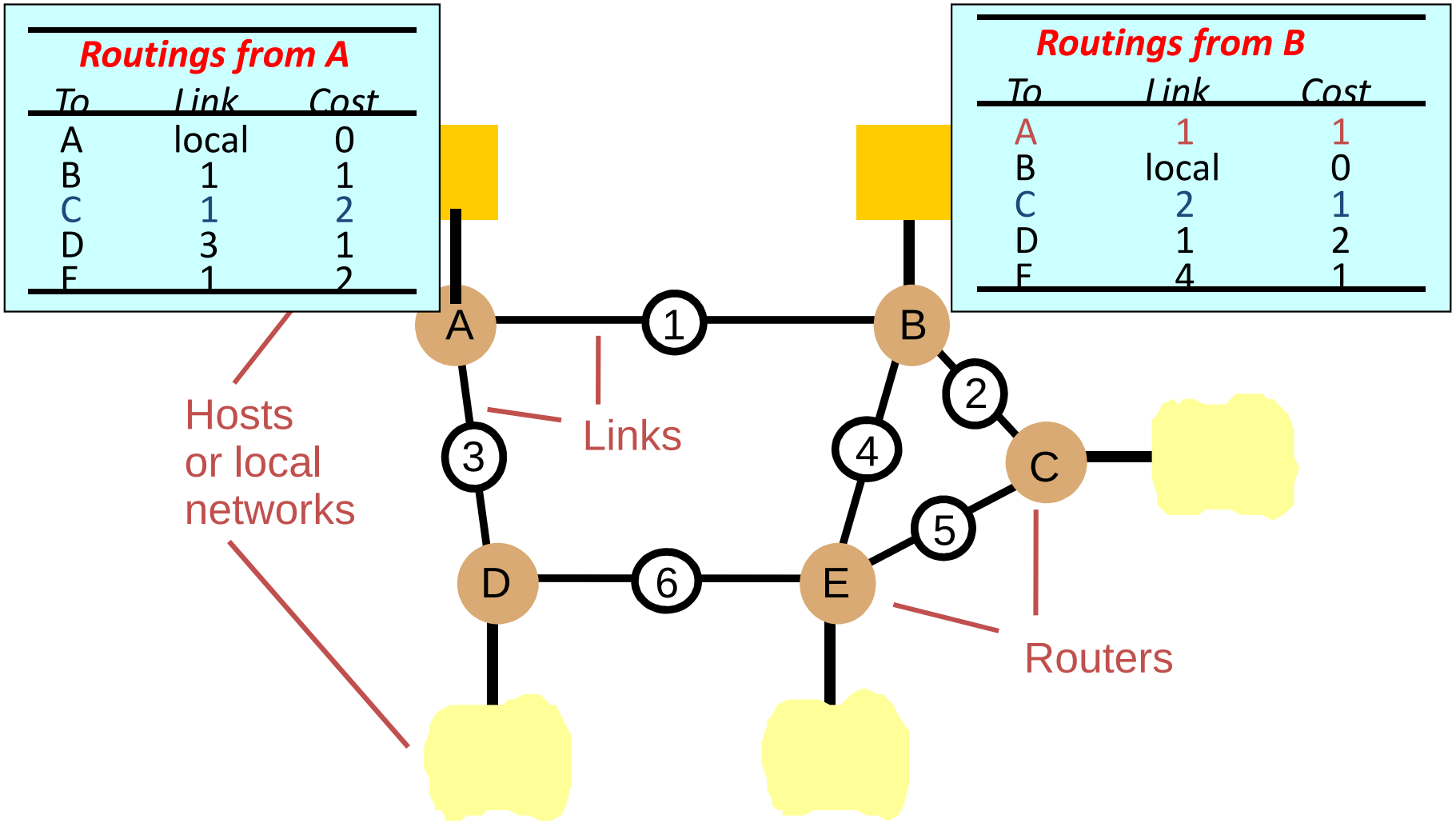
observe mac addresses …

Routing

- Necessary in non-broadcast networks (cf Internet)
- Next we look at a simple routing algorithm which IP is base on called Distance-vector algorithm
- each nodestores table of state
- cost info of links,
- cost infinity for faulty links
- determines route taken by packet (the next hop)
- periodically updates the table and sends to neighbours
- Theoretical foundation [Bellman-Ford]

- Internet similar except
  - use default routes, plus multicast and authentication
  - better convergence

Routing example



Routing tables

Routings from A

To	*Link*	*Cost*
A	local	0
B	1	1
C	1	2
D	3	1
E	1	2

Routings from B

To	*Link*	*Cost*
A	1	1
B	local	0
C	2	1
D	1	2
E	4	1

Routings from C

To	*Link*	*Cost*
A	2	2
B	2	1
C	local	0
D	5	2
E	5	1

Routings from D

To	*Link*	*Cost*
A	3	1
B	3	2
C	6	2
D	local	0
E	6	1

Routings from E

To	*Link*	*Cost*
A	4	2
B	4	1
C	5	1
D	6	1
E	local	0

RIP routing algorithm

Update: Each *30* seconds or when local table changes, send update on each non-faulty outgoing link.

Propagation*:*When router X finds that router Y has a shorter and faster path to router Z, then it will update its local table to indicate this fact. Any faster path is quickly propagated to neighbouring rotes through the ***Update*** process.

Shown to converge by mathematicians (Bertsekas).
See next slide for details.

RIP routing algorithm

Variables: Tl local table, *Tr* table received.

Send: Each *t* seconds or when *Tl* changes, send *Tl* on each non-faulty outgoing link.

Receive: Whenever a routing table *Tr* is received on link *n*:

```
for all rows Rr in Tr {
    if (Rr.link != n) {
        Rr.cost = Rr.cost + 1;
        Rr.link = n;
        if (Rr.destination is not in Tl) add Rr to Tl;
         // add new destination to Tl
        else for all rows Rl in Tl {
            if (Rr.destination = Rl.destination and
                    (Rr.cost < Rl.cost or Rl.link = n)) Rl = Rr;
            // Rr.cost < Rl.cost : remote node has better route
            // Rl.link = n : remote node is more authoritative
        }
    }
}
```

Sample routes

- Send from C to A:
  - to link 2, arrive at B
  - to link 1, arrive at A
- Send from C to A if B table modified to:
  - to link 5, arrive at E
  - to link 4, arrive at B
  - to link 1, arrive at A
- NB extra hop.

Routings from C

To	*Link*	*Cost*
B	2	1
C	local	0
E	5	1
default	5	-

other protocols that IP uses

- Address Resolution Protocol (ARP) associates an IP address with the physical address
- what is the ip address of www.cs.bham.ac.uk
- host makes an arp packet broadcast to everybody… all ignore except the host that ip belongs to

$arp www…

you can use tcpdump to see the arp packets

- Reverse Address Resolution protocol (RARP) the other way

other protocols that IP uses

- Internet Control Message Protocol (ICMP) mechanism to send (by host and routers) send notification about the datagram back to sender. … similar to postcard by julliet.

Exercise:

- learn about IP addresses and Mask
- ping
- traceroute