UNIT-IV
MULTICAST ROUTING IN MANETS

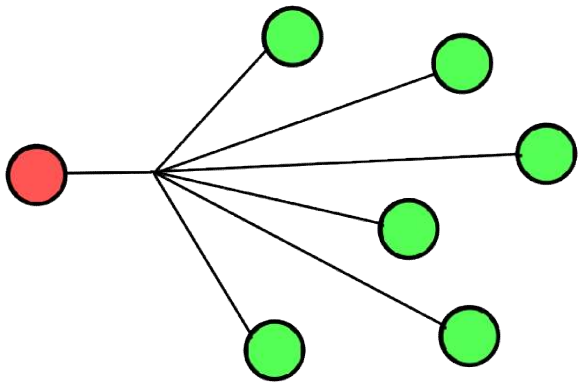
MADHESWARI.K

Outline

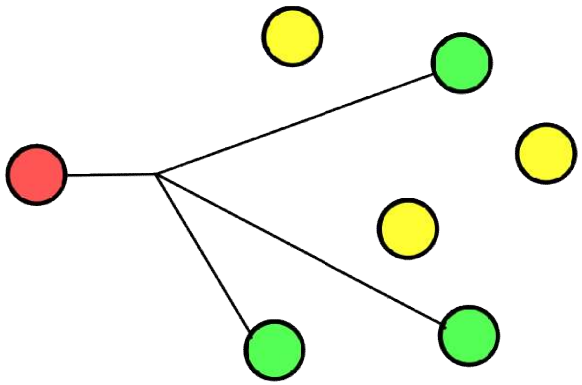
- Introduction of Multicast
- Multicast in MANET
- Multicast Protocols
- Conclusion
- Future Reading

What is Multicast

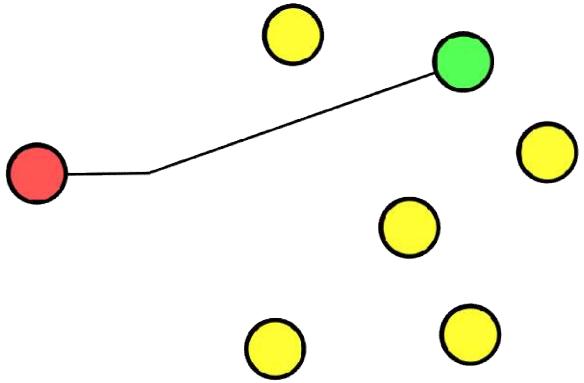
- “Point-to-multipoint" or "multipoint-to-multipoint“
- Different from broadcast and unicast



Broadcast



Multicast



Unicast

Advantages of Multicast

- Delivery to destinations simultaneously
- Deliver the messages over each link of the network only once
- only create copies when the links to the destinations split

Multicast routing in MANETs

- What is MANET (Mobil Ad Hoc Network)
  - No fixed infrastructure
  - Dynamic changed network topology
  - Limited bandwidth and power
- Multicast in MANETs
  - Play an important role
  - Internet multicast protocols are not suitable
  - On-demand multicast protocols

Types of Multicast Routing

- Tree-based
  - One path between a source-receiver pair
  - AMRoute, AMRIS
- Mash-based
  - Multiple paths between a source-receiver pair
  - ODMRP, CAMP
- Hybrid
  - Zone Routing Protocol (ZRP)

Typical Multicast Routing Protocols

- AMRIS: Ad Hoc Multicast Routing Protocol Utilizing Increasing ID Numbers
  - National University of Singapore
  - Georgia Institute of Technology
  - November 1998 [draft]
- ODMRP: On-demand Multicasting Routing Protocol
  - University of California at Los Angeles
  - January 2000 [draft]

Why we compare them?

	AMRIS	ODMRP
Big difference		
Topology	Shared Delivery Tree	Mesh of Nodes
Main Similarity		
Mobility support	Yes, based on MANET	
Driven mode	On-demand, do not store whole network topology	
Advantages	simple topology low overheads	mobility robustness
Disadvantages	sensitive to mobility	complex topology high overheads

Protocol Phases

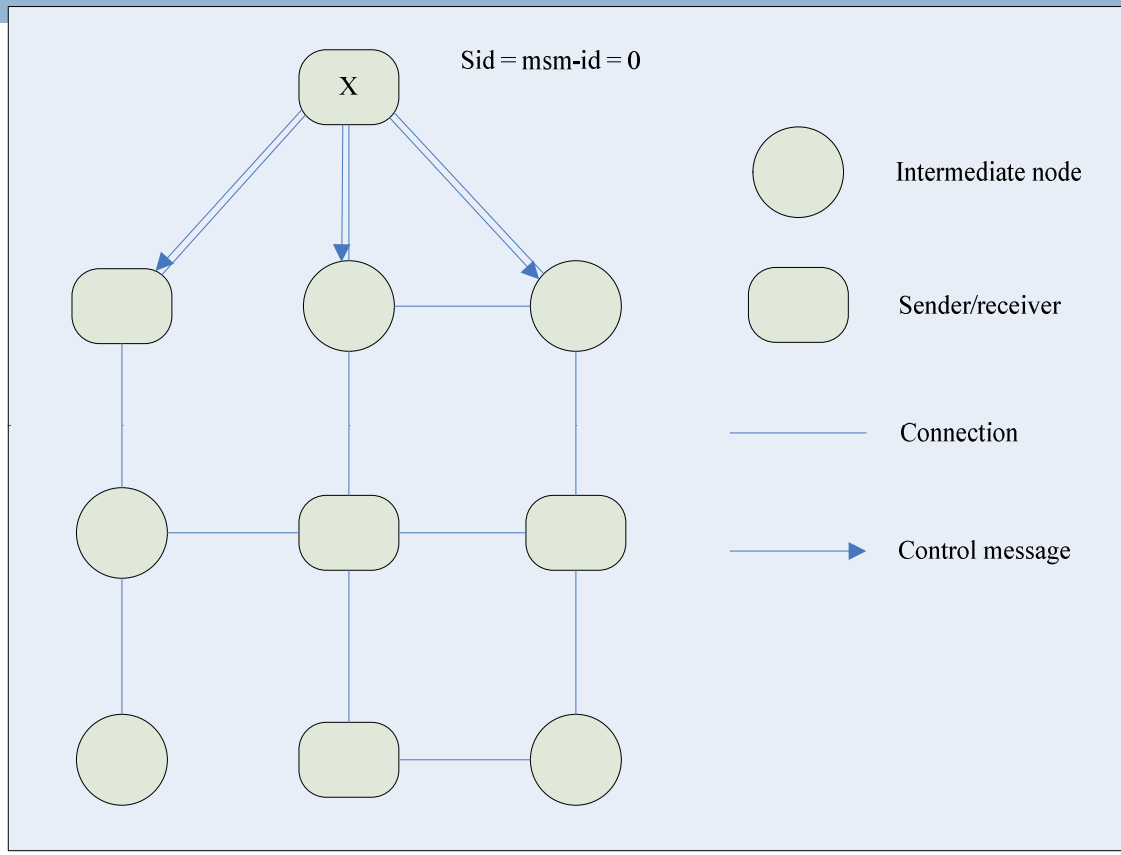
- Initialization phase
  - How to set up a multicast session?
  - How to determine the best routing path?
- Maintenance phase
  - How to maintain the topology?
  - How to join/leave a multicast session?
  - Discuss the complexity of mobility.

AMRIS

- Things need to know:
  - SID: Smallest-ID node, holder is the source;
  - msm-id: multicast session member ID;
  - Multicast Messages:
    - NEW-SESSION (N-S, includes msm-id/route table)
    - JOIN-REQ (J-R)
    - JOIN-ACK (J-A)
    - JOIN-NAK (J-N)
    - …

AMRIS: Initialization phase (1)

- Sender actions:
  - Downstream
    - Generate N-S message
    - Broadcast N-S
  - Upstream
    - Wait for J-R
    - Return J-A
    - Collect Receiver and determine the route path



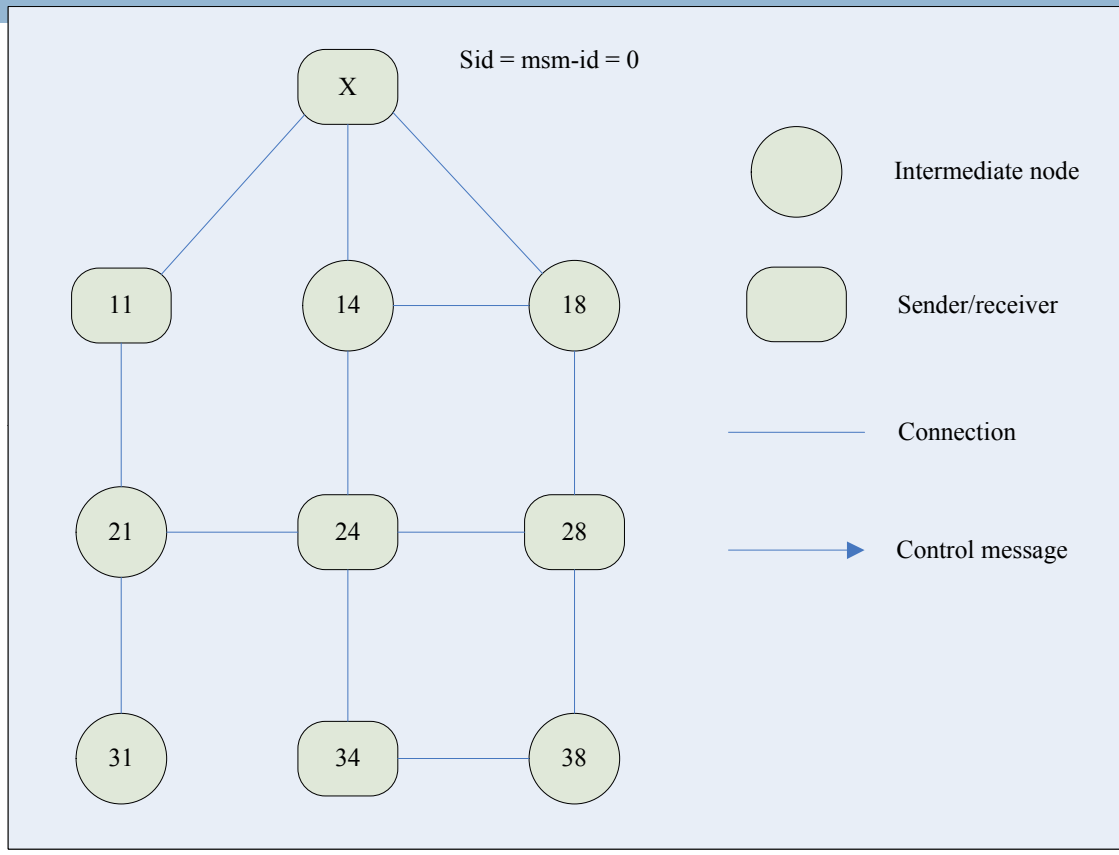
AMRIS: Initialization phase (2)

- Intermediate node actions: **(Downstream)**
  - Receive N-S;
  - Calculate own msm-id:

$$msm - id_{self} > msm - id_{parent}$$

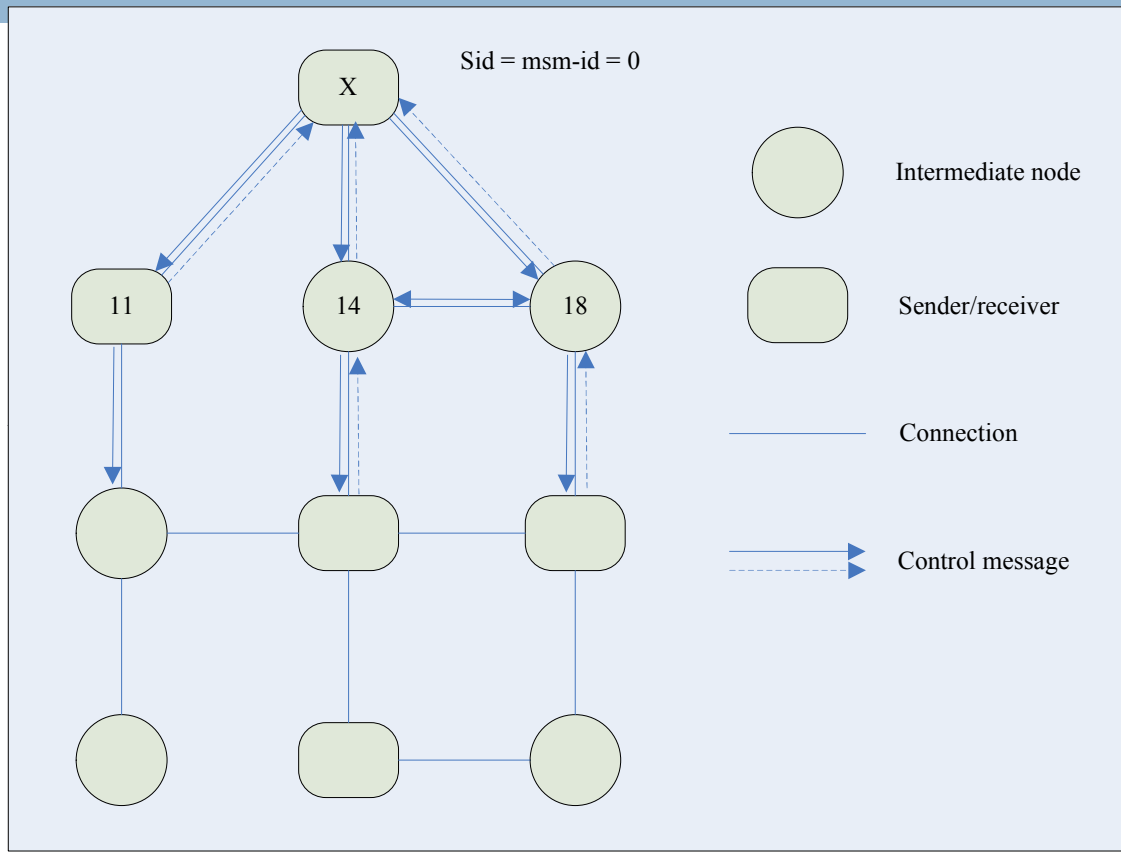
  - Broadcast N-S' (with $msm - id_{self}$);
  - One solution:

$$msm - id_{self} = INT((2\hat{}(M/2))/hop\_count$$



AMRIS: Initialization phase (3)

- Intermediate node actions: (**Upstream**)
  - Receive J-R;
  - If node already in multicast path tree
    - Reply with J-A, path established!
  - Otherwise send J-R up to potential parent (smallest $msm\text{-}id_{parent}$);
    - Receive J-A, reply J-A to J-R sender and path established!
    - Timeout or received J-N
      - BR1: send J-R to a new parent or BR2: broadcast J-R;
      - If BR1 or BR2 success, reply J-A to J-R sender and path established else reply J-N to J-R sender (failed!!);



AMRIS: Initialization phase (4)

- Receiver actions:
  - Downstream
    - Receive N-S;
    - Calculate own msm-id;
  - Upstream
    - Generate J-R message;
    - Send J-R up to potential parent (smallest $msm-id_{parent}$);
      - Receive J-A, path established!
      - Timeout or received J-N
        - BR1: send J-R to a new parent
        - BR2: broadcast J-R
        - If BR1 or BR2 success, path established el path failed!!

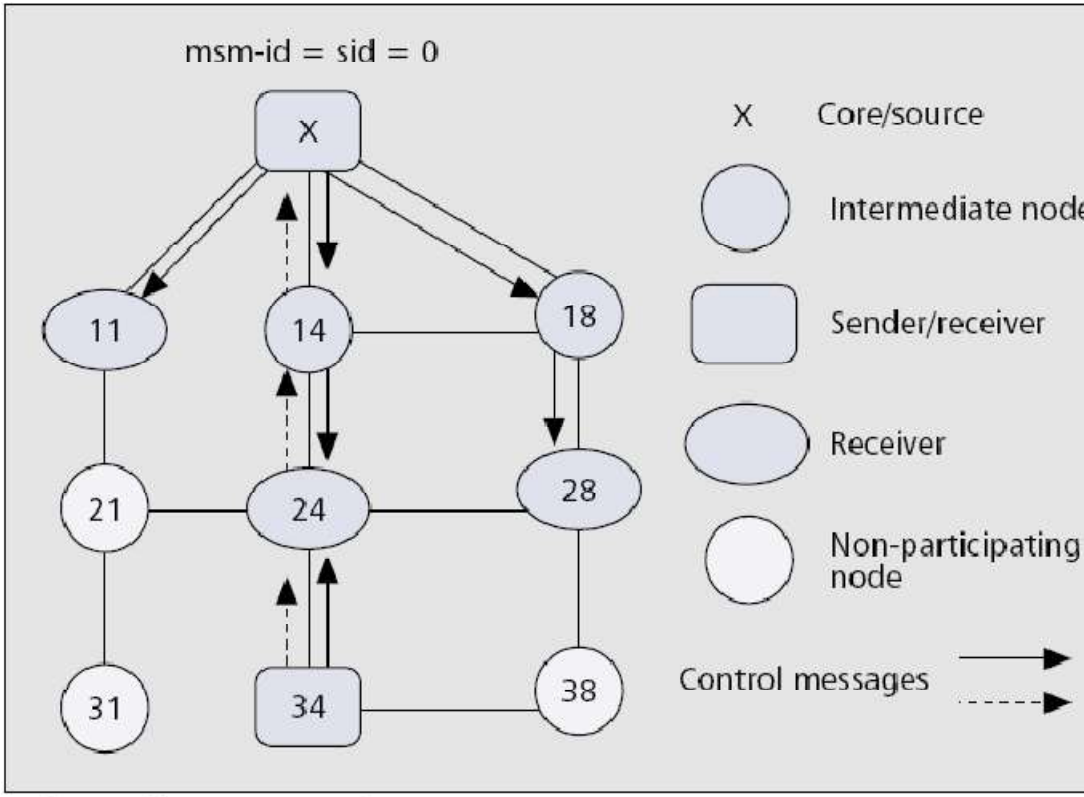


Figure 1. *AMRIS packet forwarding (X and 34 are sources; 11, 24, and 28 are recipients).*

AMRIS: Initialization phase (5)

- Initialization routine recall:
  - Sender: N-S;
  - Inter-node: relay N-S with new msm-id;
  - ……
  - Receiver: reply with J-R;
  - Inter-node: reply with J-A or relay J-R;
  - ……
  - Tree established success / fail

AMRIS: Maintenance phase (1)

- Beacon package
  - Node id;
  - msm-id;
  - membership status;
  - registered parents;
  - child's id and msm-id;
  - partition id;

AMRIS: Maintenance phase (2)

- Beaconing Mechanism
  - Node should broadcast beacon msg periodically;
  - Node should detect neighbors' beacon msg;
    - Node joins: detect beacon msg and perform BR1 and BR2 to join;
    - Node leaves: stop broadcast beacon msg;
    - Link-break: if no beacon msg received then perform BR1 and BR2 to rejoin;

ODMRP

- Things need to know:
  - Multicast Messages:
    - JOIN-QUERY (J-Q);
    - JOIN-REPLY (J-R);

ODMRP: Initialization phase (1)

- Sender actions:
  - Downstream
    - Generate J-Q message;
    - Broadcast J-Q ;
  - Upstream
    - Receive J-R (include the shortest path);

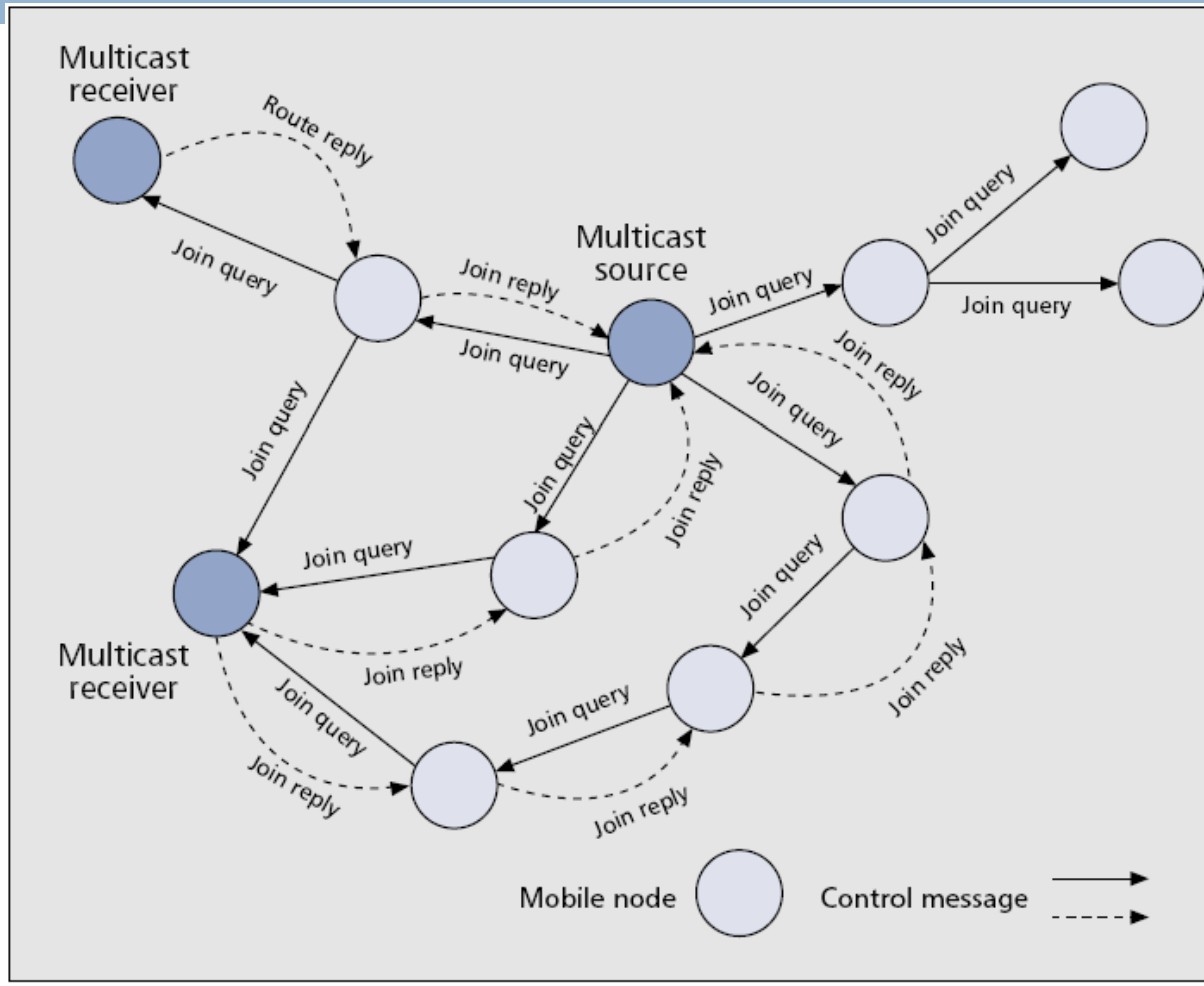


Figure 4. *Mesh creation in ODMRP.*

ODMRP: Initialization phase (2)

- Intermediate node actions: **(Downstream)**
  - Receive J-Q, omit duplicated ones (use cached sequence NO);
  - Store upstream node info;
  - Re-Broadcast J-Q;

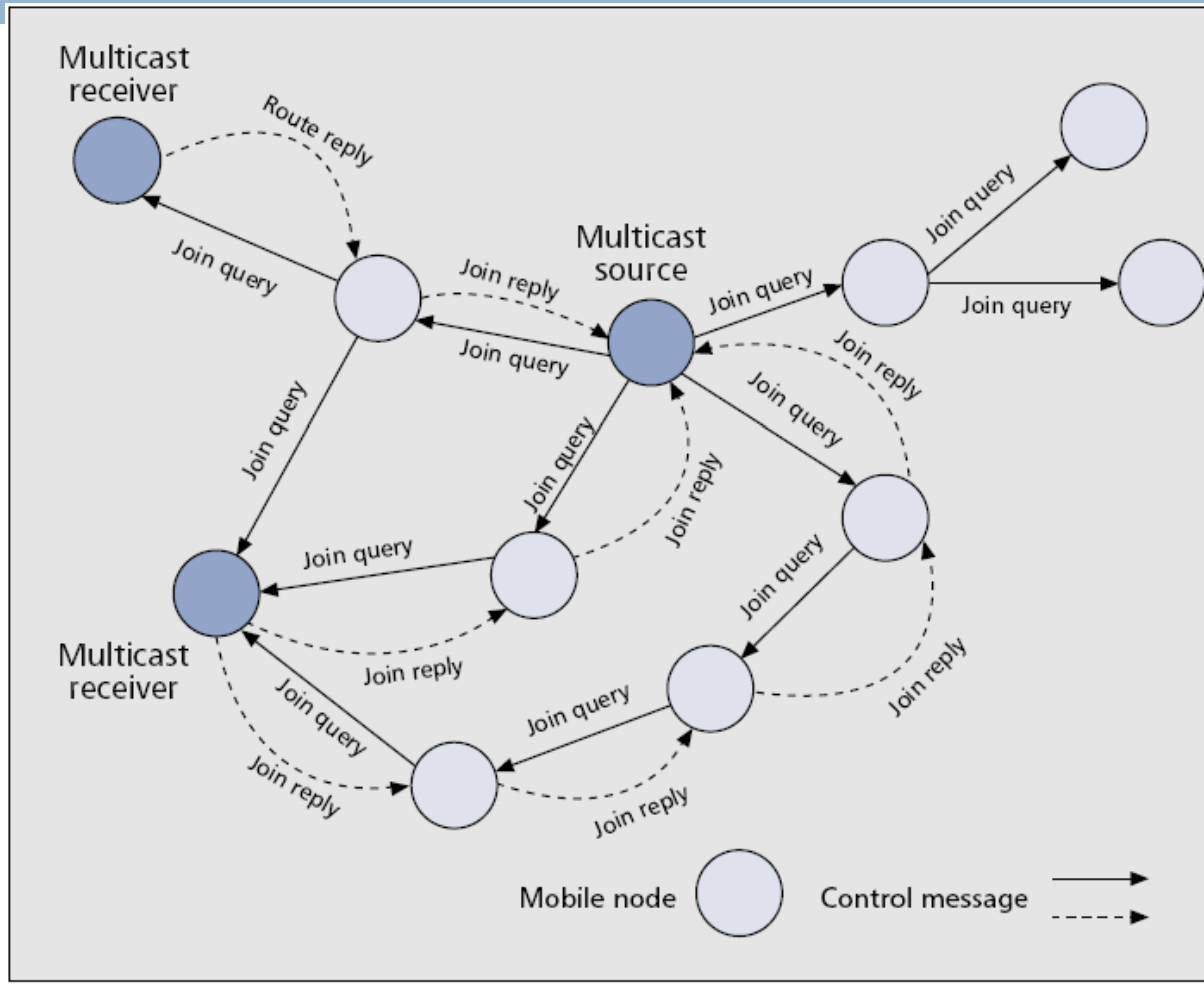


Figure 4. *Mesh creation in ODMRP.*

ODMRP: Initialization phase (3)

- Intermediate node actions: **(Upstream)**
  - Received J-R;
  - If node is on the path
    - Generate new J-R' with node info and broadcast, established!

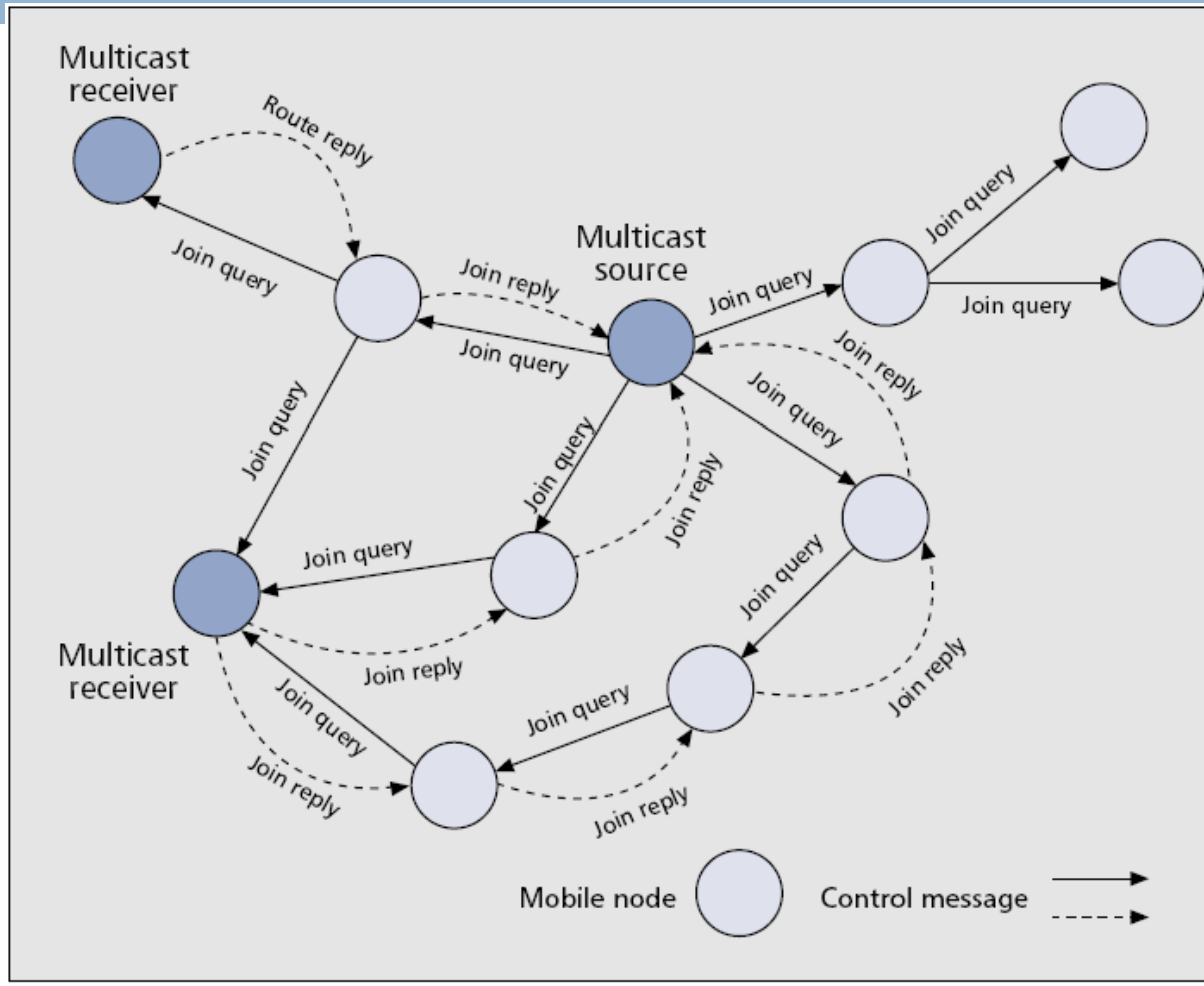
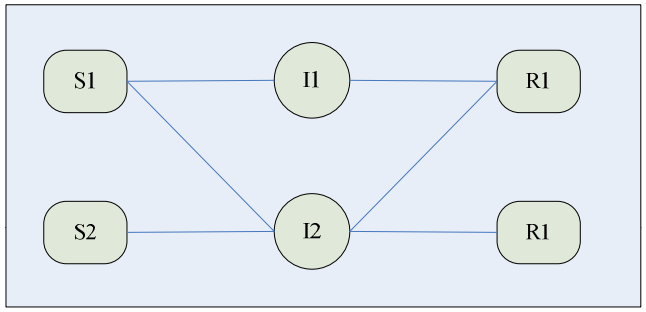


Figure 4. *Mesh creation in ODMRP.*

ODMRP: Initialization phase (4)

- JOIN-REPLY message



J-R of R1

Sender	Next Node
S1	I1
S2	I2

J-R of I1

Sender	Next Node
S1	S1

ODMRP: Initialization phase (5)

- Receiver actions:
  - Downstream
    - Received J-Q;
    - Generate J-R with (path info);
  - Upstream
    - Broadcast J-R;

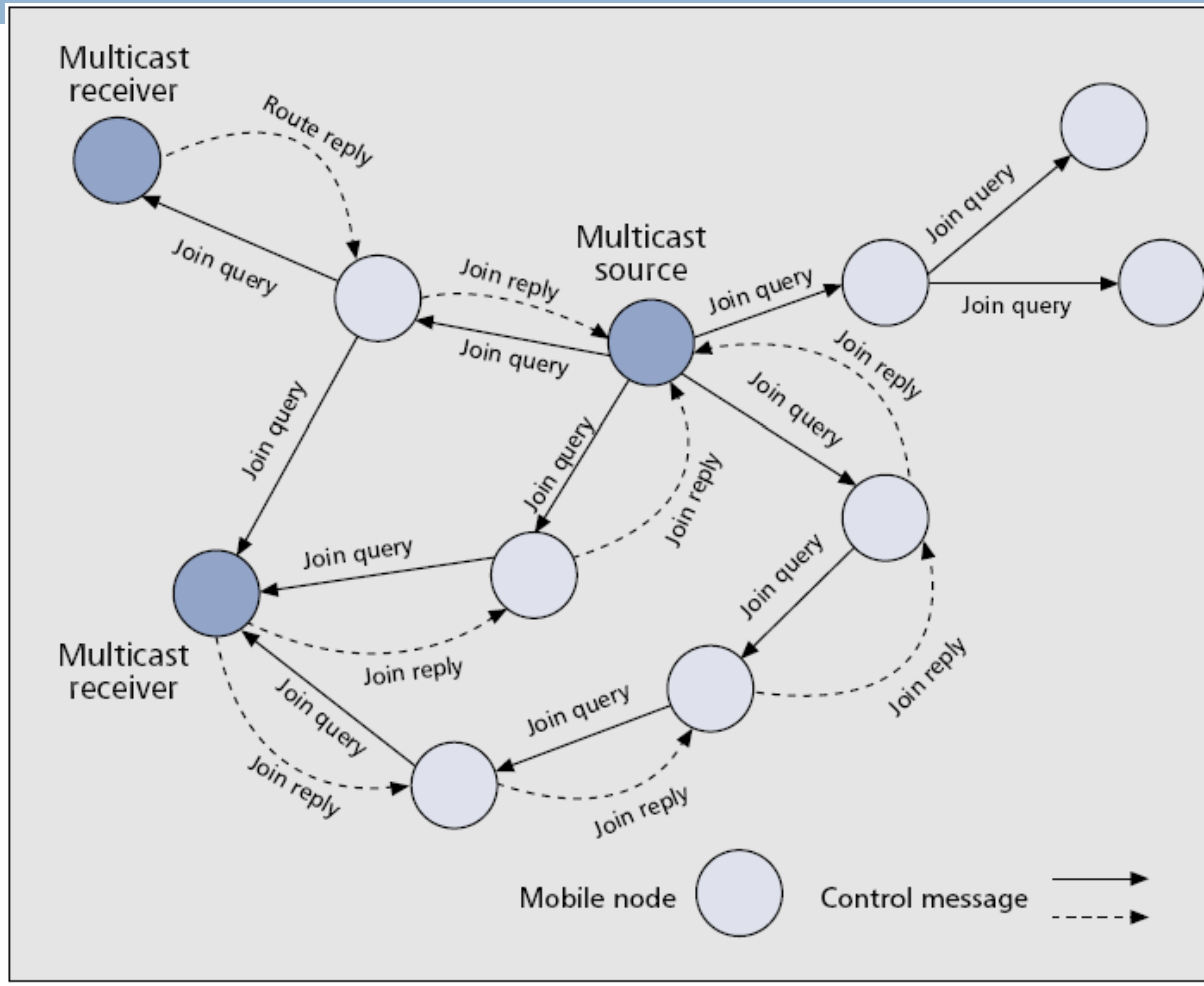


Figure 4. *Mesh creation in ODMRP.*

ODMRP: Maintenance phase

- Soft state approach
  - Sender repeat J-R periodically to maintain;
  - Node joins
    - the same as Initialization phase;
  - Node leaves
    - Sender: stop sending J-Q;
    - Receiver: stop sending J-R;
  - Link-break
    - received new J-Q and reply with J-R;

Algorithm Comparison (1)

	AMRIS	ODMRP
More differences		
Multicast topology	Shared Delivery Tree	Mesh of Nodes
Initialization	Generating msm-id;	Store upstream info;
Maintenance	All nodes periodically send beacon msg	Sender periodically send J-Q msg
Node joins	Detect beacon msg and perform BR;	Detect J-Q and response J-R;
Node leaves	Stop beacon msg;	Stop J-R or J-Q;
Link-break	No more beacon msg and perform BR;	received new J-Q and reply J-R;
More and more differences (message types, routing table info…)		

Algorithm Comparison (2)

	AMRIS and ODMRP
More Similarities	
Mobility support	Yes, based on MANET
Driven mode	On-demand, don not store whole network topology
Broadcast message	Yes
Unicast capabilities	Yes
Periodic message	Yes
Loop free	Yes
More and more similarities …	

Algorithm Improvement (1)

- AMRIS:
  - Sid selection algorithm
    - Problem: core-election type of algorithm;
    - Potential solution: investigate and select a best one;
  - Beacon mechanism
    - Problem: too many beacon messages;
    - Potential solution: Adopt algorithms from CAMP (Core-Assisted Mesh Protocol);

Algorithm Improvement (2)

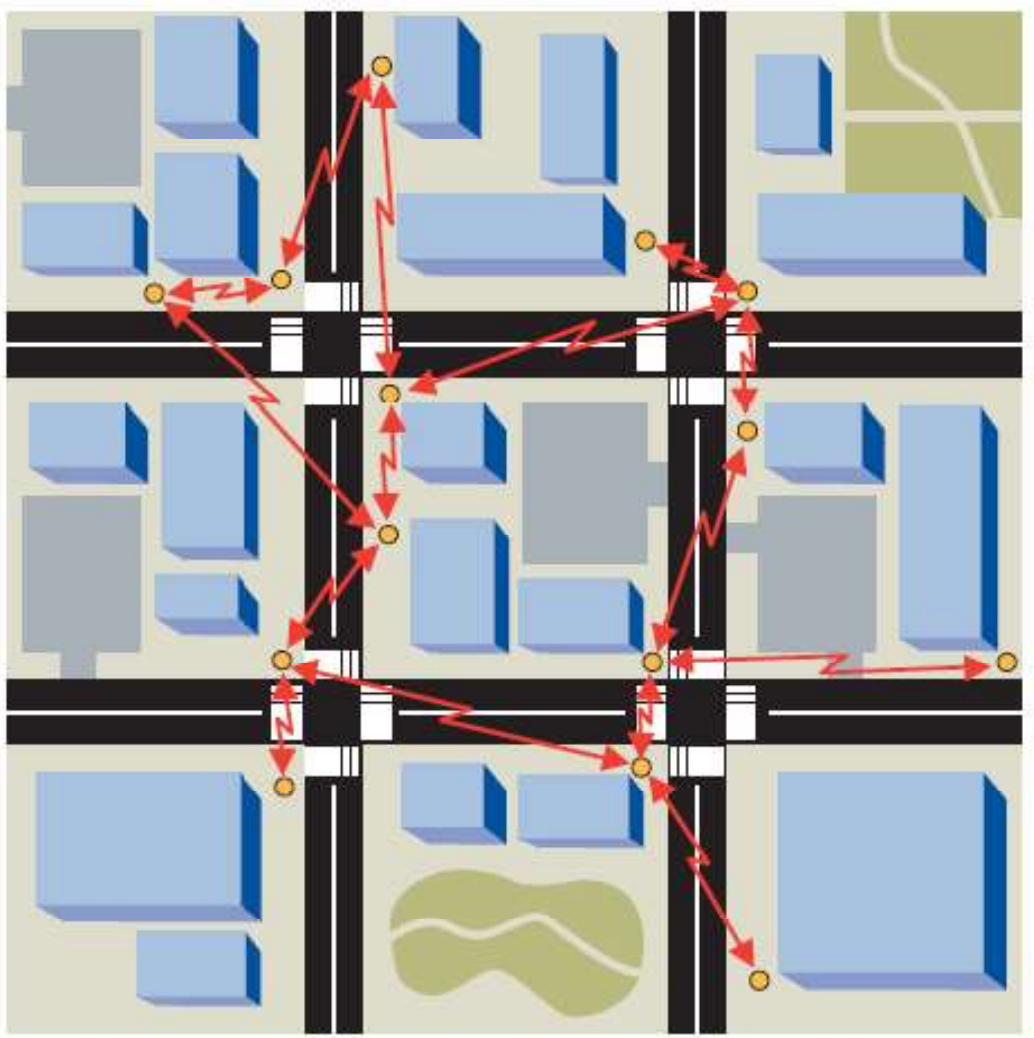
- ODMRP:
  - Overhead in multi-sender scenario
    - Problem: core-election type of algorithm;
    - Potential solution: investigate and select a best one;

Comparison of the AMRIS & ODMRP Protocols

- Initialization
  - Which one is better (under certain circumstances)?
- Maintenance
  - Adaptation to network topology changes
- Performance
  - Packet Delivery Ratio (PDR)
- Overhead
  - # of Control Bytes TXed / Data bytes Delivered

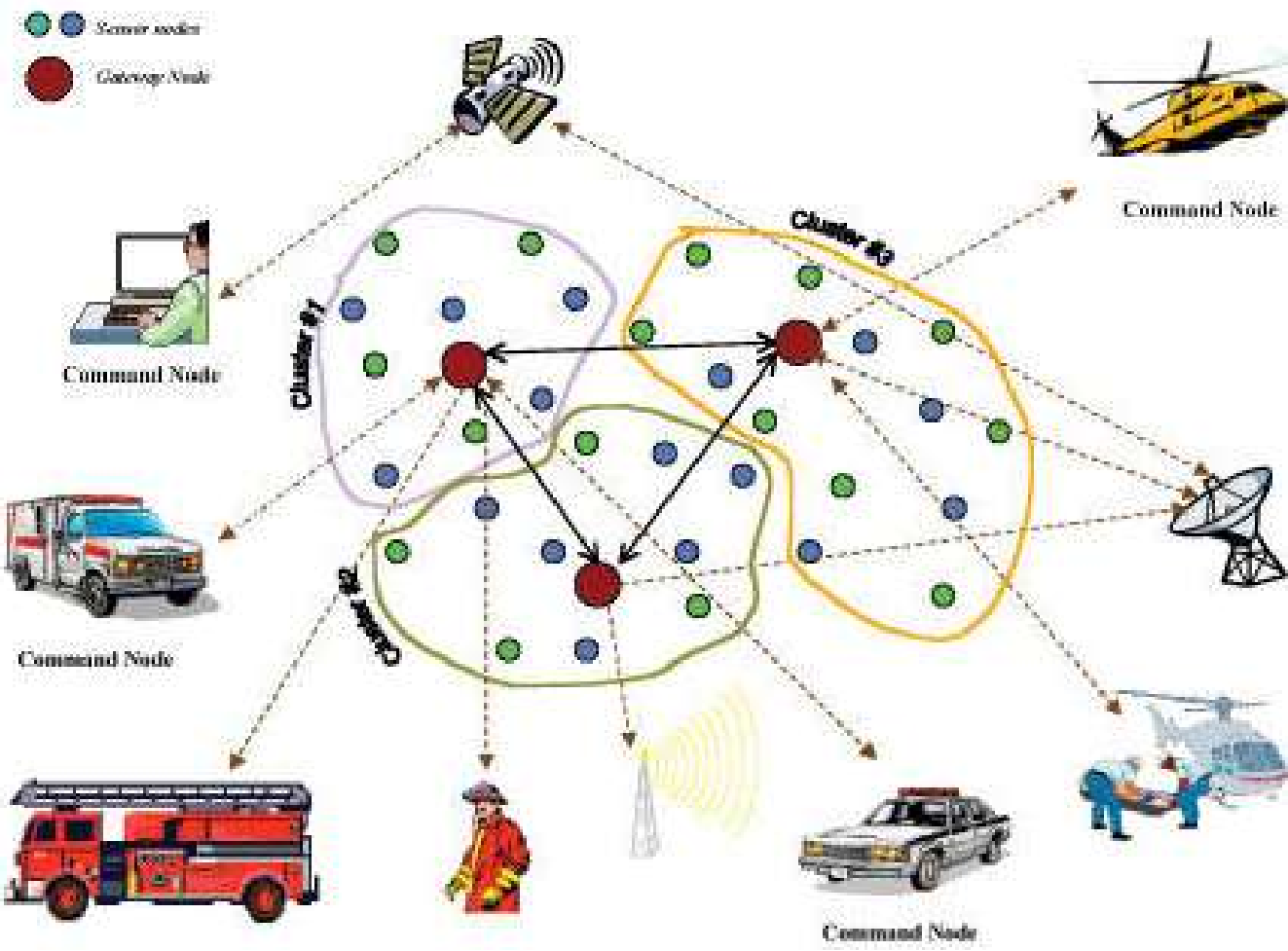
Protocol Applications (1)

- Military
  - Change frequently and unpredictably
  - ODMRP protocol
  - May suffer from excessive control overhead



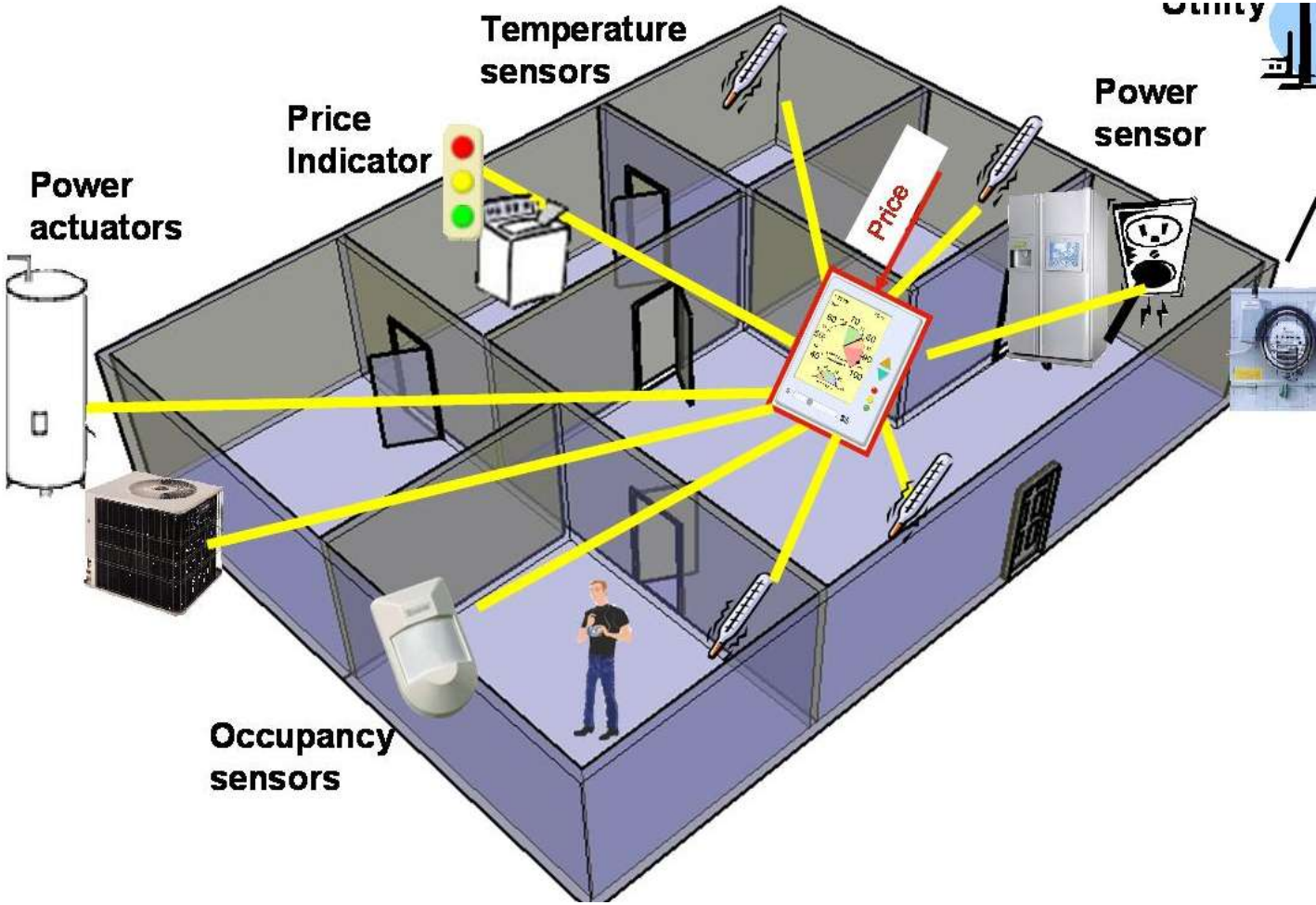
Protocol Applications (2)

- Disaster Recovery
  - Relatively Mobile
  - ODMRP protocol or hybrid protocol



Protocol Applications (3)

- Sensor Network
  - Not move frequently
  - AMRIS protocol



Protocol Applications (3)

- Entertainment
  - No base station or infrastructure
  - Sony PlayStation Portable Ad-hoc networks
    - Allows several PSP users to connect to each other as long as all the users are in broadcast range of each other
    - One unit acts as a host of the game
    - Host reduces battery life by as much as 35%

Conclusion

- AMRIS …
- ODMRP …

Future Reading

- Algorithm Drafts
  - [1] C. W. Wu, Y.C. Tay, and C.-K. Toh, "Ad Hoc Multicast Routing Protocol Utilizing Increasing id-numberS (AMRIS) Functional Specification," Internet draft, Nov. 1998.
  - [2] M. Gerla, S.-J. Lee, and W. Su. "On-Demand Multicast Routing Protocol (ODMRP) for Ad Hoc Networks," Internet draft, draft-ietf-manet-odmrp-02.txt, 2000.
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References

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