

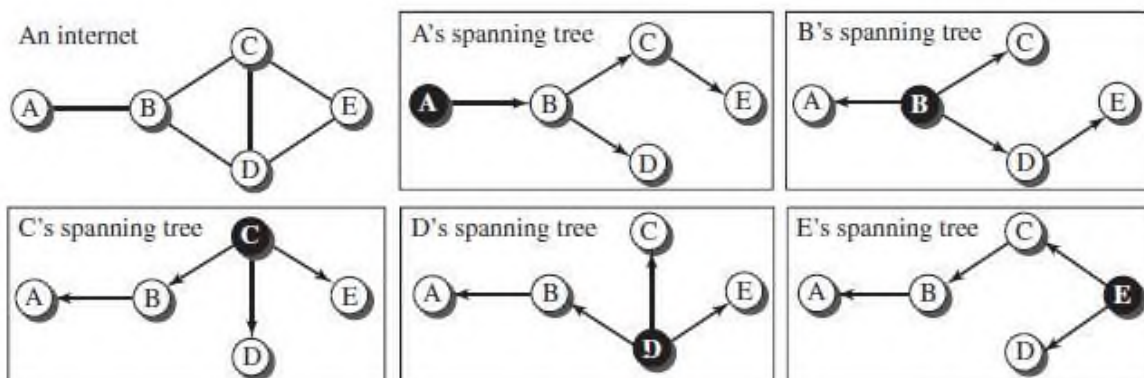
4.5 PATH VECTOR ROUTING (PVR) & BORDER GATEWAY PROTOCOL (BGP)

- Path-vector routing is an asynchronous and distributed routing algorithm.
- The Path-vector routing is not based on least-cost routing.
- The best route is determined by the source using the policy it imposes on the route.
- In other words, the source can control the path.
- Path-vector routing is not actually used in an internet, and is mostly designed to route a packet between ISPs.

Spanning Trees

Example:

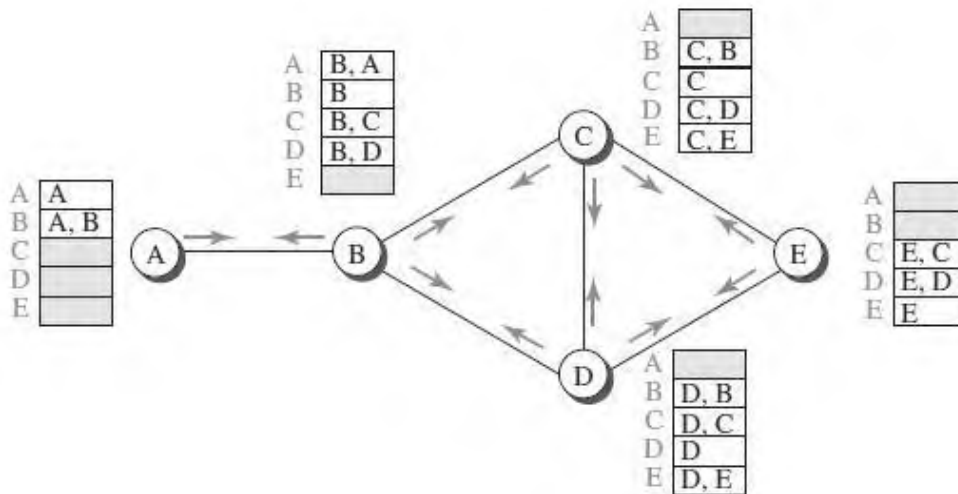
- The Figure below shows a small internet with only five nodes.
- Each source has created its own spanning tree that meets its policy.
- The policy imposed by all sources is to use the minimum number of nodes to reach a destination.
- The spanning tree selected by A and E is such that the communication does not pass through D as a middle node.
- Similarly, the spanning tree selected by B is such that the communication does not pass through C as a middle node



Path Vectors made at booting time

- The Figure below shows all of these path vectors for the example.
- Not all of these tables are created simultaneously.
- They are created when each node is booted.

- The figure also shows how these path vectors are sent to immediate neighbors after they have been created.



Updating Path Vectors

- The Figure below shows the path vector of node C after two events.
- In the first event, node C receives a copy of B's vector, which improves its vector: now it knows how to reach node A.
- In the second event, node C receives a copy of D's vector, which does not change its vector.
- The vector for node C after the first event is stabilized and serves as its forwarding table.

New C		Old C		B	
A	C, B, A	A		A	B, A
B	C, B	B	C, B	B	B
C	C	C	C	C	B, C
D	C, D	D	C, D	D	B, D
E	C, E	E	C, E	E	

$C[] = \text{best}(C[], C + B[])$

Event 1: C receives a copy of B's vector

New C		Old C		D	
A	C, B, A	A	C, B, A	A	
B	C, B	B	C, B	B	D, B
C	C	C	C	C	D, C
D	C, D	D	C, D	D	D
E	C, E	E	C, E	E	D, E

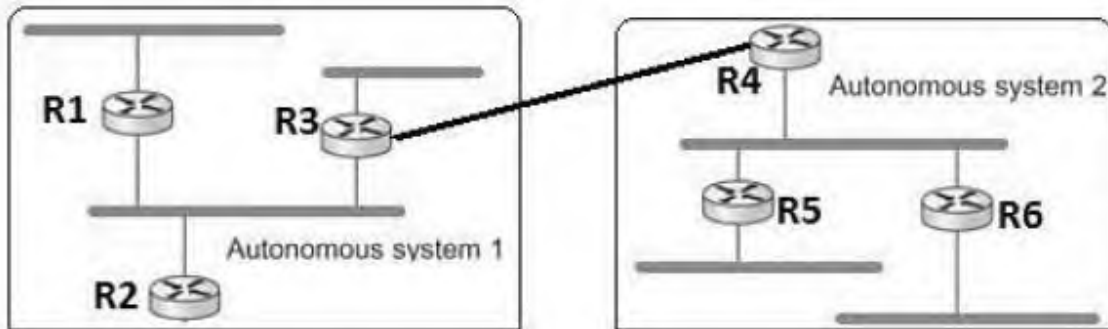
$C[] = \text{best}(C[], C + D[])$

Event 2: C receives a copy of D's vector

BORDER GATEWAY PROTOCOL (BGP)

- The Border Gateway Protocol version (BGP) is the only interdomain routing protocol used in the Internet today.

- BGP4 is based on the path-vector algorithm. It provides information about the reachability of networks in the Internet.
- BGP views internet as a set of autonomous systems interconnected arbitrarily.



- Each AS have a *border router* (gateway), by which packets enter and leave that AS. In above figure, *R3* and *R4* are border routers.
- One of the router in each autonomous system is designated as *BGP speaker*.
- BGP Speaker *exchange* reachability information with other BGP speakers, known as *external BGP* session.
- BGP advertises complete *path* as enumerated list of AS (path vector) to reach a particular network.
- Paths must be without any *loop*, i.e., AS list is unique.
- For *example*, backbone network advertises that networks 128.96 and 192.4.153 can be reached along the path $\langle AS1, AS2, AS4 \rangle$