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UNIVERSITÄT FREIBURG

Algorithms for Radio Networks

Flooding and DSR

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Characteristics of routing in mobile ad hoc networks

- **Movement of participants**
  - Reconnecting and loss of connection is more common than in other wireless networks
  - Especially at high speed
- **Other performance criteria**
  - Route stability in the face of mobility
  - energy consumption

Unicast Routing

- **Variety of protocols**
  - Adaptations and new developments
- **No protocol dominates the other in all situations**
  - Solution: Adaptive protocols?

Routing in MANETs

- **Routing**
  - Determination of message paths
  - Transport of data
- **Protocol types**
  - proactive
    - Routing tables with updates
  - reactive
    - repairm of message paths only when necessary
  - hybrid
    - combination of proactive and reactive

Routing Protocols

- **Proactive**
  - Routes are **demand independent**
  - Standard Link-State und Distance-Vector Protocols
    - Destination Sequenced Distance Vector (**DSDV**)
    - Optimized Link State Routing (**OLSR**)
- **Reactive**
  - Route are determined when needed
    - Dynamic Source Routing (**DSR**)
    - Ad hoc On-demand Distance Vector (**AODV**)
    - Dynamic MANET On-demand Routing Protocol
    - Temporally Ordered Routing Algorithm (**TORA**)
- **Hybrid**
  - combination of reactive und proactive
    - Zone Routing Protocol (**ZRP**)
    - Greedy Perimeter Stateless Routing (**GPSR**)

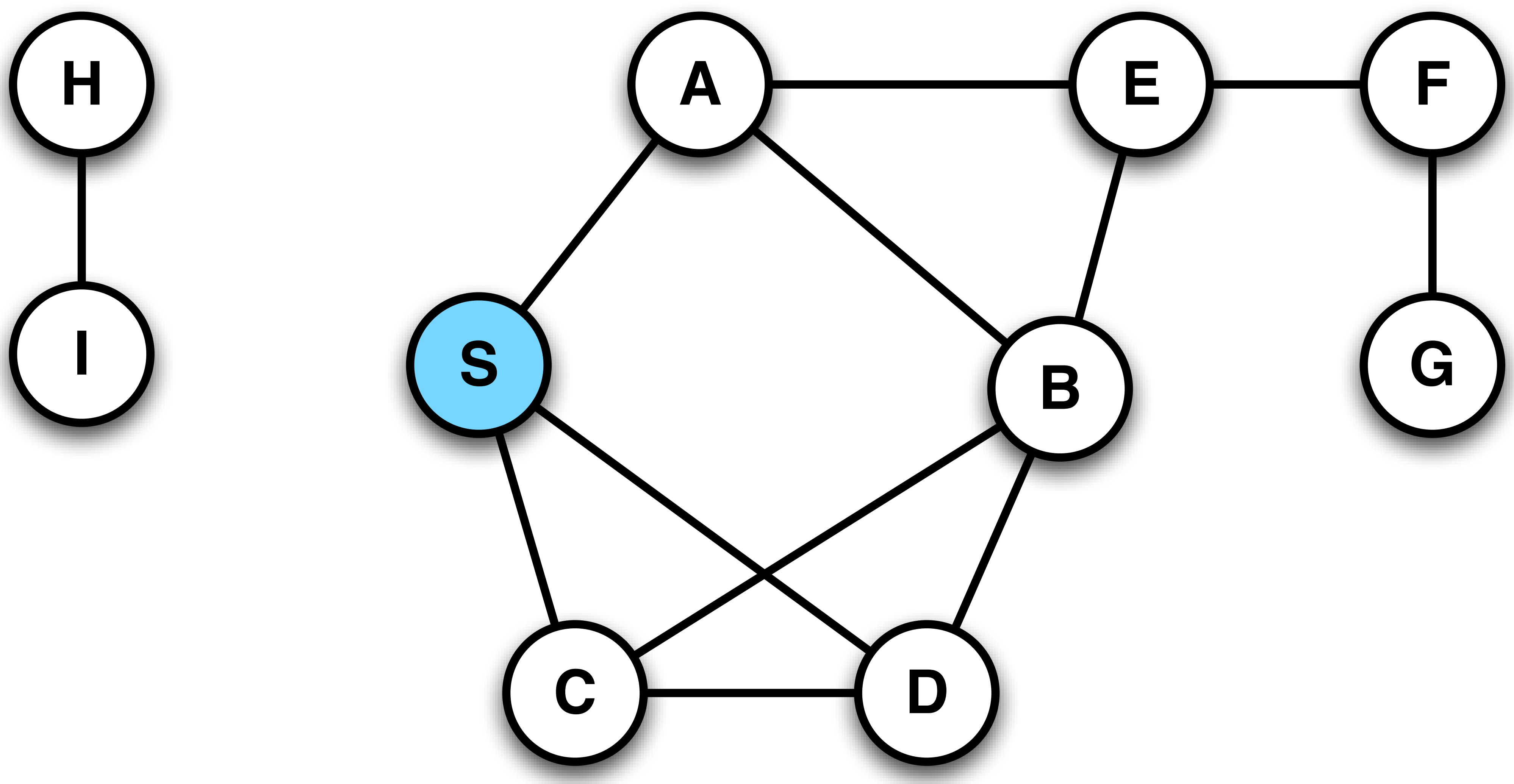
Trade-Off

- **Latenzcy because of route discovery**
  - Proactive protocols are faster
  - Reactive protocols need to find routes
- **Overhead of Route discovery and maintenance**
  - Reactive protocols have smaller overhead (number of messages)
  - Proactive protocols may have larger complexity
- **Traffic-Pattern and mobility**
  - decides which type of protocol is more efficient

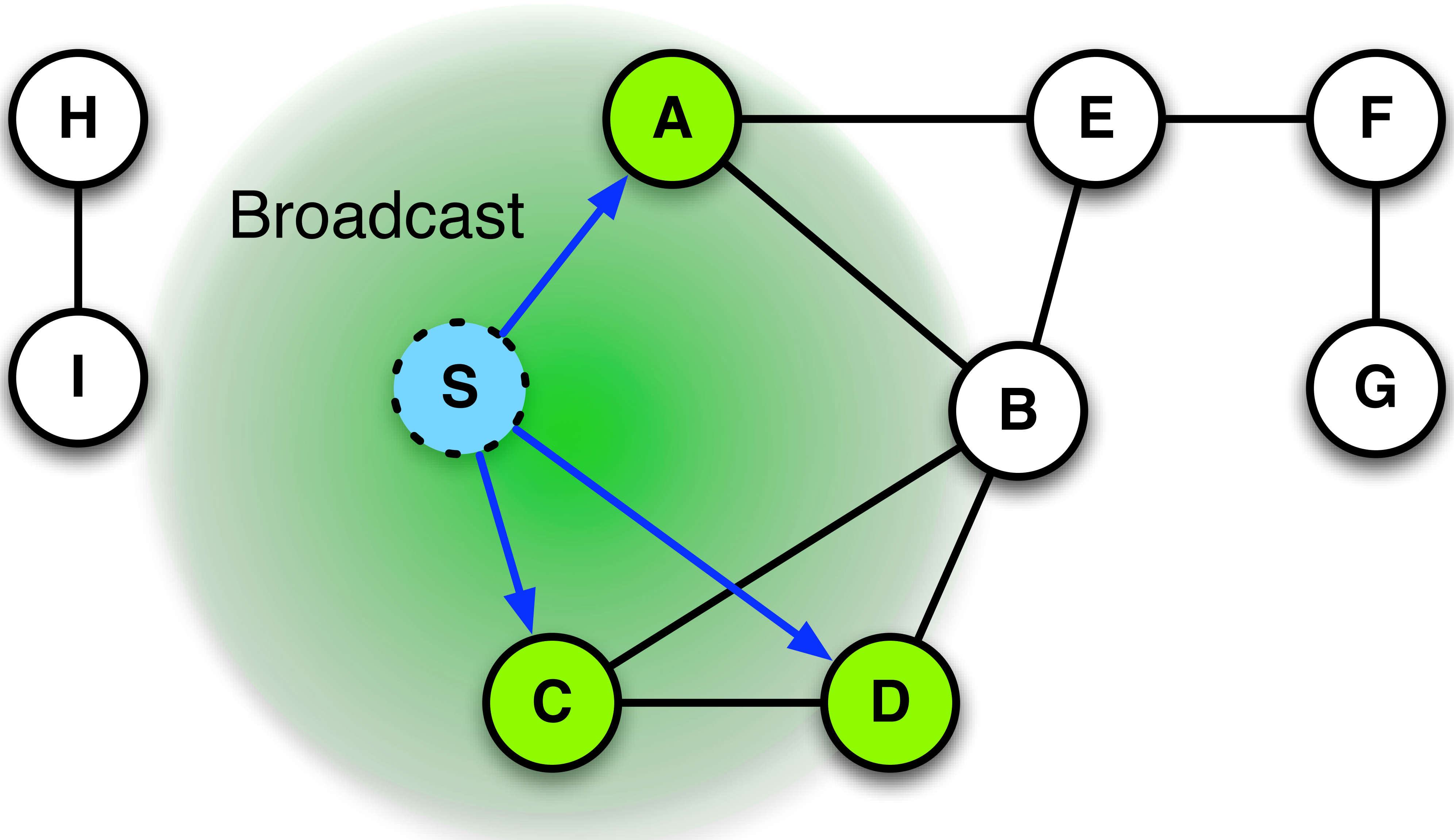
Flooding

- **Algorithm**
  - Sender S broadcasts data packet to all neighbors
  - Each node receiving a new packet
    - broadcasts this packet
    - if it is not the receiver
- **Sequence numbers**
  - identifies messages to prevent duplicates
- **Packet always reaches the target**
  - if possible

Flooding Example

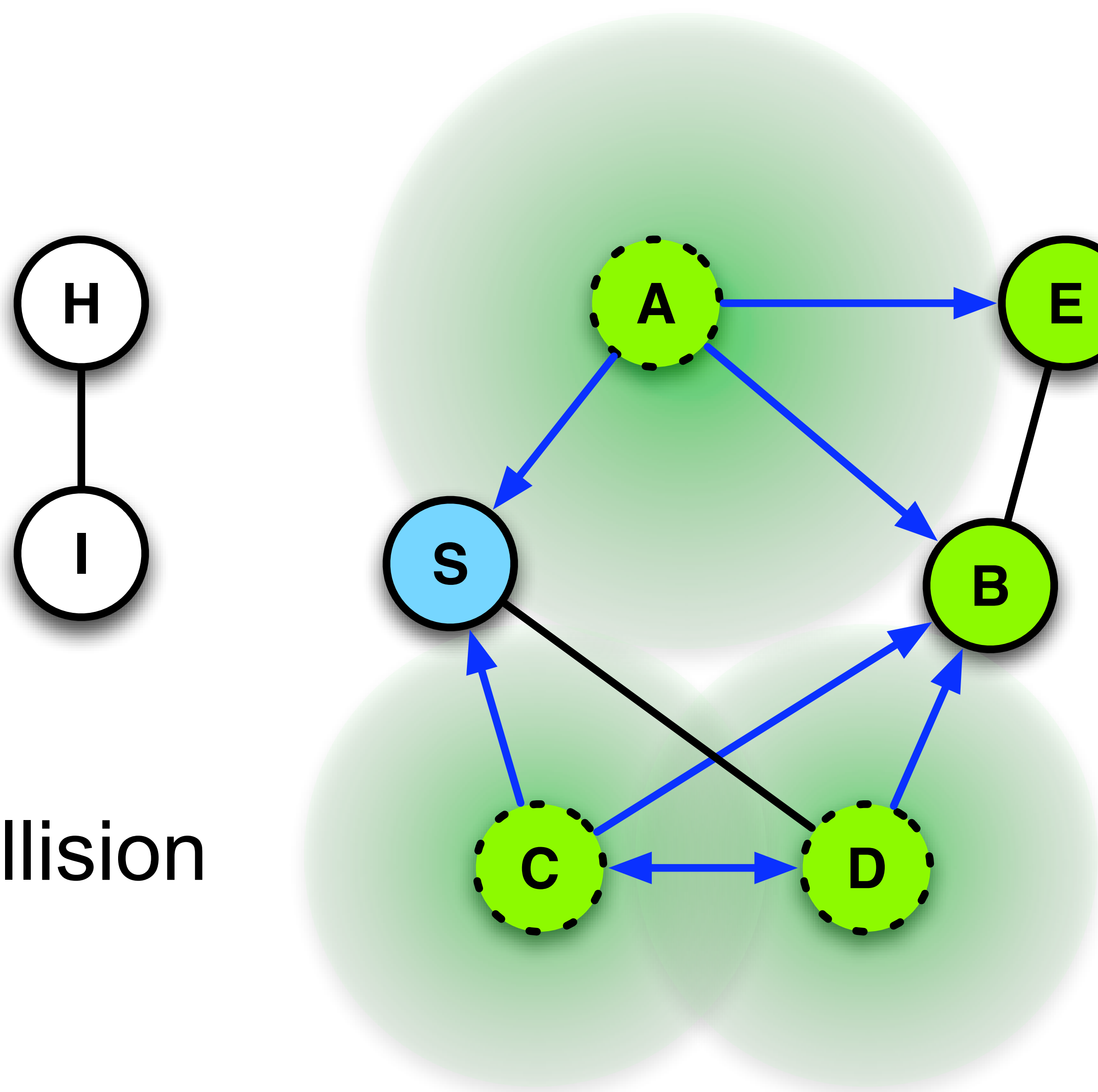


Flooding for Data Delivery



Packet for Receiver F

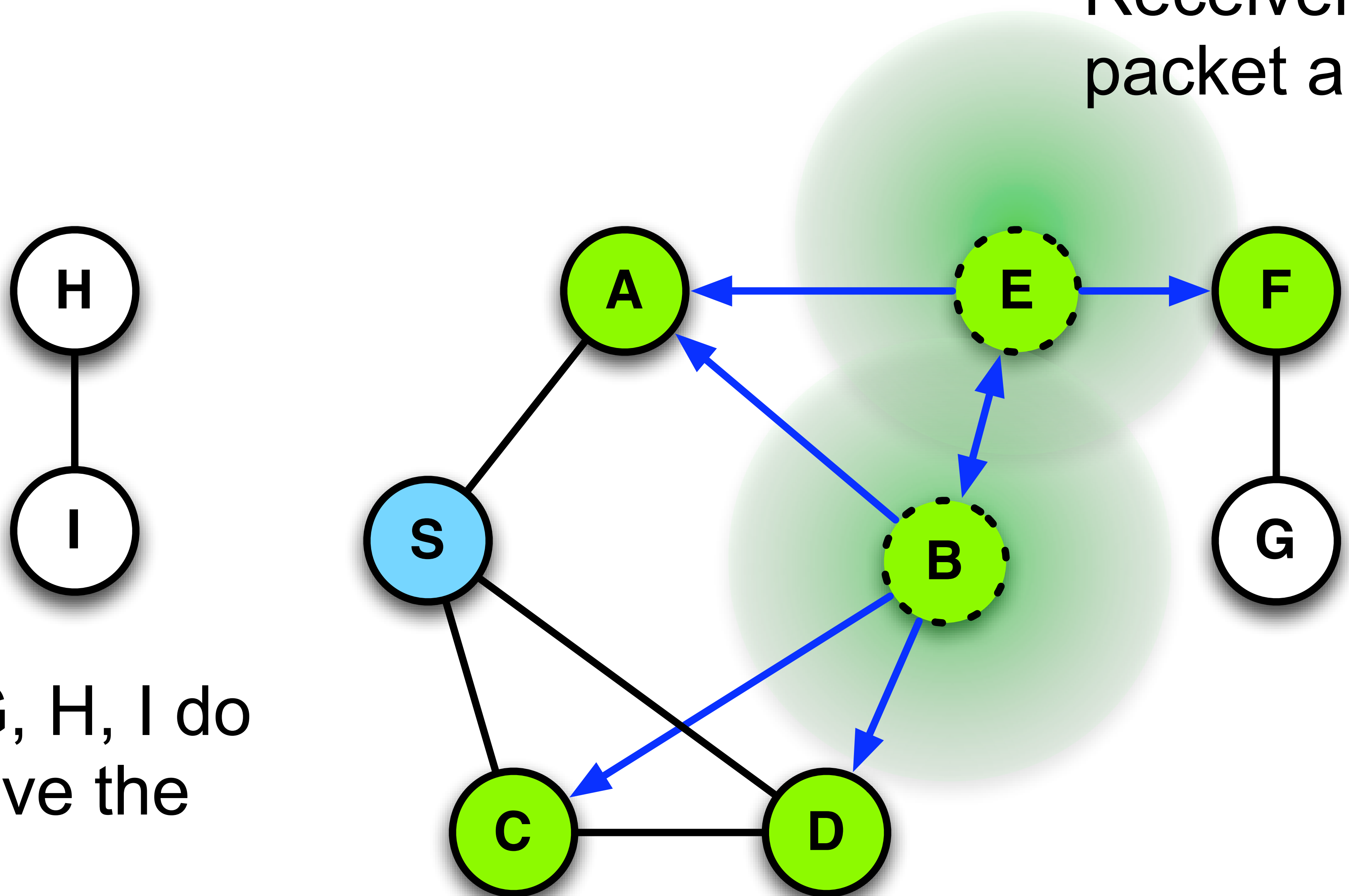
Flooding for Data Delivery



Possible collision at B

Flooding for Data Delivery

Receiver F gets packet and stops



Nodes G, H, I do not receive the packet

Flooding

- **Advantage**
  - simple and robust
  - the best approach for short packet lengths, small number of participants in highly mobile networks with light traffic
- **Disadvantage**
  - High overhead
  - Broadcasting is unreliable
    - lack of acknowledgements
    - hidden, exposed terminals lead to data loss or delay

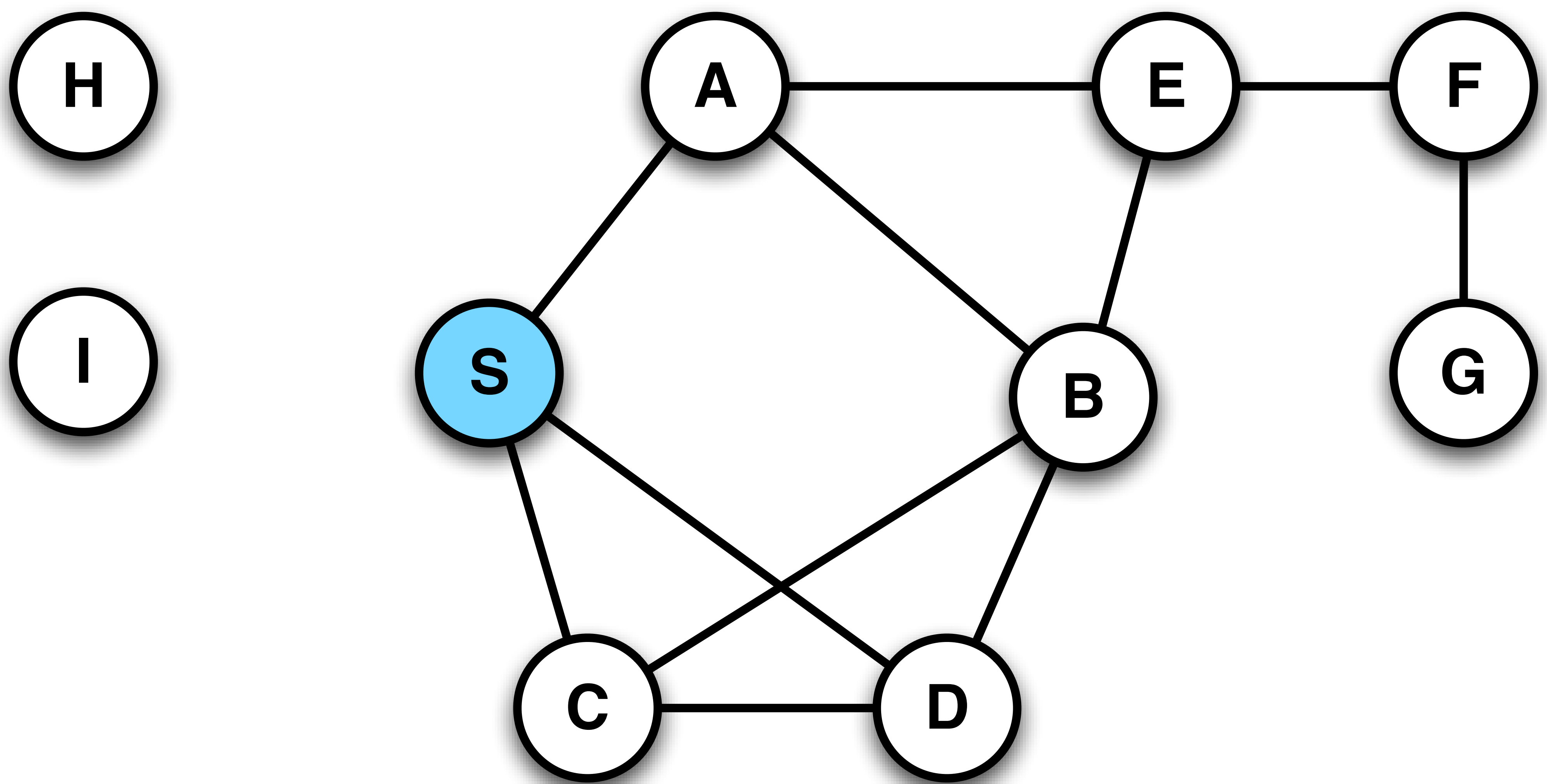
Flooding

- **Produces too many unnecessary (long) data packets**
  - in the worst case, each participant sends each packet
  - many long transmissions collisions lead to long waiting times in the medium access
- **Better approach:**
  - Use of control packets for route determination
  - Flooding of control packet leads to DSR

Dynamic Source Routing (DSR)

- **Johnson, Maltz**
  - *Dynamic Source Routing in Ad Hoc Wireless Networks*, Mobile Computing, 1996
- **Algorithm**
  - Sender initiates route discovery by flooding of **Route-Request (RREQ)**-packets
    - Each forwarding node appends his ID to the RREQ-packet
  - The receiver generates the routing information from the RREQ packet by producing a **Route-Reply (RREP)-**packet
    - using the route information of the packet is sent back to the sender
  - Transmitter sends **data packet** along with route information to the receiver

DSR Example



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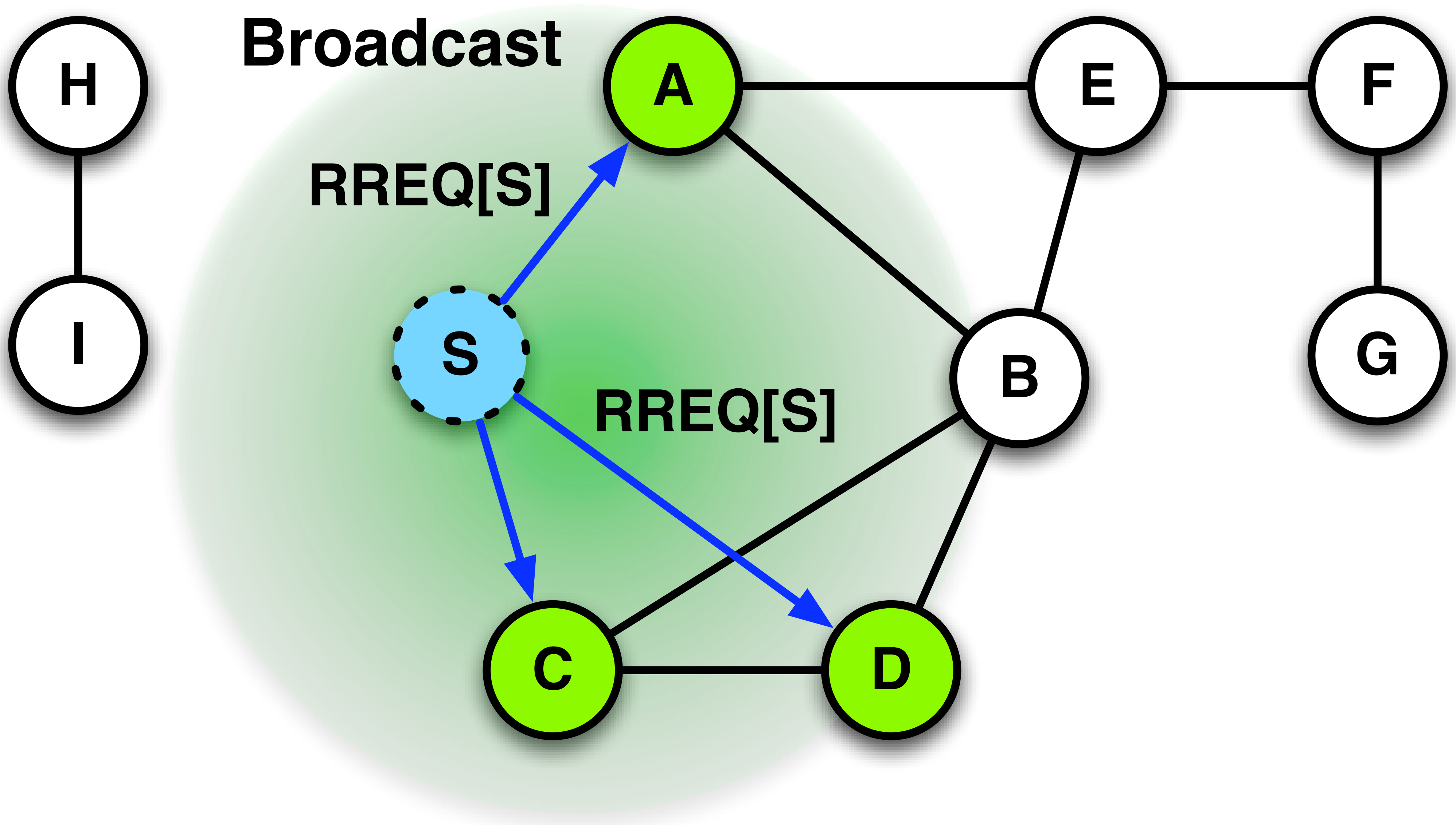

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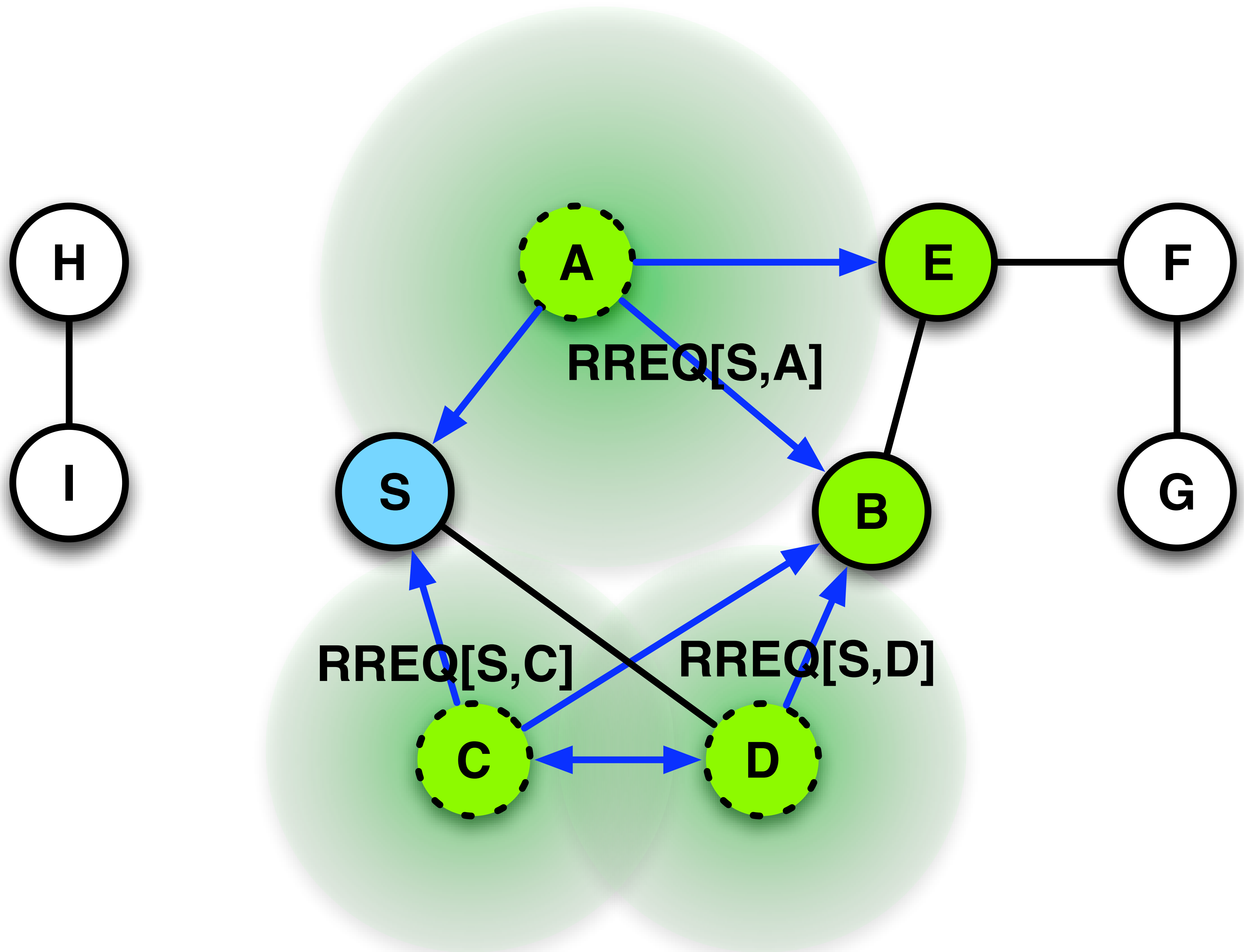

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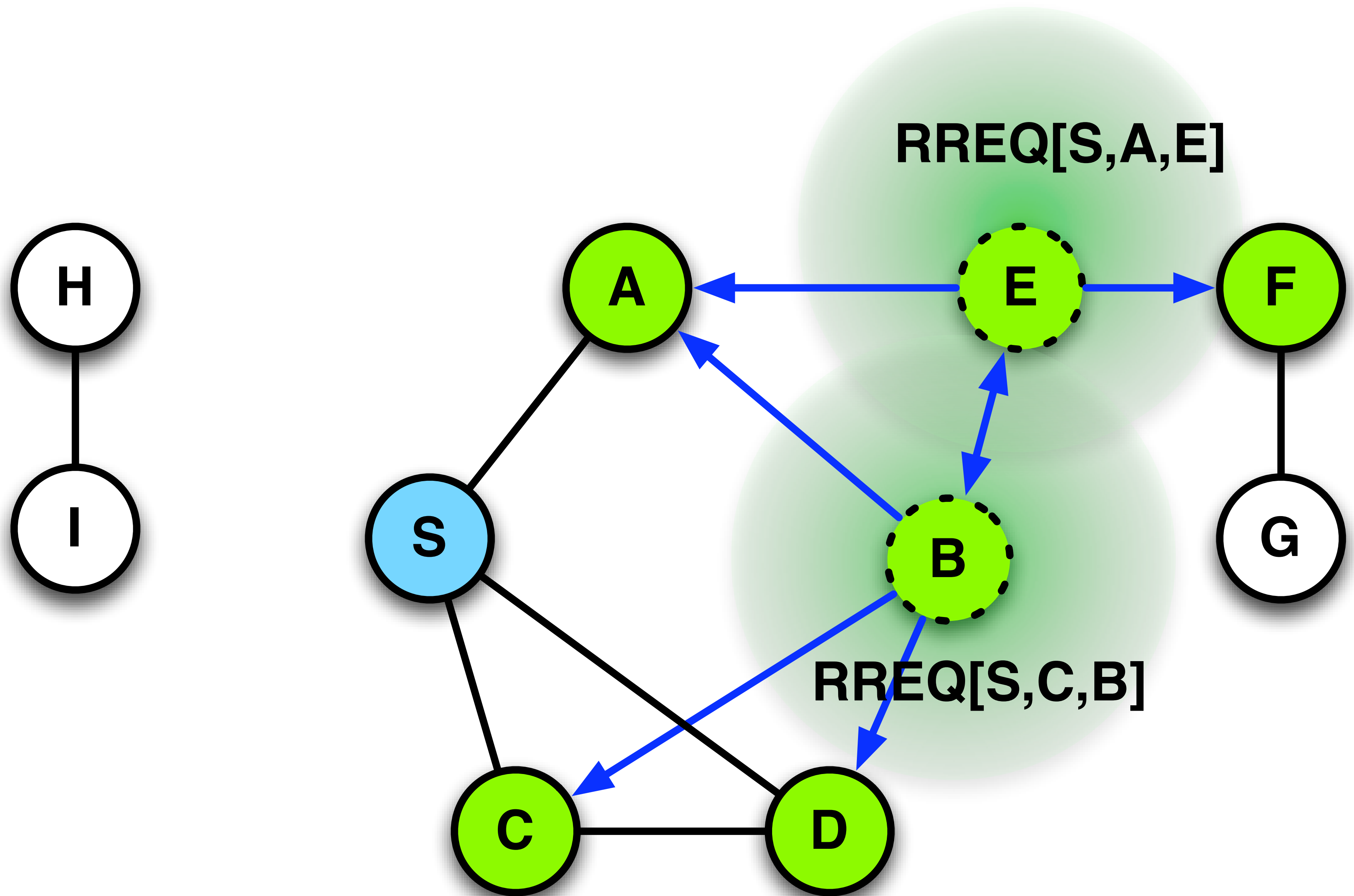

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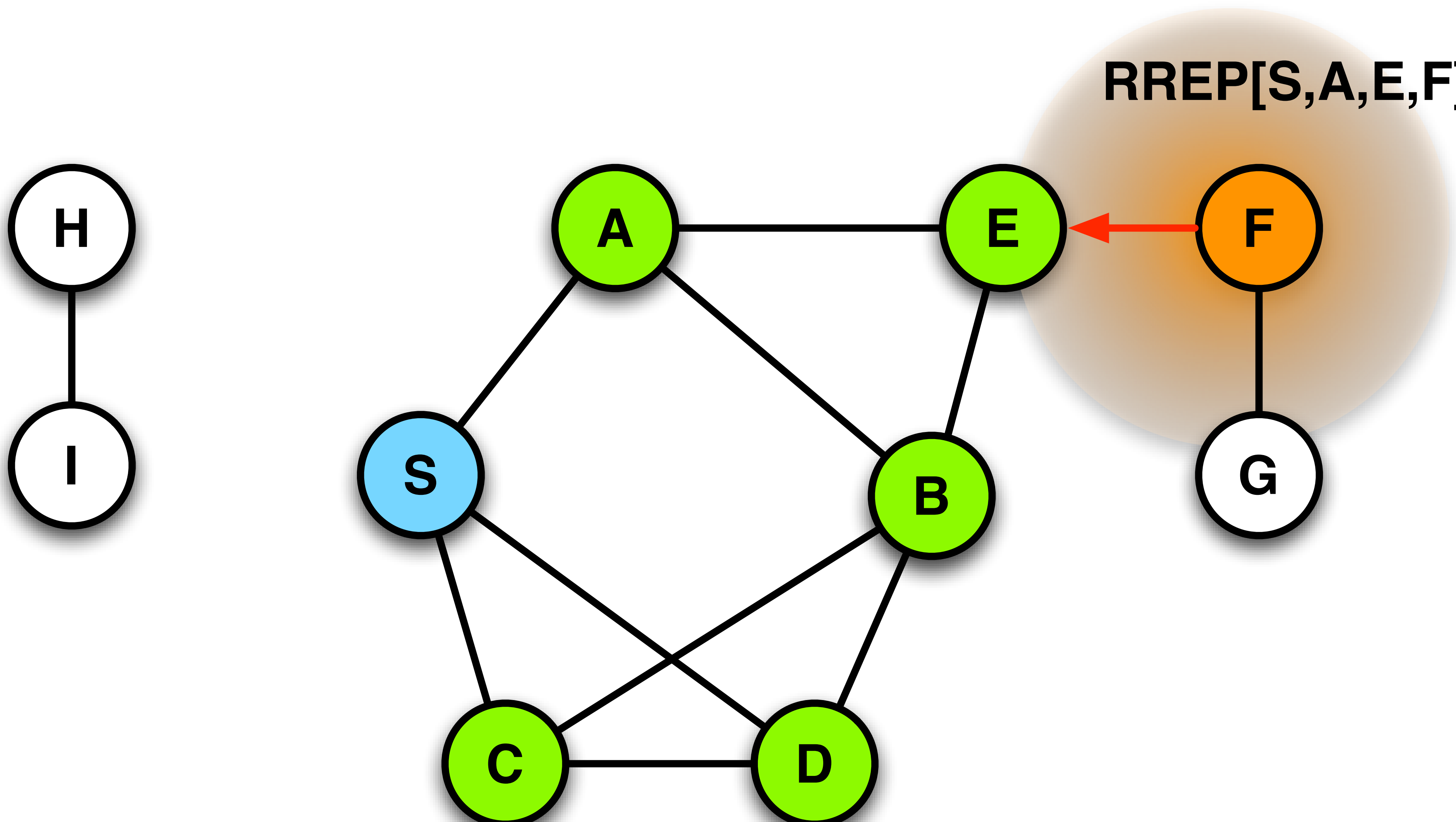

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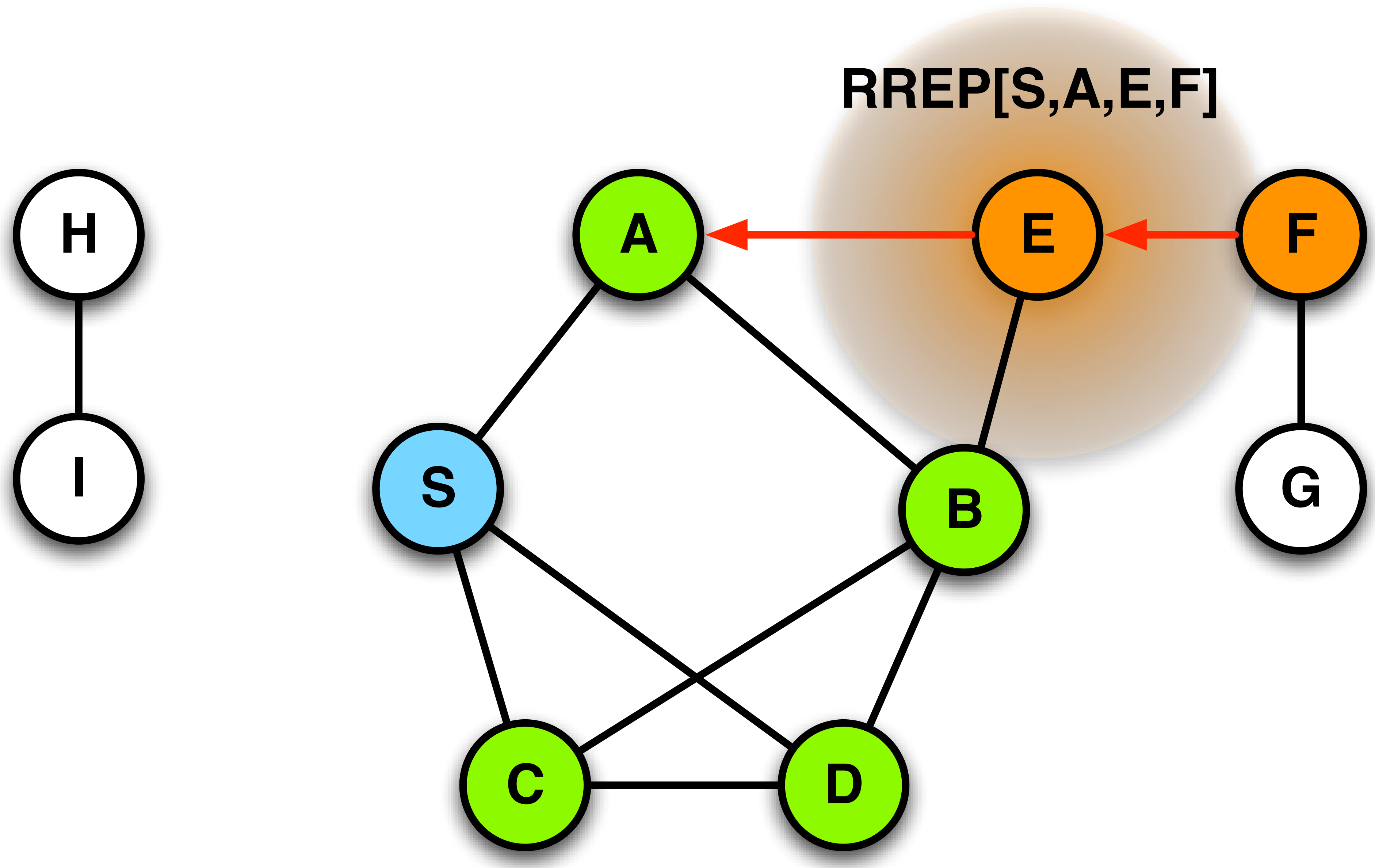

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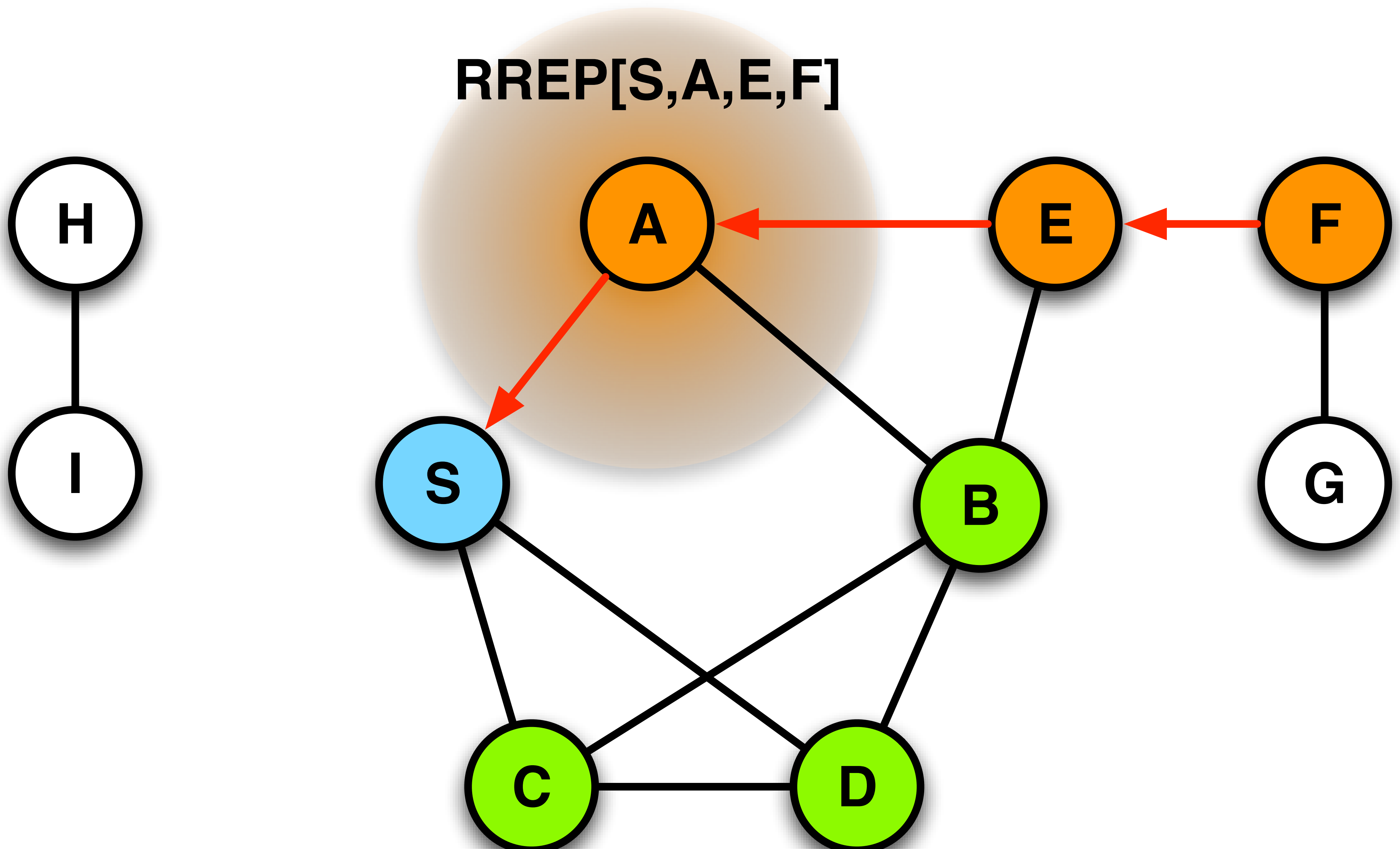

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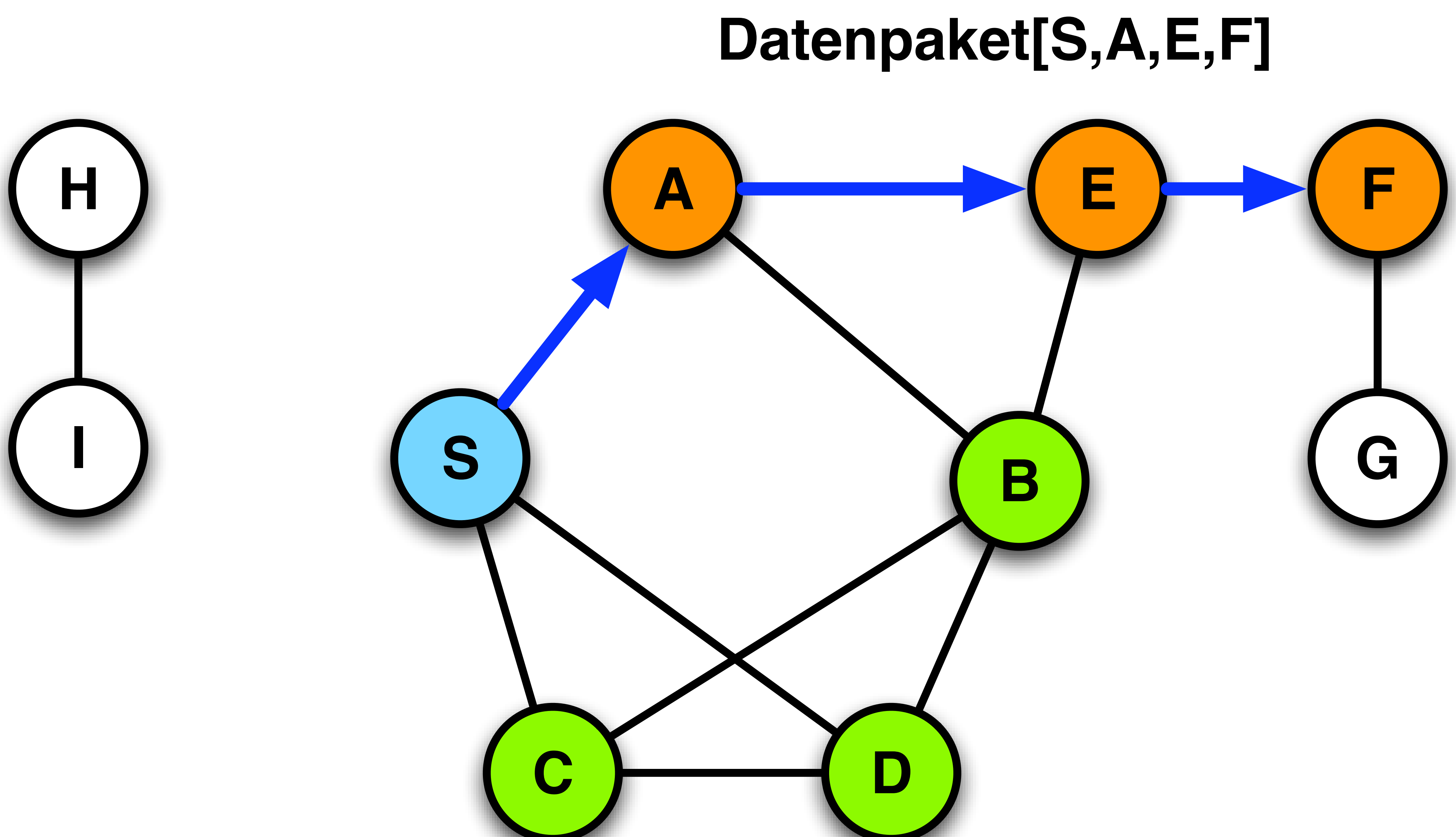


Requirements

- **Route Reply**
  - requires bidirectional connections
  - unidirectional links
    - must be tested for symmetry
    - or Route-Reply must trigger its own route-request
- **Data packet has all the routing information in the header**
  - hence: Source-Routing
- **Route determination**
  - if no valid route is known

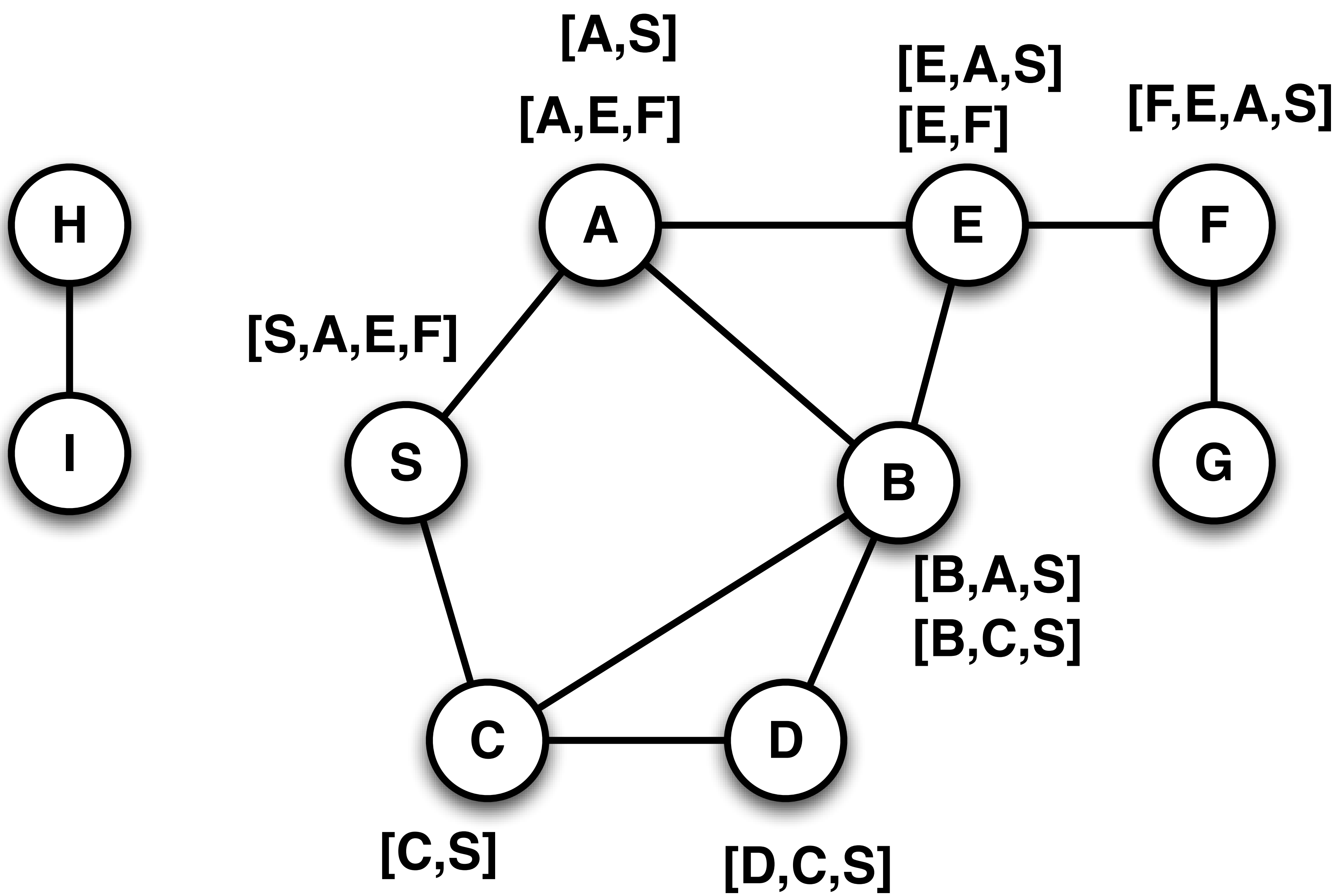
DSR Extensions and Modifications

- **Intermediate nodes can cache information RREP**
  - Problem: stale information
- **Listening to control messages**
  - can help to identify the topology
- **Random delays for answers**
  - To prevent many RREP-packets (Reply-Storm)
  - if many nodes know the answer (not for media access)
- **Repair**
  - If an error is detected then usually: route recalculation
  - Instead: a local change of the source route
- **Cache Management**
  - Mechanisms for the deletion of outdated cache information

DSR Optimization Route Caching

- **Each node stores information from all available**
  - Header of data packets
  - Route Request
  - Route-Reply
  - partial paths
- **From this information, a route reply is generated**

DSR Route Caching



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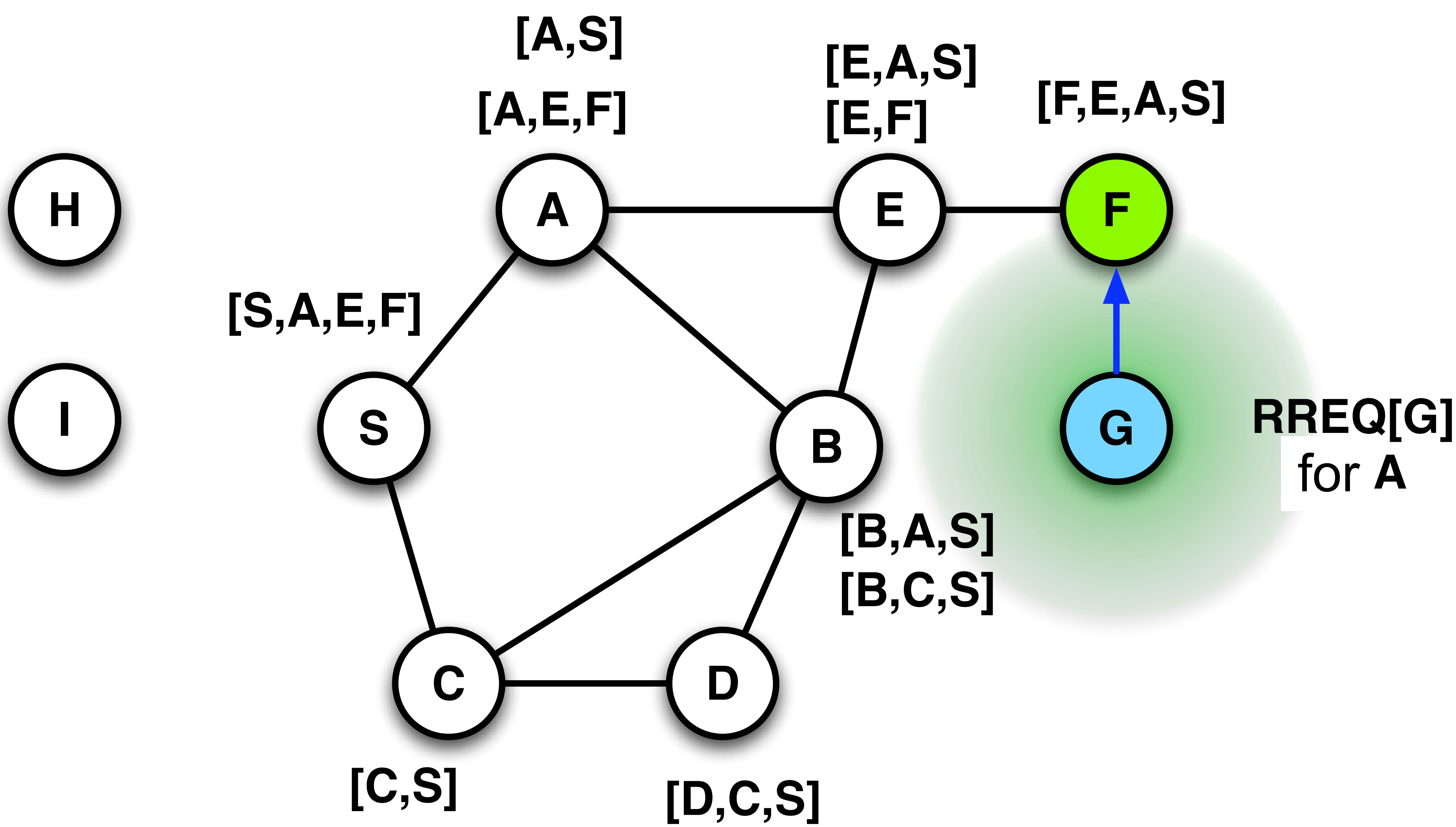

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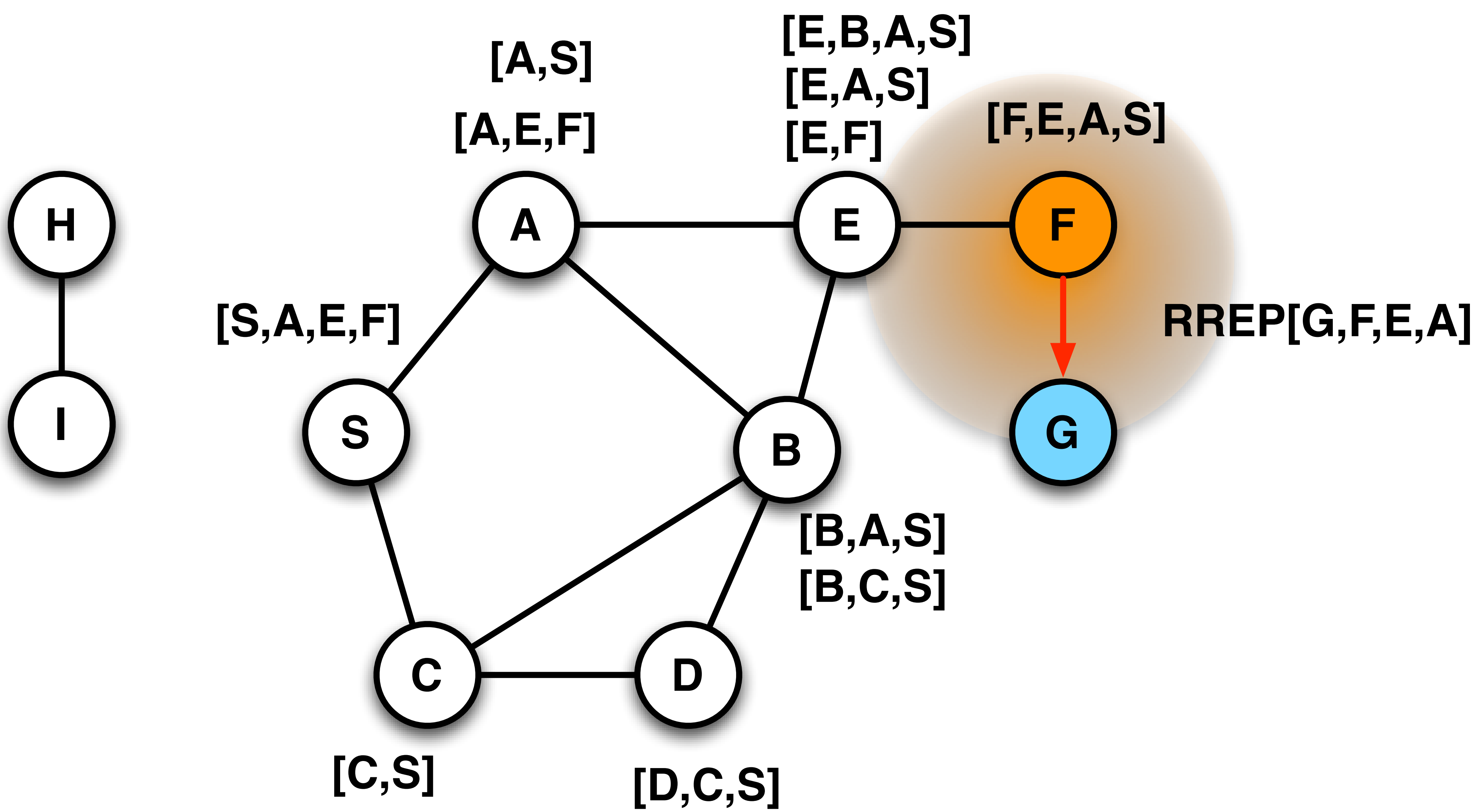

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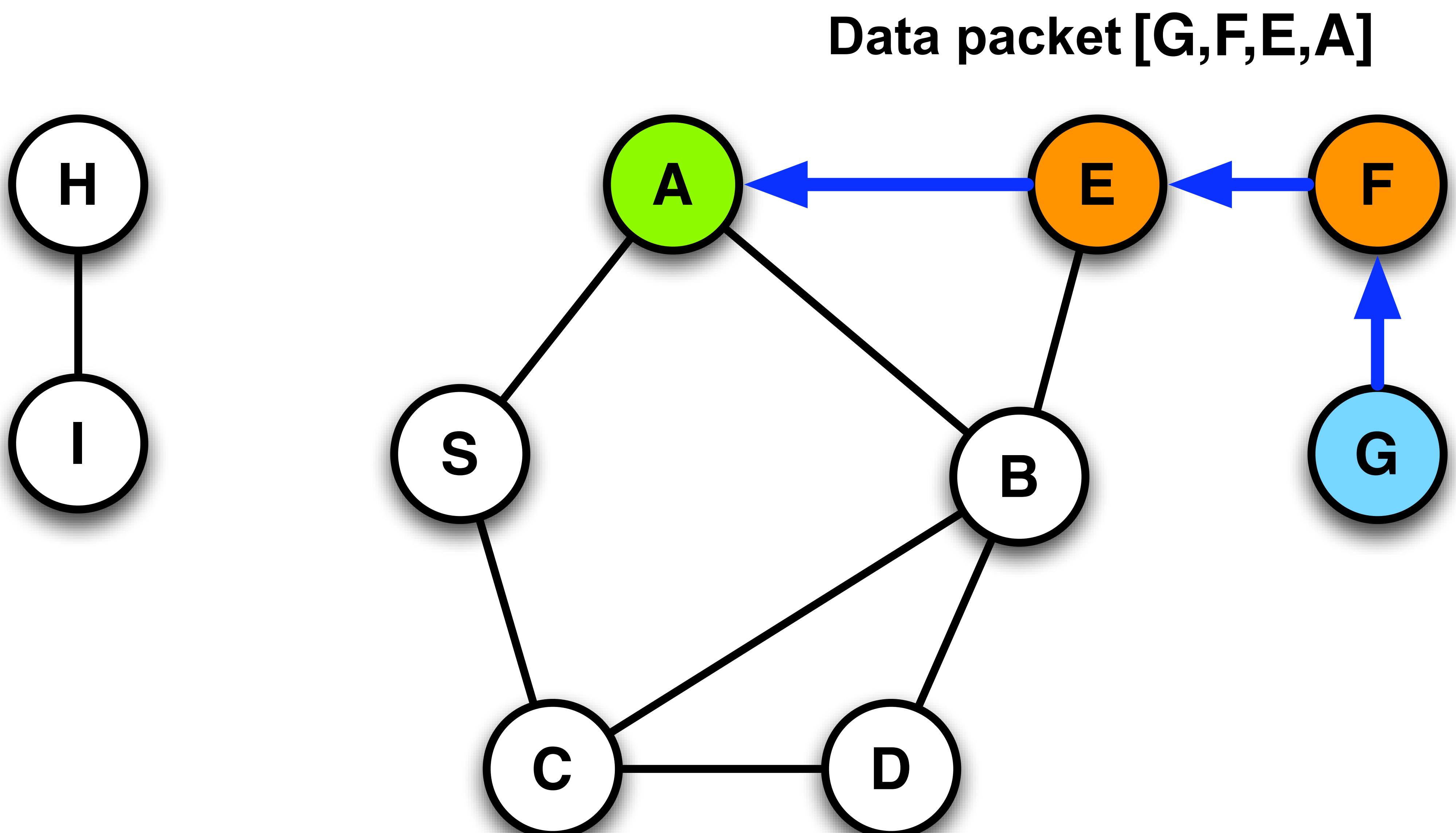
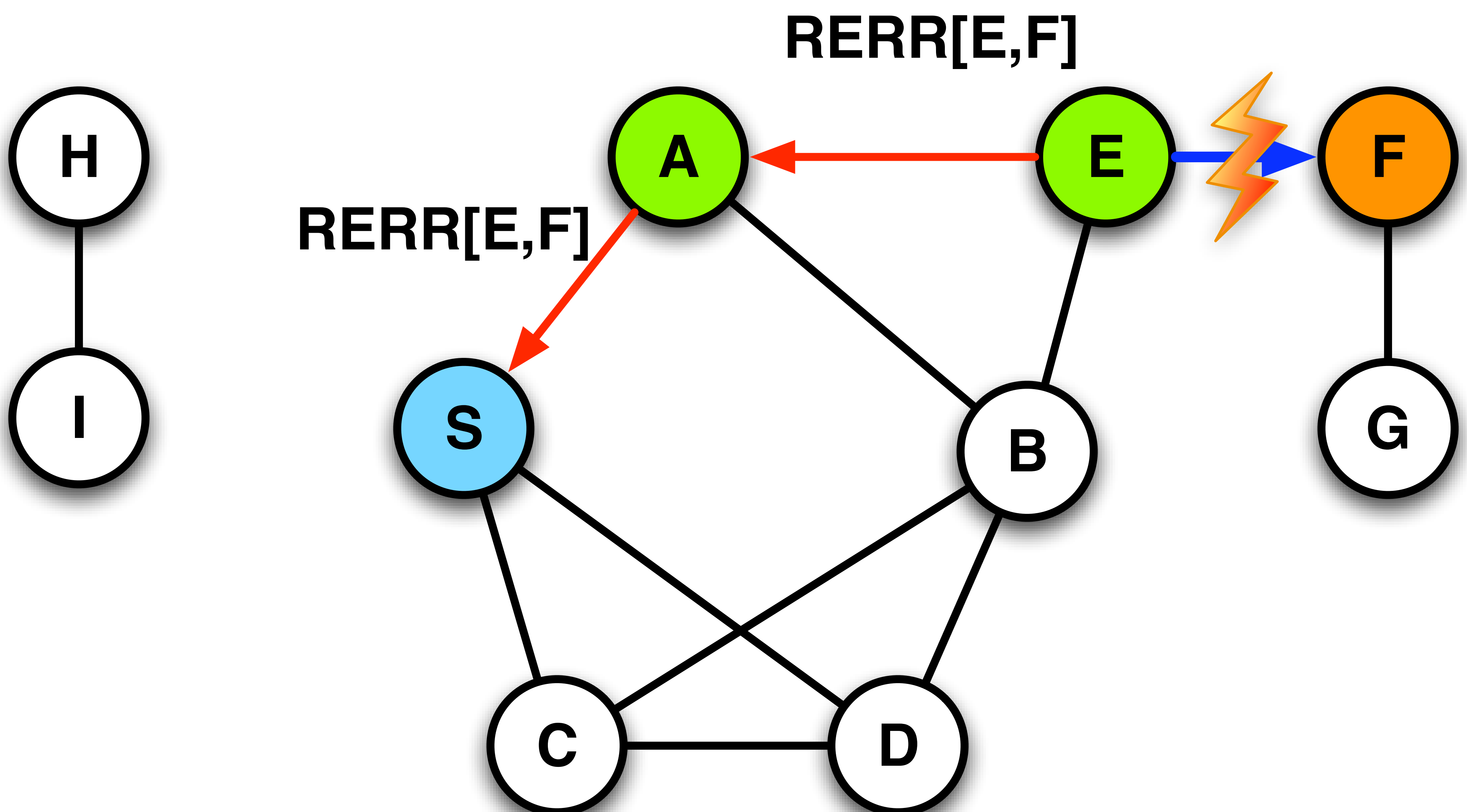


DSR Optimization
Route Caching

- **If any information is incorrect**
  - because a route no longer exists
  - then this path is deleted from the cache
  - alternative paths are used
  - or RREQ is generated
- **Missing links are distributed by (RERR) packets in the network**

Route Error



DSR Discussion

- **Benefits**
  - Routes are maintained only between communicating nodes
  - Route caching reduces route search
  - Caches help many alternative routes to find
- **Disadvantages**
  - Header size grows with distance
  - Network may be flooded with route requests
  - Route-Reply-Storm
  - Outdated information may cause cache overhead

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