Mobile Adhoc Networks

COCSC20

University of Notre Dame

Wi-Fi

- Wi-Fi:
  - name is NOT an abbreviation
- **Wireless Local Area Network (WLAN)** technology.
- WLAN and Wi-Fi often used synonymous.
- Typically **in 2.4 and 5 GHz bands.**
- Based on **IEEE 802.11** family of standards.

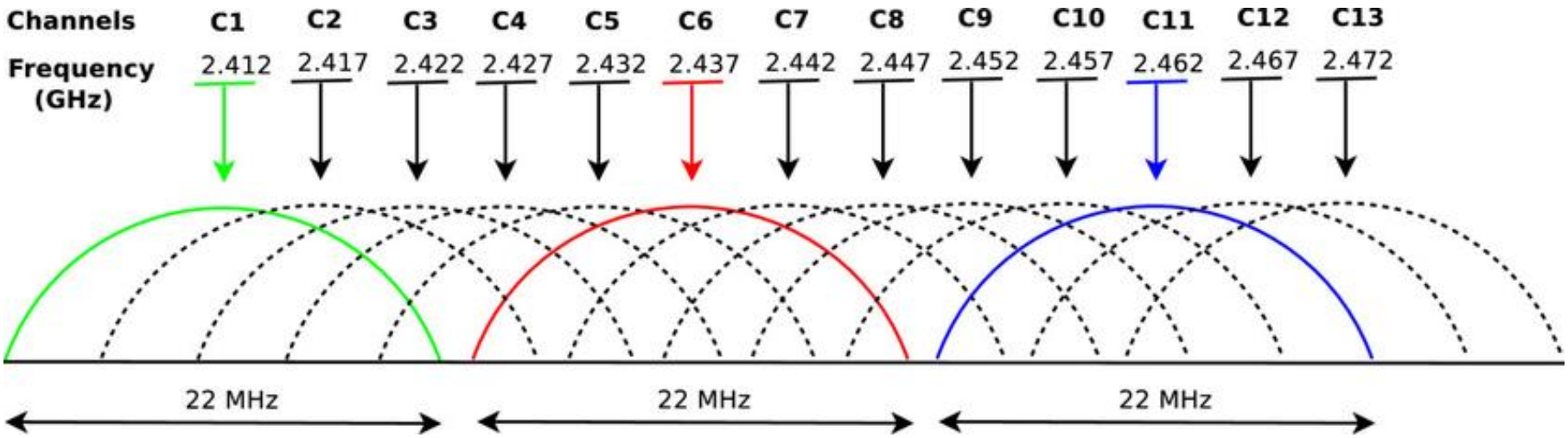
IEEE

- IEEE (Institute of Electrical and Electronics Engineers) established the 802.11 Group in 1990. Specifications for standard ratified in 1997.
- Initial speeds were 1 and 2 Mbps.
- IEEE modified the standard in 1999 to include:
  - 802.11b
  - 802.11a
  - 802.11g
  - 802.11n
  - **802.11ac**

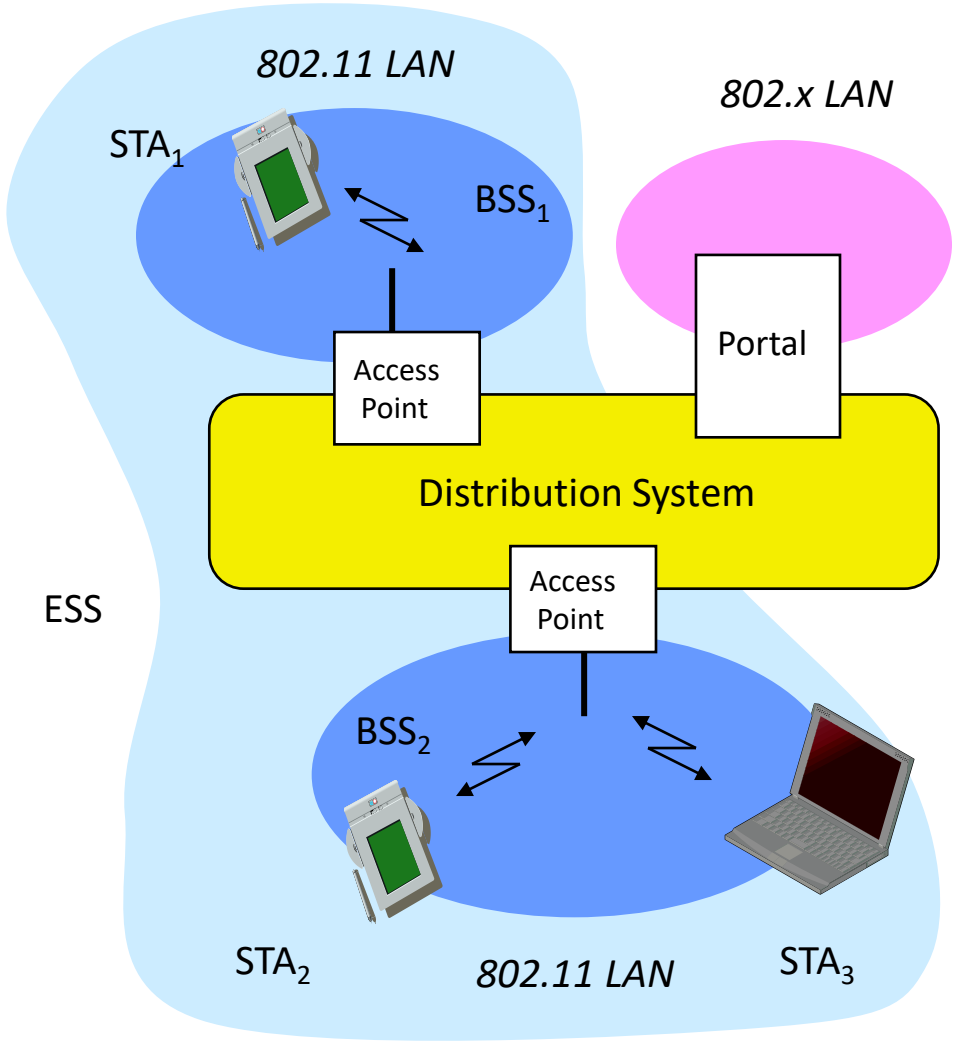
WLAN (Wi-Fi)

802.11 Wireless Standards					
IEEE Standard	802.11a	802.11b	802.11g	802.11n	802.11ac
Year Adopted	1999	1999	2003	2009	2014
Frequency	5 GHz	2.4 GHz	2.4 GHz	2.4/5 GHz	5 GHz
Max. Data Rate	54 Mbps	11 Mbps	54 Mbps	600 Mbps	1 Gbps
Typical Range Indoors*	100 ft.	100 ft.	125 ft.	225 ft.	90 ft.
Typical Range Outdoors*	400 ft.	450 ft.	450 ft.	825 ft.	1,000 ft.

Wi-Fi Channels

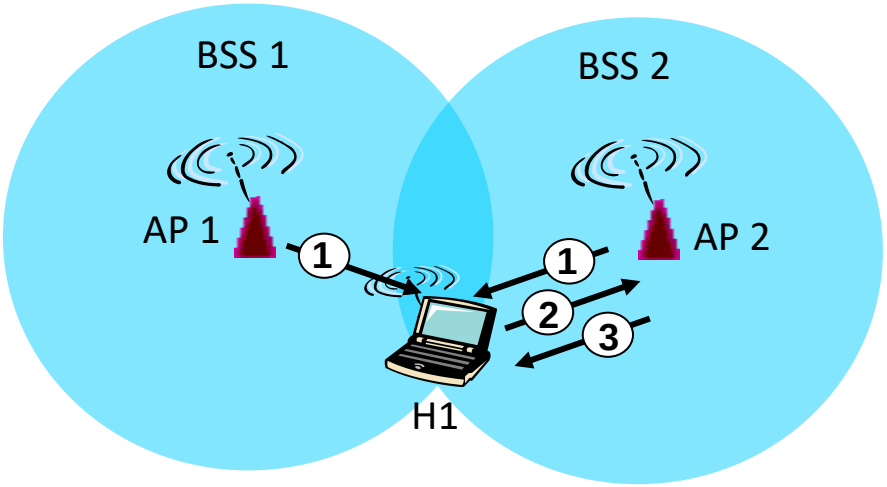


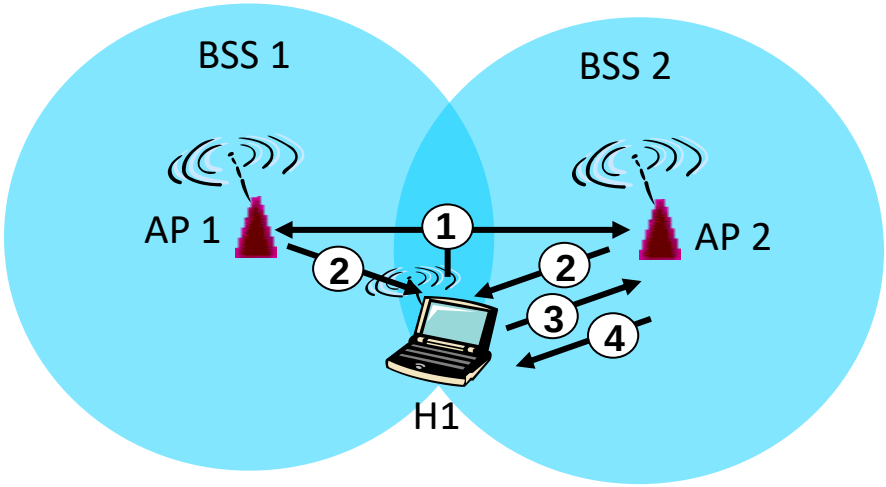
802.11 - Architecture of an Infrastructure Network



- Station (STA)
  - terminal with access mechanisms to the wireless medium and radio contact to the access point
- Basic Service Set (BSS)
  - group of stations using the same radio frequency
- Access Point
  - station integrated into the wireless LAN and the distribution system
- Portal
  - bridge to other (wired) networks
- Distribution System
  - interconnection network to form one logical network (ESS: Extended Service Set) based on several BSS

Wi-Fi (802.11) Scanning





Passive Scanning

(1) Beacons sent from APs
(2) Association Request sent from H1 to selected AP
(3) Association Response sent from AP to H1

Active Scanning

(1) Probe Request (broadcast) sent from H1
(2) Probe Response sent from APs
(3) Association Request sent from H1 to selected AP
(4) Association Response sent from AP to H1

Wi-Fi Alliance Mission Statement

- Non-profit organization
- Certify the interoperability of products and services based on IEEE 802.11 technology
- Grow the global market for **Wi-Fi® CERTIFIED** products and services across all market segments, platforms, and applications
- Rigorous interoperability testing requirements

Certificate & Logo

Wi-Fi® Interoperability Certificate

Certification ID: 24567832AP

Wi-Fi CERTIFIED a b g

This certificate represents the capabilities and features that have passed the interoperability testing governed by the Wi-Fi Alliance.

Detailed descriptions of these features can be found at www.wi-fi.org/certificate

Certification Date: February 14, 2004
Category: Access Point
Company: Name of Company
Product: Wireless LAN Access Point/Router Model#EX1010
Model/SKU #: EX1010

This product has passed Wi-Fi certification testing for the following standards:

IEEE Standard	Security	Quality of Service	Public Access
802.11a 802.11b 802.11g 802.11n **Regulatory** 802.11d 802.11h	WPA - Personal WPA - Enterprise WPA2 - Personal (802.11i) WPA2 - Enterprise (802.11i) **Supplicant** EAP-TLS EAP-TTLS/MSCHAPv2 EAP-TTLS/PAP PEAPv0/EAP-MSCHAPv2 PEAPv1/EAP-GTC PEAPv1/EAP-MD5 EAP-SIM **Authentication Server** EAP-TLS EAP-TTLS/MSCHAPv2 EAP-TTLS/PAP PEAPv0/EAP-MSCHAPv2 PEAPv1/EAP-GTC PEAPv1/EAP-MD5	WME (802.11e EDCA profile) WSM (802.11e HCCA profile)	

For more information: www.wi-fi.org/certified_products

Certificate inside packaging (optional)

Wi Fi CERTIFIED a b g n

Wi Fi CERTIFIED a b g n

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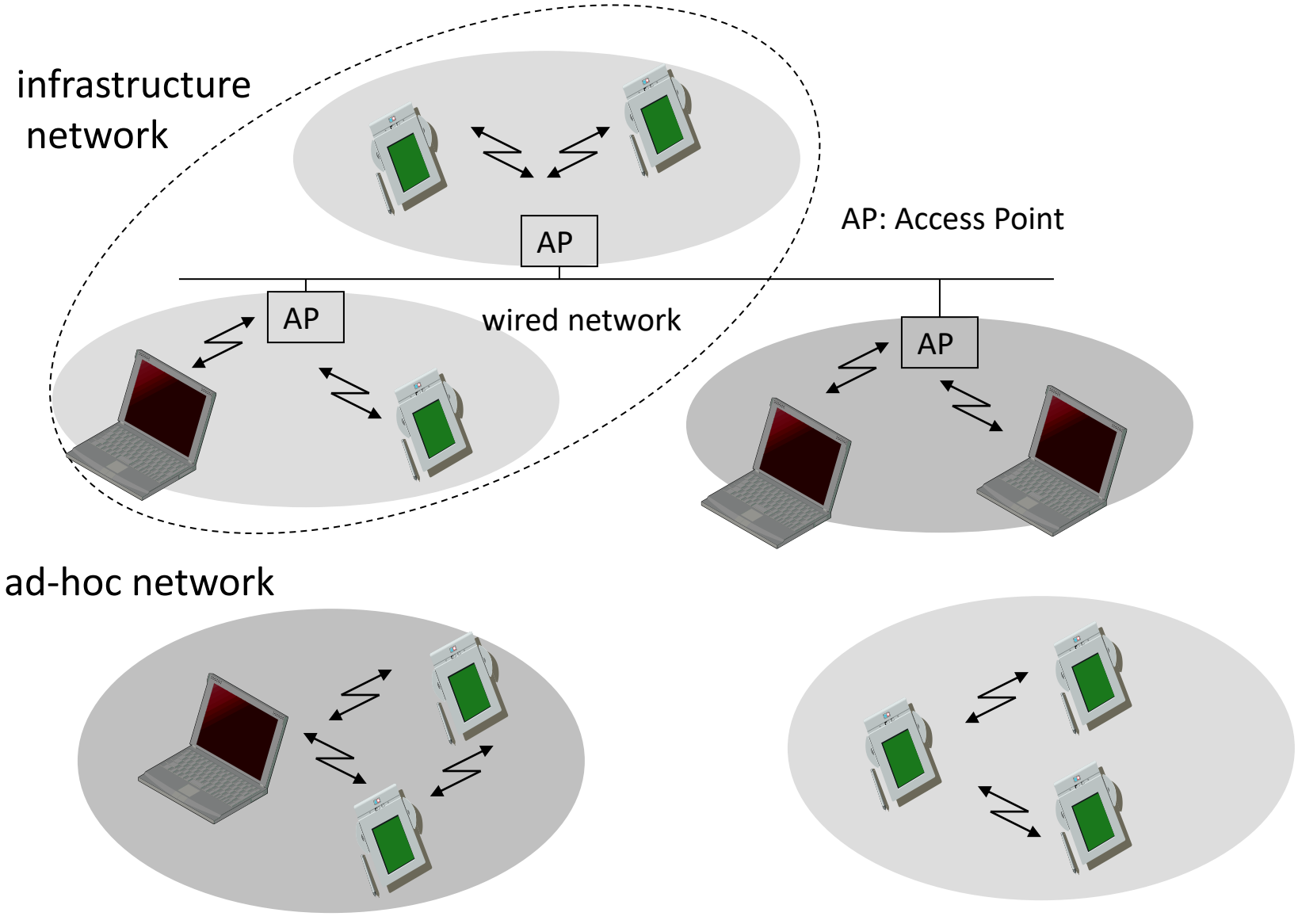
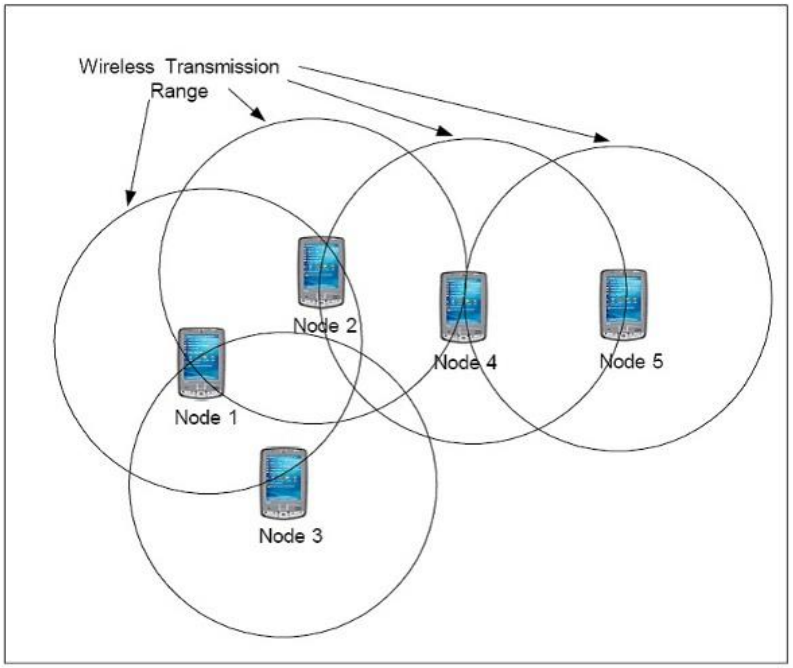
- Logo on product packaging (mandatory)
- Helps retailers and consumers

Infrastructure vs. Ad-Hoc Networks



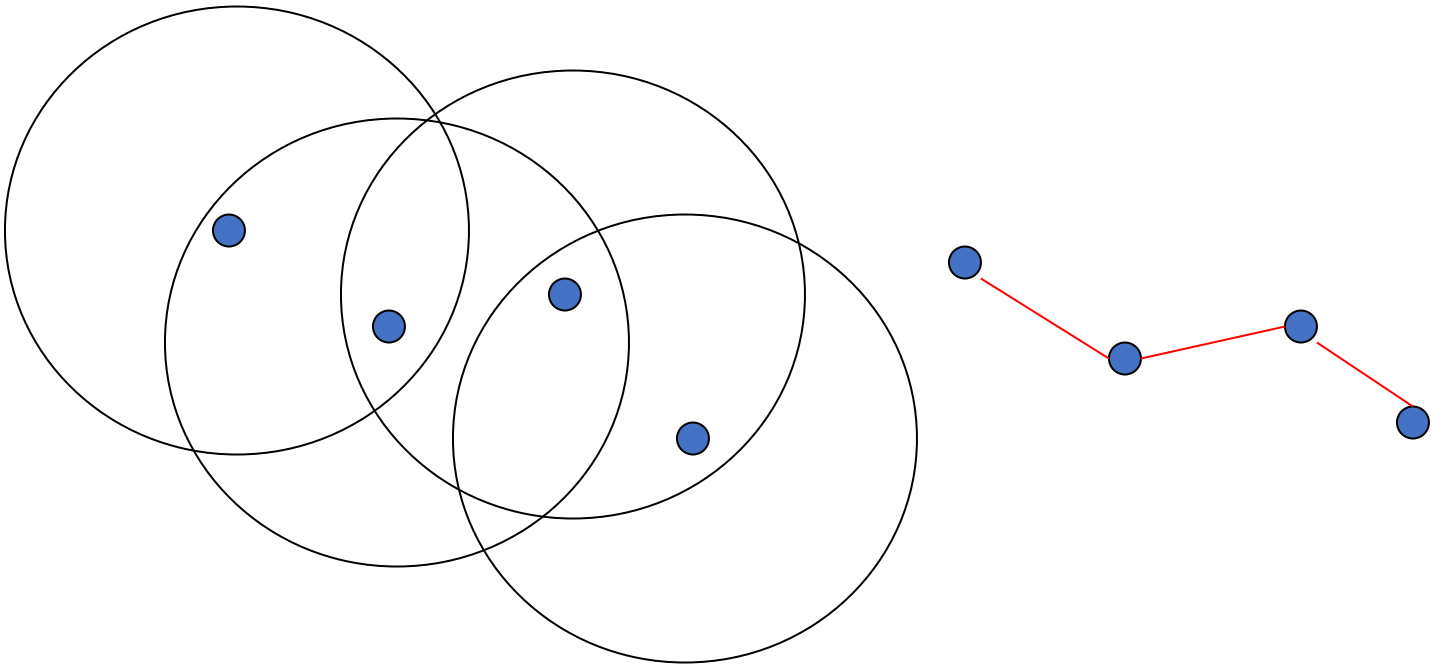
Infrastructure-Less (Ad-Hoc)

- Ad-hoc means '*for this purpose*'
- No need for infrastructure (like routers, cell towers, etc.)
- MANET: **M**obile **A**d-Hoc **Net**work



Routing

- Packets may need to traverse multiple links to reach destination
- Mobility causes route changes

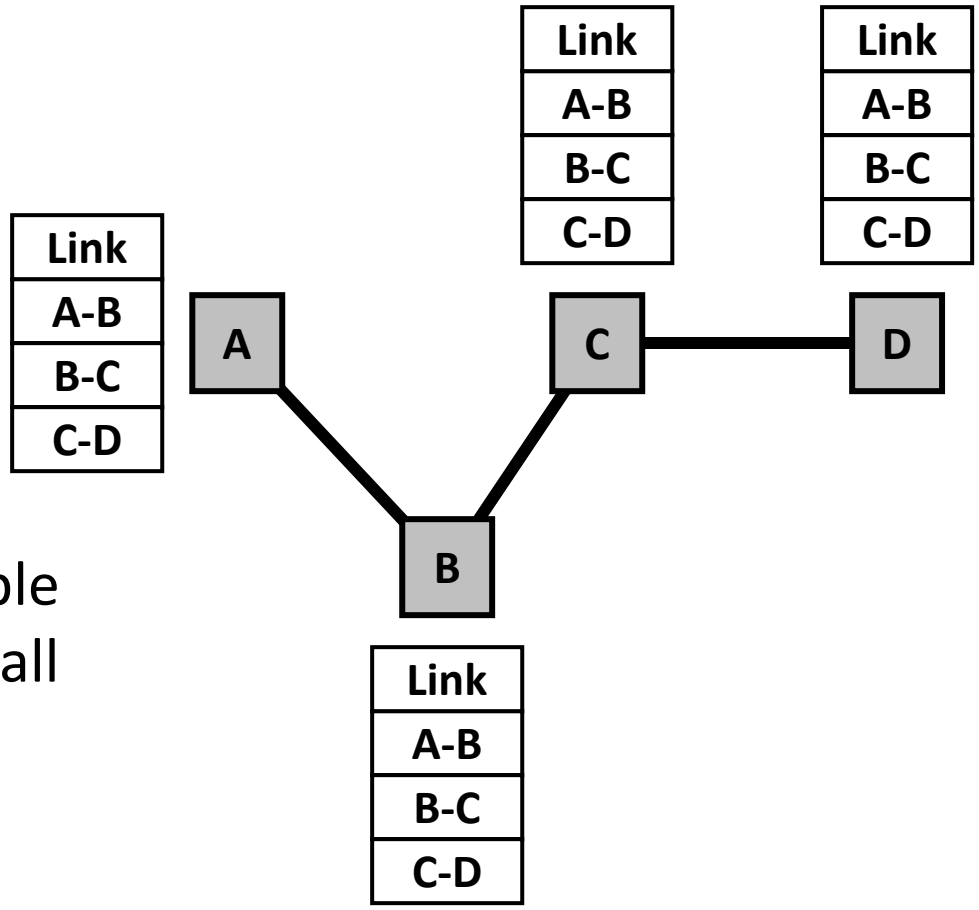


Ad-Hoc Routing Protocol

- An ad-hoc routing protocol is a convention that controls how nodes decide which way to route packets between computing devices in a mobile ad-hoc network
- Foundation in most protocols: **neighbor discovery**
  - Nodes send periodic announcements as broadcast packets (beacon messages, alive messages, …)
  - Can embed “neighbor table” into such messages; allows nodes to learn “2-hop neighborhood”
- Popular types of routing protocols:
  - **Proactive**
  - **Reactive**
  - **Geographic**

Proactive: “Link-State” Algorithms

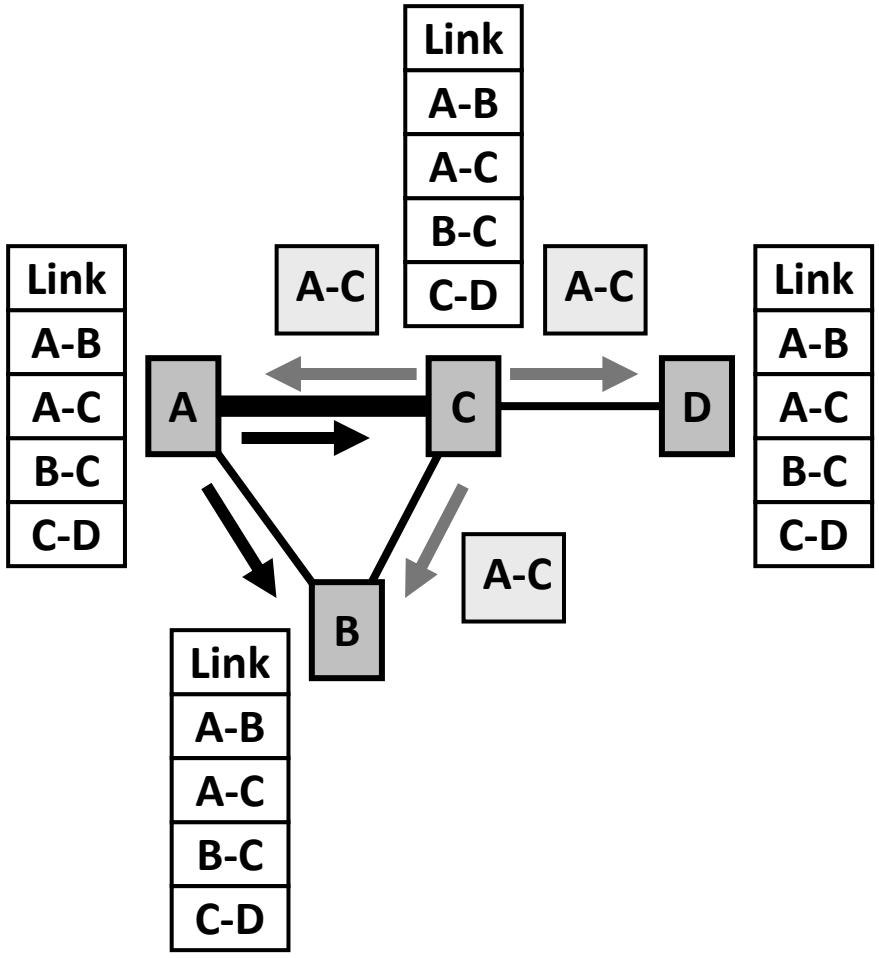
- Each node shares its link information so that all nodes can build a map of the full network topology



- Assuming the topology is stable for a sufficiently long period, all nodes will have the same topology information

Proactive: “Link-State” Algorithms

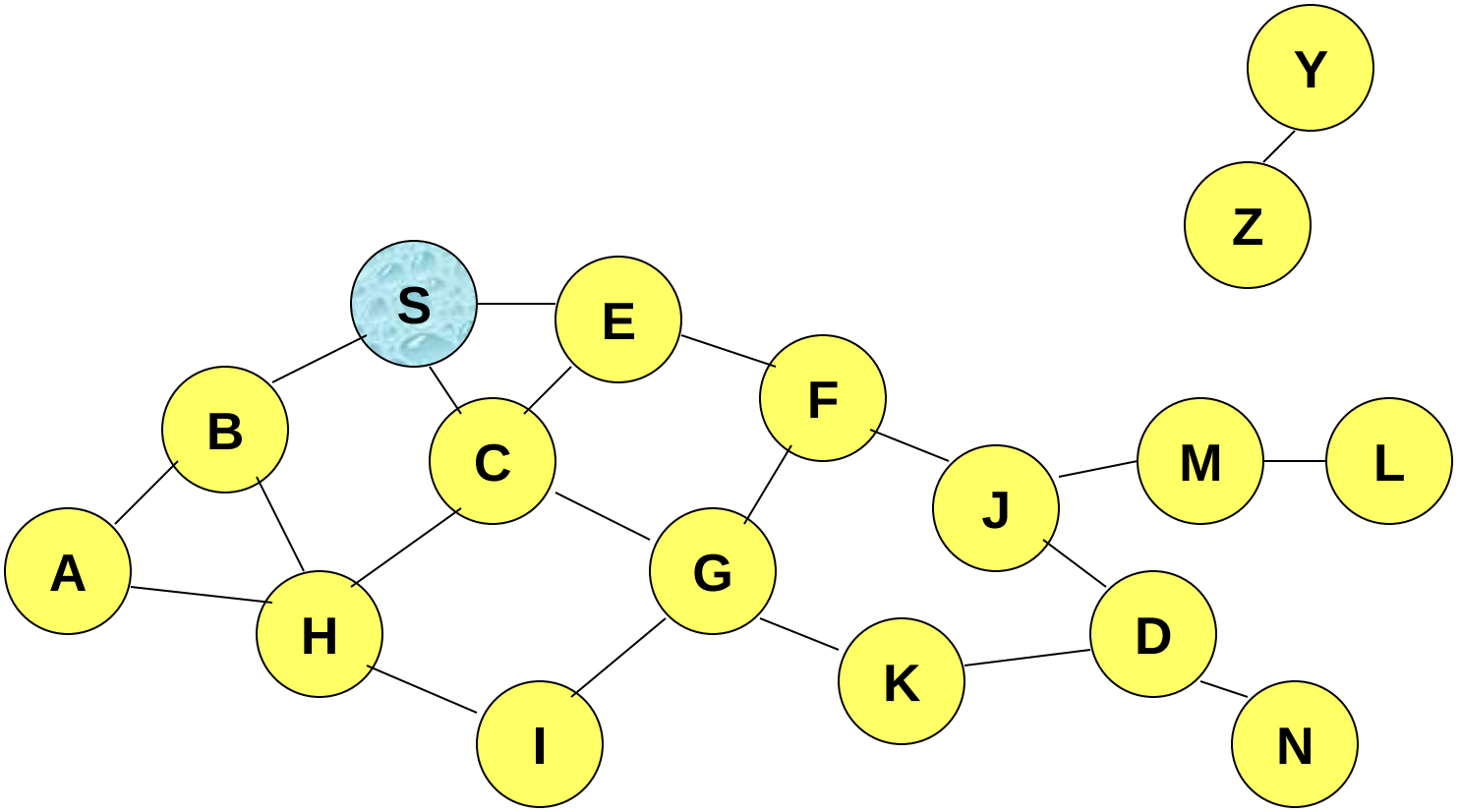
- Link information is updated when a link changes state (goes up or down)
  - by sending small “hello” packets to neighbors
- Nodes A and C propagate the existence of link A-C to their neighbors and, eventually, to the entire network



Reactive: DSR

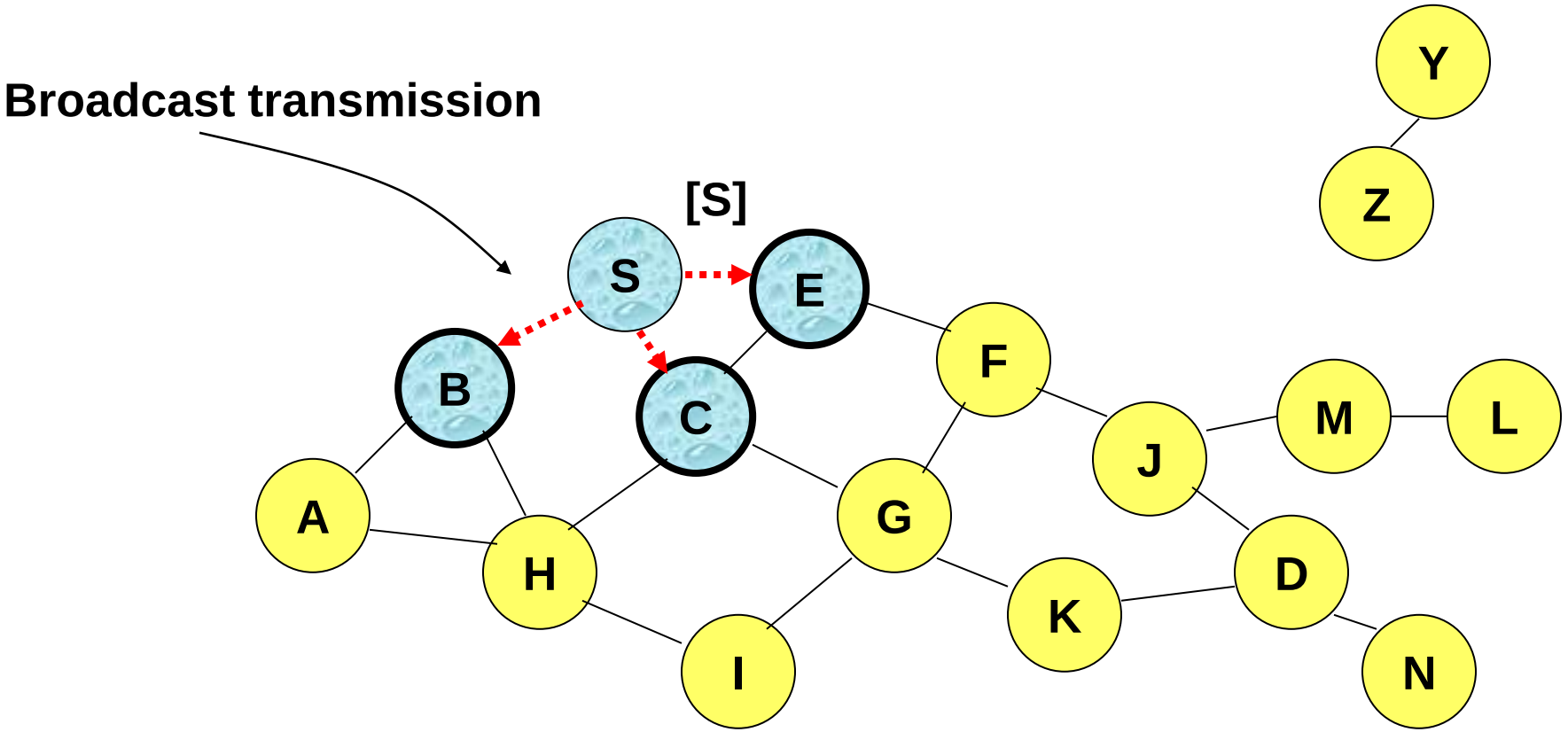
- **D**ynamic **S**ource **R**outing
- Search for route when needed only
  - Search using **Route Request (RREQ)** broadcasts
  - Response using **Route Reply (RREP)** message
- Every message along route contains entire path to help intermediate nodes to decide what to do with message

Route Discovery in DSR



Represents a node that has received RREQ for D from S

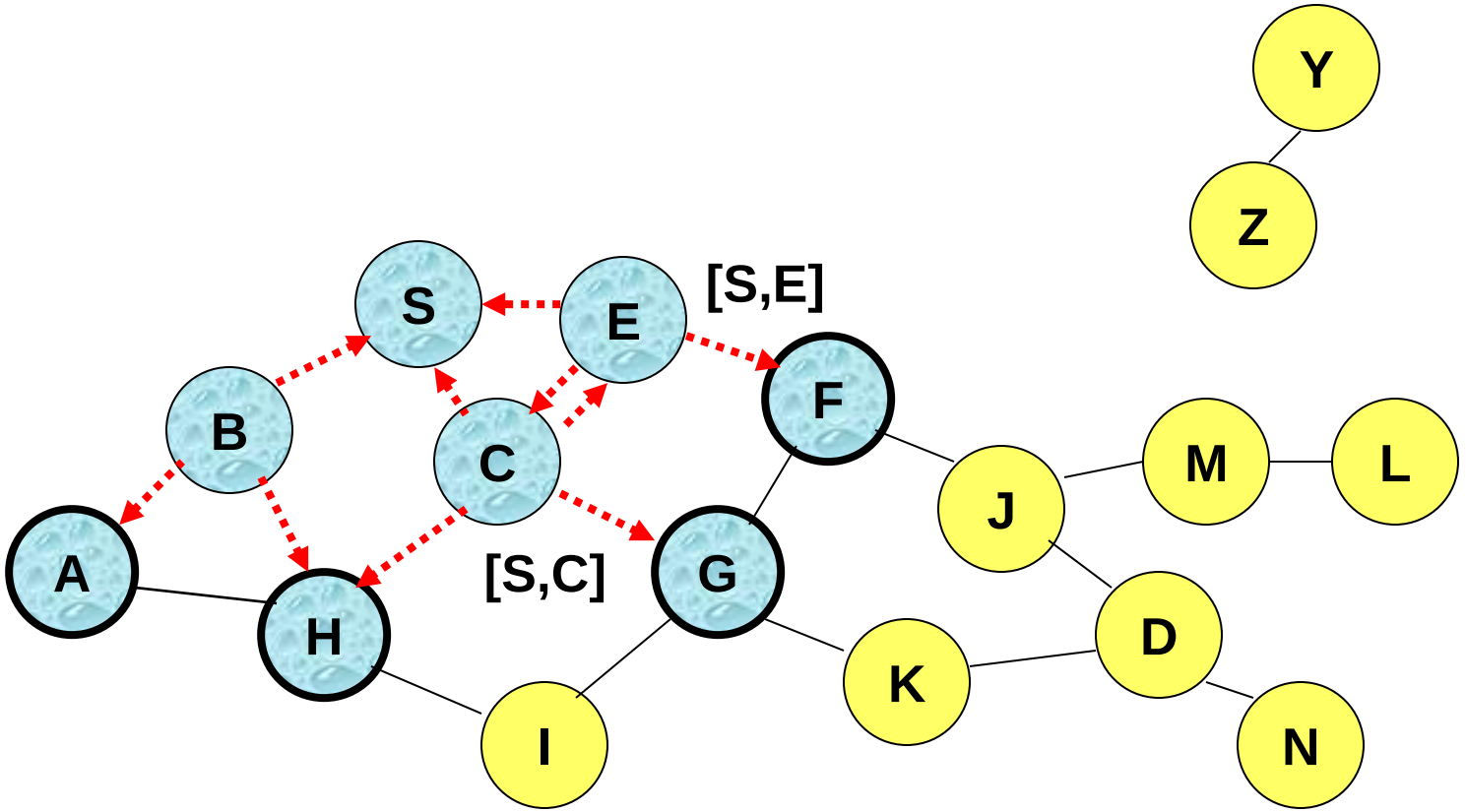
Route Discovery in DSR



Represents transmission of RREQ

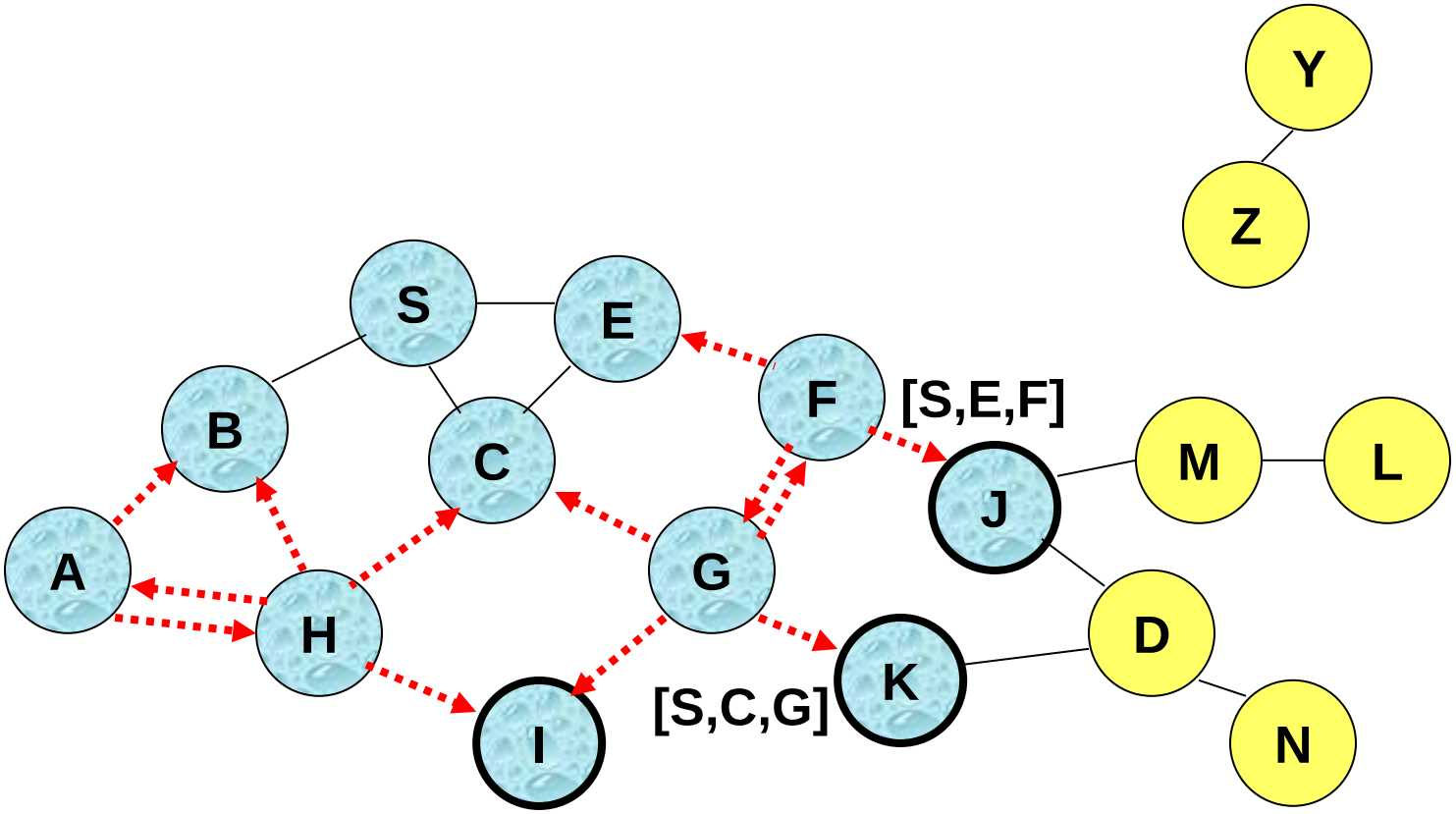
[X,Y] Represents list of identifiers appended to RREQ

Route Discovery in DSR



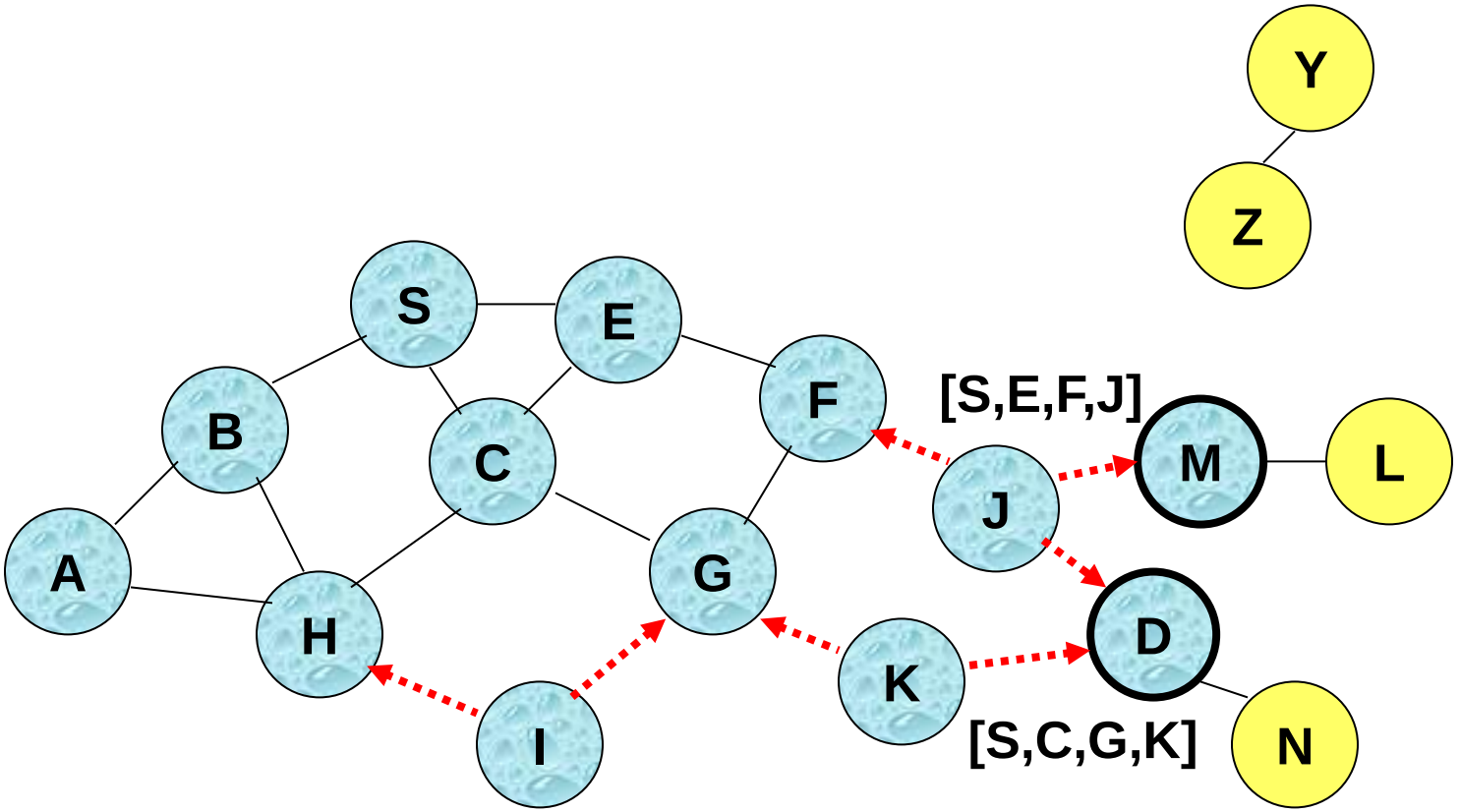
- **Node H receives packet RREQ from two neighbors:**
  potential for collision

Route Discovery in DSR



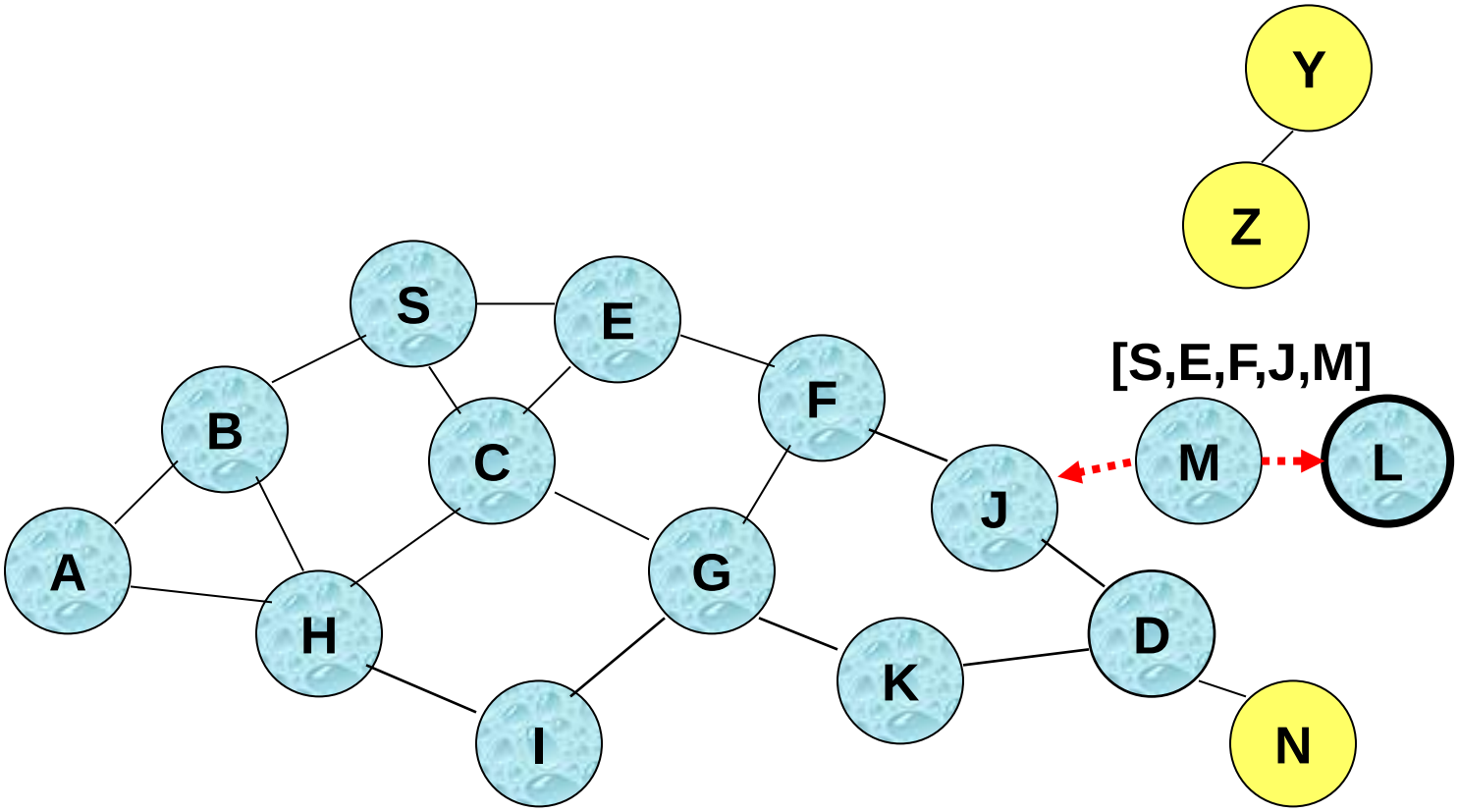
- **Node C receives RREQ from G and H, but does not forward it again, because node C has already forwarded RREQ once**

Route Discovery in DSR



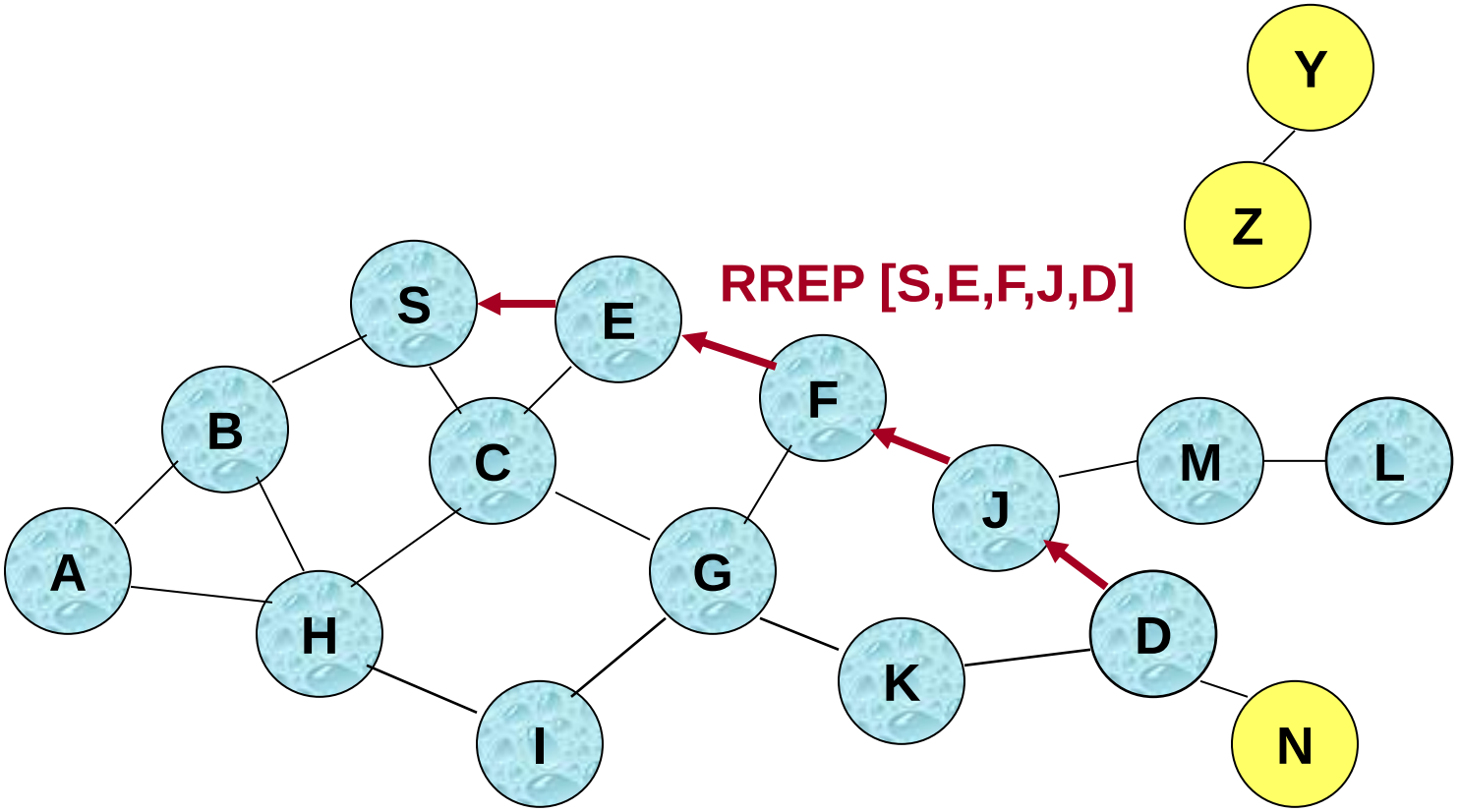
- **Nodes J and K both broadcast RREQ to node D**
- **Since nodes J and K are hidden from each other, their transmissions may collide**

Route Discovery in DSR



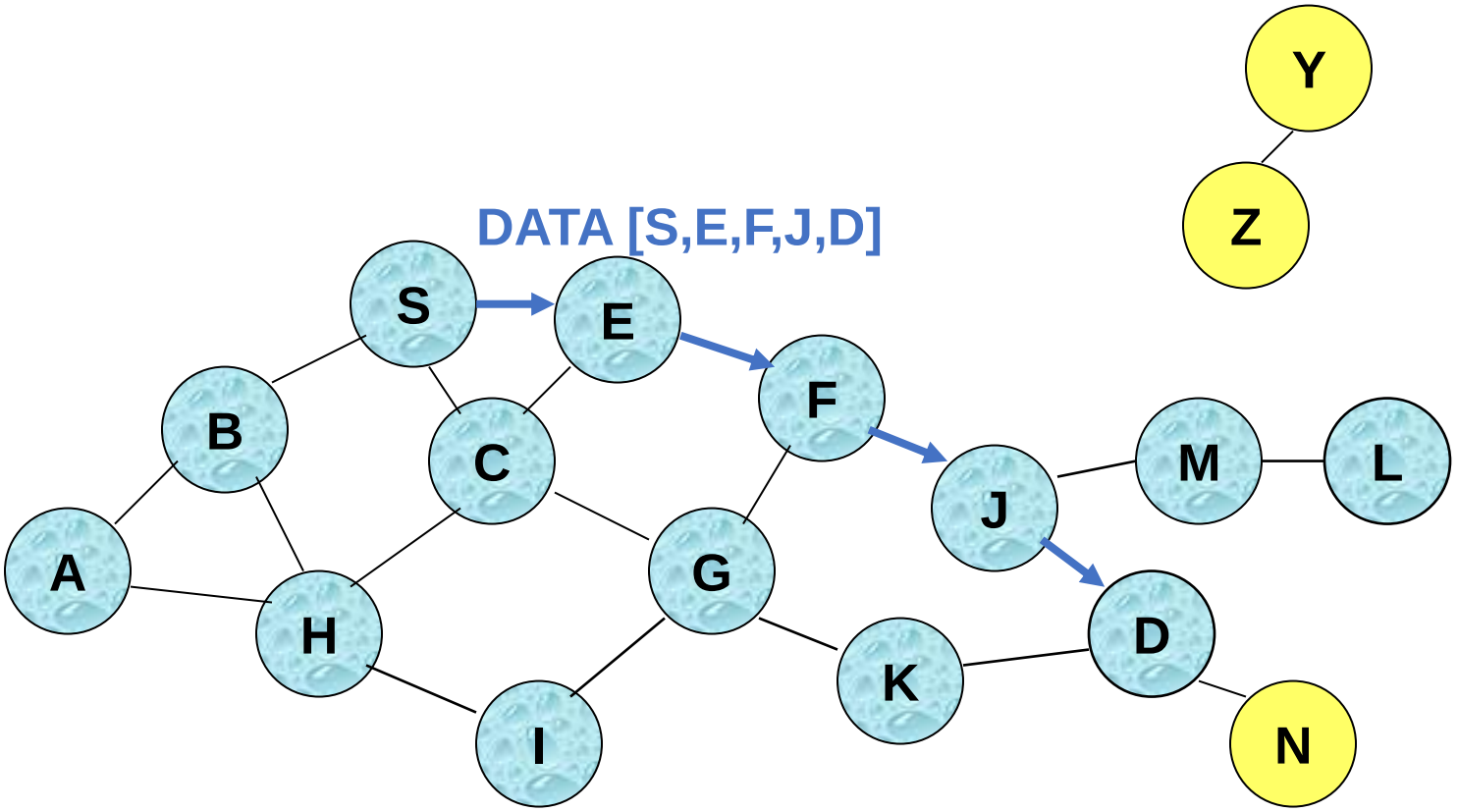
- **Node D does not forward RREQ, because node D is the intended target of the route discovery**

Route Reply in DSR



← **Represents RREP control message**

Data Delivery in DSR



Packet header size grows with route length

Proactive vs Reactive

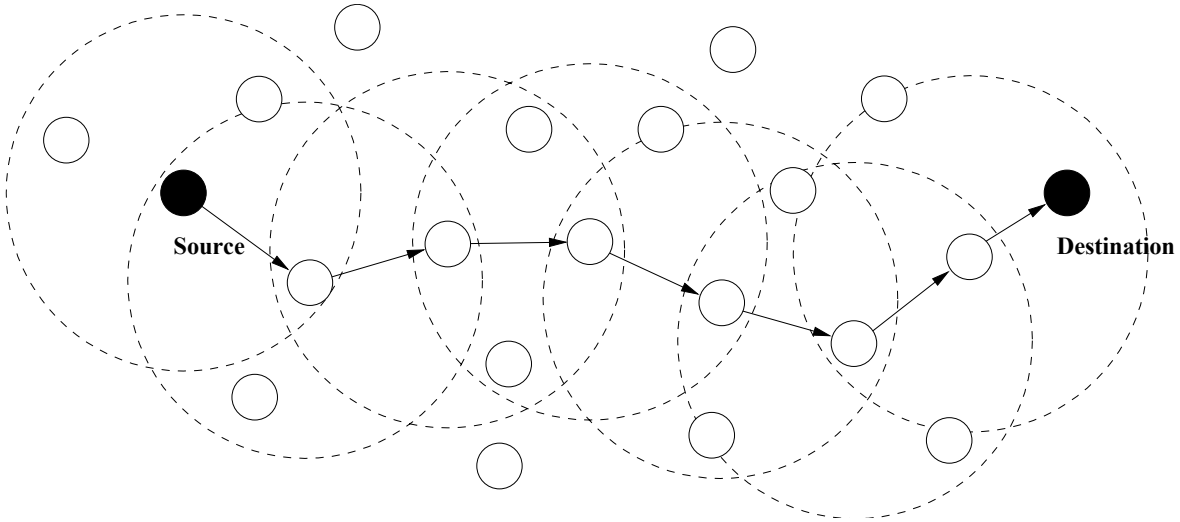
- Reactive:
  - Only establish/maintain routes between nodes needed them (in contrast: tables store ALL routes)
  - Store entire route in each message; message size grows with route length
  - Route requests cause “flooding”
- Proactive:
  - Route information always available; no need to search for route (but route information can be outdated)
  - Continuous exchange of route change updates

Geographic Routing

- Nodes use location information to make routing decisions
  - sender must know the locations of itself, the destination, and its neighbors
  - location information can be queried or obtained from a **location broker**
  - location information can come from GPS (Global Positioning System) or some other form of positioning technology.

Unicast Location-Based Routing

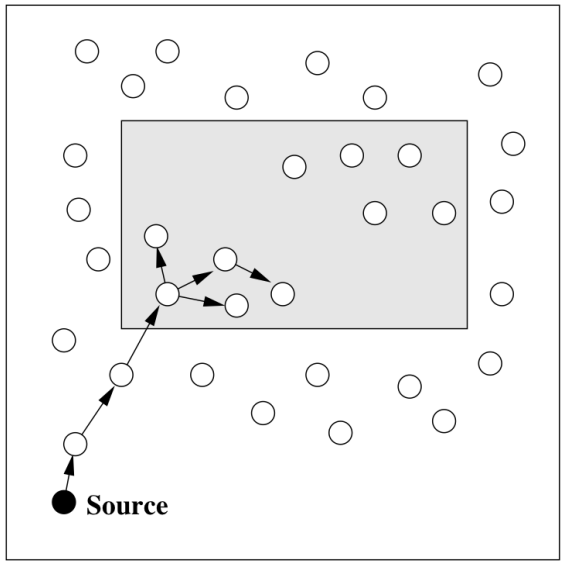
- One single destination
- Each forwarding node makes localized decision based on the location of the destination and the node's neighbors (**greedy forwarding**)
- Challenge: packet may arrive at a node without neighbors that could bring packet closer to the destination (**voids** or **holes**)



Geocasting

- Packet is sent to all or some nodes within specific geographic region
- Example: query sent to all sensors within geographic area of interest

- Routing challenge:
  - propagate a packet near the target region (similar to unicast routing)
  - distribute packet within the target region (similar to flooding)



Thank You

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