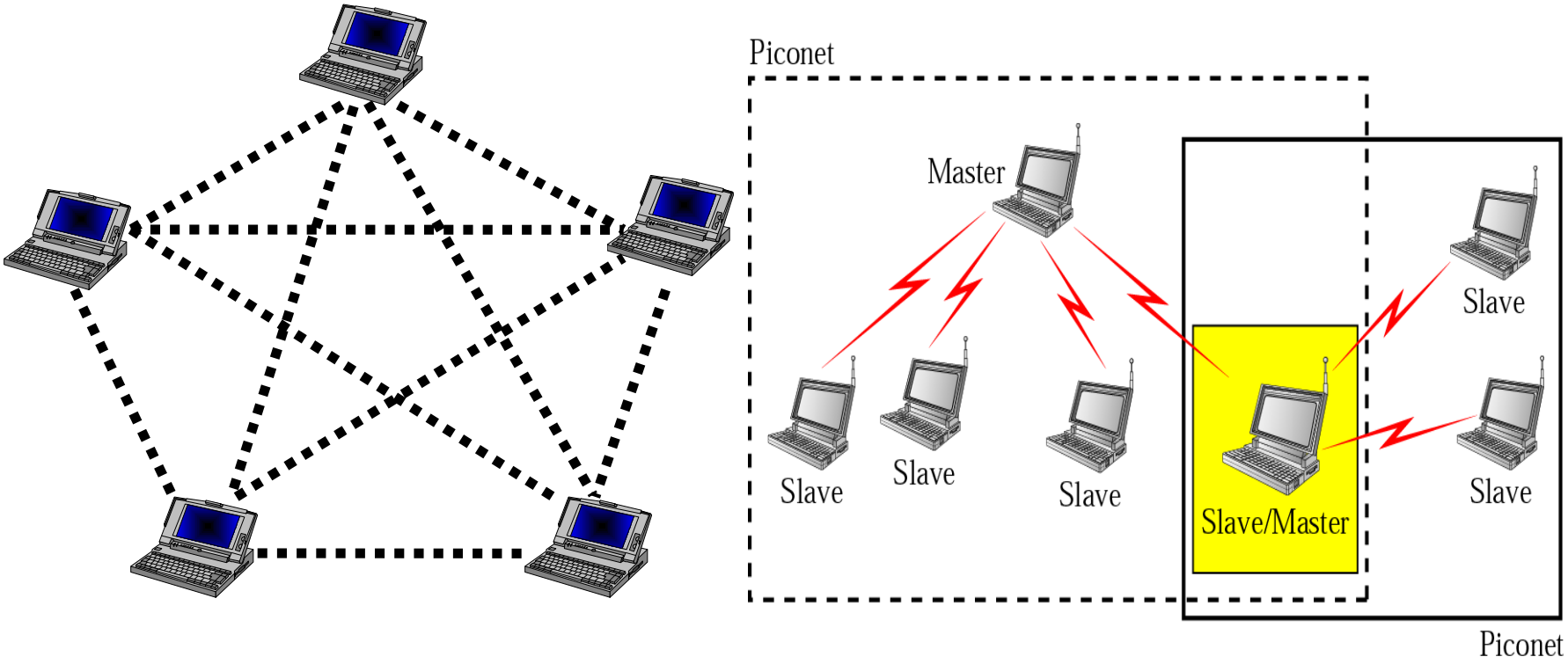
Lecture 6. Concepts of Ad-Hoc Networks (07/12)

Introduction of Wireless Networking
1. Mobile Ad-Hoc Networks
2, Introduction
3. On-Demand Routing
4. Mobile Host Registrations procedure
5. Routing in Mobile Ad Hoc Networks
6. Mobile Ad Hoc Networking

1. Introduction to Mobile Ad-Hoc Networks (MANET)

Roaming routers and hosts



a. 802.11

b. 802.15

Mobile Ad-Hoc (MANET) Network features

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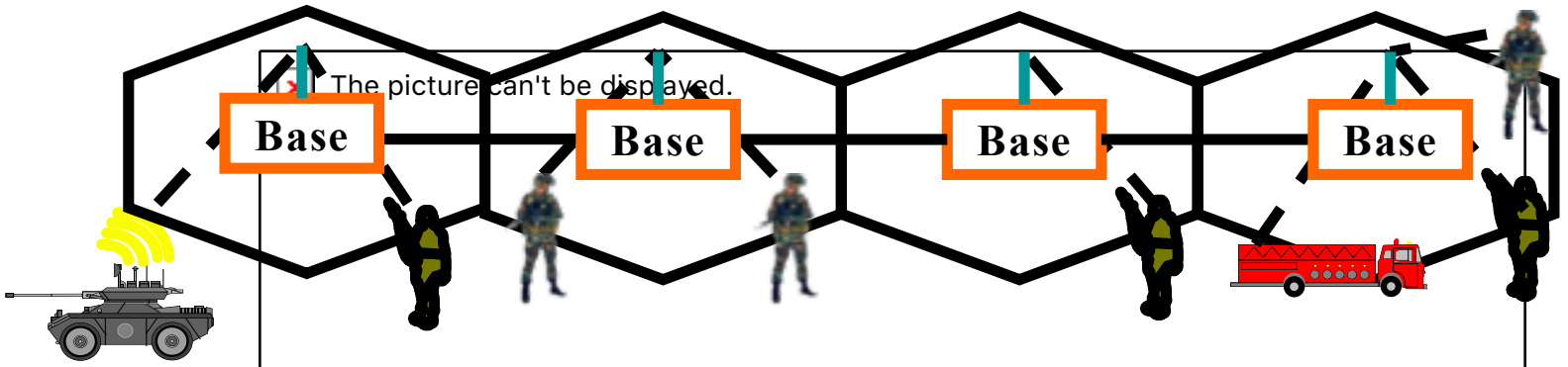
- Infrastructureless, no BS support
- Wireless multihop connection
- Limited resources: bandwidth, energy supply, memory.

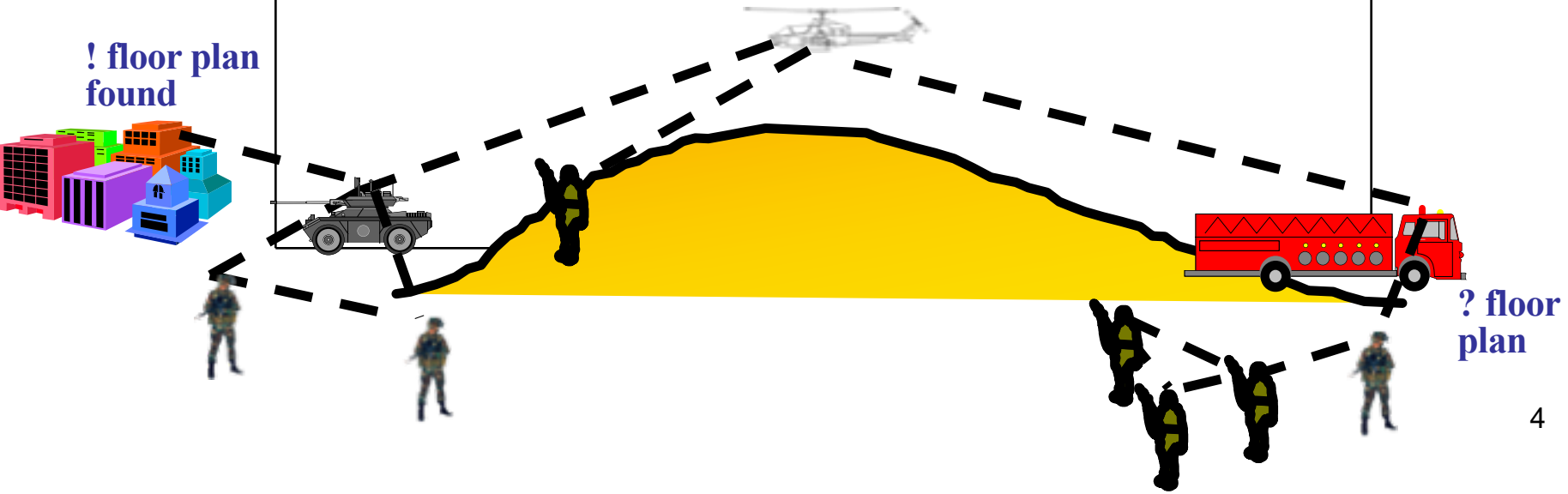
- Extend network access to unreachable areas. MANET extends mobility into unreachable area by set of nodes, which may be combined routers and hosts, they form the network routing in an Ad-Hoc fashion.

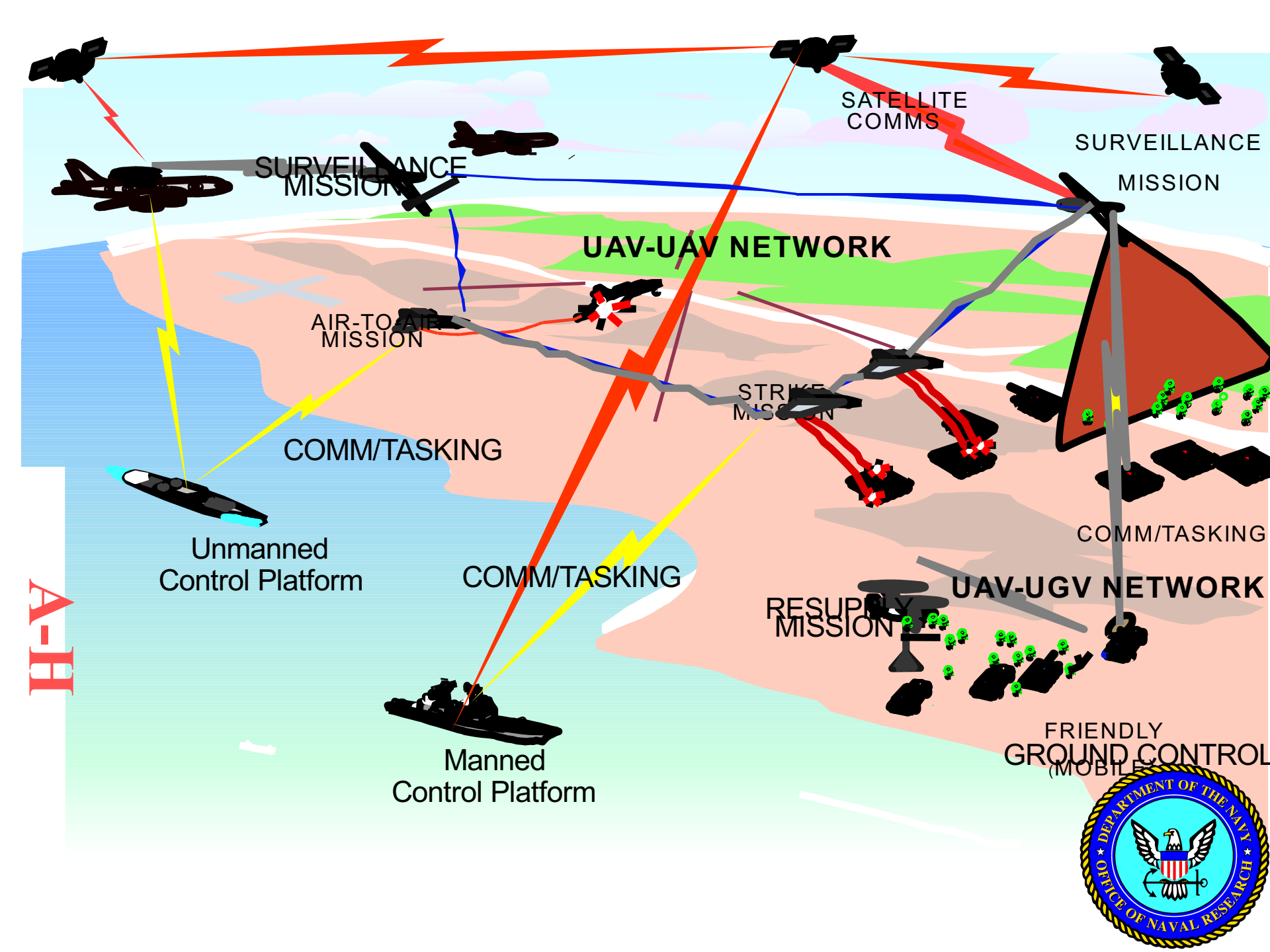
- **Applications**: **digital battlefields, sensors, disaster recovery, law enforcement, conventions, etc.**

Single Hop (Cellular)



Multihop (Ad-Hoc)




SATELLITE
COMMS
SURVEILLANCE
MISSION
SURVEILLANCE
MISSION
UAV-UAV NETWORK
AIR-TO-AIR
MISSION
STRIKE
MISSION
COMM/TASKING
Unmanned
Control Platform
COMM/TASKING
COMM/TASKING
UAV-UGV NETWORK
RESUPPLY
MISSION
Manned
Control Platform
FRIENDLY
GROUND CONTROL
(MOBILE)
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Ad-Hoc Network Applications

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Military

- Automated battlefield

Civilian

- Homeland defense
- Disaster Recovery (flood, fire, earthquakes etc)
- Law enforcement (crowd control)
- Search and rescue in remote areas
- Environment monitoring (sensors)

Ad-Hoc network implementations

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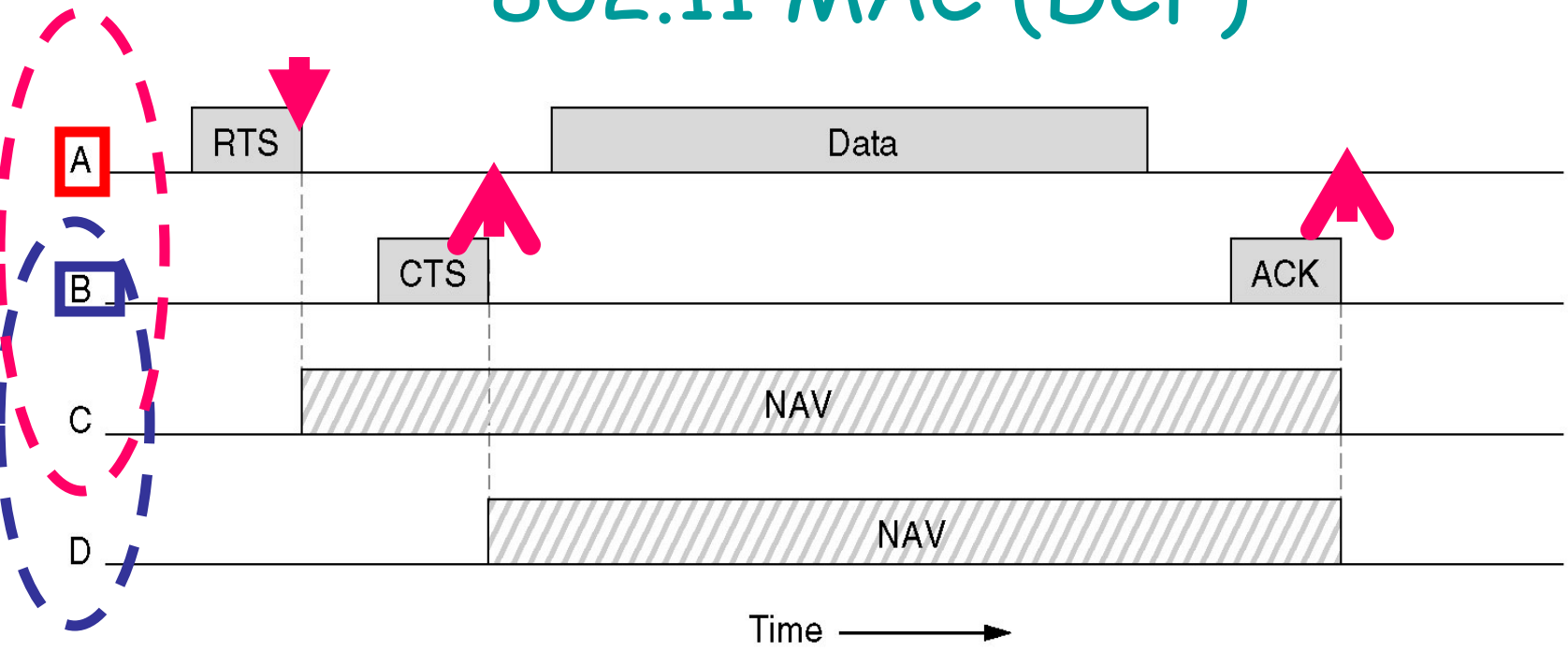
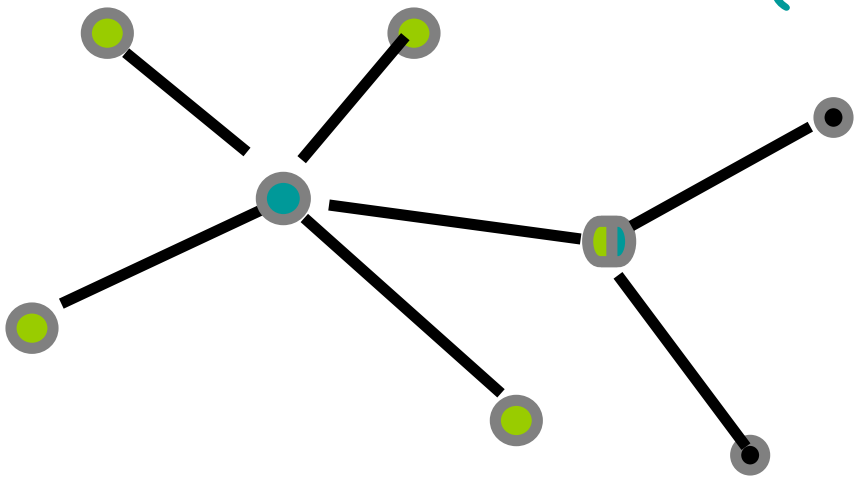
Ad-hoc Nets can be implemented with different radio and MAC technologies:

- **Most common is 802.11 "ad-hoc mode"**
- **Bluetooth 802.15 scatternets**
- **Zigbee 802.15.4 trees and meshes**

802.11 MAC (DCF)



802.15 Scatternets MAC (PCF)



MANETs characteristics:

MANET (Mobile Ad-Hoc Networks) nodes are equipped with wireless transmitters and receivers using antennas

1. **Dynamic topologies: Nodes are free to move; thus, the network topology, is typically multihop, may change randomly and rapidly, and may consist of both bidirectional and unidirectional links.**
2. **Bandwidth-controlled, variable capacity links: Wireless links will continue to have lower capacity than their hardwired counterparts.**
3. **Limited physical security: MANETs are more prone to physical security than are fixed-cable nets.**
4. **Decentralized nature of network**

A2. On-Demand Routing

- Routes are established “on demand” as requested by the source
- Only the active routes are maintained by each node
- Two leading methods for route discovery: **source routing** and **backward learning**
- **For different applications of sending packets there are different routing algorithms:**

  Broadcasting, Multi-destination, Signaling tree, Reserve path forwarding algorithms.

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Packet Routing Algorithms

- The function of the network layer is routing of packets from the source machine to the destination machine. In most subnets, packets will require multiple hops to make the connectivity.
- The algorithms that choose the routers and the data structures call the **router algorithms**.

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- **Router have two processes inside it.**

a. Forwarding: Looking up the outgoing line to use for it in the routing tables.
b. Updating: is responsible for filling in and **updating** the routing tables

- **Routing algorithm Properties:**

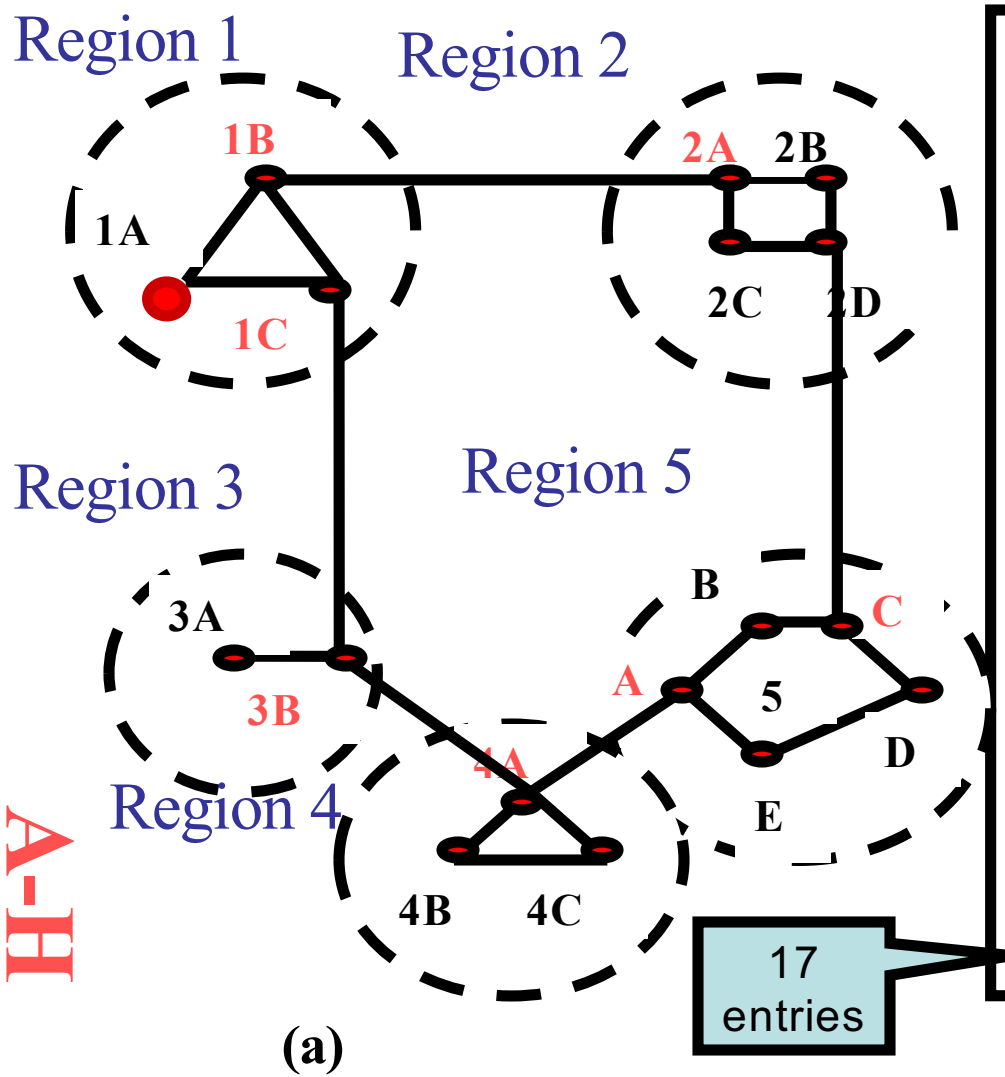
correctness, simplicity, robustness, stability, equality, and optimality.

One of helpful statement is the **Optimality principle**

- Routing algorithms: **Nonadaptive** and **Adaptive**.

a. **Nonadaptive do not base their routing decision on measurements or estimates of the current traffic and topology.**
b. **Adaptive change their routing decisions to reflect changes in the topology.**

Routing (example)



Full table for A; Hierarchical table for A

Dest.	Line.	Hop
1A	--	--
1B	1B	1
1C	1C	1
2A	1B	2
2B	1B	3
2C	1B	3
2D	1B	4
3A	1C	3
3B	1C	2
4A	1C	3
4B	1C	4
4C	1C	4
5A	1C	4
5B	1C	5
5C	1B	5
5D	1C	6
1E	1C	5

17 entries

(b)

Dest.	Line.	Hop
1A	--	--
1B	1B	1
1C	1C	1
2	1B	2
3	1C	2
4	1C	3
5	1C	4
5	1B	5

7 entries

(c)

(Kleinrock)

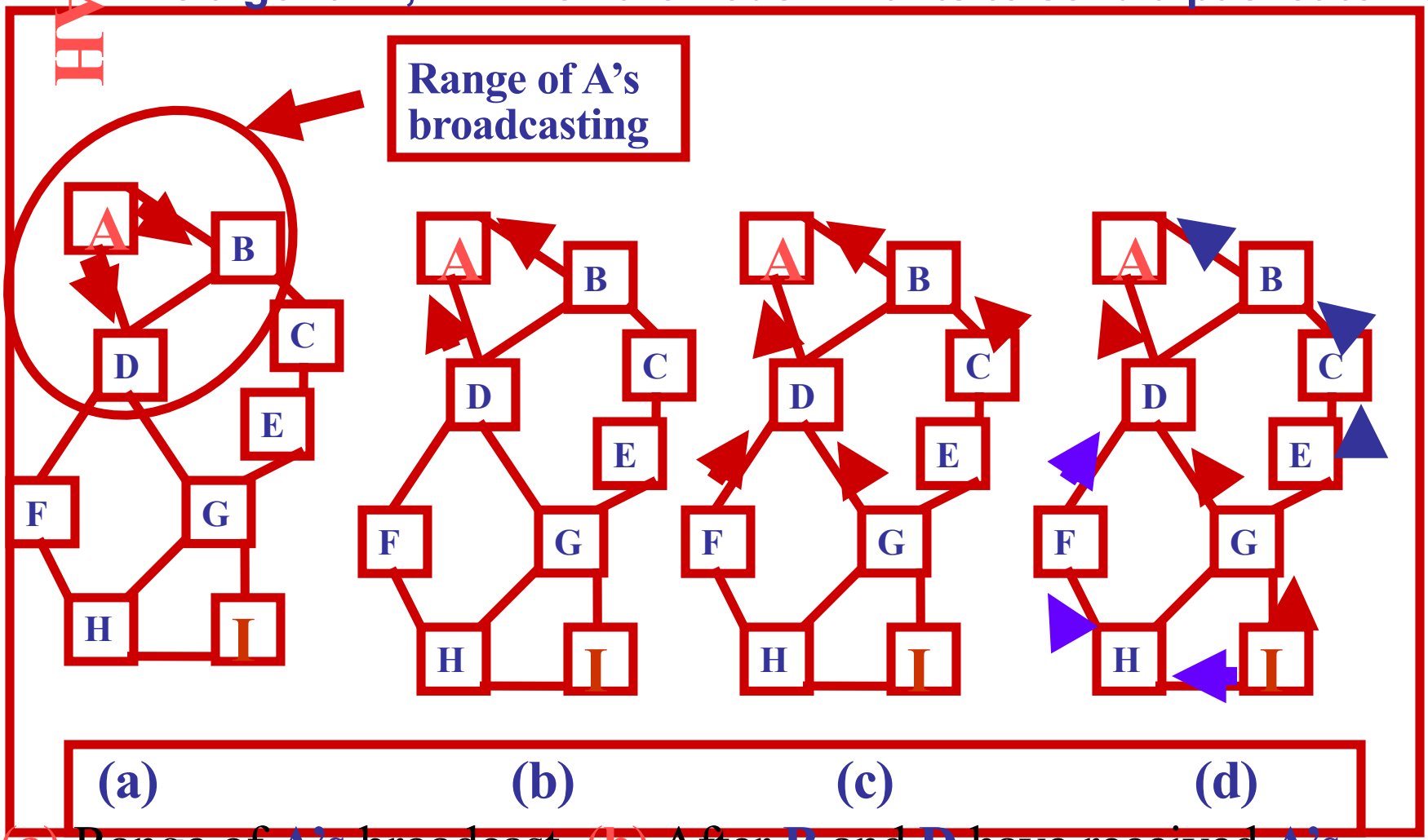
N routers need e lnN entries

For different applications there are different routing algorithms:

1-Broadcasting, 2-Multidestination, 3-Signaling tree,

4-Reserve path forwarding.

The algorithm, in which the node A wants to send a packet to node I.



(a) Range of A's broadcast. (b) After B and D have received A's broadcast. (c) after C, F, and G have received A's broadcast. (d) After E, H, and I have received A's broadcast.

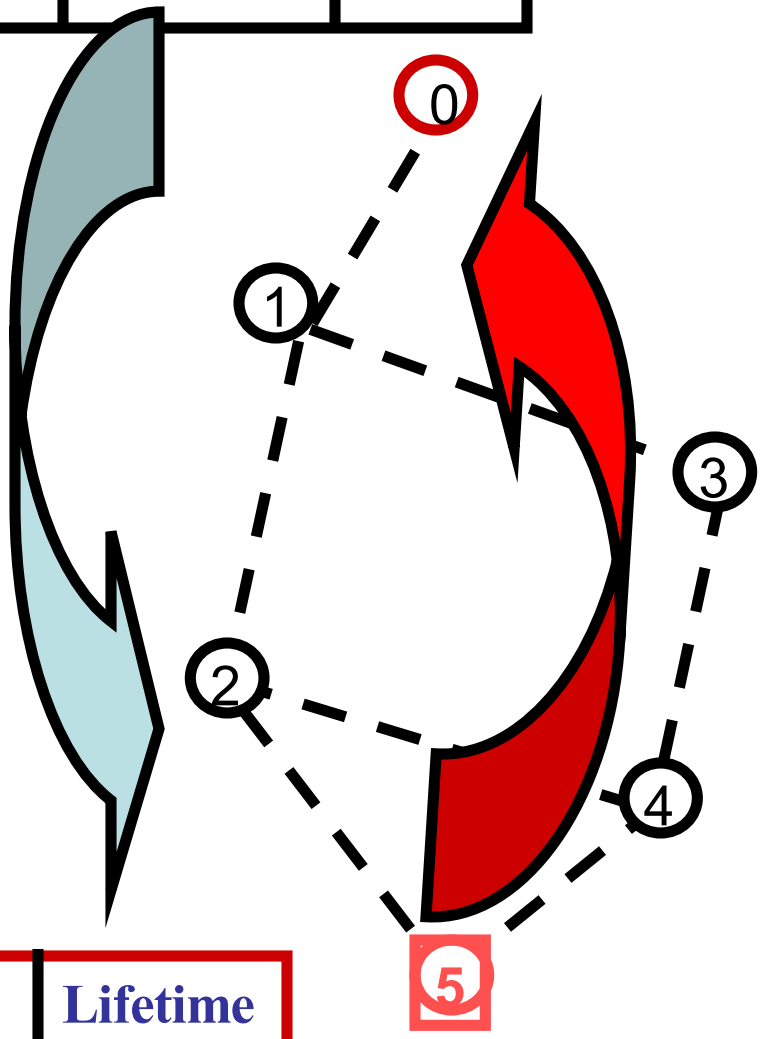
The arrows show the possible reverse routes.

ROUTE REQUEST packet arrives at node B & D,

1. The a. *Source address*, b. *Request ID* pair is looked up in a local history table to see **if this request has already been seen and processed.**
2. If it is a **duplicate**, it is **discarded** and processing stops.
3. If it is not a duplicate, **the pair *a.* & *b.* is entered into the history table** so future duplicates can be rejected, and processing continues.
4. Receiver **looks up the destination in its route table**.
5. If a fresh route to the destination, **a ROUTE REPLY packet is sent back to the source telling it how to get to the destination ("Use me").** Fresh means that the ***Destination sequence number*** **(DSN)** stored in the routing table is greater than or equal to the DSN in the **ROUTE REQUEST** packet. If less, the stored route is older than the previous route the source had for the destination, so step 3 is executed.

ROUTE REQUEST packet

Source Address	Request ID	Destination address	Source sequence #	Dest. sequence #	Hop count



ROUTE REPLY packet

Source Address	Destination address	Destination sequence #	Hop count	Lifetime

AH

Data Forwarding

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- **After group establishment and route construction process, a multicast source can transmit packets to receivers via selected routes and Forwarding Groups.**