

Networking Technologies and Applications

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October 27, 2016

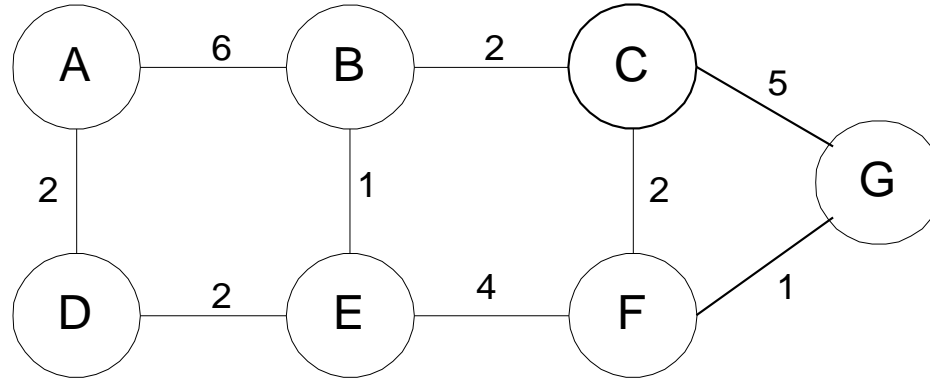


Link-state protocols

Operation of link-state protocols

- The operation of link-state protocols has two steps:
 1. Each node discovers the network topology
 - Link state records advertised in the network
 2. In the obtained graph it finds the shortest path and the next hop on the path
- **Important!**
 - The topology in each router should be the same
 - Finding the optimal path is done in the same way, in each node
 - If node A thinks the optimal route goes through B, and B thinks it goes through A
 - a loop is formed!

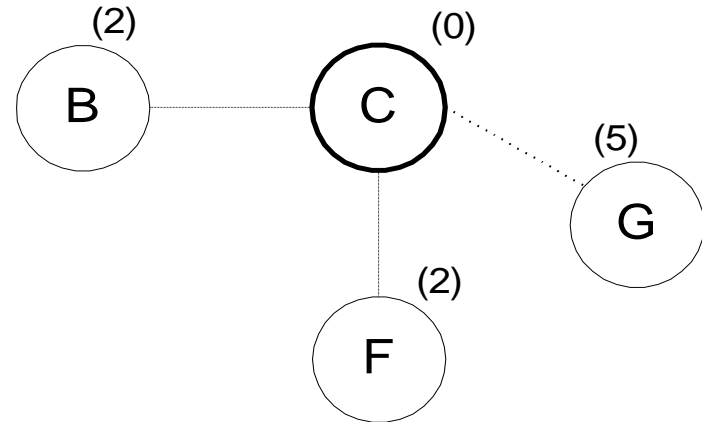
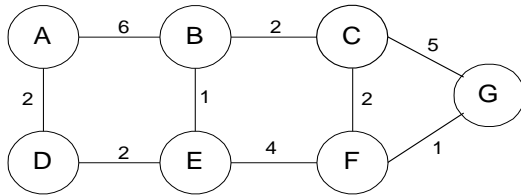
Link State Database



Link state Database						
A	B	C	D	E	F	G
B/6	A/6	B/2	A/2	B/1	C/2	C/5
D/2	C/2	F/2	E/2	D/2	E/4	F/1
	E/1	G/5		F/4		G/1

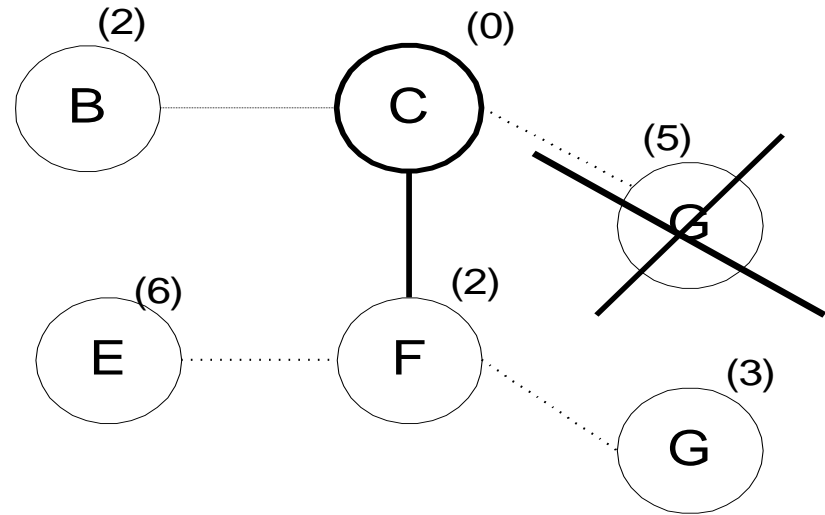
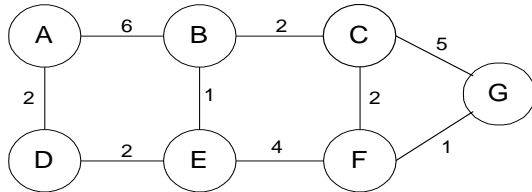
Dijkstra algorithm

- Route selection based on the Dijkstra algorithm
 - Let C be the root
 - Let's calculate the cost of the paths to our neighbors



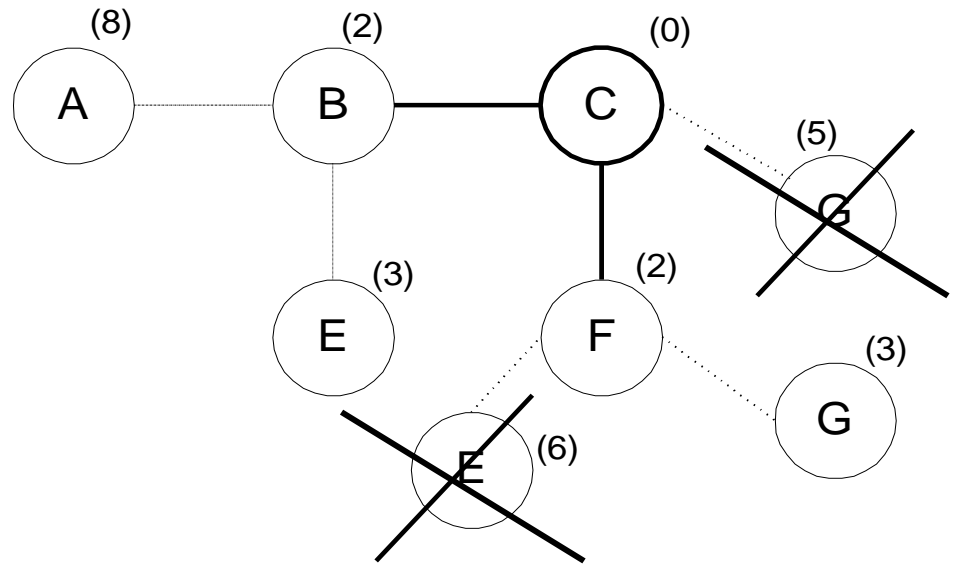
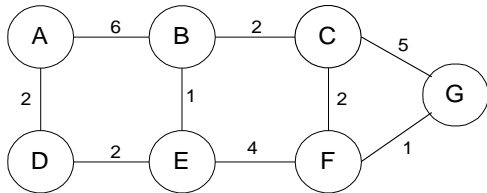
Dijkstra algorithm 2

- Let's consider node F (the smallest cost, non-visited neighbor) and calculate the costs of the paths to the neighbors of F
- Shorter path to G through F. Node E gets in the picture



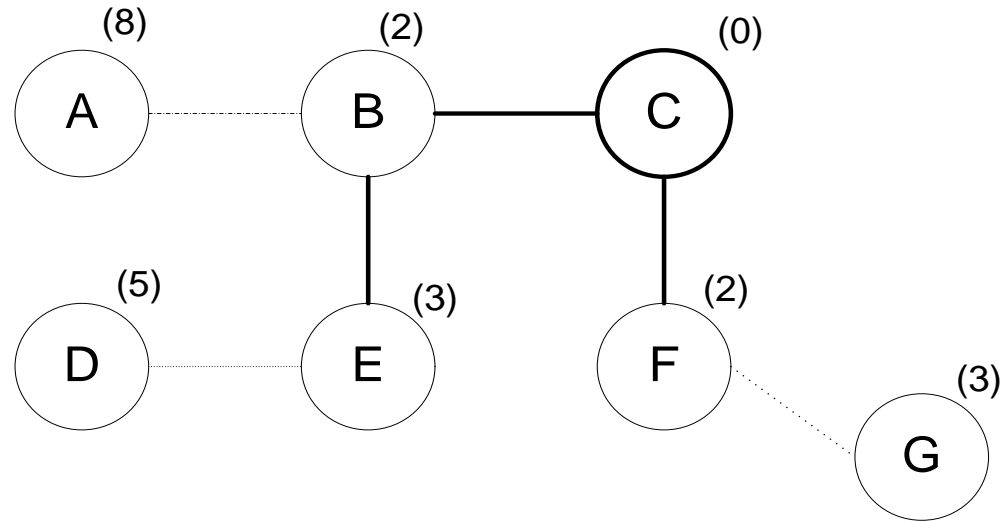
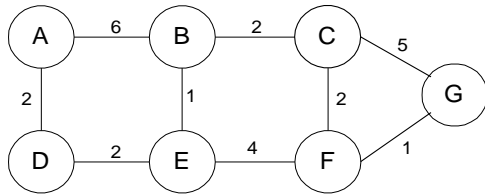
Dijkstra algorithm 3

- Let's consider node B, and calculate the costs to its neighbors
- Shorter path to E through B. Node A gets in the picture



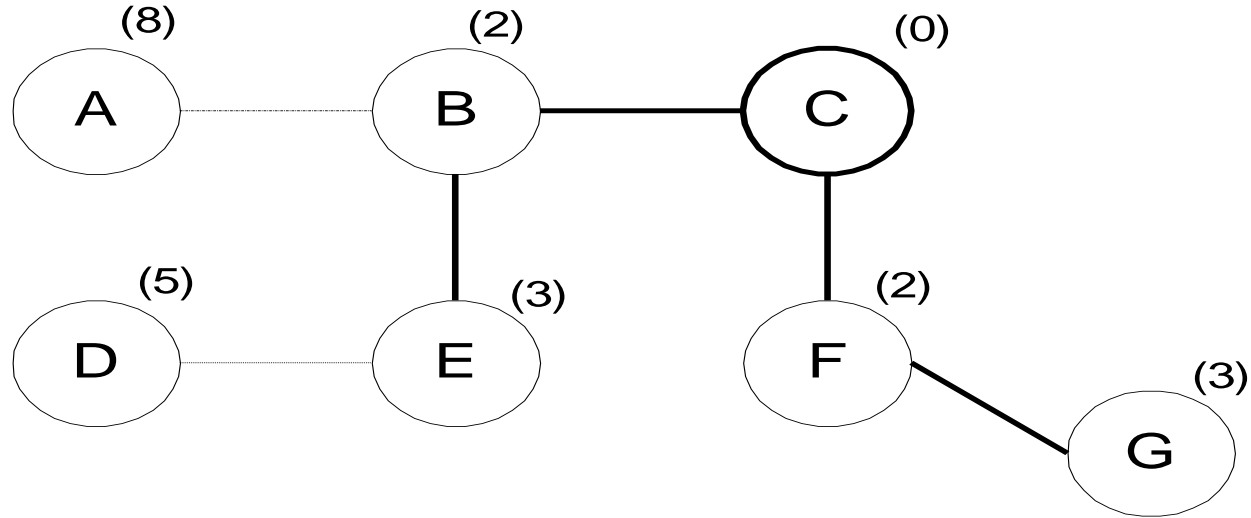
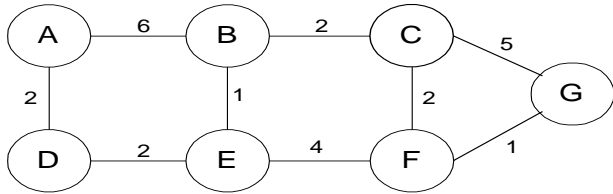
Dijkstra algorithm 4

- Let's consider node E, and calculate the costs to its neighbors
- No changes, node D gets in the picture



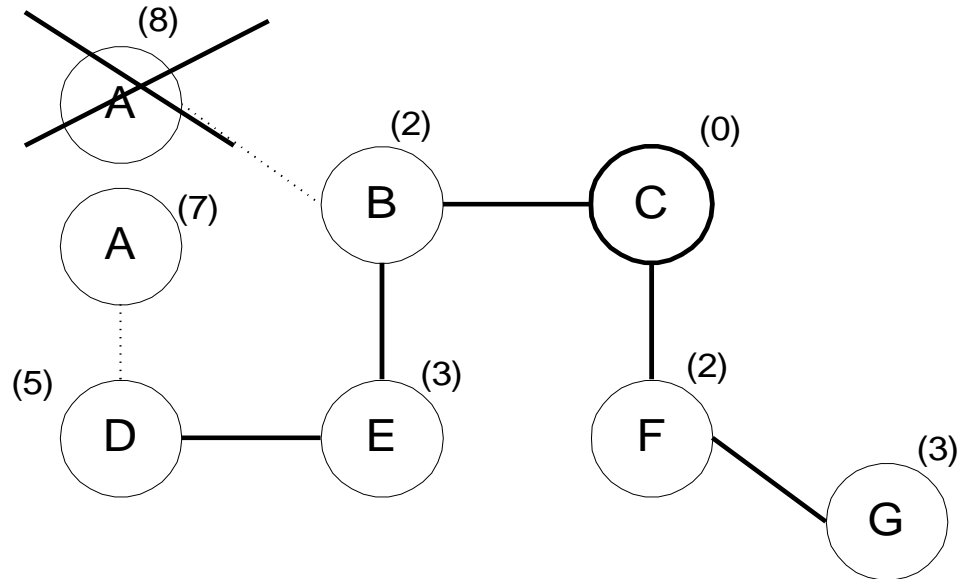
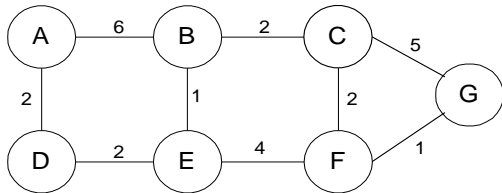
Dijkstra algorithm 5

- Consider node G, and calculate the costs
- No changes



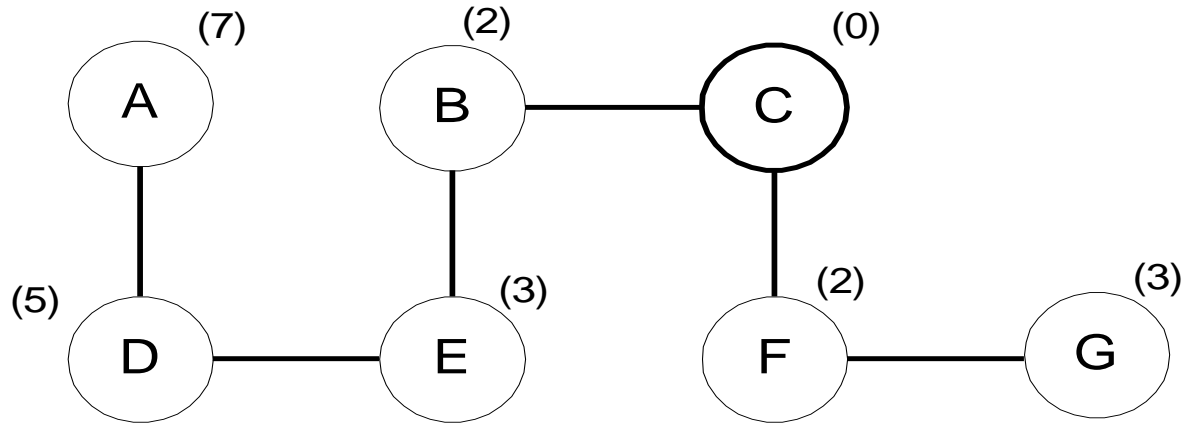
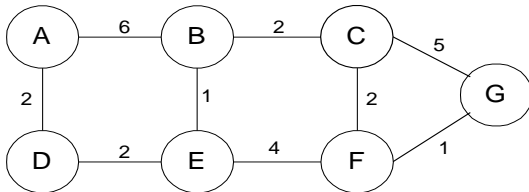
Dijkstra algorithm 6

- Consider node D, and calculate the costs to its neighbors
- Shorter path to node A!



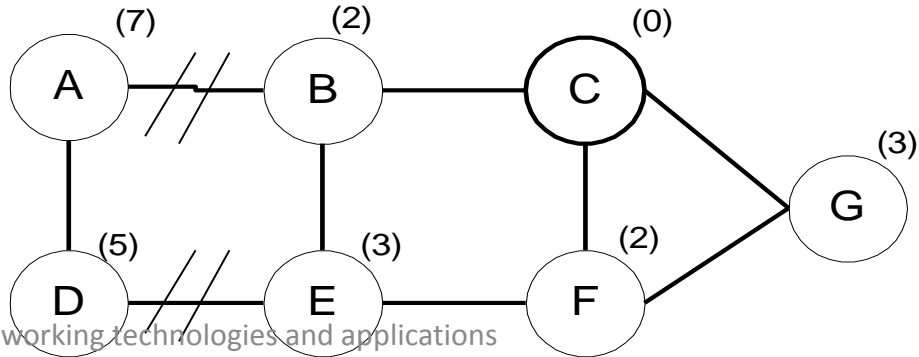
Dijkstra algorithm 7

- Consider node A, and calculate the costs
- No more neighbors
- End of story



Consequences of a broken link

- Links A-B and D-E are broken
 - The network is partitioned
 - No update messages between the two partitions
- Nodes A and D consider the rest of the network unreachable
- After the link is re-established, the routers synchronize their databases
 - Topology update

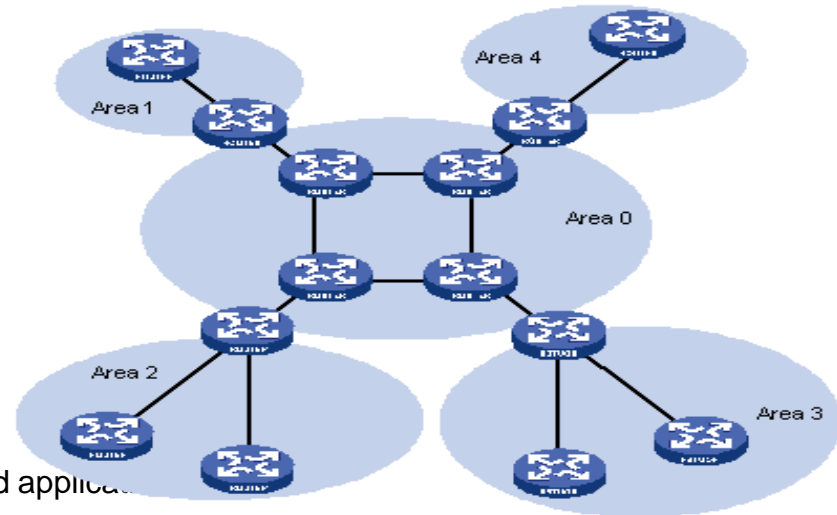
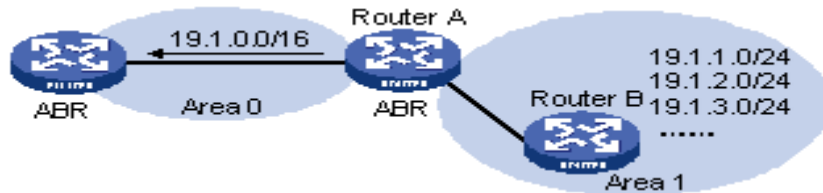


Link-state protocols

- OSPF – Open Shortest Path First
 - First standard – RFC 1131 ('89)
 - OSPFv2 – RFC 2178 ('97)
 - OSPFv3 – RFC 2740 ('99)
 - IPv6 version

2 level hierarchy

- An OSPF domain split into **areas**
 - For scalability reasons
- **LSA (Link State Advertisement)** advertised inside the areas only
- Aggregation between the areas
 - The changes inside an area not visible from outside
 - Special area – **Backbone area** (AreaID=0)



OSPF protocol operation

- Neighbor discovery
 - With the Hello protocol
- Choosing the Designated Router (DR) and Backup Designated Router (BDR)
 - Based on priorities
 - From 0 to 254
 - If priority set to 0, it will never be selected as DR or BDR
 - In case of equal priorities, the bigger Router ID wins
 - RID = the biggest configured loopback address on the router (127.x.x.x)
 - If no loopback address configured, RID = the biggest active interface address
 - If a higher priority router appears (is turned on) after the DR selection, it will not take over the DR role, until the DR and the BDR operate correctly
 - If the DR „dies”, the BDR takes over the role
 - New BDR is selected

OSPF protocol operation

- **Forming adjacencies**
 - Synchronizing the database and advertising the LSAs among the neighbors
 - The DR decreases the network traffic
 - The DR maintains a table about the entire network topology
 - Each router inside an area in a master-slave relation with the DR
 - Routers send updates to the 224.0.0.6 multicast address
 - All OSPF DR and BDR routers
 - The DR send the new table to the 224.0.0.5 multicast address
 - All OSPF routers