ROUTING ALGORITHMS

Introduction

- A packet travels from source to destination through multiple paths or sometimes a single path. So when a packet finds multiple paths to reach the destination, it has no judging methods available to find a right path.
- A router with the help of certain algorithms calculates the best path for the packet to reach the destination. These algorithms are called **routing algorithms**.
- The path with the lowest cost is considered the best.
- If cost of each link is known, a router can find optimal combination for any transmission.
- Several routing algorithms exist for this calculation
- Two most popular are:
- Distance vector routing
- Link state routing

Types of Routing Algorithms

Routing algorithms can be divided into 2 classes:

Nonadaptive or static:

Routing decisions are predetermined and not based on measurements (or estimates) of the current network topology and traffic load.

Adaptive or Dynamic:

Routing decisions may be changed when network topology and/or traffic load changes.

- Extreme case: select a new route for each Packet
- May get information just from neighboring routers, or from all routers.
- May re-determine routes periodically, or when topology changes, or when traffic load changes more than a threshold percentage.

Distance vector routing

- Uses distance and direction to find the best path to reach the destination.
- The distance is the number of hops (Router) a packet crosses to reach the destination.
- Each Router periodically shares knowledge about the entire network with its neighbors.

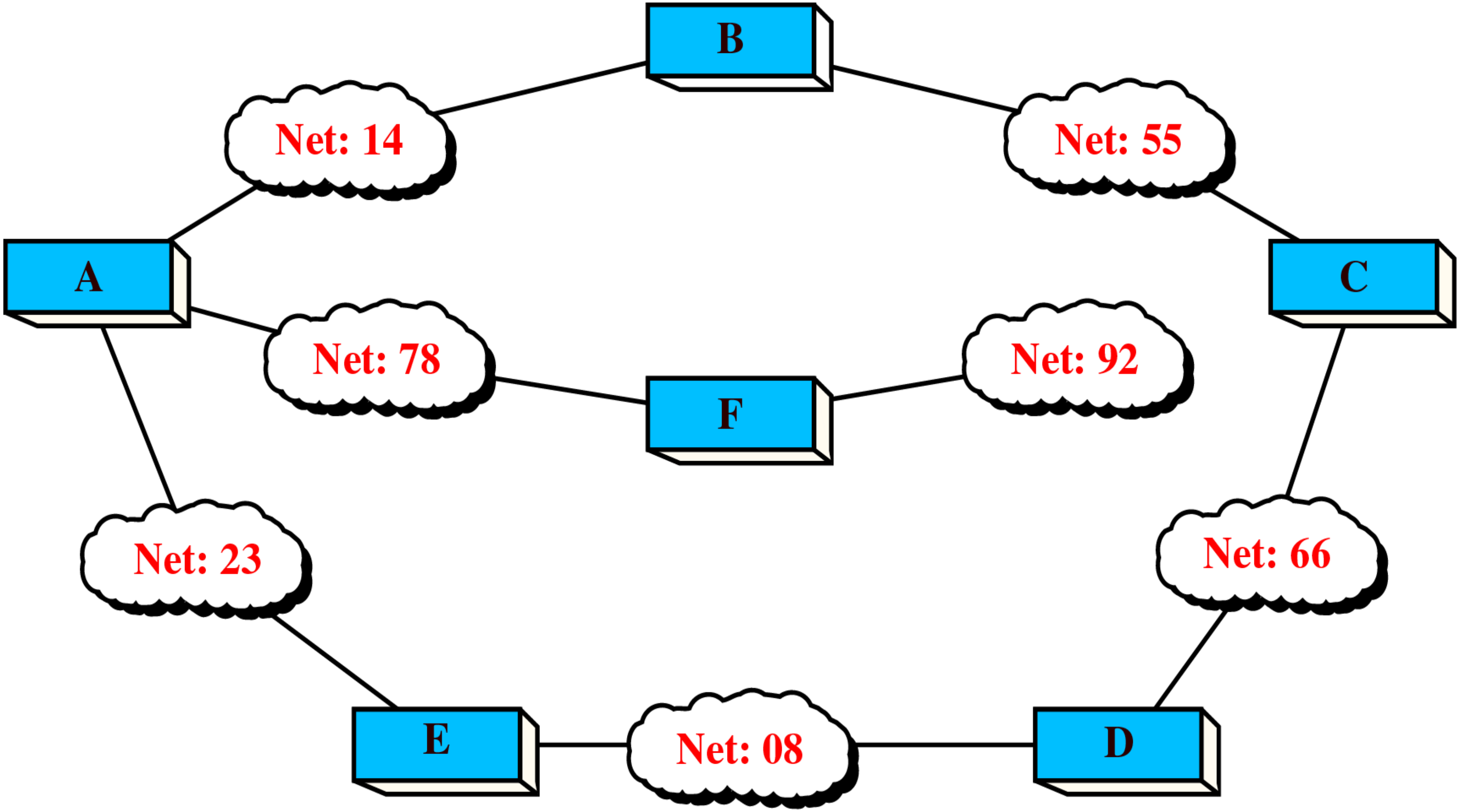
Continues….

•Working of this distance vector algorithm in three steps as follows: **Step 1:** The information about every router connected directly and routing updates will be gathered by every single router. This information about the **whole network** will be sent periodically to all the neighboring routers connected to it.

Every router updates the information in its routing table. **Step 2:** All information collected by single router about the whole network will be sent **only to its neighbors** and not to all other routers in the routing table. If there is any change in the hop count or disabled paths it will updated only to its neighbors which passes to its neighbors. **Step 3:** The above explained sharing of information will take place in a **period of 30 seconds**. If there is a change in the network (Network fails or router is added) the changed information will be updated.

- **Examples:**
  RIP and IGRP uses distance vector routing algorithm.

Sharing Information: Example of an Internet

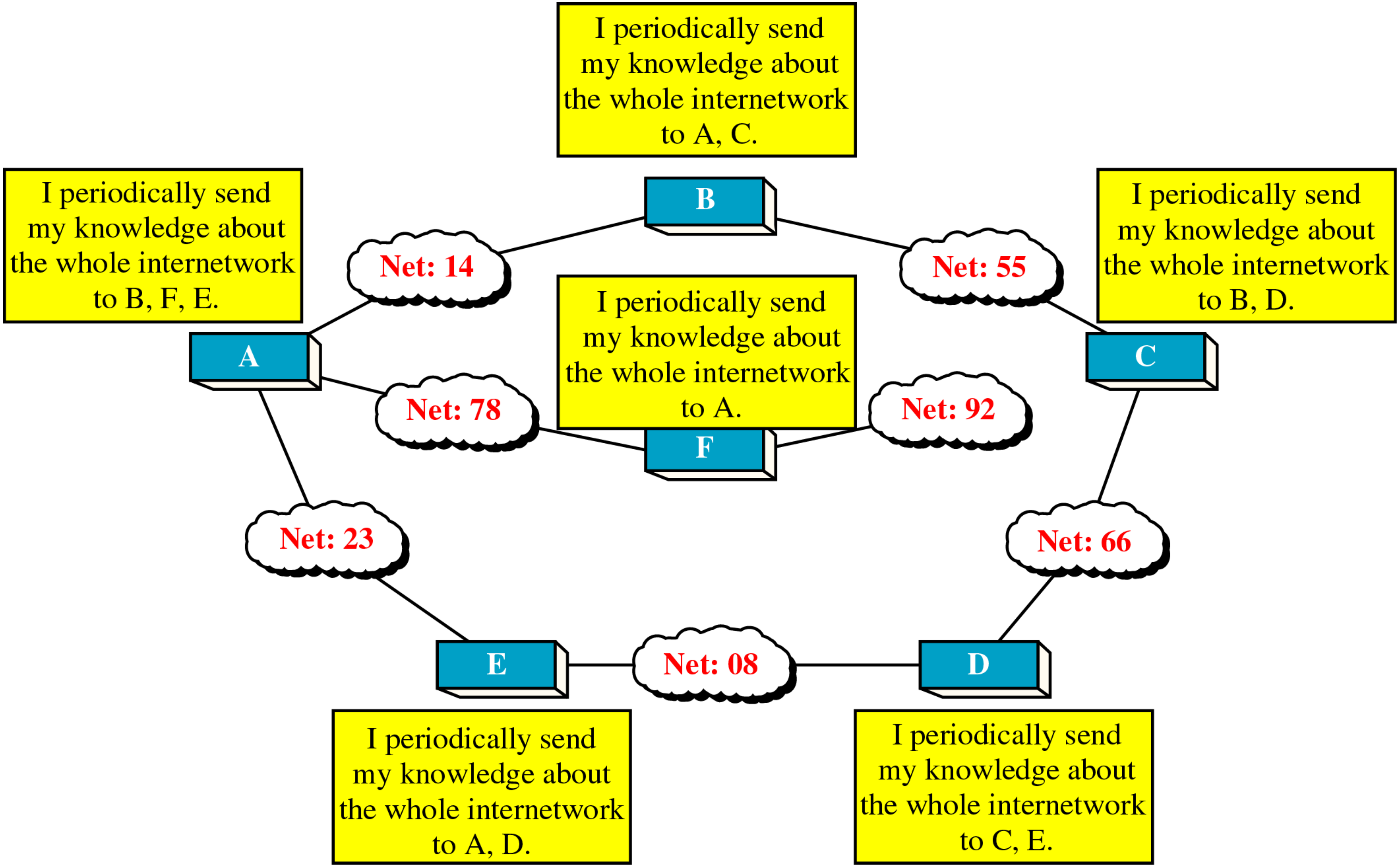


Sharing Information

- Cloud represents LANs with its LAN's Network ID.
- A, ,B, C, D,E and F are routers
- Assumes a cost of one unit for every link
- Efficiency of transmission is function of number of links required to reach a destination.
- In DVR, the cost is based on hop count.
- Each node adds its knowledge and sends the updated table to its neighbors and so on.

Figure 21-18

The Concept of Distance Vector Routing



Routing Table

- Creation of Table

  -Router only knows about its neighbors

  -Table has at least 3 types of information network ID, the cost and ID of next router

  - Network id: final destination of packet

  - Cost: number of in between hops

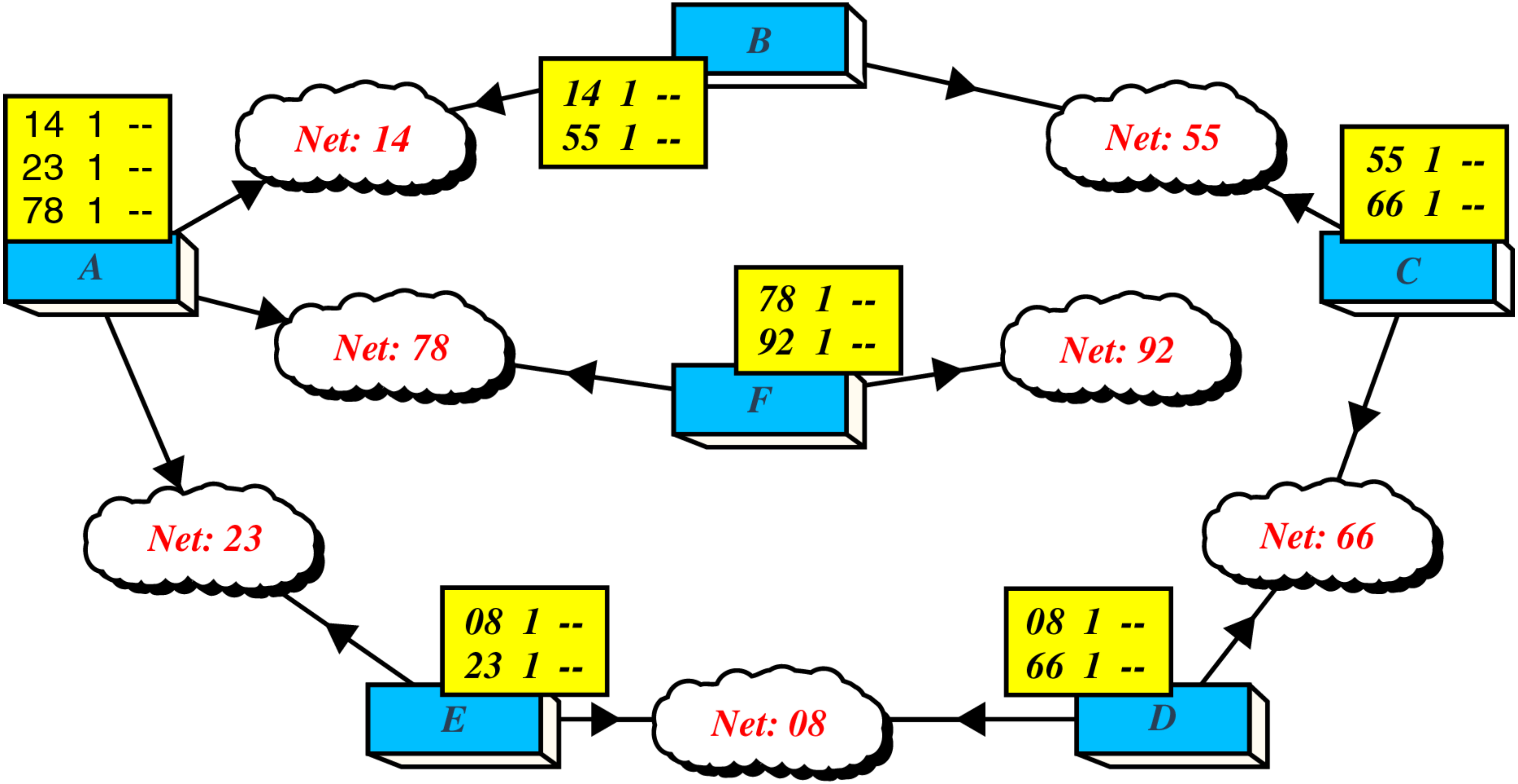
Figure 21-19

Distance Vector Routing Table

Network ID	Cost	Next Hop
. . . .	. . . .	. . . .
. . . .	. . . .	. . . .
. . . .	. . . .	. . . .
. . . .	. . . .	. . . .
. . . .	. . . .	. . . .

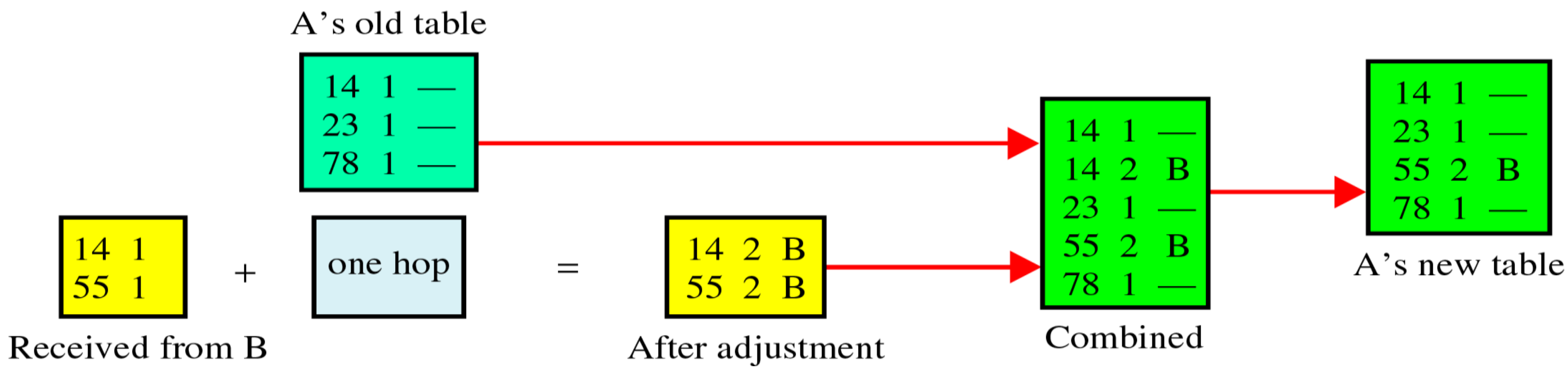
Figure 21-20

Routing Table Distribution



Updating Table

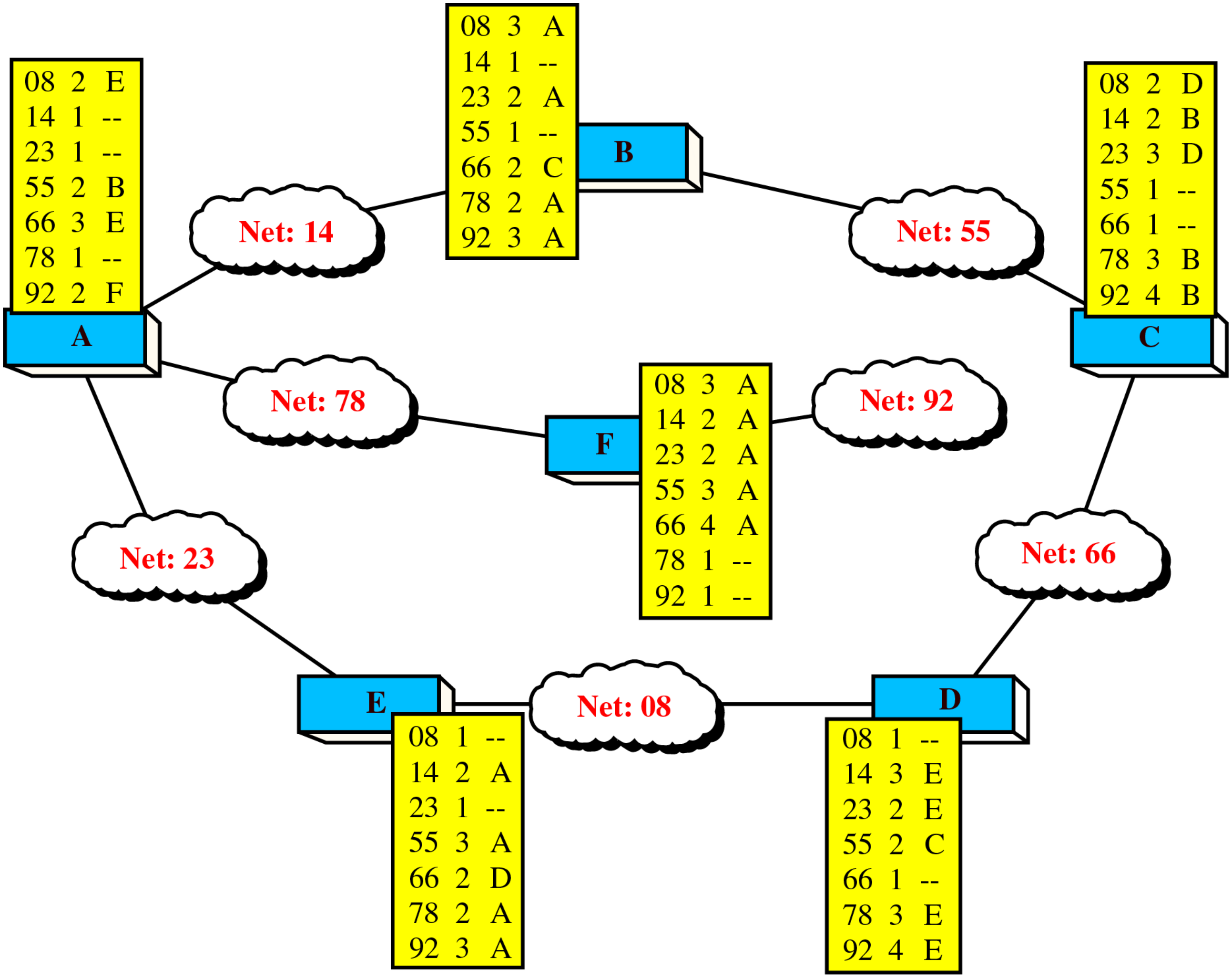
- When A receives a routing table from B, it updates its own table



- In combined table duplicate data with higher cost can be removed
- Process continues for all routers

Figure 21-22

Final Routing Tables



Updating Algorithm

- The router first add one hop to the hop count field for each advertised route.
- Following rules are followed:

1. If the advertised destination is not in the routing table , the router should add the advertised information to the table.

2. If the advertised destination is in the routing table,

a) If the next-hop filed is the same, the router should replace the entry in the with the advertised one table . Note that even if the advertised hop count is larger , the advertised entry should replace the entry in the table because the new information invalidates the old.

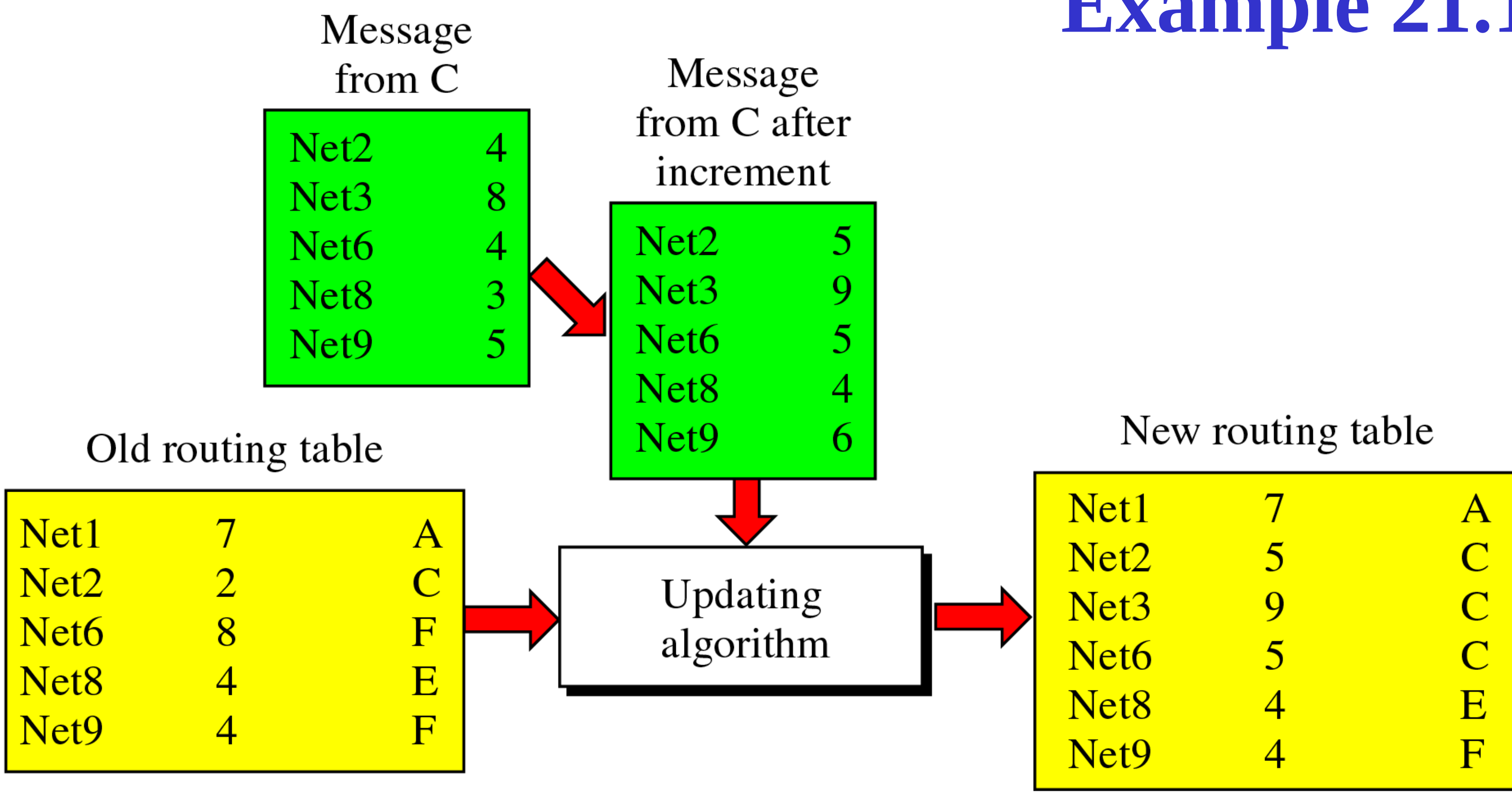
b) If the next-hop filed is not the same,

(i)If the advertised hop count is smaller than the one in the table, the router should replace the entry in the table with the new one

(ii) If the advertised hop count is not smaller, the router should do nothing.

Figure 21-23

Example 21.1



Rules

Net2: Replace **(Rule 2.a)**
Net3: Add **(Rule 1)**
Net6: Replace **(Rule 2.b.i)**
Net8: No change **(Rule 2.b.ii)**
Net9: No change **(Rule 2.b.ii)**

Note that there is no news about Net1 in the advertised message, so none of the rules apply to this entry.

Link state Routing

- In LSR, each router shares its knowledge of its neighborhood with every other router in the internetwork.
- LSR includes:

a) **Knowledge about the neighborhood:** Instead of sending its entire routing table. A router sends information about its neighborhood only.

b) **To all routers(with flooding):**Each router sends this information to every other router on the internetwork.

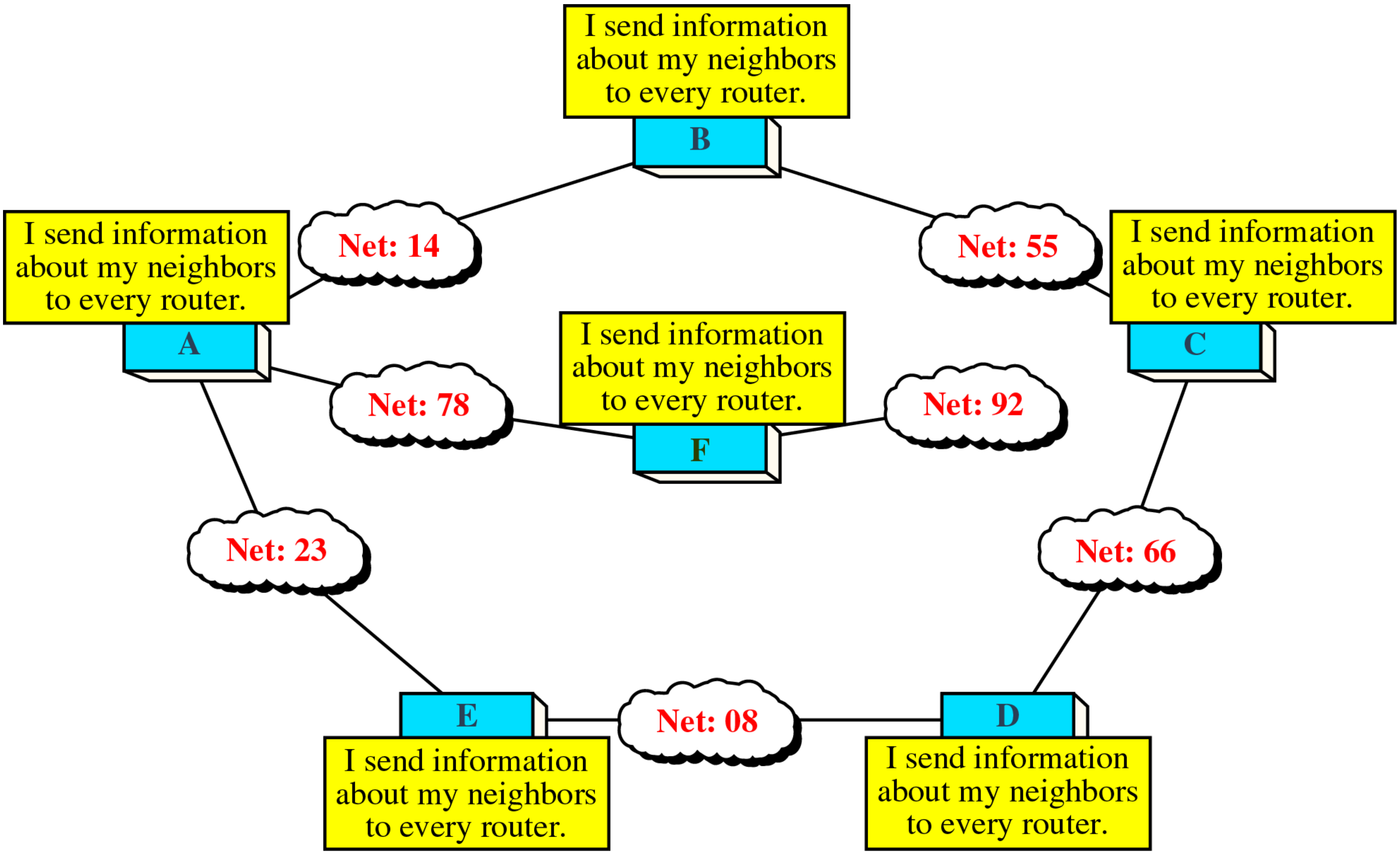
c) **Information sharing when there is a change**

Example:

OSPF routing protocol which uses link state algorithm alone.

Figure 21-24

Concept of Link State Routing

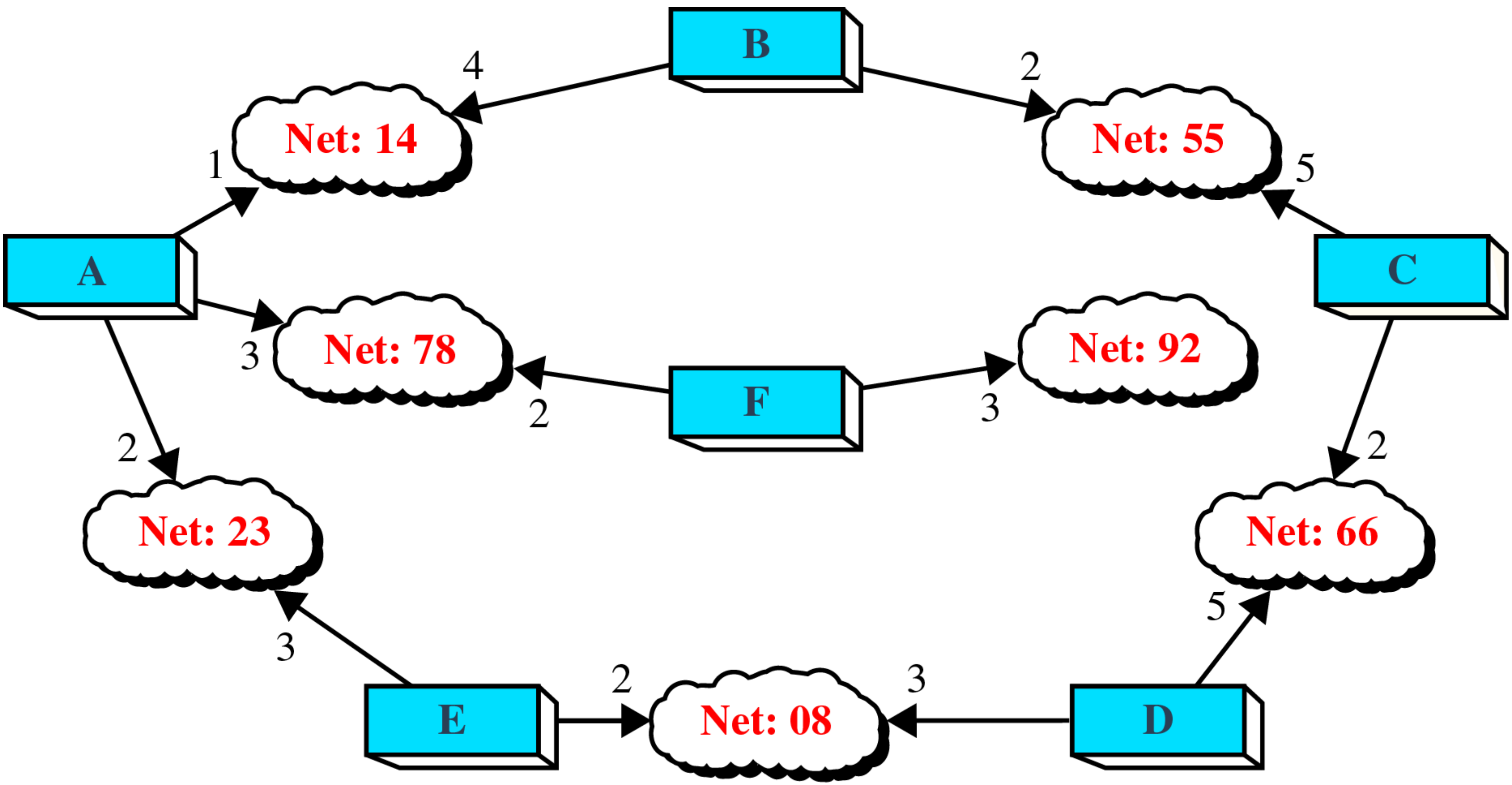


Packet cost

- In LSR cost is weighted value based on variety of factors as security levels, traffic, state of link etc.
- Cost is applied only by routers.
- Cost is applied as packet leaves the router rather than as it enters.

Figure 21-25

Cost in Link State Routing



Link state Packet

- The basis of advertising is a short packet called a link state packet(LSP)

Four fields:

- ID of advertiser
- ID of destination network
- The cost
- Id of neighbor router

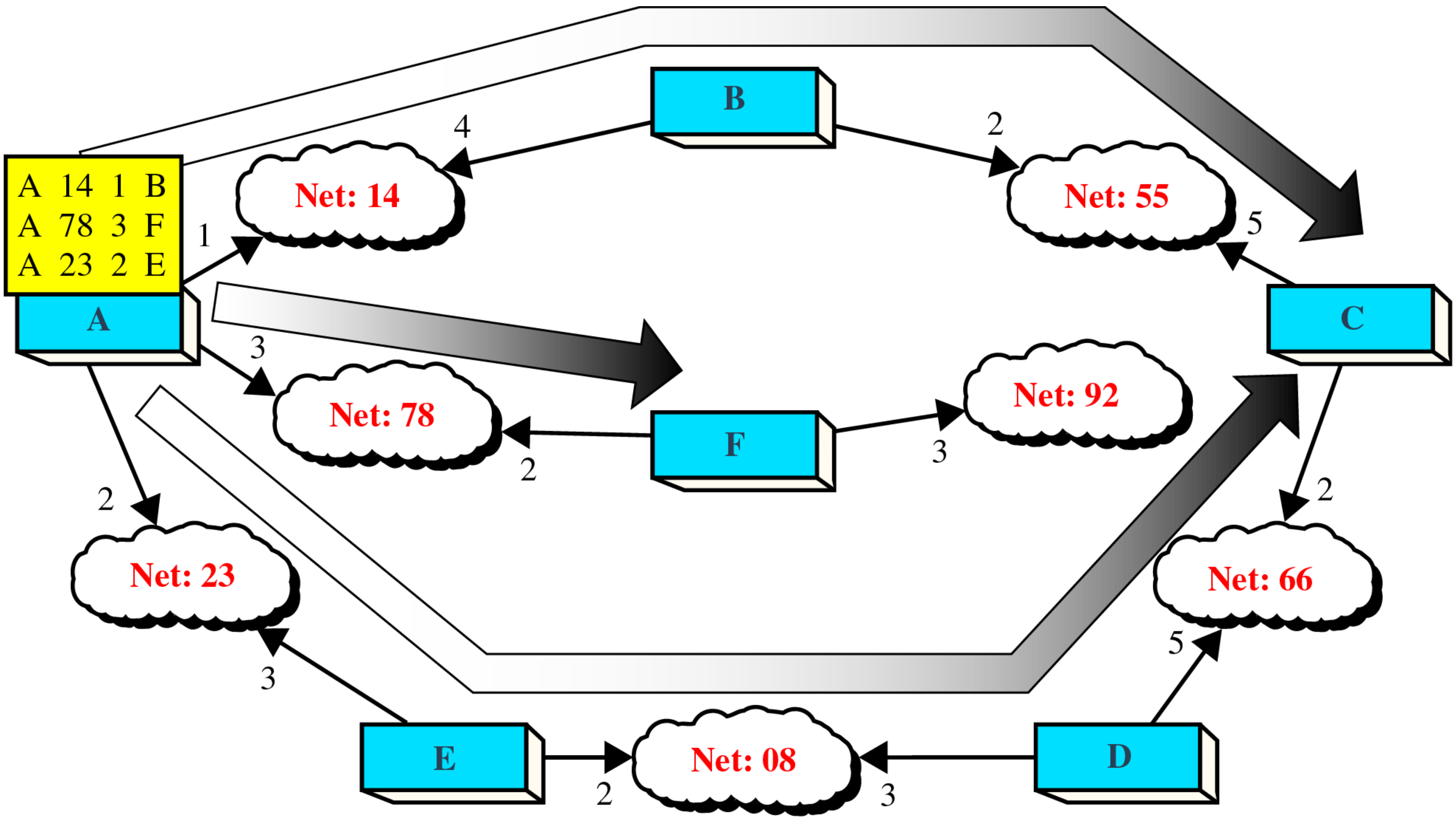
Figure 21-26

Link State Packet

Advertiser	Network	Cost	Neighbor
. . . .	. . . . . .	. . . .	. . . .
. . . .	. . . . . .	. . . .	. . . .
. . . .	. . . . . .	. . . .	. . . .

Figure 21-27

Flooding of A's LSP



Link State Database(same for all routers)

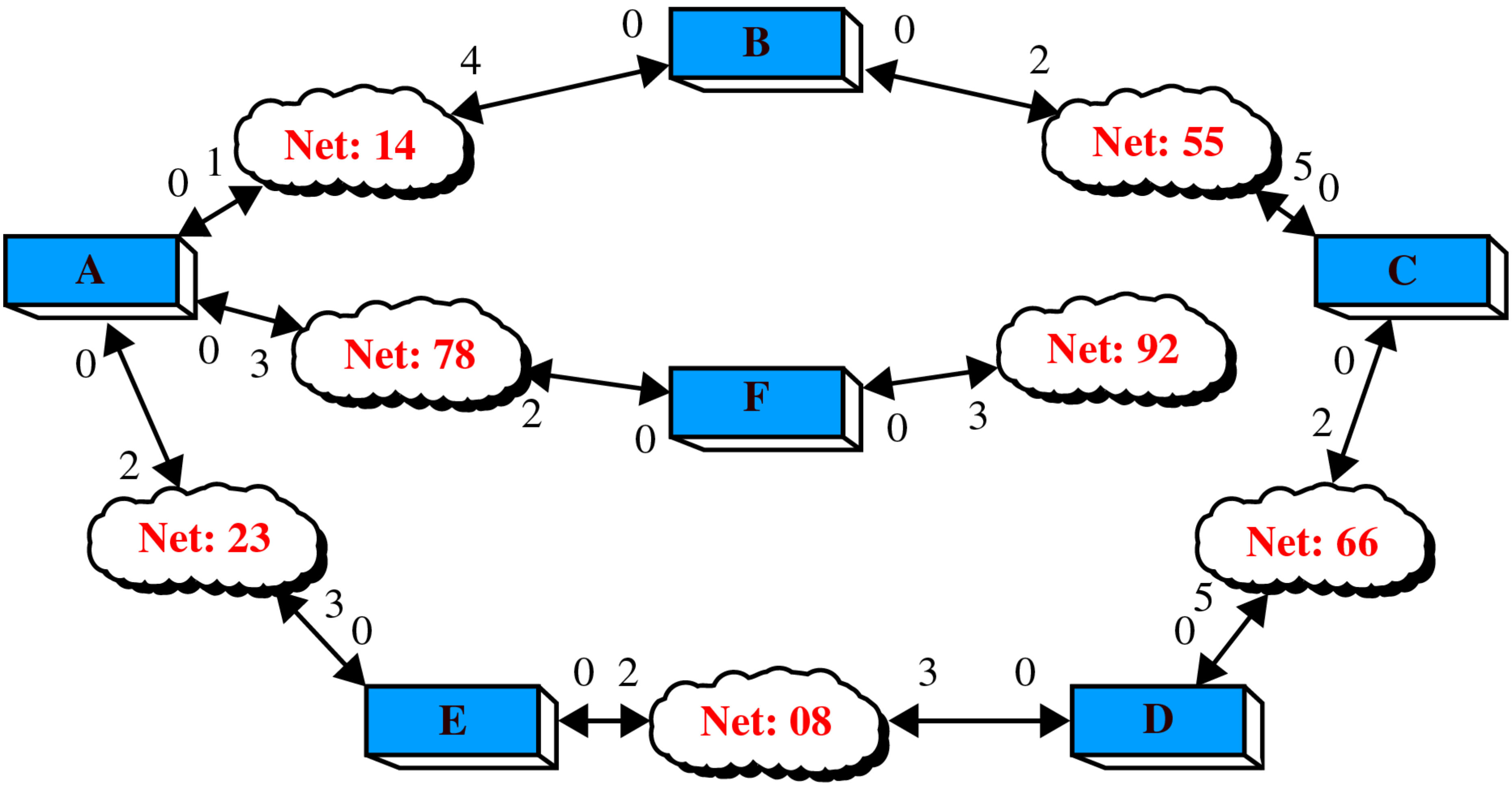
Advertiser	Network	Cost	Neighbor
A	14	1	B
A	78	3	F
A	23	2	E
B	14	4	A
B	55	2	C
C	55	5	B
C	66	2	D
D	66	5	C
D	08	3	E
E	23	3	A
E	08	2	D
F	78	2	A
F	92	3	—

Dijkstra Algorithm

- Each router applies this algorithm to link state database.
- Algorithm calculates the shortest path between two points on a network using a graph made up of nodes and arcs.
- Nodes: **networks and routers**
- Cost is applied to arc from router to network
- Cost of arc from network to router is always zero

Figure 21-29

Costs in the Dijkstra Algorithm



Shortest Path tree

- Following four steps are followed:

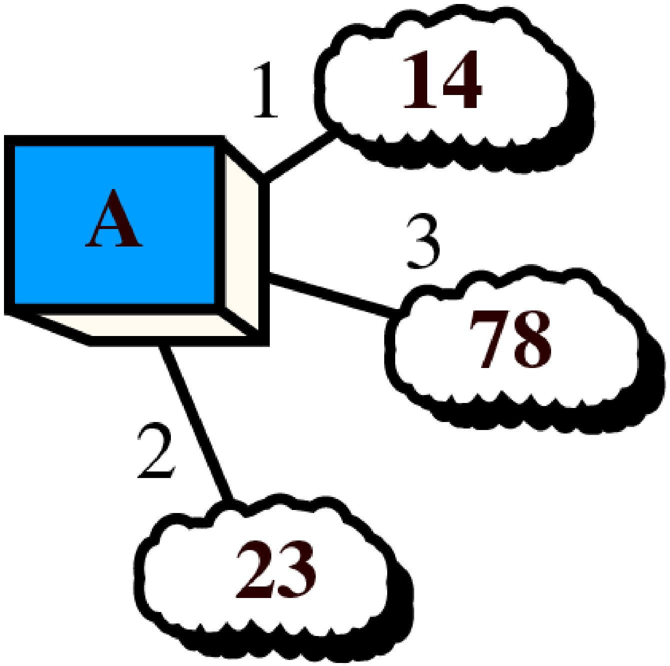
  a) Identify one router as its root

  b) Identify the arc with the lowest cumulative cost This arc and node are now permanent

  c) The algorithm examines database and identifies every node that can be reached from its chosen node. These nodes & arcs added temporarily to tree

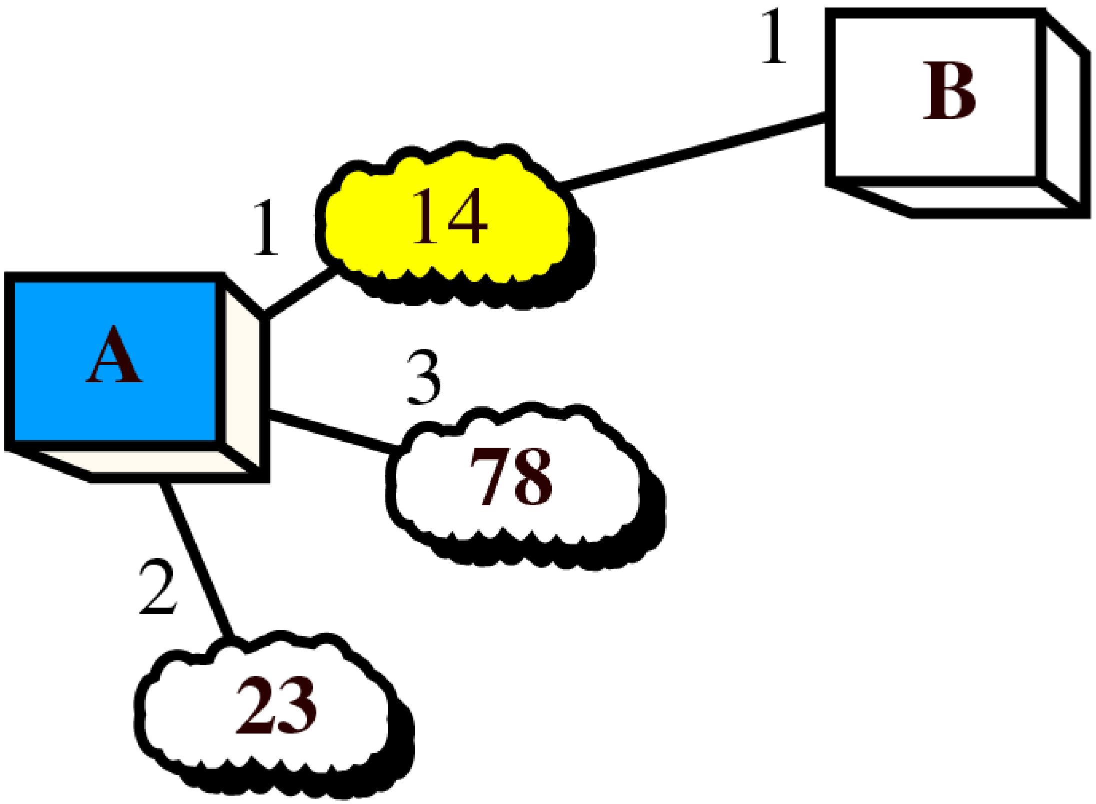
  d) Last two steps are repeated until every node in the network has become a permanent part of tree.

Shortest Path Calculation, Part I



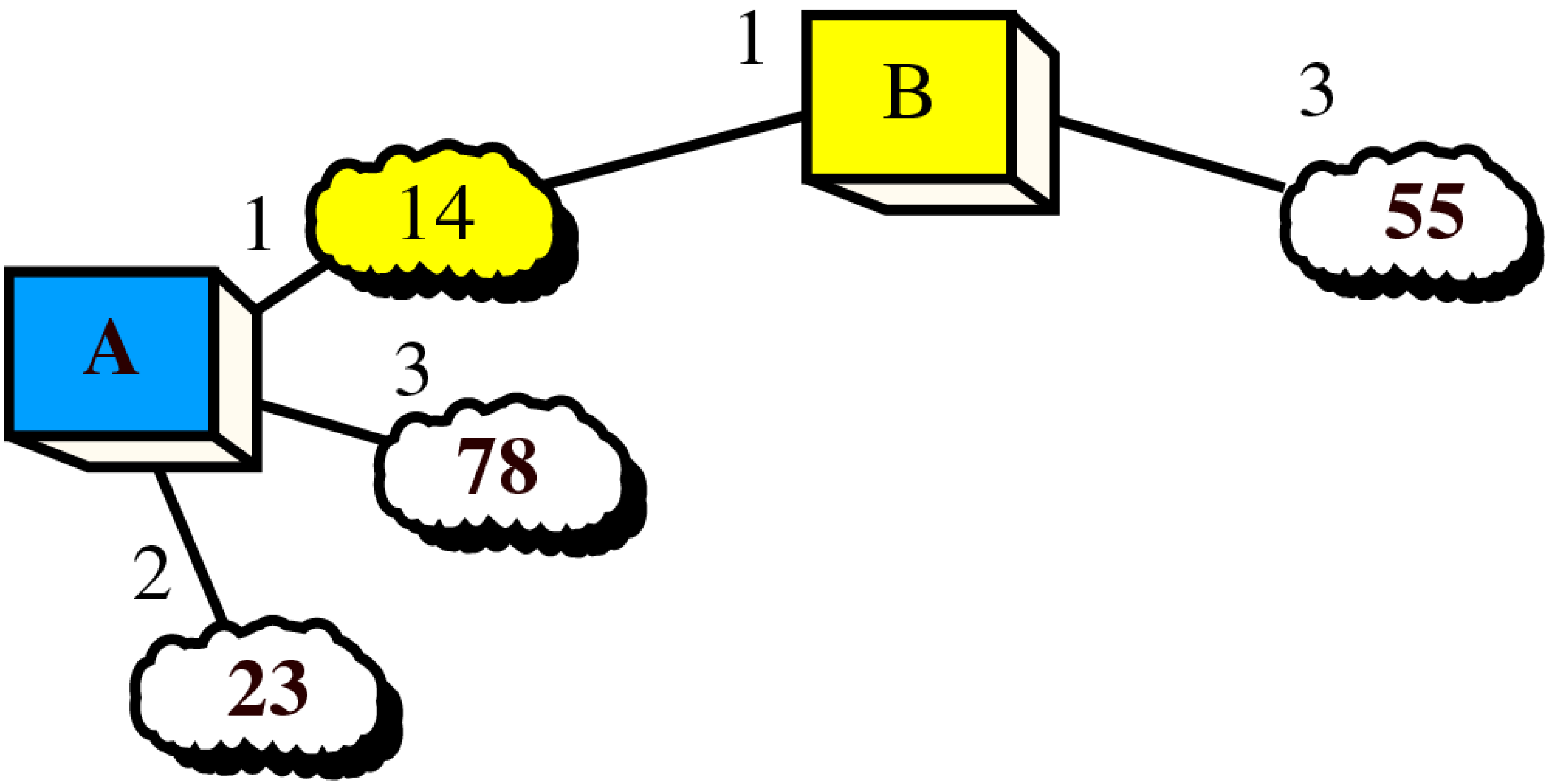
Root is A, networks
14, 78, 23 added

Shortest Path Calculation, Part II



14 permanent, B added

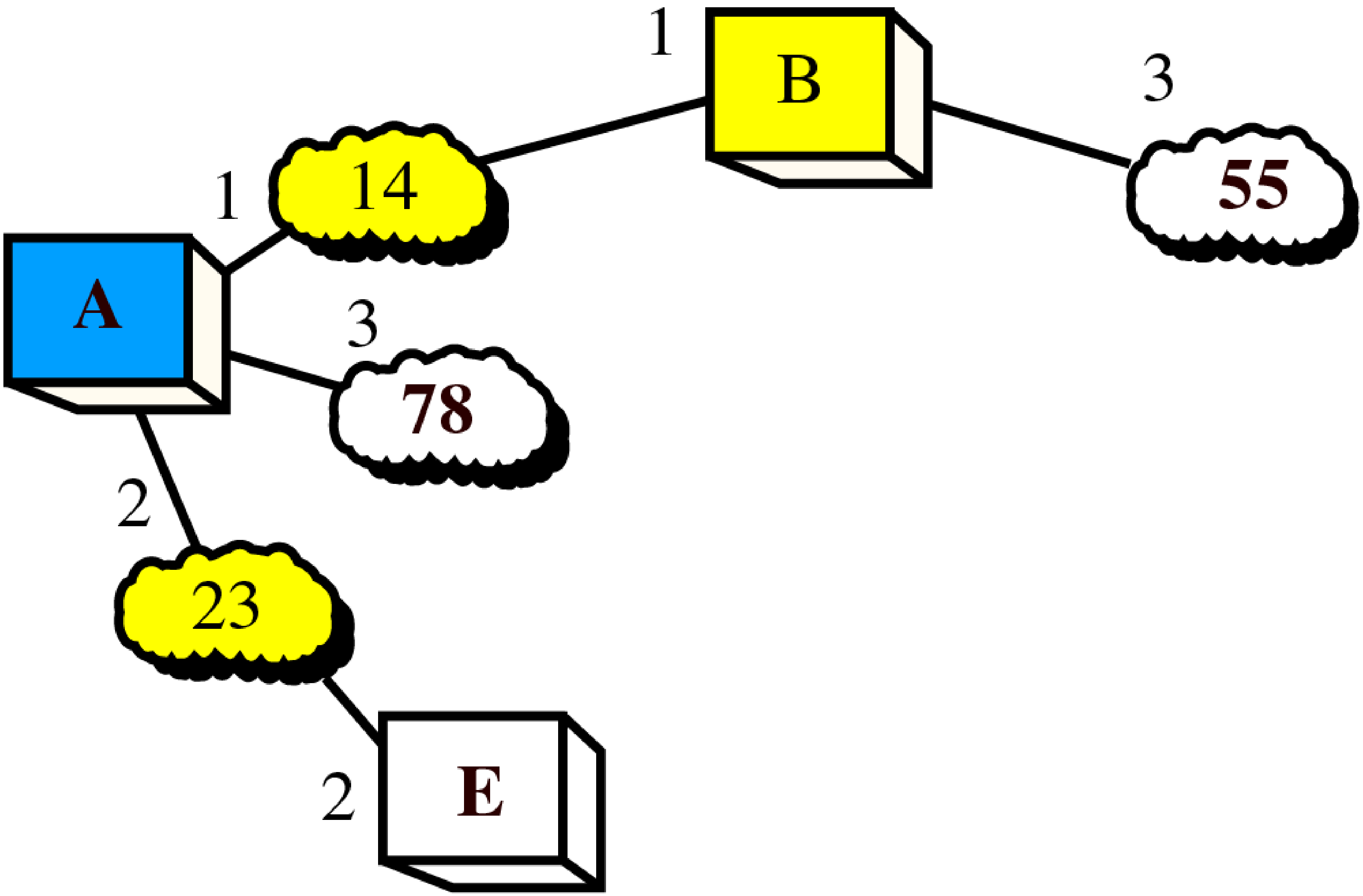
Shortest Path Calculation, Part III



B Permanent, 55 added

Figure 21-30, Part IV

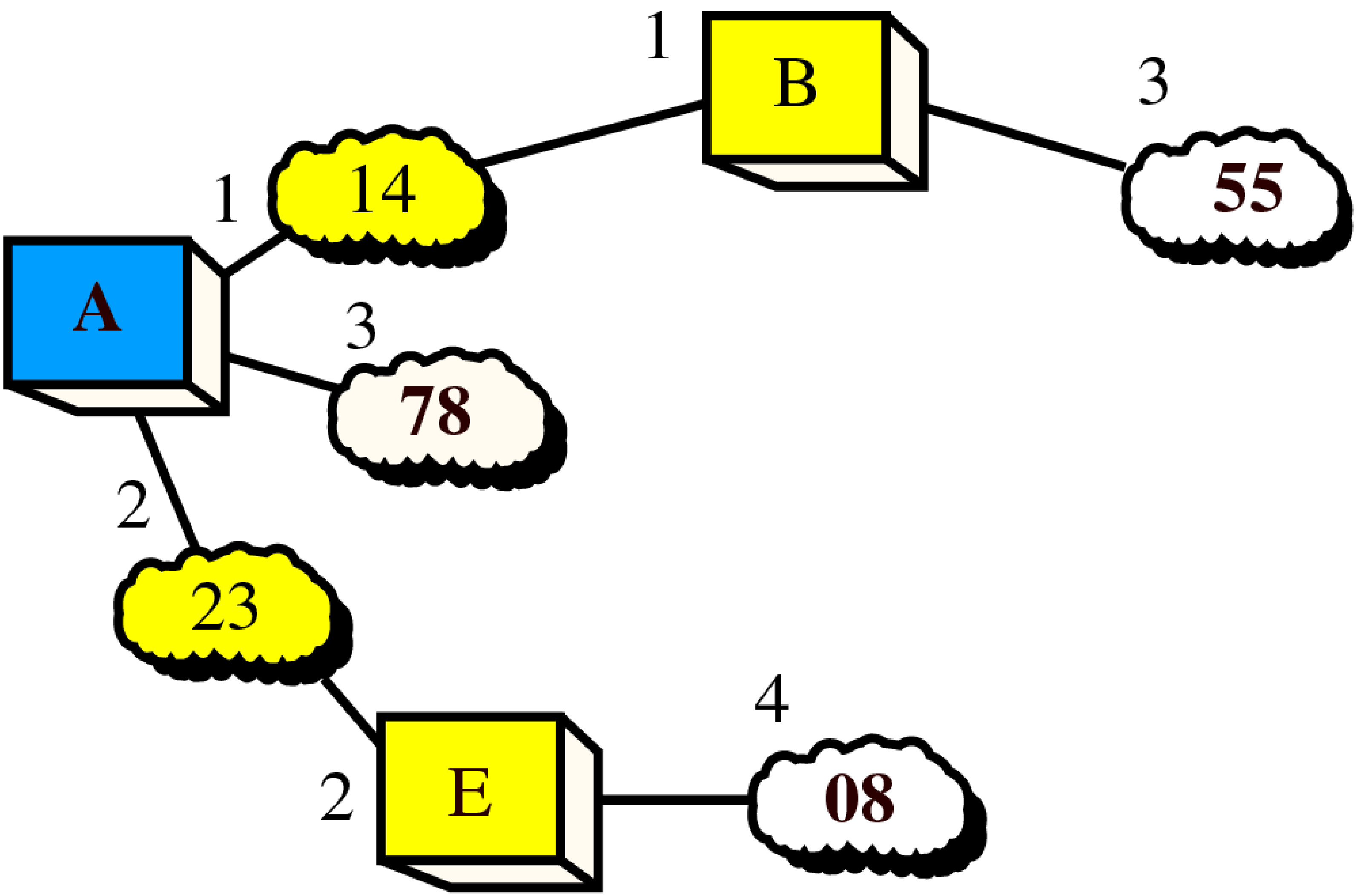
Shortest Path Calculation, Part IV



23 permanent, E added

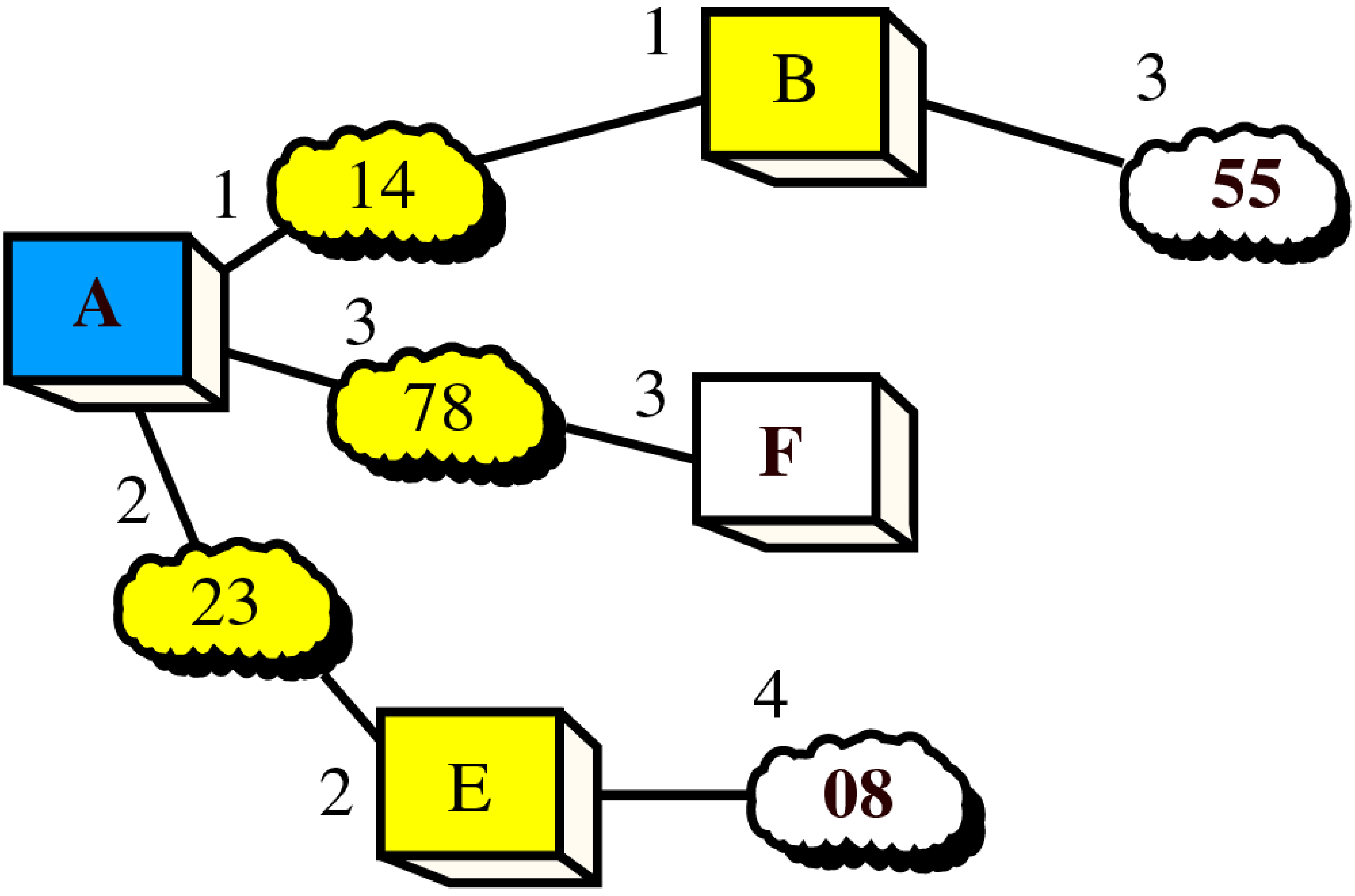
Figure 21-30, Part V

Shortest Path Calculation, Part V



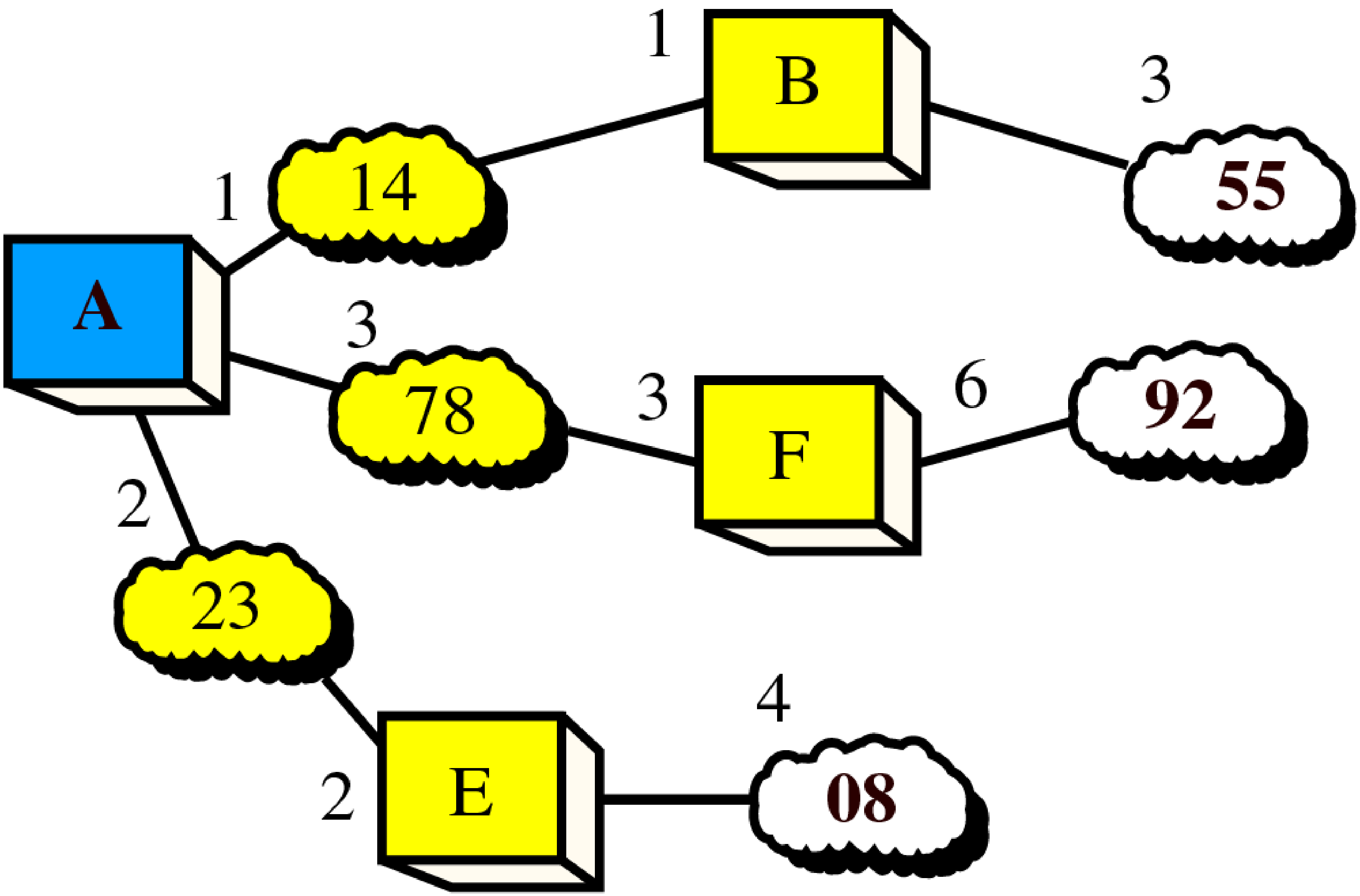
E permanent, 08 added

Shortest Path Calculation, Part VI



78 permanent, F added

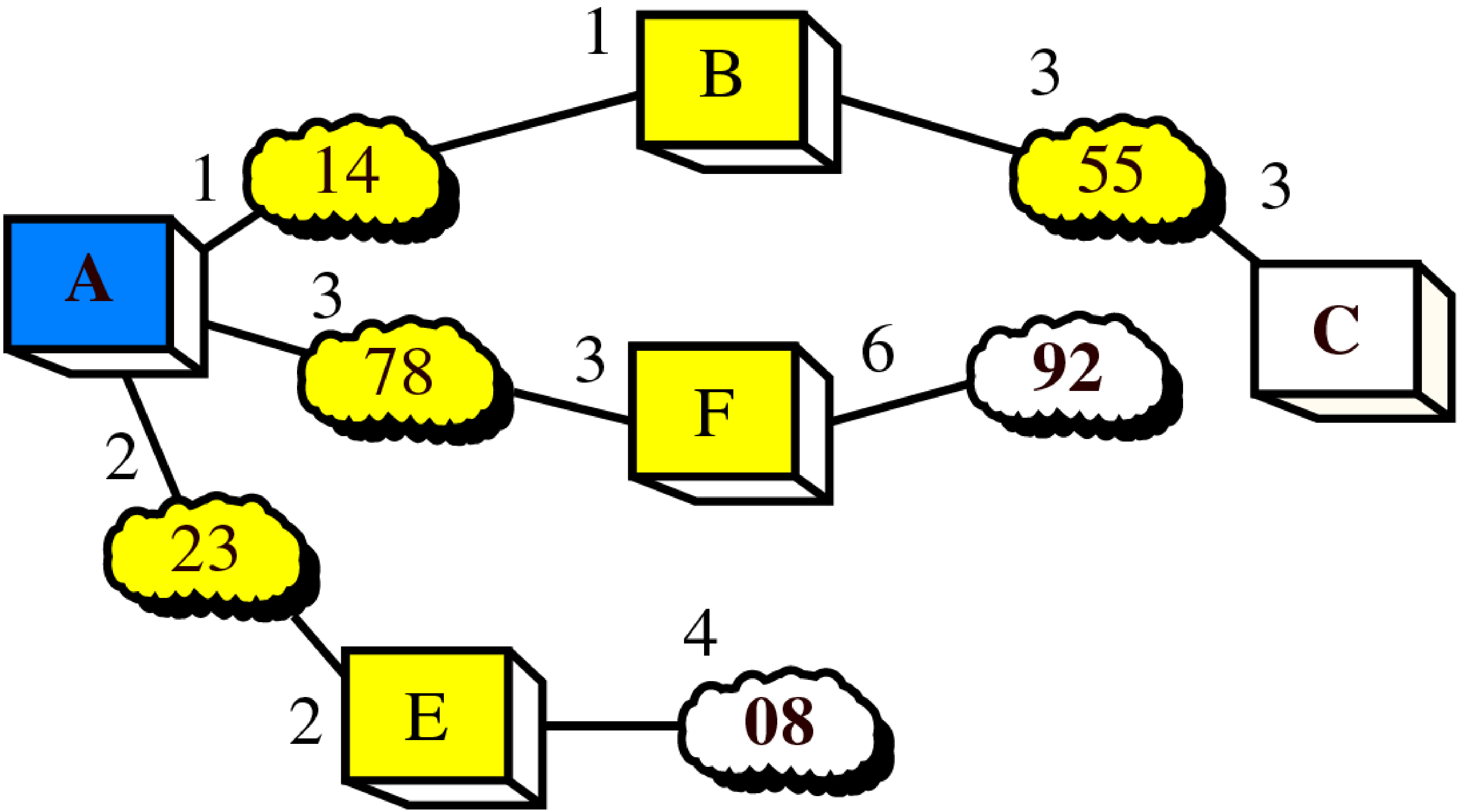
Shortest Path Calculation, Part VII



F permanent, 92 added

Figure 21-31, Part I

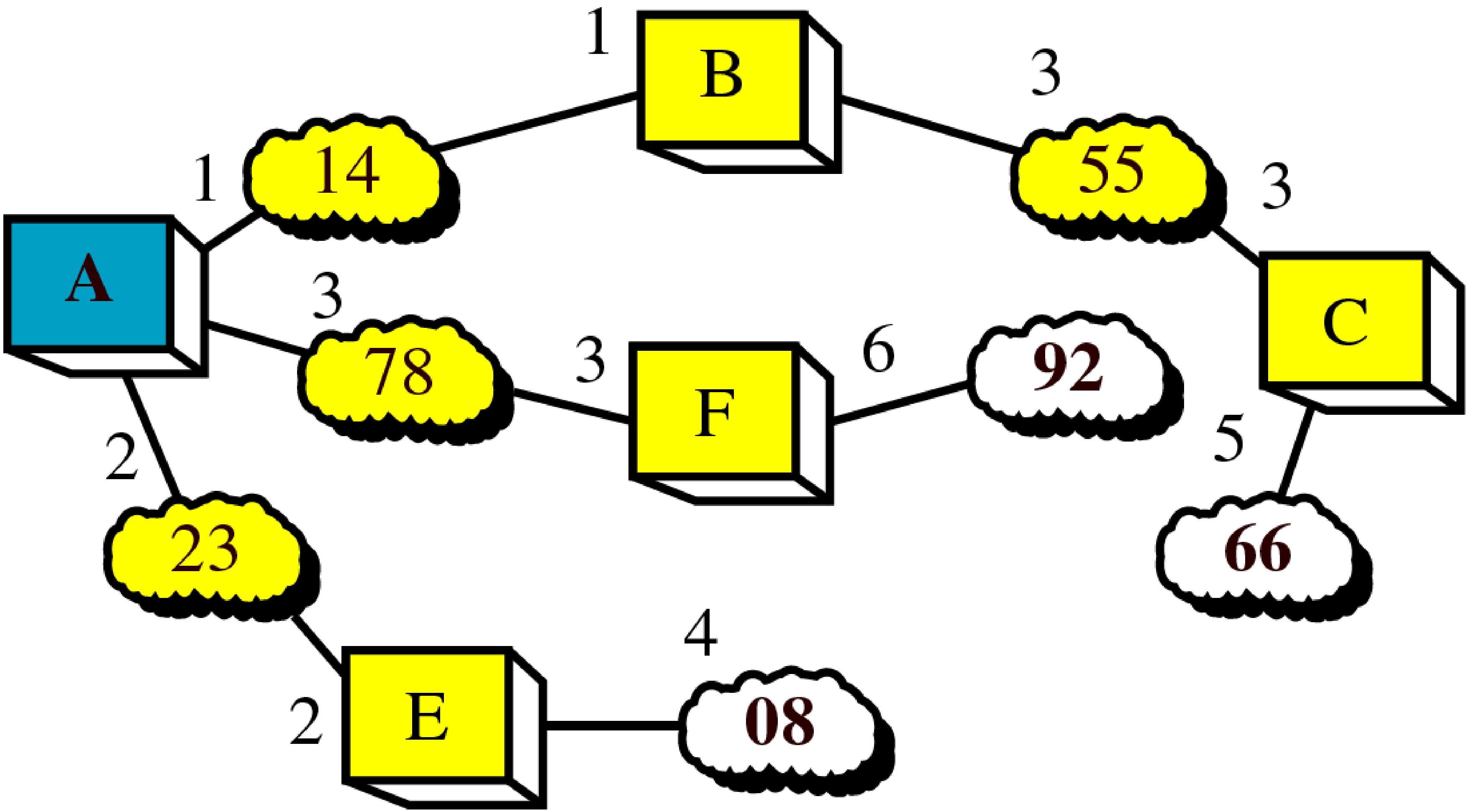
Shortest Path Calculation, Part VIII



55 permanent, C added

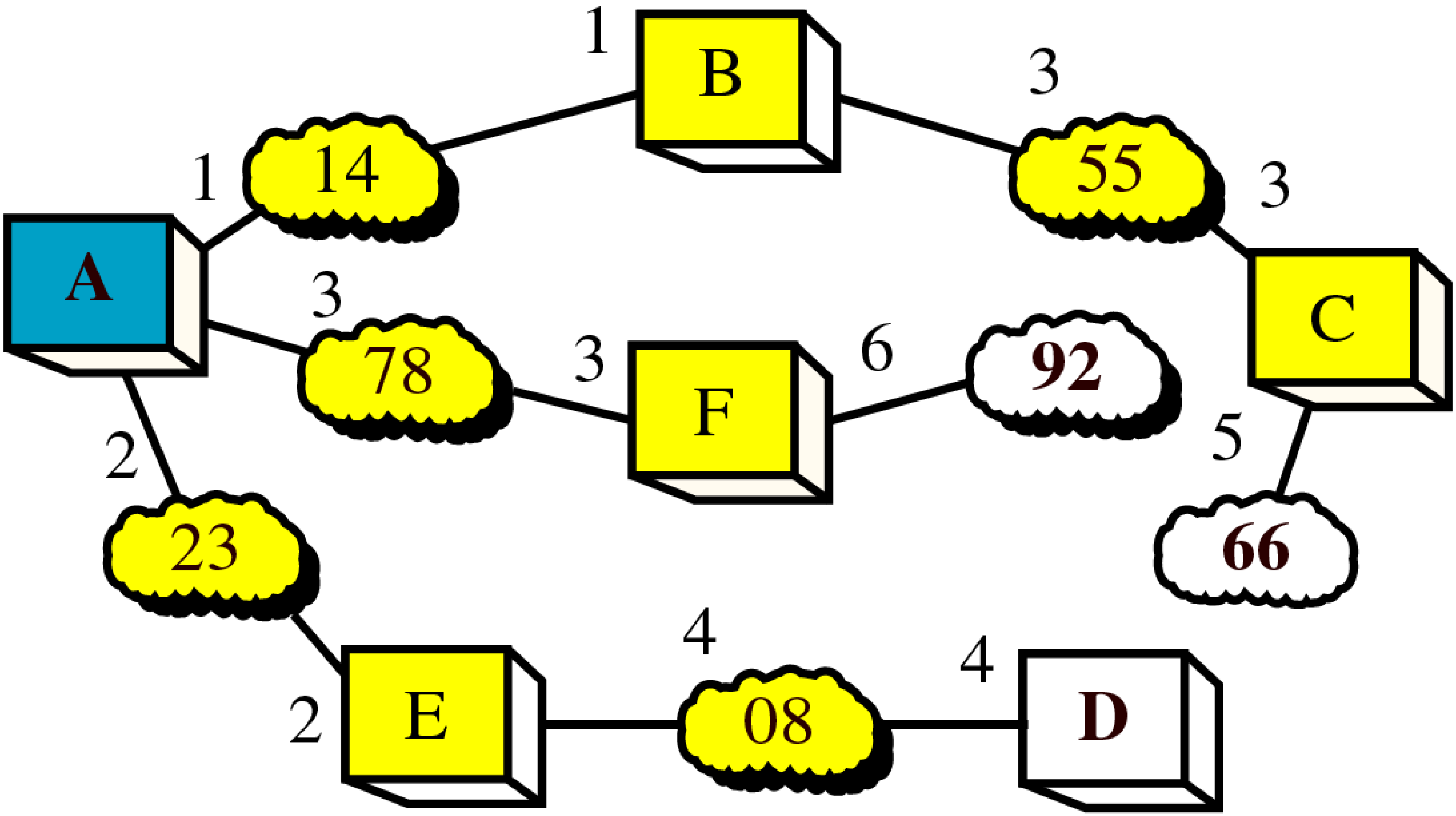
Figure 21-31, Part II

Shortest Path Calculation, Part IX



C permanent, 66 added

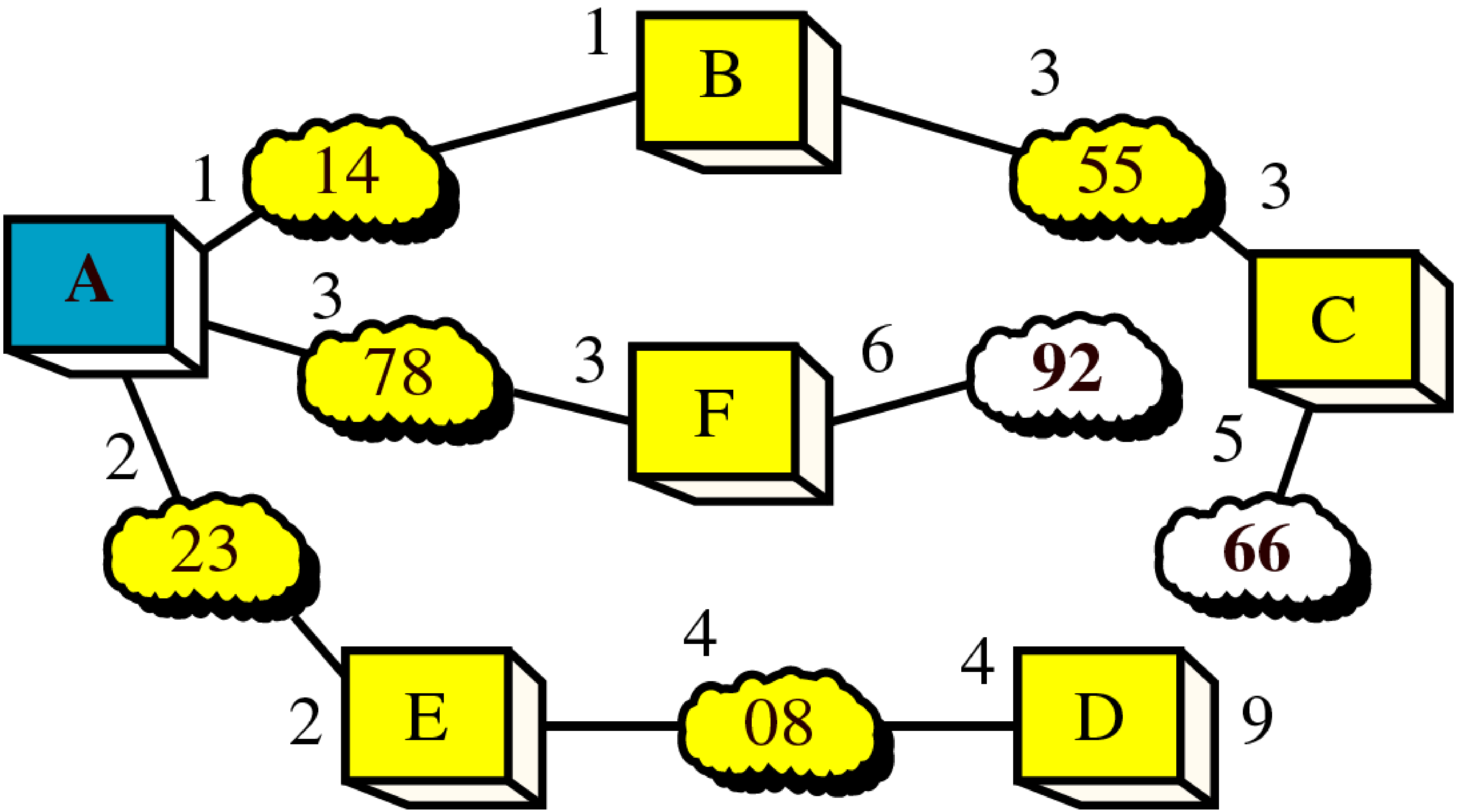
Shortest Path Calculation, Part X



08 permanent, D added

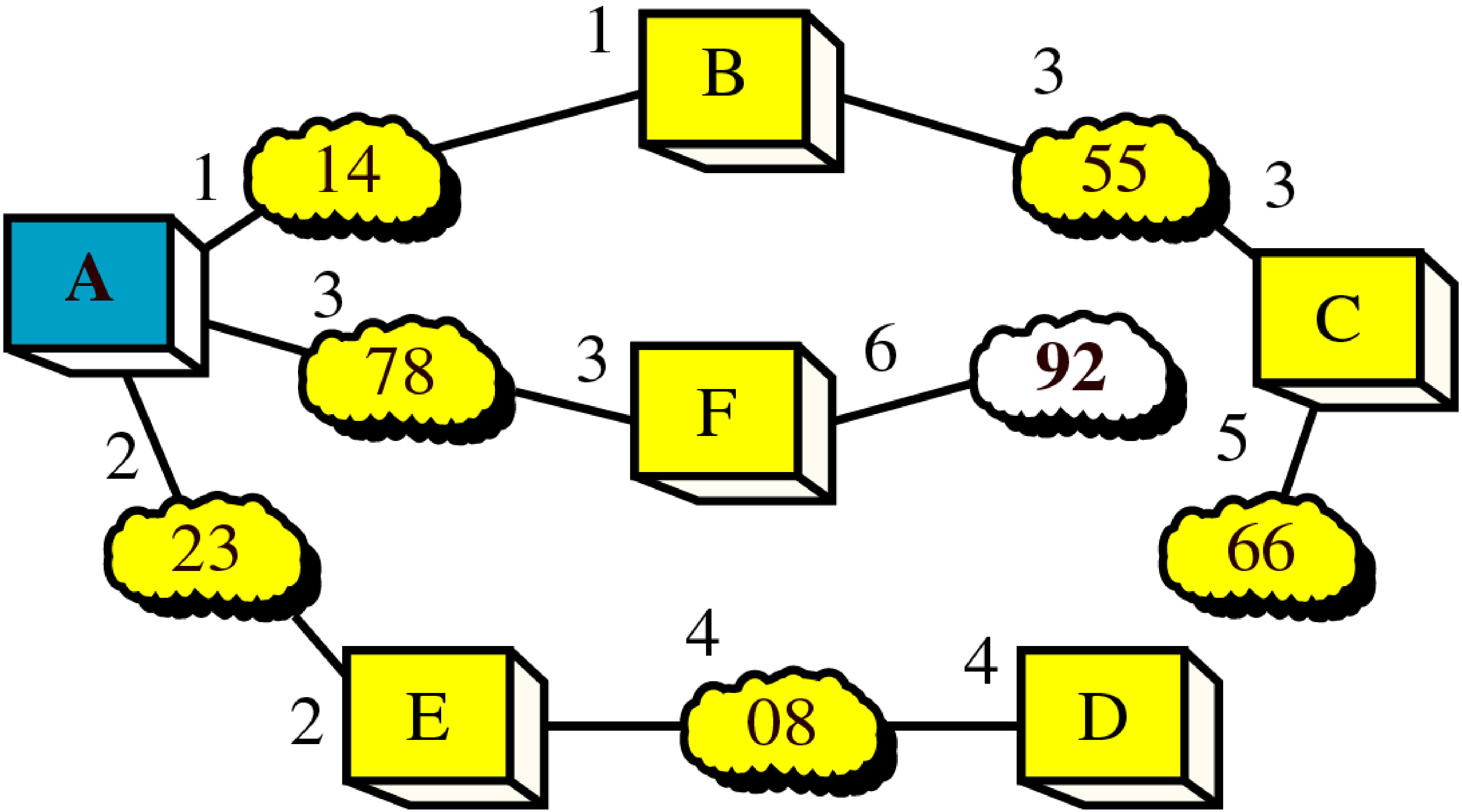
Figure 21-31, Part IV

Shortest Path Calculation, Part XI



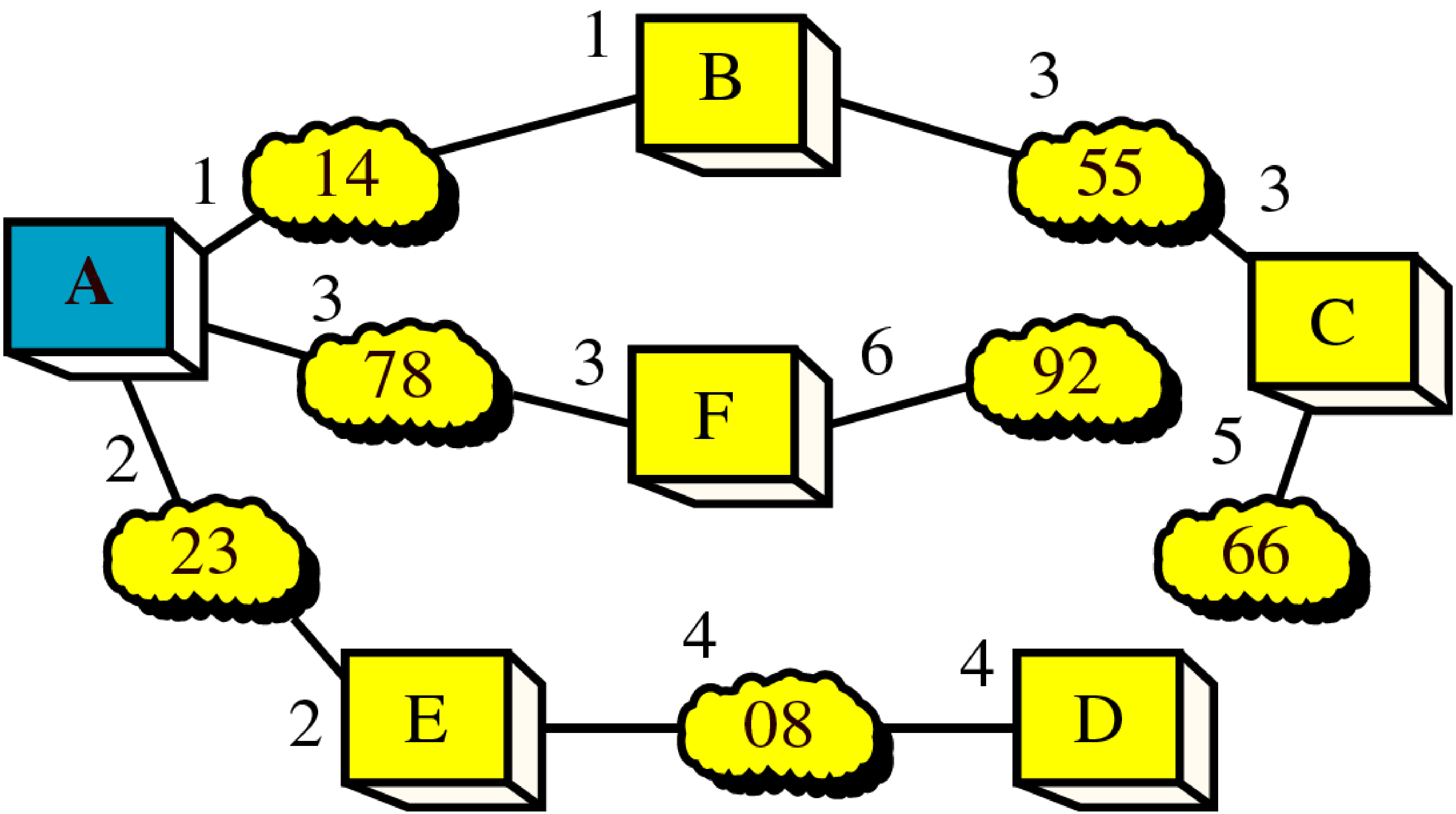
D permanent, 66 added.
But 9 > 5, so that link deleted

Shortest Path Calculation, Part XII



66 permanent

Shortest Path Calculation, Part XIII



92 permanent

Figure 21-32

Routing Table for Router A

Each router uses the shortest path tree to construct its routing table

Net	Cost	Next router
08	4	E
14	1	--
23	2	--
55	3	B
66	5	B
78	3	--
92	6	F