Go-Back-N Protocol (Java Implementation): This README is for a Java implementation of the Go-Back-N (GBN) protocol. The GBN protocol is a sliding window protocol that allows for reliable data transfer over an unreliable network. It provides an error recovery mechanism by retransmitting lost or damaged packets.

Table of Contents

File Structure

The entire code is written in a single file, `gbnsender.java`, which contains the main class `gbnsender`, along with several inner classes and functions. The initialization code is in `gbnnode.java`

Classes

gbnsender

The `gbnsender` class is the main class that contains the implementation of the GBN protocol. The sender maintains a window of packets that have been sent but not yet acknowledged.

gbnnode

The `gbnnode` class is the main class that deals with initializing the parameters.

Packet

The `Packet` class represents a packet in the GBN protocol. Each packet has a sequence number and data. This class represents a data packet with the following attributes:

- `seqNum`: Sequence number of the packet
- `data`: Data payload of the packet

AckPacket

The `AckPacket` class represents an acknowledgment packet in the GBN protocol. Each acknowledgment packet has a sequence number. This class represents an acknowledgment (ACK) packet with the following attribute:

- `seqNum`: Sequence number of the packet being acknowledged

Functions

sendPacket

The `sendPacket` function takes a `Packet` object, the receiver's address, receiver's port, and the sender's socket as arguments. It serializes the packet and sends it to the receiver.

sendAckPacket

The `sendAckPacket` function takes an `AckPacket` object, the sender's address, sender's port, and the receiver's socket as arguments. It serializes the acknowledgment packet and sends it to the sender.

decodeObject

The `decodePacket` function takes a `DatagramPacket` object as an argument and returns a deserialized `Packet` object contained in the datagram.

decodeAckPacket

The `decodeAckPacket` function takes a `DatagramPacket` object as an argument and returns a deserialized `AckPacket` object contained in the datagram.

clientListen

This function listens for incoming packets and ACKs from the receiver, and performs the following tasks:

- Decodes and processes received packets and ACKs
- Handles packet loss and retransmissions
- Maintains a count of dropped packets and calculates loss rate

main

This is the main entry point of the program, where the sender and receiver interact. It initializes the required variables, spawns a thread for listening to incoming packets and ACKs, and enters a loop to send messages to the receiver.

The user can input commands in the format "send <message>", and the message will be sent to the receiver using the Go-Back-N protocol.

Usage

To run this program, compile it using a Java compiler, and then execute it with the appropriate arguments for the sending and receiving ports, window size, drop rate, and drop probability:

java gbnsender <sendingPort> <receivingPort> <windowSize> [optional: -d <dropPackets>] [optional: -p <dropProbability>]

For example:
java gbnsender 5000 5001 4 -d 5 -p 0.1

This will run the program with a sending port of 5000, a receiving port of 5001, a window size of 4, a drop rate of 5, and a drop probability of 0.1.

When the program is running, enter commands in the format "send <message>" to send messages to the receiver using the Go-Back-N protocol.

Distance Vector Protocol (Java Implementation): This README is for a Java implementation of the Distance Vector Protocol (DVP) algorithm. The DVP algorithm is a dynamic routing protocol that calculates the best paths for sending packets between network nodes. It uses the Bellman-Ford algorithm to compute the shortest path and relies on periodic exchange of routing tables between neighboring nodes to update the routing information.

Table of Contents

File Structure

The entire code is written in a single file, `dvnode.java`, which contains the main class `dvnode`, along with several inner classes and functions.

Classes

dvnode

The `dvnode` class is the main class that contains the implementation of the Distance Vector Protocol. It maintains the local routing table, a set of visited ports, and a set of neighboring ports.

Packet

The `Packet` class represents a packet of data that is sent between nodes. It contains a routing table and the source port of the packet.

Tuple

The `Tuple` class is a helper class that represents an entry in the routing table. It contains the next hop port and the loss rate for that route.

Functions

sendPacket

`sendPacket(Packet packet, InetAddress receiverAddress, int receiverPort, DatagramSocket socket)` is a function that sends a packet to the specified receiver address and port using the provided socket.

decodePacket

`decodePacket(DatagramPacket datagram)` is a function that decodes a received datagram packet and returns the corresponding `Packet` object.

clientListen

`clientListen(InetAddress address, int sourcePort)` is a function that listens for incoming packets and updates the local routing table accordingly. It also prints the updated routing table and sends it to neighboring nodes if there's a change.

clientMode

`clientMode(int sourcePort, boolean beginSendingPackets)` is a function that sets up the node in client mode. It creates a socket and starts a listener thread to process incoming packets. If `beginSendingPackets` is true, it sends the initial routing table to all neighbors.

Usage

To run the program, compile and execute the `dvnode.java` file using the following command:

java dvnode <local-port> <neighbor1-port> <loss-rate-1> <neighbor2-port> <loss-rate-2> ... [last]

<local-port>: The port number for the current node (must be between 1024 and 65534).
<neighborX-port>: The port number for each neighboring node (must be between 1024 and 65534).
<loss-rate-X>: The corresponding loss rate for each neighboring node (must be between 0 and 1).
[last]: An optional argument that indicates whether the current node is the last one in the network. If present, the current node will start sending packets to its neighbors.

For example, java dvnode 1111 2222 .1 3333 .5 4444 .2

CNNode (Java Implementation): CNNode is a Java-based network routing application that uses the Distance Vector Protocol (DVP) to maintain and update routing tables, and Go-Back-N protocol for reliable data transmission. The application simulates a network node and handles packet transmission and routing in a multi-node network environment.

Main features:

- Distance Vector Protocol for routing table maintenance
- Go-Back-N protocol for reliable data transmission
- Packet loss simulation to test routing algorithm robustness
- Multithreading to handle packet sending, receiving, and processing

How to run the application:

1. Compile the Java source code
2. Run the application with the following command-line arguments:

java cnnode <local-port> receive <neighbor1-port> <loss-rate-1> <neighbor2-port> <loss-rate-2> ... <neighborM-port> <loss-rate-M> send <neighbor(M+1)-port> <neighbor(M+2)-port> ... <neighborN-port> [last]

- `local-port`: The port number for the local node
- `receive`: Keyword to specify receiving neighbors
- `neighbor1-port`, `neighbor2-port`, ..., `neighborM-port`: Port numbers of the receiving neighbors
- `loss-rate-1`, `loss-rate-2`, ..., `loss-rate-M`: Packet loss rates for the receiving neighbors
- `send`: Keyword to specify sending neighbors
- `neighbor(M+1)-port`, `neighbor(M+2)-port`, ..., `neighborN-port`: Port numbers of the sending neighbors
- `last`: Optional keyword to specify that the current node is the last node to start

Classes and main methods:

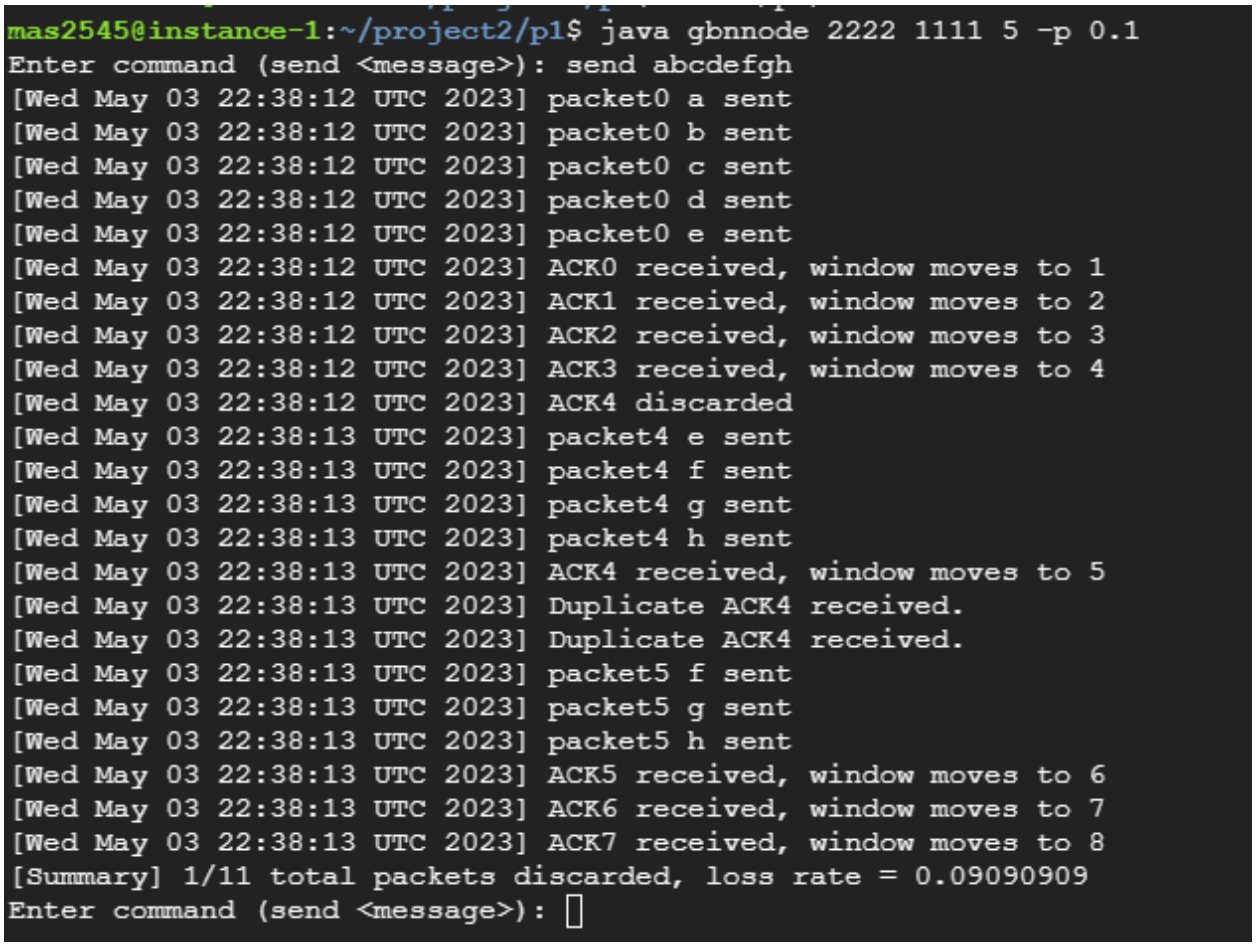
- `CNNode`: Main class with the `main()` method to run the application
- `clientMode()`: Sets up the client mode, initializing the sender and listener
- `clientListen()`: Handles listening for incoming packets and processes them
- `main()`: Sets up the parameters and starts the application

Note:

The code provided assumes that all nodes run on the same machine, using `InetAddress.getLoopbackAddress()` for the IP address. If you want to run the nodes on different machines, you will need to update the IP address accordingly.

Programming Part 1

Message 1



```
mas2545@instance-1:~/project2/p1$ java gbnnode 1111 2222 5 -p 0.1
Enter command (send <message>): [Wed May 03 22:38:12 UTC 2023] packet0 a received
[Wed May 03 22:38:12 UTC 2023] ACK0 sent, expecting packet1
[Wed May 03 22:38:12 UTC 2023] packet1 b received
[Wed May 03 22:38:12 UTC 2023] ACK1 sent, expecting packet2
[Wed May 03 22:38:12 UTC 2023] packet2 c received
[Wed May 03 22:38:12 UTC 2023] ACK2 sent, expecting packet3
[Wed May 03 22:38:12 UTC 2023] packet3 d received
[Wed May 03 22:38:12 UTC 2023] ACK3 sent, expecting packet4
[Wed May 03 22:38:12 UTC 2023] packet4 e received
[Wed May 03 22:38:12 UTC 2023] ACK4 sent, expecting packet5
[Wed May 03 22:38:13 UTC 2023] packet4 e received
[Wed May 03 22:38:13 UTC 2023] Received duplicate packet 4 and sent ACK 4
[Wed May 03 22:38:13 UTC 2023] packet5 f discarded
[Wed May 03 22:38:13 UTC 2023] packet6 g received
[Wed May 03 22:38:13 UTC 2023] Received out-of-sequence packet 6 and sent ACK 4
[Wed May 03 22:38:13 UTC 2023] packet7 h received
[Wed May 03 22:38:13 UTC 2023] Received out-of-sequence packet 7 and sent ACK 4
[Wed May 03 22:38:13 UTC 2023] packet5 f received
[Wed May 03 22:38:13 UTC 2023] ACK5 sent, expecting packet6
[Wed May 03 22:38:13 UTC 2023] packet6 g received
[Wed May 03 22:38:13 UTC 2023] ACK6 sent, expecting packet7
[Wed May 03 22:38:13 UTC 2023] packet7 h received
[Wed May 03 22:38:13 UTC 2023] ACK7 sent, expecting packet8
[Summary] 1/12 total packets discarded, loss rate = 0.083333336
```

Message 2

```
mas2545@instance-1:~/project2/p1$ java gbnnode 2222 1111 2 -d 2
Enter command (send <message>): send cat
[Wed May 03 22:43:43 UTC 2023] packet0 c sent
[Wed May 03 22:43:43 UTC 2023] packet0 a sent
[Wed May 03 22:43:43 UTC 2023] ACK0 received, window moves to 1
[Wed May 03 22:43:43 UTC 2023] packet1 a sent
[Wed May 03 22:43:43 UTC 2023] packet1 t sent
[Wed May 03 22:43:43 UTC 2023] ACK1 discarded
[Wed May 03 22:43:43 UTC 2023] packet1 timeout
[Wed May 03 22:43:44 UTC 2023] packet1 a sent
[Wed May 03 22:43:44 UTC 2023] packet1 t sent
[Wed May 03 22:43:44 UTC 2023] ACK1 received, window moves to 2
[Wed May 03 22:43:44 UTC 2023] packet2 t sent
[Wed May 03 22:43:44 UTC 2023] ACK2 discarded
[Wed May 03 22:43:44 UTC 2023] packet2 timeout
[Wed May 03 22:43:45 UTC 2023] packet2 t sent
[Wed May 03 22:43:45 UTC 2023] packet2 timeout
[Wed May 03 22:43:45 UTC 2023] packet2 t sent
[Wed May 03 22:43:45 UTC 2023] ACK2 received, window moves to 3
[Summary] 2/5 total packets discarded, loss rate = 0.4
Enter command (send <message>):
```

```
mas2545@instance-1:~/project2/p1$ java gbnnode 1111 2222 2 -d 2
Enter command (send <message>): [Wed May 03 22:43:43 UTC 2023] packet0 c received
[Wed May 03 22:43:43 UTC 2023] ACK0 sent, expecting packet1
[Wed May 03 22:43:43 UTC 2023] packet1 a discarded
[Wed May 03 22:43:43 UTC 2023] packet1 a received
[Wed May 03 22:43:43 UTC 2023] ACK1 sent, expecting packet2
[Wed May 03 22:43:43 UTC 2023] packet2 t discarded
[Wed May 03 22:43:44 UTC 2023] packet1 a received
[Wed May 03 22:43:44 UTC 2023] Received duplicate packet 1 and sent ACK 1
[Wed May 03 22:43:44 UTC 2023] packet2 t discarded
[Wed May 03 22:43:44 UTC 2023] packet2 t received
[Wed May 03 22:43:44 UTC 2023] ACK2 sent, expecting packet3
[Wed May 03 22:43:45 UTC 2023] packet2 t discarded
[Wed May 03 22:43:45 UTC 2023] packet2 t received
[Wed May 03 22:43:45 UTC 2023] Received duplicate packet 2 and sent ACK 2
[Summary] 4/9 total packets discarded, loss rate = 0.44444445
```

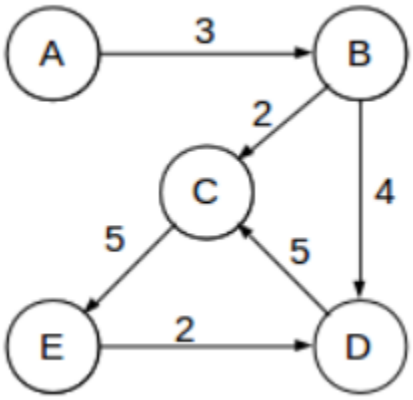
Message 3

```
mas2545@instance-1:~/project2/p1$ java gbnnode 2222 1111 2
Enter command (send <message>): [Wed May 03 22:48:37 UTC 2023] packet0 m received
[Wed May 03 22:48:37 UTC 2023] ACK0 sent, expecting packet1
[Wed May 03 22:48:37 UTC 2023] packet1 o received
[Wed May 03 22:48:37 UTC 2023] ACK1 sent, expecting packet2
[Wed May 03 22:48:37 UTC 2023] packet2 u received
[Wed May 03 22:48:37 UTC 2023] ACK2 sent, expecting packet3
[Wed May 03 22:48:37 UTC 2023] packet3 s received
[Wed May 03 22:48:37 UTC 2023] ACK3 sent, expecting packet4
[Wed May 03 22:48:37 UTC 2023] packet4 e received
[Wed May 03 22:48:37 UTC 2023] ACK4 sent, expecting packet5
[Summary] 0/5 total packets discarded, loss rate = 0.0
send cow
[Wed May 03 22:48:43 UTC 2023] packet0 c sent
[Wed May 03 22:48:43 UTC 2023] packet0 o sent
[Wed May 03 22:48:43 UTC 2023] ACK0 received, window moves to 1
[Wed May 03 22:48:43 UTC 2023] ACK1 received, window moves to 2
[Wed May 03 22:48:44 UTC 2023] packet2 w sent
[Wed May 03 22:48:44 UTC 2023] ACK2 received, window moves to 3
[Summary] 0/3 total packets discarded, loss rate = 0.0
Enter command (send <message>):
```

```
mas2545@instance-1:~/project2/p1$ java gbnnode 1111 2222 5
Enter command (send <message>): send mouse
[Wed May 03 22:48:37 UTC 2023] packet0 m sent
[Wed May 03 22:48:37 UTC 2023] packet0 o sent
[Wed May 03 22:48:37 UTC 2023] packet0 u sent
[Wed May 03 22:48:37 UTC 2023] packet0 s sent
[Wed May 03 22:48:37 UTC 2023] packet0 e sent
[Wed May 03 22:48:37 UTC 2023] ACK0 received, window moves to 1
[Wed May 03 22:48:37 UTC 2023] ACK1 received, window moves to 2
[Wed May 03 22:48:37 UTC 2023] ACK2 received, window moves to 3
[Wed May 03 22:48:37 UTC 2023] ACK3 received, window moves to 4
[Wed May 03 22:48:37 UTC 2023] ACK4 received, window moves to 5
[Summary] 0/5 total packets discarded, loss rate = 0.0
Enter command (send <message>): [Wed May 03 22:48:43 UTC 2023] packet0 c received
[Wed May 03 22:48:43 UTC 2023] ACK0 sent, expecting packet1
[Wed May 03 22:48:43 UTC 2023] packet1 o received
[Wed May 03 22:48:43 UTC 2023] ACK1 sent, expecting packet2
[Wed May 03 22:48:44 UTC 2023] packet2 w received
[Wed May 03 22:48:44 UTC 2023] ACK2 sent, expecting packet3
[Summary] 0/3 total packets discarded, loss rate = 0.0
```

Programming Part 2

Graph 1



Notation for ports: 1111 = 1, 2222 = 2 etc.

```
mas2545@instance-1:~/project2/p2$ java dvnode 1111 2222 .3
[Wed May 03 22:28:00 UTC 2023] Node 1111 Routing Table
- (0.90000004) -> Node 5555; Next hop -> Node 2222
- (0.5) -> Node 3333; Next hop -> Node 2222
- (0.70000005) -> Node 4444; Next hop -> Node 2222
- (0.3) -> Node 2222
```

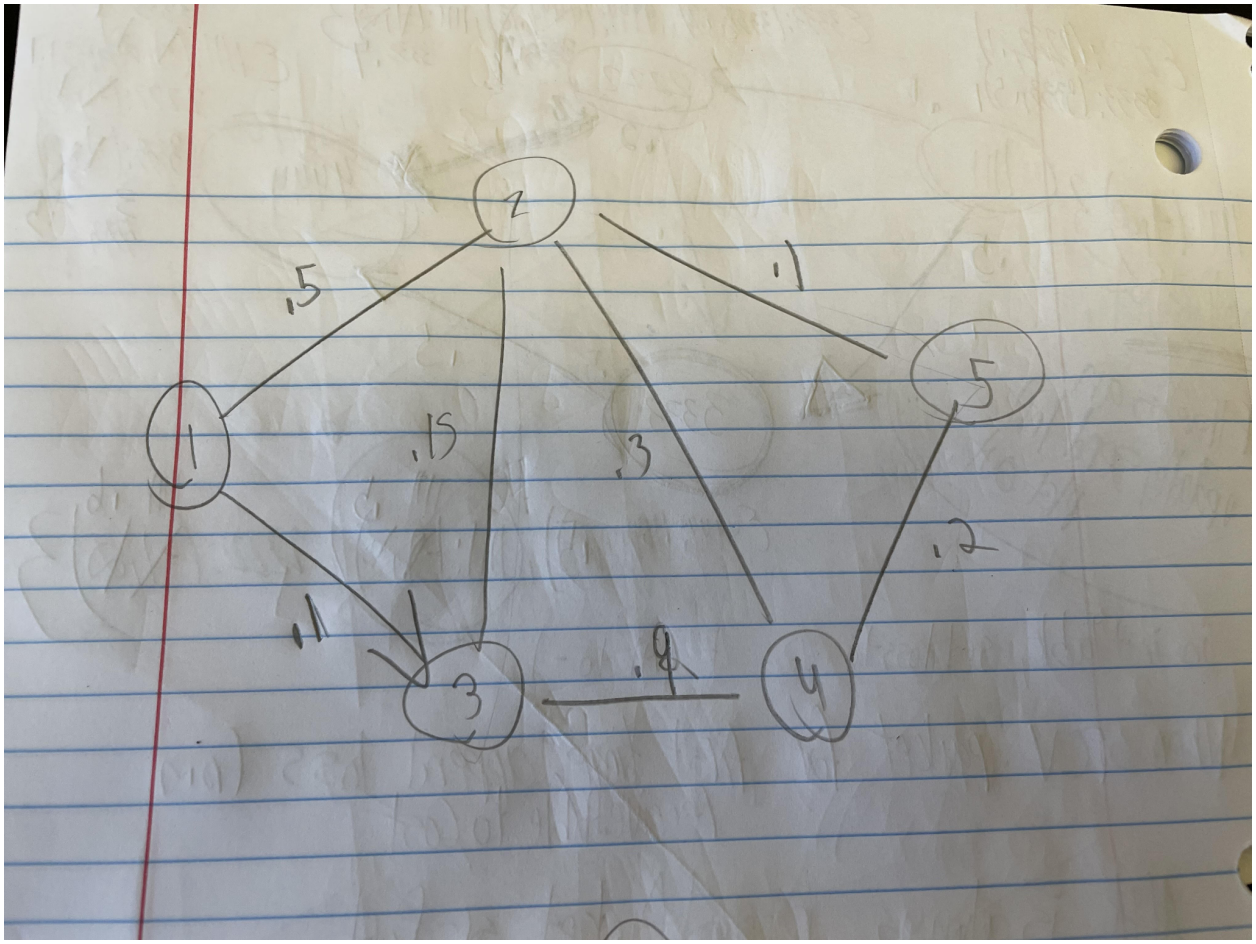
```
Last login: Wed May  3 22:26:27 2023 from 172.253.216.57
mas2545@instance-1:~$ cd project2/p2/
mas2545@instance-1:~/project2/p2$ java dvnode 2222 1111 .3 3333 .2 4444 .4
[Wed May 03 22:27:59 UTC 2023] Node 2222 Routing Table
- (0.6) -> Node 5555; Next hop -> Node 4444
- (0.2) -> Node 3333
- (0.3) -> Node 1111
- (0.4) -> Node 4444
```

```
mas2545@instance-1:~$ cd project2/p2/
mas2545@instance-1:~/project2/p2$ java dvnode 3333 2222 .2 4444 .5 5555 .5
[Wed May 03 22:27:59 UTC 2023] Node 3333 Routing Table
- (0.5) -> Node 5555
- (0.5) -> Node 4444
- (0.2) -> Node 2222

[Wed May 03 22:28:00 UTC 2023] Node 3333 Routing Table
- (0.5) -> Node 5555
- (0.5) -> Node 1111; Next hop -> Node 2222
- (0.5) -> Node 4444
- (0.2) -> Node 2222
```

```
mas2545@instance-1:~/project2/p2$ java dvnode 4444 2222 .4 3333 .5 5555 .2
[Wed May 03 22:27:59 UTC 2023] Node 4444 Routing Table
- (0.2) -> Node 5555
- (0.5) -> Node 3333
- (0.4) -> Node 2222

[Wed May 03 22:28:00 UTC 2023] Node 4444 Routing Table
- (0.2) -> Node 5555
- (0.5) -> Node 3333
- (1.2) -> Node 1111; Next hop -> Node 5555
- (0.4) -> Node 2222

[Wed May 03 22:28:00 UTC 2023] Node 4444 Routing Table
- (0.2) -> Node 5555
- (0.5) -> Node 3333
- (0.70000005) -> Node 1111; Next hop -> Node 2222
- (0.4) -> Node 2222
```

```
Last login: Wed May  3 22:26:55 2023 from 35.235.240.2
mas2545@instance-1:~$ cd project2/p2/
mas2545@instance-1:~/project2/p2$ java dvnode 5555 3333 .5 4444 .2 last
[Wed May 03 22:27:59 UTC 2023] Node 5555 Routing Table
- (0.5) -> Node 3333
- (0.2) -> Node 4444
- (0.6) -> Node 2222; Next hop -> Node 4444

[Wed May 03 22:28:00 UTC 2023] Node 5555 Routing Table
- (0.5) -> Node 3333
- (1.0) -> Node 1111; Next hop -> Node 3333
- (0.2) -> Node 4444
- (0.6) -> Node 2222; Next hop -> Node 4444

[Wed May 03 22:28:00 UTC 2023] Node 5555 Routing Table
- (0.5) -> Node 3333
- (0.90000004) -> Node 1111; Next hop -> Node 4444
- (0.2) -> Node 4444
- (0.6) -> Node 2222; Next hop -> Node 4444
```

Graph 2



Notation for ports: 1111 = 1, 2222 = 2 etc.

```
Last login: Tue May  2 22:00:50 2023 from 35.235.244.33
mas2545@instance-1:~$ cd project2/p2/
mas2545@instance-1:~/project2/p2$ java dvnode 1111 2222 .5 3333 .1
[Wed May 03 00:47:18 UTC 2023] Node 1111 Routing Table
- (0.6) -> Node 5555; Next hop -> Node 2222
- (0.1) -> Node 3333
- (0.8) -> Node 4444; Next hop -> Node 2222
- (0.5) -> Node 2222

[Wed May 03 00:47:19 UTC 2023] Node 1111 Routing Table
- (0.6) -> Node 5555; Next hop -> Node 2222
- (0.1) -> Node 3333
- (0.8) -> Node 4444; Next hop -> Node 2222
- (0.25) -> Node 2222; Next hop -> Node 3333

[Wed May 03 00:47:19 UTC 2023] Node 1111 Routing Table
- (0.35) -> Node 5555; Next hop -> Node 3333
- (0.1) -> Node 3333
- (0.55) -> Node 4444; Next hop -> Node 3333
- (0.25) -> Node 2222; Next hop -> Node 3333
```

```
Last login: Wed May  3 00:45:44 2023 from 35.235.244.32
mas2545@instance-1:~$ cd project2/p2/
mas2545@instance-1:~/project2/p2$ java dvnode 2222 1111 .5 3333 .15 4444 .3 5555 .1
[Wed May 03 00:47:18 UTC 2023] Node 2222 Routing Table
- (0.1) -> Node 5555
- (0.15) -> Node 3333
- (0.5) -> Node 1111
- (0.3) -> Node 4444

[Wed May 03 00:47:19 UTC 2023] Node 2222 Routing Table
- (0.1) -> Node 5555
- (0.15) -> Node 3333
- (0.25) -> Node 1111; Next hop -> Node 3333
- (0.3) -> Node 4444
```

```
Last login: Wed May  3 00:45:45 2023 from 35.235.244.32
mas2545@instance-1:~$ cd project2/p2/
mas2545@instance-1:~/project2/p2$ java dvnode 3333 1111 .1 2222 .15 4444 .9
[Wed May 03 00:47:18 UTC 2023] Node 3333 Routing Table
- (1.1) -> Node 5555; Next hop -> Node 4444
- (0.1) -> Node 1111
- (0.9) -> Node 4444
- (0.15) -> Node 2222

[Wed May 03 00:47:19 UTC 2023] Node 3333 Routing Table
- (0.25) -> Node 5555; Next hop -> Node 2222
- (0.1) -> Node 1111
- (0.45000002) -> Node 4444; Next hop -> Node 2222
- (0.15) -> Node 2222
```

```
Last login: Wed May  3 00:45:40 2023 from 172.253.216.57
mas2545@instance-1:~$ cd project2/p2/
mas2545@instance-1:~/project2/p2$ java dvnode 4444 3333 .9 2222 .3 5555 .2
[Wed May 03 00:47:18 UTC 2023] Node 4444 Routing Table
- (0.2) -> Node 5555
- (0.9) -> Node 3333
- (0.3) -> Node 2222

[Wed May 03 00:47:18 UTC 2023] Node 4444 Routing Table
- (0.2) -> Node 5555
- (0.45000002) -> Node 3333; Next hop -> Node 2222
- (0.8) -> Node 1111; Next hop -> Node 2222
- (0.3) -> Node 2222

[Wed May 03 00:47:19 UTC 2023] Node 4444 Routing Table
- (0.2) -> Node 5555
- (0.45) -> Node 3333; Next hop -> Node 5555
- (0.8) -> Node 1111; Next hop -> Node 2222
- (0.3) -> Node 2222

[Wed May 03 00:47:19 UTC 2023] Node 4444 Routing Table
- (0.2) -> Node 5555
- (0.45) -> Node 3333; Next hop -> Node 5555
- (0.55) -> Node 1111; Next hop -> Node 5555
- (0.3) -> Node 2222
```

```
Last login: Wed May  3 00:46:02 2023 from 172.253.216.57
mas2545@instance-1:~$ cd project2/p2/
mas2545@instance-1:~/project2/p2$ java dvnode 5555 2222 .1 4444 .2 last
[Wed May 03 00:47:18 UTC 2023] Node 5555 Routing Table
- (0.25) -> Node 3333; Next hop -> Node 2222
- (0.6) -> Node 1111; Next hop -> Node 2222
- (0.2) -> Node 4444
- (0.1) -> Node 2222

[Wed May 03 00:47:19 UTC 2023] Node 5555 Routing Table
- (0.25) -> Node 3333; Next hop -> Node 2222
- (0.35) -> Node 1111; Next hop -> Node 2222
- (0.2) -> Node 4444
- (0.1) -> Node 2222

^Cmas2545@instance-1:~/project2/p2$
```

Graph 3

Figure 3: Network Configuration Example

```
^Cmas2545@instance-1:~/project2/p2$ java dvnode 1111 2222 .1 3333 .5
[Wed May 03 22:31:32 UTC 2023] Node 1111 Routing Table
- (0.3) -> Node 3333; Next hop -> Node 2222
- (0.90000004) -> Node 4444; Next hop -> Node 2222
- (0.1) -> Node 2222

[Wed May 03 22:31:33 UTC 2023] Node 1111 Routing Table
- (0.3) -> Node 3333; Next hop -> Node 2222
- (0.8) -> Node 4444; Next hop -> Node 2222
- (0.1) -> Node 2222
```

```
^Cmas2545@instance-1:~/project2/p2$ java dvnode 2222 1111 .1 3333 .2 4444 .8
[Wed May 03 22:31:32 UTC 2023] Node 2222 Routing Table
- (0.2) -> Node 3333
- (0.1) -> Node 1111
- (0.8) -> Node 4444

[Wed May 03 22:31:32 UTC 2023] Node 2222 Routing Table
- (0.2) -> Node 3333
- (0.1) -> Node 1111
- (0.7) -> Node 4444; Next hop -> Node 3333
```

```
^Cmas2545@instance-1:~/project2/p2$ java dvnode 3333 1111 .5 2222 .2 4444 .5
[Wed May 03 22:31:32 UTC 2023] Node 3333 Routing Table
- (0.5) -> Node 1111
- (0.5) -> Node 4444
- (0.2) -> Node 2222

[Wed May 03 22:31:32 UTC 2023] Node 3333 Routing Table
- (0.3) -> Node 1111; Next hop -> Node 2222
- (0.5) -> Node 4444
- (0.2) -> Node 2222
```

```
^Cmas2545@instance-1:~/project2/p2$ java dvnode 4444 3333 .5 2222 .8 last
[Wed May 03 22:31:32 UTC 2023] Node 4444 Routing Table
- (0.5) -> Node 3333
- (0.90000004) -> Node 1111; Next hop -> Node 2222
- (0.8) -> Node 2222

[Wed May 03 22:31:33 UTC 2023] Node 4444 Routing Table
- (0.5) -> Node 3333
- (0.90000004) -> Node 1111; Next hop -> Node 2222
- (0.7) -> Node 2222; Next hop -> Node 3333

[Wed May 03 22:31:33 UTC 2023] Node 4444 Routing Table
- (0.5) -> Node 3333
- (0.8) -> Node 1111; Next hop -> Node 3333
- (0.7) -> Node 2222; Next hop -> Node 3333
```

Programming Part 3

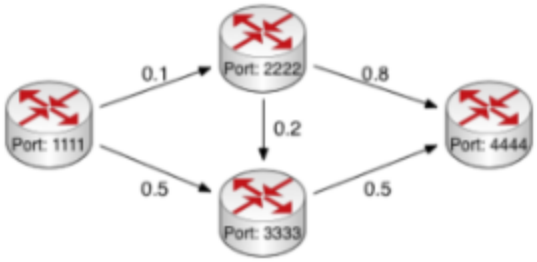


Figure 4: Network Configuration Example

```
[Sun May 21 21:24:56 UTC 2023] Link to 3333: 363 packets sent, 187 packets lost, loss rate 0.51
[Sun May 21 21:24:56 UTC 2023] Link to 2222: 194 packets sent, 19 packets lost, loss rate 0.09
[Sun May 21 21:24:57 UTC 2023] Link to 3333: 365 packets sent, 189 packets lost, loss rate 0.51
[Sun May 21 21:24:57 UTC 2023] Link to 2222: 194 packets sent, 19 packets lost, loss rate 0.09
[Sun May 21 21:24:58 UTC 2023] Link to 3333: 366 packets sent, 190 packets lost, loss rate 0.51
[Sun May 21 21:24:58 UTC 2023] Link to 2222: 195 packets sent, 19 packets lost, loss rate 0.09
[Sun May 21 21:24:59 UTC 2023] Link to 3333: 367 packets sent, 190 packets lost, loss rate 0.51
[Sun May 21 21:24:59 UTC 2023] Link to 2222: 196 packets sent, 19 packets lost, loss rate 0.09
[Sun May 21 21:25:00 UTC 2023] Link to 3333: 368 packets sent, 190 packets lost, loss rate 0.51
[Sun May 21 21:25:00 UTC 2023] Link to 2222: 197 packets sent, 19 packets lost, loss rate 0.09
[Sun May 21 21:25:01 UTC 2023] Node 1111 Routing Table
- (0.26) -> Node 3333; Next hop -> Node 2222
- (0.76) -> Node 4444; Next hop -> Node 2222
- (0.09) -> Node 2222
```

```
[Sun May 21 21:25:02 UTC 2023] Link to 3333: 106 packets sent, 19 packets lost, loss rate 0.17
[Sun May 21 21:25:02 UTC 2023] Link to 4444: 465 packets sent, 378 packets lost, loss rate 0.81
[Sun May 21 21:25:03 UTC 2023] Link to 3333: 106 packets sent, 19 packets lost, loss rate 0.17
[Sun May 21 21:25:03 UTC 2023] Link to 4444: 467 packets sent, 380 packets lost, loss rate 0.81
[Sun May 21 21:25:04 UTC 2023] Link to 3333: 106 packets sent, 19 packets lost, loss rate 0.17
[Sun May 21 21:25:04 UTC 2023] Link to 4444: 469 packets sent, 382 packets lost, loss rate 0.81
[Sun May 21 21:25:05 UTC 2023] Link to 3333: 107 packets sent, 19 packets lost, loss rate 0.17
[Sun May 21 21:25:05 UTC 2023] Link to 4444: 470 packets sent, 383 packets lost, loss rate 0.81
[Sun May 21 21:25:06 UTC 2023] Link to 3333: 107 packets sent, 19 packets lost, loss rate 0.17
[Sun May 21 21:25:06 UTC 2023] Link to 4444: 472 packets sent, 384 packets lost, loss rate 0.81
[Sun May 21 21:25:06 UTC 2023] Node 2222 Routing Table
- (0.17) -> Node 3333
- (0.09) -> Node 1111
- (0.67) -> Node 4444; Next hop -> Node 3333
```

```
[Sun May 21 21:25:02 UTC 2023] Link to 4444: 571 packets sent, 288 packets lost, loss rate 0.5
[Sun May 21 21:25:03 UTC 2023] Link to 4444: 573 packets sent, 290 packets lost, loss rate 0.5
[Sun May 21 21:25:04 UTC 2023] Link to 4444: 575 packets sent, 291 packets lost, loss rate 0.5
[Sun May 21 21:25:05 UTC 2023] Link to 4444: 577 packets sent, 292 packets lost, loss rate 0.5
[Sun May 21 21:25:06 UTC 2023] Link to 4444: 579 packets sent, 294 packets lost, loss rate 0.5
[Sun May 21 21:25:06 UTC 2023] Node 3333 Routing Table
- (0.26) -> Node 1111; Next hop -> Node 2222
- (0.5) -> Node 4444
- (0.17) -> Node 2222
```

```
[Sun May 21 21:24:46 UTC 2023] Node 4444 Routing Table
- (0.49) -> Node 3333
- (0.74) -> Node 1111; Next hop -> Node 3333
- (0.66) -> Node 2222; Next hop -> Node 3333

[Sun May 21 21:24:51 UTC 2023] Node 4444 Routing Table
- (0.5) -> Node 3333
- (0.74) -> Node 1111; Next hop -> Node 3333
- (0.67) -> Node 2222; Next hop -> Node 3333

[Sun May 21 21:24:56 UTC 2023] Node 4444 Routing Table
- (0.5) -> Node 3333
- (0.75) -> Node 1111; Next hop -> Node 3333
- (0.65999997) -> Node 2222; Next hop -> Node 3333

[Sun May 21 21:25:01 UTC 2023] Node 4444 Routing Table
- (0.5) -> Node 3333
- (0.77) -> Node 1111; Next hop -> Node 3333
- (0.68) -> Node 2222; Next hop -> Node 3333
```