



CS120: Computer Networks

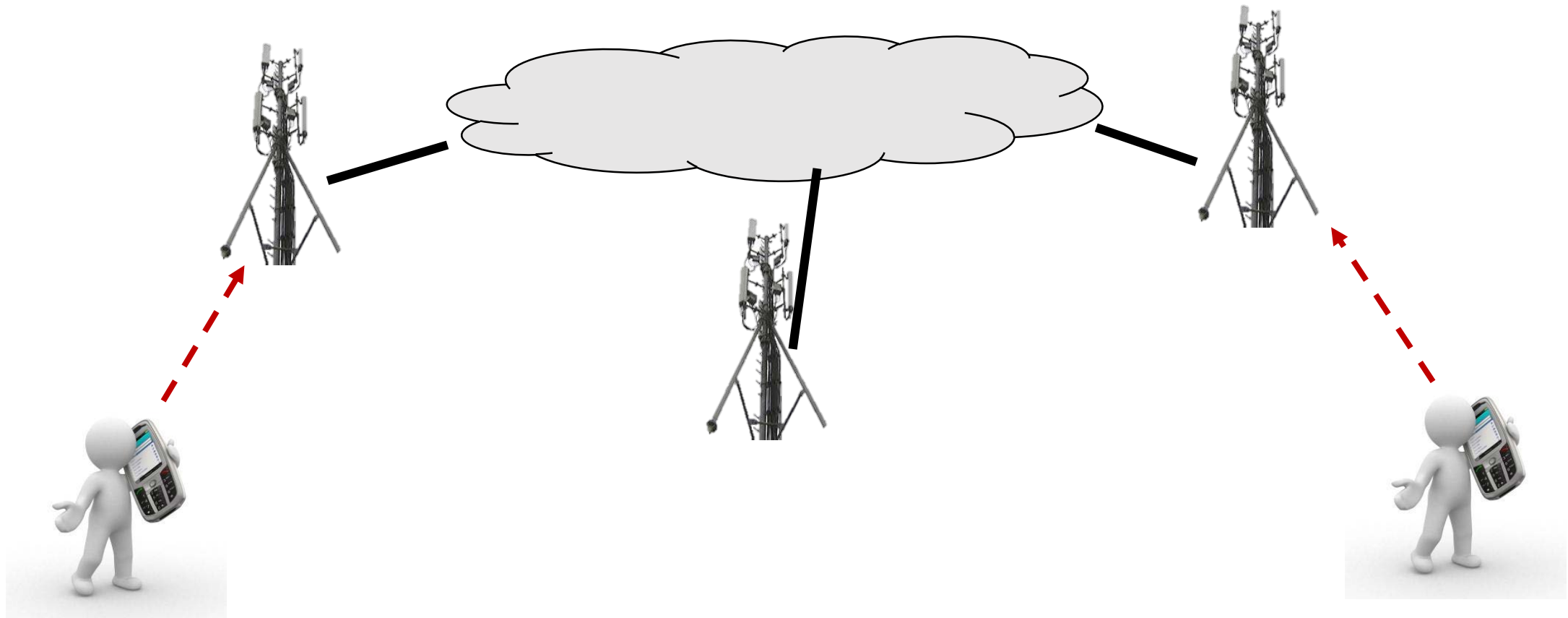
Lecture 14. Mobile Routing

Zhice Yang

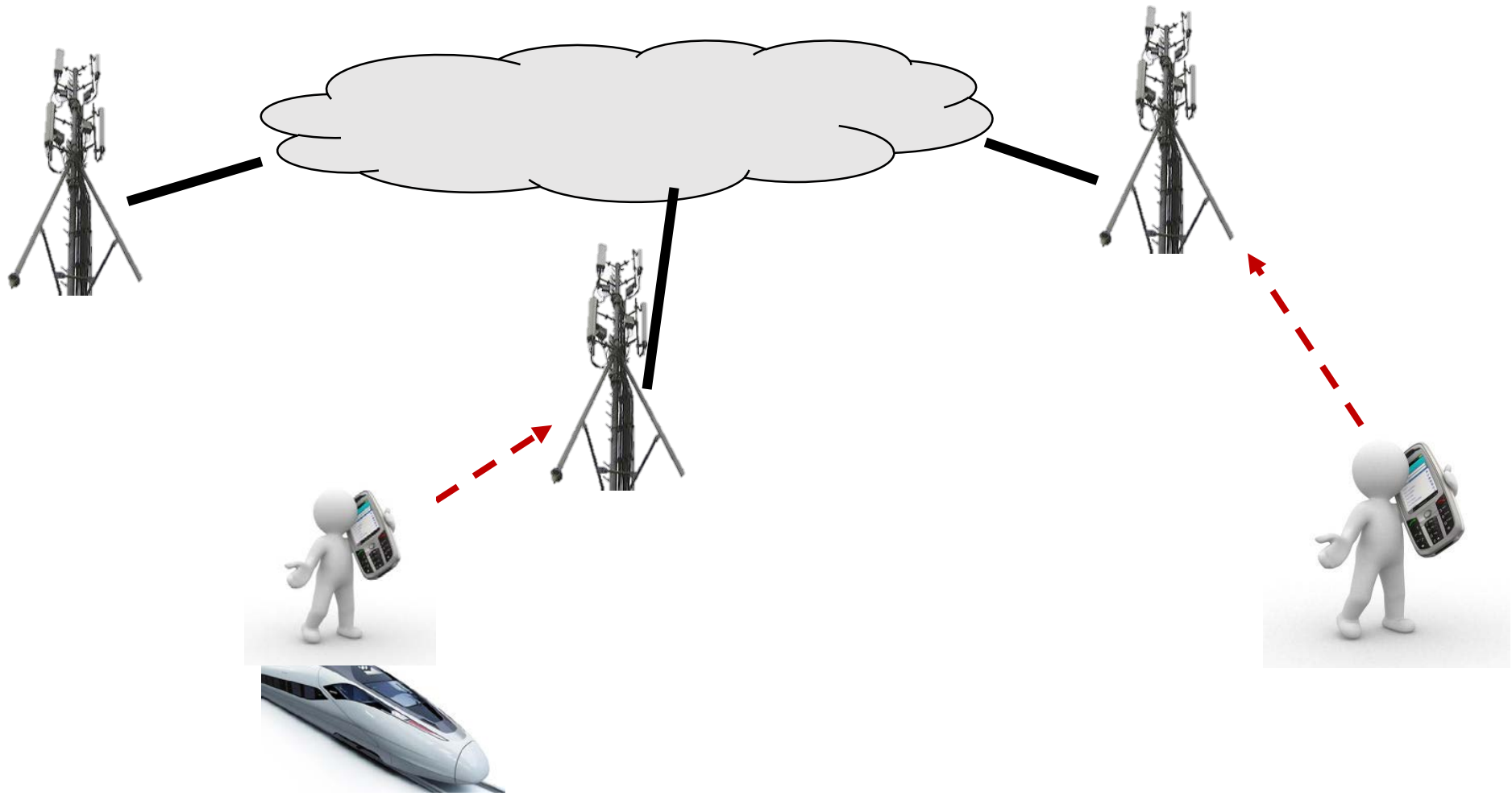
Outline

- Mobile Routing
 - Mobile IP
 - Routing in Mobile Ad Hoc Network (MANET)
 - AODV
 - OLSR

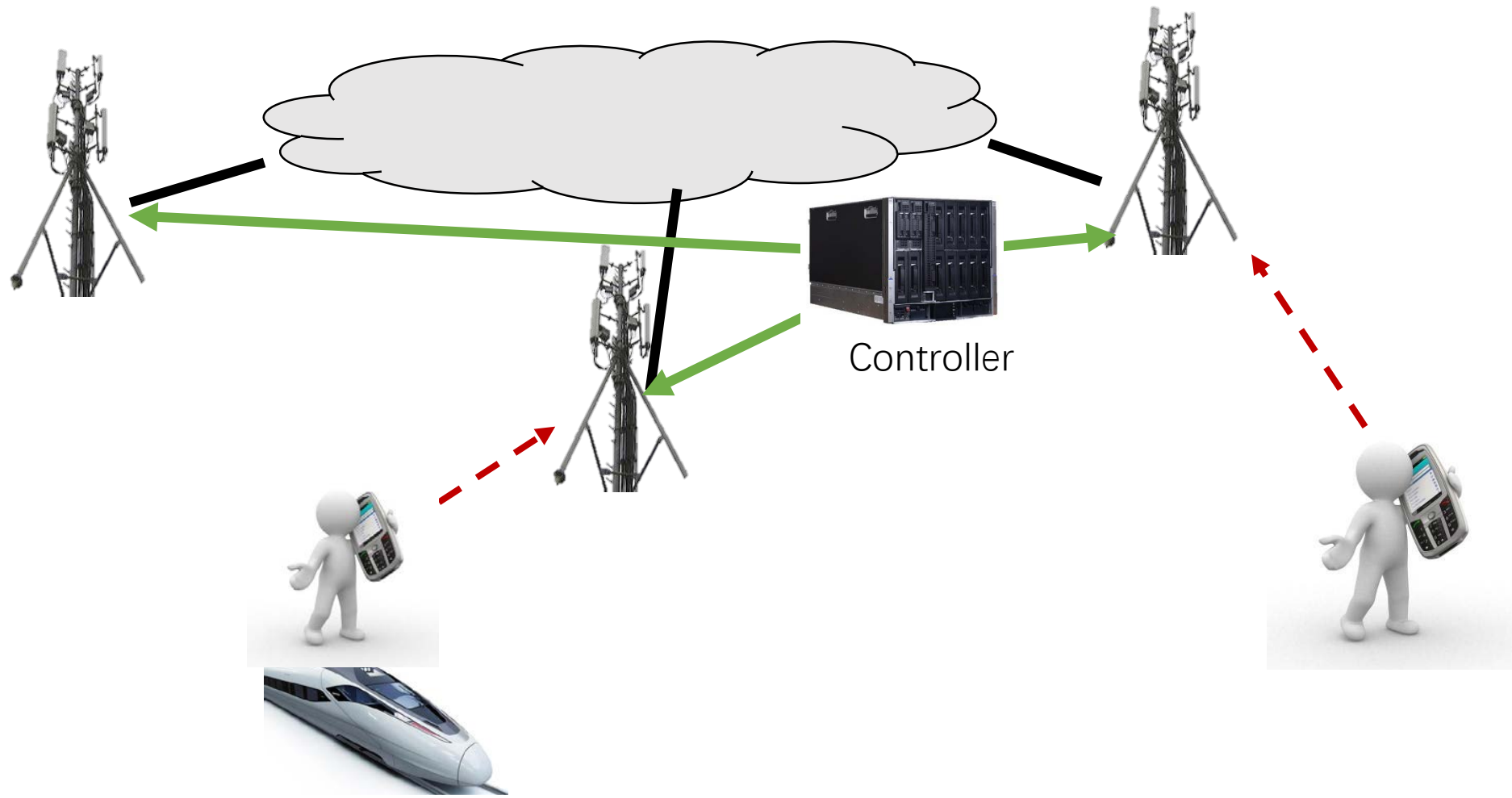
Mobile Network



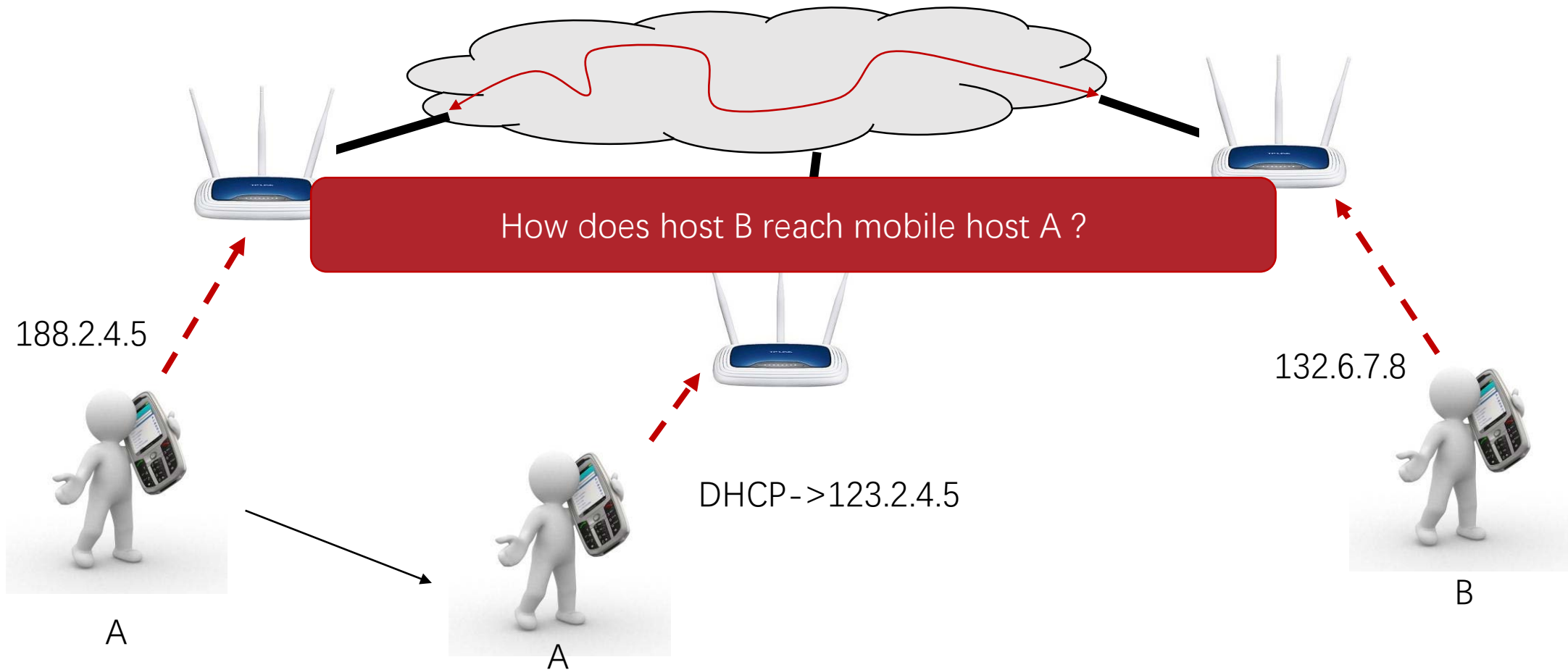
Mobile Network



Mobile Network



Mobile Network over IP

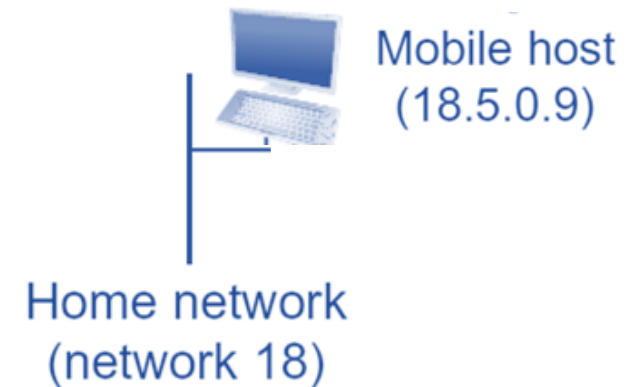


Mobile IP

- Goal
 - Mobile IP is designed to provide seamless network connectivity under mobile situation where subnetwork changes may occur.
 - e.g., From one WLAN to another WLAN
- Standard by IETF in 2002

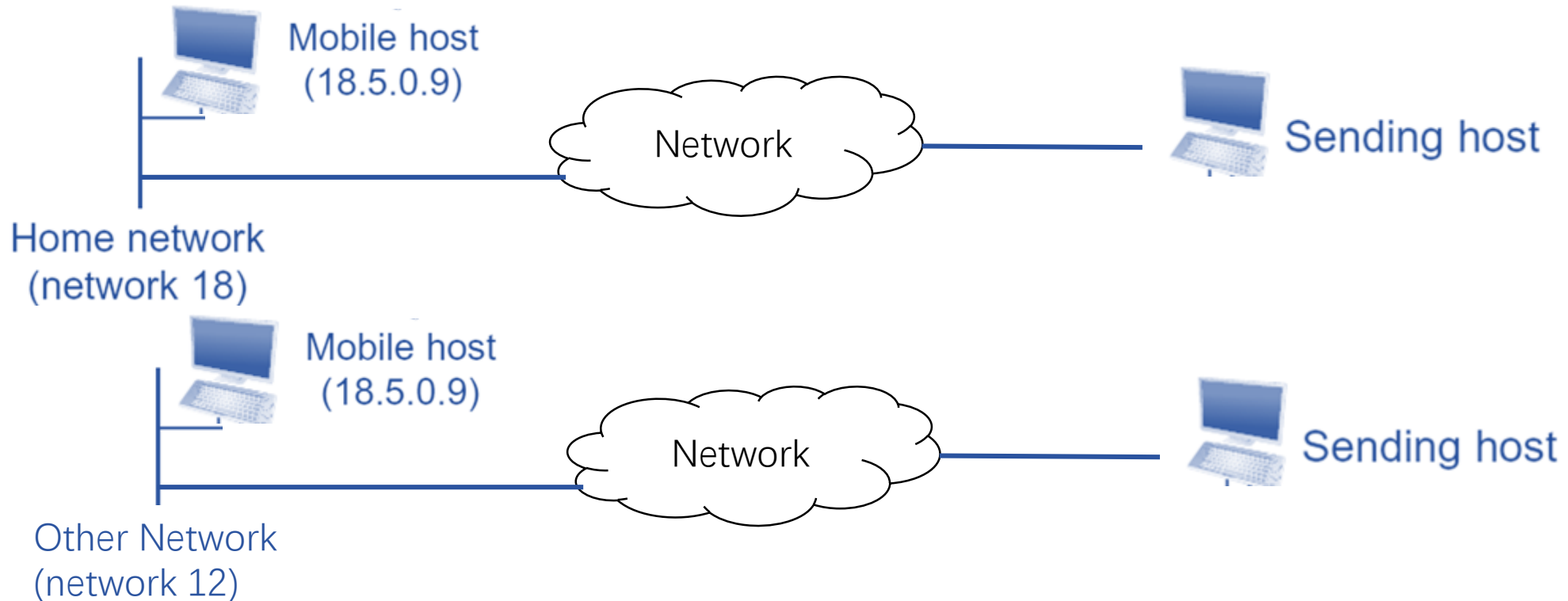
Mobile IP

- Home Address
 - Permanent IP address of the mobile host
 - e.g., 18.5.0.9
 - Other host uses it to contact the mobile host
- Home Network
 - The network that the home address resides
 - e.g., 18.X.X.X
 - “Home” network of the mobile host



Mobile IP

- Goal
 - A sending host can find the mobile host through its home address



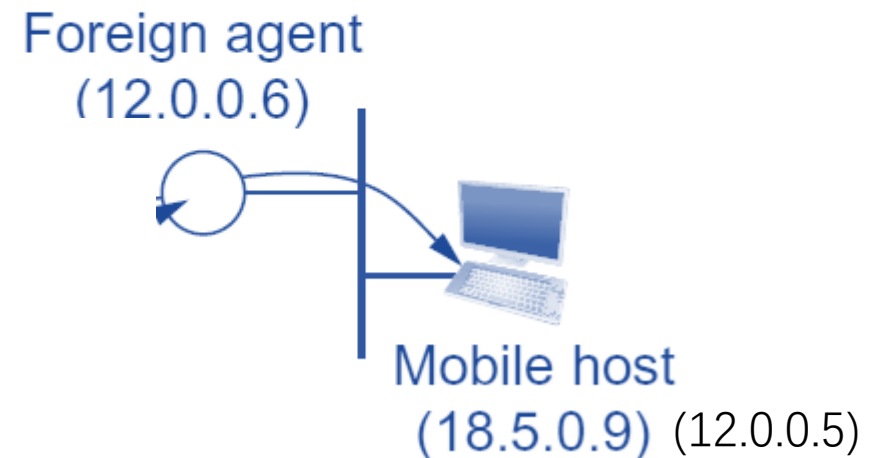
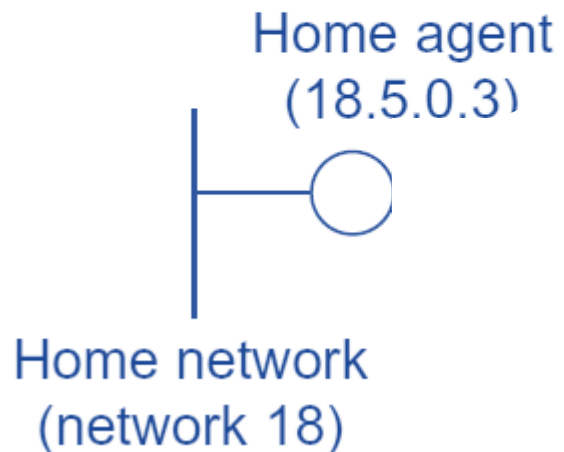
Mobile IP

- Home Agent
 - The router in the home network to support mobile IP
 - e.g.: 18.5.0.3
- Foreign Agent
 - The router out of the home network to support mobile IP
 - e.g.: 12.0.0.6



Mobile IP

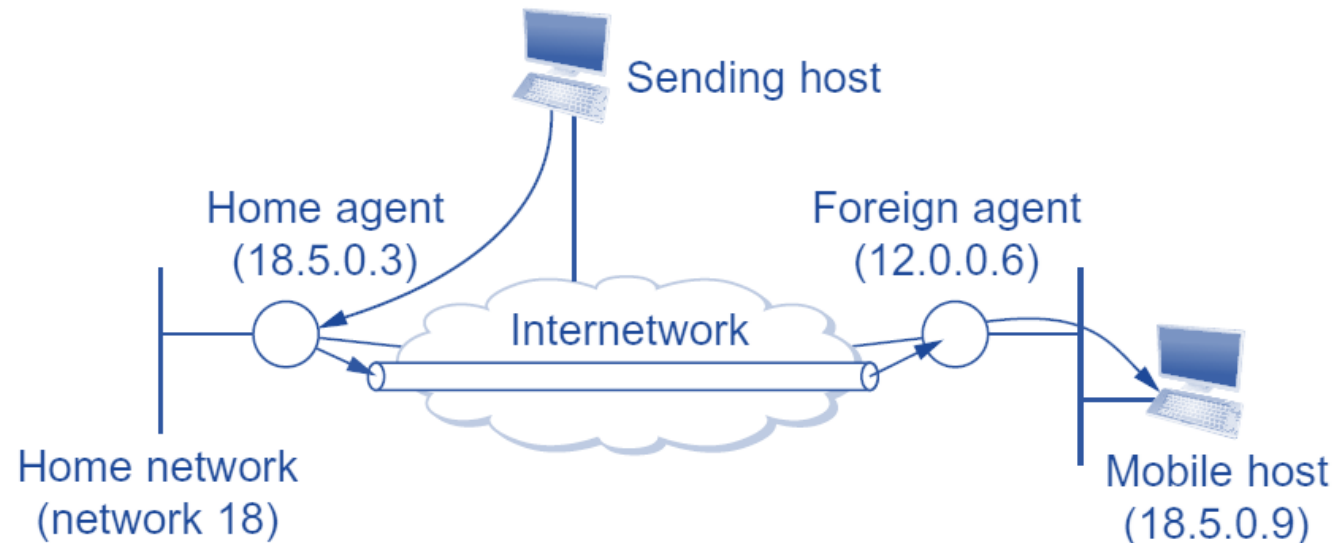
- Foreign Address
 - The IP address of the mobile obtained from the foreign network by DHCP
 - e.g.: 12.0.0.5



Mobile IP

- Steps

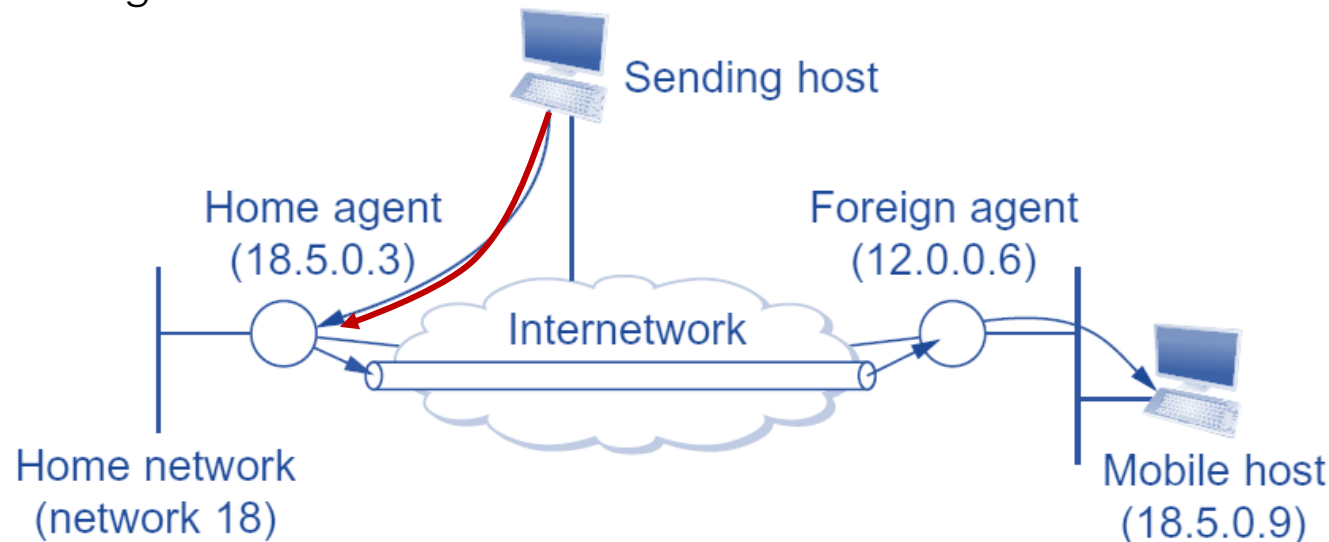
- Packets from sending host to mobile host are routed to home network
- Home agent redirects packets for mobile host to the foreign agent
- Foreign agent recognizes and delivers packets for the mobile host



Mobile IP

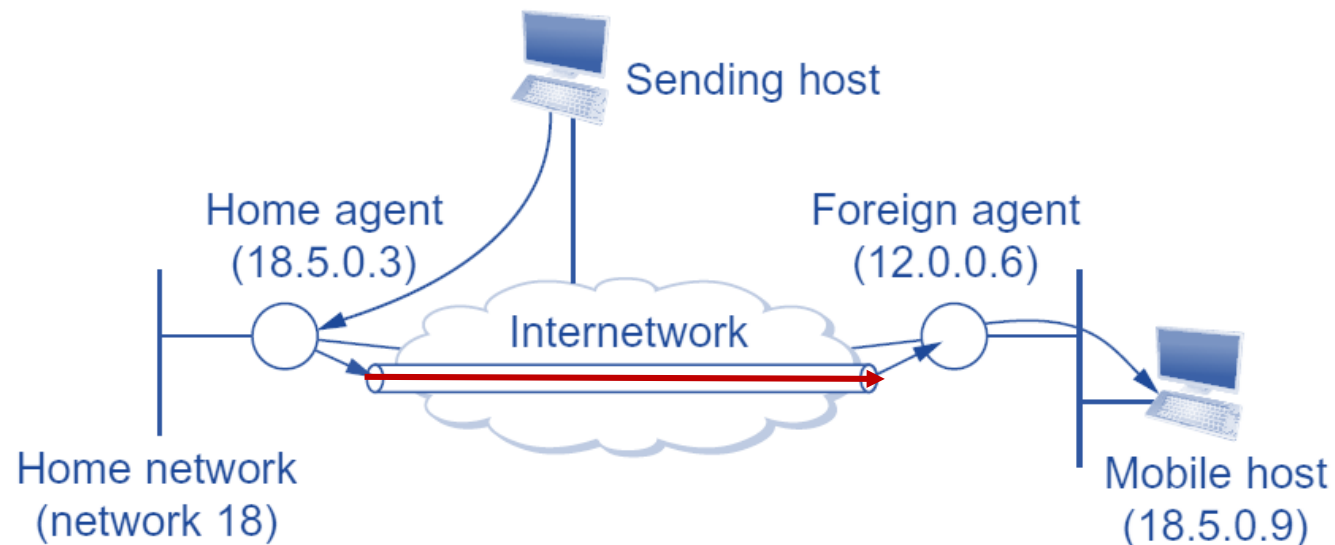
- Steps

- Packets from sending host to mobile host are routed to home network
 - Problem: route of sending host to mobile host does not go through home agent
 - Sending host is in the home network
 - Router in sending host's path is connected to the home network
- Solution: Proxy ARP
 - Home agent broadcasts ARP to bind mobile host's MAC with home agent's IP



Mobile IP

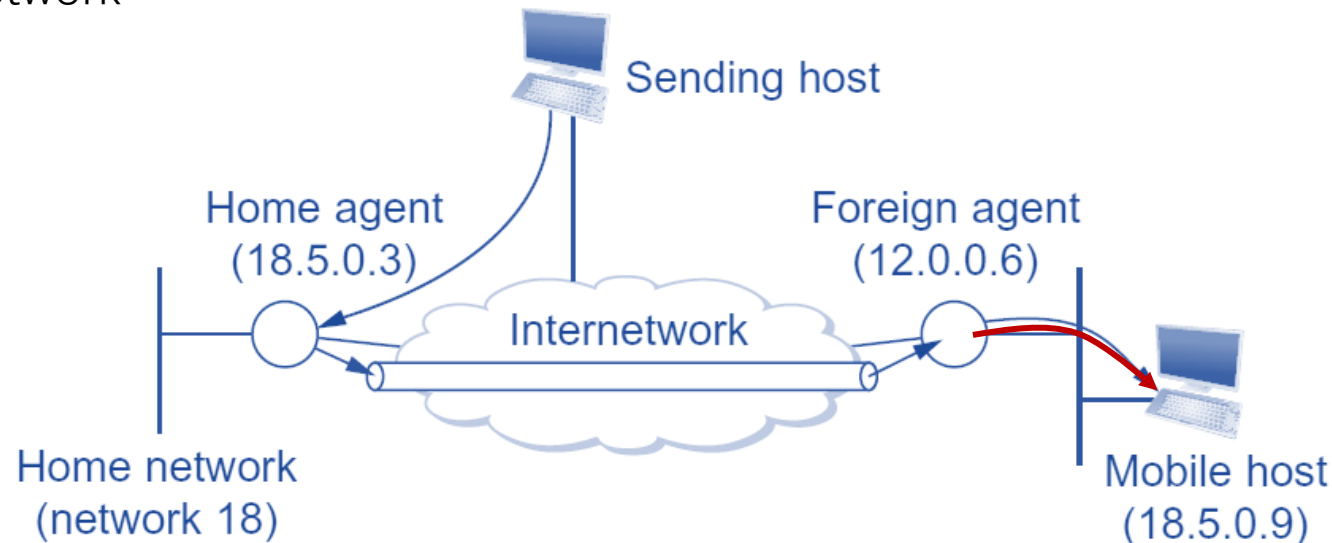
- Steps
 - Home agent redirects packets for mobile host to the foreign agent
 - Problem: routers in the network cannot correctly forward according to mobile host's home address
 - Solution: tunneling
 - Home agent and foreign agent is connected through IP tunnel



Mobile IP

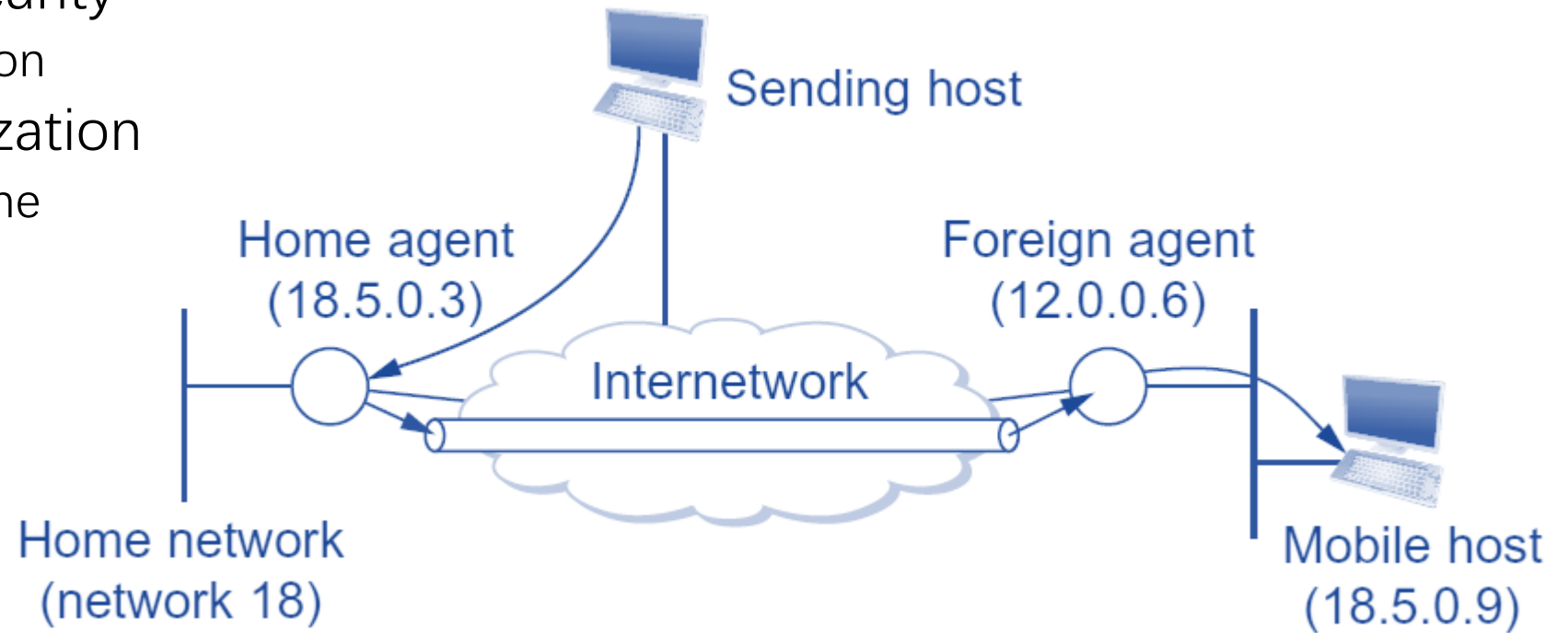
- Steps

- Foreign agent recognizes and delivers packets for the mobile host
 - Problem:
 - Why there is a foreign agent
 - Solution: combine foreign agent and mobile host
 - A software in mobile host acts as the foreign agent and obtain DHCP IP from foreign network



Mobile IP

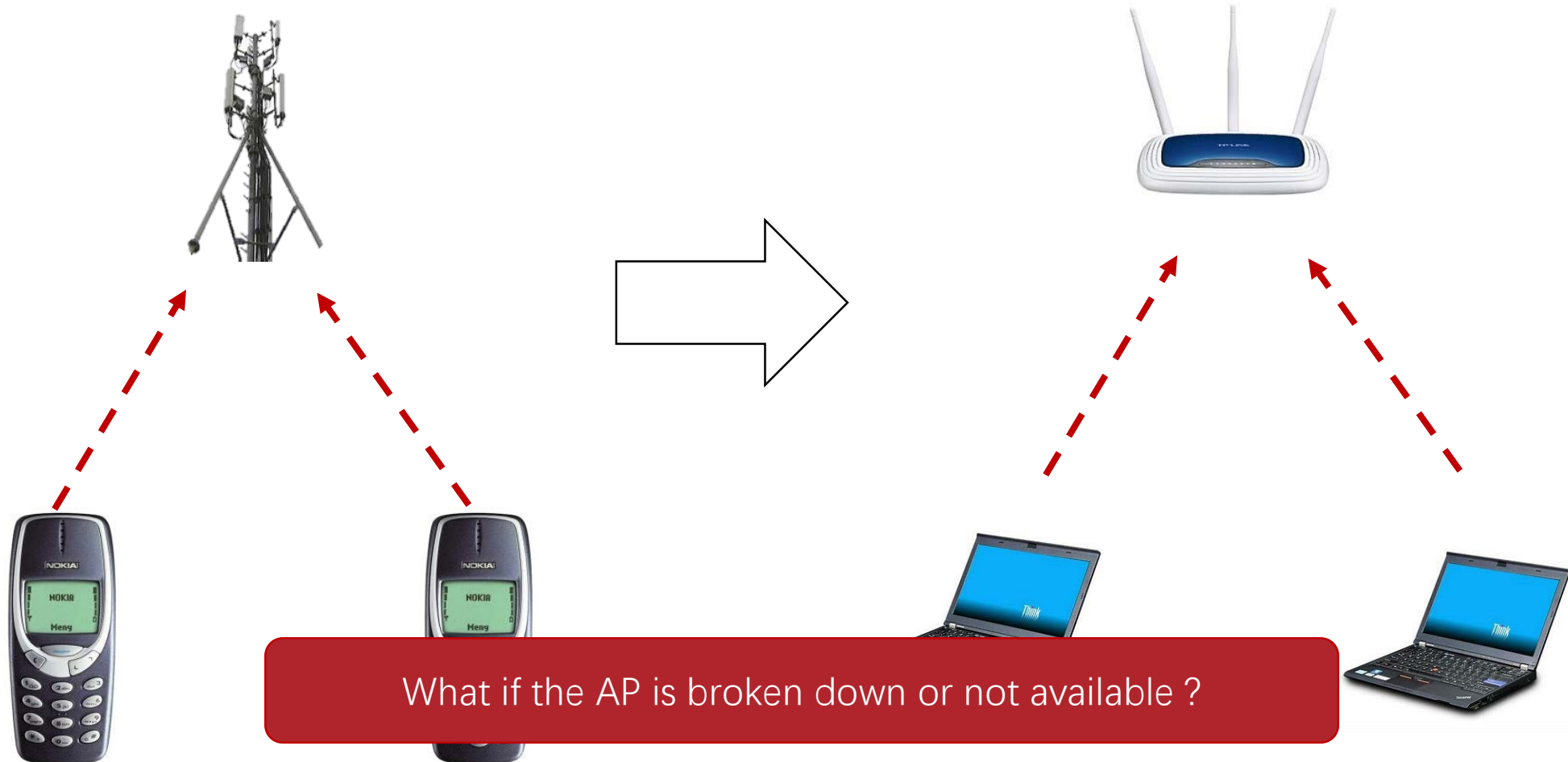
- Other Problems
 - Tunneling Security
 - Authentication
 - Route Optimization
 - Binding Cache



Outline

- Mobile Routing
 - Mobile IP
 - Routing in Mobile Ad Hoc Network (MANET)
 - AODV
 - OLSR

Wireless Network with Infrastructure



Mobile Ad Hoc Networks

- Wireless
- Rapidly deployable, self configuring
- No Infrastructure

Emergency

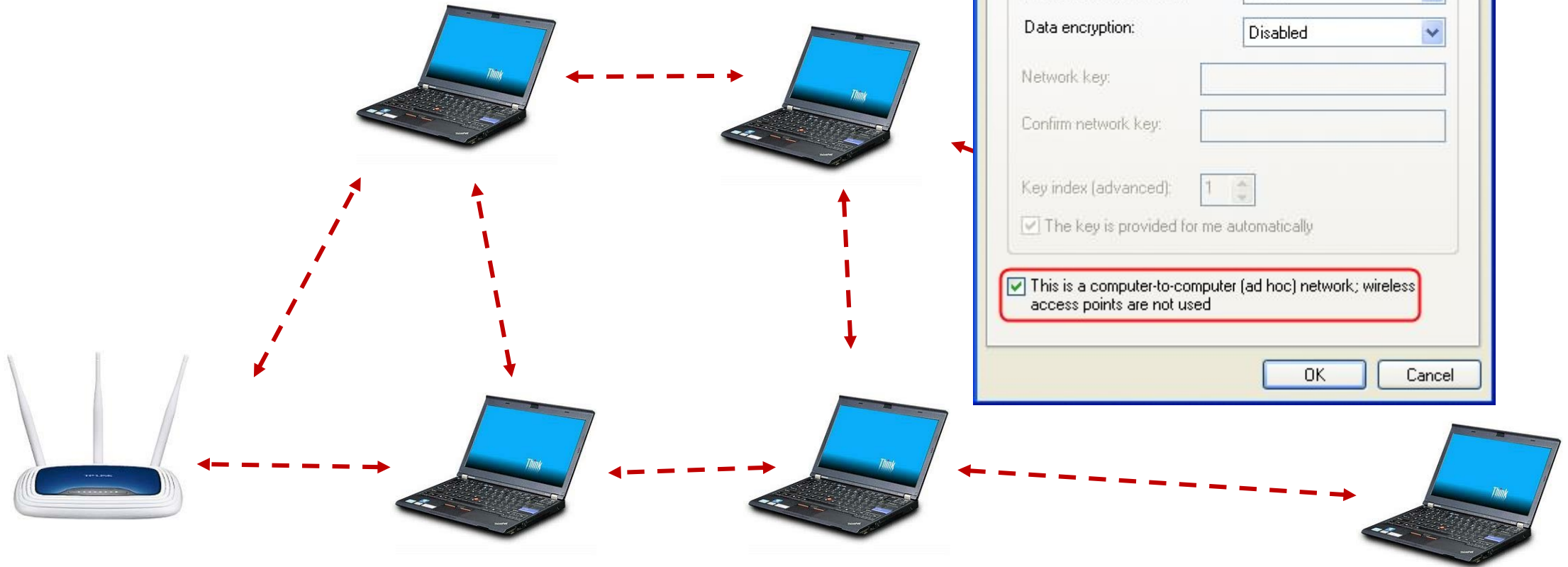


Military



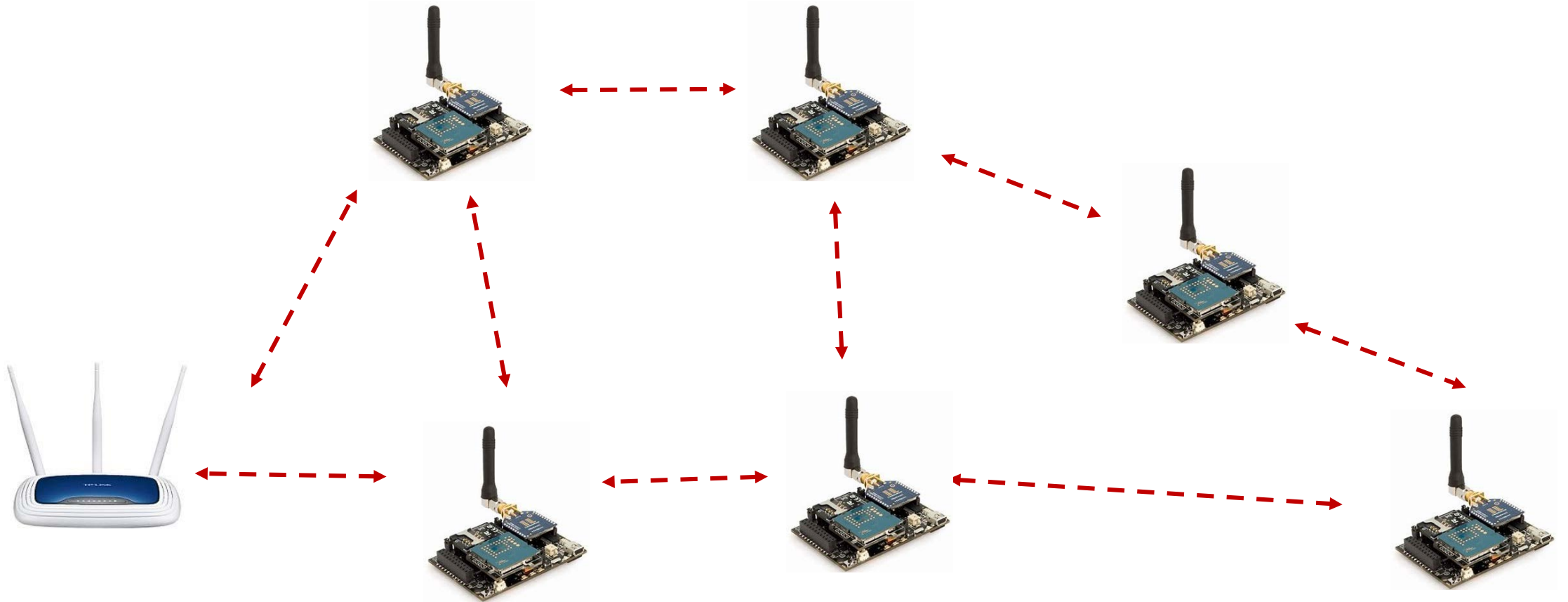
Mobile Ad Hoc Networks

- Mesh Network



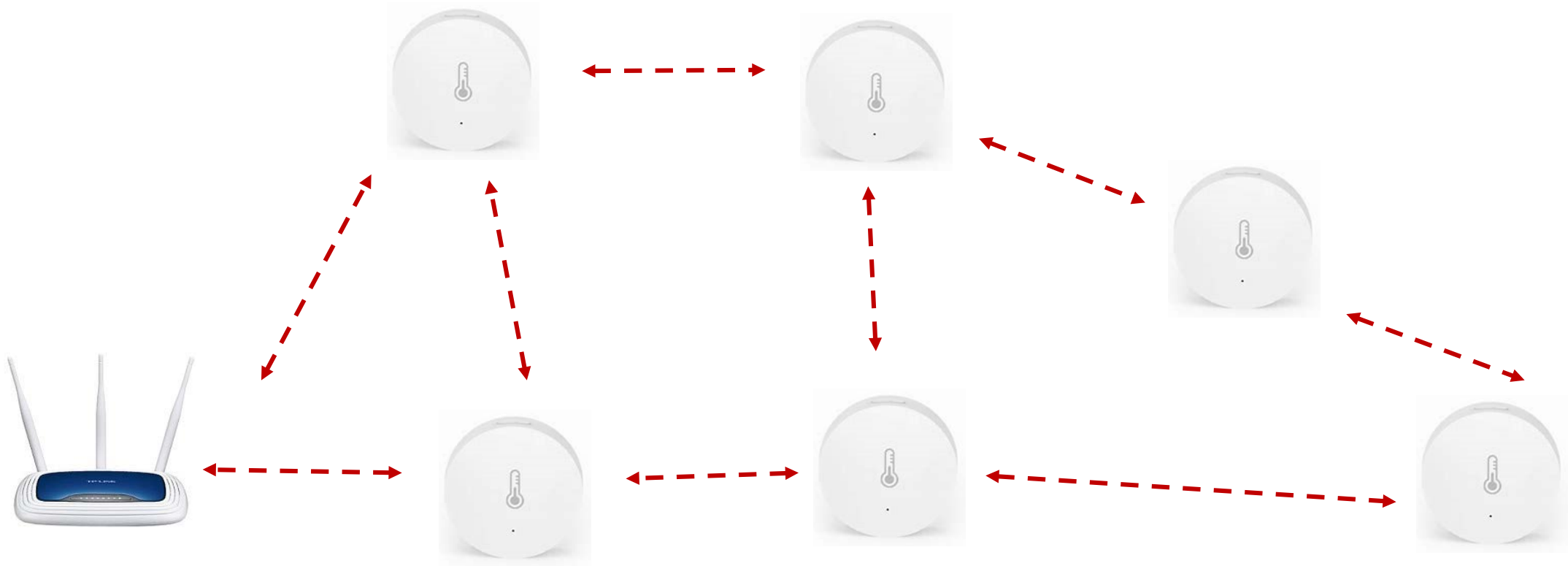
Mobile Ad Hoc Networks

- Wireless Sensor Network



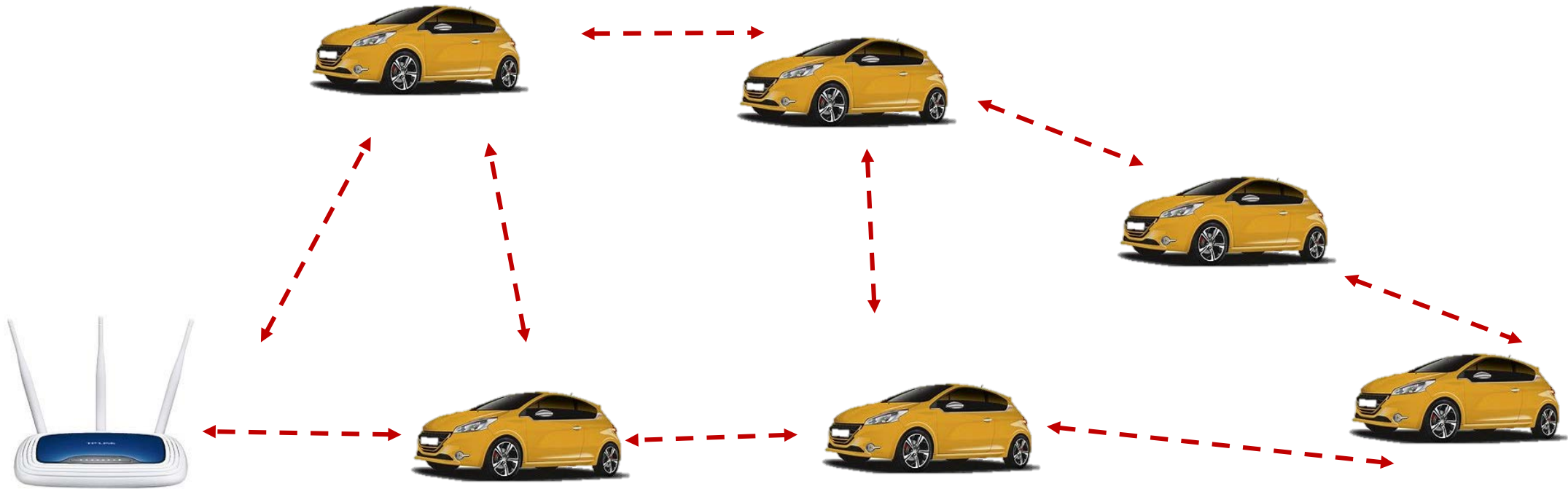
Mobile Ad Hoc Networks

- Internet of Things



Mobile Ad Hoc Networks

- Internet of Things

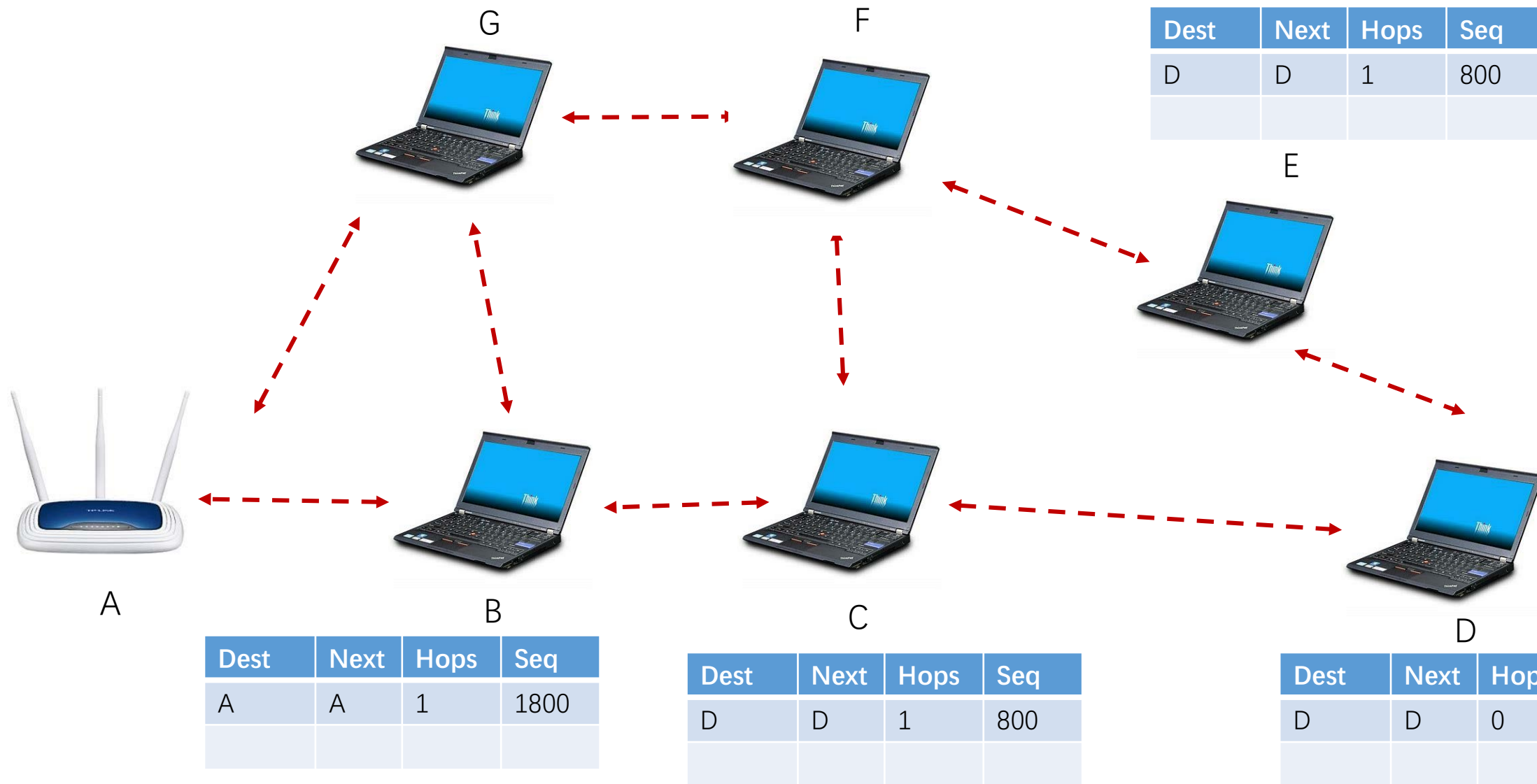


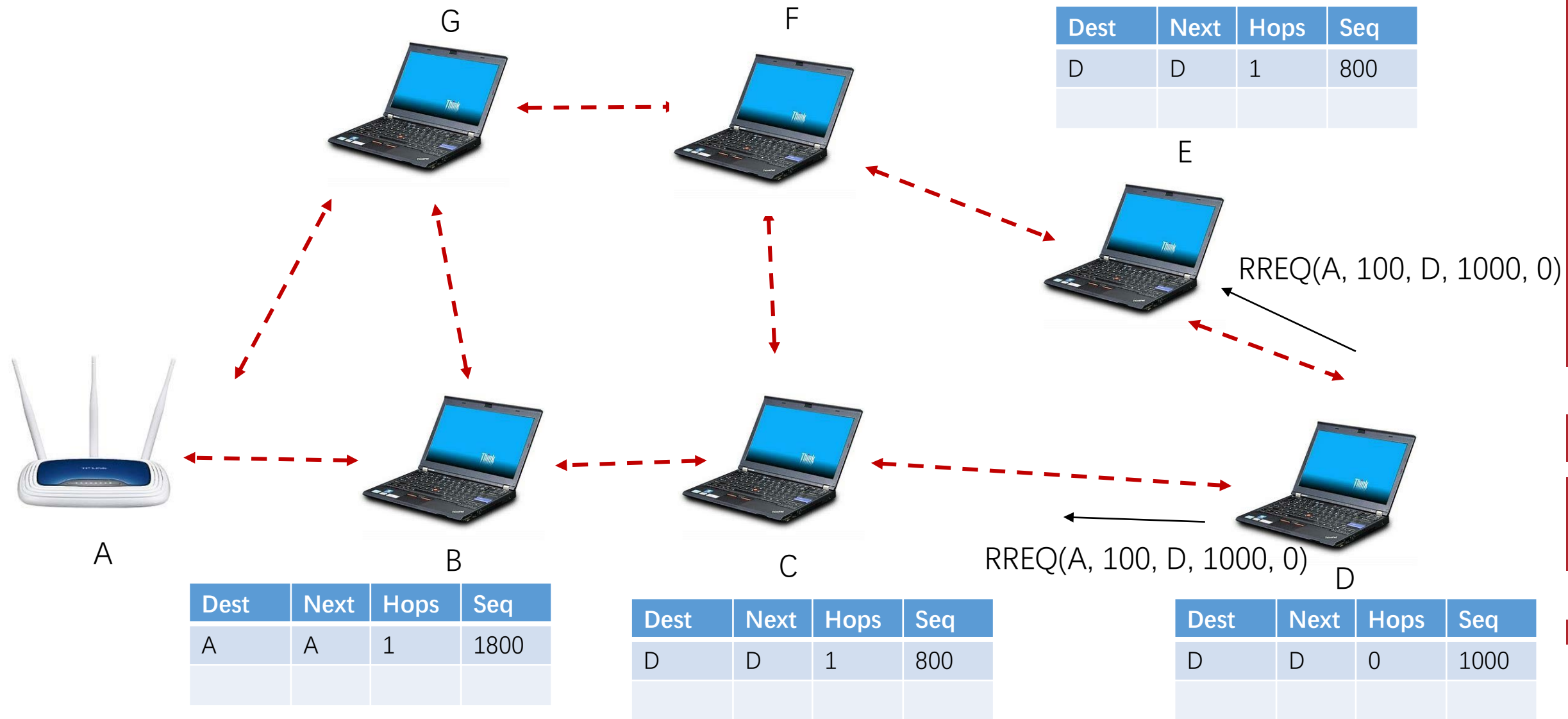
Routing in Ad Hoc Networks

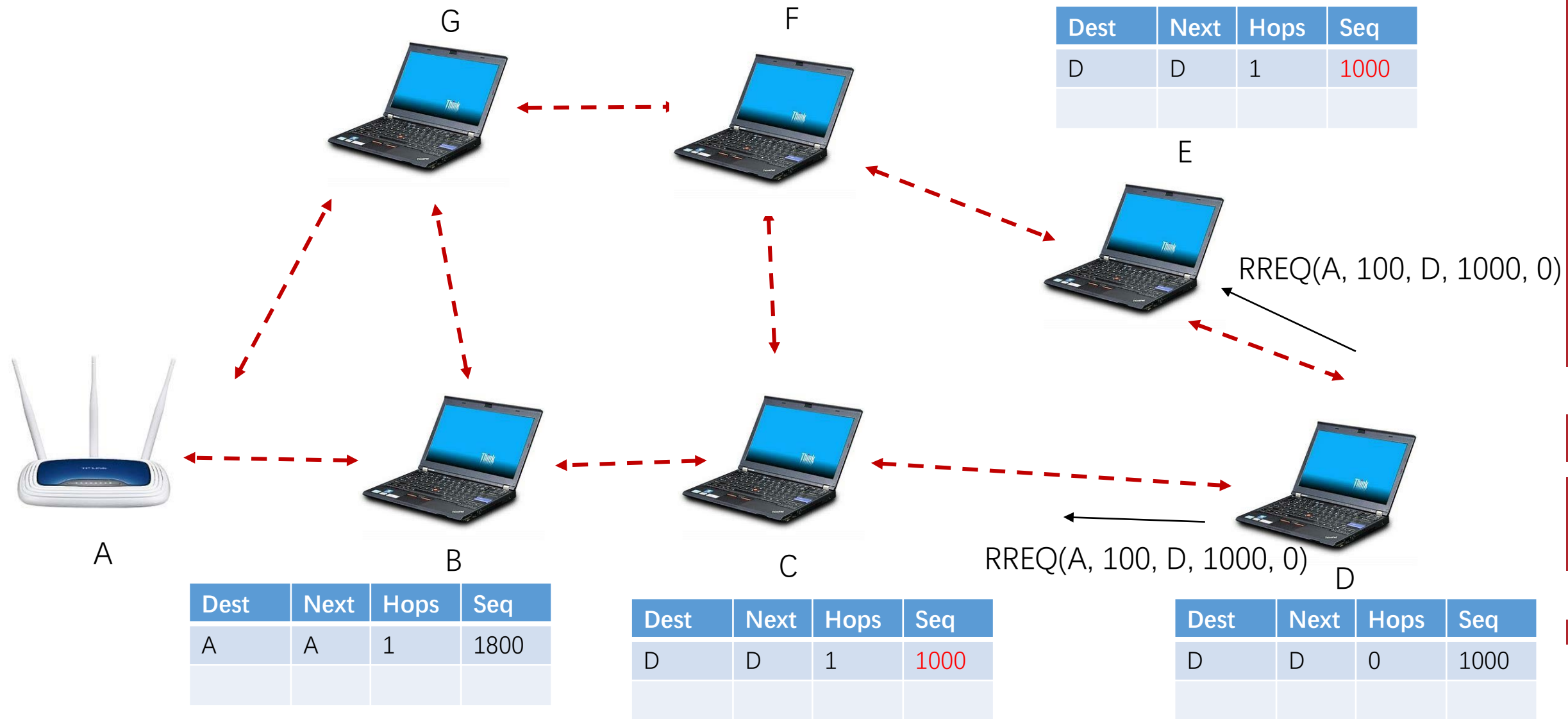
- Problem:
 - Multi-hop operation requires a routing mechanism designed for mobile nodes
- Challenges:
 - Network topology is highly dynamic
 - Connection quality, Mobility of Participant, etc.
 - Resource of mobile devices is very limited
 - Bandwidth, Power, Computing Ability, Storage, etc.
 - Network connections can be asymmetric
 - e.g. A can reach B but B cannot reach A

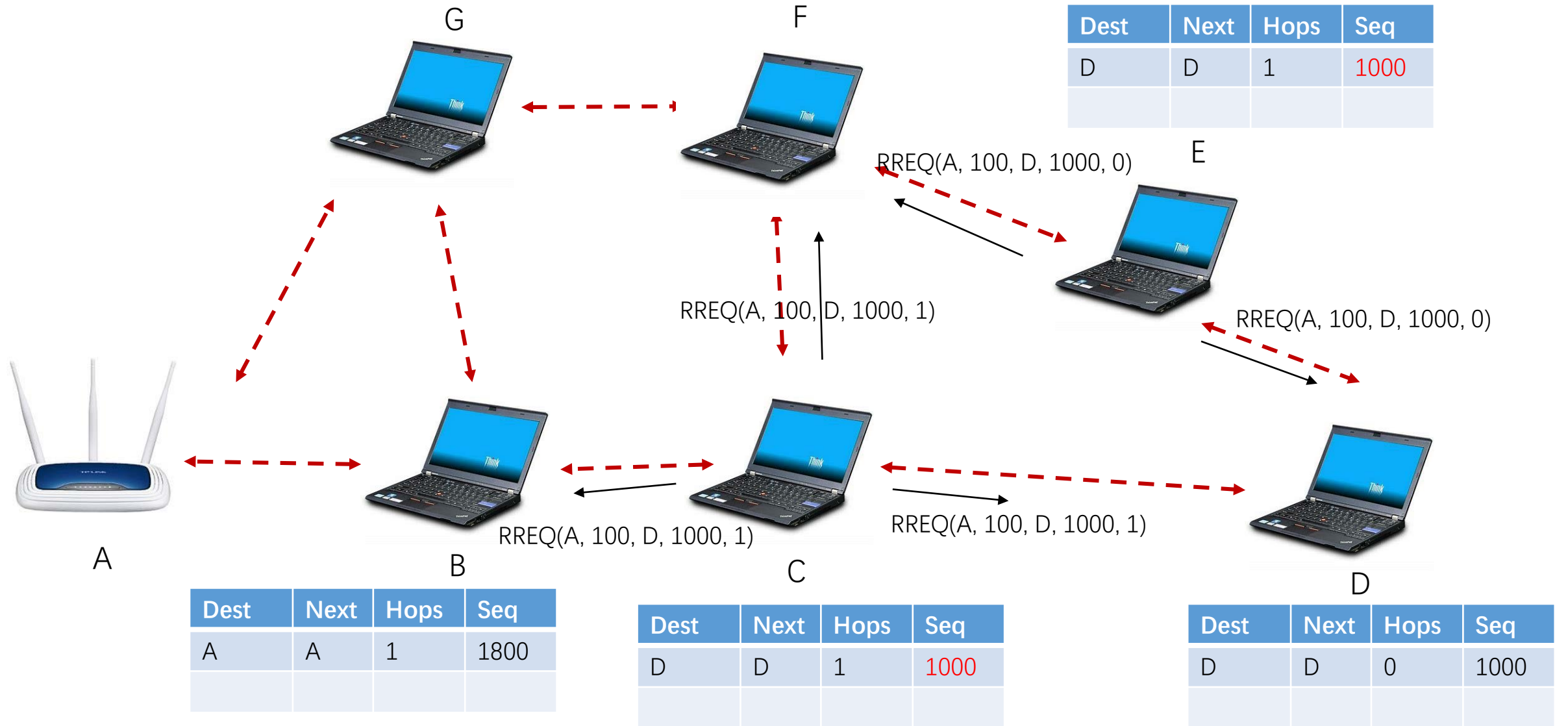
Ad Hoc on Demand Distance Vector (AODV)

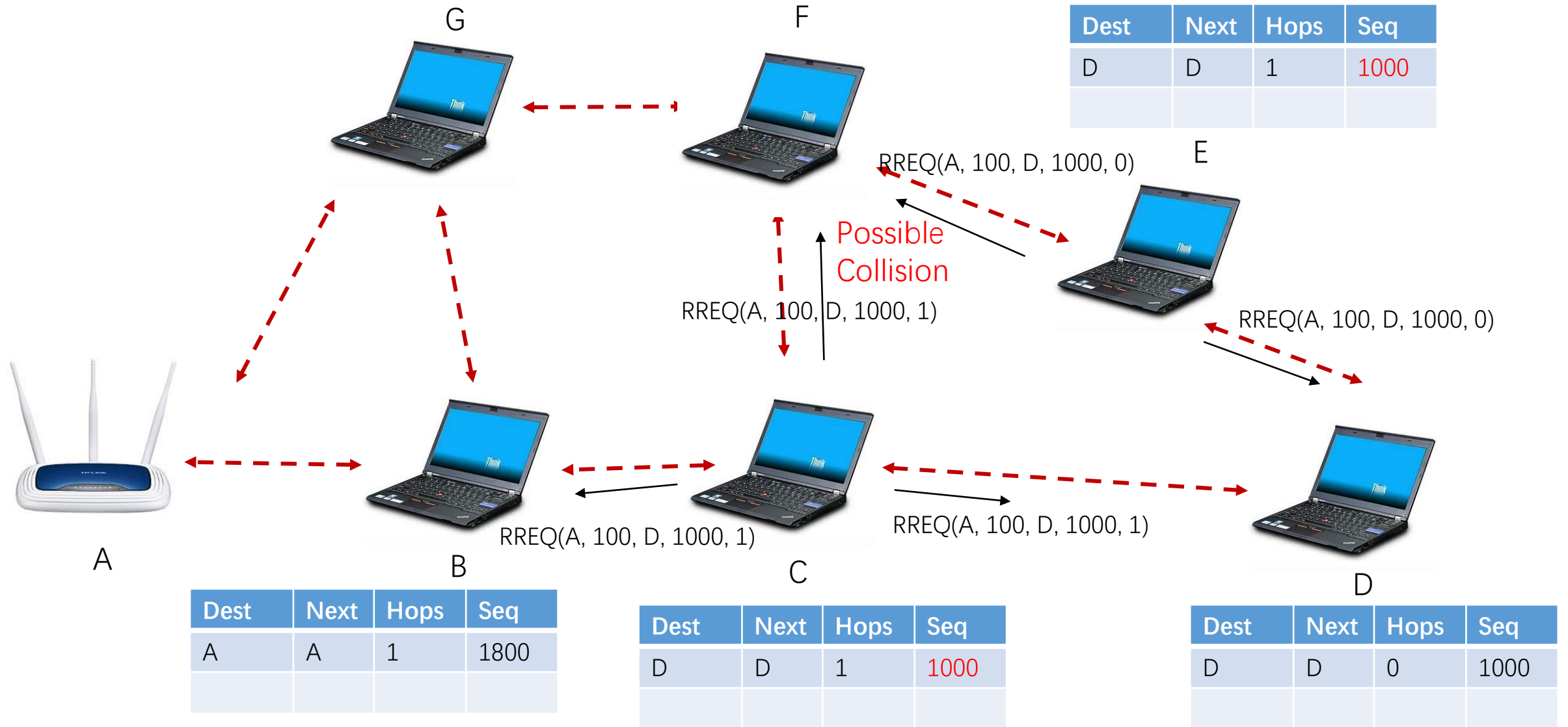
- RFC 3561
- Re-active/On Demand
 - Does not take initiative for finding routes
- Routing Method
 - Broadcast Route Request (RREQ) packet
 - (DestAddr, Dest#, SrcAddr, Src#, Hop)
 - Node Reply Route Reply (RREP) with unicast
 - (DestAddr, Dest#, Hop)

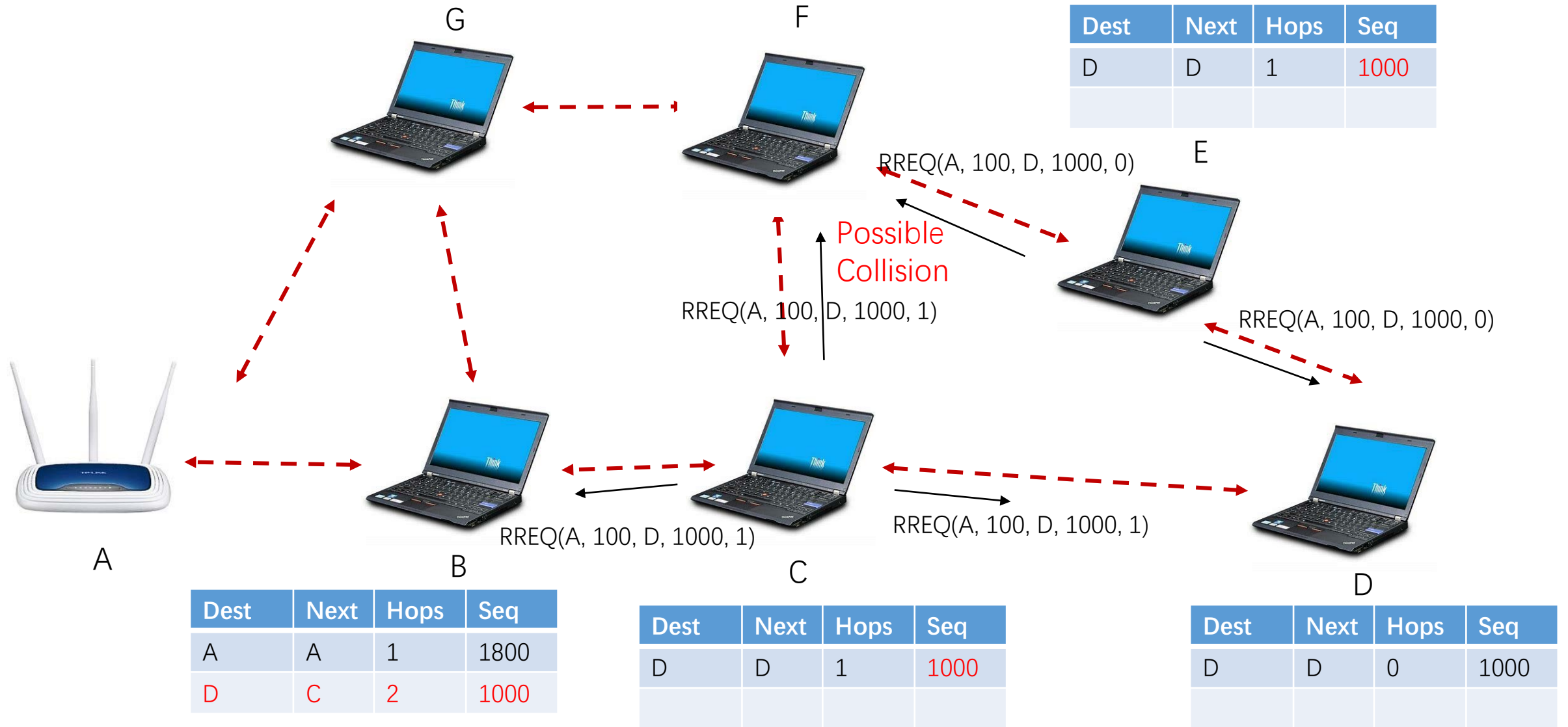


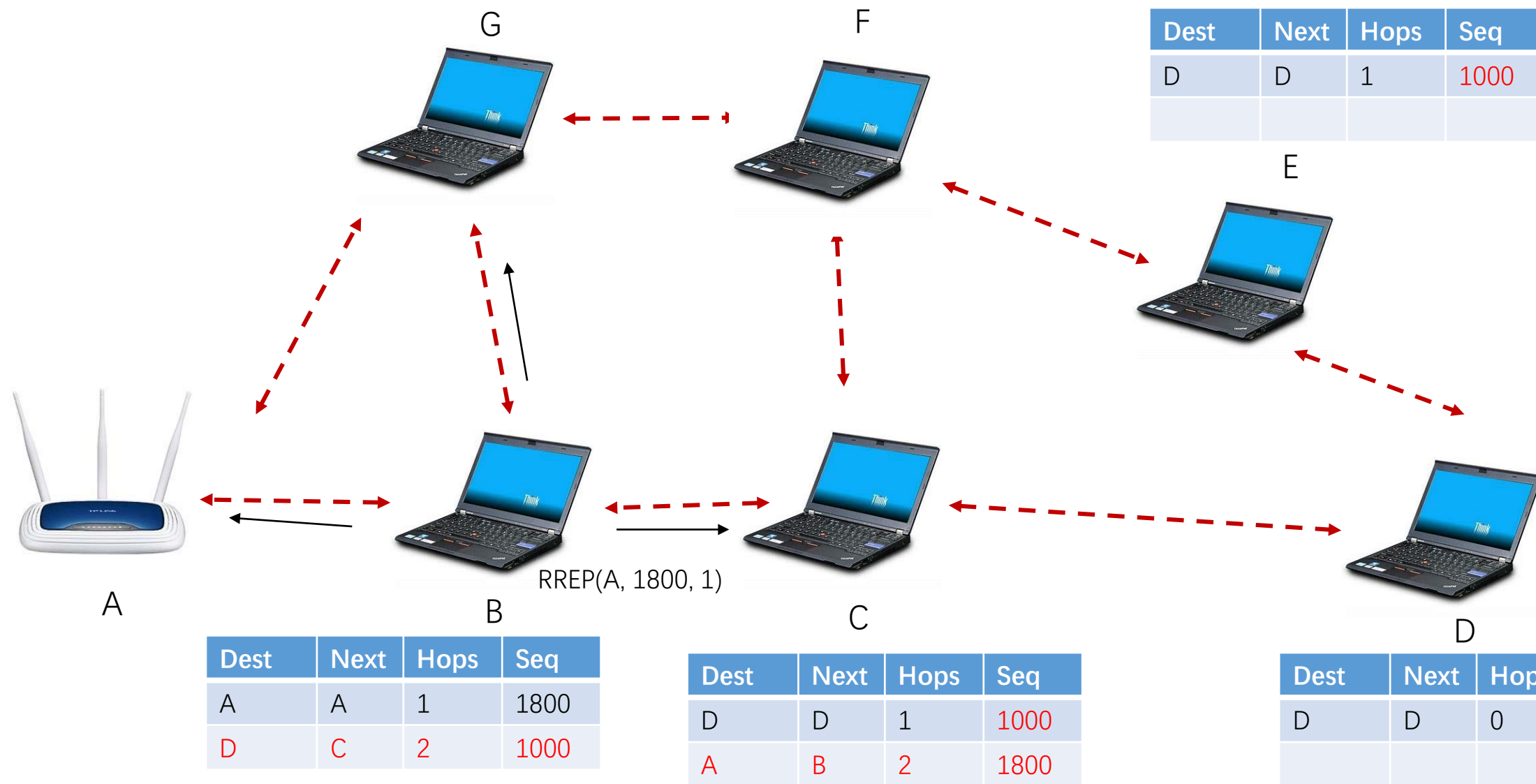


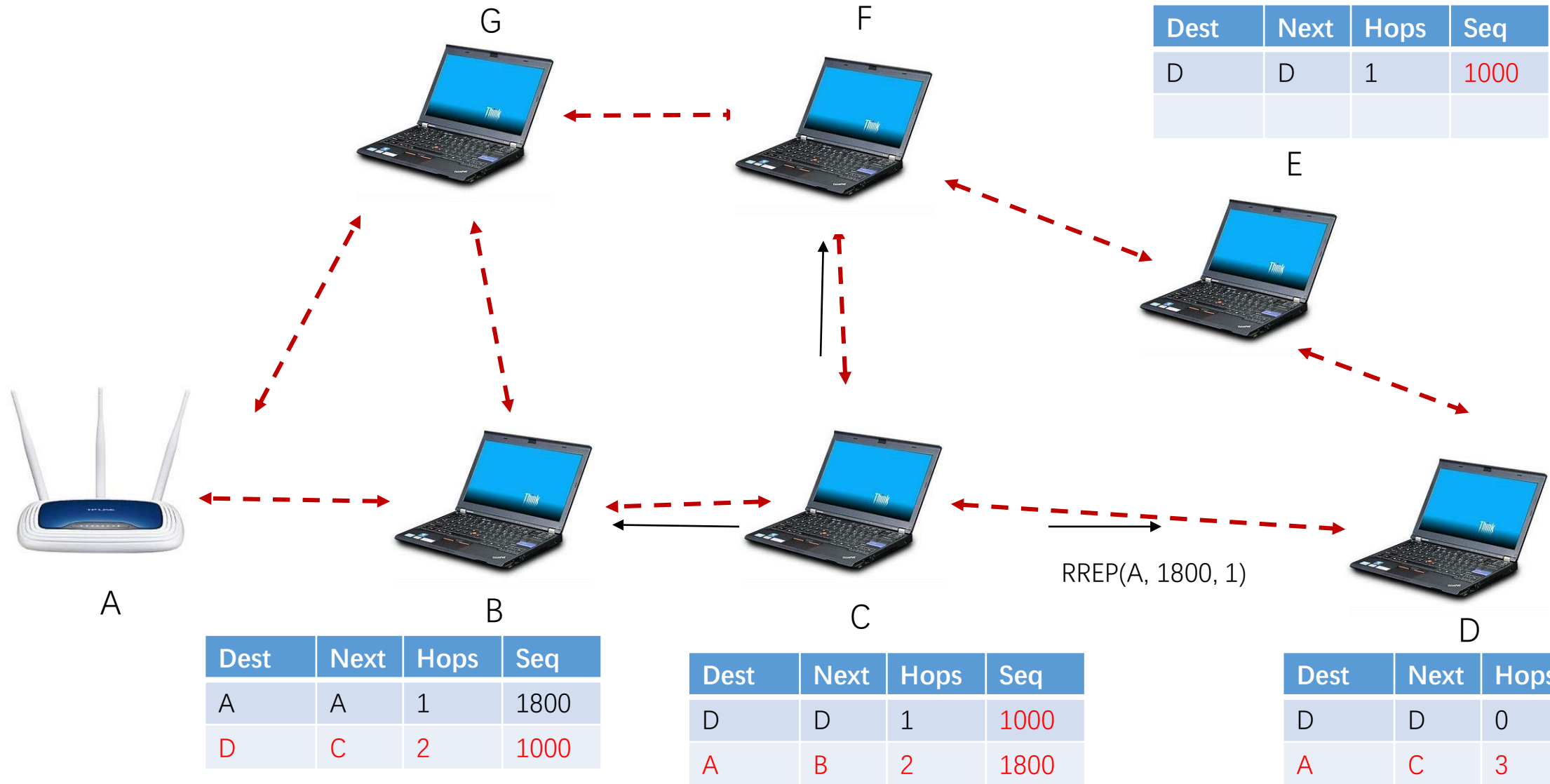










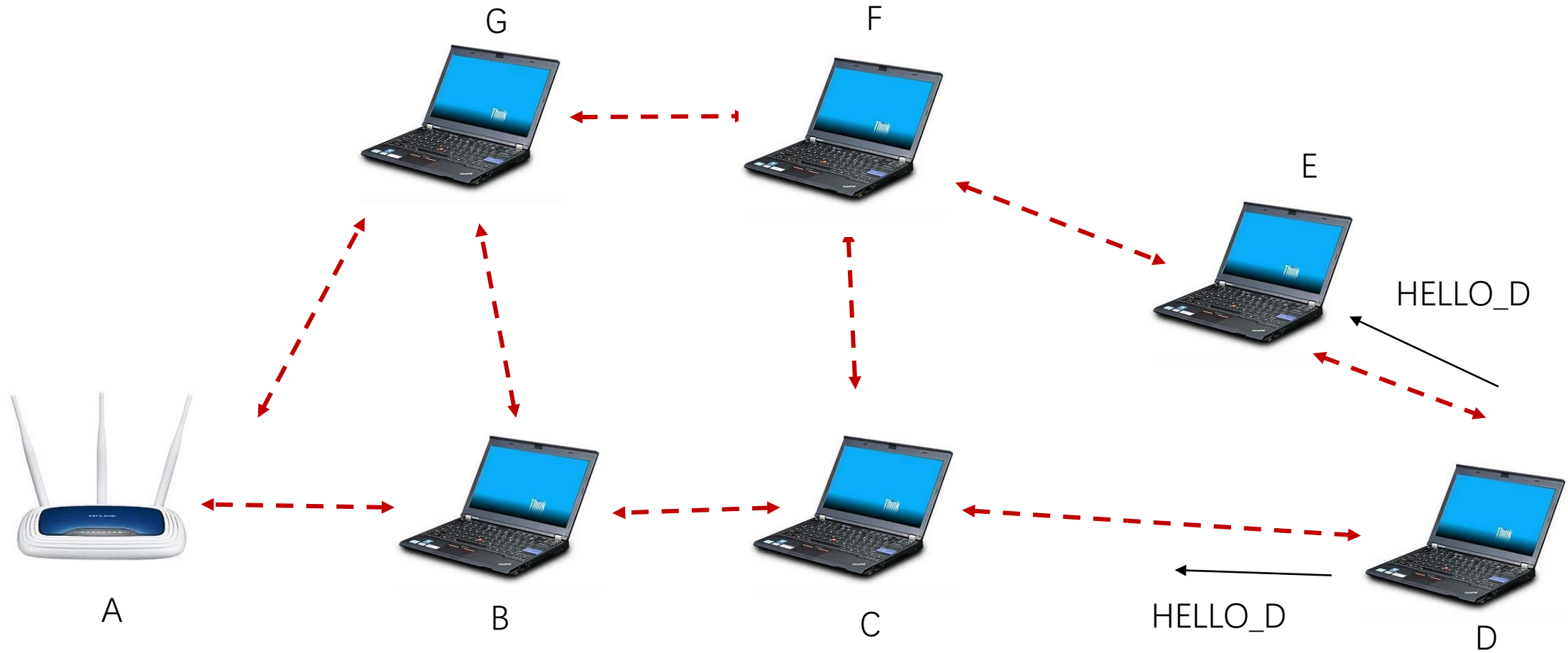


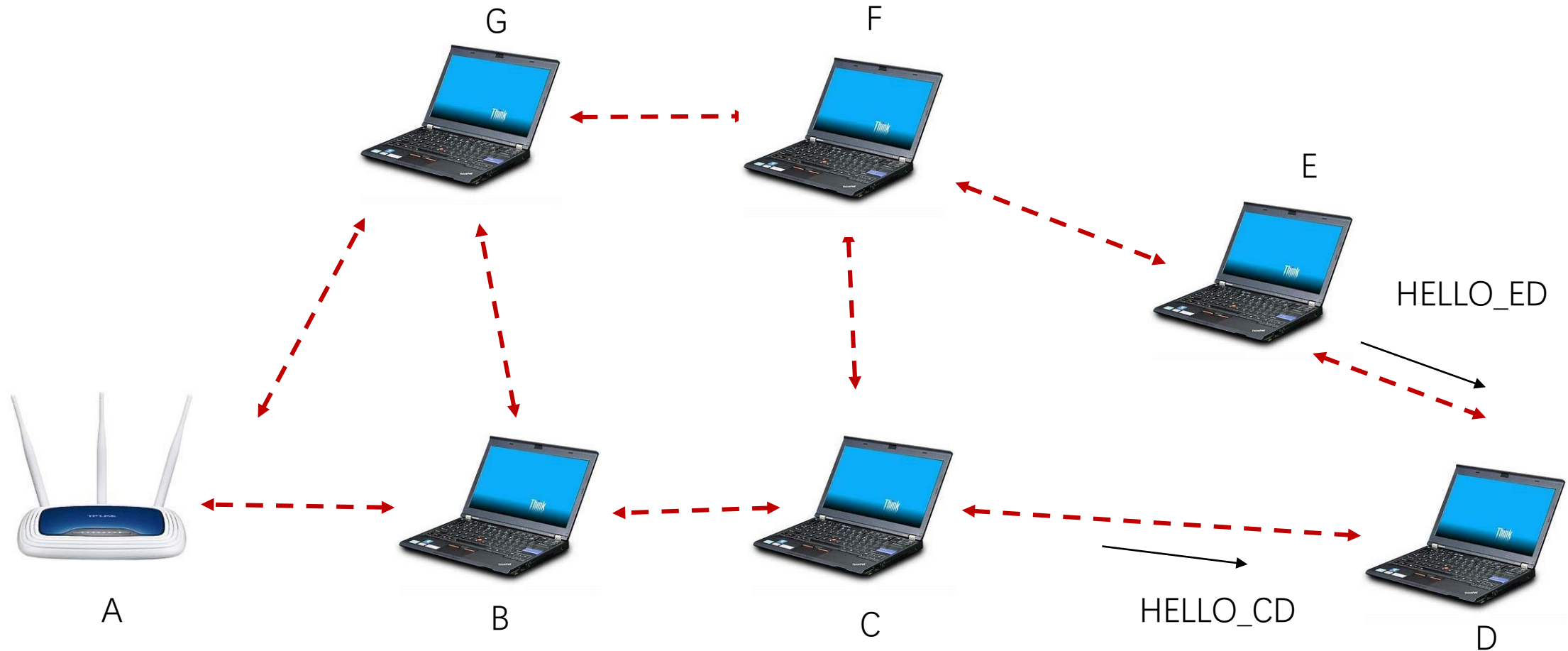
Ad Hoc on Demand Distance Vector (AODV)

- RFC 3561
- Re-active/On Demand
 - Does not take initiative for finding routes
- Routing Method
 - Broadcast Route Request (RREQ) packet
 - Node Reply Route Reply (RREP) with unicast
- Pros and Cons
 - Routing does not use bandwidth except when finding a route
 - Flooding overhead
 - Flooding reliability
 - Initial delay
 - Assume symmetric links

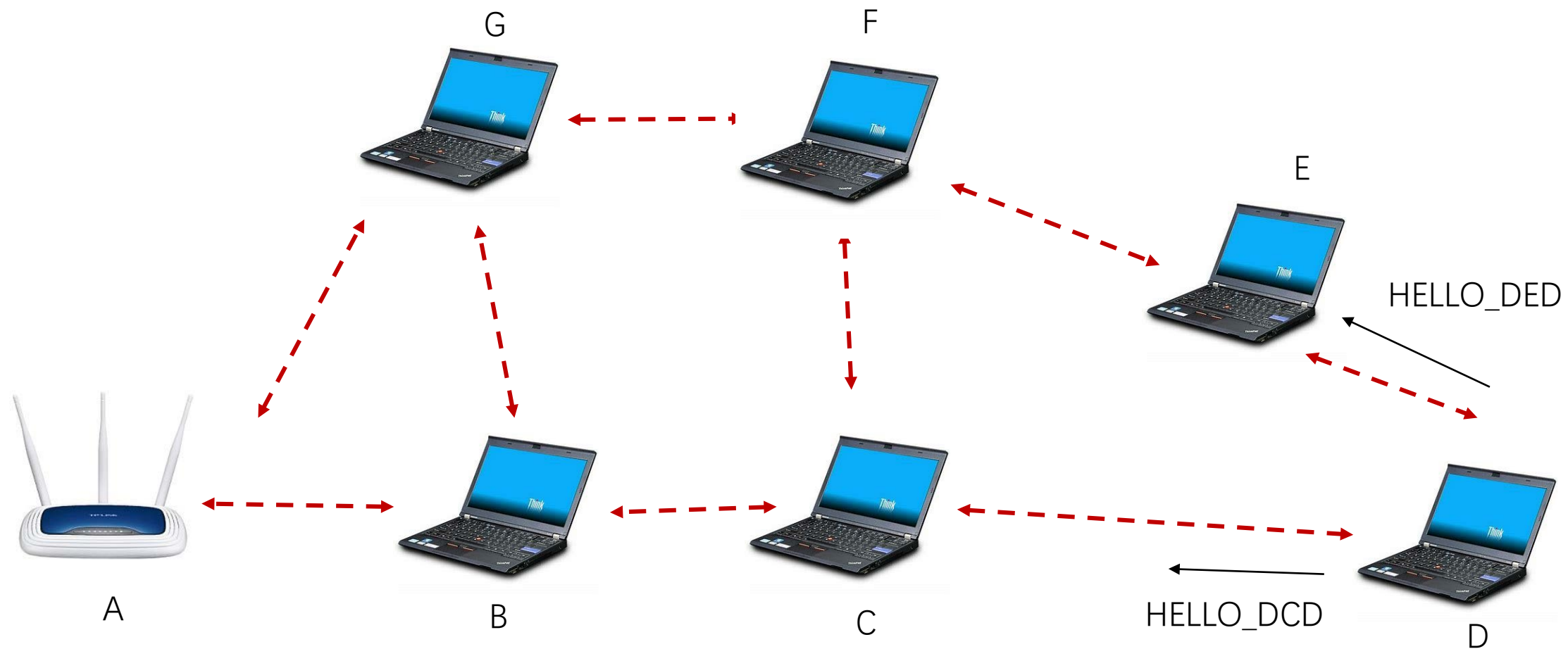
Optimized Link State Routing (OLSR)

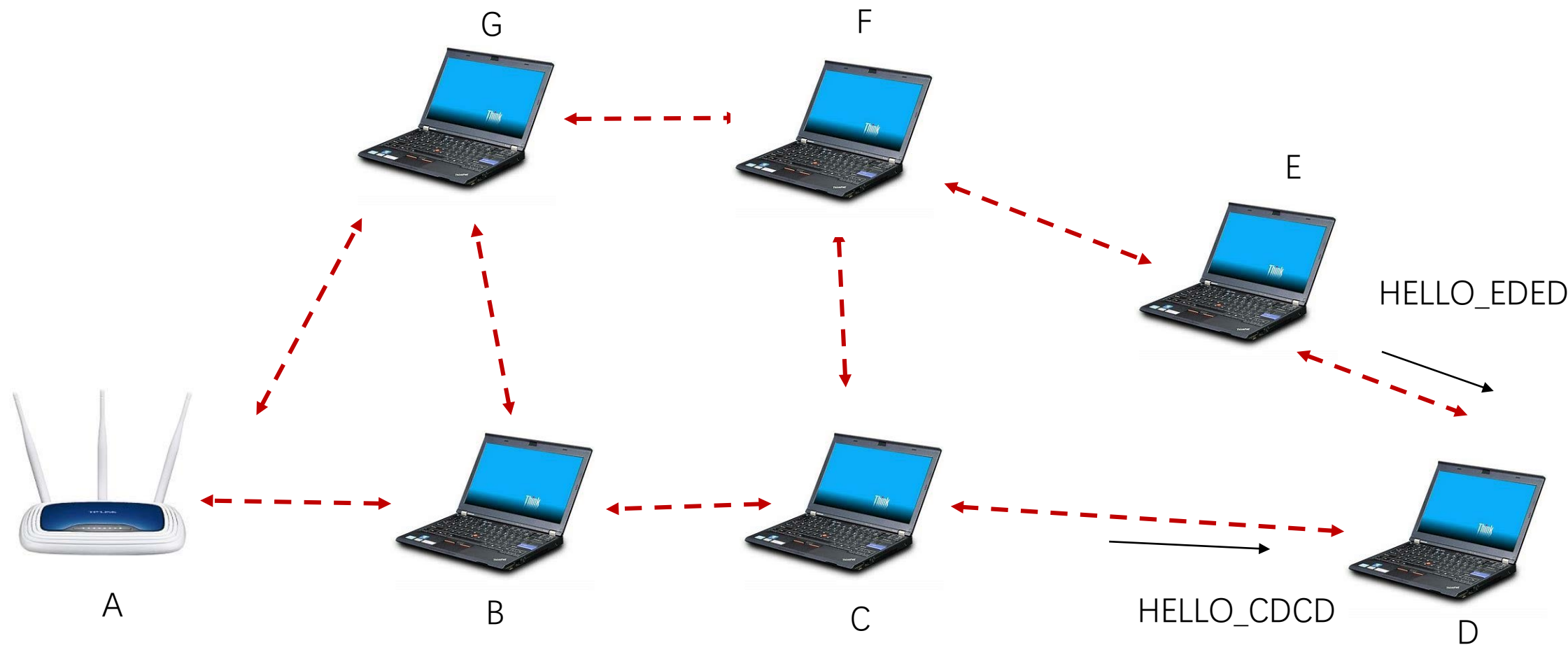
- RFC 3626
- Pro-Active
 - Routes are set up based on continuous control traffic
- Routing Method
 - Link sensing
 - “Selective” flooding
 - Link-State messaging





D knows C and E can receive from D, but C and E do not know whether D can receive from C and E

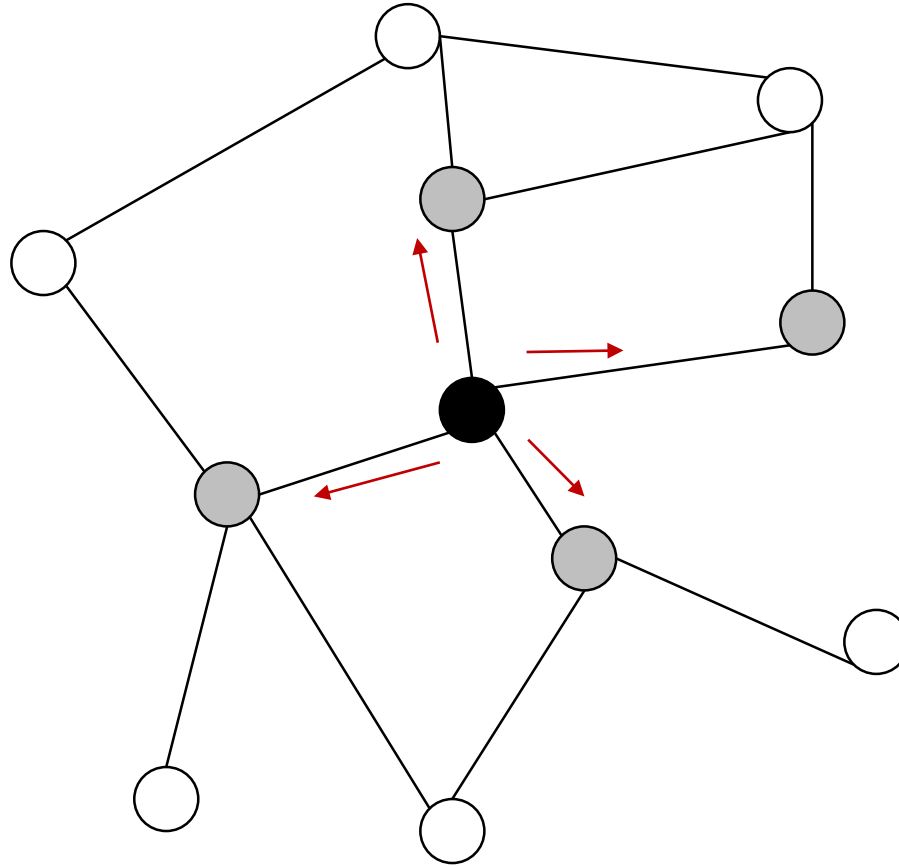




Link Sensing

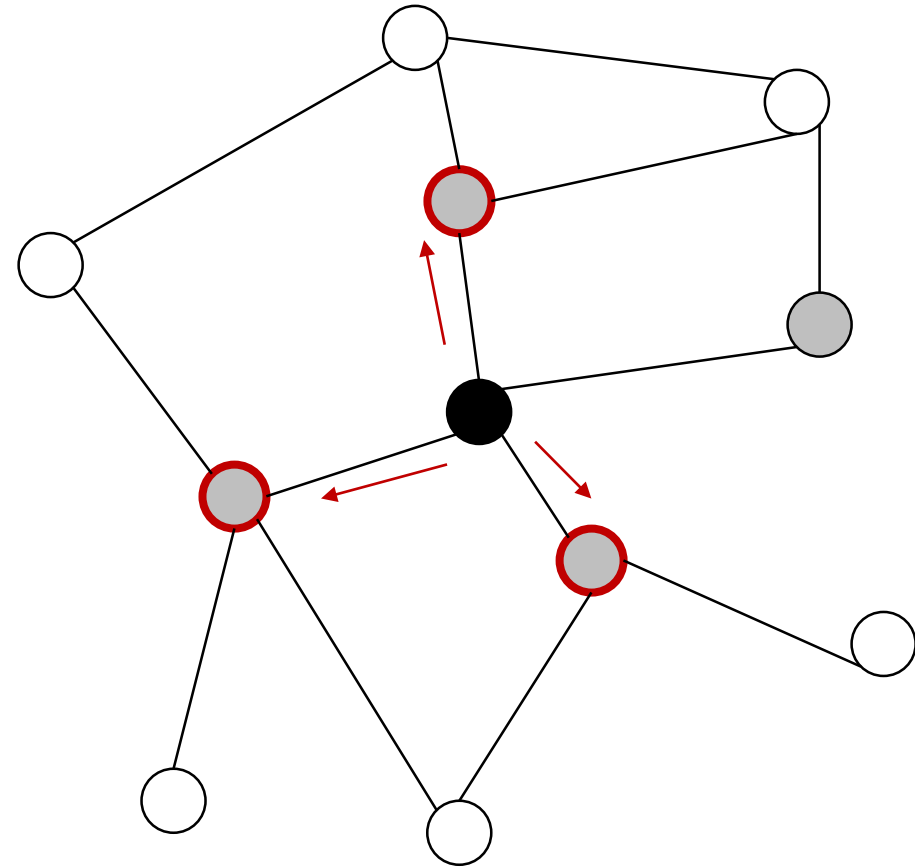
- HELLO messages are used to find symmetric links
- Using HELLO messages each node knows not only its 1-hop neighborhood but its 2-hop neighborhood
 - Similar as OSPF

Normal Flooding



“Selective” Flooding

- Select MultiPoint Relay (MPR)
 - to reduce broadcasting overhead
 - For all 2 hop neighbors there must exist a MPR set so that these 2 hop neighbors can be connected through nodes in MPR



Link-State Messaging

- Flood Link State
 - Similar as OSPF
 - Reduce overhead with MPR

Optimized Link State Routing (OLSR)

- Pro-Active
 - Routes are set up based on continuous control traffic
- Routing Method
 - Link sensing
 - “Selective” flooding
 - Link-State messaging
- Pros and Cons
 - Constant routing overhead
 - Routes are always available

Reference

- Textbook 4.4