# Fisheye State Routing (FSR): Protocol and OMNeT++ Implementation

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CENG513 - Wireless Communication and Networks

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# Outline

1. FSR Protocol Overview
2. OMNeT++ Implementation & Results

# Introduction to FSR

- **Proactive, link-state protocol** for ad hoc networks
- **Multi-level fisheye scopes** to balance detail vs. overhead
- Maintains full network topology at each node

# Network Model & Data Structures

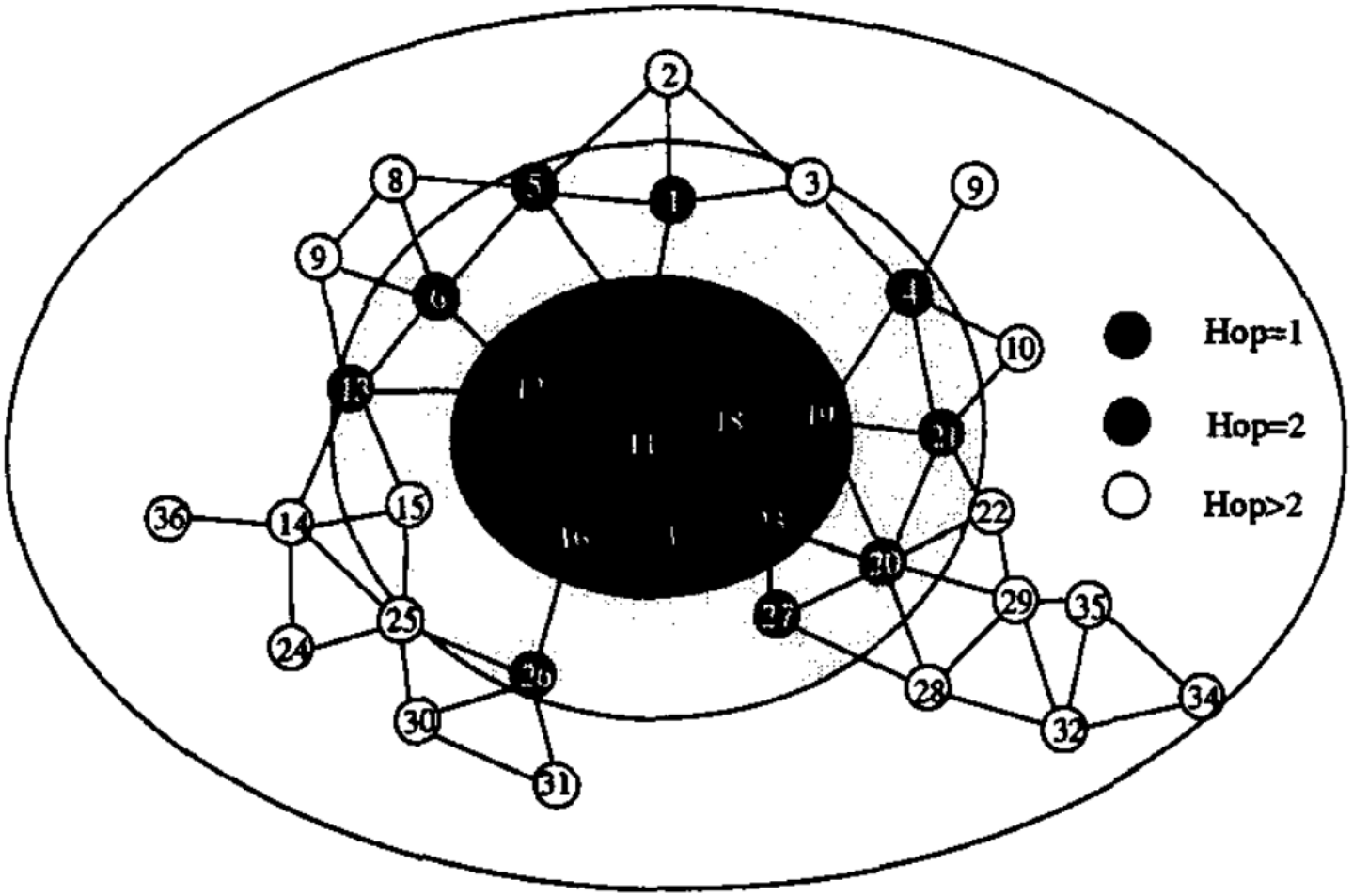
- **Neighbor List** $A_i$: one-hop neighbors
- **Topology Table** $\mathrm{TT}_i$: $(\mathrm{LS}(j), \mathrm{SEQ}(j))$

| Destination | Scope | Next Hop | Distance | Last Update (s) |
|---|---|---|---|---|
| B | 1-hop | B | 1 | 1.0 |
| C | 2-hop | B | 2 | 3.5 |
| D | >2-hop | C | 2 | 8.0 |
| E | >2-hop | C | 3 | 9.5 |

- **Next Hop Table** $\mathrm{NEXT}_i$ and **Distance Table** $\mathrm{D}_i$
- *Min-hop* paths (link weight $= 1$)

# Fisheye Scopes

- **Scope levels**: define concentric hop-radius zones
- **High update frequency** for near nodes, **low** for distant
- Example: 1-hop (black), 2-hop (gray), $>$ 2-hop (white)



# Advertisement Table Example

## Link State Advertisement Table at Node 11

| Destination | Next Hop | Seq. No. | Scope Level |
|---|---|---|---|
| 1 (1-hop) | 1 | 15 | 1 |
| 2 (2-hop) | 3 | 14 | 2 |
| 5 ($>$ 2-hop) | 4 | 10 | 3 |

- Entries with Scope $= 1$ updated every $\Delta_1$ s
- Scope $= 2$ every $\Delta_2$ s, Scope $= 3$ every $\Delta_3$ s

# Advantages of FSR

- **Reduced overhead**: up to 80% control load saved with 3 scopes
- **Low latency**: routes ready in background
- **Scalability**: overhead grows slowly with network size
- **Mobility resilience**: accuracy increases as packet nears destination

# Simulation Environment

- **OMNeT++ v6.1** with **INET 4.5.4**
- **FSR** module is added to the src/inet/routing
- Network size, mobility of the nodes, network connectivity and link capacity experiments
- Each simulation run 30 times. Results show the averages.

# FSR Module Design

- `FSR.ned`: simple module parameters
- `FSR.cc/.h`: maintain tables, schedule timers, broadcast LSAs
- `FsrPacket.msg`: Defines the FSR link state advertisement messages
- `FsrNode.ned`: Defines the FSR nodes

# Simulation Setup

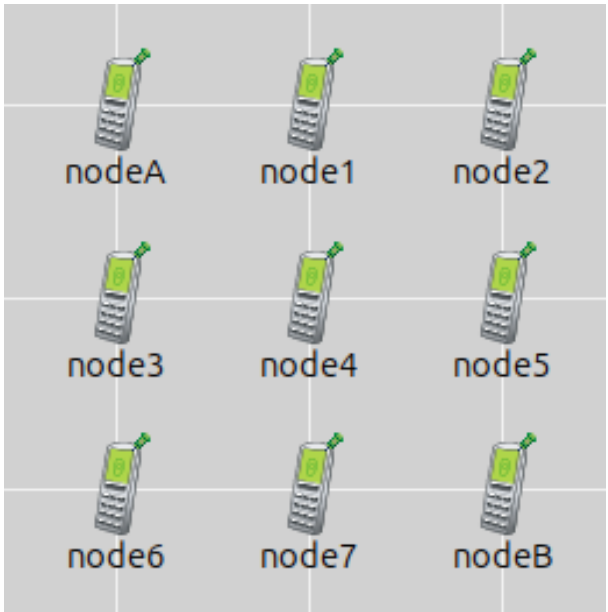
- **Network Size**: Nodes are configured in square topology (4, 9, ..., 81, 100 nodes).
- **Mobility**: Intermediate nodes move upwards with varying speed.
- **Network Connectivity**: Average degree of the nodes increased step by step.
- **Link Capacity**: Capacity of the link increased step by step.

# Measured Metrics

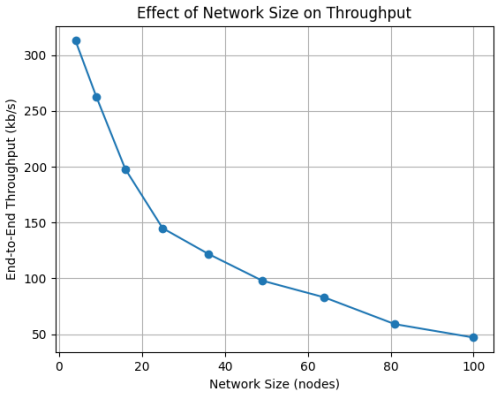
- **End-to-End Throughput**
- **End-to-End Delay**
- **Packet Delivery Ratio**
- **Average Data bits**
- **Average Control bits**

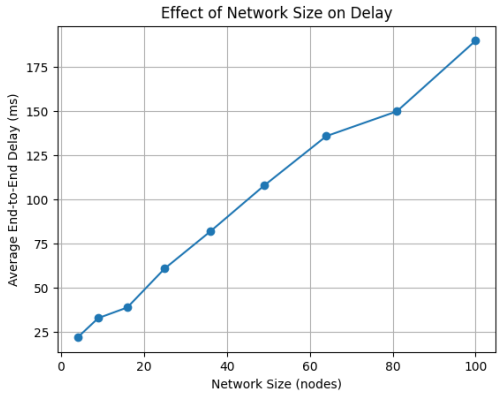
# Network Size

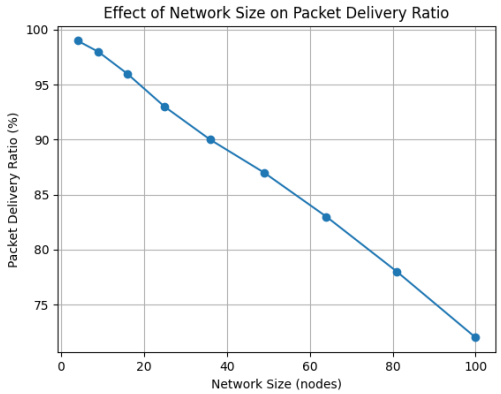
The network size is increased step by step. Every time the measurements are taken from top left to bottom right node.

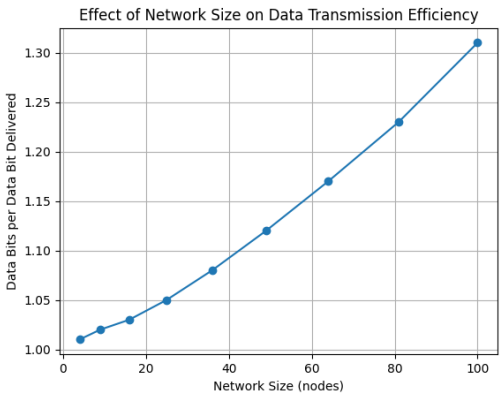


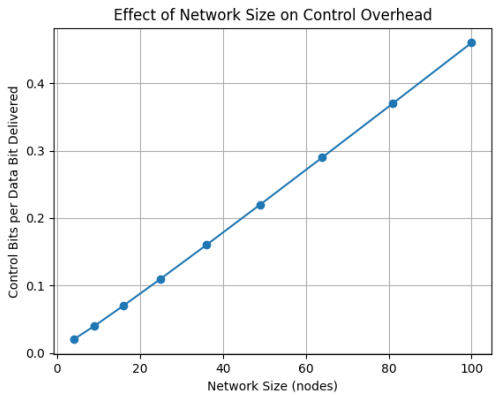
# Network Size



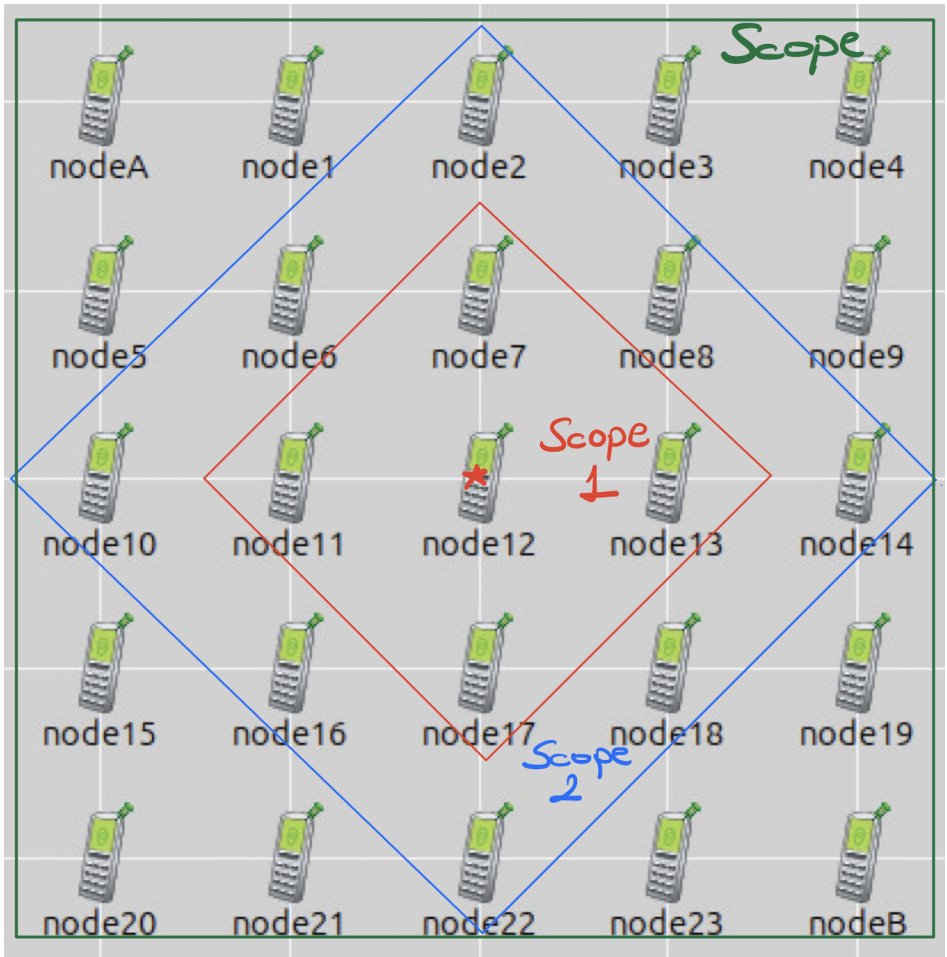



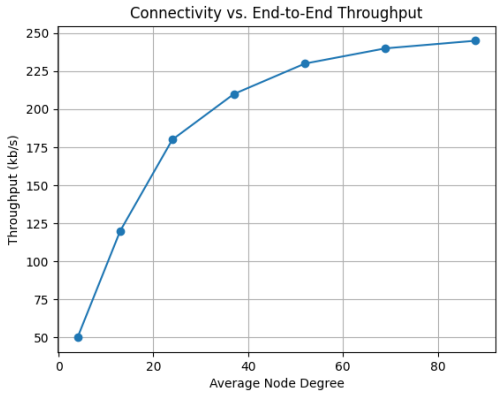



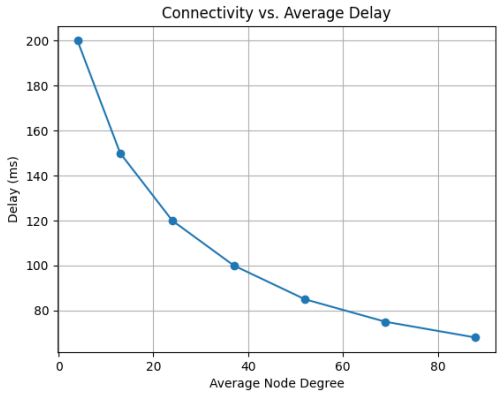
# Network Connectivity

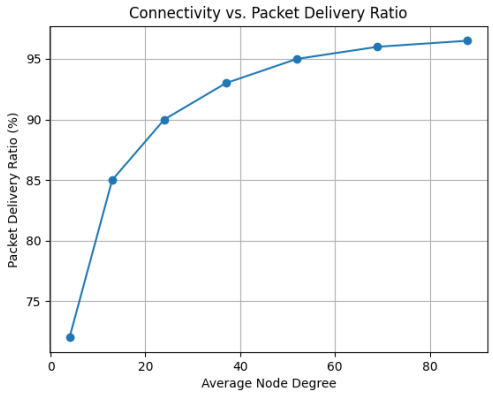
The transmission range of the radios increased step by step so that each time scope-1 grew bigger.

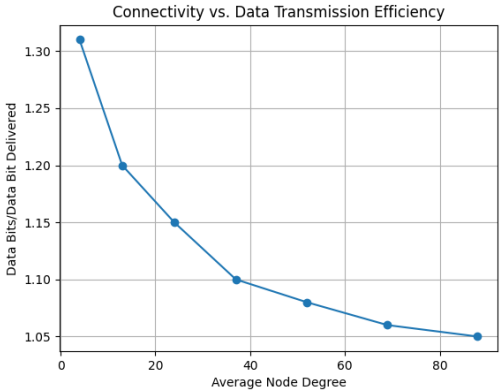


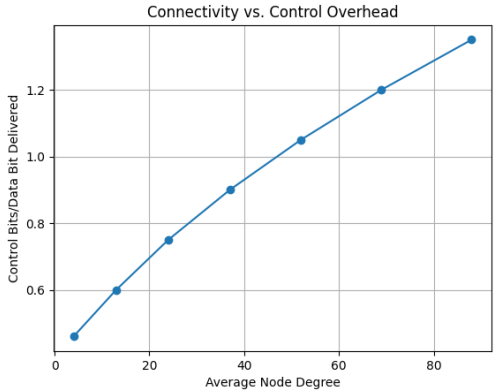
# Network Connectivity Results



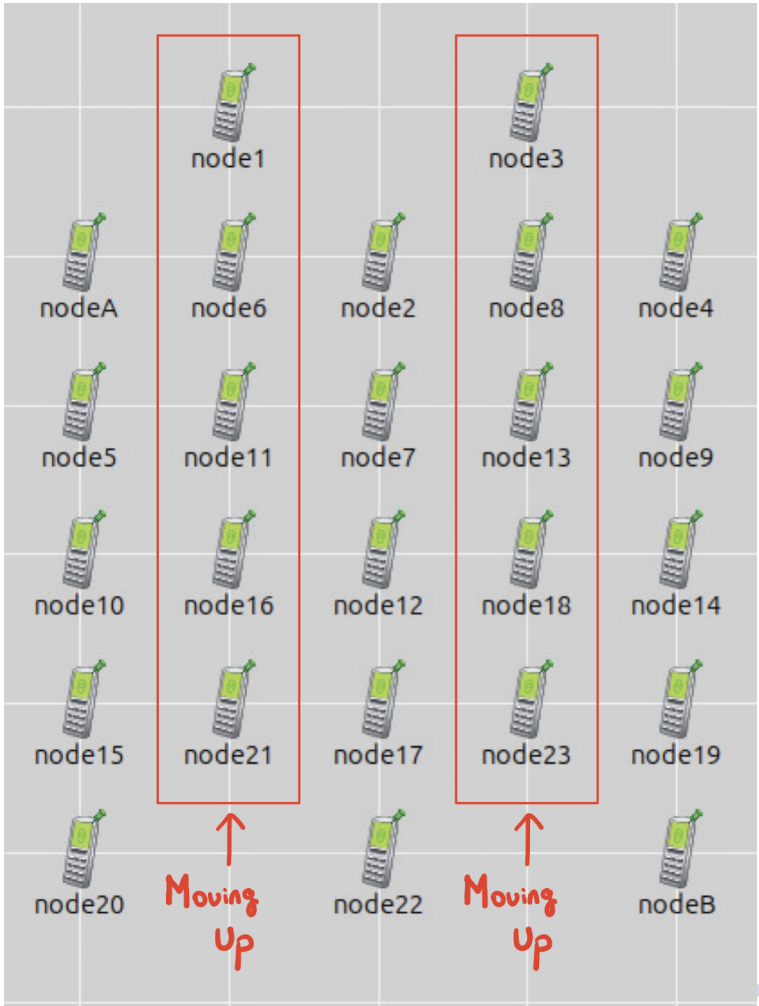



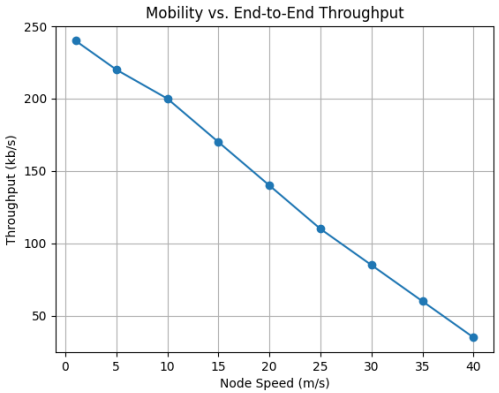



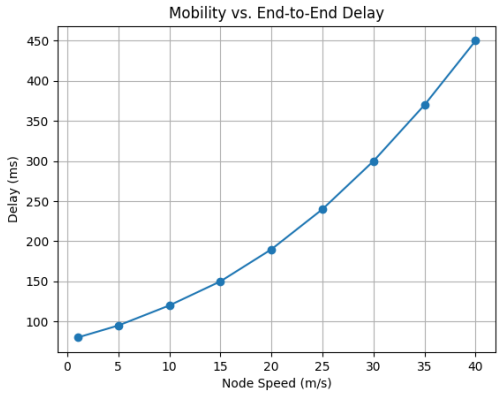
# Network Mobility

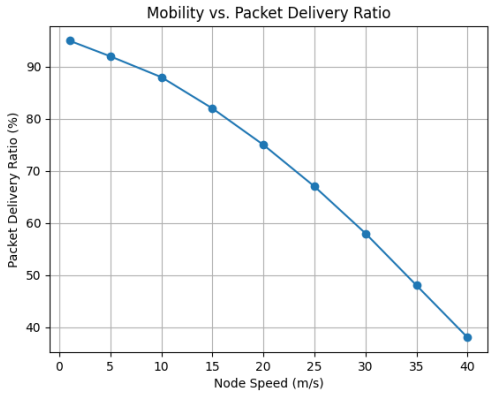
The even numbered columns are moved upwards with increasing speed. The connections between the nodes change frequently.

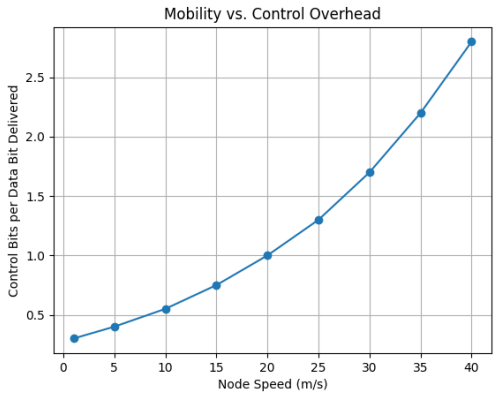


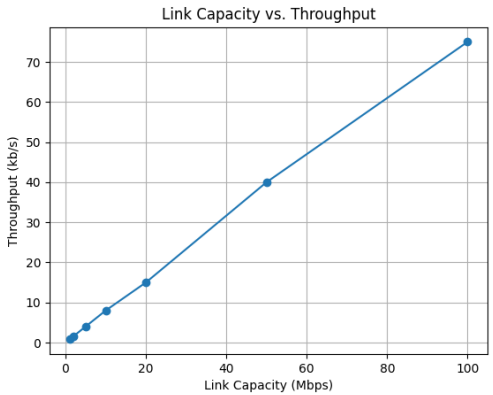
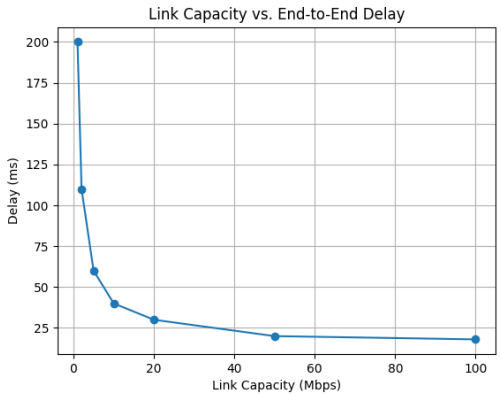
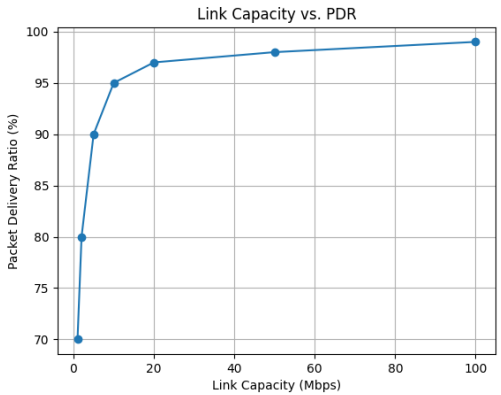
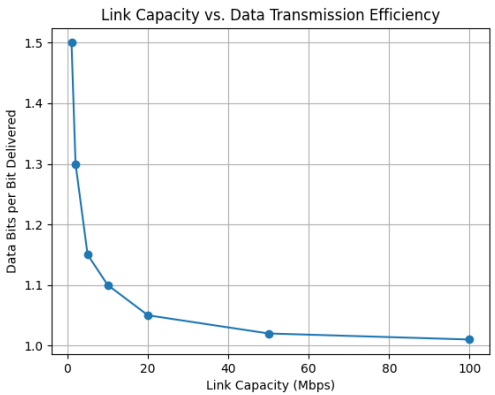
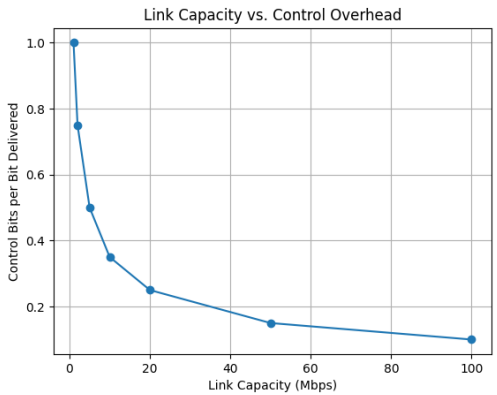
# Network Mobility Results





# Link Capacity Results

The capacity of the link between the nodes increased step by step