# Zone Routing Protocol

## Query Control Mechanisms

Group 6
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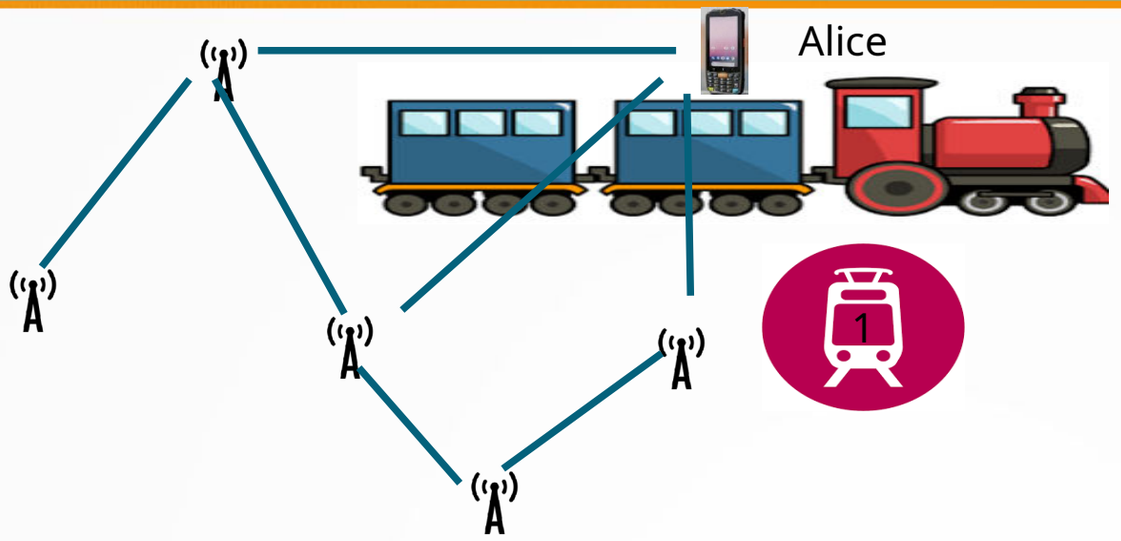
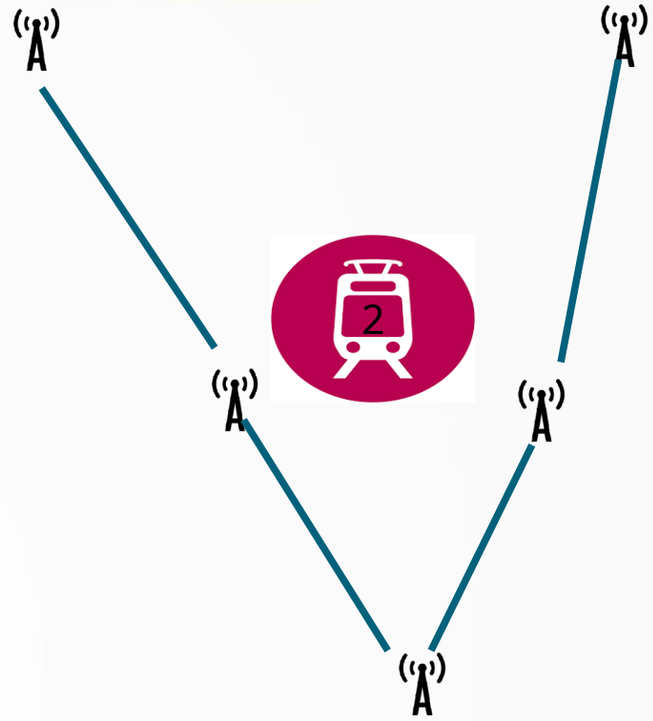
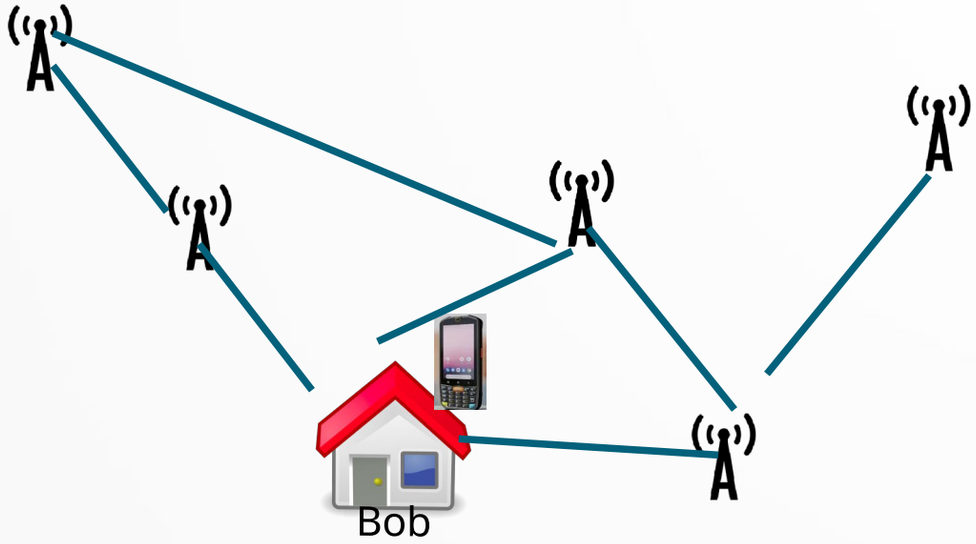
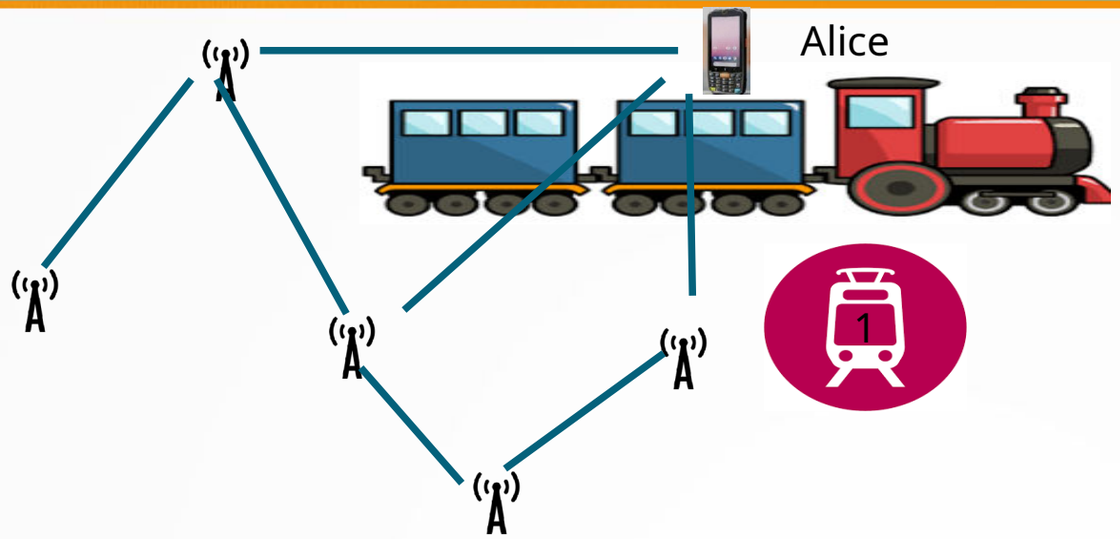
Reading Assignment

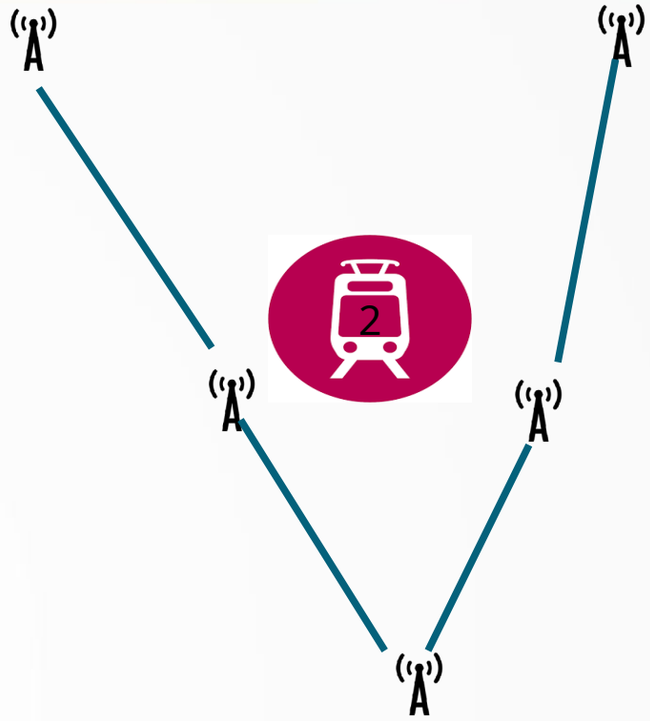


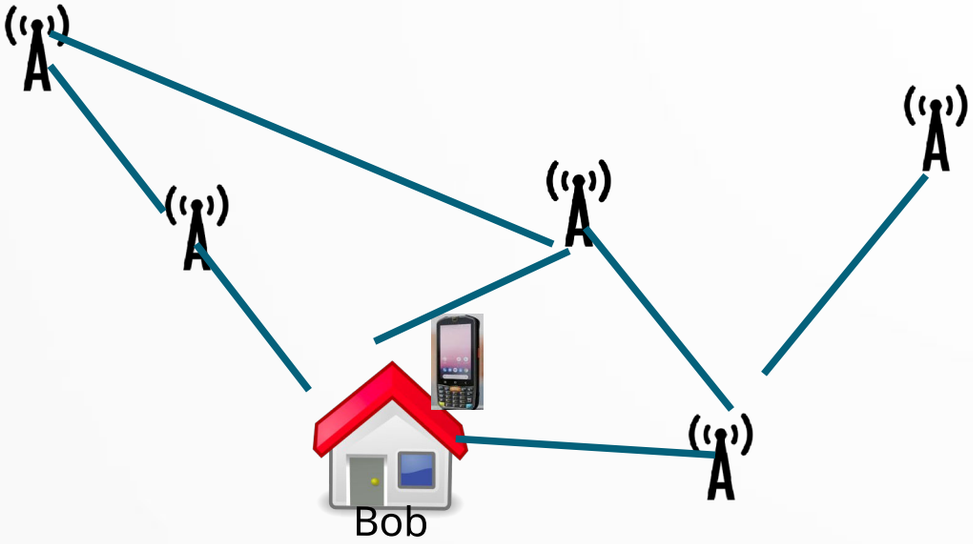




Alice travelling by train
Bob is at home far away
From Alice.

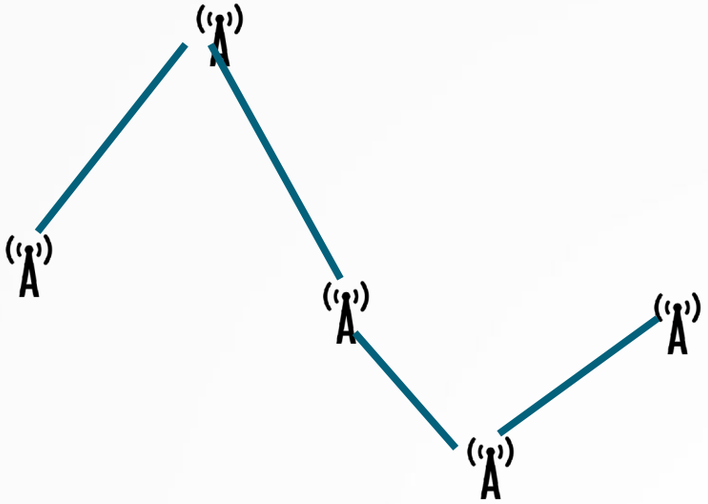


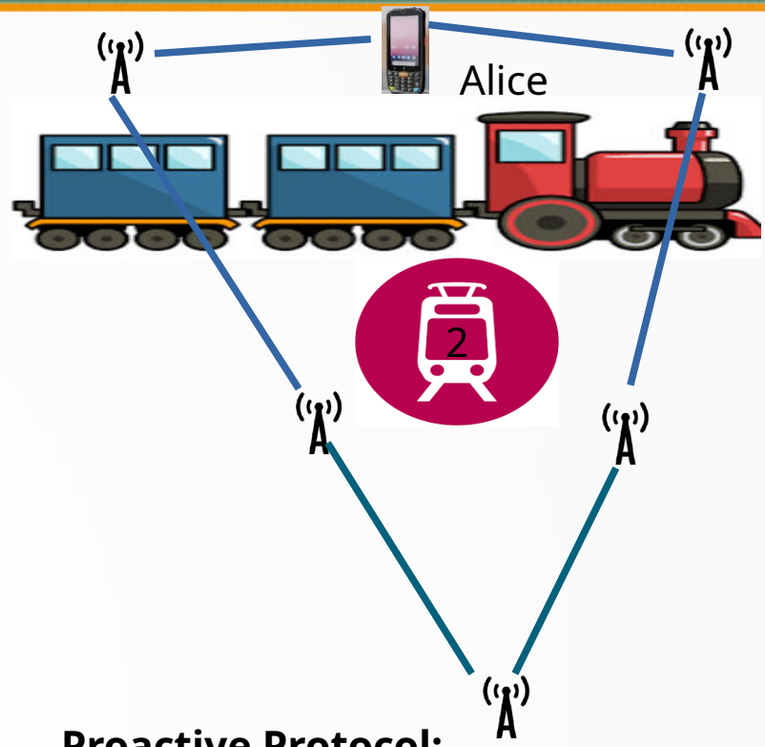



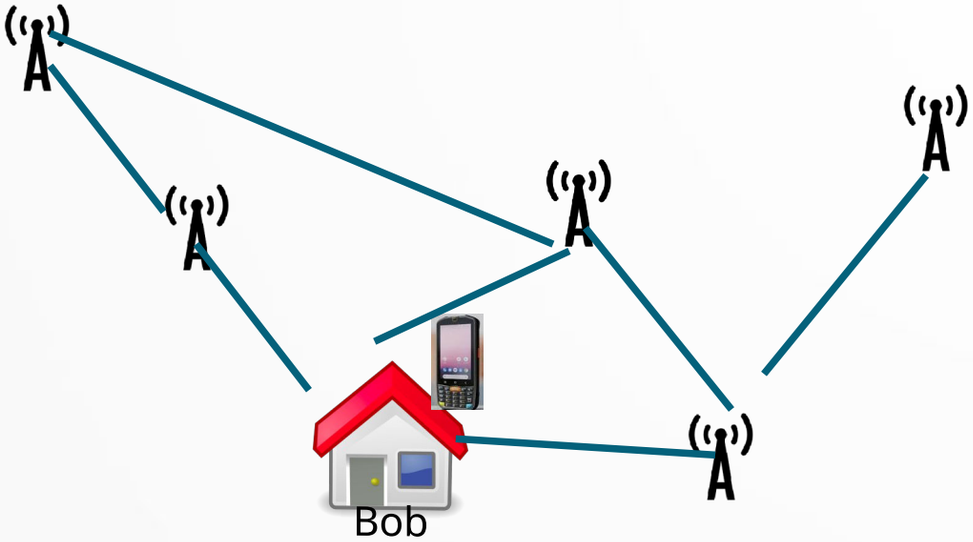




**Proactive Protocol:**
Each node calculting route to each other node in the network periodicaly.

Issue: Alice don’t need to use the Route for some period.

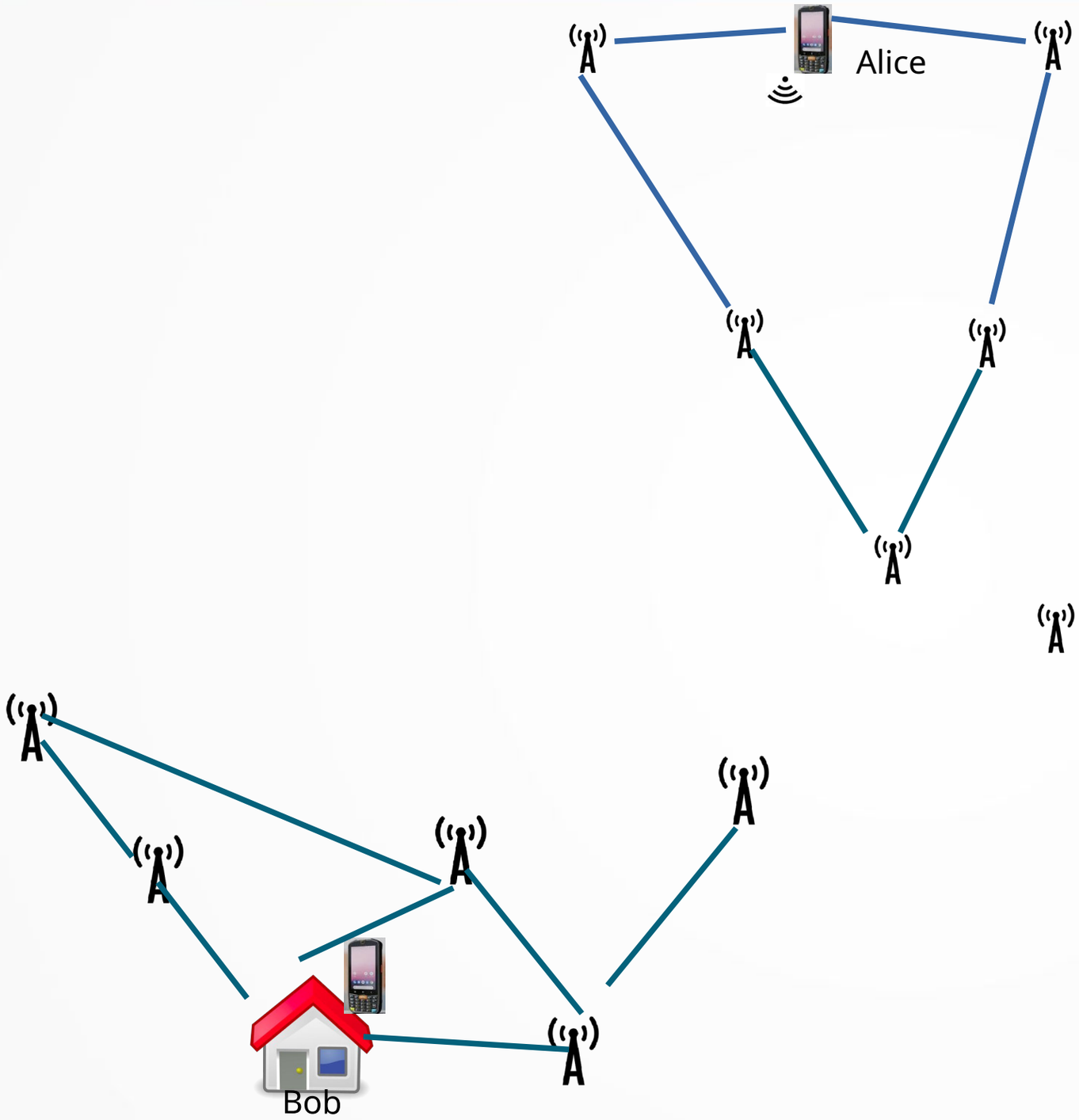



**Proactive Protocol:**
Alice reaches station 2.
The topology of Alice node
Entirely change from previous.

Issue: Bob node is far away from
Alice eventhouigh both of them
Needs to update the routing path



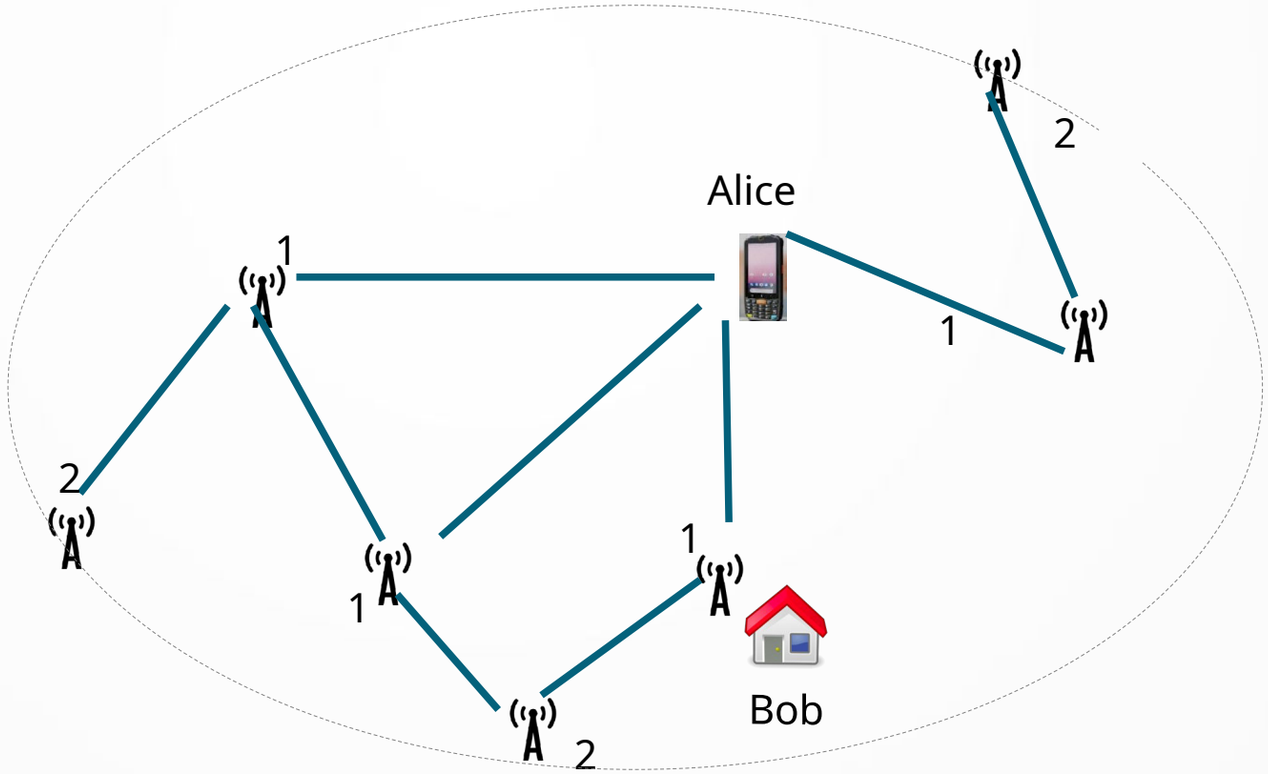

**Reactive Protocol**
This is a ondemand service.
Like Alice wants to send a packet
Then be brodcust his quary to the
entire network.

Issue: Brodcusting uses networking
Resources. Also as the route
Is not availavle it makes time delay.
Another issue is that if Alice needs
To send packet very frequently
Then it make network conjunction.

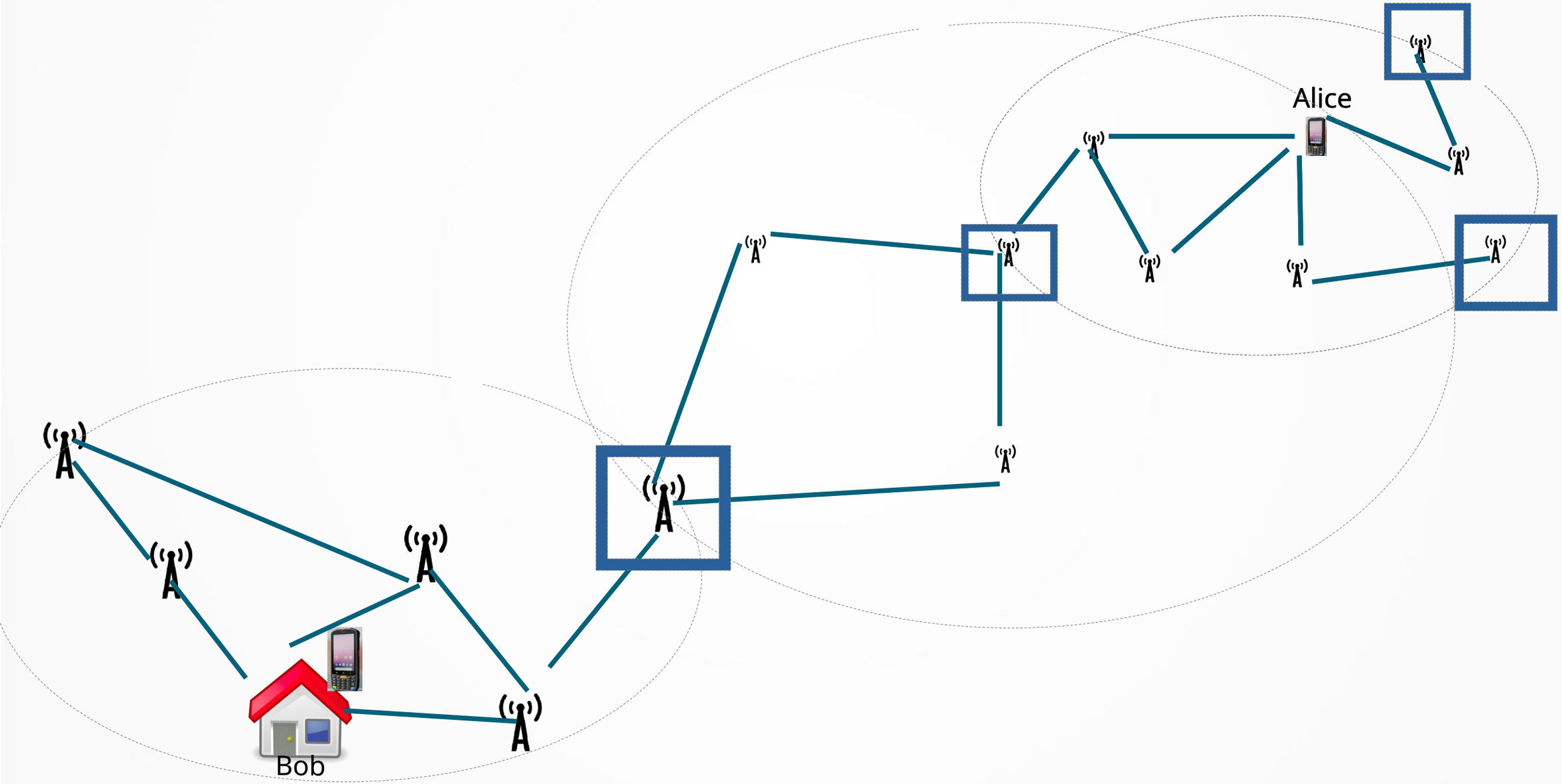
**Zone Route Protocol(ZRP)** is a hybride protocol
By taking both Proactive and Reactive Protocol.

Here we define a radius of a zone according to the Hop distance. Then proactively find route on on the Radius zone. Also use reactive protocol in controlled Manner for out side of the radius(zone).

**In case of destination is in the zone of source**
Here Alice want to send packet to Bob.



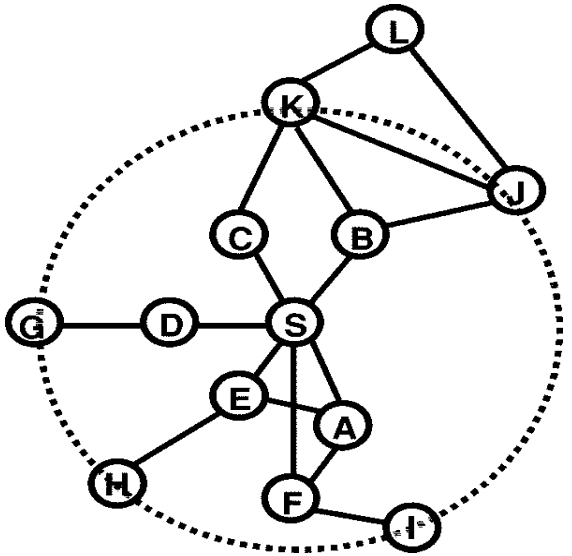
**In case of destination is out side the zone of source**



# ZONE ROUTING PROTOCOL

- A hybrid routing protocol combining both proactive and reactive routing approaches
- Each node maintains a routing zone which is defined by a parameter called the zone radius

  For e.g. zone radius, ρ = 2 hops




- The construction of a routing zone requires a node to know its neighbors. This is done using the Neighbor Discovery protocol (NDP)

- THE PROACTIVE COMPONENT OF ZRP IS THE INTRAZONE ROUTING PROTOCOL (IARP) WHOSE SCOPE IS LIMITED TO THE LOCAL NEIGHBORHOOD OF A NODE

- THE REACTIVE COMPONENT OF ZRP IS THE INTERZONE ROUTING PROTOCOL (IERP)

# INTRAZONE ROUTING PROTOCOL (IARP)

- Maintains routes to nodes within the routing zone
- Proactive Protocol
- Local routes are immediately available for use
- It uses the neighbor discovery information gained using Neighbor Discovery Protocol (NDP)

# INTERZONE ROUTING PROTOCOL (IERP)

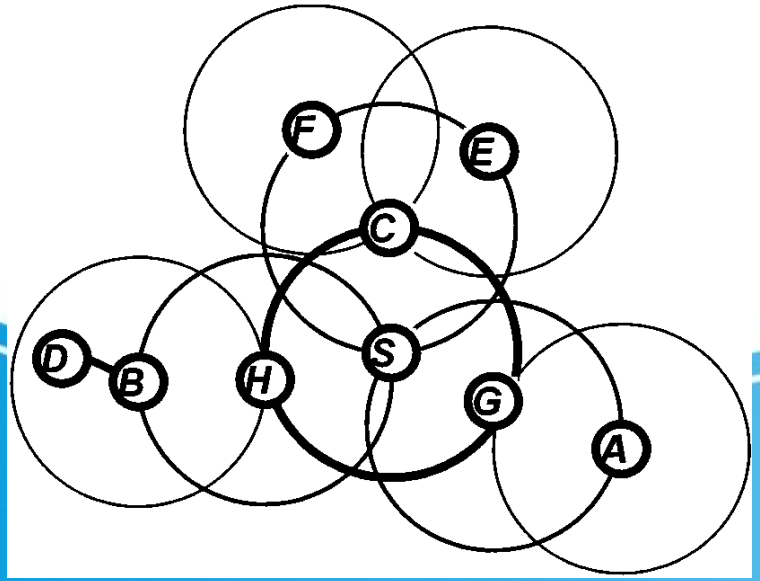
- Discovers routes to nodes outside the routing zone on an on-demand basis
- Reactive Protocol
- Based on query-response exchange
- Different from standard flooding algorithms
- Uses Bordercasting

# BORDERCASTING

- Packet-delivery service provided by the ZRP
- Allows a source node to send messages to its peripheral nodes
- Implemented using Bordercast Resolution Protocol (BRP)
- BRP identifies the nodes that will relay the query

# AN EXAMPLE OF ROUTE DISCOVERY USING IERP MECHANISM

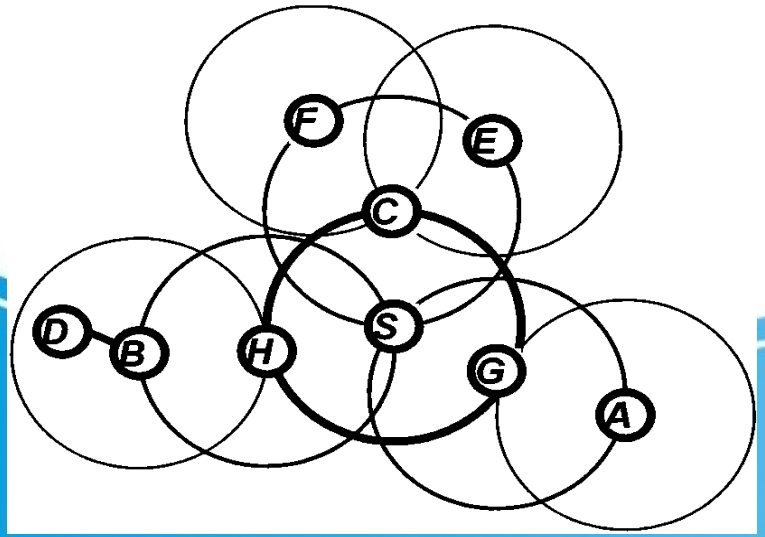
- IERP route query is invoked whenever the data packet is for a destination node (D) that is not in the routing zone of the source
- The source (S) generates a root query packet uniquely identified by {source id, request number}
- The query is bordercast to its peripheral nodes (C,G,H)
- On receiving a route query packet each node adds its ID to it
- The sequence of IDs recorded in this manner specifies an accumulated route from the source to the current routing zone



- These peripheral nodes check if the destination node is in their routing zone. If it is there, then it sends back a route reply to the source along the accumulated route in a reverse manner
- If the destination is not in the routing zone, these peripheral nodes bordercast the query to their peripheral nodes ( For e.g. H sends the query to B)

  This continues until the destination node is found in some routing zone.

Here B recognizes D to be in its routing zone and thus sends a reply which indicates the path S→H→B→D



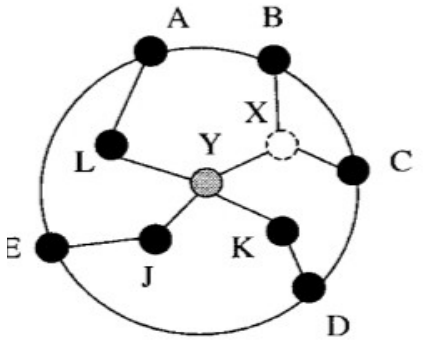

A source may get multiple route responses this way. The best of those can be selected based on parameters such as hop count.

# CONSTRUCTION OF BORDERCAST TREE

- Required for execution of a Bordercast.
- There are two types of approach for constructing Bordercast Tree.

1. **Root directed approach**: Only the root can construct the Bordercast Tree on behalf of all tree members, appending forwarding instructions to root query packet.
2. **Distributed Bordercast approach**: An interior member of Bordercast Tree is able to reconstruct the tree by independent, proactive tracking of the region topology.

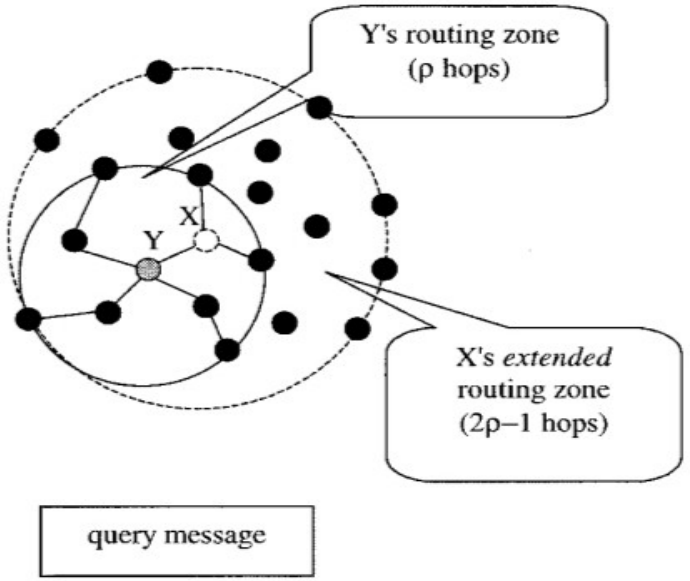
- Let an interior bordercast tree node be situated at most p-1 hops from the root.
  It wants to construct p hop tree, then the node needs to track topology of p+(p-1) = 2p-1 hop extended routing zone.




| query message | |
|---|---|
| Y | X |
| Y | K |
| Y | J |
| Y | L |
| X | B |
| X | C |
| K | D |
| J | E |
| L | A |

*appended bordercast tree map*

(a)




(b)

**(a) describes Root Directed approach.**

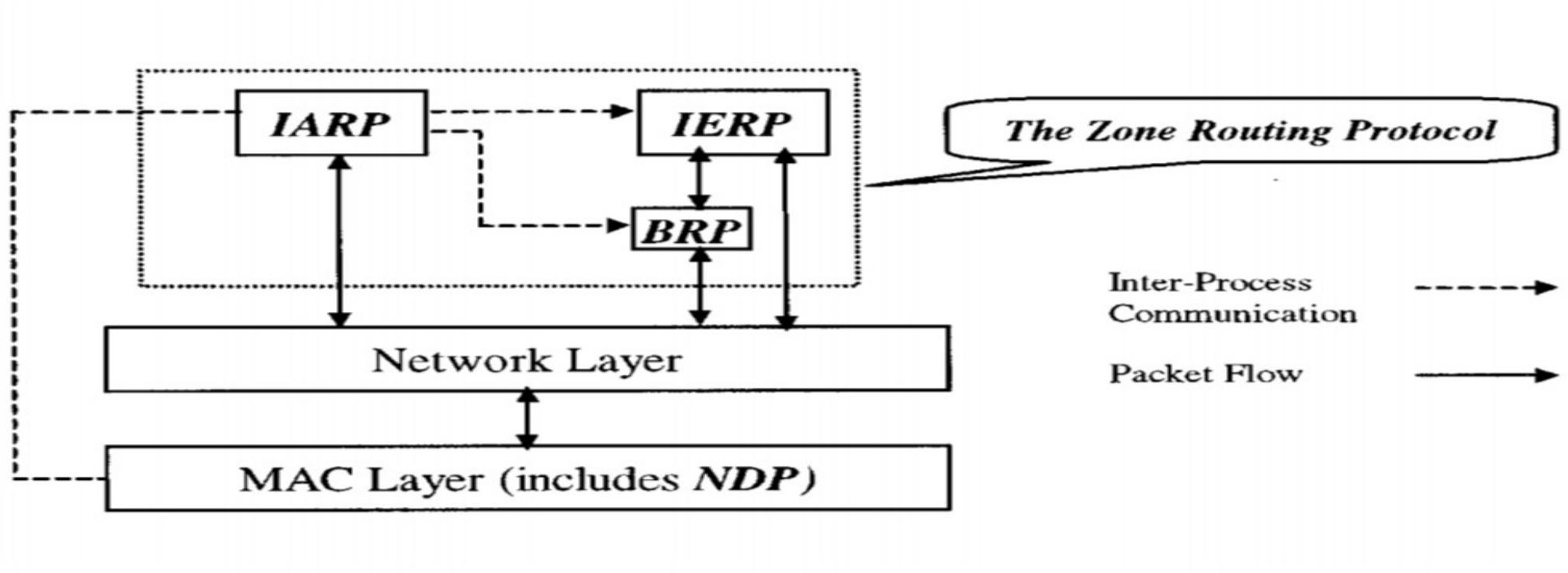
**(b) describes Distributed Bordercast.**

# ZRP ARCHITECTURE

- **IARP** maintain routing zone topology proactively through exchange of root update packets.
  It is notified by an MAC level NDP when a link to a neighbor is established or broken.

- **IERP** acquires routes to nodes beyond routing zone using a query reply mechanism.
  Forwards queries using BRP's bordercast packet delivery system.
  Uses IARP's local routes to respond to incoming route queries. The route response are
  then relayed back to the query source through network layer unicast.

- **ZRP** can be categorized as a **Flat Protocol**.
- Access to a **ZRP** routing zone is provided through the best of the multiple peripheral nodes.
- Communication beyond a routing zone is passed across overlapping routing zones in a peer-to-peer manner.




**ZRP architecture**

# Query Control Mechanisms

- Notice that these queries will have to be forwarded intelligently.
- Else, there could be a flood of queries and this would result in a performance that is worse than flooding.
- What is meant by forwarded intelligently ? They should propagate outward instead of inward.
- ZRP has three schemes for query control.
- Query detection (QD1/QD2), Early Termination(ET), Random Query Processing Delay (RQPD)

# Query detection QD1/QD2

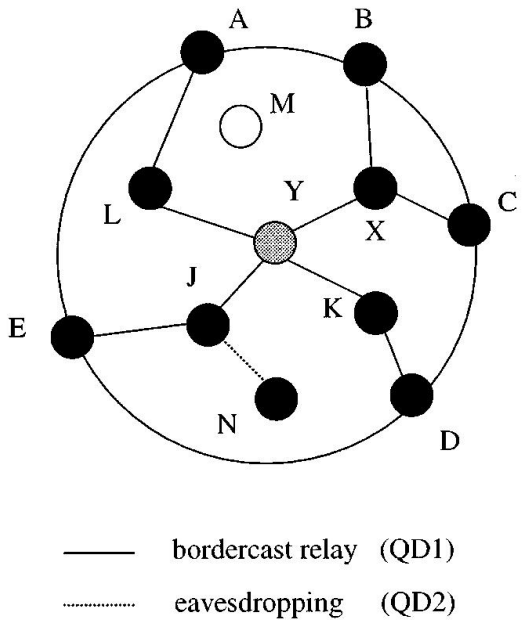


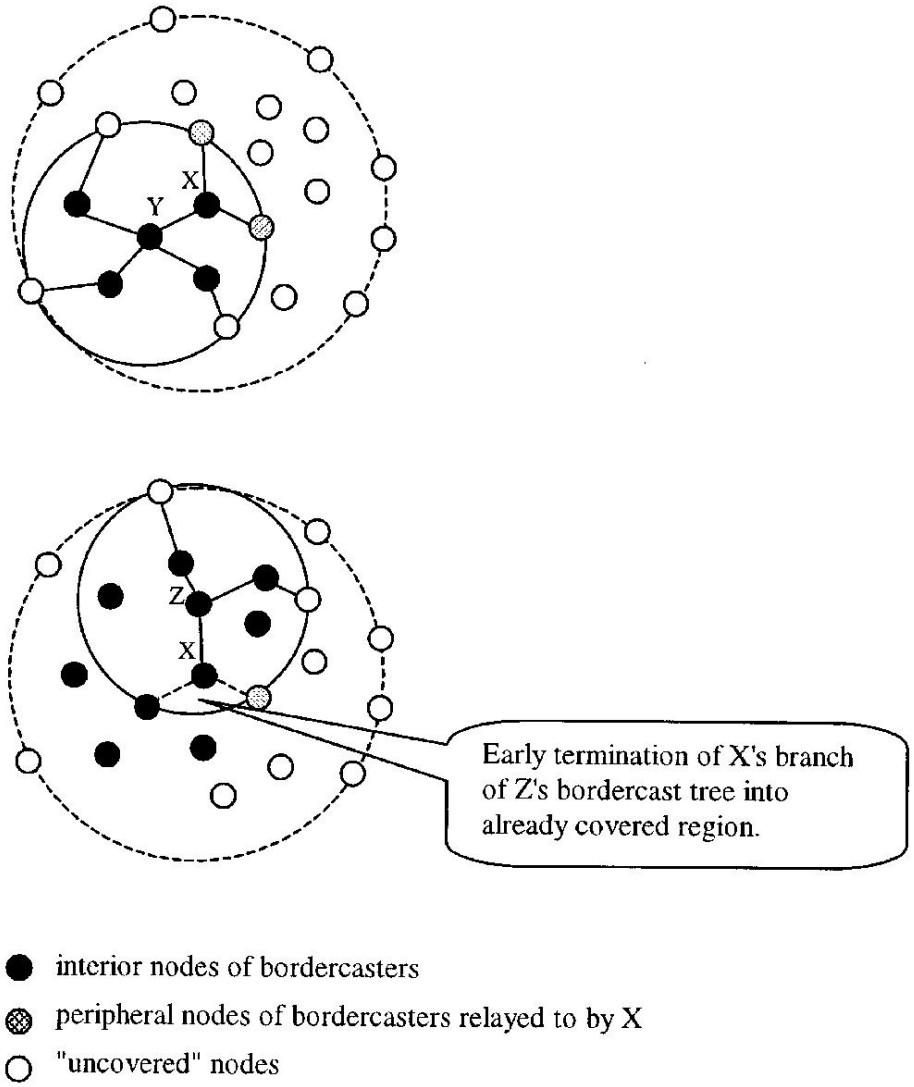

Figure: Query Detection.

- Y bordercasts to peripheral nodes A–E, using BRP, if destination isn't in it's routing zone.
- All relaying nodes in the tree are able to detect the query (QD1), here J,K,L and X.
- If the query message were relayed from any node to other nodes via IP, the query would travel through it's routing zone, undetected by ZRP, but detected by MAC of some node, if it lies inside the transmission range of the node(QD2).
- Here N is eavesdropping J's transmission.
- M doesn't overhear the query.

# Query detection QD1/QD2

- The query detection scheme needs to record the query source node's address and query id in a Query Detection Table.
- Some query control mechanisms may require QD to record additional information contained in the route query packet. Of particular importance is the ID of the node that most recently bordercast the query.
- This information provides valuable insight into the local coverage of the query, which can be used to terminate or prevent redundant queries.

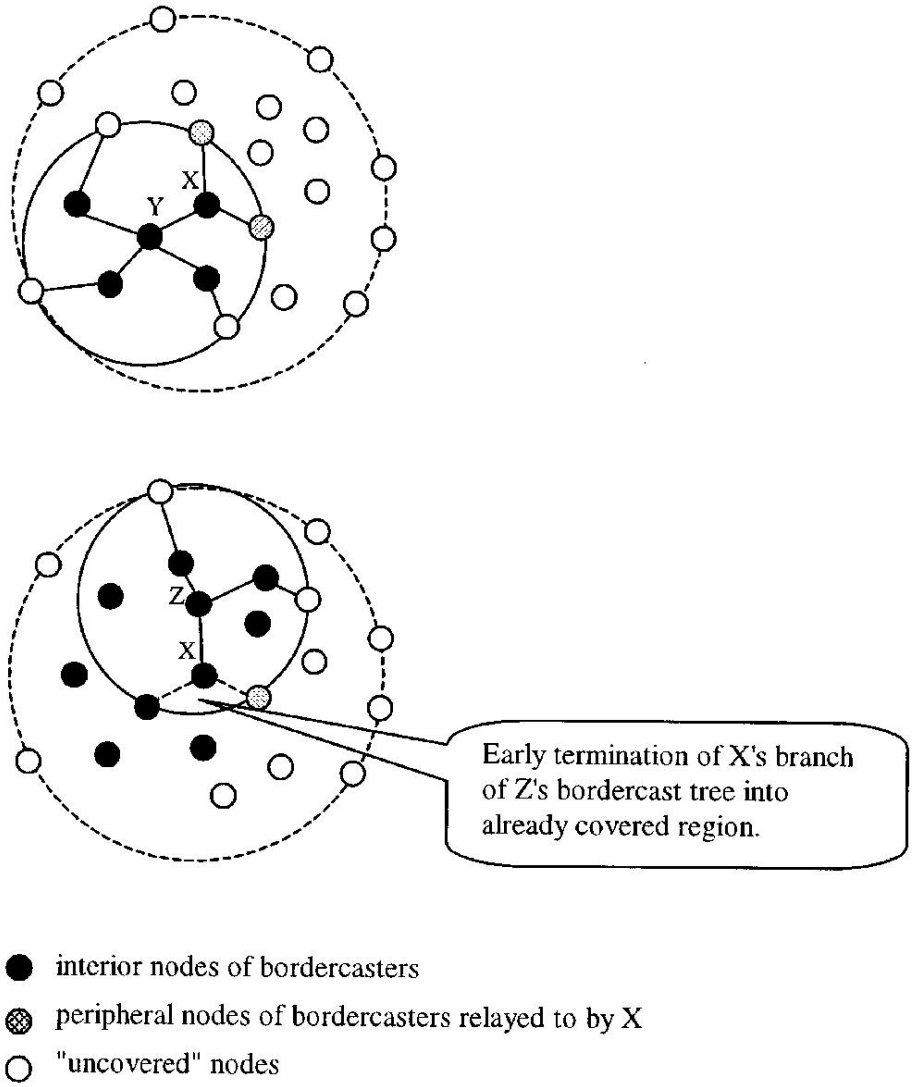
# Early Termination




- Node X first receives a query message to relay for bordercasting node Y.
- X takes advantage of its extended routing zone and QD to identify all of Y's interior routing zone nodes as being covered. X then reconstructs Y's bordercast tree (again, based on the extended routing zone) and relays the query message to two downstream peripheral nodes. These downstream peripheral nodes are also considered by X to be covered.

Figure: Early Termination.

# Early Termination




- X receives a second copy of the query to relay on behalf of bordercasting node Z. Again X identifies the interior nodes of Z's routing zone and reconstructs Z's bordercast tree, X should relay the query to two of Z's peripheral nodes.
- X recognizes that both peripheral nodes have already been covered.So X can prune both peripheral nodes from the bordercast tree and safely discard the query.

Figure: Early Termination.

# Random Query Processing Delay

- Problem of "simultaneous" bordercasts can be addressed by spreading out the bordercasts with a Random Query Processing Delay (RQPD). Specifically, each bordercasting node schedules a random delay prior to bordercast tree construction and ET.
- The waiting node benefits from the opportunity to detect the added query coverage from earlier bordercasting nodes.
- This promotes a more thorough pruning of the bordercast tree (through ET) when it is time for the waiting node to bordercast.

# Random Query Processing Delay(RPQD)

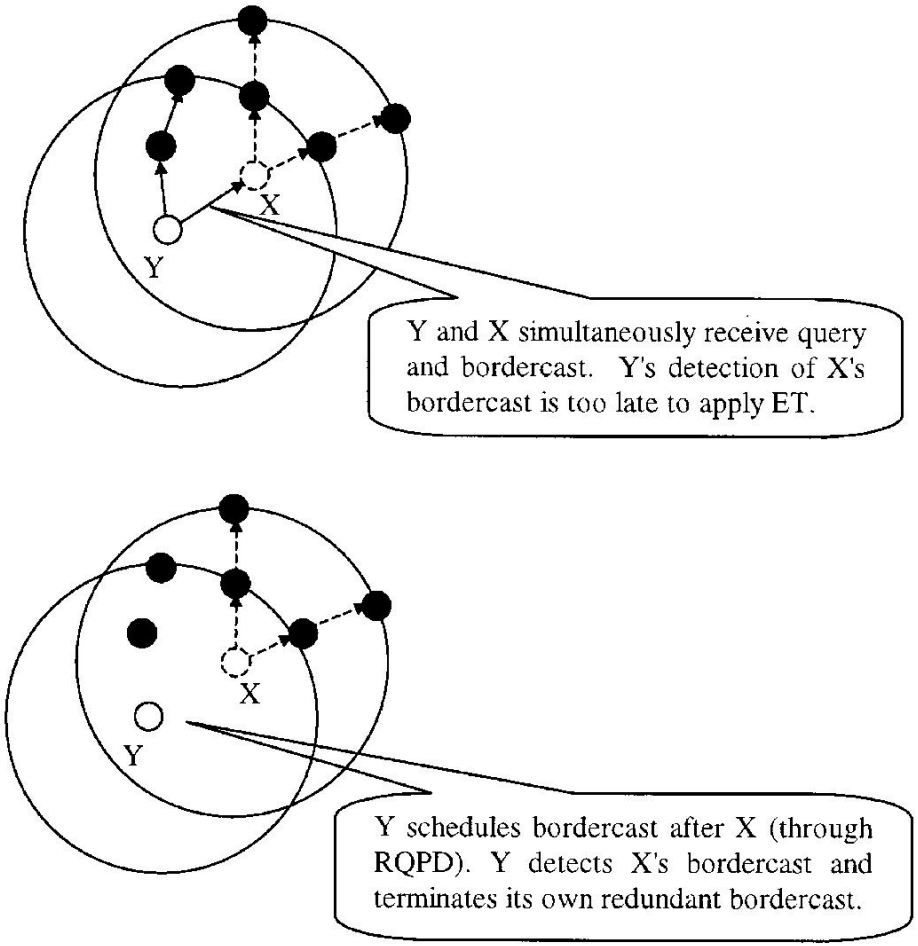



Figure: RPQD.

- Nodes X and Y are peripheral nodes that share a common upstream neighbor in the zone's bordercast tree.
- Assuming neither node is pruned from the bordercast tree through ET, X and Y will receive the route query at approximately the same time.
- Without RQPD, X and Y will both proceed to bordercast the query to their peripheral nodes. Only later will both nodes determine (via QD) that their bordercasts were redundant.

# Random Query Processing Delay(RPQD)

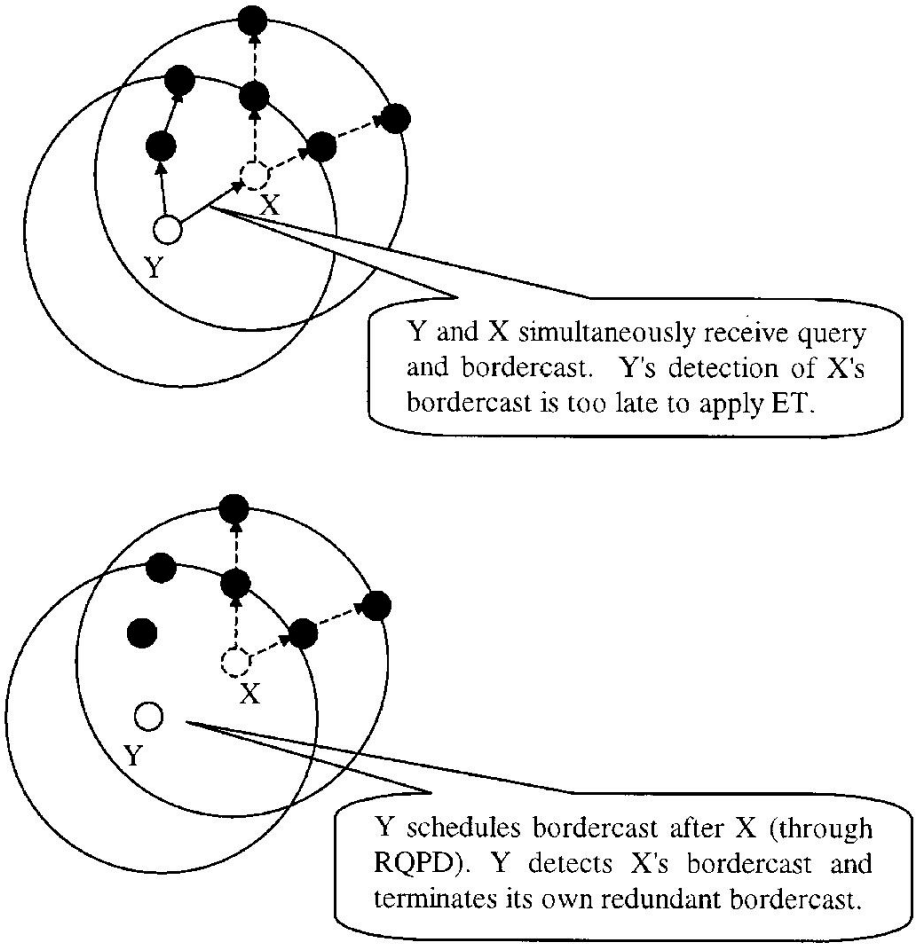



Figure: RPQD.

- However, when RQPD is applied, X and Y each "back off" a random period of time with sufficiently large mean. In this case, X schedules its bordercast far enough in advance of Y, allowing to detect X's bordercast before launching its own.
- X then applies this detected query information to prune its remaining downstream peripheral nodes (since they all lie inside of Y's routing zone).

# CONCLUSION

- ZRP can be used for large networks with topology that changes quite often (Ad hoc mobile networks) since it considerably reduces the traffic as opposed to purely proactive and purely reactive protocols
- Another nice feature of this protocol is that a route discovery process can return multiple routes to the destination, which increases reliability and performance.
- In ZRP, each node maintains a routing zone, so there is considerable overlapping among neighbors. This overlap can lead to Redundant Querying or even repeated querying in loops.
- Using distributed Bordercasting and query control mechanisms such as Query Detection, Early Termination and Random Query Processing Delay, the unnecessary querying and thus the control traffic due to this overlap can be reduced.
- Therefore, ZRP coupled with proper Query Control Techniques is very efficient for Ad hoc networks.

# References

Zygmunt J. Haas, Senior Member, IEEE and Marc R. Pearlman, Member, IEEE. *The Performance of Query Control Schemes for the Zone Routing Protocol* . *IEEE/ACM TRANSACTIONS ON NETWORKING, VOL. 9, NO. 4, AUGUST 2001 (427 - 438).*

# THANK YOU


## GROUP 6

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