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## **CS-542 PROJECT REPORT**

# **Link State Routing Simulator**

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# 1. Introduction

The goal of this project is to develop the simulator to implement Link-State Routing Protocol which shows following functionalities:

1. Creation of a connection table for each node as default and displays all of them
2. Demonstration of a packet travelling from Source Node to Destination Node
3. Modification of link weight of existing topology and display new connection table as well as find the shortest path from Source Node to Destination Node

The idea behind link state routing can be stated as.

Each router must do the following:

1. Discover its neighbors and learn their network addresses
2. Measure the delay or cost to each of its neighbors
3. Construct a packet telling all it has just learned
4. Send this packet to all other routers
5. Using the Dijkstra algorithm, each router calculates the shortest path to each network and enters this information into the route table.

# 2. System Features

The document provides the basic system features in detail of how it works. As far as the software features are concerned it is very important that they are simple to use and display high performance in possibly all aspects from both users and the developer. Here are some main points which describe the system features effectively.

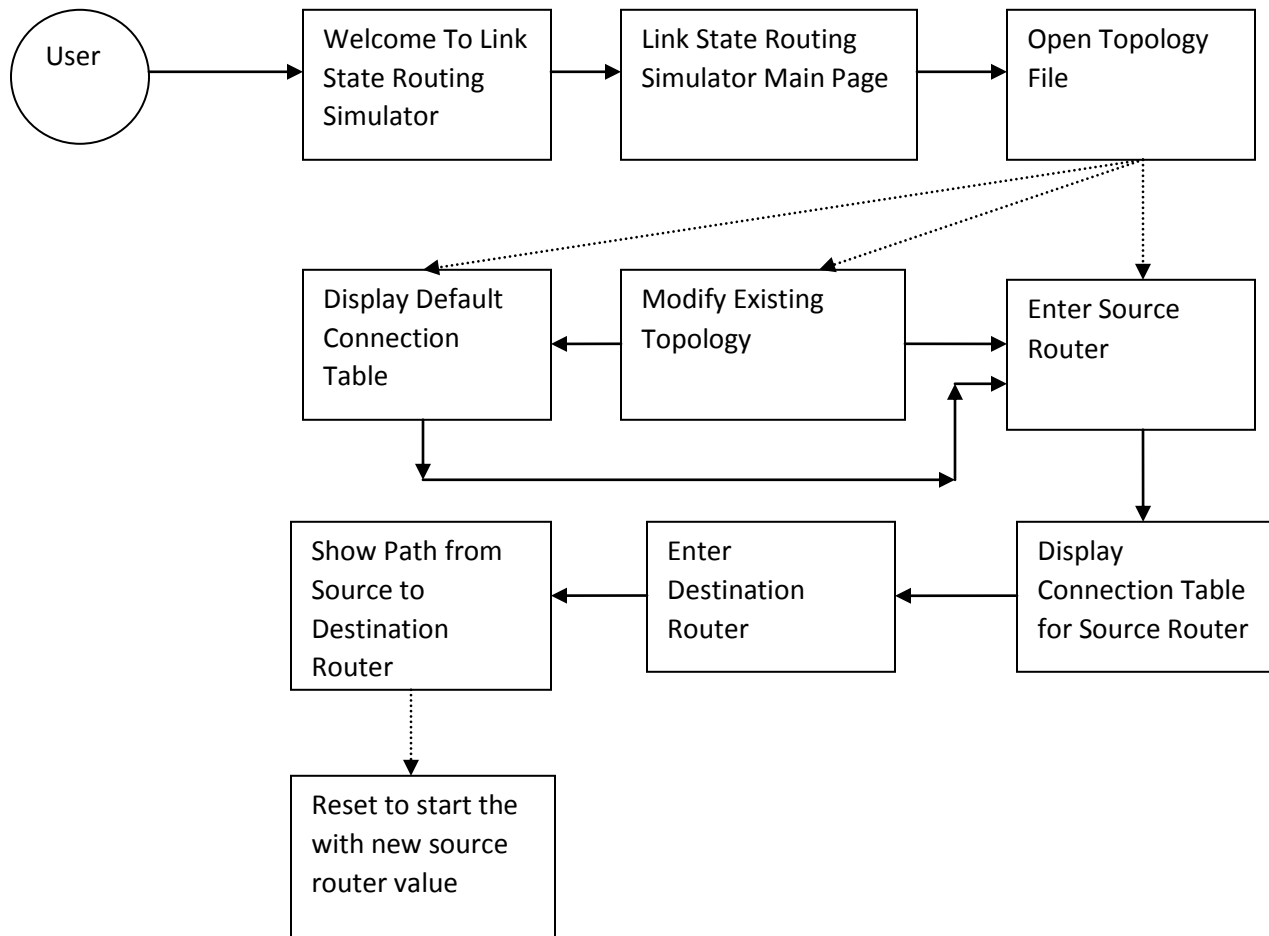
1. **User Defined Topology File:** The system provides its users an option to choose their own topology as an input to the system. With help of user defined topology file, the system carries out all the required operations which provides user an efficient way to evaluate its own topology and get a result regarding the connection tables at each phase of the system as well as the shortest path from source to destination routers

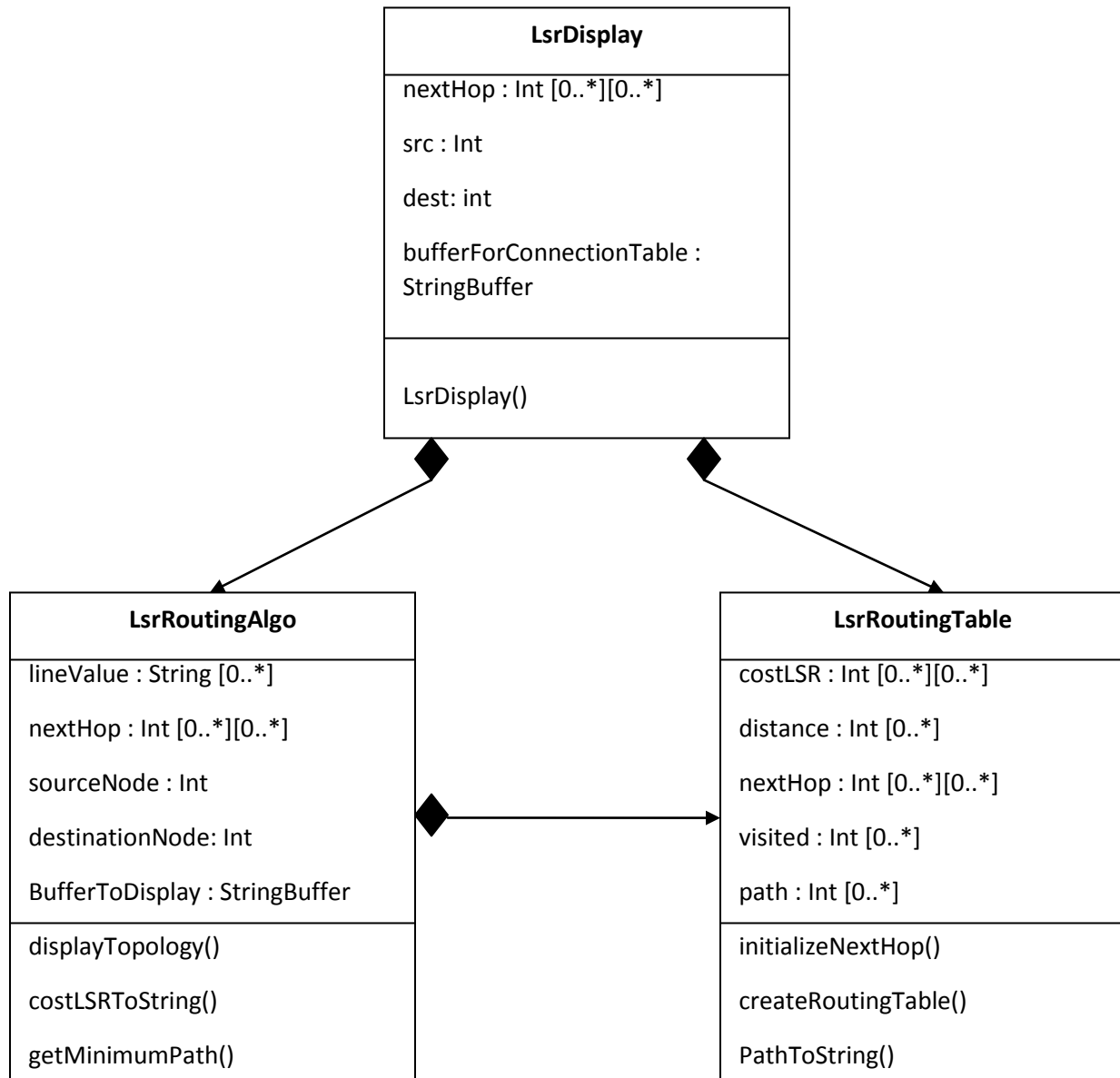
2. **Default Connection Table :** The system has been developed in such a way that it facilitates the user to view all Default Connection Tables possessed by each router, those are involved in the topology. This options proves to be very useful if any user is in need of having a detailed view of all the connection tables and would want to compare them for future estimations
3. **Modification of Default Topology:** The system gives its user an opportunity to modify the Default Input Topology by asking to enter the source and destination router where it wants to modify the link weight. This option modifies the default topology and displays the modified topology and then performs all the required operations to get the results in which users are interested
4. **Connection Table:** This feature has been implemented to check the Connection Table at each phase of the system implementation. This option asks for the router number, for which the user wants to view individual connection table
5. **Finding Shortest Path:** The system has been implemented to find the shortest path between the mentioned Source router to Destination router. This feature allows user to quickly view the shortest path present between the given input routers. System also demonstrates the route of reaching from source to destination using shortest path
6. **Efficient Navigation:** The system has been implemented in a such way that, it gives no overheads to its user for navigating within the system flow and provides efficient access to all its features and results

### 3. System Design

The In this phase, mapping of various requirements to the software environment is carried out and also the implementation decisions by concentrating on how the software will be built. Decision of how the software will be structured into components and how the components will be implemented is taken. This system was divided into four different components. Using different modeling techniques, basic design models of the project were built.

#### High Level Design:



**Class Diagram :**

**Low Level Design :**

Low Level Design consists of detailed explanation about the working of each class and its corresponding function.

**1. Class : LsrDisplay**

- This class is used for creation of GUI for the Link State Routing Simulator. This class addresses all action listeners for the operations the simulator supposed to perform in order to serve the user requirements
- As we can observe in the High Level Design , this class is calling the methods implemented in other classes
- This is the main class with the help of which the entire workflow of the simulator has been managed

**2. Class : LsrRoutingAlgo**

- This class implements some of the important methods those have been used to get the minimum path, to display the input topology
- **getMinimumPath()** : This function takes the input of source router, destination router form user and calculates the minimum path required from the given source to destination. This function also states the path taken by the packet while travelling from source to destination and displays the cost of travelling
- **costLSRToString()**: This function is used to display the input topology matrix to the simulator in the matrix form, stating the names of each router and displaying the weight each link carries to each other link
- **displayTopology()**: This is most important function as it stores the input topology is an 2-D array and all the remaining calculations are getting performed on this cost matrix and serves as a important element of the system programming implementation

**3. Class: LsrRoutingTable**

- This class serves to implement another important user requirement of displaying connection table of each router's connection table by default or after taking the source input from user
- **createRoutingTable()**: This functions checks whether the destination is reachable or not. If the destination is reachable, then it takes Cost Matrix as a reference and checks from the current position which will be the link having minimum weight and sets it as Minimum. This is been done to store the minimum weight link and is later used to backtrack the cost matrix to find the shortest path and to set the hopping for the packet from source to destination
- **pathToStirng()**: This function is used to actual display of the connection table for each router by default as well as it takes source router as a input from user and displays the connection table for that particular router

## 4. Algorithm

1. Mark all nodes as unvisited in {Visited[]} array.
2. Set the distance[] array with the value of weight of the source node given by user
3. Set Visited[] of source node to 1.
4. By traversing the array, check which nodes are unreachable and set their value to the maximum number (e.g 99999) i.e it marks it as Infinity
5. Initialize the value of min to 99999.
6. Find the minimum by traversing the array.
7. Set the index of minimum value to NextHop
8. Set visited[] of NextHop node as 1.
9. Check if  $(\text{min} + \text{costLSRMatrix}[\text{nextHop}][\text{index}] < \text{distance}[\text{index}])$  where index equals unvisited node from Visited[] array.
10. If condition is true then set  $\text{distance}[\text{index}]$  to  $(\text{min} + \text{costLSRMatrix}[\text{nextHop}][\text{index}])$ .
11. Traverse the loop (from step 9) till all the un-visited nodes has been visited
12. Repeat from step 5 until all the nodes are visited

### Important Parameters Used :

Visited[] : set of visited vertices

min : minimum cost list of the shortest path

sourceNode : Source router

destinationNode : Destination router

routerCount : Number of routers.

costLSRMatrix[][] : Topology matrix stored from the file

distance[] : distance used in the Dijkstra's algorithm



**Dijkstra's Algorithm**

```

for (int i = 0; i < routerCount; i++)
{
    min = 99999;
    FindMinimumPath();
    nodeVisited[nextNode] = 1;
    for (int i = 0; i < routerCount; i++)
    {
        if (Visited[i] != 1 && costLSRMatrix[nextHop][xi] != -1)
        {
            if (min + costLSRMatrix[nextHop][i] < distance[i])
            {
                distance[i] = min + costLSRMatrix[nextHop][i];
                path[i] = nextHop;
            }
        }
    }
}

```

There are certain assumption made while implementing the algorithm, which are :

1. The topology matrix must contain non-negative integers (as per requirement of Dijkstra's algorithm) and greater than 0, except for -1 for infinity
2. The project accepts an input text file, containing topology matrix, where each element is Delimited by space.
3. The distance of any link between 2 routers should be d i.e.  $0 < d < 99999$ .

## 5. Project Schedule and Team Structure

A Project Schedule is created to outline and define the work to be done and define the timeline for the project. It is only one of the inputs necessary to produce a Project Schedule that can be used to effectively manage a project. Below mentioned is the overall project schedule and details as per development of modules.

- Man-Hour Project Estimation

Name	Time in Hours
Sumit Rana	61
Mayuresh Jakhotia	62
Vedant Godhamgaonkar	60

- Project Scheduling

Period	Details	Resource
20-24 October	Requirement Gathering and Survey	Sumit, Vedant, Mayuresh
28 October – 3 November	Development of Work Plan (Division on Module Basis)	Sumit, Vedant, Mayuresh
4-7 November	Selection of Platform, along with Installation and setup Beginning of Programming of Project	Sumit, Vedant, Mayuresh
7-10 November	Module -1 : Graphical User Interface Development and Designing of User Interface	Sumit
12-15 November	Module-2: Connection Table Worked on Logic and Design of Connection Table	Vedant
15- 18 November	Module-3 : Finding Shortest Path Worked on logic and programming of finding shortest path between source and destination	Mayuresh
19 – 20 November	Final Testing as per module and Testing the entire system Documentation	Sumit, Vedant, Mayuresh
21 November	System is delivered (Uploaded on BlackBoard)	Sumit, Vedant, Mayuresh

## 6. Software Testing

The testing phase involves the testing of the developed system using various kinds of data. An elaborated testing of data is prepared and a system is tested using the test data. While testing, errors are noted and corrections remade, the corrections are also noted for future use.

Programming starts by writing the tests before writing actual code, then just write enough code to get to tests to pass. Using this kind of methodology helps to keep the system as simple as possible. The categorizer module consists of many individual classes as components.

### **Strategies used:**

#### **Unit Testing:**

During the implementation of the system each module of the system was tested separately to uncover errors within its boundaries. User interface was used a guide in the process.

#### **Integration Testing:**

Integration testing is a systematic technique for constructing the program structure while conducting tests to uncover errors associated with interfacing. The objective is to take unit-tested module and build a program structure that has been dictated by design.

#### **Validation Testing:**

As per the requirement of the client the software that is developed are updated & validated. Validation testing is done to provide final assurance that software meets all the functional, behavioral, & performance requirements.

#### **System Testing:**

After the completion of the software the whole software is tested as a whole & resolves every queries of the software before delivering to the client. The system testing verifies that all the elements of the system work in union with the software developed & the overall system function /performance is achieved.

Testing is a set of activities that can be planned in advance & conducted systematically. A number of software testing strategies have been proposed. A Strategy for software testing must be accommodate low-level tests that are necessary to verify that a small source code segment has been correctly implemented as well as high – level tests that validate major functions against client requirements.

<b>Test Case ID</b>	<b>TC001</b>
<b>Test Case Description</b>	Verification of system before inserting topology
<b>Test Data</b>	Click event on operation buttons
<b>Steps</b>	Click on any button before loading the Topology file
<b>Expected Result</b>	This invalid operation should show user an error message with suggestion
<b>Actual Result</b>	Error Message Displayed

<b>Test Case ID</b>	<b>TC002</b>
<b>Test Case Description</b>	Verify Input of topology file
<b>Test Data</b>	Topology Matrix Text File
<b>Steps</b>	Click on File --> Open --> Select Topology.txt file
<b>Expected Result</b>	This valid operation should show user an input topology file with appropriate indentation
<b>Actual Result</b>	Displayed input topology file

<b>Test Case ID</b>	<b>TC003</b>
<b>Test Case Description</b>	Verify default connection table
<b>Test Data</b>	Topology Matrix
<b>Steps</b>	Click on File --> Open --> Select Topology.txt file --> Click on Default Connection Table button
<b>Expected Result</b>	This valid operation should show user the default connection tables for each present router
<b>Actual Result</b>	Displayed default connection tables for each router

<b>Test Case ID</b>	<b>TC004</b>
<b>Test Case Description</b>	Verify modification of existing topology
<b>Test Data</b>	Topology Matrix
<b>Steps</b>	Click on File --> Open --> Select Topology.txt file --> Click on Modify button
<b>Expected Result</b>	This valid operation should show user the option to modify the link weight between given source and destination router
<b>Actual Result</b>	Displayed Modified Topology Matrix

<b>Test Case ID</b>	<b>TC005</b>
<b>Test Case Description</b>	Verify Shortest Path
<b>Test Data</b>	Topology Matrix
<b>Steps</b>	Click on File --> Open --> Select Topology.txt file --> Enter Source Router --> Click Next button --> Enter Destination Router --> Click Path button
<b>Expected Result</b>	This valid operation should show user the Shortest Path between entered source router and destination router
<b>Actual Result</b>	Displayed Shortest Path

## Additional Test Cases :

Test Case ID : 1

Test Data : Input\_Topology.txt file with following contents :

0	16	9	35	-1	-1	-1	-1
16	0	-1	12	25	-1	-1	-1
9	-1	0	15	-1	22	-1	-1
35	12	15	0	14	17	19	20
-1	25	-1	14	0	-1	8	10
-1	-1	22	17	-1	0	14	10
-1	-1	-1	19	8	14	0	-1
-1	-1	-1	18	7	13	12	0

Operation : Open

Result:

Input Topology ->

R1 R2 R3 R4 R5 R6 R7 R8

```

R1 0 16 9 35 -1 -1 -1 -1
R2 16 0 -1 12 25 -1 -1 -1
R3 9 -1 0 15 -1 22 -1 -1
R4 35 12 15 0 14 17 19 20
R5 -1 25 -1 14 0 -1 8 10
R6 -1 -1 22 17 -1 0 14 10
R7 -1 -1 -1 19 8 14 0 -1
R8 -1 -1 -1 18 7 13 12 0

```

**Test Case ID : 2**

**Test Data : Input Topology Matrix**

0	16	9	35	-1	-1	-1	-1
16	0	-1	12	25	-1	-1	-1
9	-1	0	15	-1	22	-1	-1
35	12	15	0	14	17	19	20
-1	25	-1	14	0	-1	8	10
-1	-1	22	17	-1	0	14	10
-1	-1	-1	19	8	14	0	-1
-1	-1	-1	18	7	13	12	0

**Operation : Modify Topology**

**Modify Link From R:1**

**Modify Link To R:3**

**Modify Link Weight : 12**

**Result :**

Input Topology ->

R1 R2 R3 R4 R5 R6 R7 R8

```

R1 0 16 12 35 -1 -1 -1 -1
R2 16 0 -1 12 25 -1 -1 -1
R3 9 -1 0 15 -1 22 -1 -1
R4 35 12 15 0 14 17 19 20
R5 -1 25 -1 14 0 -1 8 10
R6 -1 -1 22 17 -1 0 14 10
R7 -1 -1 -1 19 8 14 0 -1
R8 -1 -1 -1 18 7 13 12 0

```

**Test Case ID : 3**

0	16	9	35	-1	-1	-1	-1
16	0	-1	12	25	-1	-1	-1
9	-1	0	15	-1	22	-1	-1
35	12	15	0	14	17	19	20
-1	25	-1	14	0	-1	8	10
-1	-1	22	17	-1	0	14	10
-1	-1	-1	19	8	14	0	-1
-1	-1	-1	18	7	13	12	0

**Operation : Default Connection Table****Result :**

Router R1 Connection Table -&gt;

| Destination | Next Hop |

---

R1	-
R2	2
R3	3
R4	3
R5	3
R6	3
R7	3
R8	3

Router R2 Connection Table -&gt;

| Destination | Next Hop |

---

R1	1
R2	-
R3	1
R4	4
R5	5
R6	4
R7	4
R8	4

Router R3 Connection Table ->

| Destination | Next Hop |

---

R1	1
R2	1
R3	-
R4	4
R5	4
R6	6
R7	4
R8	6

Router R4 Connection Table ->

| Destination | Next Hop |

---

R1	3
R2	2
R3	3
R4	-
R5	5
R6	6
R7	7
R8	8

Router R5 Connection Table ->

| Destination | Next Hop |

---

R1	4
R2	2
R3	4
R4	4
R5	-
R6	7
R7	7
R8	8



Router R6 Connection Table -&gt;

Destination	Next Hop
-------------	----------

R1	3
R2	4
R3	3
R4	4
R5	8
R6	-
R7	7
R8	8

Router R7 Connection Table -&gt;

Destination	Next Hop
-------------	----------

R1	4
R2	4
R3	4
R4	4
R5	5
R6	6
R7	-
R8	5

Router R8 Connection Table -&gt;

Destination	Next Hop
-------------	----------

R1	4
R2	4
R3	4
R4	4
R5	5
R6	6
R7	7
R8	-

**Test Case ID : 4**

0	16	9	35	-1	-1	-1	-1
16	0	-1	12	25	-1	-1	-1
9	-1	0	15	-1	22	-1	-1
35	12	15	0	14	17	19	20
-1	25	-1	14	0	-1	8	10
-1	-1	22	17	-1	0	14	10
-1	-1	-1	19	8	14	0	-1
-1	-1	-1	18	7	13	12	0

**Operation : Source Router Value:R1****Result:**

Router R1 Connection Table -&gt;

| Destination | Next Hop |

---

R1	-
R2	2
R3	3
R4	3
R5	3
R6	3
R7	3
R8	3

**Test Case ID : 5**

0	16	9	35	-1	-1	-1	-1
16	0	-1	12	25	-1	-1	-1
9	-1	0	15	-1	22	-1	-1
35	12	15	0	14	17	19	20
-1	25	-1	14	0	-1	8	10
-1	-1	22	17	-1	0	14	10
-1	-1	-1	19	8	14	0	-1
-1	-1	-1	18	7	13	12	0

**Operation : Destination Router Value:R4**

**Click Path button**

**Result :**

The Least Cost Path from R1 to R4 is:

1=>3=>4

Minimum Cost to reach Destination: 24

**Test Case ID : 6**

**Operation : Destination Router Value:R5**

**Click Path button**

The Least Cost Path from R1 to R5 is:

1=>3=>4=>5

Minimum Cost to reach Destination: 38

**Additional Test Cases :**

(1) Accept Input Topology File - Input\_Topology\_1.txt

Input Topology ->

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
R1	0	16	19	35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R2	16	0	-1	12	25	-1	5	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R3	9	-1	0	15	-1	22	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R4	35	5	15	0	14	17	10	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R5	-1	25	-1	14	0	-1	8	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R6	-1	-1	22	17	-1	0	14	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R7	-1	-1	-1	19	8	14	0	3	10	12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R8	-1	-1	-1	-1	-1	-1	6	0	-1	4	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R9	-1	-1	-1	-1	-1	-1	10	-1	0	3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R10	-1	-1	-1	-1	-1	-1	12	-1	3	0	16	-1	-1	12	-1	-1	-1	-1	-1	-1
R11	-1	-1	-1	-1	-1	-1	-1	-1	-1	16	0	-1	-1	-1	8	-1	-1	-1	-1	-1
R12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	1	-1	4	-1	10	-1	-1	-1	-1
R13	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	6	0	-1	-1	5	-1	-1	-1	-1	-1

```

R14 -1 -1 -1 -1 -1 -1 -1 -1 -1 12 -1 -1 -1 0 -1 -1 -1 9 -1 -1
R15 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 8 4 -1 -1 0 -1 -1 -1 -1 -1
R16 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 5 -1 -1 0 -1 -1 39 -1
R17 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 10 -1 -1 -1 -1 0 -1 6 23
R18 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 9 -1 -1 -1 -1 0 -1 10
R19 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 39 6 -1 0 -1
R20 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 16 30 -1 0

```

## (2) Default Connection Table

Router R1 Connection Table ->

| Destination | Next Hop |

R1	-
R2	2
R3	3
R4	2
R5	2
R6	2
R7	2
R8	2
R9	2
R10	2
R11	2
R12	2
R13	2
R14	2
R15	2
R16	2
R17	2
R18	2
R19	2
R20	2

Router R2 Connection Table ->

| Destination | Next Hop |

R1	1
R2	-
R3	4
R4	4
R5	7
R6	7
R7	7
R8	7

R9	7
R10	7
R11	7
R12	7
R13	7
R14	7
R15	7
R16	7
R17	7
R18	7
R19	7
R20	7

Router R3 Connection Table ->

Destination	Next Hop
-------------	----------

R1	1
R2	4
R3	-
R4	4
R5	4
R6	6
R7	4
R8	4
R9	4
R10	4
R11	4
R12	4
R13	4
R14	4
R15	4
R16	4
R17	4
R18	4
R19	4
R20	4

Router R4 Connection Table ->

Destination	Next Hop
-------------	----------

R1	2
R2	2
R3	3
R4	-
R5	5
R6	6

R7	7
R8	2
R9	2
R10	2
R11	2
R12	2
R13	2
R14	2
R15	2
R16	2
R17	2
R18	2
R19	2
R20	2

Router R5 Connection Table ->

| Destination | Next Hop |

---

R1	4
R2	4
R3	4
R4	4
R5	-
R6	7
R7	7
R8	7
R9	7
R10	7
R11	7
R12	7
R13	7
R14	7
R15	7
R16	7
R17	7
R18	7
R19	7
R20	7

Router R6 Connection Table ->

| Destination | Next Hop |

---

R1	3
R2	4
R3	3
R4	4

R5	7
R6	-
R7	7
R8	7
R9	7
R10	7
R11	7
R12	7
R13	7
R14	7
R15	7
R16	7
R17	7
R18	7
R19	7
R20	7

Router R7 Connection Table ->

| Destination | Next Hop |

R1	4
R2	4
R3	4
R4	4
R5	5
R6	6
R7	-
R8	8
R9	9
R10	8
R11	8
R12	8
R13	8
R14	8
R15	8
R16	8
R17	8
R18	8
R19	8
R20	8

Router R8 Connection Table ->

| Destination | Next Hop |

R1	7
R2	7

R3	7
R4	7
R5	7
R6	7
R7	7
R8	-
R9	10
R10	10
R11	10
R12	10
R13	10
R14	10
R15	10
R16	10
R17	10
R18	10
R19	10
R20	10

Router R9 Connection Table ->

Destination	Next Hop
-------------	----------

---

R1	7
R2	7
R3	7
R4	7
R5	7
R6	7
R7	7
R8	7
R9	-
R10	10
R11	10
R12	10
R13	10
R14	10
R15	10
R16	10
R17	10
R18	10
R19	10
R20	10

Router R10 Connection Table ->

Destination	Next Hop
-------------	----------



R1	7
R2	7
R3	7
R4	7
R5	7
R6	7
R7	7
R8	7
R9	9
R10	-
R11	11
R12	11
R13	11
R14	14
R15	11
R16	11
R17	11
R18	14
R19	11
R20	14

Router R11 Connection Table ->

| Destination | Next Hop |

---

R1	10
R2	10
R3	10
R4	10
R5	10
R6	10
R7	10
R8	10
R9	10
R10	10
R11	-
R12	15
R13	15
R14	10
R15	15
R16	15
R17	15
R18	10
R19	15
R20	15

Router R12 Connection Table ->

Destination	Next Hop
-------------	----------

R1	15
R2	15
R3	15
R4	15
R5	15
R6	15
R7	15
R8	15
R9	15
R10	15
R11	15
R12	-
R13	13
R14	15
R15	15
R16	13
R17	17
R18	15
R19	17
R20	17

Router R13 Connection Table -&gt;

Destination	Next Hop
-------------	----------

R1	12
R2	12
R3	12
R4	12
R5	12
R6	12
R7	12
R8	12
R9	12
R10	12
R11	12
R12	12
R13	-
R14	12
R15	12
R16	16
R17	12
R18	12
R19	12

R20 12

Router R14 Connection Table -&gt;

| Destination | Next Hop |

R1	10
R2	10
R3	10
R4	10
R5	10
R6	10
R7	10
R8	10
R9	10
R10	10
R11	10
R12	10
R13	10
R14	-
R15	10
R16	10
R17	18
R18	18
R19	18
R20	18

Router R15 Connection Table -&gt;

| Destination | Next Hop |

R1	11
R2	11
R3	11
R4	11
R5	11
R6	11
R7	11
R8	11
R9	11
R10	11
R11	11
R12	12
R13	12
R14	11
R15	-
R16	12
R17	12

R18        11  
R19        12  
R20        12

Router R16 Connection Table ->

| Destination | Next Hop |

---

R1	13
R2	13
R3	13
R4	13
R5	13
R6	13
R7	13
R8	13
R9	13
R10	13
R11	13
R12	13
R13	13
R14	13
R15	13
R16	-
R17	13
R18	13
R19	13
R20	13

Router R17 Connection Table ->

| Destination | Next Hop |

---

R1	12
R2	12
R3	12
R4	12
R5	12
R6	12
R7	12
R8	12
R9	12
R10	12
R11	12
R12	12
R13	12
R14	12
R15	12

R16	12
R17	-
R18	20
R19	19
R20	20

Router R18 Connection Table ->

Destination	Next Hop
-------------	----------

R1	14
R2	14
R3	14
R4	14
R5	14
R6	14
R7	14
R8	14
R9	14
R10	14
R11	14
R12	20
R13	20
R14	14
R15	20
R16	20
R17	20
R18	-
R19	20
R20	20

Router R19 Connection Table ->

Destination	Next Hop
-------------	----------

R1	17
R2	17
R3	17
R4	17
R5	17
R6	17
R7	17
R8	17
R9	17
R10	17
R11	17
R12	17
R13	17

R14	17
R15	17
R16	17
R17	17
R18	17
R19	-
R20	17

Router R20 Connection Table ->

| Destination | Next Hop |

R1	18
R2	18
R3	18
R4	18
R5	18
R6	18
R7	18
R8	18
R9	18
R10	18
R11	17
R12	17
R13	17
R14	18
R15	17
R16	17
R17	17
R18	18
R19	17
R20	-

(3) Add link weight 6 from R11 to R12

Input Topology ->

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
R1	0	16	19	35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R2	16	0	-1	12	25	-1	5	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R3	9	-1	0	15	-1	22	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R4	35	5	15	0	14	17	10	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R5	-1	25	-1	14	0	-1	8	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

```

R6 -1 -1 22 17 -1 0 14 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
R7 -1 -1 -1 19 8 14 0 3 10 12 -1 -1 -1 -1 -1 -1 -1 -1
R8 -1 -1 -1 -1 -1 -1 6 0 -1 4 -1 -1 -1 -1 -1 -1 -1 -1
R9 -1 -1 -1 -1 -1 -1 10 -1 0 3 -1 -1 -1 -1 -1 -1 -1 -1
R10 -1 -1 -1 -1 -1 -1 12 -1 3 0 16 -1 -1 12 -1 -1 -1 -1
R11 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 16 0 6 -1 -1 8 -1 -1
R12 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0 1 -1 4 -1 10 -1
R13 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 6 0 -1 -1 5 -1 -1
R14 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 12 -1 -1 -1 0 -1 -1 9 -1
R15 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 8 4 -1 -1 0 -1 -1 -1
R16 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 5 -1 -1 0 -1 -1 39 -1
R17 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 10 -1 -1 -1 -1 0 -1 6 23
R18 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 9 -1 -1 -1 0 -1 10
R19 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 39 6 -1 0 -1
R20 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 16 30 -1 0

```

(4) Select source router as R4

Router R4 Connection Table ->

| Destination | Next Hop |

R1	2
R2	2
R3	3
R4	-
R5	5
R6	6
R7	7
R8	7
R9	7
R10	7
R11	7
R12	7
R13	7
R14	7
R15	7
R16	7
R17	7
R18	7
R19	7
R20	7

(5) Select destination router as R7

The Least Cost Path from R4 to R7 is:

4=>7

Minimum Cost to reach Destination: 10

Another Path is available (With Same Cost):

4=>2=>7

(1) Accept Input Topology File - Input\_Topology\_2.txt

Input Topology ->

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
R1	0	-1	19	24	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R2	16	0	-1	-1	25	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R3	9	-1	0	15	-1	22	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R4	24	5	15	0	14	17	12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R5	-1	25	-1	14	0	-1	8	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R6	-1	-1	22	17	-1	0	14	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R7	-1	-1	-1	19	8	14	0	3	12	12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R8	-1	-1	-1	-1	-1	-1	6	0	-1	4	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R9	-1	-1	-1	-1	-1	-1	12	-1	0	3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R10	-1	-1	-1	-1	-1	-1	12	-1	3	0	16	-1	-1	12	-1	-1	-1	-1	-1	-1
R11	-1	-1	-1	-1	-1	-1	-1	-1	-1	16	0	-1	-1	-1	8	-1	-1	-1	-1	-1
R12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	1	-1	4	-1	12	-1	-1	50	-1
R13	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	6	0	-1	-1	5	-1	-1	-1	-1	-1
R14	-1	-1	-1	-1	-1	-1	-1	-1	-1	12	-1	-1	-1	0	-1	-1	-1	9	-1	-1
R15	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	8	4	-1	-1	0	-1	-1	-1	-1	-1
R16	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	5	-1	-1	0	-1	-1	39	-1	-1
R17	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	12	-1	-1	-1	-1	0	-1	6	-1	-1
R18	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	9	-1	-1	-1	0	-1	12	-1
R19	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	39	6	-1	0	-1	-1
R20	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	16	-1	-1	0	-1

(2) Default Connection Table

Router R1 Connection Table ->

| Destination | Next Hop |

---



R1	-
R2	4
R3	3
R4	4
R5	4
R6	3
R7	4
R8	4
R9	4
R10	4
R11	4
R12	4
R13	4
R14	4
R15	4
R16	4
R17	4
R18	4
R19	4
R20	4

Router R2 Connection Table ->

| Destination | Next Hop |

---

R1	1
R2	-
R3	1
R4	5
R5	5
R6	5
R7	5
R8	5
R9	5
R10	5
R11	5
R12	5
R13	5
R14	5
R15	5
R16	5
R17	5
R18	5
R19	5
R20	5

Router R3 Connection Table ->

Destination	Next Hop
-------------	----------

R1	1
R2	4
R3	-
R4	4
R5	4
R6	6
R7	4
R8	4
R9	4
R10	4
R11	4
R12	4
R13	4
R14	4
R15	4
R16	4
R17	4
R18	4
R19	4
R20	4

Router R4 Connection Table -&gt;

Destination	Next Hop
-------------	----------

R1	2
R2	2
R3	3
R4	-
R5	5
R6	6
R7	7
R8	7
R9	7
R10	7
R11	7
R12	7
R13	7
R14	7
R15	7
R16	7
R17	7
R18	7
R19	7

R20            7

Router R5 Connection Table -&gt;

| Destination | Next Hop |

---

R1	4
R2	4
R3	4
R4	4
R5	-
R6	7
R7	7
R8	7
R9	7
R10	7
R11	7
R12	7
R13	7
R14	7
R15	7
R16	7
R17	7
R18	7
R19	7
R20	7

Router R6 Connection Table -&gt;

| Destination | Next Hop |

---

R1	3
R2	4
R3	3
R4	4
R5	7
R6	-
R7	7
R8	7
R9	7
R10	7
R11	7
R12	7
R13	7
R14	7
R15	7
R16	7
R17	7

R18        7  
R19        7  
R20        7

Router R7 Connection Table ->

| Destination | Next Hop |

---

R1	4
R2	4
R3	4
R4	4
R5	5
R6	6
R7	-
R8	8
R9	8
R10	8
R11	8
R12	8
R13	8
R14	8
R15	8
R16	8
R17	8
R18	8
R19	8
R20	8

Router R8 Connection Table ->

| Destination | Next Hop |

---

R1	7
R2	7
R3	7
R4	7
R5	7
R6	7
R7	7
R8	-
R9	10
R10	10
R11	10
R12	10
R13	10
R14	10
R15	10

R16	10
R17	10
R18	10
R19	10
R20	10

Router R9 Connection Table ->

Destination	Next Hop
-------------	----------

R1	7
R2	7
R3	7
R4	7
R5	7
R6	7
R7	7
R8	7
R9	-
R10	10
R11	10
R12	10
R13	10
R14	10
R15	10
R16	10
R17	10
R18	10
R19	10
R20	10

Router R10 Connection Table ->

Destination	Next Hop
-------------	----------

R1	7
R2	7
R3	7
R4	7
R5	7
R6	7
R7	7
R8	7
R9	9
R10	-
R11	11
R12	11
R13	11

R14	14
R15	11
R16	11
R17	11
R18	14
R19	11
R20	14

Router R11 Connection Table ->

| Destination | Next Hop |

R1	10
R2	10
R3	10
R4	10
R5	10
R6	10
R7	10
R8	10
R9	10
R10	10
R11	-
R12	15
R13	15
R14	10
R15	15
R16	15
R17	15
R18	10
R19	15
R20	10

Router R12 Connection Table ->

| Destination | Next Hop |

R1	15
R2	15
R3	15
R4	15
R5	15
R6	15
R7	15
R8	15
R9	15
R10	15
R11	15

R12	-
R13	13
R14	15
R15	15
R16	13
R17	17
R18	15
R19	17
R20	20

Router R13 Connection Table ->

| Destination | Next Hop |

R1	12
R2	12
R3	12
R4	12
R5	12
R6	12
R7	12
R8	12
R9	12
R10	12
R11	12
R12	12
R13	-
R14	12
R15	12
R16	16
R17	12
R18	12
R19	12
R20	12

Router R14 Connection Table ->

| Destination | Next Hop |

R1	10
R2	10
R3	10
R4	10
R5	10
R6	10
R7	10
R8	10
R9	10

R10	10
R11	10
R12	10
R13	10
R14	-
R15	10
R16	10
R17	18
R18	18
R19	18
R20	18

Router R15 Connection Table ->

| Destination | Next Hop |

---

R1	11
R2	11
R3	11
R4	11
R5	11
R6	11
R7	11
R8	11
R9	11
R10	11
R11	11
R12	12
R13	12
R14	11
R15	-
R16	12
R17	12
R18	11
R19	12
R20	12

Router R16 Connection Table ->

| Destination | Next Hop |

---

R1	13
R2	13
R3	13
R4	13
R5	13
R6	13
R7	13



R8	13
R9	13
R10	13
R11	13
R12	13
R13	13
R14	13
R15	13
R16	-
R17	13
R18	13
R19	13
R20	13

Router R17 Connection Table ->

| Destination | Next Hop |

---

R1	12
R2	12
R3	12
R4	12
R5	12
R6	12
R7	12
R8	12
R9	12
R10	12
R11	12
R12	12
R13	12
R14	12
R15	12
R16	12
R17	-
R18	12
R19	19
R20	12

Router R18 Connection Table ->

| Destination | Next Hop |

---

R1	14
R2	14
R3	14
R4	14
R5	14

R6	14
R7	14
R8	14
R9	14
R10	14
R11	14
R12	20
R13	20
R14	14
R15	20
R16	20
R17	20
R18	-
R19	20
R20	20

Router R19 Connection Table ->

| Destination | Next Hop |

---

R1	17
R2	17
R3	17
R4	17
R5	17
R6	17
R7	17
R8	17
R9	17
R10	17
R11	17
R12	17
R13	17
R14	17
R15	17
R16	17
R17	17
R18	17
R19	-
R20	17

Router R20 Connection Table ->

| Destination | Next Hop |

---

R1	17
R2	17
R3	17

R4	17
R5	17
R6	17
R7	17
R8	17
R9	17
R10	17
R11	17
R12	17
R13	17
R14	17
R15	17
R16	17
R17	17
R18	17
R19	17
R20	-

(3) Modify link weight from 19 to 16 from R1 to R3

Input Topology ->

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
R1	0	-1	16	24	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R2	16	0	-1	-1	25	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R3	9	-1	0	15	-1	22	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R4	24	5	15	0	14	17	12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R5	-1	25	-1	14	0	-1	8	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R6	-1	-1	22	17	-1	0	14	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R7	-1	-1	-1	19	8	14	0	3	12	12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R8	-1	-1	-1	-1	-1	-1	6	0	-1	4	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R9	-1	-1	-1	-1	-1	-1	12	-1	0	3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R10	-1	-1	-1	-1	-1	-1	12	-1	3	0	16	-1	-1	12	-1	-1	-1	-1	-1	-1
R11	-1	-1	-1	-1	-1	-1	-1	-1	-1	16	0	-1	-1	-1	8	-1	-1	-1	-1	-1
R12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	1	-1	4	-1	12	-1	-1	50	-1
R13	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	6	0	-1	-1	5	-1	-1	-1	-1	-1
R14	-1	-1	-1	-1	-1	-1	-1	-1	-1	12	-1	-1	-1	0	-1	-1	9	-1	-1	-1
R15	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	8	4	-1	-1	0	-1	-1	-1	-1	-1
R16	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	5	-1	-1	0	-1	-1	39	-1	-1
R17	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	12	-1	-1	-1	-1	0	-1	6	-1	-1
R18	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	9	-1	-1	-1	0	-1	12	-1

```

R19 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 39 6 -1 0 -1
R20 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 16 -1 -1 0

```

(4) Select source router as R1

Router R1 Connection Table ->

| Destination | Next Hop |

R1	-
R2	4
R3	3
R4	4
R5	4
R6	3
R7	4
R8	4
R9	4
R10	4
R11	4
R12	4
R13	4
R14	4
R15	4
R16	4
R17	4
R18	4
R19	4
R20	4

(5) Select destination router as R19

The Least Cost Path from R1 to R19 is:

1=>4=>7=>8=>10=>11=>15=>12=>17=>19

Minimum Cost to reach Destination: 89

(1) Accept Input Topology File - Input\_Topology\_3.txt

Input Topology ->

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
R1	0	-1	19	24	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R2	16	0	-1	-1	25	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R3	9	-1	0	15	-1	22	-1	-1	-1	-1	41	-1	-1	-1	-1	-1	-1	-1	-1	-1
R4	24	5	15	0	17	7	12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R5	-1	25	-1	17	0	-1	8	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R6	-1	-1	22	7	-1	0	17	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R7	-1	-1	-1	19	8	17	0	3	12	12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R8	-1	-1	-1	-1	-1	-1	6	0	-1	4	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R9	-1	-1	-1	-1	-1	-1	12	-1	0	3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R10	-1	-1	-1	-1	-1	-1	12	-1	3	0	16	-1	-1	12	-1	-1	-1	-1	-1	-1
R11	-1	-1	-1	-1	-1	-1	-1	-1	-1	16	0	-1	-1	-1	8	-1	-1	-1	-1	-1
R12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-1	-1	4	-1	12	-1	-1	50	-1
R13	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-1	-1	5	-1	-1	-1	-1	-1
R14	-1	-1	-1	-1	-1	-1	-1	-1	-1	12	-1	-1	-1	0	-1	-1	-1	9	-1	-1
R15	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	8	4	-1	-1	0	-1	-1	-1	-1	-1
R16	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	5	-1	-1	0	-1	6	39	-1	-1
R17	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	12	-1	-1	-1	-1	0	-1	6	-1	-1
R18	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	9	-1	-1	-1	0	-1	-1	-1
R19	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	39	6	-1	0	-1	-1
R20	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	16	-1	-1	0	-1

## (2) Default Connection Table

Router R1 Connection Table ->

| Destination | Next Hop |

R1	-
R2	4
R3	3
R4	4
R5	4
R6	4
R7	4
R8	4
R9	4
R10	4
R11	4
R12	4

R13	4
R14	4
R15	4
R16	4
R17	4
R18	4
R19	4
R20	4

Router R2 Connection Table ->

Destination	Next Hop
-------------	----------

R1	1
R2	-
R3	1
R4	1
R5	5
R6	1
R7	5
R8	5
R9	5
R10	5
R11	5
R12	5
R13	5
R14	5
R15	5
R16	5
R17	5
R18	5
R19	5
R20	5

Router R3 Connection Table ->

Destination	Next Hop
-------------	----------

R1	1
R2	4
R3	-
R4	4
R5	4
R6	6
R7	4
R8	4
R9	4
R10	4

R11	11
R12	11
R13	11
R14	4
R15	11
R16	11
R17	11
R18	4
R19	11
R20	11

Router R4 Connection Table ->

| Destination | Next Hop |

R1	2
R2	2
R3	3
R4	-
R5	5
R6	6
R7	7
R8	7
R9	7
R10	7
R11	7
R12	7
R13	7
R14	7
R15	7
R16	7
R17	7
R18	7
R19	7
R20	7

Router R5 Connection Table ->

| Destination | Next Hop |

R1	4
R2	4
R3	4
R4	4
R5	-
R6	4
R7	7
R8	7

R9	7
R10	7
R11	7
R12	7
R13	7
R14	7
R15	7
R16	7
R17	7
R18	7
R19	7
R20	7

Router R6 Connection Table ->

Destination	Next Hop	
-------------	----------	--

R1	4
R2	4
R3	3
R4	4
R5	4
R6	-
R7	7
R8	7
R9	7
R10	7
R11	7
R12	7
R13	7
R14	7
R15	7
R16	7
R17	7
R18	7
R19	7
R20	7

Router R7 Connection Table ->

Destination	Next Hop	
-------------	----------	--

R1	4
R2	4
R3	4
R4	4
R5	5
R6	6



R7	-
R8	8
R9	8
R10	8
R11	8
R12	8
R13	8
R14	8
R15	8
R16	8
R17	8
R18	8
R19	8
R20	8

Router R8 Connection Table ->

| Destination | Next Hop |

R1	7
R2	7
R3	7
R4	7
R5	7
R6	7
R7	7
R8	-
R9	10
R10	10
R11	10
R12	10
R13	10
R14	10
R15	10
R16	10
R17	10
R18	10
R19	10
R20	10

Router R9 Connection Table ->

| Destination | Next Hop |

R1	7
R2	7
R3	7
R4	7

R5	7
R6	7
R7	7
R8	7
R9	-
R10	10
R11	10
R12	10
R13	10
R14	10
R15	10
R16	10
R17	10
R18	10
R19	10
R20	10

Router R10 Connection Table ->

| Destination | Next Hop |

R1	7
R2	7
R3	7
R4	7
R5	7
R6	7
R7	7
R8	7
R9	9
R10	-
R11	11
R12	11
R13	11
R14	14
R15	11
R16	11
R17	11
R18	14
R19	11
R20	11

Router R11 Connection Table ->

| Destination | Next Hop |

R1	10
R2	10

R3	10
R4	10
R5	10
R6	10
R7	10
R8	10
R9	10
R10	10
R11	-
R12	15
R13	15
R14	10
R15	15
R16	15
R17	15
R18	10
R19	15
R20	15

Router R12 Connection Table ->

| Destination | Next Hop |

---

R1	15
R2	15
R3	15
R4	15
R5	15
R6	15
R7	15
R8	15
R9	15
R10	15
R11	15
R12	-
R13	17
R14	15
R15	15
R16	17
R17	17
R18	15
R19	17
R20	20

Router R13 Connection Table ->

| Destination | Next Hop |

R1	16
R2	16
R3	16
R4	16
R5	16
R6	16
R7	16
R8	16
R9	16
R10	16
R11	16
R12	16
R13	-
R14	16
R15	16
R16	16
R17	16
R18	16
R19	16
R20	16

Router R14 Connection Table ->

| Destination | Next Hop |

---

R1	10
R2	10
R3	10
R4	10
R5	10
R6	10
R7	10
R8	10
R9	10
R10	10
R11	10
R12	10
R13	10
R14	-
R15	10
R16	10
R17	10
R18	18
R19	10
R20	10

Router R15 Connection Table ->

Destination	Next Hop
-------------	----------

R1	11
R2	11
R3	11
R4	11
R5	11
R6	11
R7	11
R8	11
R9	11
R10	11
R11	11
R12	12
R13	12
R14	11
R15	-
R16	12
R17	12
R18	11
R19	12
R20	12

Router R16 Connection Table -&gt;

Destination	Next Hop
-------------	----------

R1	18
R2	18
R3	18
R4	18
R5	18
R6	18
R7	18
R8	18
R9	18
R10	18
R11	18
R12	18
R13	13
R14	18
R15	18
R16	-
R17	19
R18	18
R19	19

R20            18

Router R17 Connection Table -&gt;

| Destination | Next Hop |

---

R1	12
R2	12
R3	12
R4	12
R5	12
R6	12
R7	12
R8	12
R9	12
R10	12
R11	12
R12	12
R13	19
R14	12
R15	12
R16	19
R17	-
R18	19
R19	19
R20	12

Router R18 Connection Table -&gt;

| Destination | Next Hop |

---

R1	14
R2	14
R3	14
R4	14
R5	14
R6	14
R7	14
R8	14
R9	14
R10	14
R11	14
R12	14
R13	14
R14	14
R15	14
R16	14
R17	14

R18 -  
R19 14  
R20 14

Router R19 Connection Table ->

| Destination | Next Hop |

---

R1	17
R2	17
R3	17
R4	17
R5	17
R6	17
R7	17
R8	17
R9	17
R10	17
R11	17
R12	17
R13	16
R14	16
R15	17
R16	16
R17	17
R18	16
R19	-
R20	17

Router R20 Connection Table ->

| Destination | Next Hop |

---

R1	17
R2	17
R3	17
R4	17
R5	17
R6	17
R7	17
R8	17
R9	17
R10	17
R11	17
R12	17
R13	17
R14	17
R15	17

R16        17  
 R17        17  
 R18        17  
 R19        17  
 R20        -

(3) Modify link weight as 29 from R11 to R19

Input Topology ->

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
R1	0	-1	19	24	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R2	16	0	-1	-1	25	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R3	9	-1	0	15	-1	22	-1	-1	-1	-1	41	-1	-1	-1	-1	-1	-1	-1	-1	-1
R4	24	5	15	0	17	7	12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R5	-1	25	-1	17	0	-1	8	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R6	-1	-1	22	7	-1	0	17	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R7	-1	-1	-1	19	8	17	0	3	12	12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R8	-1	-1	-1	-1	-1	-1	6	0	-1	4	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R9	-1	-1	-1	-1	-1	-1	12	-1	0	3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R10	-1	-1	-1	-1	-1	-1	12	-1	3	0	16	-1	-1	12	-1	-1	-1	-1	-1	-1
R11	-1	-1	-1	-1	-1	-1	-1	-1	-1	16	0	-1	-1	-1	8	-1	-1	-1	29	-1
R12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-1	-1	4	-1	12	-1	-1	50	-1
R13	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-1	-1	5	-1	-1	-1	-1	-1
R14	-1	-1	-1	-1	-1	-1	-1	-1	-1	12	-1	-1	-1	0	-1	-1	9	-1	-1	-1
R15	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	8	4	-1	-1	0	-1	-1	-1	-1	-1
R16	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	5	-1	-1	0	-1	6	39	-1	-1
R17	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	12	-1	-1	-1	-1	0	-1	6	-1	-1
R18	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	9	-1	-1	-1	0	-1	-1	-1
R19	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	39	6	-1	0	-1	-1	-1
R20	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	16	-1	-1	0	-1	-1

(4) Select source router as R2

Router R2 Connection Table ->

| Destination | Next Hop |

R1	1
R2	-



R3	1
R4	1
R5	5
R6	1
R7	5
R8	5
R9	5
R10	5
R11	5
R12	5
R13	5
R14	5
R15	5
R16	5
R17	5
R18	5
R19	5
R20	5

(5) Select destination router as R12

The Least Cost Path from R2 to R12 is:

2=>5=>7=>8=>10=>11=>15=>12

Minimum Cost to reach Destination: 68

(1) Accept Input Topology File - Input\_Topology\_4.txt

Input Topology ->

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
R1	0	-1	19	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R2	16	0	-1	-1	25	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R3	9	-1	0	15	-1	22	-1	-1	-1	-1	41	-1	-1	-1	-1	-1	-1	-1	-1	-1
R4	24	5	15	0	10	6	35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R5	-1	25	-1	10	0	-1	8	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R6	-1	-1	22	6	-1	0	10	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R7	-1	-1	-1	19	8	10	0	3	12	12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

```

R8 -1 -1 -1 -1 -1 -1 -1 0 -1 4 -1 -1 -1 -1 -1 -1 -1 -1 -1
R9 -1 -1 -1 -1 -1 -1 12 -1 0 3 -1 -1 -1 -1 -1 -1 -1 -1 -1
R10 -1 -1 -1 -1 -1 -1 12 4 3 0 16 -1 -1 12 -1 -1 -1 -1 -1
R11 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 16 0 -1 -1 -1 8 -1 -1 -1
R12 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0 -1 -1 4 -1 12 -1 50
R13 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0 -1 -1 5 -1 -1
R14 -1 -1 -1 -1 -1 -1 -1 -1 -1 12 -1 -1 -1 0 -1 -1 -1 9 -1
R15 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 8 4 -1 -1 0 -1 -1 -1 -1
R16 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 5 -1 -1 0 -1 6 39
R17 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 12 -1 -1 -1 0 -1 6 -1
R18 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 9 -1 -1 -1 0 -1 -1
R19 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 39 6 -1 0 -1
R20 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 16 -1 -1 0

```

## (2) Default Connection Table

Router R1 Connection Table ->

| Destination | Next Hop |

---

R1	-
R2	3
R3	3
R4	3
R5	3
R6	3
R7	3
R8	3
R9	3
R10	3
R11	3
R12	3
R13	3
R14	3
R15	3
R16	3
R17	3
R18	3
R19	3
R20	3

Router R2 Connection Table ->

| Destination | Next Hop |

---

--	--

R1	1
R2	-
R3	1
R4	5
R5	5
R6	5
R7	5
R8	5
R9	5
R10	5
R11	5
R12	5
R13	5
R14	5
R15	5
R16	5
R17	5
R18	5
R19	5
R20	5

Router R3 Connection Table ->

| Destination | Next Hop |

---

R1	1
R2	4
R3	-
R4	4
R5	4
R6	4
R7	4
R8	4
R9	4
R10	4
R11	11
R12	11
R13	11
R14	4
R15	11
R16	11
R17	11
R18	4
R19	11
R20	11

Router R4 Connection Table ->

Destination	Next Hop
-------------	----------

R1	2
R2	2
R3	3
R4	-
R5	5
R6	6
R7	6
R8	6
R9	6
R10	6
R11	6
R12	6
R13	6
R14	6
R15	6
R16	6
R17	6
R18	6
R19	6
R20	6

Router R5 Connection Table -&gt;

Destination	Next Hop
-------------	----------

R1	4
R2	4
R3	4
R4	4
R5	-
R6	4
R7	7
R8	7
R9	7
R10	7
R11	7
R12	7
R13	7
R14	7
R15	7
R16	7
R17	7
R18	7
R19	7

R20            7

Router R6 Connection Table -&gt;

| Destination | Next Hop |

---

R1	4
R2	4
R3	4
R4	4
R5	4
R6	-
R7	7
R8	7
R9	7
R10	7
R11	7
R12	7
R13	7
R14	7
R15	7
R16	7
R17	7
R18	7
R19	7
R20	7

Router R7 Connection Table -&gt;

| Destination | Next Hop |

---

R1	6
R2	6
R3	6
R4	6
R5	5
R6	6
R7	-
R8	8
R9	8
R10	8
R11	8
R12	8
R13	8
R14	8
R15	8
R16	8
R17	8

R18        8  
R19        8  
R20        8

Router R8 Connection Table ->

| Destination | Next Hop |

---

R1	10
R2	10
R3	10
R4	10
R5	10
R6	10
R7	10
R8	-
R9	10
R10	10
R11	10
R12	10
R13	10
R14	10
R15	10
R16	10
R17	10
R18	10
R19	10
R20	10

Router R9 Connection Table ->

| Destination | Next Hop |

---

R1	7
R2	7
R3	7
R4	7
R5	7
R6	7
R7	7
R8	10
R9	-
R10	10
R11	10
R12	10
R13	10
R14	10
R15	10

R16	10
R17	10
R18	10
R19	10
R20	10

Router R10 Connection Table ->

Destination	Next Hop
-------------	----------

R1	7
R2	7
R3	7
R4	7
R5	7
R6	7
R7	7
R8	8
R9	9
R10	-
R11	11
R12	11
R13	11
R14	14
R15	11
R16	11
R17	11
R18	14
R19	11
R20	11

Router R11 Connection Table ->

Destination	Next Hop
-------------	----------

R1	10
R2	10
R3	10
R4	10
R5	10
R6	10
R7	10
R8	10
R9	10
R10	10
R11	-
R12	15
R13	15

R14	10
R15	15
R16	15
R17	15
R18	10
R19	15
R20	15

Router R12 Connection Table ->

| Destination | Next Hop |

R1	15
R2	15
R3	15
R4	15
R5	15
R6	15
R7	15
R8	15
R9	15
R10	15
R11	15
R12	-
R13	17
R14	15
R15	15
R16	17
R17	17
R18	15
R19	17
R20	20

Router R13 Connection Table ->

| Destination | Next Hop |

R1	16
R2	16
R3	16
R4	16
R5	16
R6	16
R7	16
R8	16
R9	16
R10	16
R11	16



R12	16
R13	-
R14	16
R15	16
R16	16
R17	16
R18	16
R19	16
R20	16

Router R14 Connection Table -&gt;

Destination	Next Hop	
-------------	----------	--

R1	10
R2	10
R3	10
R4	10
R5	10
R6	10
R7	10
R8	10
R9	10
R10	10
R11	10
R12	10
R13	10
R14	-
R15	10
R16	10
R17	10
R18	18
R19	10
R20	10

Router R15 Connection Table -&gt;

Destination	Next Hop	
-------------	----------	--

R1	11
R2	11
R3	11
R4	11
R5	11
R6	11
R7	11
R8	11
R9	11

R10	11
R11	11
R12	12
R13	12
R14	11
R15	-
R16	12
R17	12
R18	11
R19	12
R20	12

Router R16 Connection Table ->

| Destination | Next Hop |

---

R1	18
R2	18
R3	18
R4	18
R5	18
R6	18
R7	18
R8	18
R9	18
R10	18
R11	18
R12	18
R13	13
R14	18
R15	18
R16	-
R17	19
R18	18
R19	19
R20	18

Router R17 Connection Table ->

| Destination | Next Hop |

---

R1	12
R2	12
R3	12
R4	12
R5	12
R6	12
R7	12

R8	12
R9	12
R10	12
R11	12
R12	12
R13	19
R14	12
R15	12
R16	19
R17	-
R18	19
R19	19
R20	12

Router R18 Connection Table ->

Destination	Next Hop
-------------	----------

---

R1	14
R2	14
R3	14
R4	14
R5	14
R6	14
R7	14
R8	14
R9	14
R10	14
R11	14
R12	14
R13	14
R14	14
R15	14
R16	14
R17	14
R18	-
R19	14
R20	14

Router R19 Connection Table ->

Destination	Next Hop
-------------	----------

---

R1	17
R2	17
R3	17
R4	17
R5	17

R6	17
R7	17
R8	17
R9	17
R10	17
R11	17
R12	17
R13	16
R14	16
R15	17
R16	16
R17	17
R18	16
R19	-
R20	17

Router R20 Connection Table ->

| Destination | Next Hop |

---

R1	17
R2	17
R3	17
R4	17
R5	17
R6	17
R7	17
R8	17
R9	17
R10	17
R11	17
R12	17
R13	17
R14	17
R15	17
R16	17
R17	17
R18	17
R19	17
R20	-

(3) Modify link weight as 10 from R20 to R19

Input Topology ->

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
R1	0	-1	19	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R2	16	0	-1	-1	25	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R3	9	-1	0	15	-1	22	-1	-1	-1	-1	41	-1	-1	-1	-1	-1	-1	-1	-1	-1
R4	24	5	15	0	10	6	35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R5	-1	25	-1	10	0	-1	8	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R6	-1	-1	22	6	-1	0	10	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R7	-1	-1	-1	19	8	10	0	3	12	12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R8	-1	-1	-1	-1	-1	-1	-1	0	-1	4	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R9	-1	-1	-1	-1	-1	-1	12	-1	0	3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R10	-1	-1	-1	-1	-1	-1	12	4	3	0	16	-1	-1	12	-1	-1	-1	-1	-1	-1
R11	-1	-1	-1	-1	-1	-1	-1	-1	-1	16	0	-1	-1	-1	8	-1	-1	-1	-1	-1
R12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-1	-1	4	-1	12	-1	-1	50	-1
R13	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-1	-1	5	-1	-1	-1	-1	-1
R14	-1	-1	-1	-1	-1	-1	-1	-1	-1	12	-1	-1	-1	0	-1	-1	-1	9	-1	-1
R15	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	8	4	-1	-1	0	-1	-1	-1	-1	-1
R16	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	5	-1	-1	0	-1	6	39	-1	-1
R17	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	12	-1	-1	-1	-1	0	-1	6	-1	-1
R18	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	9	-1	-1	-1	0	-1	-1	-1
R19	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	39	6	-1	0	-1	-1	-1
R20	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	16	-1	10	0	-1	-1

(4) Select source router as R6

Router R6 Connection Table ->

| Destination | Next Hop |

R1	4
R2	4
R3	4
R4	4
R5	4
R6	-
R7	7
R8	7
R9	7
R10	7
R11	7
R12	7
R13	7

R14	7
R15	7
R16	7
R17	7
R18	7
R19	7
R20	7

(5) Select destination router as R10

The Least Cost Path from R6 to R10 is:

6=>7=>8=>10

Minimum Cost to reach Destination: 17

(1) Accept Input Topology File - Input\_Topology\_5.txt

Input Topology ->

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
R1	0	-1	19	-1	30	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R2	16	0	-1	-1	13	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R3	9	-1	0	15	-1	22	-1	-1	-1	41	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R4	28	5	15	0	10	6	35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R5	-1	13	-1	10	0	-1	8	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R6	-1	-1	22	6	-1	0	10	-1	-1	-1	21	-1	-1	-1	-1	45	-1	-1	-1	-1
R7	-1	-1	-1	19	8	10	0	3	26	26	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R8	-1	-1	-1	-1	-1	-1	-1	0	-1	4	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R9	-1	-1	-1	-1	-1	-1	26	-1	0	3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R10	-1	-1	-1	-1	-1	-1	26	4	3	0	16	-1	-1	26	-1	-1	-1	-1	-1	-1
R11	-1	-1	-1	-1	-1	-1	-1	-1	-1	16	0	-1	-1	-1	8	-1	-1	-1	-1	-1
R12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-1	-1	4	-1	26	-1	-1	50	-1
R13	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-1	-1	5	-1	-1	-1	-1	-1
R14	-1	-1	-1	-1	-1	-1	-1	-1	-1	26	-1	-1	-1	0	-1	-1	9	-1	-1	-1
R15	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	8	4	-1	-1	0	-1	-1	-1	-1	-1
R16	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	5	-1	-1	0	-1	6	39	-1	-1
R17	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	26	-1	-1	-1	-1	0	-1	6	-1	-1

```

R18 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 9 -1 -1 -1 0 -1 -1
R19 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 39 6 -1 0 -1
R20 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 16 -1 -1 0

```

## (2) Default Connection Table

Router R1 Connection Table ->

| Destination | Next Hop |

---

R1	-
R2	3
R3	3
R4	3
R5	5
R6	3
R7	5
R8	5
R9	5
R10	5
R11	3
R12	3
R13	3
R14	5
R15	3
R16	3
R17	3
R18	5
R19	3
R20	3

Router R2 Connection Table ->

| Destination | Next Hop |

---

R1	1
R2	-
R3	1
R4	5
R5	5
R6	5
R7	5
R8	5
R9	5

R10	5
R11	5
R12	5
R13	5
R14	5
R15	5
R16	5
R17	5
R18	5
R19	5
R20	5

Router R3 Connection Table ->

| Destination | Next Hop |

---

R1	1
R2	4
R3	-
R4	4
R5	4
R6	4
R7	4
R8	4
R9	4
R10	4
R11	11
R12	11
R13	4
R14	4
R15	11
R16	4
R17	4
R18	4
R19	4
R20	11

Router R4 Connection Table ->

| Destination | Next Hop |

---

R1	2
R2	2
R3	3
R4	-
R5	5
R6	6
R7	6



R8	6
R9	6
R10	6
R11	6
R12	6
R13	6
R14	6
R15	6
R16	6
R17	6
R18	6
R19	6
R20	6

Router R5 Connection Table ->

Destination	Next Hop
-------------	----------

---

R1	2
R2	2
R3	4
R4	4
R5	-
R6	4
R7	7
R8	7
R9	7
R10	7
R11	7
R12	7
R13	4
R14	7
R15	7
R16	4
R17	4
R18	7
R19	4
R20	7

Router R6 Connection Table ->

Destination	Next Hop
-------------	----------

---

R1	4
R2	4
R3	4
R4	4
R5	4

R6	-
R7	7
R8	7
R9	7
R10	7
R11	11
R12	11
R13	17
R14	7
R15	11
R16	17
R17	17
R18	7
R19	17
R20	11

Router R7 Connection Table ->

| Destination | Next Hop |

---

R1	5
R2	5
R3	6
R4	6
R5	5
R6	6
R7	-
R8	8
R9	8
R10	8
R11	8
R12	8
R13	6
R14	8
R15	8
R16	6
R17	6
R18	8
R19	6
R20	8

Router R8 Connection Table ->

| Destination | Next Hop |

---

R1	10
R2	10
R3	10

R4	10
R5	10
R6	10
R7	10
R8	-
R9	10
R10	10
R11	10
R12	10
R13	10
R14	10
R15	10
R16	10
R17	10
R18	10
R19	10
R20	10

Router R9 Connection Table ->

Destination	Next Hop
-------------	----------

R1	7
R2	7
R3	7
R4	7
R5	7
R6	7
R7	7
R8	10
R9	-
R10	10
R11	10
R12	10
R13	10
R14	10
R15	10
R16	10
R17	10
R18	10
R19	10
R20	10

Router R10 Connection Table ->

Destination	Next Hop
-------------	----------

R1	7
----	---

R2	7
R3	7
R4	7
R5	7
R6	7
R7	7
R8	8
R9	9
R10	-
R11	11
R12	11
R13	11
R14	14
R15	11
R16	11
R17	11
R18	14
R19	11
R20	11

Router R11 Connection Table ->

| Destination | Next Hop |

---

R1	10
R2	10
R3	10
R4	10
R5	10
R6	10
R7	10
R8	10
R9	10
R10	10
R11	-
R12	15
R13	15
R14	10
R15	15
R16	15
R17	15
R18	10
R19	15
R20	15

Router R12 Connection Table ->

| Destination | Next Hop |

---

R1	15
R2	15
R3	15
R4	15
R5	15
R6	15
R7	15
R8	15
R9	15
R10	15
R11	15
R12	-
R13	17
R14	15
R15	15
R16	17
R17	17
R18	15
R19	17
R20	20

Router R13 Connection Table ->

| Destination | Next Hop |

---

R1	16
R2	16
R3	16
R4	16
R5	16
R6	16
R7	16
R8	16
R9	16
R10	16
R11	16
R12	16
R13	-
R14	16
R15	16
R16	16
R17	16
R18	16
R19	16
R20	16

Router R14 Connection Table -&gt;

Destination	Next Hop
-------------	----------

R1	10
R2	10
R3	10
R4	10
R5	10
R6	10
R7	10
R8	10
R9	10
R10	10
R11	10
R12	10
R13	10
R14	-
R15	10
R16	10
R17	10
R18	18
R19	10
R20	10

Router R15 Connection Table -&gt;

Destination	Next Hop
-------------	----------

R1	11
R2	11
R3	11
R4	11
R5	11
R6	11
R7	11
R8	11
R9	11
R10	11
R11	11
R12	12
R13	12
R14	11
R15	-
R16	12
R17	12
R18	11

R19 12

R20 12

Router R16 Connection Table ->

| Destination | Next Hop |

---

R1	18
R2	18
R3	18
R4	18
R5	18
R6	18
R7	18
R8	18
R9	18
R10	18
R11	18
R12	18
R13	13
R14	18
R15	18
R16	-
R17	19
R18	18
R19	19
R20	18

Router R17 Connection Table ->

| Destination | Next Hop |

---

R1	12
R2	12
R3	12
R4	12
R5	12
R6	12
R7	12
R8	12
R9	12
R10	12
R11	12
R12	12
R13	19
R14	19
R15	12
R16	19

R17 -  
R18 19  
R19 19  
R20 12

Router R18 Connection Table ->

| Destination | Next Hop |

---

R1	14
R2	14
R3	14
R4	14
R5	14
R6	14
R7	14
R8	14
R9	14
R10	14
R11	14
R12	14
R13	14
R14	14
R15	14
R16	14
R17	14
R18	-
R19	14
R20	14

Router R19 Connection Table ->

| Destination | Next Hop |

---

R1	17
R2	17
R3	17
R4	17
R5	17
R6	17
R7	17
R8	17
R9	17
R10	17
R11	17
R12	17
R13	16
R14	16



R15	17
R16	16
R17	17
R18	16
R19	-
R20	17

Router R20 Connection Table ->

| Destination | Next Hop |

R1	17
R2	17
R3	17
R4	17
R5	17
R6	17
R7	17
R8	17
R9	17
R10	17
R11	17
R12	17
R13	17
R14	17
R15	17
R16	17
R17	17
R18	17
R19	17
R20	-

(3) Add link weight as 9 from R15 to R20

Input Topology ->

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
R1	0	-1	19	-1	30	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R2	16	0	-1	-1	13	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R3	9	-1	0	15	-1	22	-1	-1	-1	41	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
R4	28	5	15	0	10	6	35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

```

R5 -1 13 -1 10 0 -1 8 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
R6 -1 -1 22 6 -1 0 10 -1 -1 -1 21 -1 -1 -1 -1 -1 45 -1 -1 -1
R7 -1 -1 -1 19 8 10 0 3 26 26 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
R8 -1 -1 -1 -1 -1 -1 -1 0 -1 4 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
R9 -1 -1 -1 -1 -1 -1 26 -1 0 3 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
R10 -1 -1 -1 -1 -1 -1 26 4 3 0 16 -1 -1 26 -1 -1 -1 -1 -1 -1
R11 -1 -1 -1 -1 -1 -1 -1 -1 -1 16 0 -1 -1 -1 8 -1 -1 -1 -1 -1
R12 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0 -1 -1 4 -1 26 -1 -1 50
R13 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0 -1 -1 5 -1 -1 -1 -1
R14 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 26 -1 -1 -1 0 -1 -1 -1 9 -1 -1
R15 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 8 4 -1 -1 0 -1 -1 -1 9
R16 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 5 -1 -1 0 -1 6 39 -1
R17 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 26 -1 -1 -1 -1 0 -1 6 -1
R18 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 9 -1 -1 -1 0 -1 -1
R19 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 39 6 -1 0 -1
R20 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 16 -1 -1 0

```

(4) Select source router as R3

Router R3 Connection Table ->

| Destination | Next Hop |

R1	1
R2	4
R3	-
R4	4
R5	4
R6	4
R7	4
R8	4
R9	4
R10	4
R11	11
R12	11
R13	4
R14	4
R15	11
R16	4
R17	4
R18	4
R19	4
R20	11

(5) Select destination router as R18

The Least Cost Path from R3 to R18 is:

3=>4=>6=>7=>8=>10=>14=>18

Minimum Cost to reach Destination: 73

## 7. User Manual

### What You Need to Know?

To work with the Link State Routing Simulator you have to be familiar with the Basic working knowledge in WINDOWS Environment.

### Steps To Execute the Simulator:

1. Double-Click the executable JAR file
2. Give the InputTopology.txt as a input to the simulator via Open option from File Menu
3. To get the Default Connection Tables for all the routers press Default Connection Table button
4. To modify the existing topology click Modify button
5. To view the modified topology press Display button
6. To proceed with path finding click Next button by giving input to the source router
7. To view the Shortest Path from source to specified destination click on Path button
8. To view the existing topology press Reset button
9. To Exit from the simulator press (X) button and select YES as a option after the pop-up window

## 8. Conclusion:

This simulator provides a complete solution to its user for getting the required results. The simulator is well equipped to provide the results for the minimum path as well as provides the hopping of the packet from its sources and destination routers using the Link State Routing Protocol. This simulator serves to be the best tool for network administrators to analyze the connectivity of the network and travelling of the sent packets from the source to destination and which could be the shortest path it could take. It also calculates the cost of the path, thus gives an insight to the user about the probable shortest path.