Week 6 – Network Layer Contd

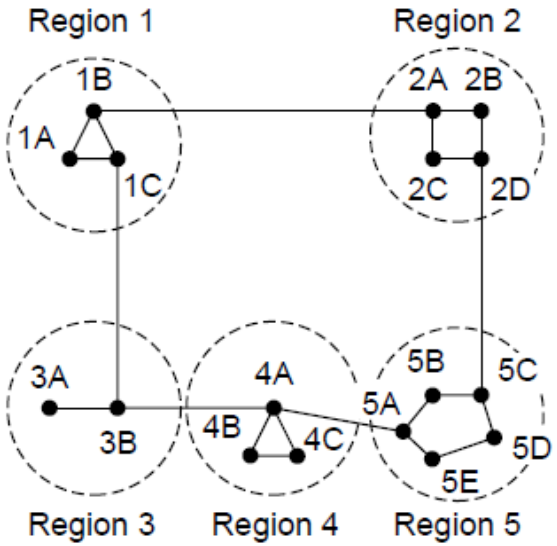
Internet Technologies
COMP90007

Hierarchical Routing

- As networks grow in size, routing tables expand but this impacts CPU and memory requirements
- Dividing all routers into regions allows efficiencies
  - Each router knows everything about other routers in its region but nothing about routers in other regions
  - Routers which connect to two regions act as exchange points for routing decisions

Hierarchical routing contd.

- Hierarchical routing reduces the work of route computation but may result in slightly longer paths than flat routing



Full table for 1A

Dest.	Line	Hops
1A	–	–
1B	1B	1
1C	1C	1
2A	1B	2
2B	1B	3
2C	1B	3
2D	1B	4
3A	1C	3
3B	1C	2
4A	1C	3
4B	1C	4
4C	1C	4
5A	1C	4
5B	1C	5
5C	1B	5
5D	1C	6
5E	1C	5

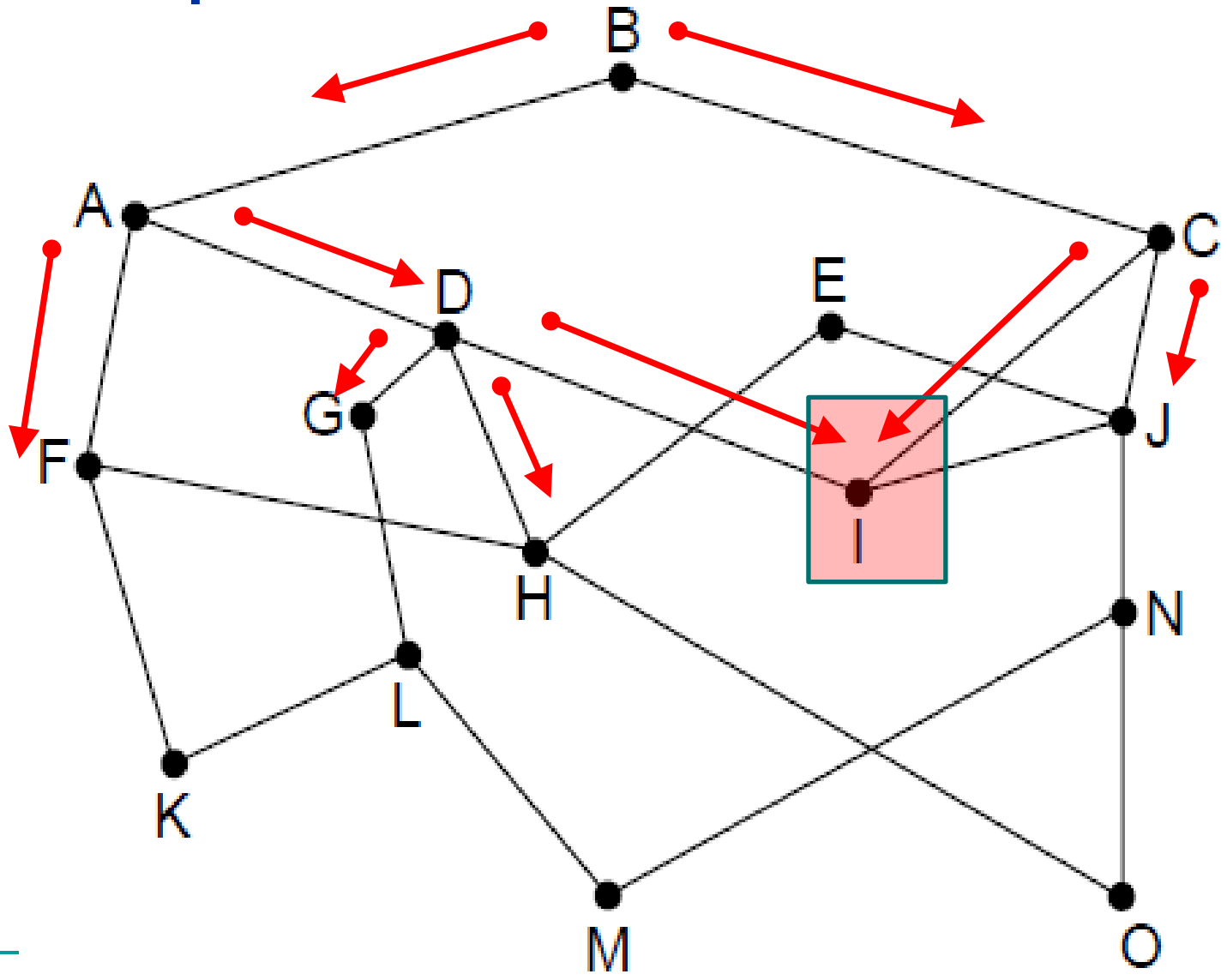
Hierarchical table for 1A

Dest.	Line	Hops
1A	–	–
1B	1B	1
1C	1C	1
2	1B	2
3	1C	2
4	1C	3
5	1C	4

Flooding

- A non-adaptive algorithm
- **Every incoming packet is sent out on every outgoing line except the one on which it arrived**
- Generates a large number of duplicate packets - inefficient
- Selective flooding (where routers send packets only on links which are in approximately the right direction) is an improved variation

Example



Link State Routing

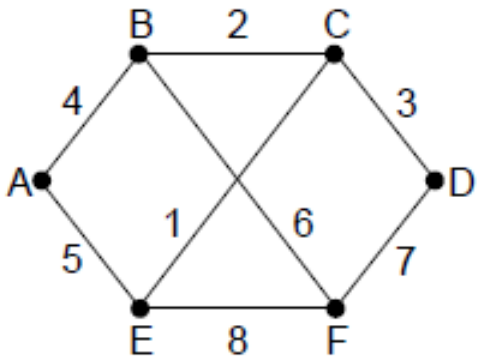
- A dynamic algorithm
  - An alternative to distance vector
    - **DV** - primary problem that caused its demise in late 70s was that the algorithm often took **too long to converge** after the network topology changed
  - Used in the Internet (under names OSPF, ISIS)
  - More computation but simpler dynamics

Link State Routing

- Each router has to do 5 steps:
  1. Discover neighbours and learn their network addresses
  2. Measure delay or cost to each neighbour
  3. Construct packet with all the info
  4. Send this packet to all other routers/receive similar packets
  5. Compute the shortest path to every other router
- "Local information shared globally"

Building link state packets

- LSP (Link State Packet) for a node lists neighbors and weights of links to reach them



Network

Link State Packets

A	
Seq.	
Age	
B	4
E	5

B	
Seq.	
Age	
A	4
C	2
F	6

C	
Seq.	
Age	
B	2
D	3
E	1

D	
Seq.	
Age	
C	3
F	7

E	
Seq.	
Age	
A	5
C	1
F	8

F	
Seq.	
Age	
B	6
D	7
E	8

LSP for each node

Difficulty is…

- The hard part is determining when to build LSP and how to send these packets
- Smart flooding is used with sequence numbers and age fields for sending
- Periodically, that is, at regular intervals is when to build
- Build them when some significant event occurs as well, such as a line or neighbour going down or coming back up again or changing its properties appreciably

Broadcast Routing

- Broadcast routing allows hosts to send messages to many or all other hosts
  - Single distinct packet (inefficient, source needs all destination addresses)
  - Multi-destination routing which means routers do the replication when needed (more efficient but source needs to know a lot still)
  - Flooding with improvements such as sequence numbers we have seen

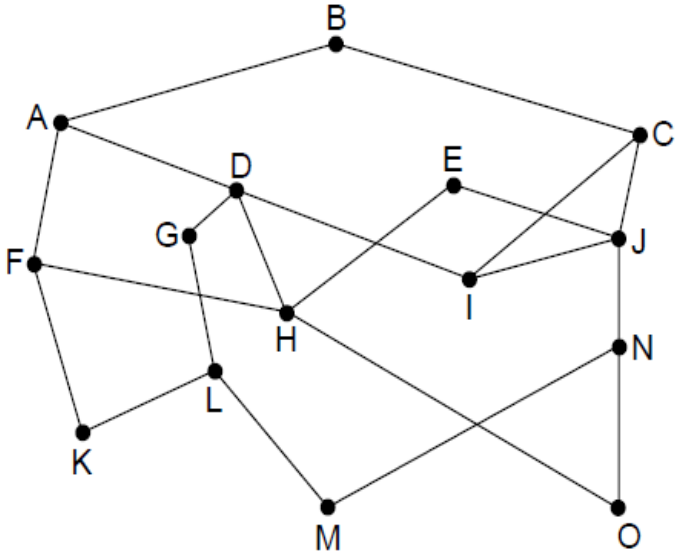
Broadcast Routing Contd

- Even better: *Reverse path forwarding*
- When a broadcast packet arrives at a router, the router checks to see **if the packet arrived on the line normally used for sending packets to the source of the broadcast**. If so there is a high probability that the route used is the best route and data is fresh. The router then forwards the packet onto all other lines.
- If the broadcast **packet arrived on a link other than the preferred one for reaching the source, the packet is discarded** as a likely duplicate.

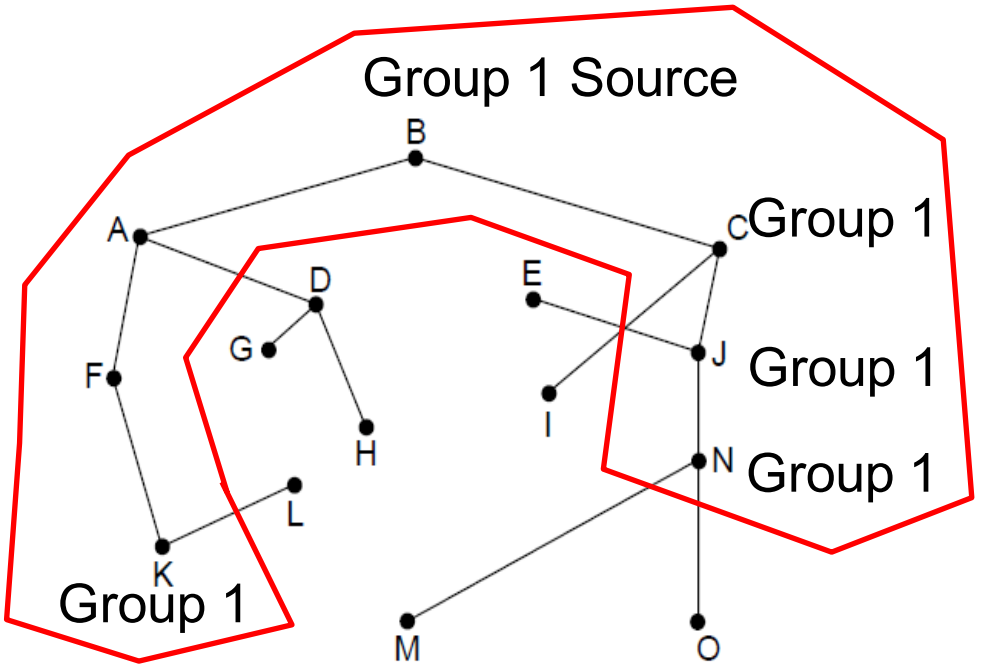
Multicast Routing

- A routing algorithm used to send a message to a **well-defined group** within the whole network
- Each router computes a **spanning tree** covering all other routers – the first router to receive the packet prunes the spanning tree to eliminate all lines which do not lead to members of the group for multicasting to the group

Example



Network



A spanning tree sourced at B and multicast tree to reach Group 1 highlighted