18748 – Wireless Sensor Networks

Lab Assignment III

Team No. 15

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TASK:

To build a multi hop mesh network consisting of 1 gateway and 3 peers.

CONSTRAINTS:

- Update rates of at-least once every 30 seconds.
- Sensor sampling rates and network update rates to be configurable from the gateway.
- Neighbor list creation at run-time.
- Availability of neighbor list at the gateway.
- Routing between peers and gateway **must** be routed.
- Routing between other combinations of nodes is optional.
- Optimization of a performance metric from the following relevant to the course project:
    - Throughput
    - Low latency
    - Reliability
    - Energy
    - Mobility

DESIGN:

The given problem statement can be implemented using two broad methodologies / approaches. The divide of control between the base station and the peers influence the efficiency of the network in terms of data loss, routing of nodes, energy constraints, etc. The following section describes the two approaches briefly.

<u>Approach 1 – Active Peers:</u>

The sequence of message exchange takes place as follows:

- The peers broadcast a message requesting all the nodes present in its range to reply with their MAC address. On receiving this, the peer compiles a neighboring list along with its MAC address and broadcasts it again, now with a recipient address as that of the gateway.
- Every peer, on receiving this, broadcasts it again until the gateway receives the message and in turn broadcasts the routing information.
- Once all the peers receive the routing table, subsequent messages are sent to the node indicated in the routing table.

- The peers are said to be active as they are responsible to send their routing information periodically without the gateway requesting for it.

Positives of this approach:

- Peers do not send the neighbor list at the same time, therefore reducing the network traffic.
- Computation of neighbor lists happen more efficiently.

Negatives of this approach:

- At the time of a change in the topology, it becomes difficult for the gateway to trigger the change in the previous routing information i.e., discarding of routes that aren't present in the current routing table.
- Network update rate is not predictable as updating the sampling and network update rates are difficult.
- Becomes difficult when expanding the network as the latency increases.

Variations in this approach:

- On routing data from one peer to another, the debate on whether to send immediate acknowledgements between the nodes versus an open broadcast acknowledgement from the gateway arises.
- In the former, control is transferred locally between the peers; however, the latter continues to keep the control with the gateway. On the other hand, there is more coordination in the former as compared to the latter.
- With the former, there is an accumulated delay when the message finally reaches the gateway.

<u>Approach 2 – Active Gateway:</u>

The sequence of message exchange in this approach is as follows:

- The discovery of the neighbors takes place in a similar manner as mentioned above i.e., every peer broadcasts a message with its MAC address and all the nodes that receive this message reply with their MAC address appended.
- Communicating the message list however happens in a slightly different manner. The gateway sends a neighbor list request to the peers, which then respond by sending their list as an acknowledgment.
- In return, the gateway responds with the updated routing table.
- By this way, there is a stronger control over the network update rate as the gateway decides when to receive the neighbor list and update the routing table.
- When sending data, the peers follow the route as mentioned or directed by in the routing table.

Positives of this approach:

- Sharp control over the network rate is established.
- Change in the routing table/information happens more easily when there is a change in topology or a node going down.

Negatives of this approach:

- There is an increased packet loss as compared to the previously discussed architecture as all peers transmit their neighbor list multiple times (this is done to prevent loss of essential data from reaching the gateway).

LESSONS LEARNT:

- One of the important lessons learnt was setting the period of the receiving task to 100ms. Since the receiver of the BMAC checks for messages every 100ms, setting the same period for the receiving task tends to optimize the calculations.
- Writing down multiple approaches on paper before reaching the implementation stage tends to clear out possible problems that can be faced.

IMPLEMENTATION DETAILS:

- The approach implemented for submission was approach 2, as this would help us with the basics of the course project. Some of the parameters optimized have been:

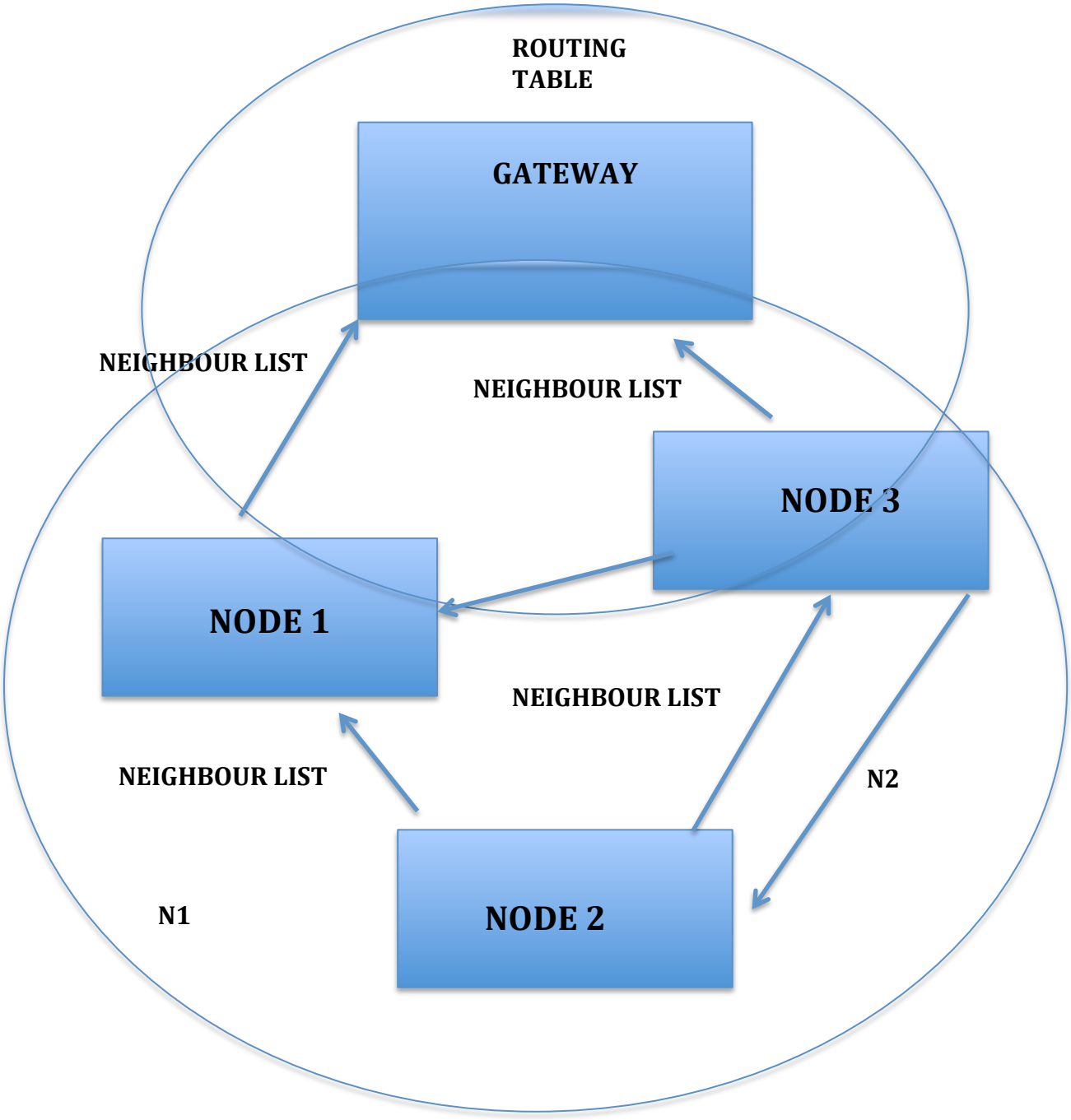
  - Throughput:

    Since the message exchange is coordinated from the gateway, every message has a specific purpose and hence the number of bits packed into the message is reduced. But the frequency of these messages are more, therefore the throughput is increased.
  - Low Latency:

    Since the peers do not follow a concept of providing intermediate acknowledgements to packets received from other peers, but only a global acknowledgement from the gateway, the time taken for the data packet to travel from the peer to the gateway is reduced. On future expansion of the network, the latency difference is considerable.
  - Mobility:

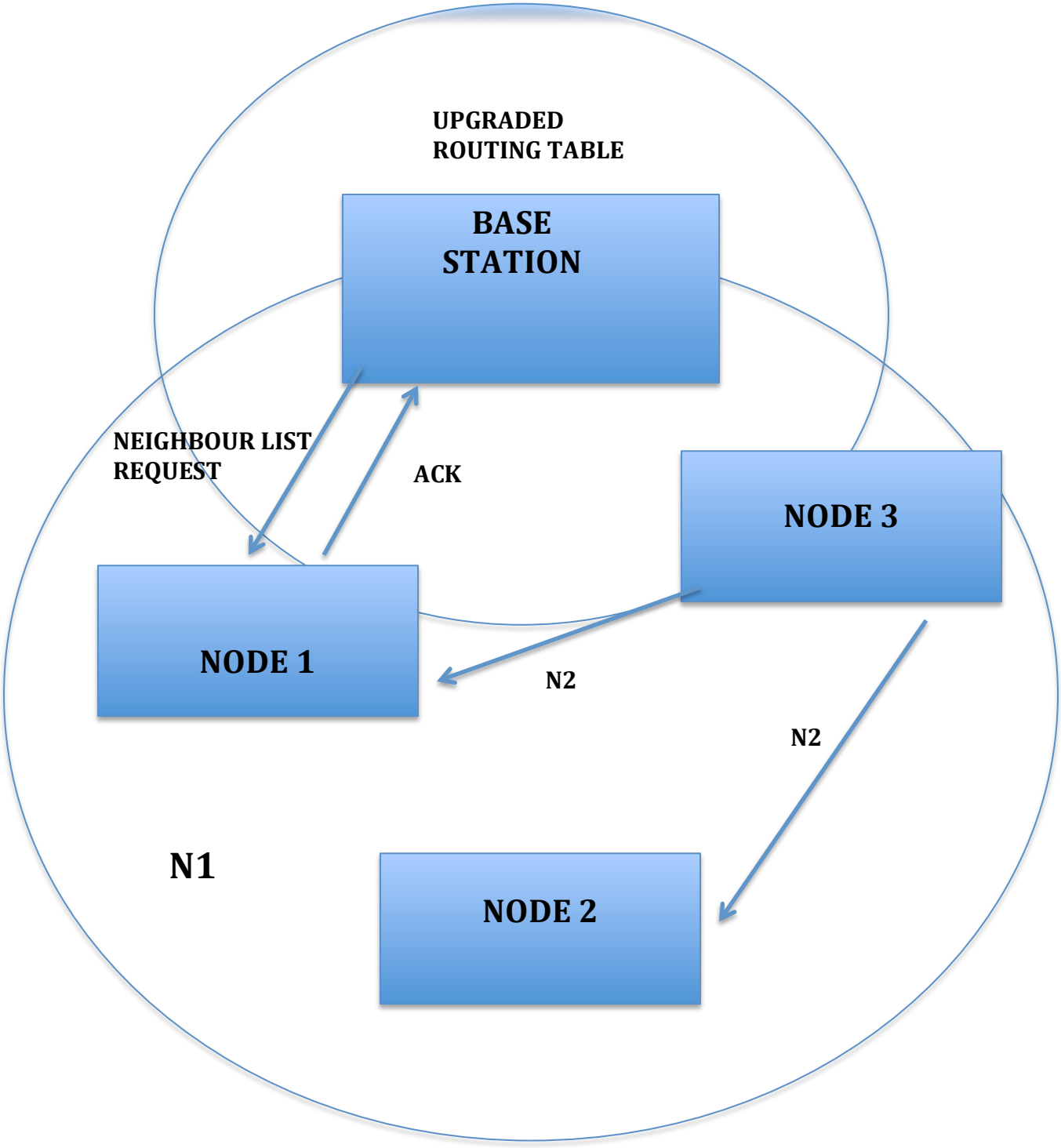
    With an improved method of receiving the neighbor lists from the peers in the second approach, there is greater mobility established. However, there is a compromise on the energy aspect. This is a potential area of improvement when moving on to the project.

Approach 1:



N1: CHECK FOR NODES IN NEIGHBOURHOOD
N2: SENDS MAC ADDRESS

Approach 2:



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