CSEE W4119 Computer Networks - PA2

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Combination

1 Building intruction

```
cd src
make
```

Then run java program.

2 Document detail

`src/`

- `Accessory.java`
- `Constant.java`
- `CN.java`
- `cnnode.java`
- `GBN.java`
- `Link.java`
- `Receiver.java`
- `Transmission.java`
- `makefile`

The the main function of the project is `cnnode.java`.
Besides files that has already used in GBN and DV. Here are a new:

1. Link.java: here two endpoint on a link is no longer the same – one is probe sender and the other is probe receiver. Besides, Class Link also stores link loss_rate as the loss_rate changed from time to time.

3 Project feature

1. Combine GBN and DV together.
2. Using GBN protocol to probe the link weight.
3. Using DV algorithm to update the link table.
4. Print the link weight every one second.
5. Print router table.

4 Data structure

There are several subclasses in the main class CN.

4.1 UpdateRoutingTask

class UpdateRoutingTask is used to update the link situation, using the link situation to update the route table. If table changed, send it to neighbours.

A timer should be used to do this every 5 seconds.

4.2 PrintStatusTask

We are required to print the link status every 1 second. This task is used to do that.

4.3 GBNProbe

This class is a thread, this thread only do one thing: send prob message – in more detail, it calls GBN.Send_Prob agiain and again. The GBN sending algorithm is encapsulated in class GBN.

5 Algorithm

5.1 Sending probe message

I use multithread in this project. However, I did create a thread to each probe link, the reason is very firm, thread comsumes too much CPU and memory. Suppose there are 100 link for the node to send probe message, even PC in CLIC can hardly deal with 100 busily sending thread.

My solution is:

- Using an array to realize many probe links – `GBN send_gbn[]` in `CN.java`.
- Using **for** each `send_gbn,` do `GBN.Send_Prob`. As mentioned above, the GBN protocol is encapsulated in the class GBN. Thereby, it easy for the outside to do it.

In this way, I only use one thread to realize multi-link probe.

5.2 Update routing table

See `CN.UpdateTable()`.

This directly applies Bellman-Ford algorithm that:

- Each $D_{self}(dest)$ is to be checked.
- If there exist a neighbour that pass by will reduce the total path weight. Replace it.

5.3 Self update table from link

Updating table is different from the previous project DV:

1. Link weight is dynamic, it should be used to update the table rather than merely used to do initialization as in project DV.

2. Elements in routing table can increase. In previous project DV, as link weight is static, elements in routing table can only decrease. Here, as the link weight increases. The coorespondent elements in routing table might increase.

See `CN.UpdateLink()`.

- Get loss rate from each GBN (contain number of sent messages and number of lost messages).
- Update it to Link.
- Call `CN.UpdateTable()`. This step is very important as the change of link will change the routing table.

5.4 Update table through messages

First a very important thing is that: there is a sender and a receiver on each link. The problem is the sender knows the link condition while the receiver does not know it. But the receiver should also have to change the link status. Thereby, I make the update message contains link status. Then those nodes who is a receiver can also update the link condition.

Thereby when each node recieves a message, it will:

- Update the link it there is.
- Update the routing table.

See `Receiver.Update()`.

6 Usage scenario

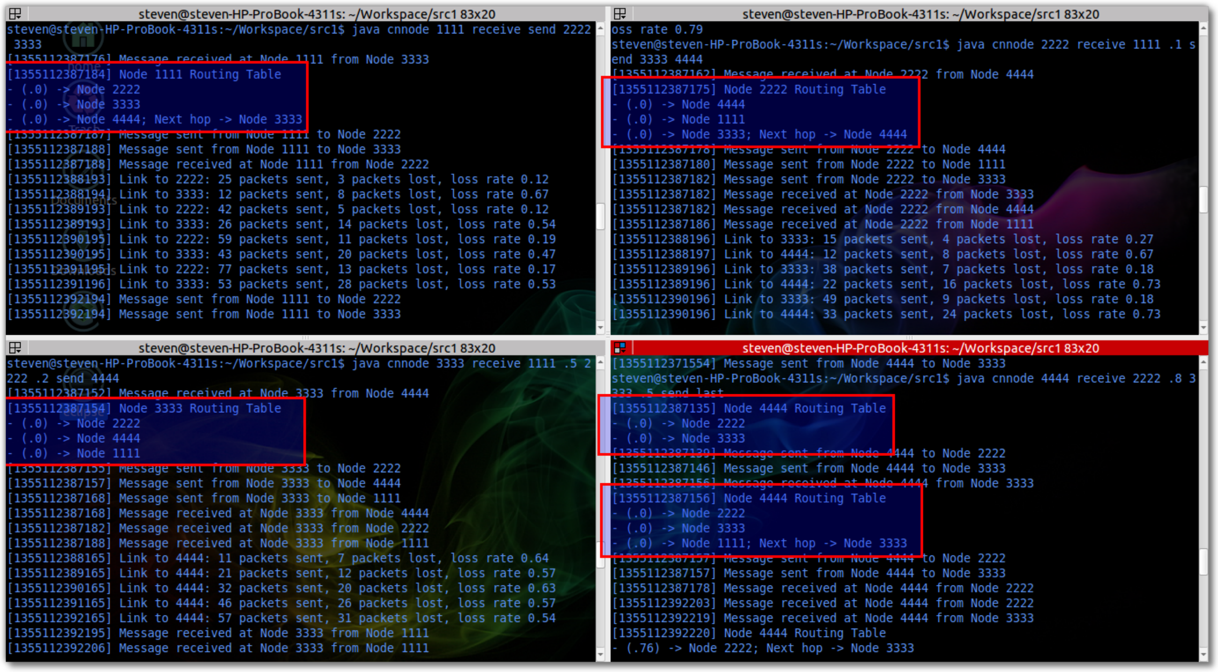
With proper run command, after the "last" node starts, they first exchange messages. Then probe starts and they print link status. Every 5 seconds they exchange message again.

7 Test

A test output is in folder "`Test/`", this use the model given in the homework example.
In detail:

- file "`1111`": the output of node whose port is 1111.
- file "`2222`": the output of node whose port is 2222.
- file "`3333`": the output of node whose port is 3333.
- file "`4444`": the output of node whose port is 4444.

Fig 7-1 is shows at first they update routing table, each path is 0.



```
steven@steven-HP-ProBook-4311s: ~/Workspace/src1 83x20
steven@steven-HP-ProBook-4311s:~/Workspace/src1$ java cnnode 1111 receive send 2222
 3333
[1355112387176] Message received at Node 1111 from Node 3333
[1355112387184] Node 1111 Routing Table
- (.0) -> Node 2222
- (.0) -> Node 3333
- (.0) -> Node 4444; Next hop -> Node 3333
[1355112387187] Message sent from Node 1111 to Node 2222
[1355112387188] Message sent from Node 1111 to Node 3333
[1355112387188] Message received at Node 1111 from Node 2222
[1355112388193] Link to 2222: 25 packets sent, 3 packets lost, loss rate 0.12
[1355112388194] Link to 3333: 12 packets sent, 8 packets lost, loss rate 0.67
[1355112389193] Link to 2222: 42 packets sent, 5 packets lost, loss rate 0.12
[1355112389193] Link to 3333: 26 packets sent, 14 packets lost, loss rate 0.54
[1355112390195] Link to 2222: 59 packets sent, 11 packets lost, loss rate 0.19
[1355112390195] Link to 3333: 43 packets sent, 20 packets lost, loss rate 0.47
[1355112391195] Link to 2222: 77 packets sent, 13 packets lost, loss rate 0.17
[1355112391196] Link to 3333: 53 packets sent, 28 packets lost, loss rate 0.53
[1355112392194] Message sent from Node 1111 to Node 2222
[1355112392194] Message sent from Node 1111 to Node 3333
```

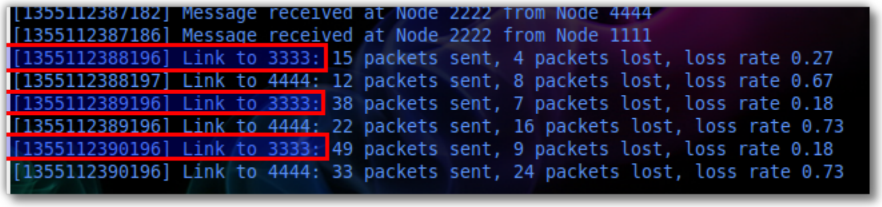
```
steven@steven-HP-ProBook-4311s: ~/Workspace/src1 83x20
oss rate 0.79
steven@steven-HP-ProBook-4311s:~/Workspace/src1$ java cnnode 2222 receive 1111 .1 s
end 3333 4444
[1355112387162] Message received at Node 2222 from Node 4444
[1355112387175] Node 2222 Routing Table
- (.0) -> Node 4444
- (.0) -> Node 1111
- (.0) -> Node 3333; Next hop -> Node 4444
[1355112387178] Message sent from Node 2222 to Node 4444
[1355112387180] Message sent from Node 2222 to Node 1111
[1355112387182] Message sent from Node 2222 to Node 3333
[1355112387182] Message received at Node 2222 from Node 3333
[1355112387182] Message received at Node 2222 from Node 4444
[1355112387186] Message received at Node 2222 from Node 1111
[1355112388196] Link to 3333: 15 packets sent, 4 packets lost, loss rate 0.27
[1355112388197] Link to 4444: 12 packets sent, 8 packets lost, loss rate 0.67
[1355112389196] Link to 3333: 38 packets sent, 7 packets lost, loss rate 0.18
[1355112389196] Link to 4444: 22 packets sent, 16 packets lost, loss rate 0.73
[1355112390196] Link to 3333: 49 packets sent, 9 packets lost, loss rate 0.18
[1355112390196] Link to 4444: 33 packets sent, 24 packets lost, loss rate 0.73
```

```
steven@steven-HP-ProBook-4311s: ~/Workspace/src1 83x20
steven@steven-HP-ProBook-4311s:~/Workspace/src1$ java cnnode 3333 receive 1111 .5 2
222 .2 send 4444
[1355112387152] Message received at Node 3333 from Node 4444
[1355112387154] Node 3333 Routing Table
- (.0) -> Node 2222
- (.0) -> Node 4444
- (.0) -> Node 1111
[1355112387155] Message sent from Node 3333 to Node 2222
[1355112387157] Message sent from Node 3333 to Node 4444
[1355112387168] Message sent from Node 3333 to Node 1111
[1355112387168] Message received at Node 3333 from Node 4444
[1355112387182] Message received at Node 3333 from Node 2222
[1355112387188] Message received at Node 3333 from Node 1111
[1355112388165] Link to 4444: 11 packets sent, 7 packets lost, loss rate 0.64
[1355112389165] Link to 4444: 21 packets sent, 12 packets lost, loss rate 0.57
[1355112390165] Link to 4444: 32 packets sent, 20 packets lost, loss rate 0.63
[1355112391165] Link to 4444: 46 packets sent, 26 packets lost, loss rate 0.57
[1355112392165] Link to 4444: 57 packets sent, 31 packets lost, loss rate 0.54
[1355112392195] Message received at Node 3333 from Node 1111
[1355112392206] Message received at Node 3333 from Node 1111
```

```
steven@steven-HP-ProBook-4311s: ~/Workspace/src1 83x20
[1355112371554] Message sent from Node 4444 to Node 3333
steven@steven-HP-ProBook-4311s:~/Workspace/src1$ java cnnode 4444 receive 2222 .8 3
333 .5 send last
[1355112387135] Node 4444 Routing Table
- (.0) -> Node 2222
- (.0) -> Node 3333
[1355112387139] Message sent from Node 4444 to Node 2222
[1355112387146] Message sent from Node 4444 to Node 3333
[1355112387156] Message received at Node 4444 from Node 3333
[1355112387156] Node 4444 Routing Table
- (.0) -> Node 2222
- (.0) -> Node 3333
- (.0) -> Node 1111; Next hop -> Node 3333
[1355112387157] Message sent from Node 4444 to Node 2222
[1355112387157] Message sent from Node 4444 to Node 3333
[1355112387178] Message received at Node 4444 from Node 2222
[1355112392203] Message received at Node 4444 from Node 2222
[1355112392219] Message received at Node 4444 from Node 3333
[1355112392220] Node 4444 Routing Table
- (.76) -> Node 2222; Next hop -> Node 3333
```

Fig 7-1

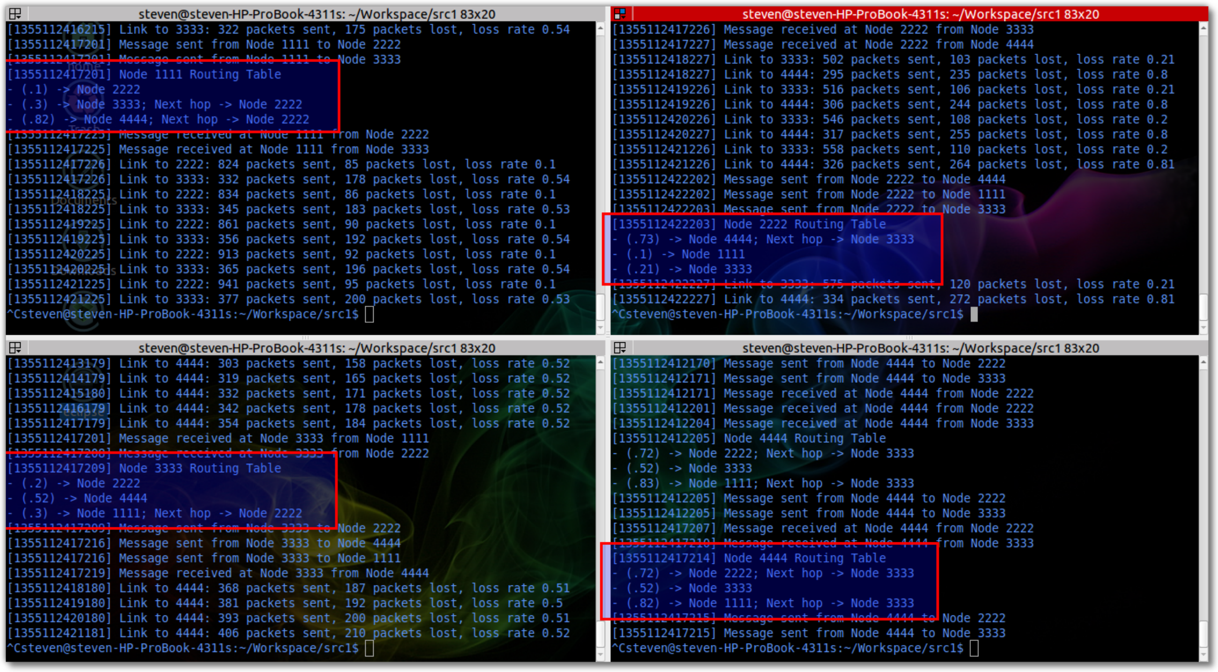
Fig 7-2 shows some link status at node 2222, the print rate is 1 second:



```
[1355112387182] Message received at Node 2222 from Node 4444
[1355112387186] Message received at Node 2222 from Node 1111
[1355112388196] Link to 3333: 15 packets sent, 4 packets lost, loss rate 0.27
[1355112388197] Link to 4444: 12 packets sent, 8 packets lost, loss rate 0.67
[1355112389196] Link to 3333: 38 packets sent, 7 packets lost, loss rate 0.18
[1355112389196] Link to 4444: 22 packets sent, 16 packets lost, loss rate 0.73
[1355112390196] Link to 3333: 49 packets sent, 9 packets lost, loss rate 0.18
[1355112390196] Link to 4444: 33 packets sent, 24 packets lost, loss rate 0.73
```

Fig 7-2

Fig 7-3 shows the routing table before I killed them, it is very close to the input data:



```
steven@steven-HP-ProBook-4311s: ~/Workspace/src1 83x20
[1355112416215] Link to 3333: 322 packets sent, 175 packets lost, loss rate 0.54
[1355112417201] Message sent from Node 1111 to Node 2222
[1355112417201] Message sent from Node 1111 to Node 3333
[1355112417201] Node 1111 Routing Table
- (.1) -> Node 2222
- (.3) -> Node 3333; Next hop -> Node 2222
- (.82) -> Node 4444; Next hop -> Node 2222
[1355112417225] Message received at Node 1111 from Node 2222
[1355112417225] Message received at Node 1111 from Node 3333
[1355112417226] Link to 2222: 824 packets sent, 85 packets lost, loss rate 0.1
[1355112417226] Link to 3333: 332 packets sent, 178 packets lost, loss rate 0.54
[1355112418225] Link to 2222: 834 packets sent, 86 packets lost, loss rate 0.1
[1355112418225] Link to 3333: 345 packets sent, 183 packets lost, loss rate 0.53
[1355112419225] Link to 2222: 861 packets sent, 90 packets lost, loss rate 0.1
[1355112419225] Link to 3333: 356 packets sent, 192 packets lost, loss rate 0.54
[1355112420225] Link to 2222: 913 packets sent, 92 packets lost, loss rate 0.1
[1355112420225] Link to 3333: 365 packets sent, 196 packets lost, loss rate 0.54
[1355112421225] Link to 2222: 941 packets sent, 95 packets lost, loss rate 0.1
[1355112421225] Link to 3333: 377 packets sent, 200 packets lost, loss rate 0.53
^Csteven@steven-HP-ProBook-4311s:~/Workspace/src1$
```

```
steven@steven-HP-ProBook-4311s: ~/Workspace/src1 83x20
[1355112417226] Message received at Node 2222 from Node 3333
[1355112417227] Message received at Node 2222 from Node 4444
[1355112418227] Link to 3333: 502 packets sent, 103 packets lost, loss rate 0.21
[1355112418227] Link to 4444: 295 packets sent, 235 packets lost, loss rate 0.8
[1355112419226] Link to 3333: 516 packets sent, 106 packets lost, loss rate 0.21
[1355112419226] Link to 4444: 306 packets sent, 244 packets lost, loss rate 0.8
[1355112420226] Link to 3333: 546 packets sent, 108 packets lost, loss rate 0.2
[1355112420227] Link to 4444: 317 packets sent, 255 packets lost, loss rate 0.8
[1355112421226] Link to 3333: 558 packets sent, 110 packets lost, loss rate 0.2
[1355112421226] Link to 4444: 326 packets sent, 264 packets lost, loss rate 0.81
[1355112422202] Message sent from Node 2222 to Node 4444
[1355112422202] Message sent from Node 2222 to Node 1111
[1355112422203] Message sent from Node 2222 to Node 3333
[1355112422203] Node 2222 Routing Table
- (.73) -> Node 4444; Next hop -> Node 3333
- (.1) -> Node 1111
- (.21) -> Node 3333
[1355112422227] Link to 3333: 575 packets sent, 120 packets lost, loss rate 0.21
[1355112422227] Link to 4444: 334 packets sent, 272 packets lost, loss rate 0.81
^Csteven@steven-HP-ProBook-4311s:~/Workspace/src1$
```

```
steven@steven-HP-ProBook-4311s: ~/Workspace/src1 83x20
[1355112413179] Link to 4444: 303 packets sent, 158 packets lost, loss rate 0.52
[1355112414179] Link to 4444: 319 packets sent, 165 packets lost, loss rate 0.52
[1355112415180] Link to 4444: 332 packets sent, 171 packets lost, loss rate 0.52
[1355112416179] Link to 4444: 342 packets sent, 178 packets lost, loss rate 0.52
[1355112417179] Link to 4444: 354 packets sent, 184 packets lost, loss rate 0.52
[1355112417201] Message received at Node 3333 from Node 1111
[1355112417208] Message received at Node 3333 from Node 2222
[1355112417209] Node 3333 Routing Table
- (.2) -> Node 2222
- (.52) -> Node 4444
- (.3) -> Node 1111; Next hop -> Node 2222
[1355112417209] Message sent from Node 3333 to Node 2222
[1355112417216] Message sent from Node 3333 to Node 4444
[1355112417216] Message sent from Node 3333 to Node 1111
[1355112417219] Message received at Node 3333 from Node 4444
[1355112418180] Link to 4444: 368 packets sent, 187 packets lost, loss rate 0.51
[1355112419180] Link to 4444: 381 packets sent, 192 packets lost, loss rate 0.5
[1355112420180] Link to 4444: 393 packets sent, 200 packets lost, loss rate 0.51
[1355112421181] Link to 4444: 406 packets sent, 210 packets lost, loss rate 0.52
^Csteven@steven-HP-ProBook-4311s:~/Workspace/src1$
```

```
steven@steven-HP-ProBook-4311s: ~/Workspace/src1 83x20
[1355112412170] Message sent from Node 4444 to Node 2222
[1355112412171] Message sent from Node 4444 to Node 3333
[1355112412171] Message received at Node 4444 from Node 2222
[1355112412201] Message received at Node 4444 from Node 2222
[1355112412204] Message received at Node 4444 from Node 3333
[1355112412205] Node 4444 Routing Table
- (.72) -> Node 2222; Next hop -> Node 3333
- (.52) -> Node 3333
- (.83) -> Node 1111; Next hop -> Node 3333
[1355112412205] Message sent from Node 4444 to Node 2222
[1355112412205] Message sent from Node 4444 to Node 3333
[1355112417207] Message received at Node 4444 from Node 2222
[1355112417210] Message received at Node 4444 from Node 3333
[1355112417214] Node 4444 Routing Table
- (.72) -> Node 2222; Next hop -> Node 3333
- (.52) -> Node 3333
- (.82) -> Node 1111; Next hop -> Node 3333
[1355112417215] Message sent from Node 4444 to Node 2222
[1355112417215] Message sent from Node 4444 to Node 3333
^Csteven@steven-HP-ProBook-4311s:~/Workspace/src1$
```

Fig 7-3