University of Hertfordshire

Wireless Mobile & Multimedia Networking

7COM1076

Ad-hoc Networks 2

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Outline

- **Table Driven Routing protocols**
- **DSDV**
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  - Basic operation
  - Routing table Structure
  - Sequence Number
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  - Route Updating
- **DSDV Routing Establishment**
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- **DSDV Route Maintenance**
  - Link Breakage
- **Stability and Scalability**

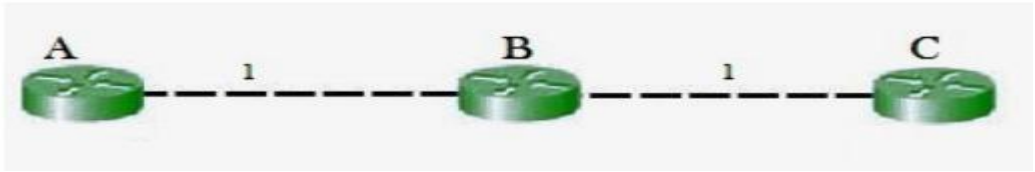
Table Driven Routing protocols

- They are extension of wired network routing protocols.
- They maintain the global topology information in the form of tables in every node.
- These tables are updated frequently in order to maintain consistent and accurate network state information.
  - Destination Sequenced Distance-Vector (DSDV)
  - Wireless Routing protocol (WRP)
  - Source-tree Adaptive Routing Protocol (STAR)
  - Cluster-Head Gateway Switch Routing Protocol (CGSR)

Destination Sequenced Distance-Vector Routing Protocol

- Enhanced version of Bellman-Ford routing protocol
- Loop free
  - Tag each routing table entry with a Destination sequence number
- Faster convergence
  - Make immediate route advertisement on significant changes in routing table
  - but wait with advertising of unstable routes (damping fluctuations)
- Counter the count-to-infinity problem

Count–to–Infinity problem



Routing table of A

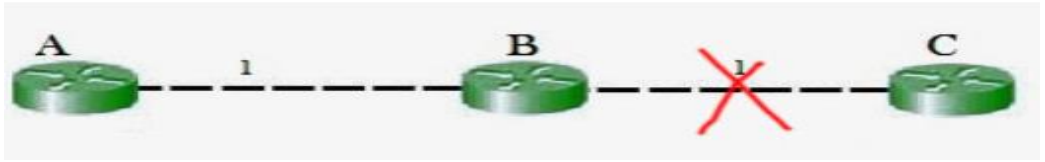
dest	next node	dist
A	A	0
B	B	1
C	B	2

Routing table of B

dest	next node	dist
B	B	0
A	A	1
C	C	1

Routing table of C

dest	next node	dist
C	C	0
B	B	1
A	B	2



Routing table of A

dest	next node	dist
A	A	0
B	B	1
C	B	2

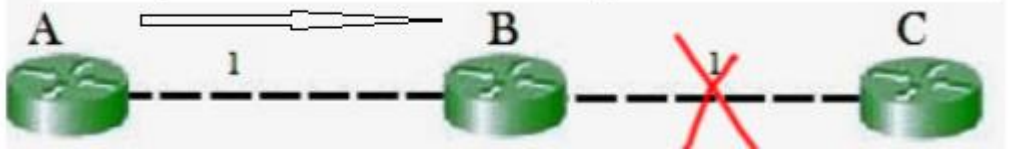
Routing table of B

dest	next node	dist
B	B	0
A	A	1

Routing table of C

dest	next node	dist
C	C	0
B	B	1
A	B	2

A sends update to B before B sends update about the broken link



A sends its update to B

Routing table of A

dest	next node	dist
A	A	0
B	B	1
C	B	2

Routing table of B

dest	next node	dist
B	B	0
A	A	1

After getting update from A, B will assume it can reach C through A with 3 hops

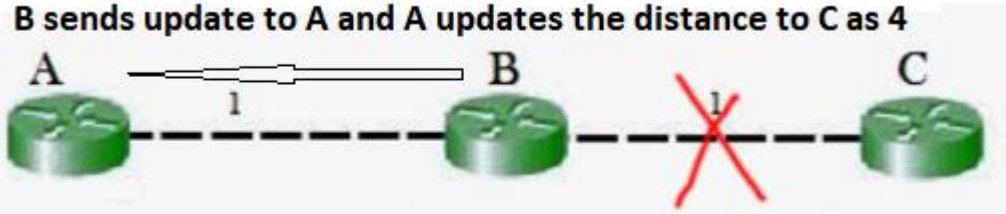
Routing table of A

dest	next node	dist
A	A	0
B	B	1
C	B	2

Routing table of B

dest	next node	dist
B	B	0
A	A	1
C	A	3

B sends update to A and A updates the distance to C as 4



Routing table of A

dest	next node	dist
A	A	0
B	B	1
C	B	4

Routing table of B

dest	next node	dist
B	B	0
A	A	1
C	A	3

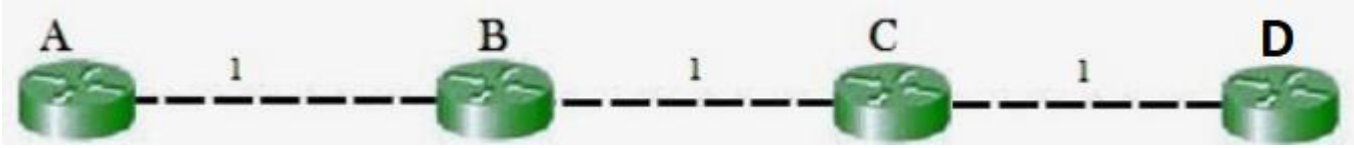
Basic operation - DSDV

- Each node maintains routing information for all known destinations
- Routing information must be updated periodically (no sleeping nodes)
- Traffic overhead even if there is no change in network topology
- Maintains routes which are never used

Basic operation – DSDV (cont.)

- Tables are exchanged between neighbors at regular intervals to keep up-to-date view of the network topology
- Routes to ALL destinations are readily available at every node at all times.
- Table updates are initiated by a destination with a new sequence number always greater than the previous one.

Routing Table Structure



Routing table of A

Dest	NextNode	Dist	SeqNo
A	A	0	A-550
B	B	1	B-102
C	B	2	C-588
D	B	3	D-312

- Dest: destination node
- NextNode: go to the destination through this node
- Dist: distance of going to the destination through the NextNode.
- SeqNo: sequence number originated from destination.

Use of Sequence Number

- Destination sequenced
- On each advertisement the sender increases its own destination sequence number (use only even numbers)
- If a node is no more reachable (timeout) increase sequence number of this node by 1 (odd sequence number) and set metric = ∞
- Ensures a route is loop-free and fresh.

Route Advertisement

- Routing information in tables is transmitted by broadcast.
- Route advertisements are transmitted periodically or immediately when any significant topology change is available.
- Two types of advertisement
  - Full dump: all information from the transmitting node
  - Incremental dump: all information that has changed since the last full dump
  - Full dump if incremental dump exceeds one NPDU (network protocol data unit)

Route Updating

- Rules
  - The route entry with the higher sequence number is chosen;
  - If the sequence numbers of two route entries are the same, the one with the smaller metric is chosen

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DSDV Route Establishment & Maintenance

- **Example of Building Routing Tables (1)**
  - Initial states

Dest.	Next	Dist	Seq
A	A	0	A-0

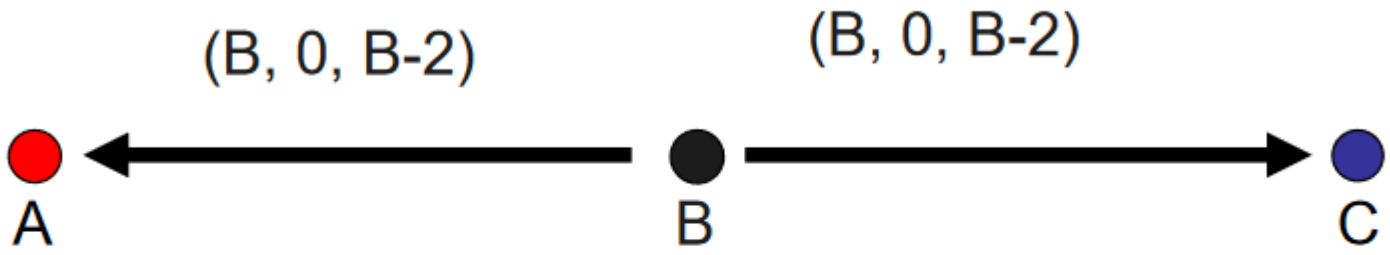
Dest.	Next	Dist	Seq
B	B	0	B-0

Dest.	Next	Dist	Seq
C	C	0	C-0

DSDV Route Establishment & Maintenance

Example of Building Routing Tables (2)

- B advertises a full dump.
- A receives the advertisement and updates its routing table.
- C receives the advertisement and updates its routing table.



Dest.	Next	Dist	Seq
A	A	0	A-0
B	B	1	B-2

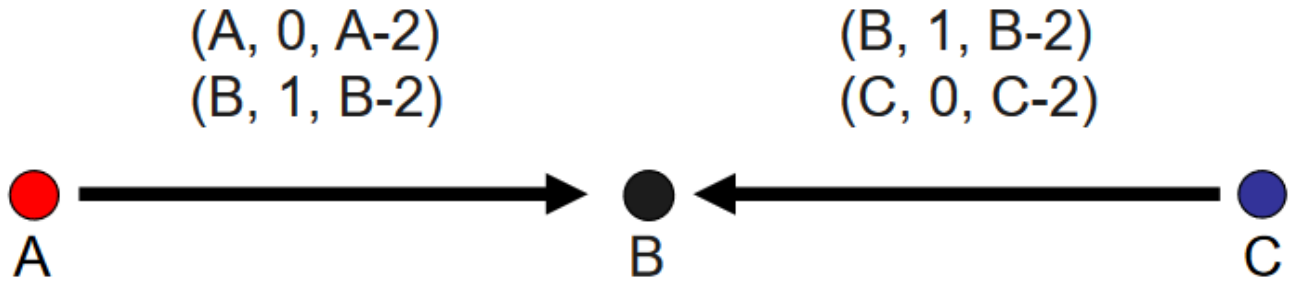
Dest.	Next	Dist	Seq
B	B	0	B-2

Dest.	Next	Dist	Seq
B	B	1	B-2
C	C	0	C-0

DSDV Route Establishment & Maintenance

Example of Building Routing Tables (3)

- A advertises a full dump
- C advertises a full dump
- B receives both advertisements and updates its routing table.



Dest.	Next	Dist	Seq
A	A	0	A-2
B	B	1	B-2

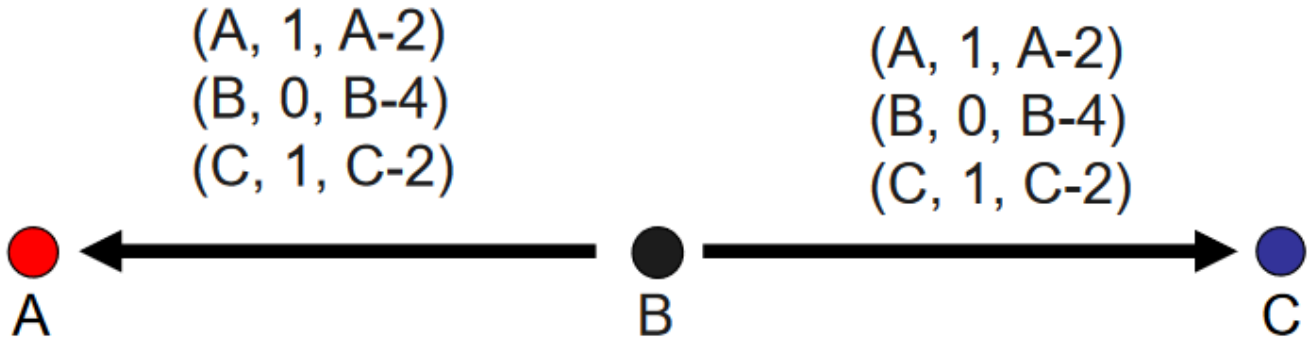
Dest.	Next	Dist	Seq
A	A	1	A-2
B	B	0	B-2
C	C	1	C-2

Dest.	Next	Dist	Seq
B	B	1	B-2
C	C	0	C-2

DSDV Route Establishment & Maintenance

Example of Building Routing Tables (4)

- B advertises a full dump
- A receives the advertisement and updates its routing table
- C receives the advertisement and updates its routing table



Dest.	Next	Dist	Seq
A	A	0	A-2
B	B	1	B-4
C	B	2	C-2

Dest.	Next	Dist	Seq
A	A	1	A-2
B	B	0	B-4
C	C	1	C-2

Dest.	Next	Dist	Seq
A	B	2	A-2
B	B	1	B-4
C	C	0	C-2

DSDV Route Establishment & Maintenance

Example of New Node (1)

- New node D comes and broadcasts its existence.
- C receives D's advertisement, updates its routing table

Dest.	Next	Dist	Seq
A	A	0	A-24
B	B	1	B-24
C	B	2	C-24

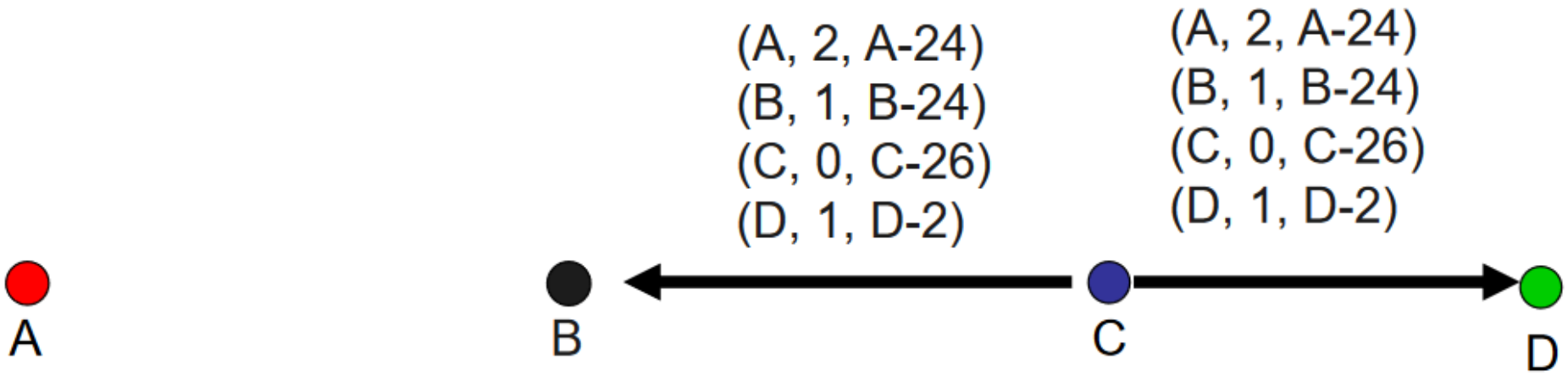
Dest.	Next	Dist	Seq
A	A	1	A-24
B	B	0	B-24
C	C	1	C-24

Dest.	Next	Dist	Seq
A	B	2	A-24
B	B	1	B-24
C	C	0	C-24
D	D	1	D-2

DSDV Route Establishment & Maintenance

Example of New Node (2)

- C broadcasts a full dump immediately



Dest.	Next	Dist	Seq
A	A	0	A-24
B	B	1	B-24
C	B	2	C-24

Dest.	Next	Dist	Seq
A	A	1	A-24
B	B	0	B-24
C	C	1	C-24

Dest.	Next	Dist	Seq
A	B	2	A-24
B	B	1	B-24
C	C	0	C-26
D	D	1	D-2

DSDV Route Establishment & Maintenance

Example of New Node (3)

- D creates the routing table based on C's advertisement.
- B updates its routing table

Dest.	Next	Dist	Seq
A	A	1	A-24
B	B	0	B-24
C	C	1	C-26
D	C	2	D-2

Dest.	Next	Dist	Seq
A	B	2	A-24
B	B	1	B-24
C	C	0	C-26
D	D	1	D-2

Dest.	Next	Dist	Seq
A	C	3	A-24
B	C	2	B-24
C	C	1	C-26
D	D	0	D-2

DSDV Route Establishment & Maintenance

Example of Link Breakage (1)

Node D leaves, and node C detects the link breakage, and updates its routing table by setting the distance to D as infinity and increasing the sequence number to D by 1.

Dest.	Next	Dist	Seq
A	A	1	A-34
B	B	0	B-34
C	C	1	C-34
D	C	2	D-10

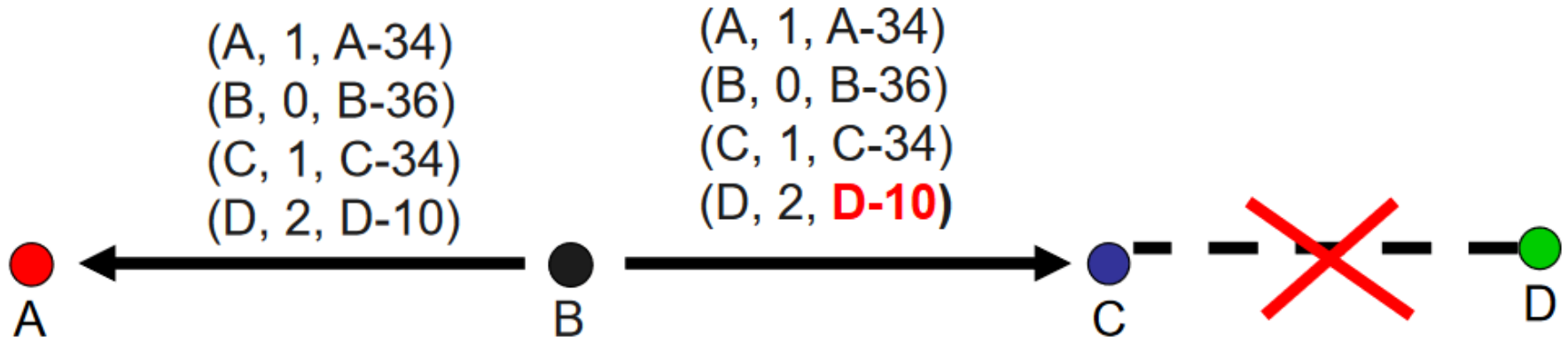
Dest.	Next	Dist	Seq
A	B	2	A-34
B	B	1	B-34
C	C	0	C-34
D	D	∞	**D-11**

Dest.	Next	Dist	Seq
A	C	3	A-34
B	C	2	B-34
C	C	1	C-34
D	D	0	D-10

DSDV Route Establishment & Maintenance

Example of Link Breakage (2)

When node B's full dump reaches node C, node C notes it is out-of-date, since node C has a higher sequence number for destination D in its routing table.



Dest.	Next	Dist	Seq
A	A	0	A-34
B	B	1	B-36
C	B	2	C-34
D	B	3	D-10

Dest.	Next	Dist	Seq
A	A	1	A-34
B	B	0	B-36
C	C	1	C-34
D	C	2	D-10

Dest.	Next	Dist	Seq
A	B	2	A-34
B	B	1	B-36
C	C	0	C-34
D	D	∞	D-11

DSDV Route Establishment & Maintenance

- **Example of Link Breakage (4)**

  Node B broadcasts the link breakage to node A

(A, 1, A-34)
(B, 0, B-38)
(C, 1, C-36)
(D, ∞, **D-11**)

Dest.	Next	Dist	Seq
A	A	0	A-34
B	B	1	B-38
C	B	2	C-36
D	B	∞	**D-11**

Dest.	Next	Dist	Seq
A	A	1	A-34
B	B	0	B-38
C	C	1	C-36
D	C	∞	**D-11**

Dest.	Next	Dist	Seq
A	B	2	A-34
B	B	1	B-36
C	C	0	C-36
D	D	∞	**D-11**

Stability and Scalability

- DSDV requires a full dump update periodically so it is not efficient in route updating
- Whenever topology of a network changes, DSDV is unstable until update packets propagate through the network
- DSDV is effective for creating ad-hoc networks for small populations of mobile nodes
- DSDV is a fairly brute force approach, because connectivity information needs periodical update throughout the whole network

References

- Ad Hoc Wireless Networks, architectures and protocols. C. Siva Ram Murthy and B. S. Manoj, 1st edition.
  - Sections 7.1, 7.2, 7.3, 7.4.1
- RFC 2501.
  - http://www.ietf.org/rfc/rfc2501.txt

Thank you

Any Questions?

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