University of Hertfordshire

Wireless Mobile & Multimedia Networking

7COM1076

Ad-hoc Networks 3

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Outline

- **On-Demand Routing protocol**
- **Dynamic Source Routing (DSR)**
  - DSR Features
  - Basic operations
    - Route Discovery
    - Route Cache
    - Route Maintenance
- **DSR Routing Establishment**
- **DSR Reply**
- **DSR Route Maintenance**
- **Advantages & Disadvantages**
- **Further Improvement**

On-Demand Routing protocols

- On-demand routing protocols also known as reactive routing protocols.
- Execute the path-finding process and exchange routing information only when a path is required from source to a destination.
- No periodic routing updates or routing information exchange.
- Some of the existing on-demand routing protocols are as follows:
  - Dynamic Source Routing Protocol (DSR)
  - Ad hoc On-demand Distance-Vector Routing Protocol (AODV)
  - Temporally Ordered Routing Algorithm (TORA)
  - Location-Aided Routing (LAR)
  - Signal Stability-Based Adaptive Routing protocol (SSA)

Dynamic Source (DSR) Routing Protocol

- Features
  - On-demand routing protocol.
  - Designed to restrict the bandwidth consumed by control packets by eliminating periodic routing updates that is required in table-driven approaches.
  - Operation is based on Source Routing
    - Route discovery is initiated by the source node.
  - Less network overhead as the number of message exchange between nodes is low.

Basic Operations – DSR

- The basic operations of DSR include
  - Route Discovery
  - Route Cache
  - Route Maintenance

Basic operation – DSR (cont.)

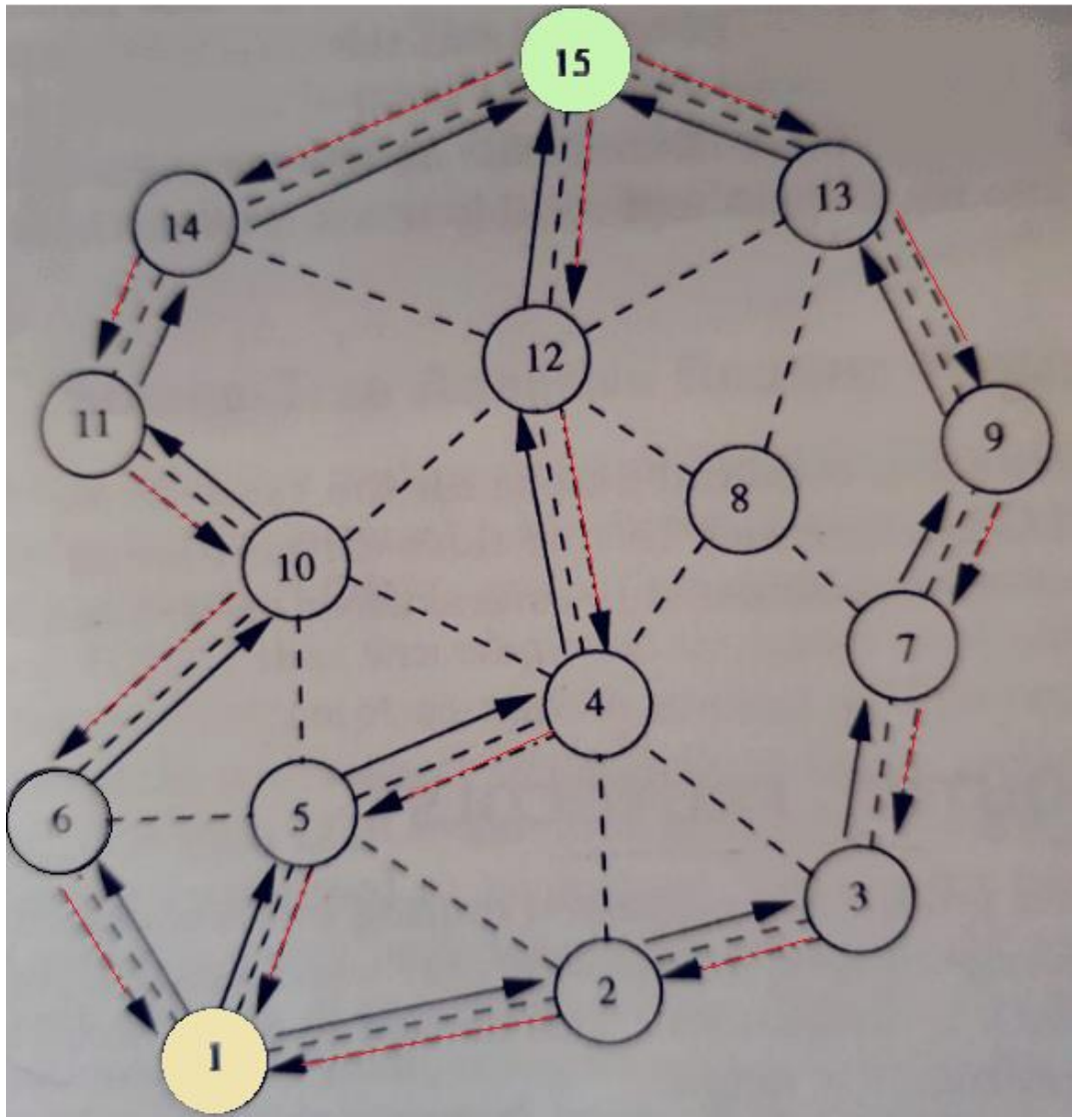
- Route Discovery

  When a node (source) intends to send data to another node (destination node) in the network it enters the route discovery phase

  - Source node:
    - Initializes and sends *RouteRequest* (*RREQ)* to the network.
  - Intermediate nodes:
    - Forward *RouteRequest* to the network by flooding.
    - Use a source-sequenced number in *RouteRequest* to prevent loop format and to avoid transmissions of the same *RouteRequest* .
  - Destination node:
    - Replies *RouteReply* to the source node through the reverse path the *RouteRequest* packet had traversed.

Basic operation – DSR (cont.)

Node 1 is the source and node 15 is the destination node.



Path : 1-2-3-7-9-13-15
Path 1-5-4-12-15
Path:1-6-10-11-14-15

Basic operation – DSR (cont.)

- Route Caches
  - Each node maintains a route cache that stores routes for destination nodes.
  - Route cache is used during the route construction phase.
  - Intermediate nodes can reply to the source node by sending a *RouteReply* (*RREP)* with the information in its route cache.

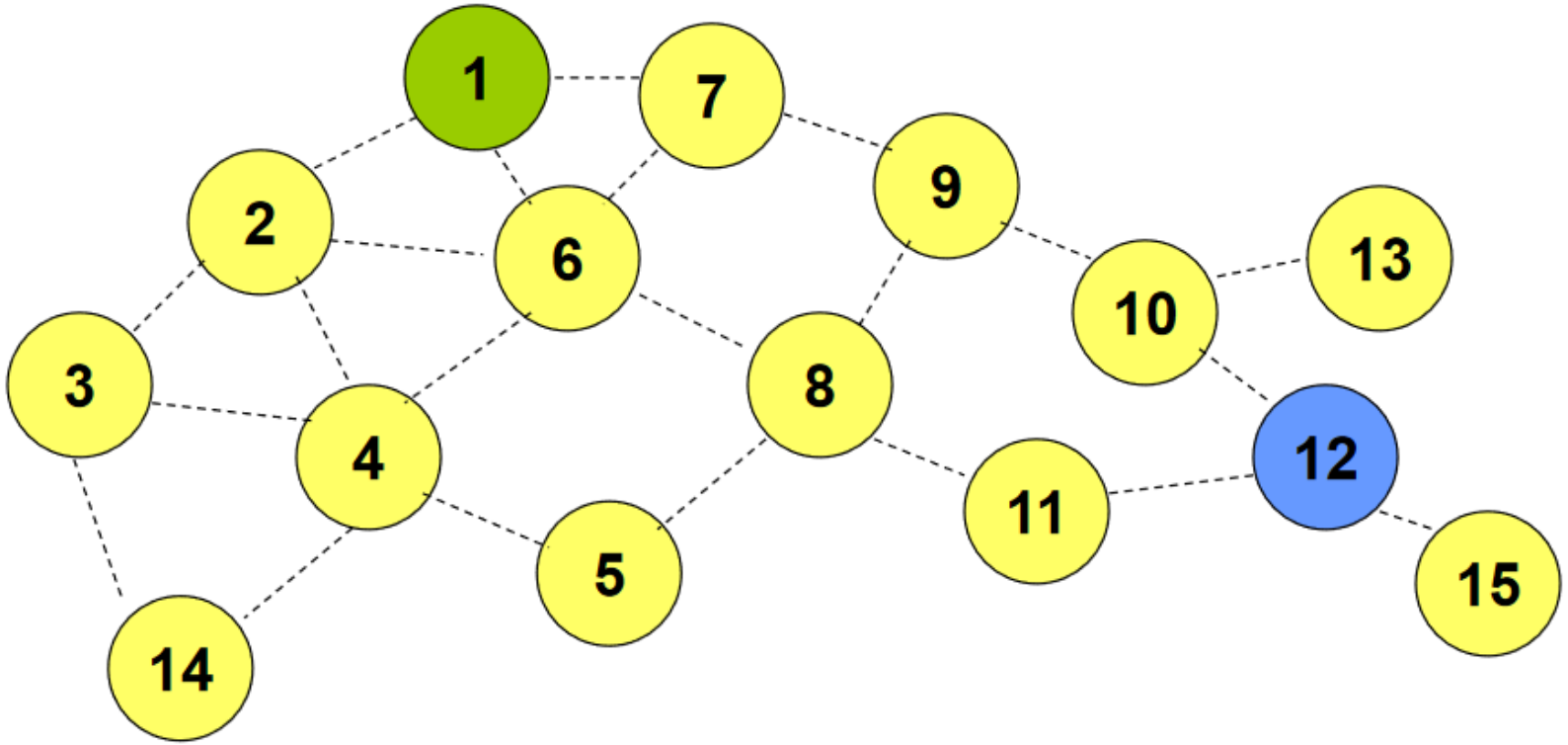
- Why is route cache used?
- Good or bad?

Basic operation – DSR (cont.)

- Route maintenance
  - When a wireless link is broken, a *RouteError* (*RERR)* message is generated from the node adjacent to the broken link to inform the source node.
  - The source node reinitializes the route discovery procedure.
  - The intermediate nodes and the source node remove the cashed entries when receiving the *RouteError* message.

DSR Route Established – Route Discovery

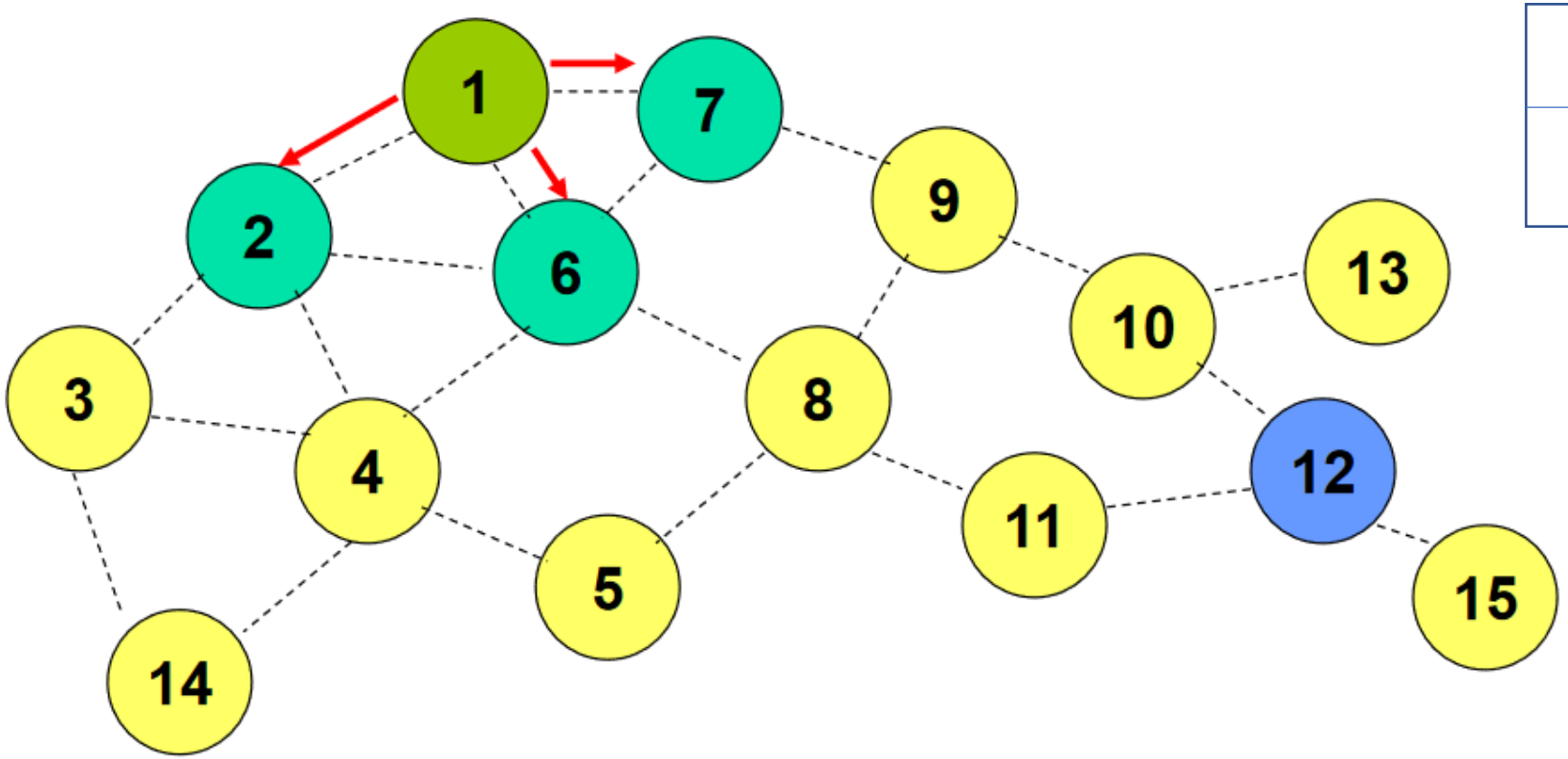
- **Example - Route Discovery (1)**
  - Node 1 wants to send data to node 12.



DSR Route Established – Route Discovery (cont.)

Example - Route Discovery (2)

- Node 1 which is the source node floods *RouteRequest* (RREQ) message

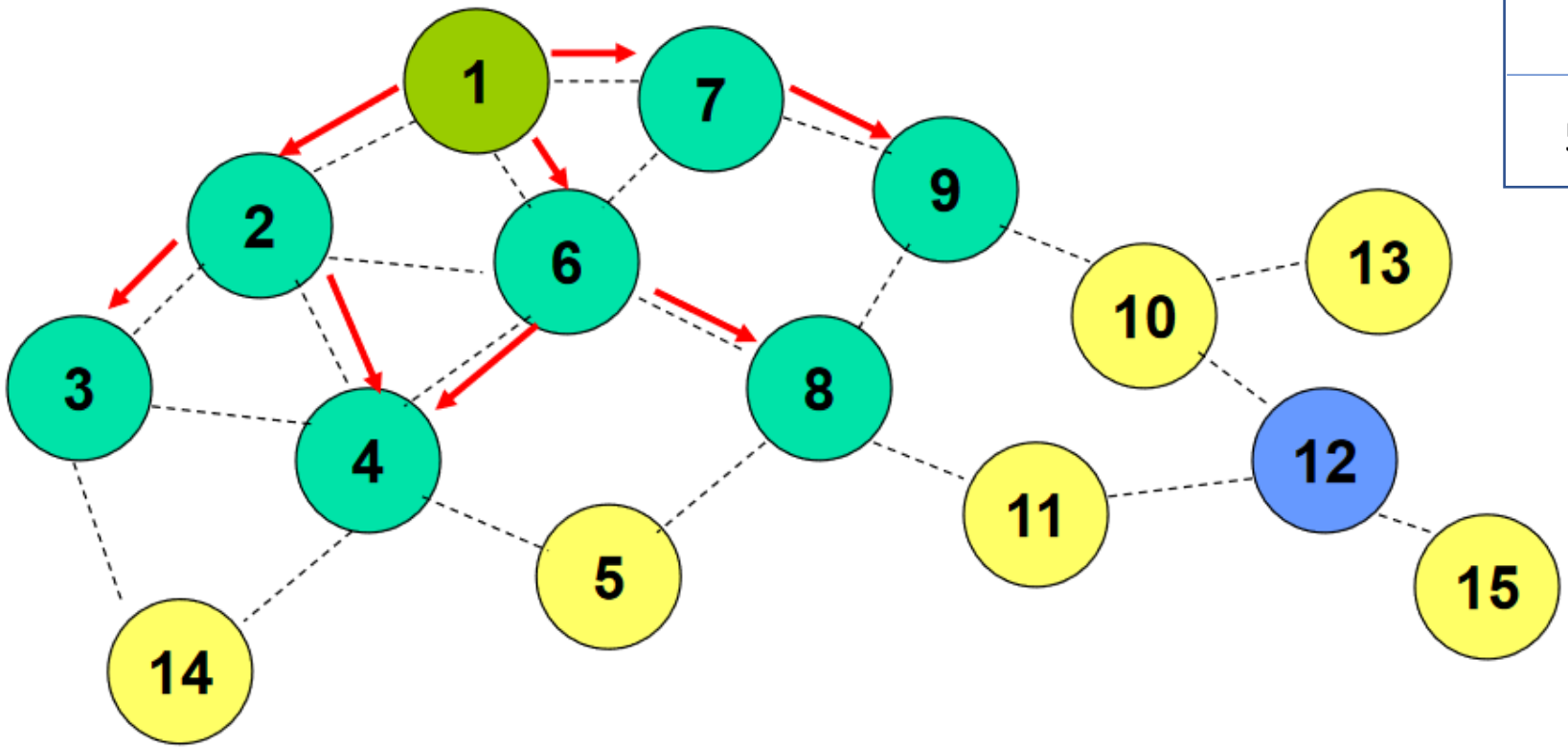


Seq No.	Source	Dest
5	1	12

RREQ Packet from node 1

DSR Route Established – Route Discovery (cont.)

- **Example - Route Discovery (3)**
  - After intermediate nodes 2, 6 & 7 flood *RouteRequest* message

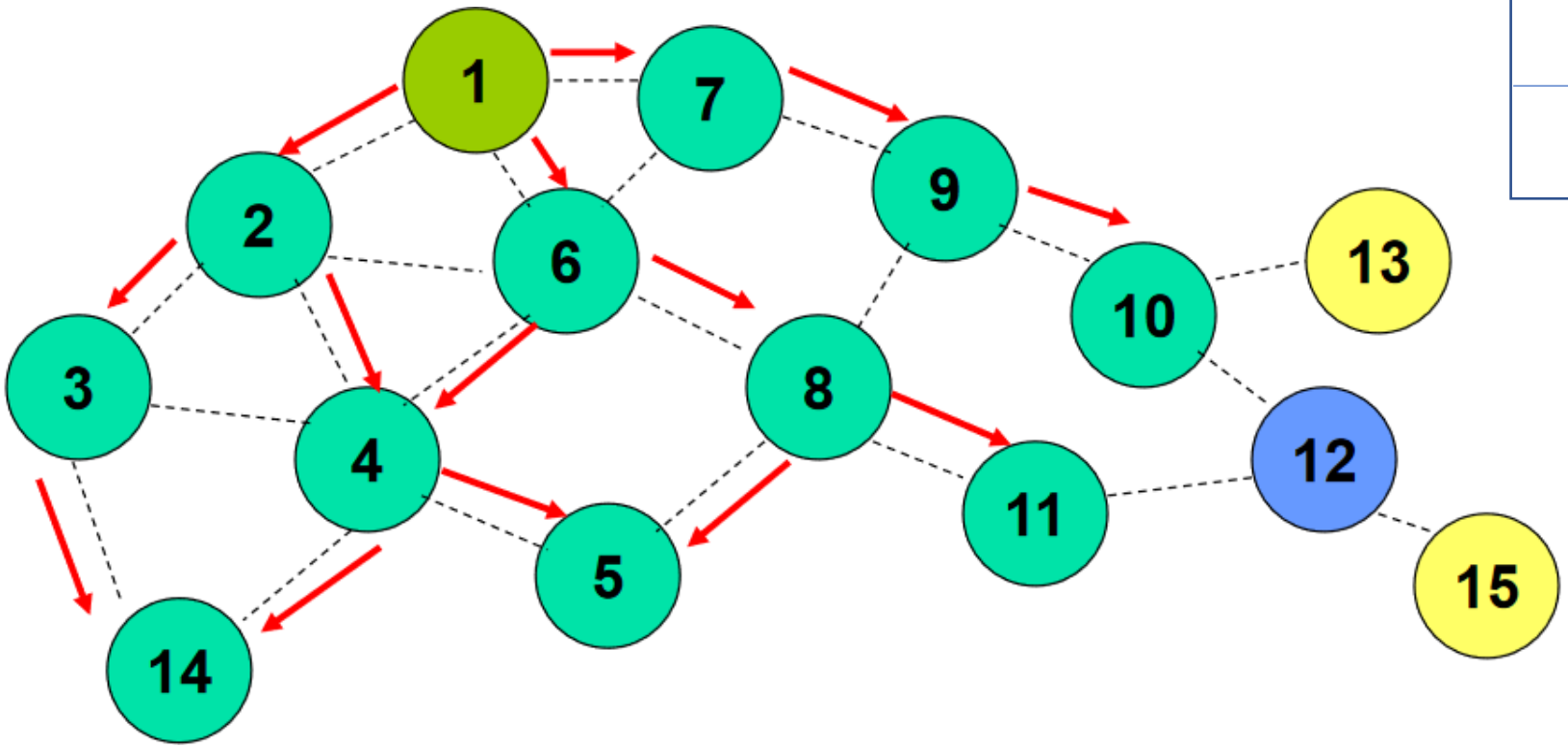


Seq No.	Source		Dest
5	1	7	12

RREQ Packet from node 7

DSR Route Established – Route Discovery (cont.)

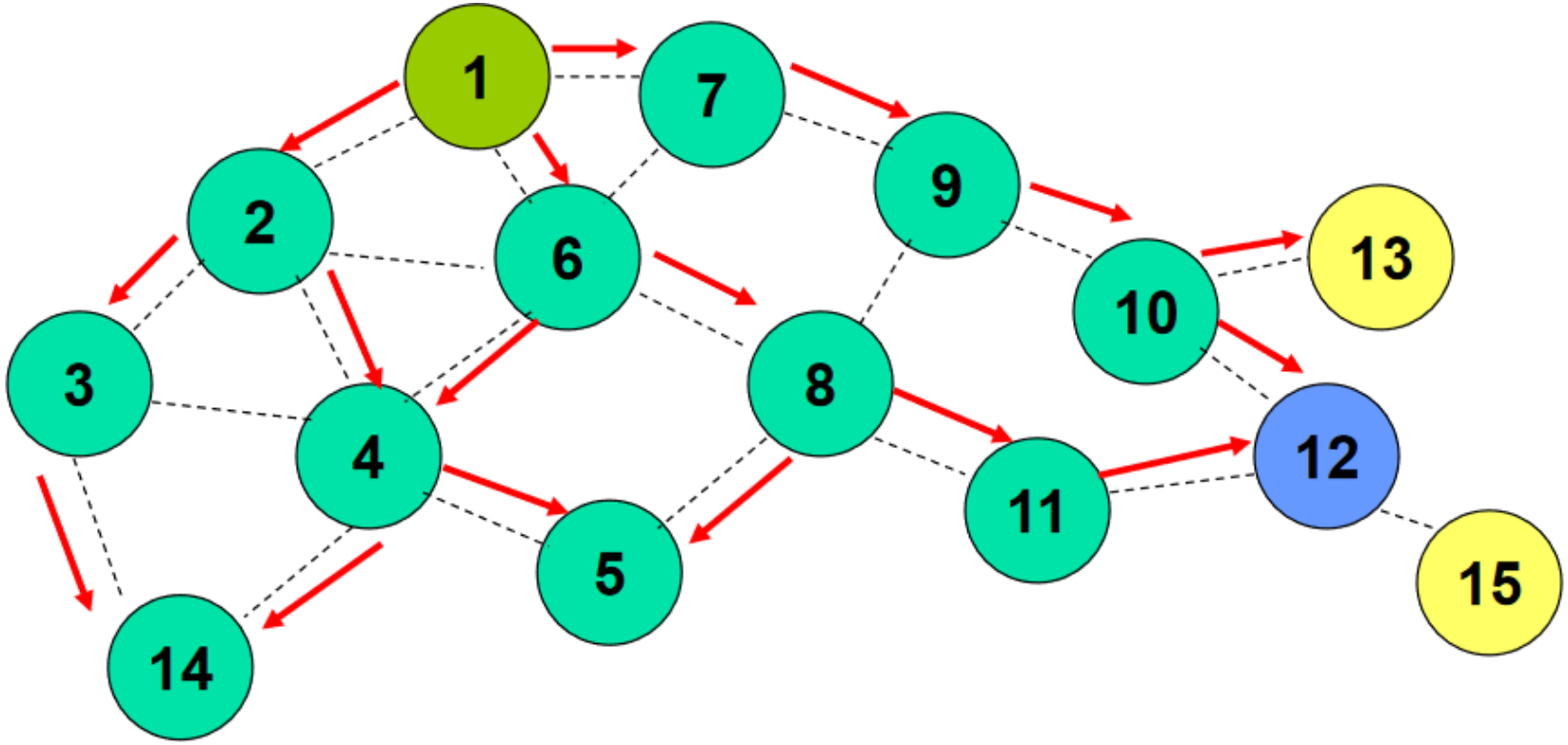
- **Example - Route Discovery (4)**
  - After intermediate nodes 3, 4, 8 & 9 flood *RouteRequest* message



Seq No.	Source			Dest
5	1	7	9	12

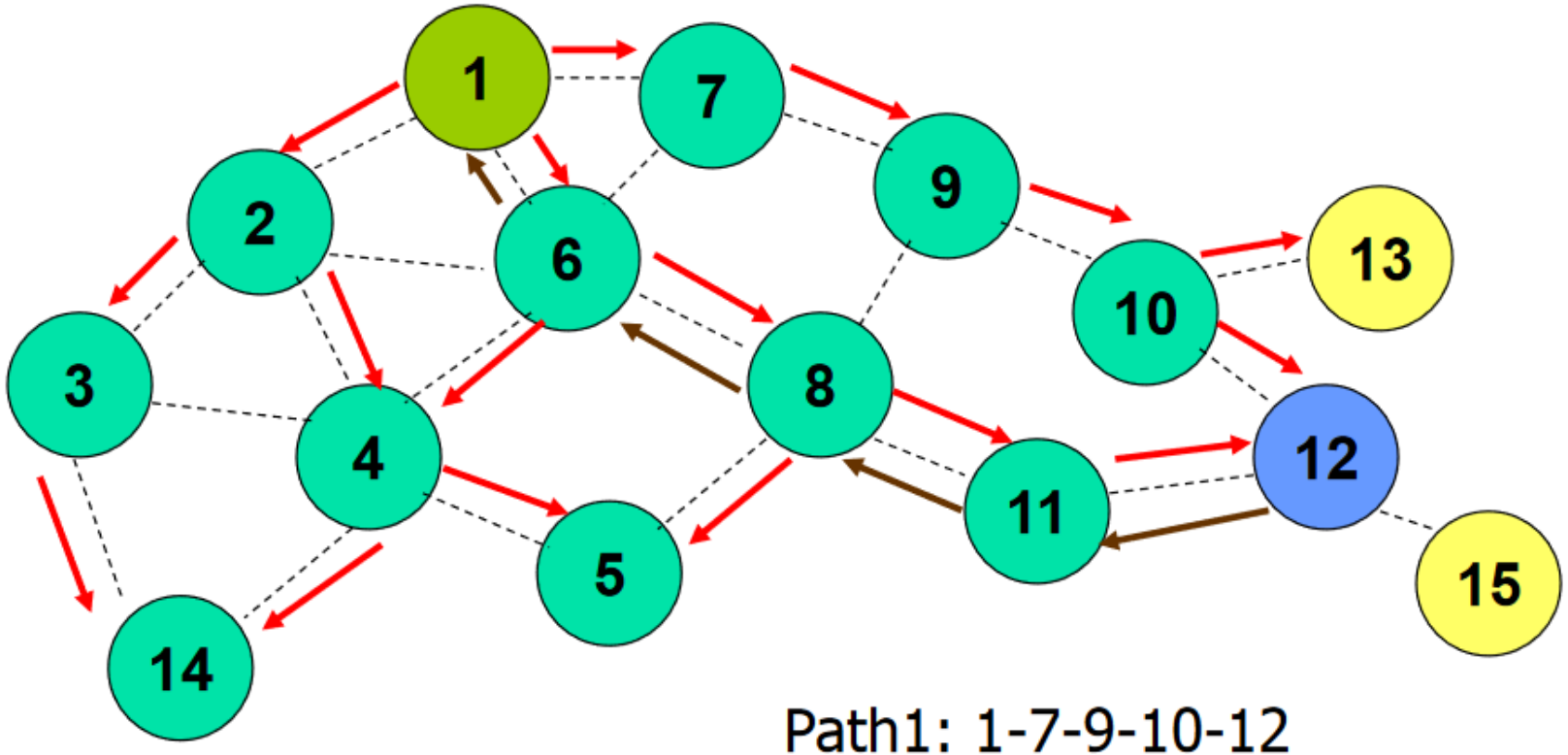
DSR Route Established – Route Discovery (cont.)

- **Example - Route Discovery (5)**
  - After intermediate nodes 10 & 11 flood *RouteRequest* message



DSR Route Established – Route Discovery (cont.)

- **Example - Route Discovery (6)**
  - Destination node 12 sends back *RouteReply* message



Path1: 1-7-9-10-12

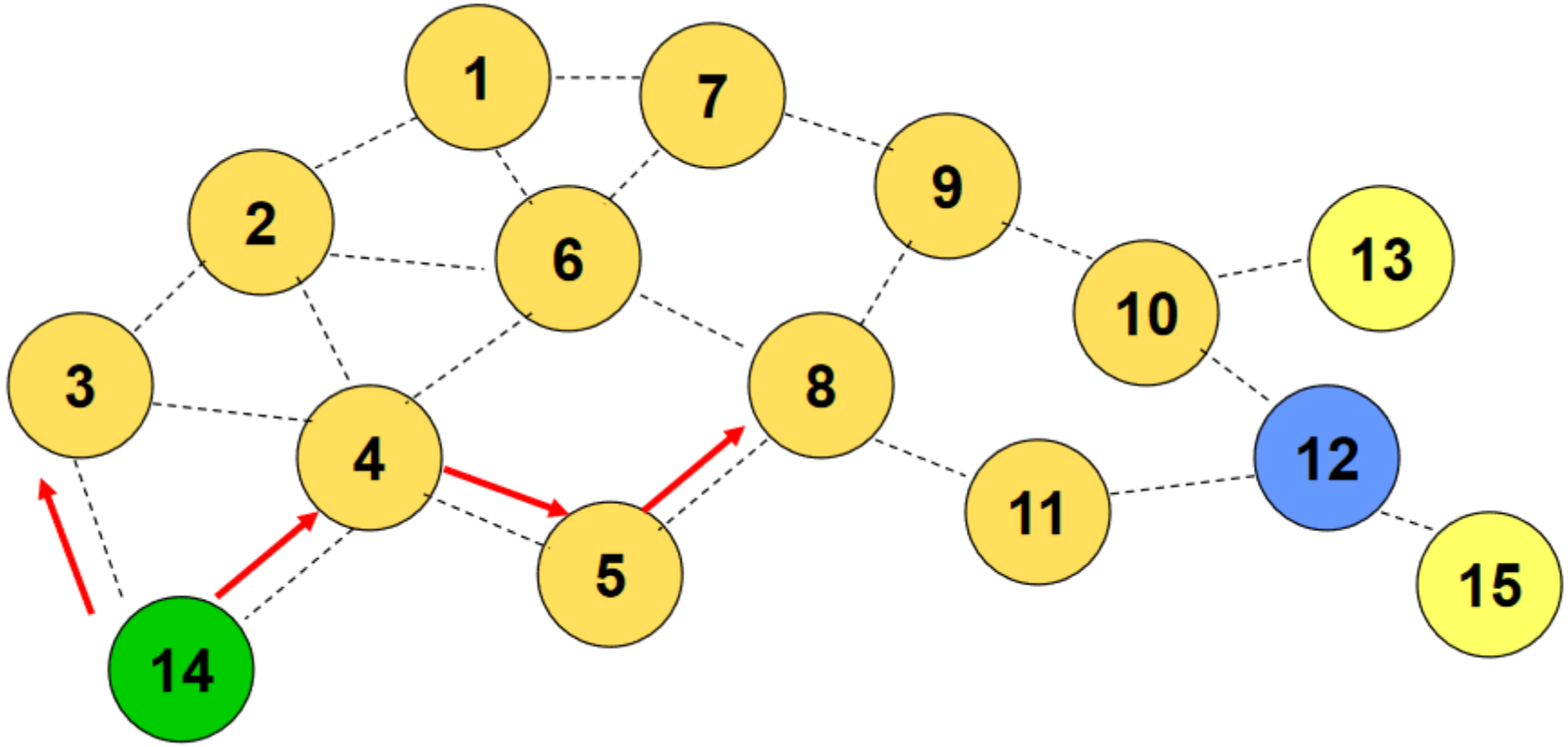
Path2: 1-6-8-11-12

DSR Route Established – Route Reply

- **Route Reply**
  - Destination node on receiving the first *RouteRequest* , sends a *RouteReply (RREP)*
  - *RouteReply* includes the route from the source to the destination on which *RouteRequest* was received by the destination
  - *Route Reply* is sent by reversing the route in *RouteRequest*
    - This requires bi-directional link
    - If unidirectional (asymmetric) links are allowed, then *RouteReply* may need a route discovery for the source node from the destination node
    - Piggyback *RouteRequest* on *RouteReply* to the source

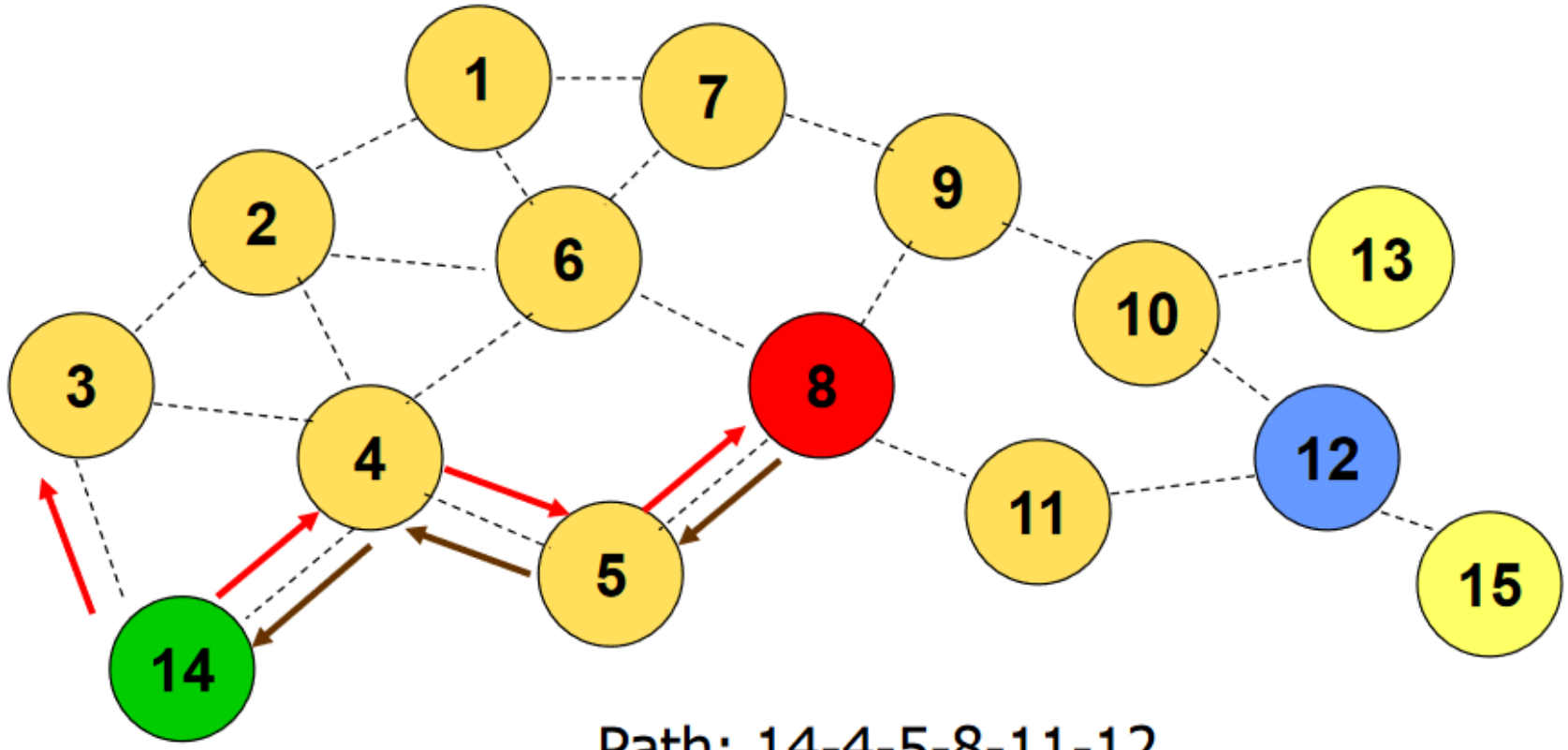
DSR Route Establishment – Route Cache

- **Example - Route Cache (1)**
  - Node 14 wants to send data to node 12 and floods *RouteRequest* message



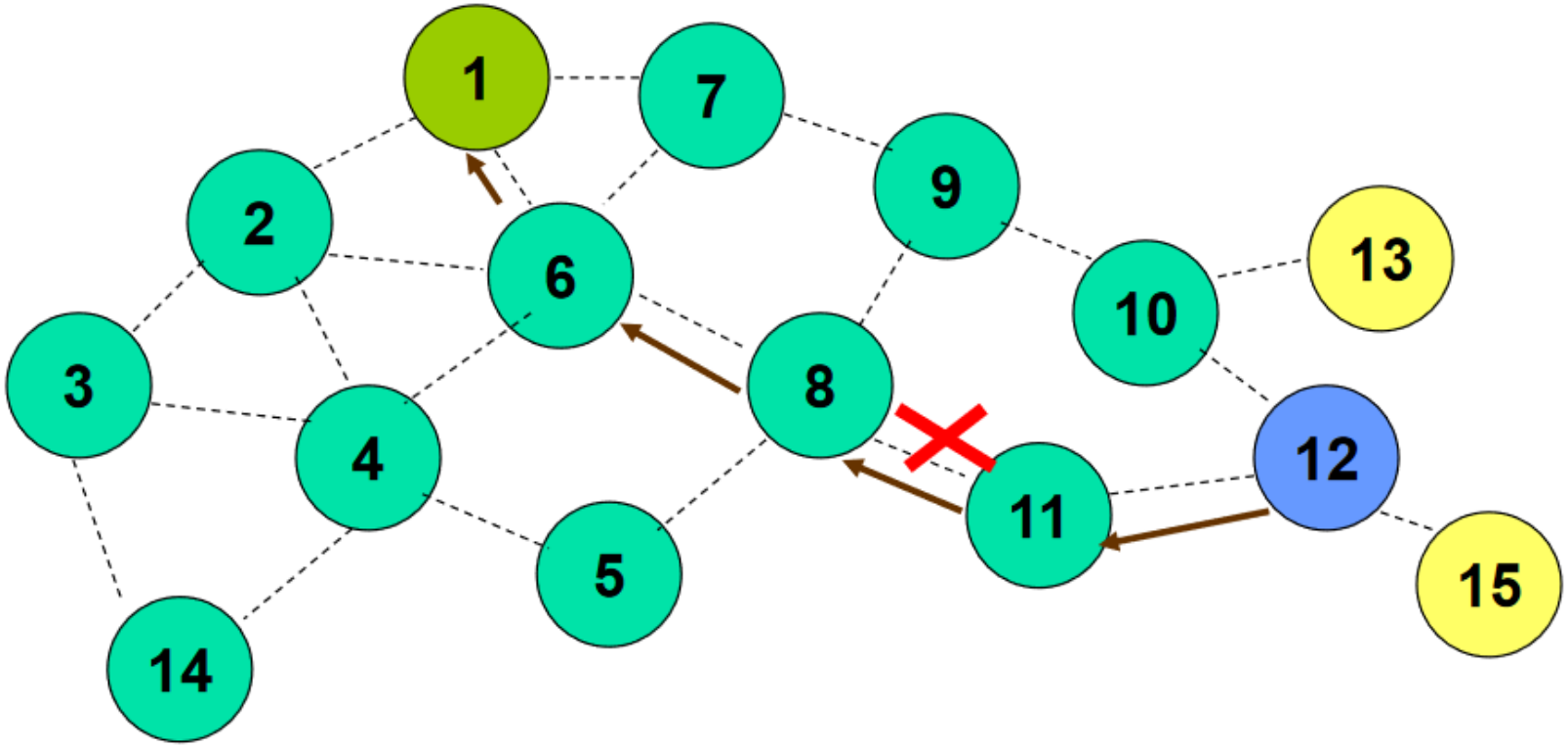
DSR Route Establishment – Route Cache (cont.)

- **Example - Route Cache (2)**
  - Node 14 wants to send data to node 12 and floods *RouteRequest* message



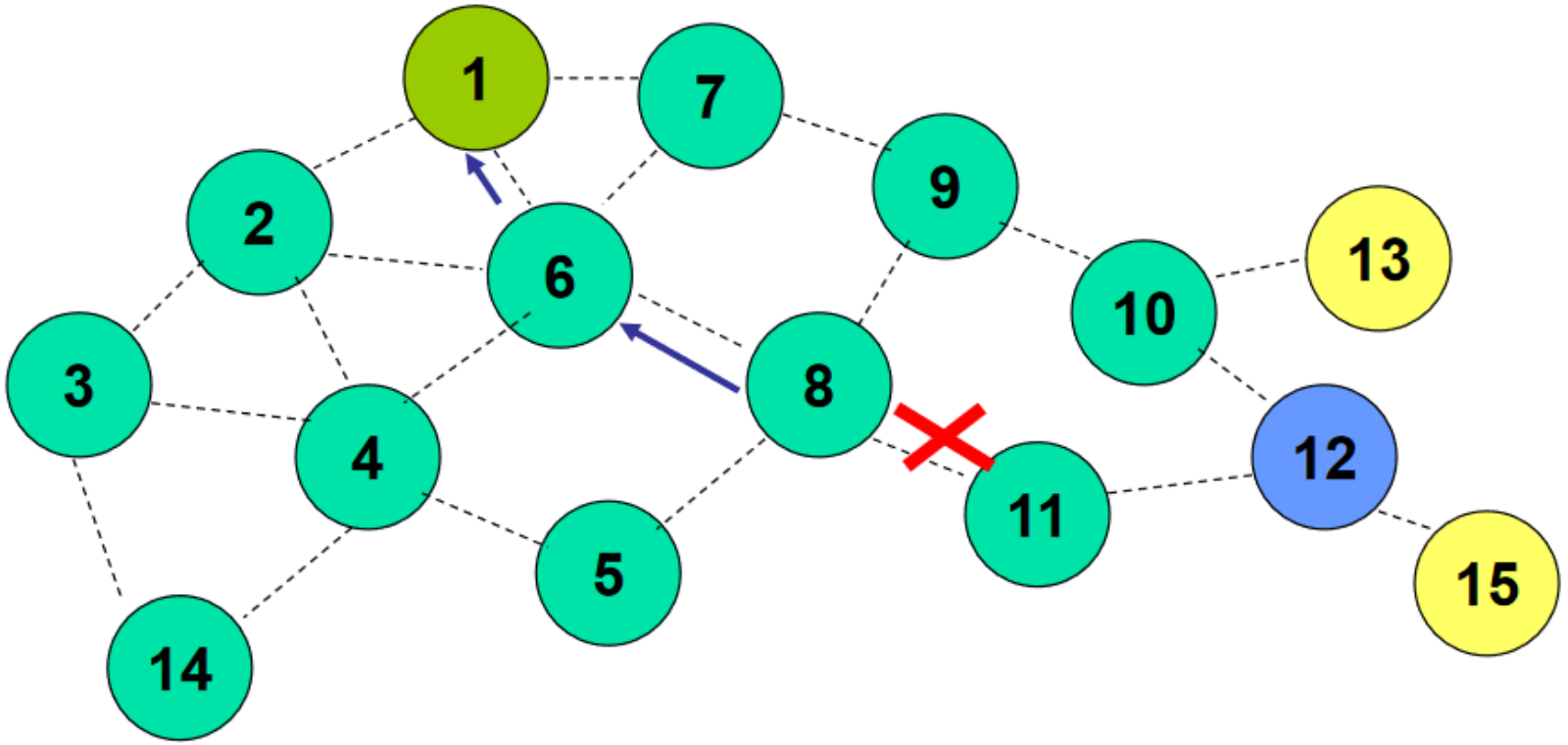
DSR Route Maintenance

- **Example - Route Maintenance (1)**
  - The link between node 8 & 11 is broken.



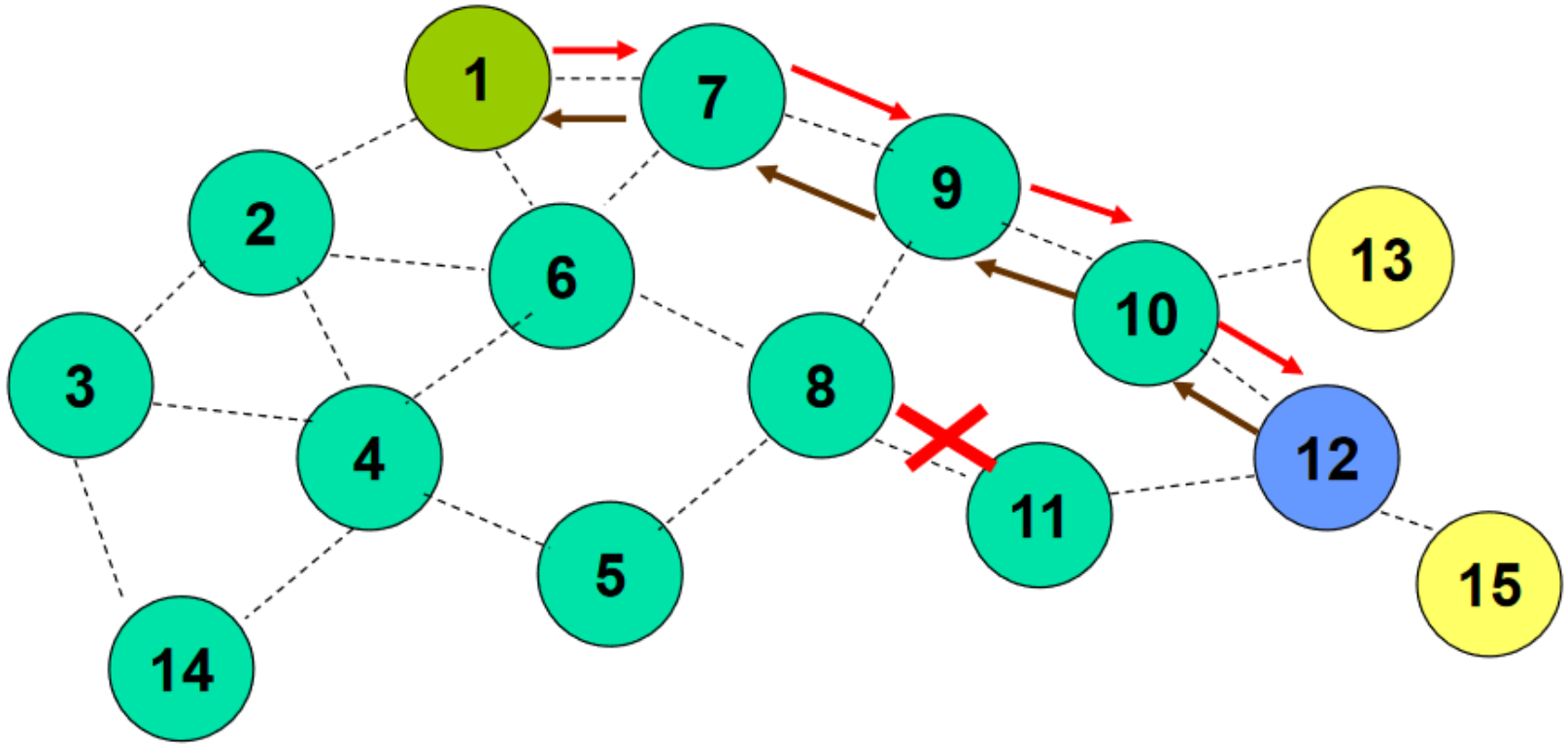
DSR Route Maintenance (cont.)

- **Example - Route Maintenance (2)**
  - Node 8 sends back *RouteError* message to source node 1.



DSR Route Maintenance (cont.)

- **Example - Route Maintenance (3)**
  - Node 1 re-discovers a route to destination node 12.



DSR Advantages & Disadvantages

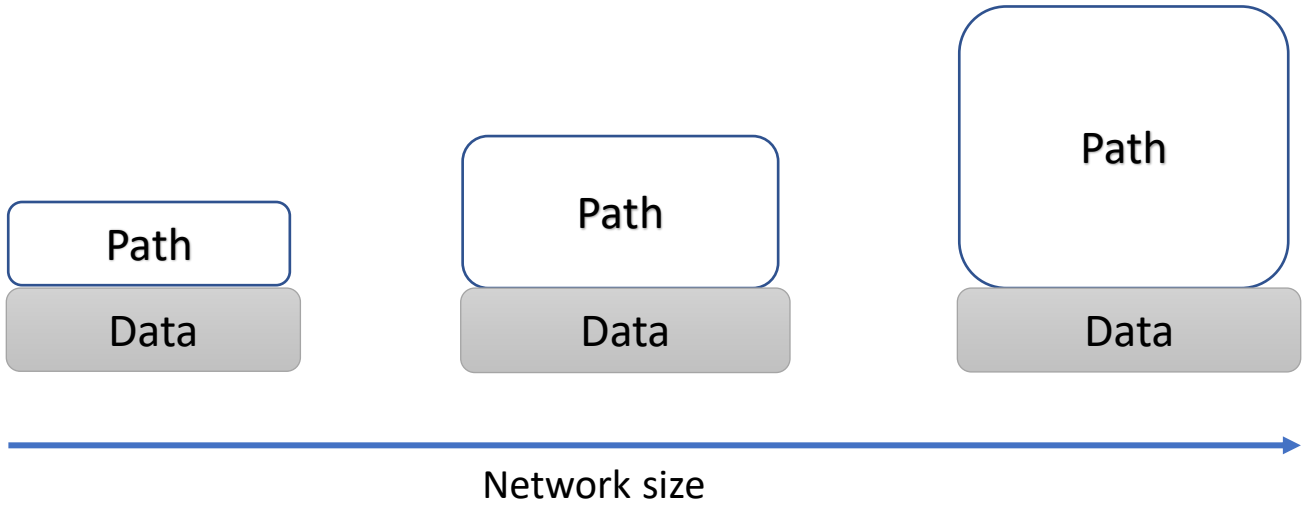
Advantages

- No need of periodical exchange of routing table.
- No need to find routes to all other nodes. / Only need to find a route to the destination.
- Route cache helps reduce the control overhead and route setting up time

Disadvantages

- Route maintenance does not locally repair a broken link.
- Route cache may be staled.
- High route setup delay.
- Routing overhead proportional to the path length.
- Packet header size grows with path length.

- As the network size increases the route path also increases.
- Increase in data packet's header.
- Inefficient usage of network bandwidth



Further Improvements

- Care must be taken to avoid collisions between route requests and route reply propagated by neighbouring nodes.
- Increased contention if too many route replies come back due to nodes replying using their local cache.
  - Route Reply Storm problem
    - Reply storm may be eased by preventing a node from sending RREP if it hears another RREP with a shorter route
    - Route reply storms also prevented by randomising delay time before sending route replies

References

- Ad Hoc Wireless Networks, architectures and protocols. C. Siva Ram Murthy and B. S. Manoj, 1st edition.
  - Sections 7.5.1

Thank you

Any Questions?

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