University of Massachusetts Amherst

ECE697AA – Lecture 8

Routing: Centralized Routing Algorithms

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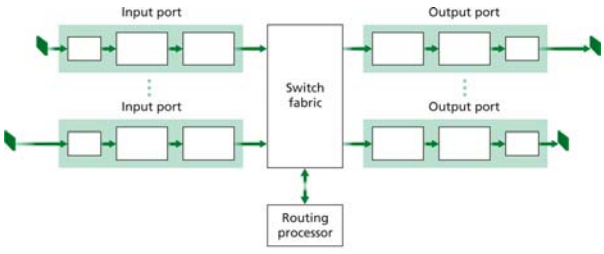
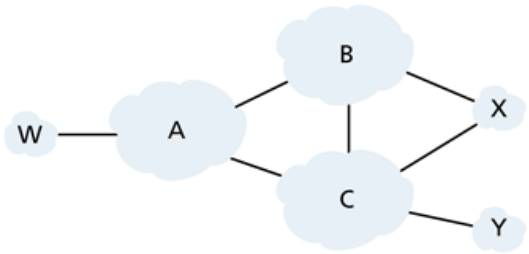
Routing problem

- Routing problem: in which direction to send packets?
  - Need to get packet to destination
  - Need to find cheap(est?) path
  - Need to adapt to changing network conditions
- Routing vs. forwarding
  - Routing maintains path cost, multiple paths, etc.
  - Forwarding is condensed information



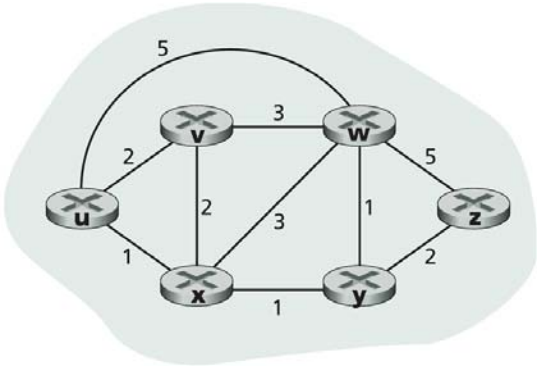
Routing problem

- Why is routing difficult?



Routing algorithms

- Representation of network as graph
  - Routers as nodes
  - Links as edges
    - » Link weights determine cost
- Routing problem as graph problem
  - Find the least cost path from u to z



Exchanging routing information

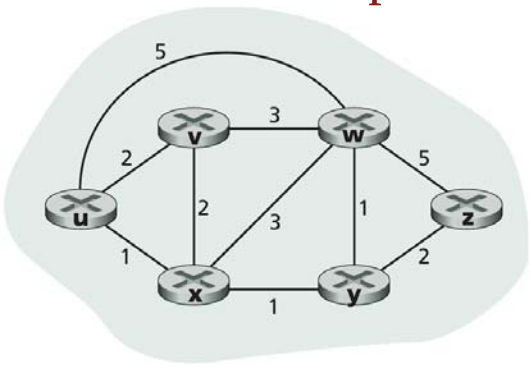
- Centralized approach
  - Each node has full "view" of network
  - Each node calculates shortest path using routing algorithm
  - "Link state algorithm"
  - (Exchange of link information always decentralized)
- Distributed approach
  - Each node computes best path without full view
  - Shortest path computed as link information is exchanged
  - "Distance vector algorithm"

Link state algorithm

- Link cost of all links is broadcast to all nodes
- Dijkstra's algorithm to find shortest path to all nodes
  - Each node calculates its own tree
- Notation:
  - D(v) is least cost to v in current iteration
  - p(v) is previous node along least cost path
  - N' is subset of nodes with guaranteed least cost paths
- Algorithm
  - Initialization:
    - » N'={u}
    - » For all nodes v: if neighbor of u then D(v)=c(u,v), else D(v)=∞
  - Loop until N'=N:
    - » Find w∉N' with minimum D(w) and add w to N'
    - » For each neighbor v of w (v∉N'): D(v)=min(D(v),D(w)+c(w,v))

Link state example

- Example:

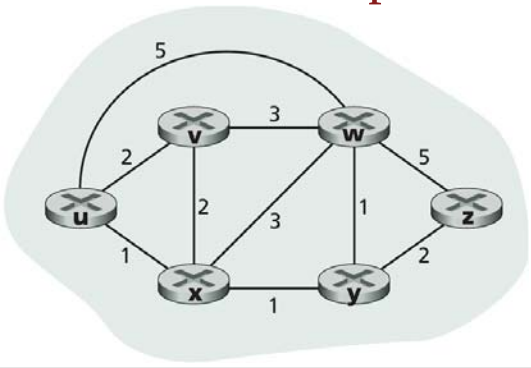


- Iterations:

step	N'	D(v),p(v)	D(w),p(w)	D(x),p(x)	D(y),p(y)	D(z),p(z)
0						
1						
2						
3						
4						
5						

Link state example

- Example:

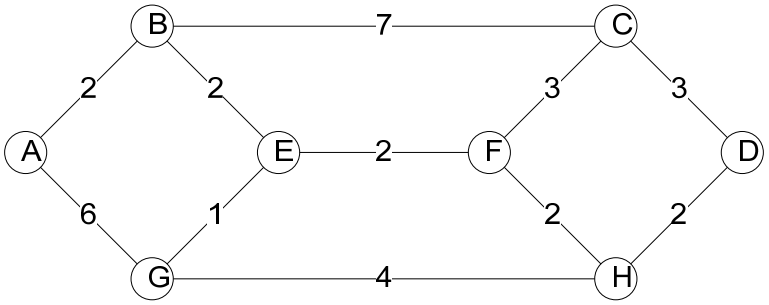


- Iterations:

step	N'	D(v),p(v)	D(w),p(w)	D(x),p(x)	D(y),p(y)	D(z),p(z)
0	{u}	2,u	5,u	1,u	∞	∞
1	{ux}	2,u	4,x		2,x	∞
2	{uxy}	2,u	3,y			4,y
3	{uxyv}		3,y			4,y
4	{uxyvw}					4,y
5	{uxyvwz}					

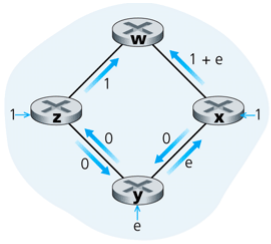
Worksheet

- Try yourself:

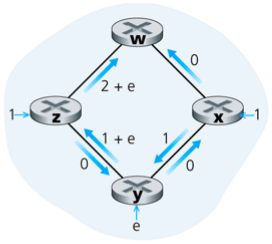


Link state problem

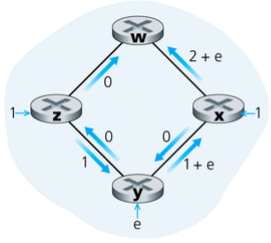
- Route oscillations
- Example:
  - x,y, and z send to w
  - Link cost depends on traffic load



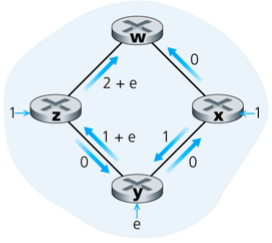
a. Initial routing



b. *x, y* detect better path to *w*, clockwise



c. *x, y, z* detect better path to *w*, counterclockwise



d. *x, y, z,* detect better path to *w*, clockwise

Assignments

- Read
  - Kurose & Ross: Chapter 4.6
- SPARK
  - Assessment quiz