Internet Engineering

241-461

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Contents

Routing Algorithms

- Routing Algorithm
  - Graph Traversal Algorithm
- Routing Protocol
  - Algorithm
  - Plus details needed
    - To make it practical
    - (Where does the information come from?)
- Concentrate on
  - Distributed
  - Dynamic
    - Protocols
- This is the interesting selection
  - Centralised
    - Not different (Harder information collection)
  - Static
    - Either the same (Or very boring)

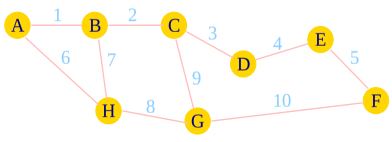
Algorithms

- Two classes of algorithm
  - Bellman-Ford
  - Dijkstra
- Examine both
  - Start with Bellman-Ford
- Bellman-Ford Algorithms
  - Each node tells neighbours
    - All destinations it knows
    - And cost to reach each
  - And tells again
    - Each time information changes
  - That's It!

Contents

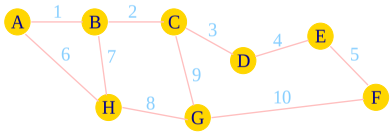
- What is Routing?
- Types of Routing
- What has to be done?
- The Routing Problem
- Routing Algorithms
  - Bellman-Ford (Distance Vector)
  - Dijkstra (Link State)
- Hierarchical Routing
- Exterior Routing

B-F Example



- Letters indicate node names
- Numbers indicate destinations
  - Not Costs
- All links have cost of 1
  - Then path cost == distance
    - Number of hops
  - Distance Vector Protocols
- Each node sends vector of all known destinations to all neighbour nodes
  - Contains destination, and cost (distance)

B-F Example (2)

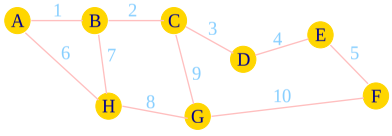


A: Know 1 cost 0
A: Know 6 cost 0

B: Know 1 cost 0
B: Know 2 cost 0
B: Know 7 cost 0

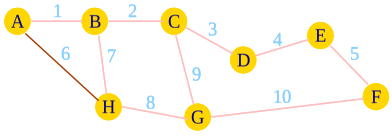
H: Know 6 cost 0
H: Know 7 cost 0

B-F Example (3)



A: Know 1 cost 0	direct	
A: Know 6 cost 0	direct	
A: Know 2 cost 1	via B	
A: Know 7 cost 1	via B	(or H)
A: Know 8 cost 1	via H	
B: Know 1 cost 0	direct	
B: Know 2 cost 0	direct	
B: Know 7 cost 0	direct	

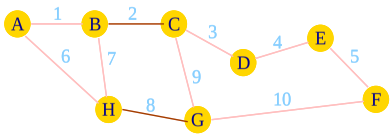
Split Horizon



G: Know 6 cost 1
F: Know 6 cost 2

- Link from H to net 6 breaks
  - G: Know 6 cost 3
  - F: Know 6 cost 2
- Forwarding Loop
  - Don't advertise route to the node
  - to which you will send traffic
    - Split Horizon
    - Don't send same information everywhere

Counting to Infinity



B: Know 3 cost 1
A: Know 3 cost 2
H: Know 3 cost 2

- Links 2 & 8 break

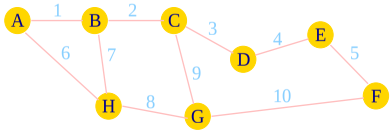
H: Know 3 cost 3
B: Know 3 cost 4
A: Know 3 cost 5
H: Know 3 cost 6
B: Know 3 cost 7

RIP

- Routing Information Protocol
- Sends distance vector to neighbours
  - every 30 seconds
  - 180 seconds + no update -> gone
- 24 (25) routes/packet (512 byte limit)
- Infinity == 16
- Usually implements split horizon
- Usually implements triggered updates
  - Send an update whenever a route change occurs
- Usually implements hold-downs
  - Don't overreact to routing changes

Contents

Dijkstra's Algorithm

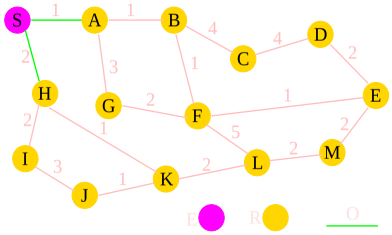


- Each node tells every other node its links
  - A: I have connections to 1, 6
  - B: I have connections to 1, 2, 7
  - C: I have connections to 2, 3, 9
  - H: I have connections to 6, 7, 8
    - This is Link State
      - Hence: Link State Algorithms
- All nodes receive all advertisements
  - Each can build the graph
  - Each knows topology of the net

Shortest Path First

- Algorithm from Dijkstra
- Allows nodes to find path to any destination through a graph
  - Create 2 sets & a list
    - Set of all known reachable nodes (E)
    - Set of all unknown destinations (R)
    - ordered list of all paths found (O)
  - Order list of paths by path cost (length)
    - Shortest Path First
  - Set E to contain the source node (S)
  - Add direct paths from S to O

SPF (1)

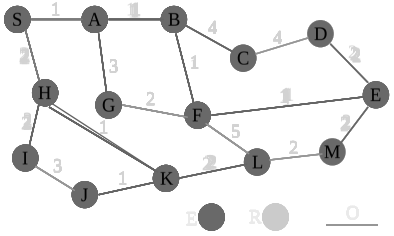


- Here
  - Numbers on arcs are costs
  - Names on nodes are destinations

SPF (2)

- Take shortest path from O
- If destination in E, drop, repeat
- Add destination to E
- add to O all destinations from that path
  - keep list ordered
- repeat
- When done, anything in unknown set is unreachable
- Every other path is shortest to destination

SPF Example



- At end O contains

S-A (1) S-A-B (2) S-H (2)
S-H-K (3) S-A-B-F3) S-A-G (4)
S-H-I (4) S-H-K-J (4) S-A-B-F-E (4)
S-H-K-L (5) S-A-B-C (6) S-A-B-F-E-D (6)
S-A-B-F-E-M (6)

- Paths from S
  - To all destinations
  - Paths from other sources different