Redes de Comunicação
2023/2024

TP09
Routing Protocols

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TP09: Routing protocols

Overview:

- Dijkstra algorithm (link-state routing)
- RIP (distance-vector)

Dijkstra algorithm

Given:

- N: set of vertices in graph
- S: origin vertex
- T: set of vertices (already) added by the algorithm
- w(i,j): cost of path from i to j
- L(n): cost of the path with lower cost from s to n, already added by the algorithm

The algorithm uses 3 steps

- Step 1: initialization
- Step 2 and 3 are repeated until T = N (until spanning tree starting at origin vertex is formed)

Dijkstra algorithm

Step 1 – Initialization

1.1 T = {s}

1.2 L(n) = w(s,n)

L(s) = **0**

L(i) = **w(s,i)** (to neighbouring nodes of *s*)

L(n) = **infinite** (to other nodes which are not neighbors of *s*)

Dijkstra algorithm

Step 2 – chooses next vertex to add

2.1 Find x not belonging to T for which L(x) = min L(j), for all j not in T

2.2 Add x to T

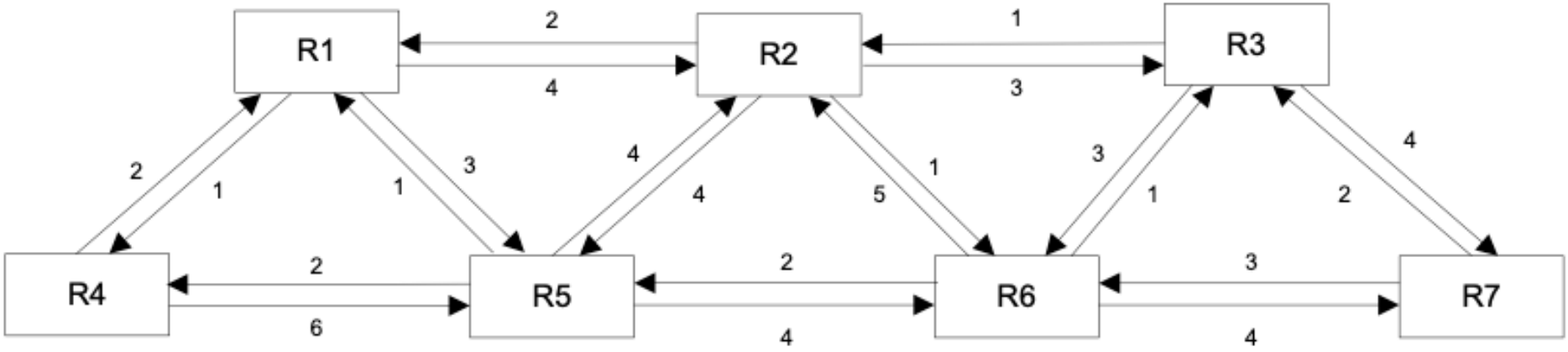
2.3 Add link to x to T

Step 3 – update least cost paths

L(n) = min [L(n), L(x)+w(x,n)],
for all n not in T

Dijkstra algorithm (exercise)

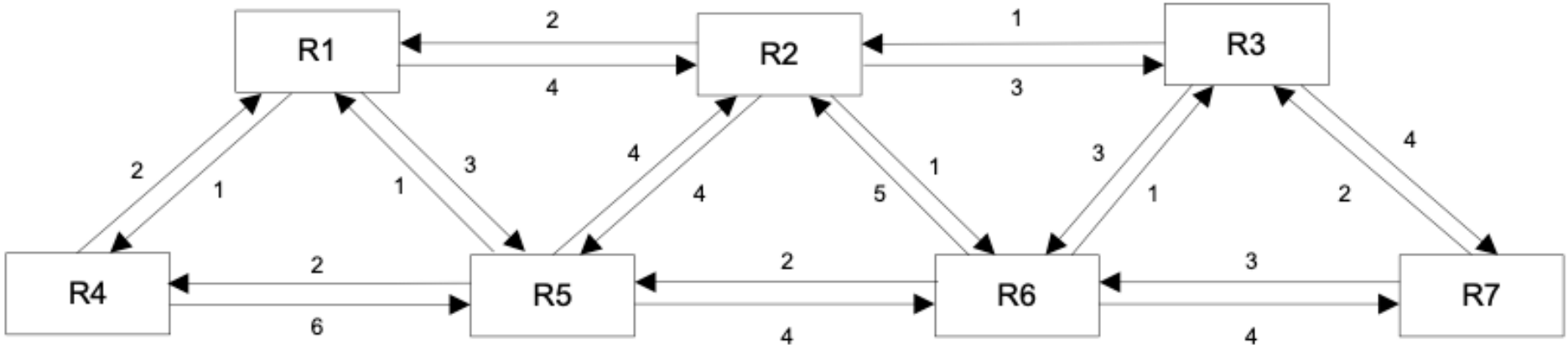
Find a *spanning tree* starting at router R2, using the Dijkstra algorithm:



Dijkstra algorithm (solution)

Link added by the algorithm:

T={R2}	
T={R2, R6}	R2,R6
T={R2,R6,R1}	R2,R1 (or R6,R3)
T={R2,R6,R1,R3}	R6,R3 (ou R2, R1)
T={R2,R6,R1,R3,R5}	R6,R5 (ou R1,R4)
T={R2,R6,R1,R3,R5,R4}	R1,R4 (ou R6,R5)
T={R2,R6,R1,R3,R5,R4,R7}=N	R6,R7



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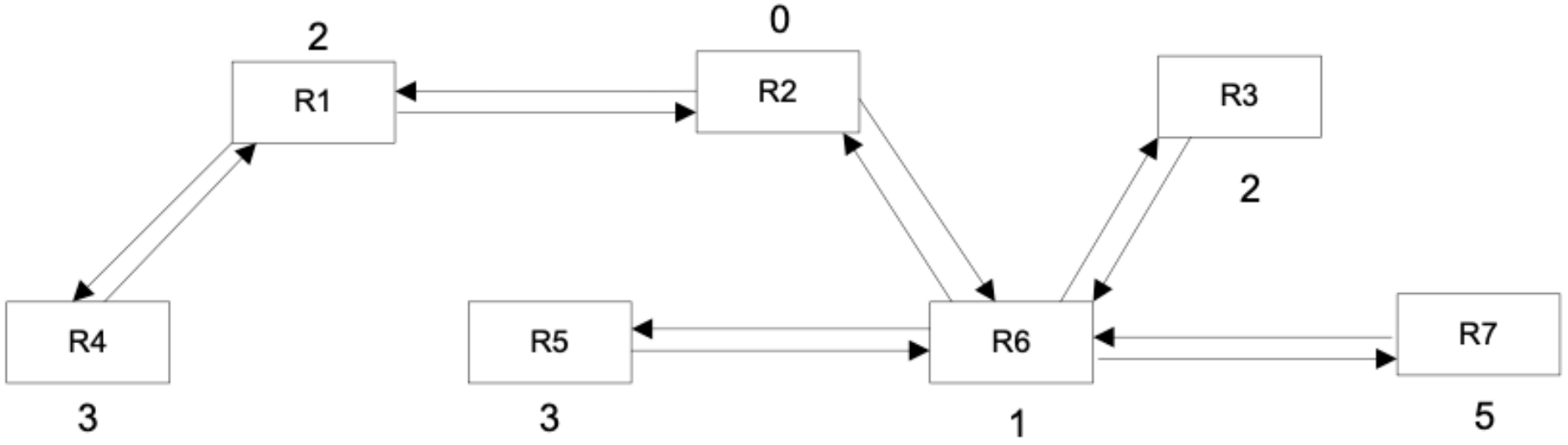


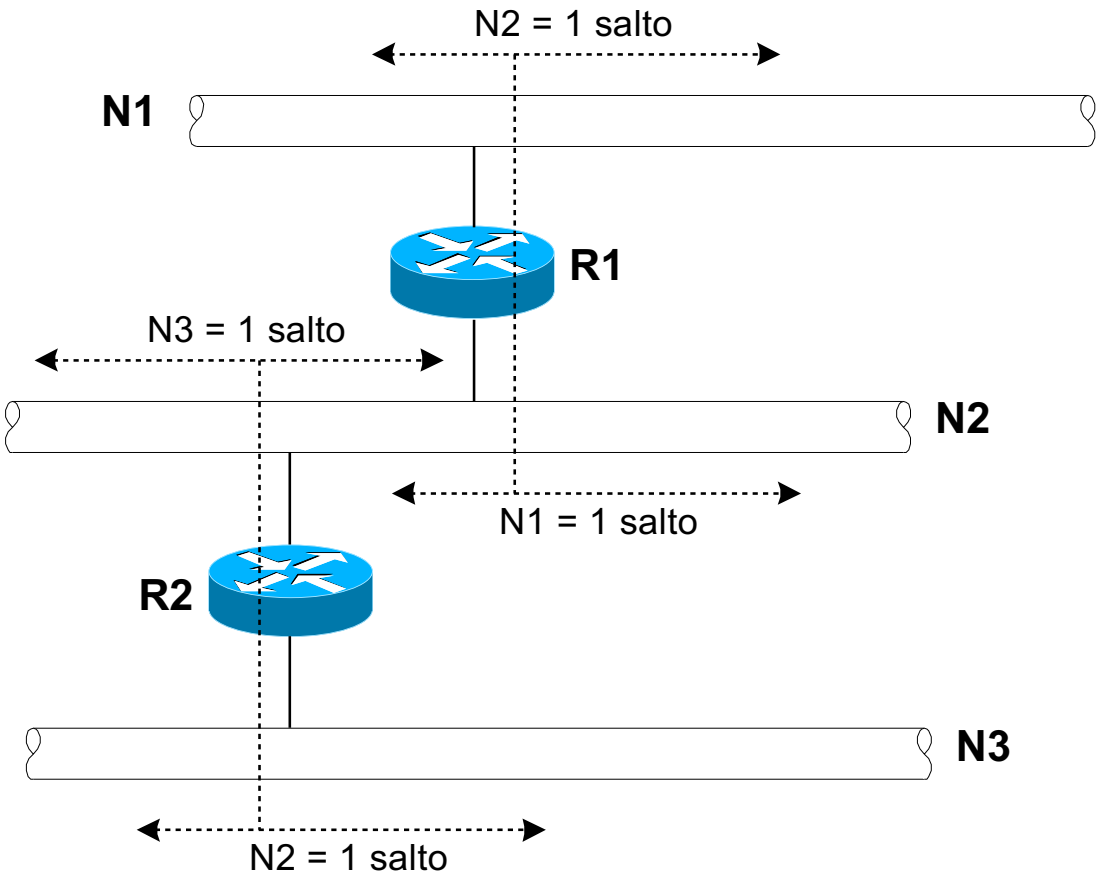
Router Information Protocol

- RIP-2 – Defined in RFC 1723 (1994)
- Router *broadcasts* routing information at each 30 s
- Sends immediate update upon detecting change on a link
- Router uses information received from its neighbours to calculate the shortest paths to all reachable (and known) destinations
- Uses *hop count* as metric
- Maximum hop count of 15 (16 is considered “infinite”, or “unreachable”)
- Reports are broadcasted to neighbours
- A route expires if no update is received for 180s

Routing Information Protocol

- May store up to 6 equal cost paths to same destination
- Supports load ballacing using paths with the same cost
- Timer values used by the protocol:
  - **Update interval**: 30s (periodic update of routes sent to neighbours)
  - **Invalid timer**: 180s (time since last update for route, upon which route is marked as invalid and put “on hold”: *hop count* 16 or “infinite”)
  - **Flush timer**: 240 s (time since last update upon which route is flushed or deleted)

Routing Information Protocol



Routing Information Protocol

Example (update of routes using “distance vector” strategy):

A

Rede dest.	Router seg.	Dist.
1	-	1
2	B	2
3	B	4
4	D	2
5	D	5

Estado inicial

B	C	D
3	7	4
1	6	3
4	5	2
3	5	1
5	5	2

Vectores recebidos

A

Rede dest.	Router seg.	Dist.
1	-	1
2	B	2
3	D	3
4	D	2
5	D	3

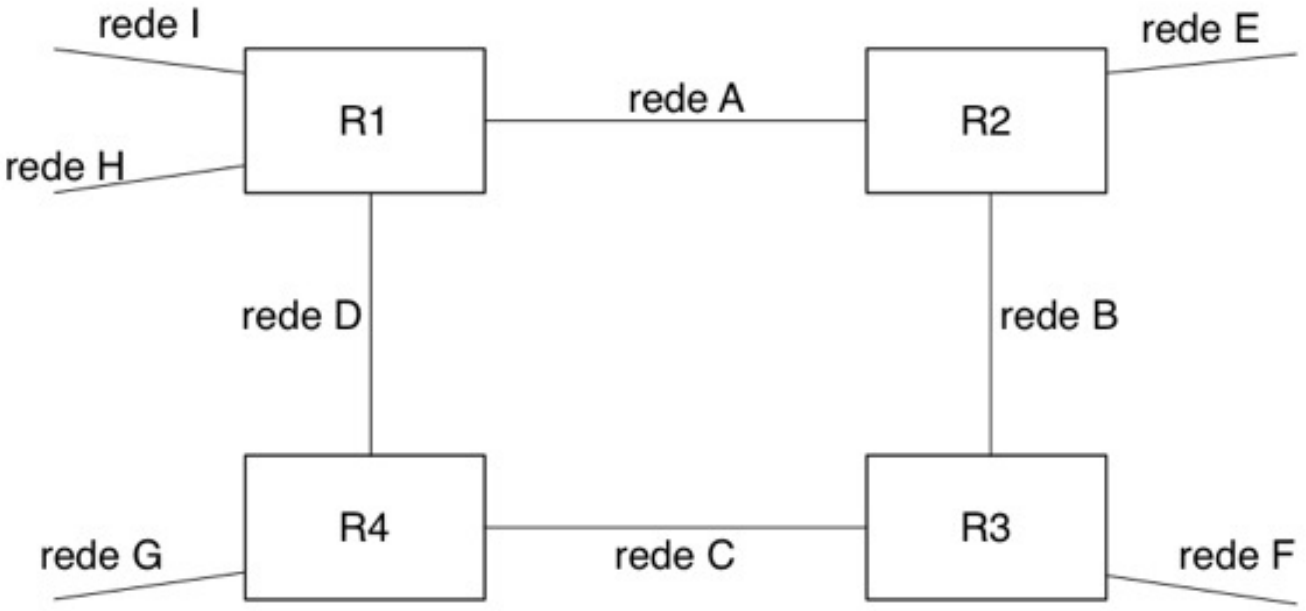
Estado final

Routing Information Protocol

Exercise 1:

Consider that RIP is being used in the following network, and that all routing tables are already stabilized. Indicate the routing table for router R4 using the following syntax:

<destination network>,<next router>,<distance>



Please note: With RIP directly connected routes are at a distance of “1”, and unreachable networks at a distance of “16”

Routing Information Protocol

Exercise 1 (solution):

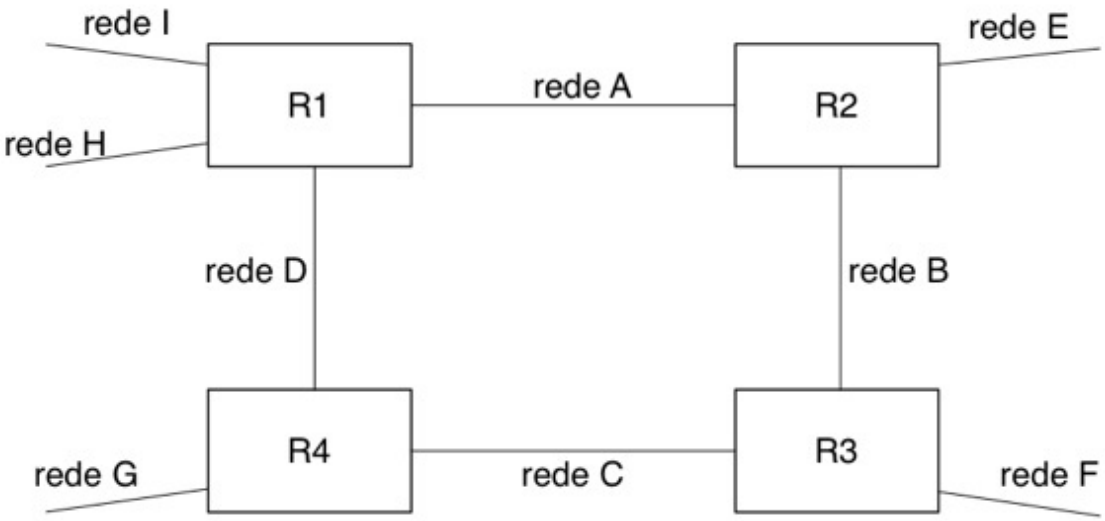
<destination network>,<next router>,<distance>

C, - , 1 D, - , 1 G, - , 1

I, R1, 2, H,R1,2 A,R1,2

F,R3,2 B,R3,2

E,R3,3 (ou E,R1,3)

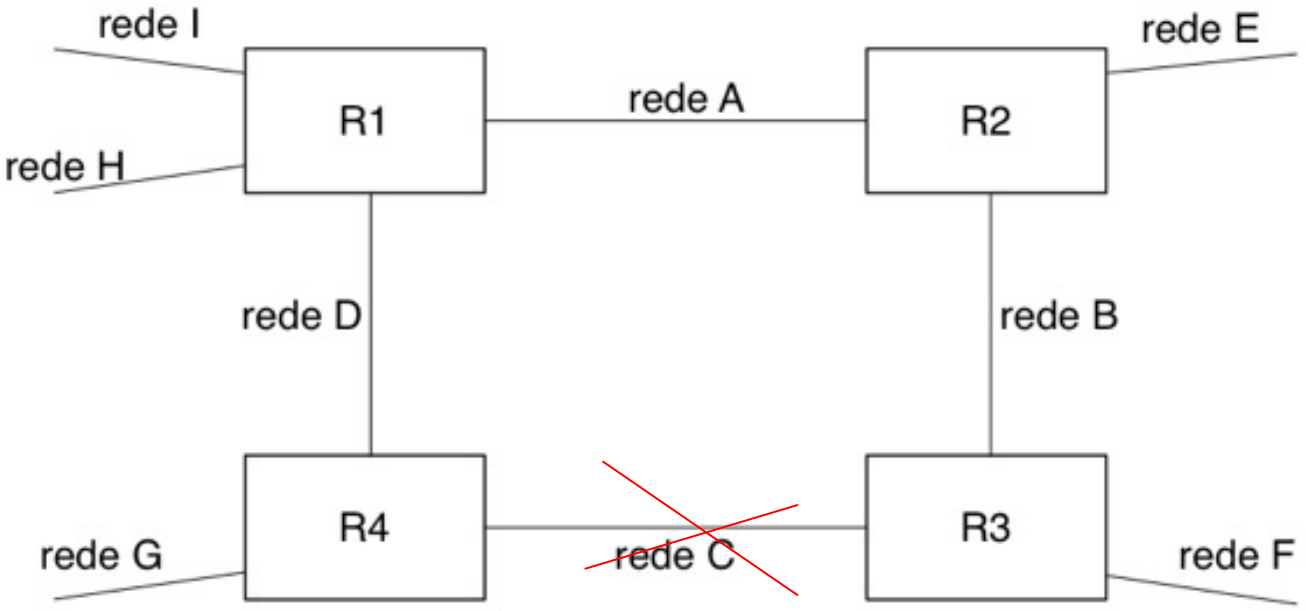


Routing Information Protocol

Exercise 2:

Consider now that network (link C) is down. Indicate the routing table for router R4 after the routing information has stabilized (after change has propagated to other routers using RIP):

<destination network>,<next router>,<distance>



Please note: With RIP directly connected routes are at a distance of “1”, and unreachable networks at a distance of “16”

Routing Information Protocol

Exercise 2 (solution):

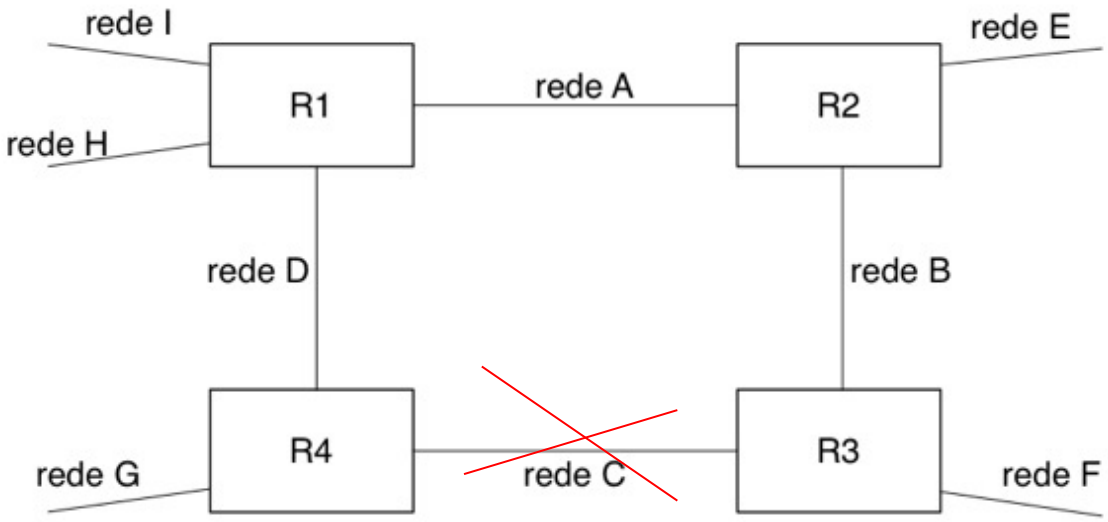
<destination network>,<next router>,<distance>

C, - , 16 D, - , 1 G, - , 1

I, R1, 2, H,R1,2 A,R1,2

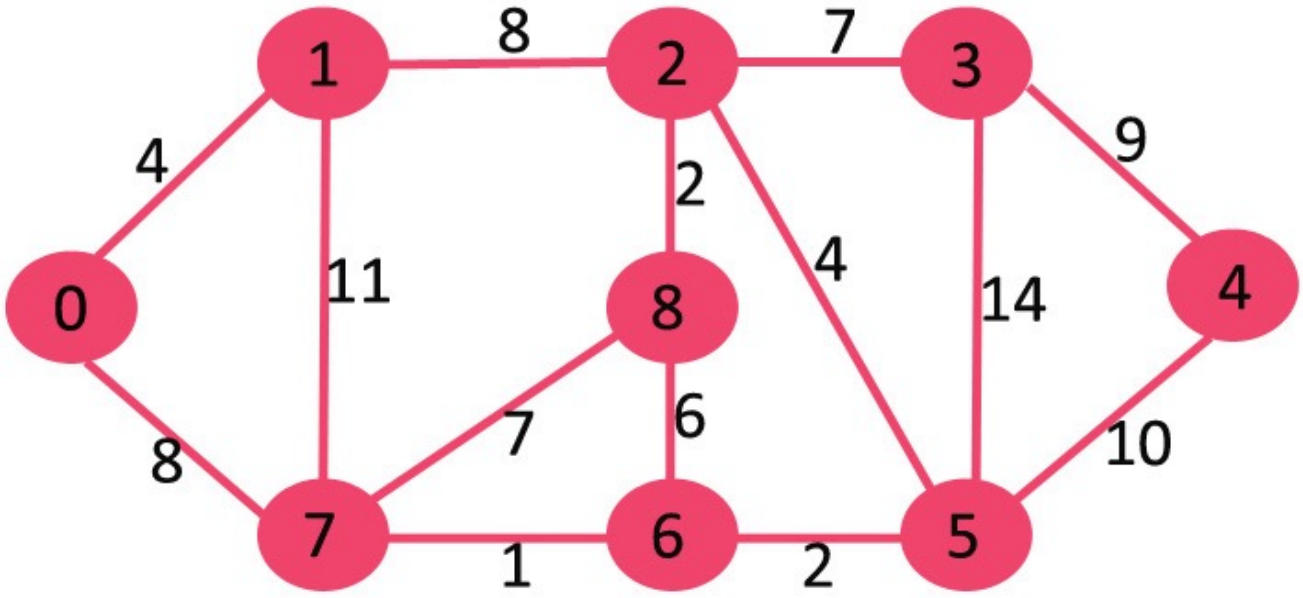
F,R1,4 B,R1,3

E,R1,3



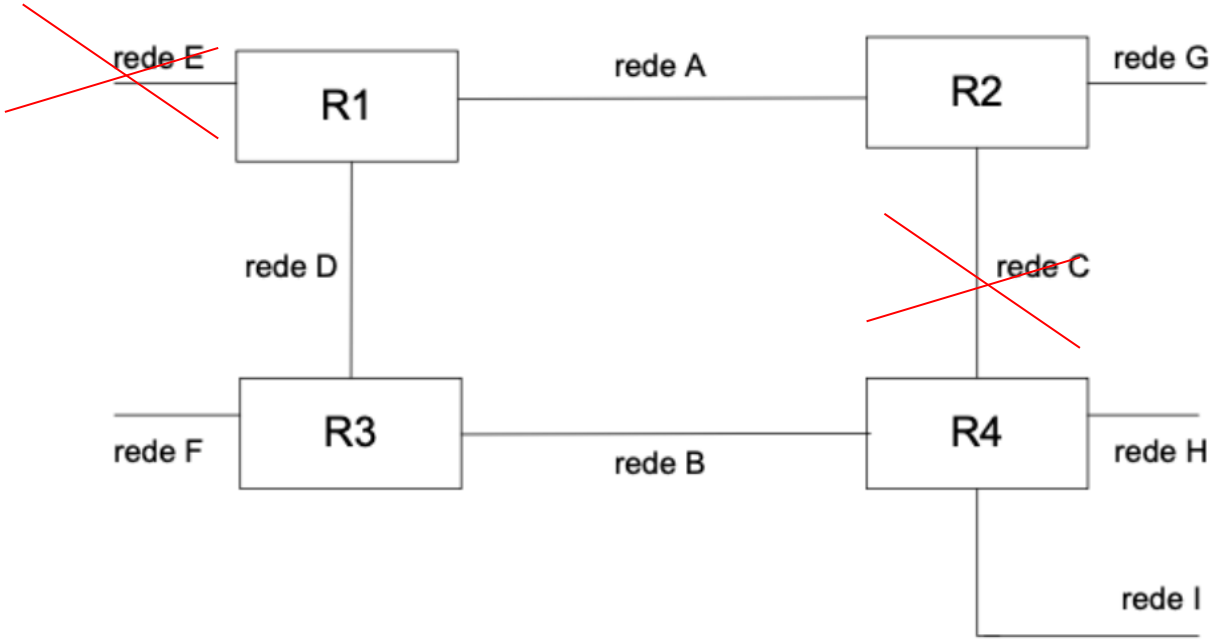
Dijkstra algorithm (exercise)

Considere o cenário de rede ilustrado na figura seguinte, na qual os valores indicados representam o custo da comunicação entre os routers. Encontre uma spanning tree a partir do router 8:



RIP (exercise)

Considere o cenário de rede ilustrado na figura seguinte, no qual se utiliza o protocolo de encaminhamento RIP. Considere também que ocorreram falhas irrecuperáveis nas redes C e E, que as deixam inoperacionais. Apresente a tabela de encaminhamento no Router R4, após a estabilização das rotas.



TP09: Summary

What have we covered here?

- Dijkstra algorithm (link-state routing)
- RIP (distance-vector)
- Exercises