Routing Protocol for Ad Hoc Mobile Wireless Networks

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Online

- Introduction
- Table driven routing protocol
- On-demand routing protocol
- Conclusion

Routing Protocol for Ad Hoc Mobile Wireless Networks

Introduction

Introduction

- Ad hoc routing protocol can be divided into
  - Table driven routing protocol
    - Proactive
    - Continuously evaluate the routes
    - Attempt to maintain consistent, up-to-date routing information

Introduction

- On demand routing protocol
  - Reactive
  - Create routes only when it is desired by the source node
  - Longer delay

Routing Protocol for Ad Hoc Mobile Wireless Networks

Table-Driven Routing Protocol

Table Driven Routing Protocol

- Each node maintains one or more tables containing routing information to every other node in the network.
- The following pages will introduce
  - DSDV
  - WRP
  - CGSR

DSDV (Destination Sequence Distance Vector)

- Base on the idea of the distance vector routing algorithm
  - Periodical broadcast（update）
- Each node keeps a routing table to all other nodes
  - Base on next-hop routing

DSDV – the concept of routing table

- The routing table contains:
  - All available destinations
  - Next hop node
  - Metric (the # of hops to reach the destination)
  - Sequence number (assigned by the destination node)

DSDV – Routing advertisement and update

- Each node broadcast its routing table
- Routes with more recent seq. no. are always preferred
- Of paths with the same seq. no., those with smaller metric are preferred
- Bi-directional links

DSDV – Routing update

- Full dump
  - Sends the full routing table to the neighbors
- Incremental
  - only carries info. changed since the last full dump
  - Must be fit into a packet

DSDV

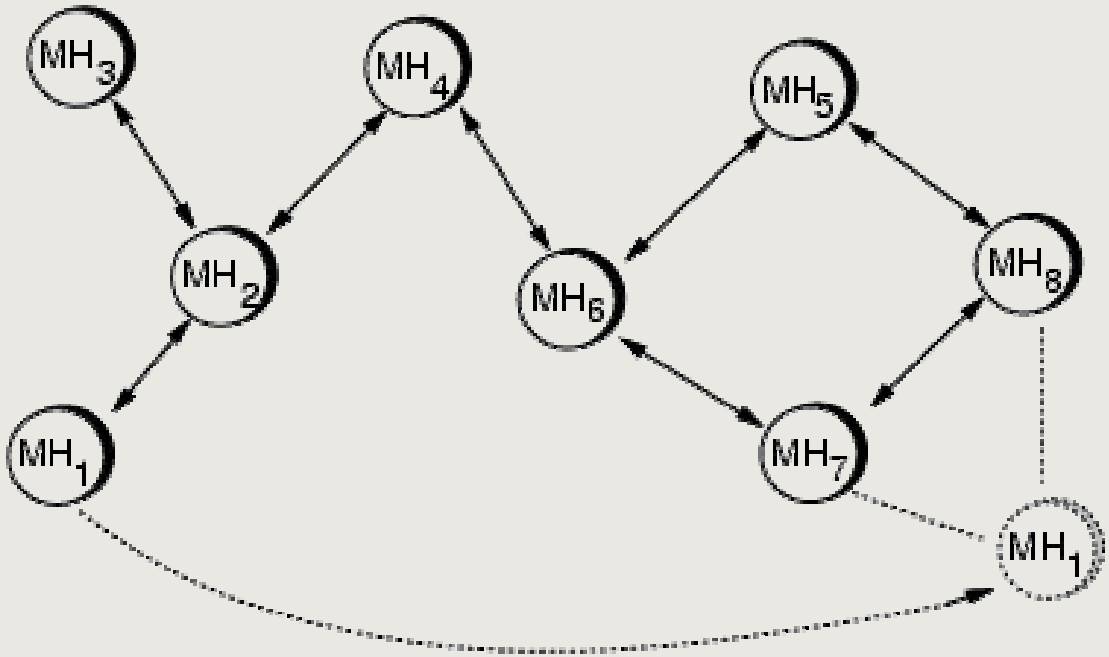


Figure 1: Movement in an ad-hoc network

DSDV

Destination	NextHop	Metric	Sequence number	Install	Stable_data
MH_1	MH_2	2	S406_MH_1	T001_MH_4	Ptr1_MH_1
MH_2	MH_2	1	S128_MH_2	T001_MH_4	Ptr1_MH_2
MH_3	MH_2	2	S564_MH_3	T001_MH_4	Ptr1_MH_3
MH_4	MH_4	0	S710_MH_4	T001_MH_4	Ptr1_MH_4
MH_5	MH_6	2	S392_MH_5	T002_MH_4	Ptr1_MH_5
MH_6	MH_6	1	S076_MH_6	T001_MH_4	Ptr1_MH_6
MH_7	MH_6	2	S128_MH_7	T002_MH_4	Ptr1_MH_7
MH_8	MH_6	3	S050_MH_8	T002_MH_4	Ptr1_MH_8

Table 1: Structure of the MH_4 forwarding table

DSDV

Destination	NextHop	Metric	Sequence number	Install	Stable_data
MH_1	**MH_6**	**3**	**S516_MH_1**	**T810_MH_4**	Ptr1_MH_1
MH_2	MH_2	1	S238_MH_2	T001_MH_4	Ptr1_MH_2
MH_3	MH_2	2	S674_MH_3	T001_MH_4	Ptr1_MH_3
MH_4	MH_4	0	S820_MH_4	T001_MH_4	Ptr1_MH_4
MH_5	MH_6	2	S502_MH_5	T002_MH_4	Ptr1_MH_5
MH_6	MH_6	1	S186_MH_6	T001_MH_4	Ptr1_MH_6
MH_7	MH_6	2	S238_MH_7	T002_MH_4	Ptr1_MH_7
MH_8	MH_6	3	S160_MH_8	T002_MH_4	Ptr1_MH_8

Table 3: MH_4 forwarding table (updated)

WRP (Wireless Routing Protocol)

- A table-based distance-vector routing protocol
- Each node maintains
  - Distance table
  - Routing table
  - Link-cost table
  - Message Retransmission List (MRL)
    - Let a node know which of its neighbor has not acknowledged its update message

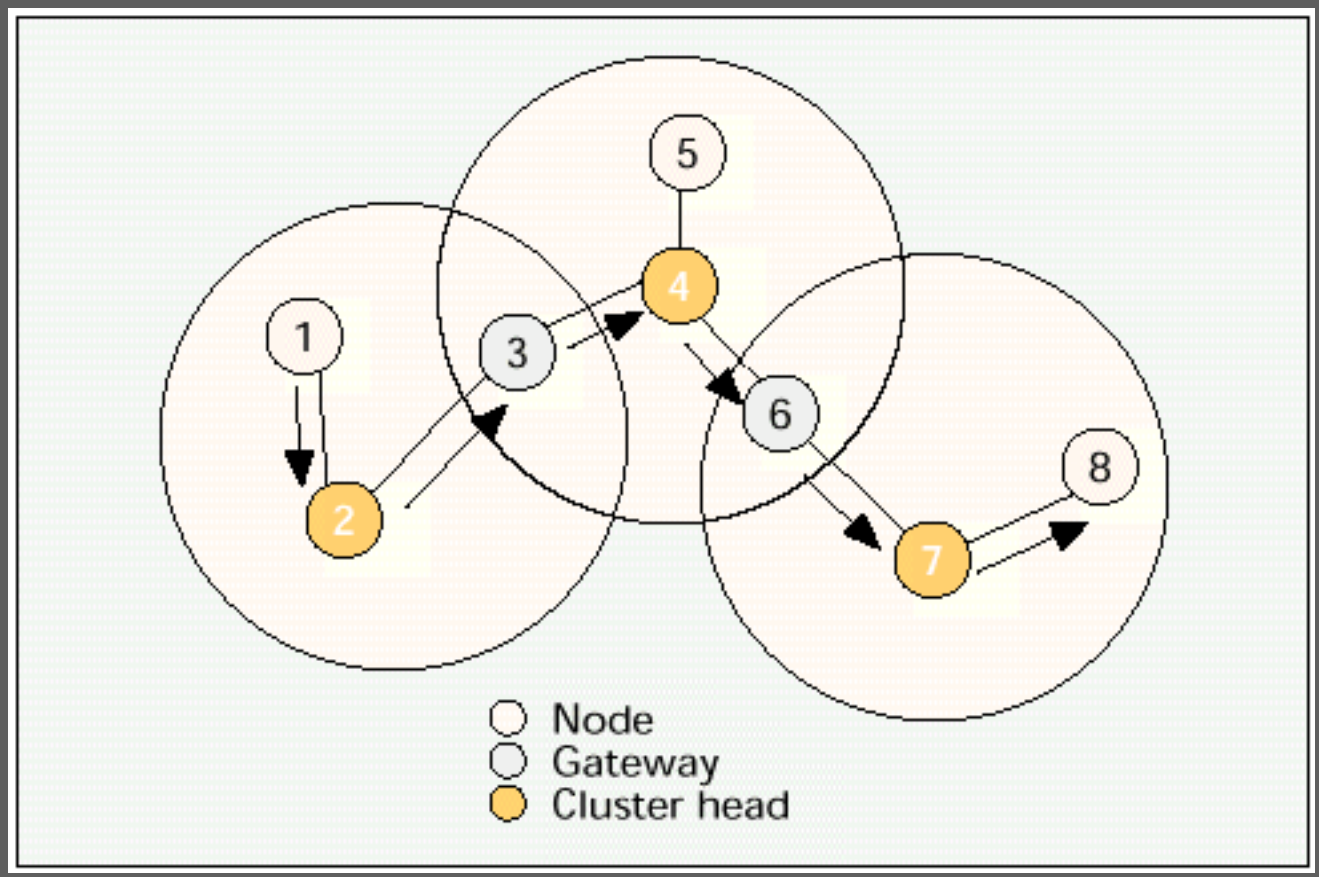
WRP (Wireless Routing Protocol)

- The main difference
  - It checks the consistency of all its neighbor every time it detects a change in link of any of its neighbors
  - Using the MRL to check the consistency of all its neighbors
- Consistency check has fast convergence

CGSR (Clusterhead Gateway Switch Routing Protocol)

- The mobile node are aggregated into into clusters and a cluster-head is elected
- A gateway node is in the communication range of two or more cluster-heads
- Each node maintains a cluster member table and routing table
  - Also based on the DSDV algorithm

CGSR (Clusterhead Gateway Switch Routing Protocol)



CGSR (Clusterhead Gateway Switch Routing Protocol)

- Data forwarding steps
  - from cluster head to cluster head
  - then from cluster head to cluster members
  - between two cluster heads, gateways are used to forward the packets
  - EX: No.1 to No.8

CGSR (Clusterhead Gateway Switch Routing Protocol)

- Cluster-head change occurs only if
  - a change in the network causes two cluster-head come into one one cluster or
  - one of the nodes moves out of all the cluster-heads
- Advantage
  - Less information to be kept
  - Local change will not affect the overall routing table
- Disadvantage
  - Longer route

Routing Protocol for Ad Hoc Mobile Wireless Networks

On-demand Routing Protocol

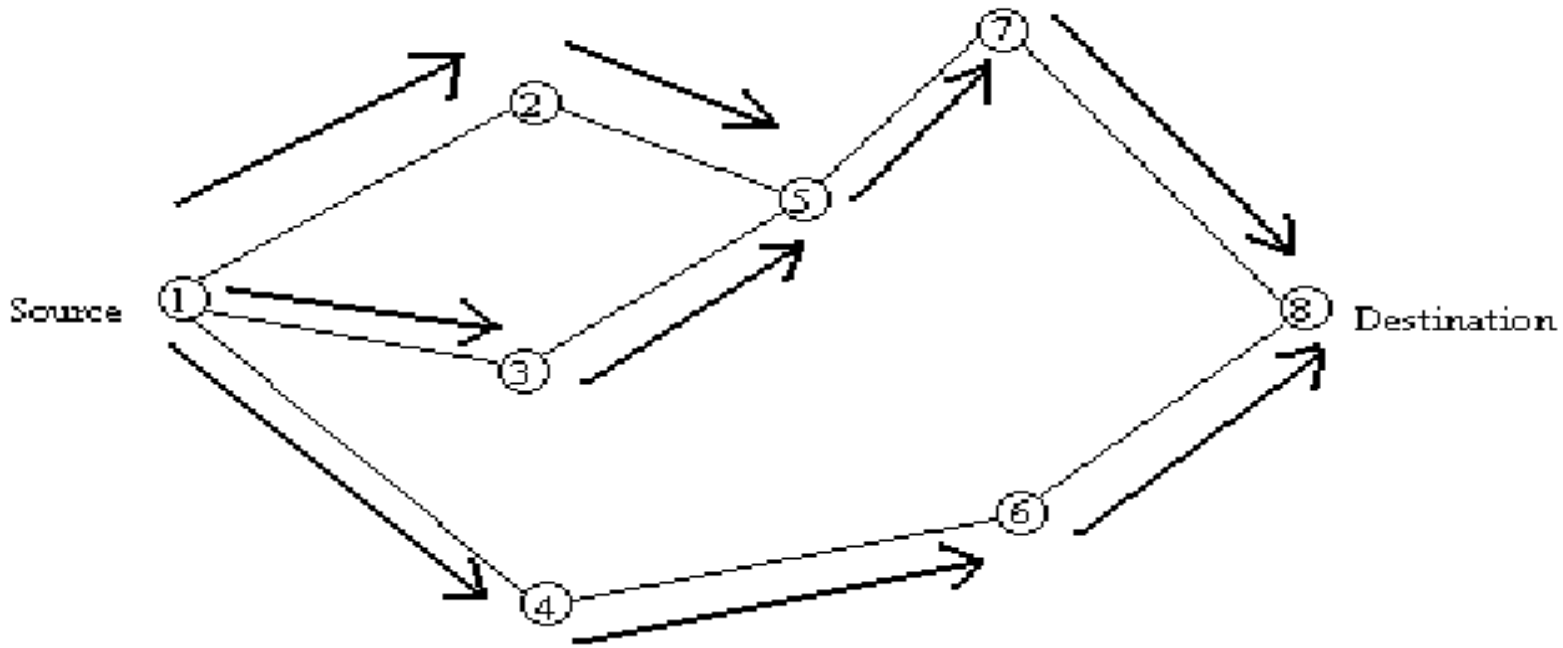
On-demand routing protocol

- All up-to-date routes are not maintained at every node, instead the routes are created as and when needed
- The following pages will introduce
  - ADOV
  - DSR
  - TORA
  - ABR

ADOV (Ad hoc On-demand Distance Vector Routing)

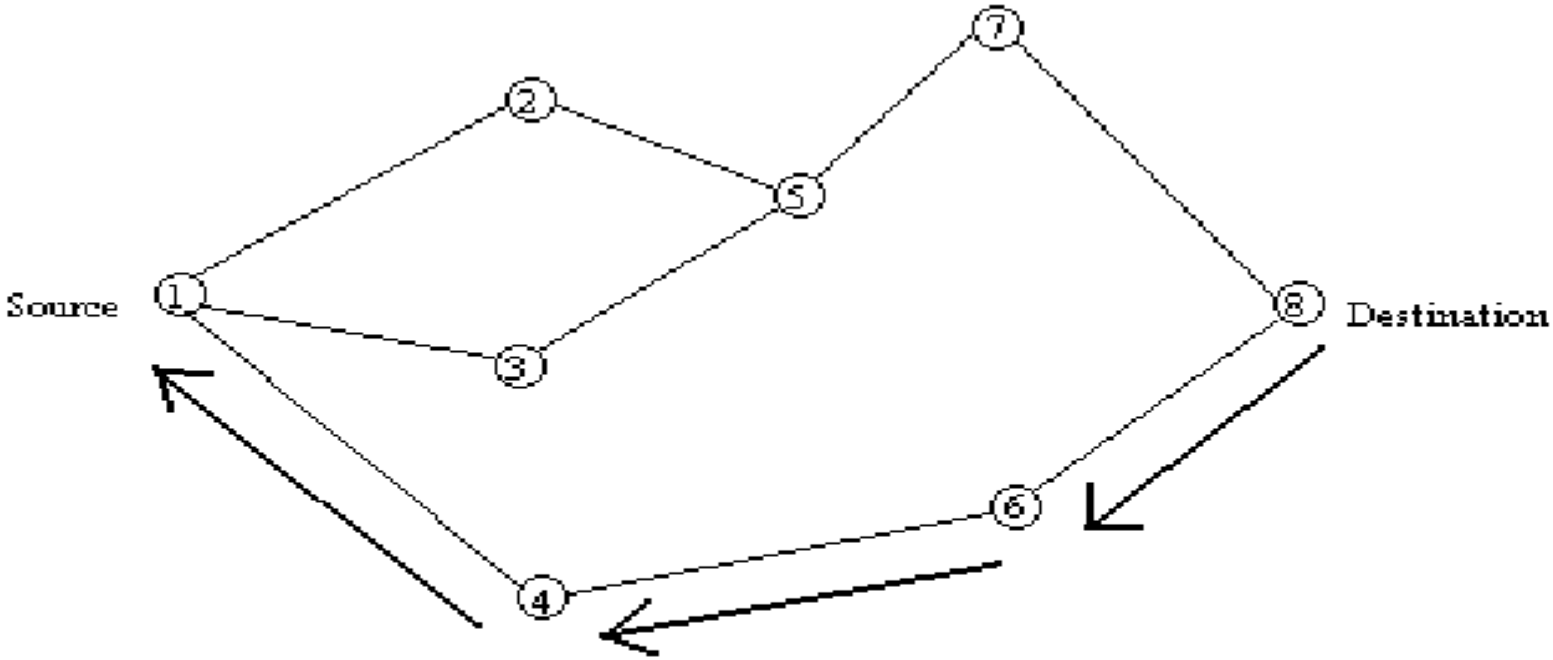
- Creating routes on-demand as opposed to DSDV
- To find a path to the destination
  - The source broadcast a route request packet
  - The neighbor rebroadcast it
- ADOV uses only symmetric links

ADOV (Ad hoc On-demand Distance Vector Routing)



(a) Propogation of Route Request (RREQ) Packet

ADOV (Ad hoc On-demand Distance Vector Routing)



(b) Path taken by the Route Reply (RREP) Packet

Figure 4. Route discovery in AODV

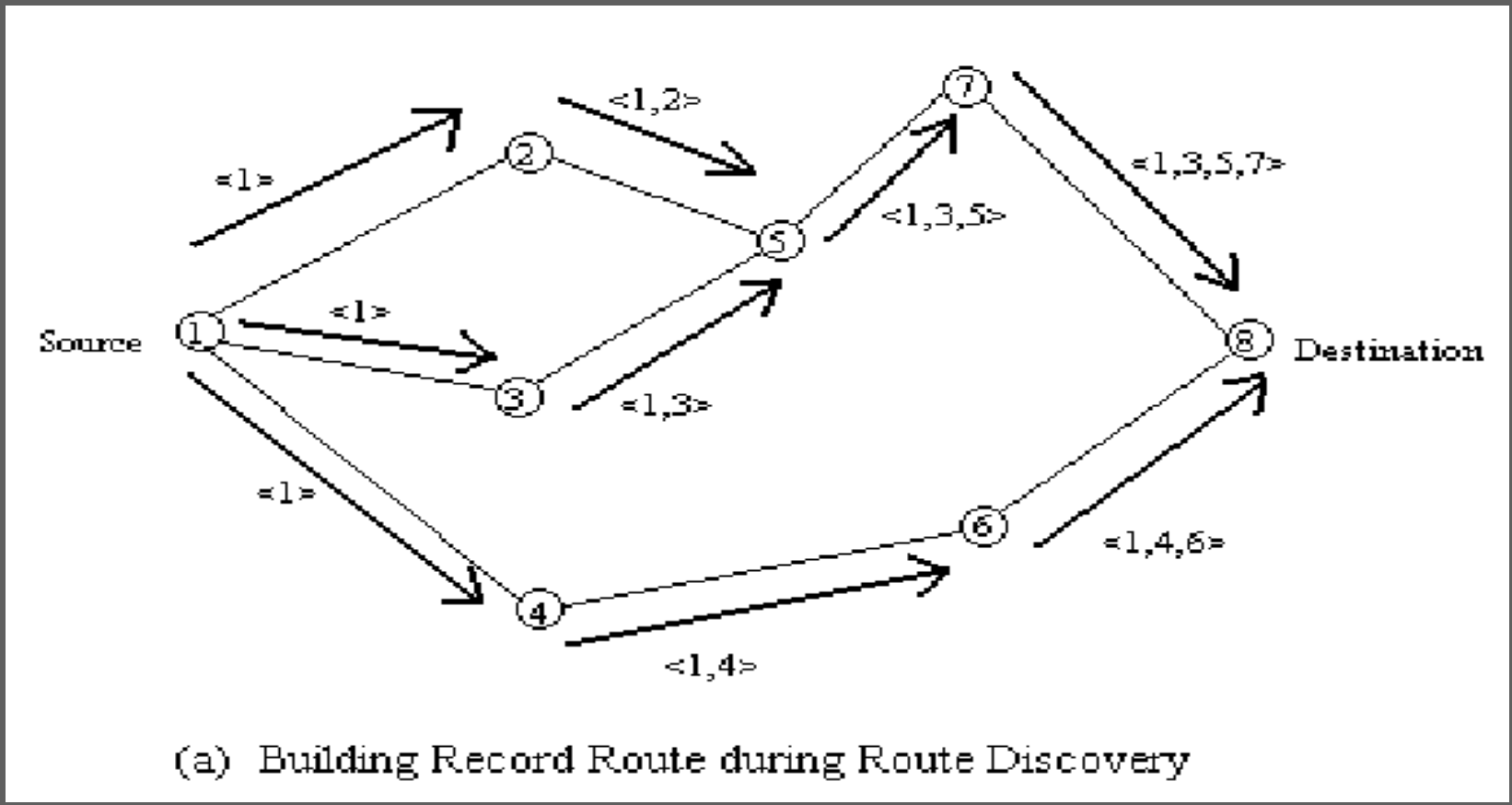
DSR (Dynamic Source Routing)

- Each host maintains a **route cache** which contains all routes it has learnt.
- Source Routing:
  - routes are denoted with complete information
- Two major part
  - route discovery
  - route maintenance

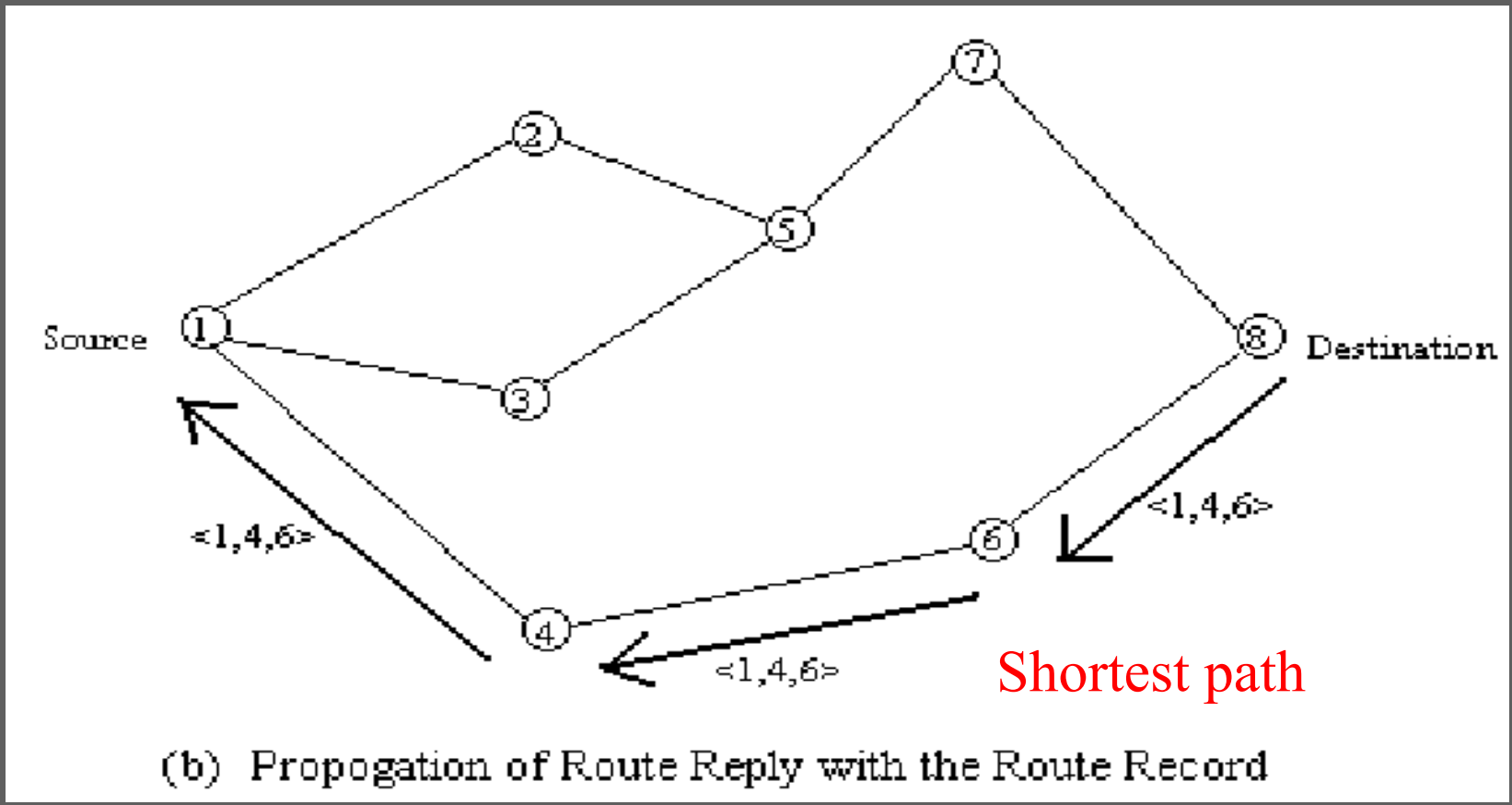
DSR (Dynamic Source Routing)

- Route Discovery:
  - There is a "route record" field in the packet.
    - The source node will add its address to the record.
    - On receipt of the packet, a host will add its address to the "route record" and rebroadcast the packet
- A ROUTE_REPLY packet is generated when
  - the route request packet reaches the destination
  - an intermediate host has an unexpired route to the destination

DSR (Dynamic Source Routing)



DSR (Dynamic Source Routing)

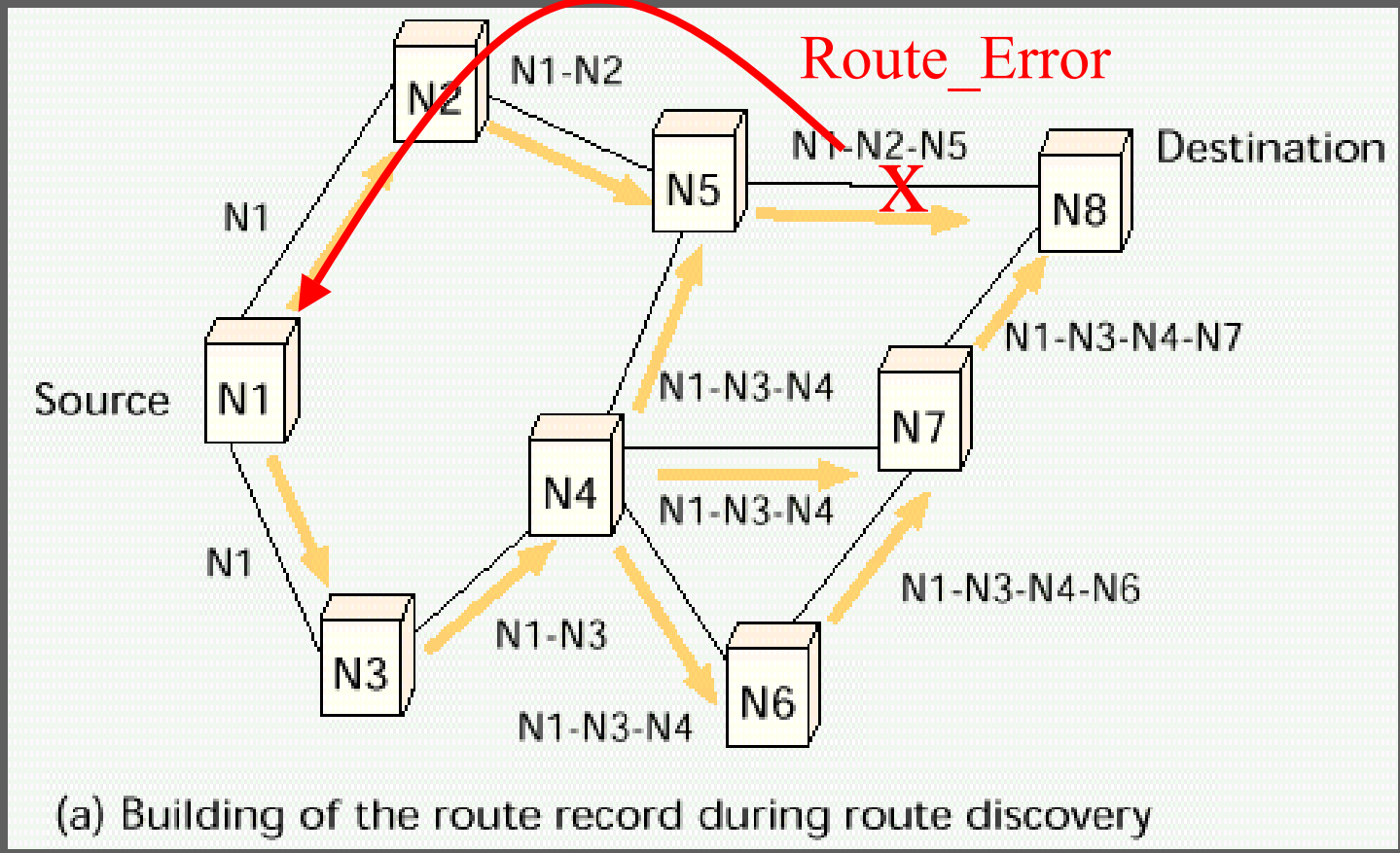


(b) Propogation of Route Reply with the Route Record

DSR (Dynamic Source Routing)

- When the data link layer encounters a link breakage, a ROUTE_ERROR packet will be initiated.
  - The packet will traverse in the backward direction to the source.
  - The source will then initiate another ROUTE_REQUEST.
- Maintenance of route cache:
  - All routes which contain the breakage hop have to be removed from the route cache.

DSR (Dynamic Source Routing)

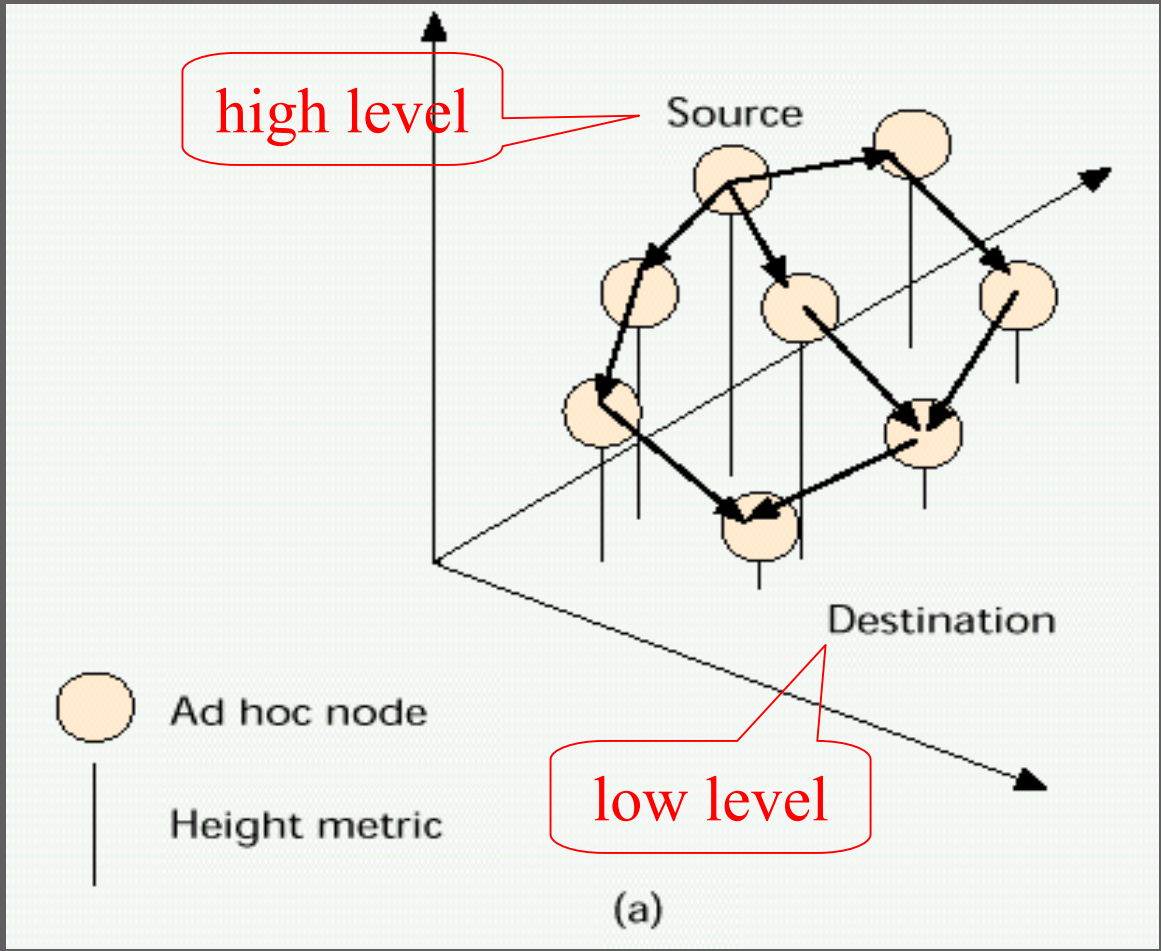


(a) Building of the route record during route discovery

TORA (Temporally Ordered Routing Protocol)

- It finds multiple routes from a source node to a destination node
- Like water flowing, it goes from upstream to downstream.
- for highly dynamic mobile networks
  - The control messages are localized to a very small set of nodes near the occurrence of a topological change

TORA (Temporally Ordered Routing Protocol)



TORA (Temporally Ordered Routing Protocol) – Main idea

- Regard the network as a directed graph.
- For each destination, a DAG (directed acyclic graph) will be maintained.
  - Note: There are *n* copies of DAG's, each associated with one destination, where *n* is the number of hosts.
  - In the following discussion, we only discuss one DAG associated with a destination.
- The DAG is accomplished by assigning each node *i* a height metric h_i.
  - A link from *i* to *j* means $h_i > h_j$.

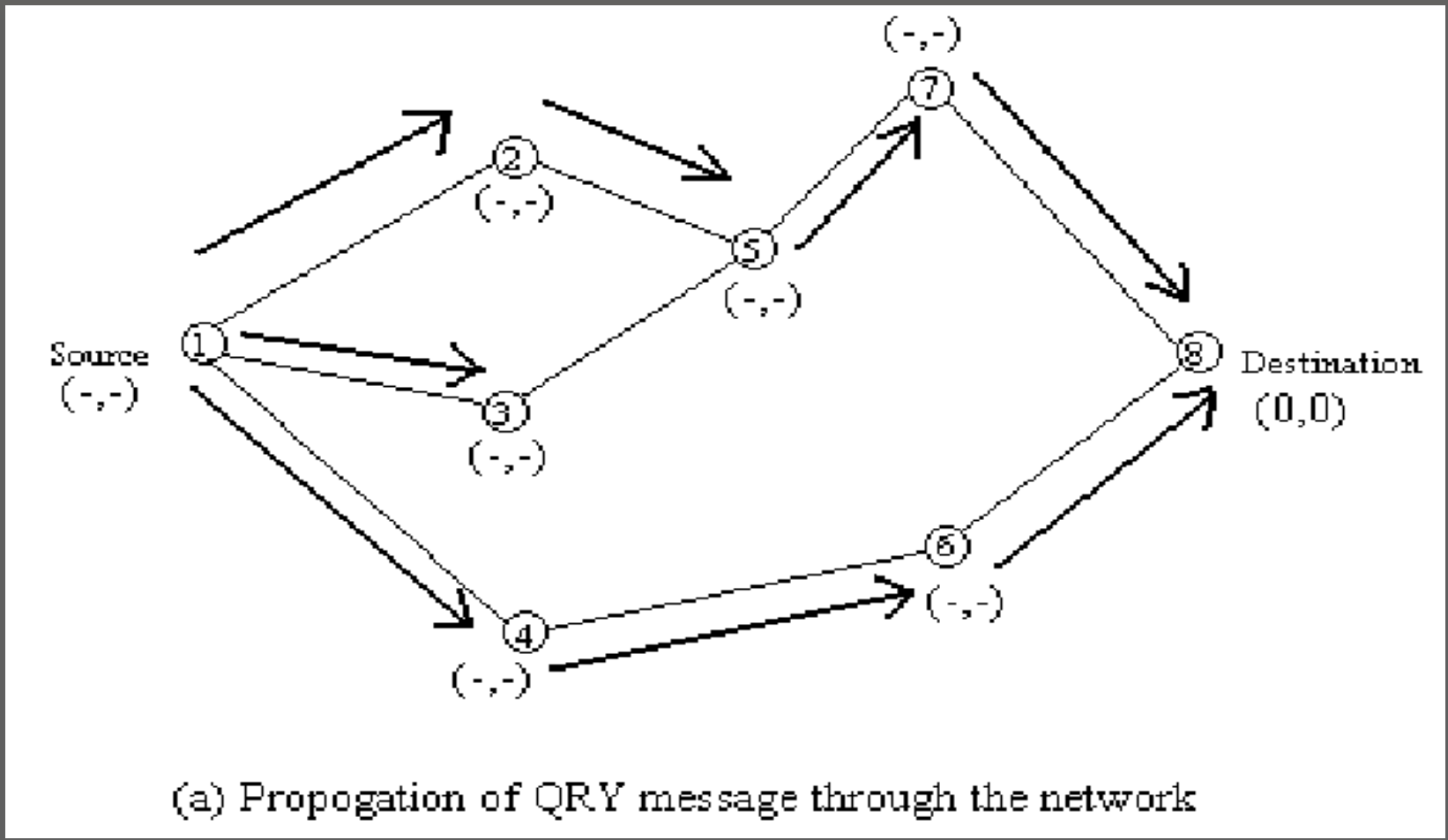
TORA (Temporally Ordered Routing Protocol)

- A node will update its height to adapt to the change of network topology.
- Height h_i = ($value_i$, ID_i)
  - a node will change its value to change the direction of a link
- Relation: $h_i > h_j$ if the following is true:
  - 1. $value_i > value_j$
  - 2. ($value_i = value_j$) and ($ID_i > ID_j$)
  - Ex: (5, 4) > (4, 6) → value=5 > value=4
  - Ex: (5, 4) > (5, 2) → ID=4 > ID=2

TORA (Temporally Ordered Routing Protocol)

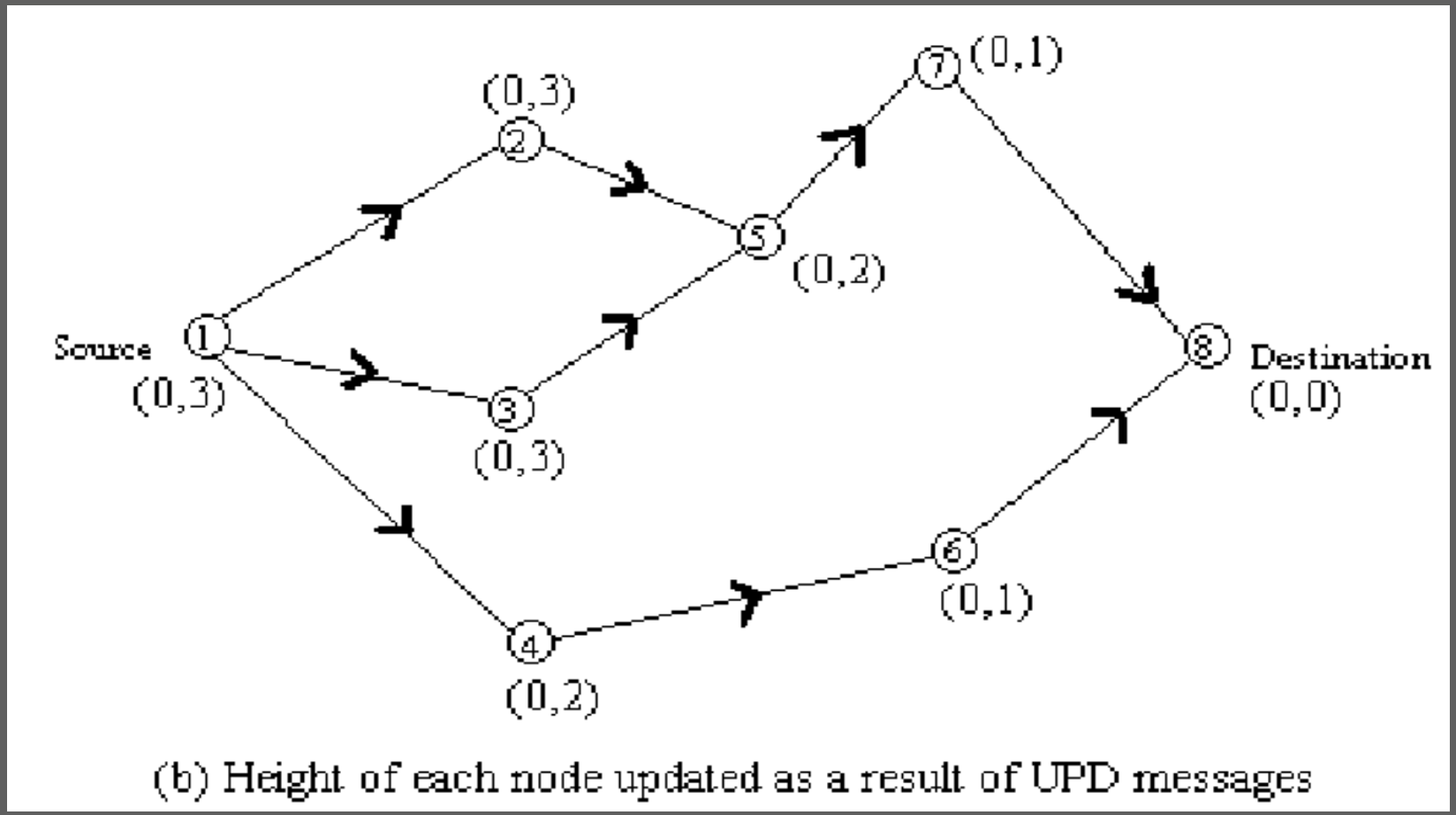
- Three basic functions:
  - route creation
  - route maintenance
  - route erasure
- Three control packets:
  - query (QRY)
  - update (UPD)
  - clear (CLR)

TORA (Temporally Ordered Routing Protocol)



(a) Propogation of QRY message through the network

TORA (Temporally Ordered Routing Protocol)



(b) Height of each node updated as a result of UPD messages

ABR (Associativity Based Routing)

- ABR considers the stability of a link.
  - A new metric for routing known as the degree of association stability
- Basic Idea:
  - Each node periodically generates a beacon to signify its existence.
  - On receipt of the beacon, a neighboring node will increase the "tick" of the sender by 1.
    - Tick ↑ , low mobility of the node
  - When a link becomes broken, the node will set the tick of the other node to 0.

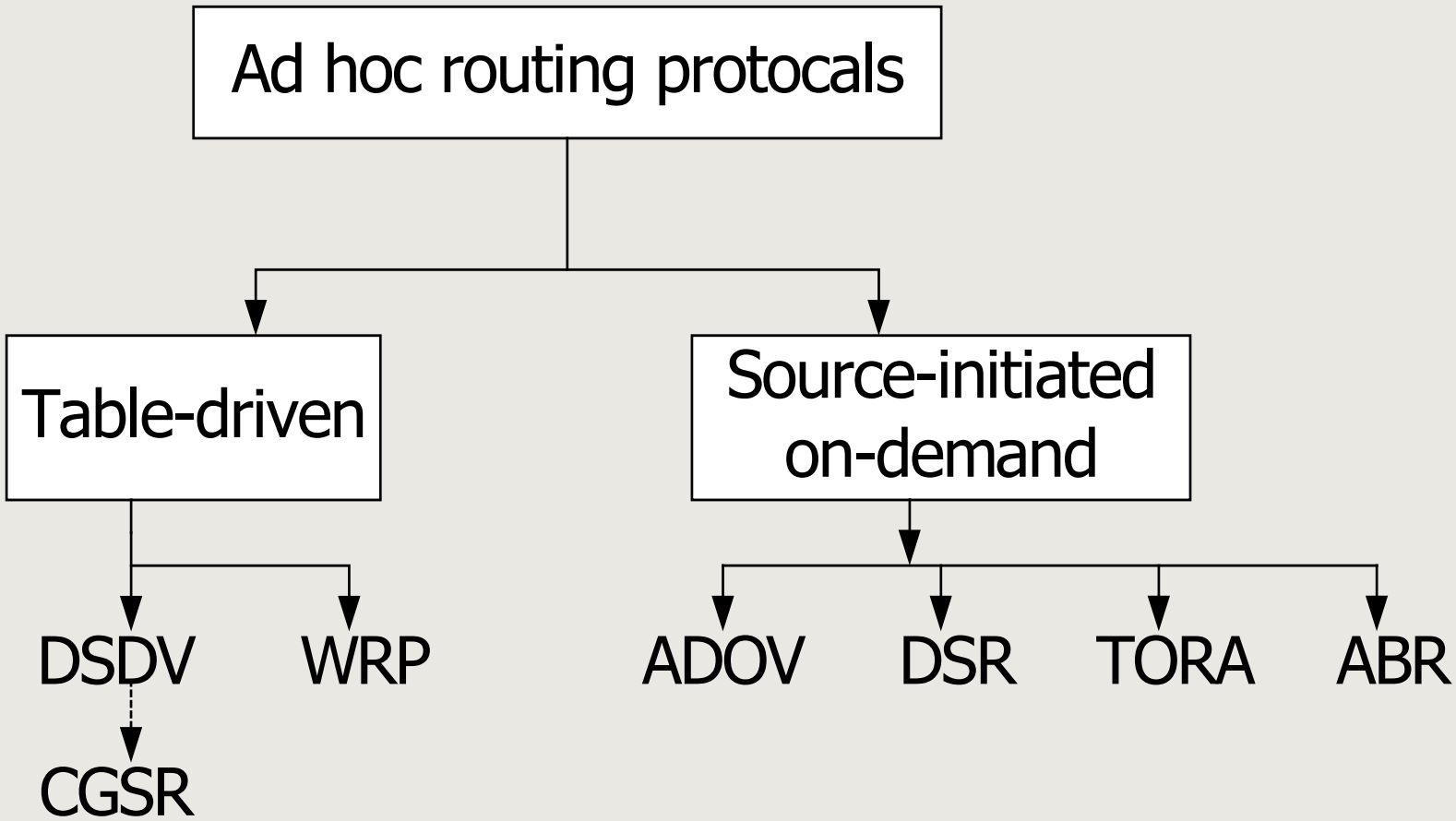
ABR (Associativity Based Routing)

- Route Discovery:
  - (similar to DSR)
    - On needing a route, a host will broadcast a ROUTE_REQUEST packet.
    - Each receiving host will append its address to the packet.
  - The tick is also appended in the ROUTE_REQUEST packet.
  - The destination node will select the best route, and then respond a packet to the source.
    - Ticks ↑ , the path is better
    - If ticks are equal, the minimum # of hops is better

Conclusion

- Table driven routing protocols
  - Maintain the routing table periodically
  - Will generate more traffic for exchanging information
  - Can response network topology as soon as fast
- On demand routing protocols
  - Maintain the routing table on demand
  - Can’t response network topology fast

Conclusion


Ad hoc routing protocals
Table-driven
Source-initiated on-demand
DSDV
WRP
CGSR
ADOV
DSR
TORA
ABR