15. TCP/IP Protocol Suite
IP

Contents

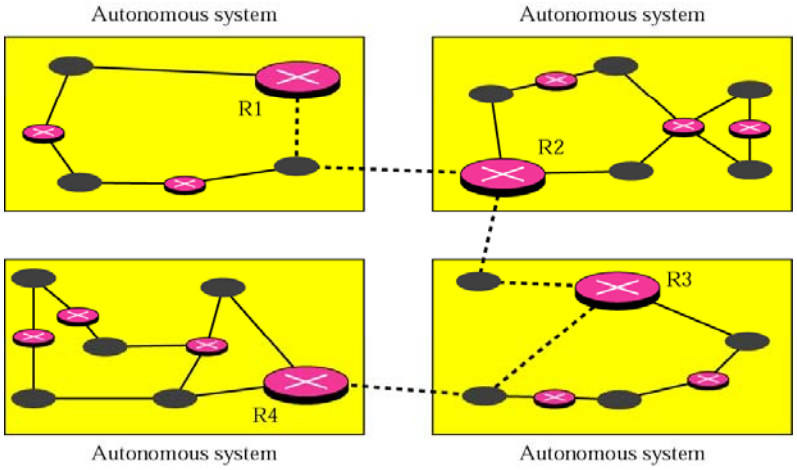
i. Programming of routers

Intradomain and Interdomain routing

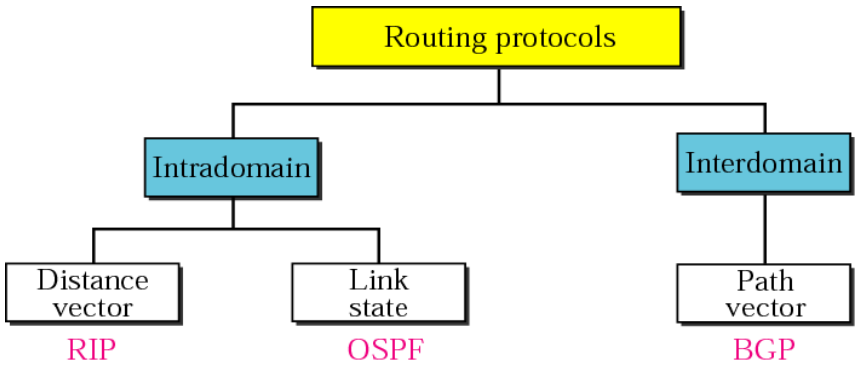
•Routing inside an autonomous system is referred to as intradomain routing

•Routing between autonomous systems is referred to as interdomain routing.

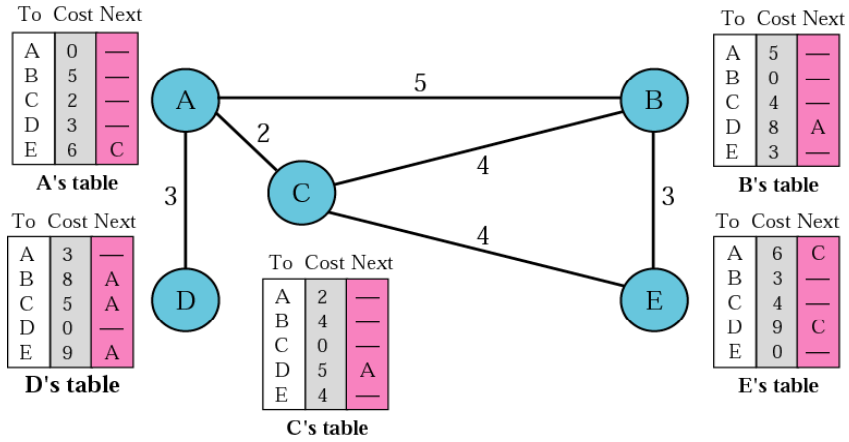
Autonomous systems



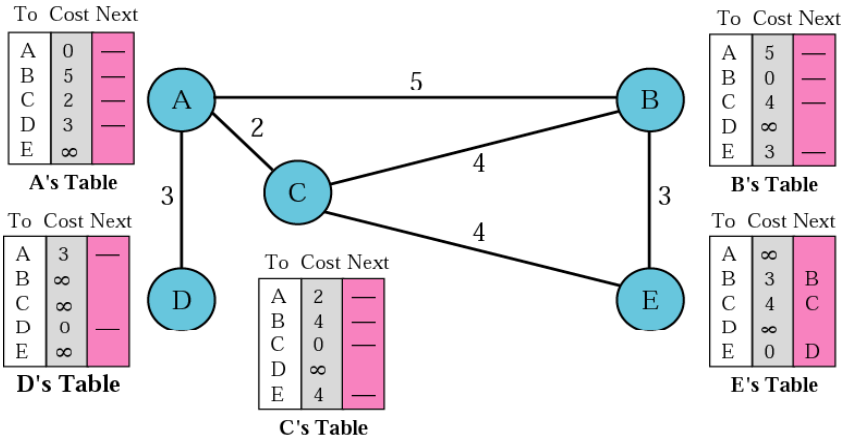
Popular routing protocols



Distance vector routing tables

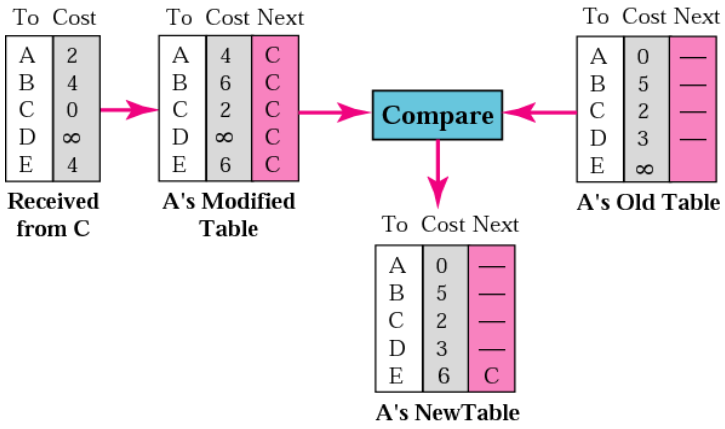


Initialization of tables in distance vector routing

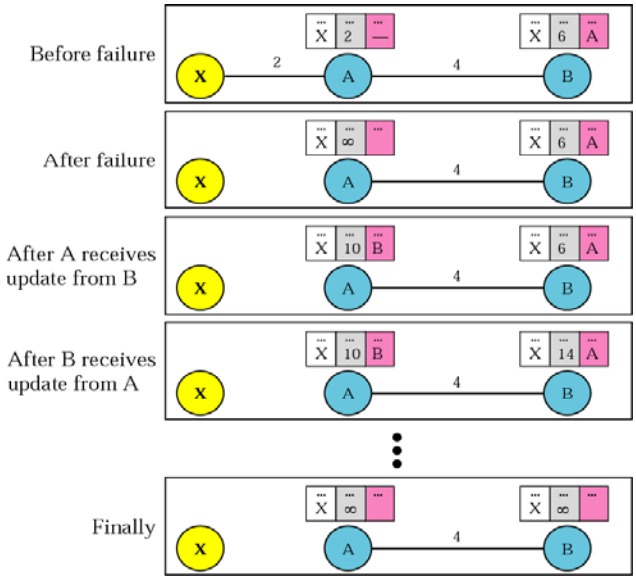


In distance vector routing, each node shares its routing table with its immediate neighbors periodically and when there is a change.

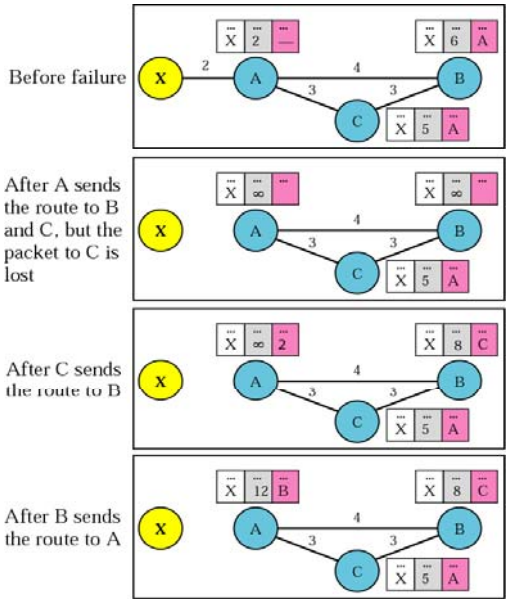
Updating in distance vector routing



Two-node instability



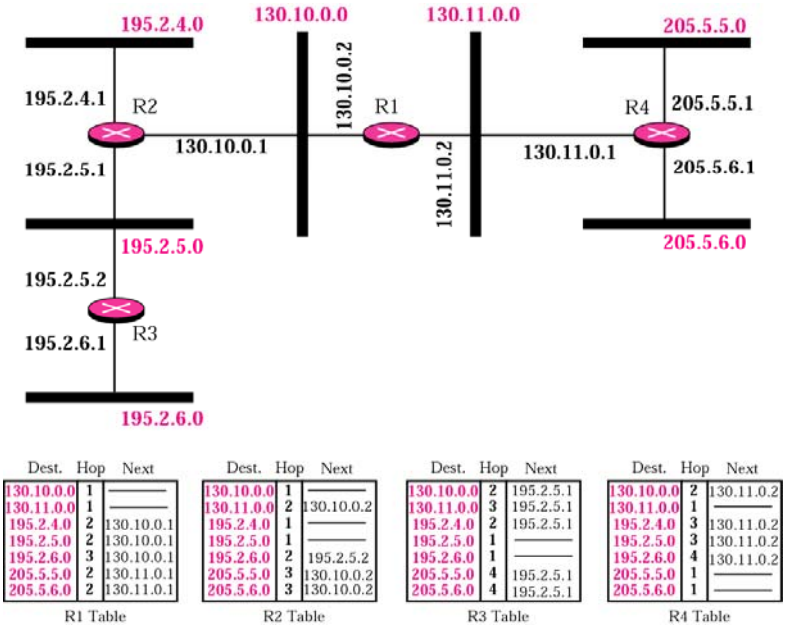
Three-node instability



RIP

- RIP Message Format
- Requests and Responses
- Timers in RIP
- RIP Version 2
- Encapsulation

Example of a domain using RIP



R1 Table

Dest.	Hop	Next
130.10.0.0	1	———
130.11.0.0	1	———
195.2.4.0	2	130.10.0.1
195.2.5.0	2	130.10.0.1
195.2.6.0	3	130.10.0.1
205.5.5.0	2	130.11.0.1
205.5.6.0	2	130.11.0.1

R2 Table

Dest.	Hop	Next
130.10.0.0	1	———
130.11.0.0	2	130.10.0.2
195.2.4.0	1	———
195.2.5.0	1	———
195.2.6.0	2	195.2.5.2
205.5.5.0	3	130.10.0.2
205.5.6.0	3	130.10.0.2

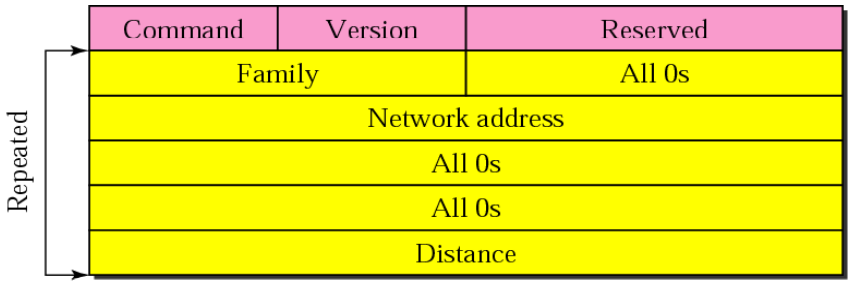
R3 Table

Dest.	Hop	Next
130.10.0.0	2	195.2.5.1
130.11.0.0	3	195.2.5.1
195.2.4.0	2	195.2.5.1
195.2.5.0	1	———
195.2.6.0	1	———
205.5.5.0	4	195.2.5.1
205.5.6.0	4	195.2.5.1

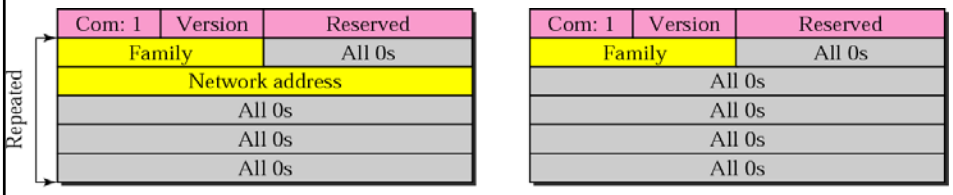
R4 Table

Dest.	Hop	Next
130.10.0.0	2	130.11.0.2
130.11.0.0	1	———
195.2.4.0	3	130.11.0.2
195.2.5.0	3	130.11.0.2
195.2.6.0	4	130.11.0.2
205.5.5.0	1	———
205.5.6.0	1	———

RIP message format



Request messages



a. Request for some

b. Request for all

Example 1

The following figure shows the update message sent from router R1 to router R2 in Figure 14.8. The message is sent out of interface 130.10.0.2.

The message is prepared with the combination of split horizon and poison reverse strategy in mind.

Router R1 has obtained information about networks 195.2.4.0, 195.2.5.0, and 195.2.6.0 from router R2.

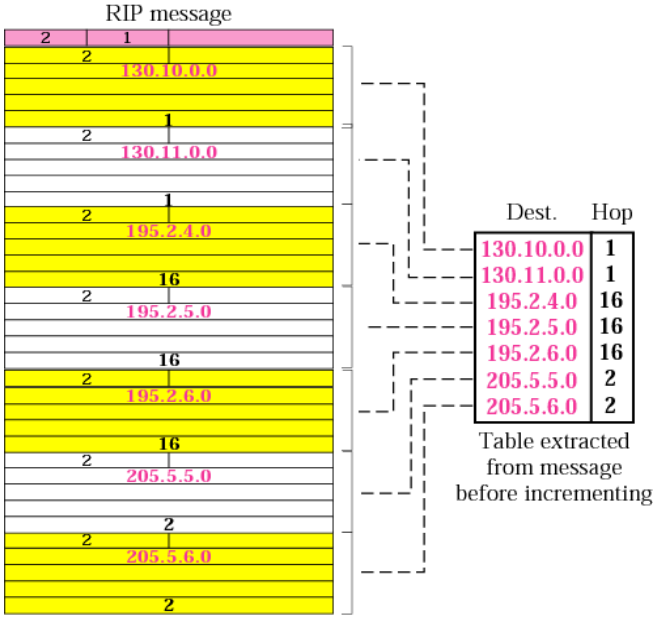
Example 1

When R1 sends an update message to R2, it replaces the actual value of the hop counts for these three networks with 16 (infinity) to prevent any confusion for R2.

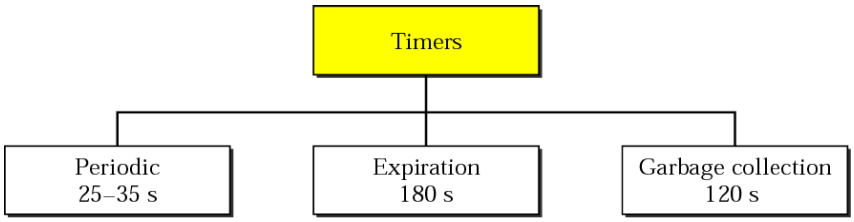
The figure also shows the table extracted from the message.

Router R2 uses the source address of the IP datagram carrying the RIP message from R1 (130.10.02) as the next hop address.

Solution:



RIP timers



Example

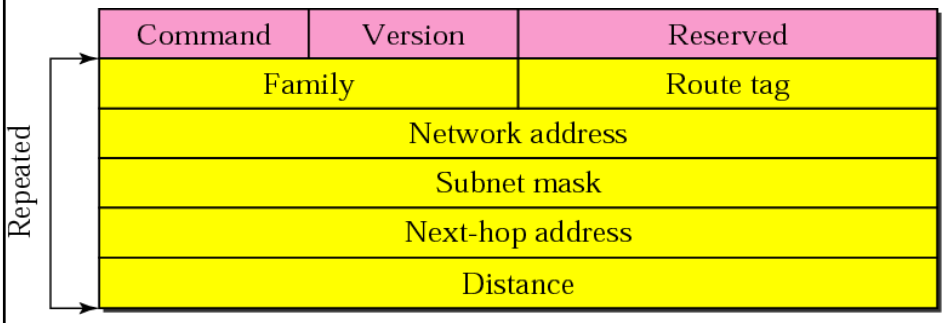
A routing table has 20 entries. It does not receive information about five routes for 200 s. How many timers are running at this time?

Solution

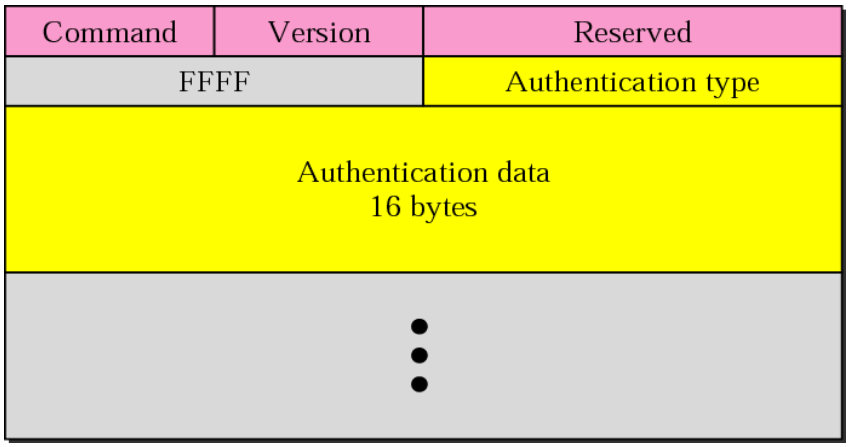
The 21 timers are listed below:

Periodic timer: 1
Expiration timer: 20 − 5 = 15
Garbage collection timer: 5

RIP version 2 format



Authentication RIP v2

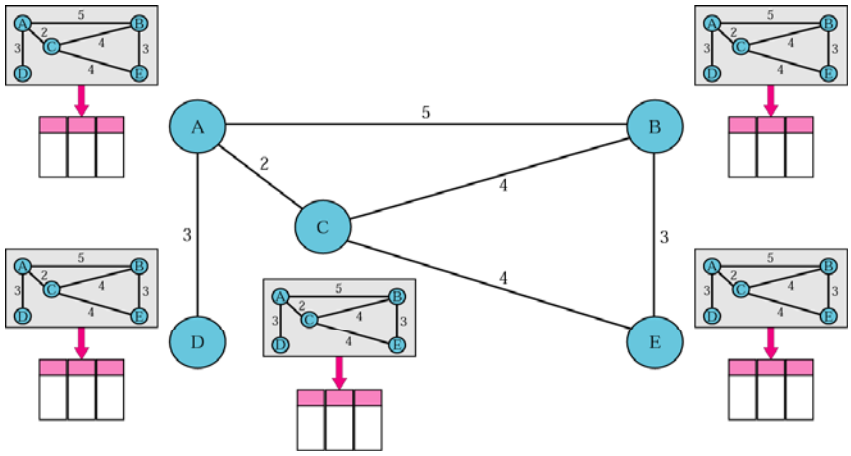


Link state rounting

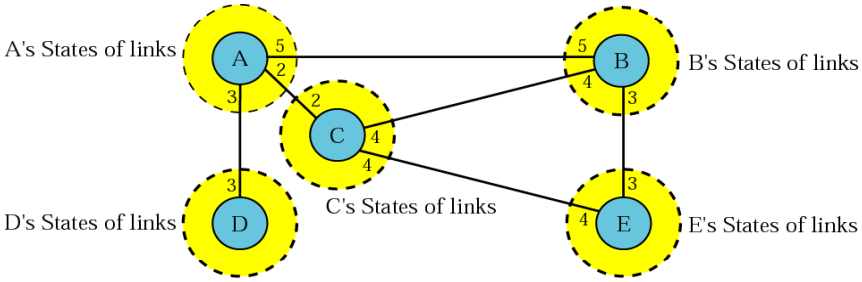
In link state routing, if each node in the domain has the entire topology of the domain, the node can use Dijkstra's algorithm to build a routing table.

- Building routing tables

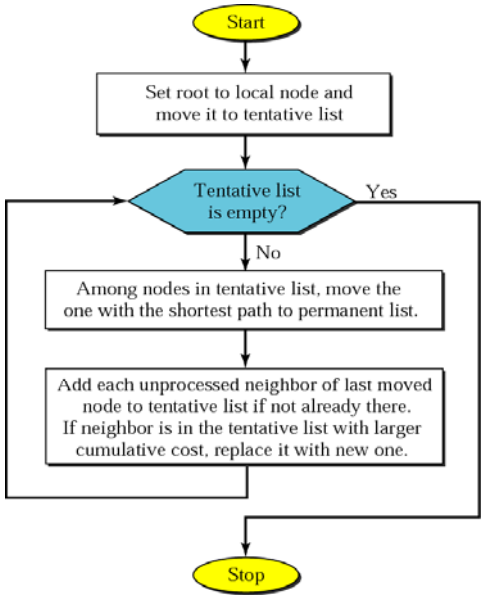
Concept of link state routing



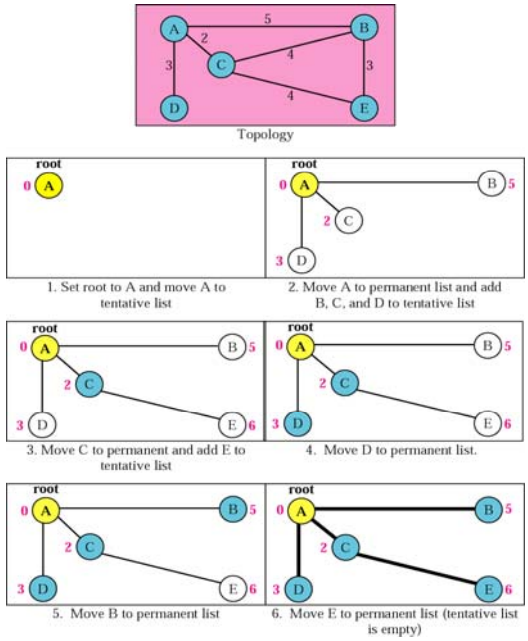
Link state knowledge



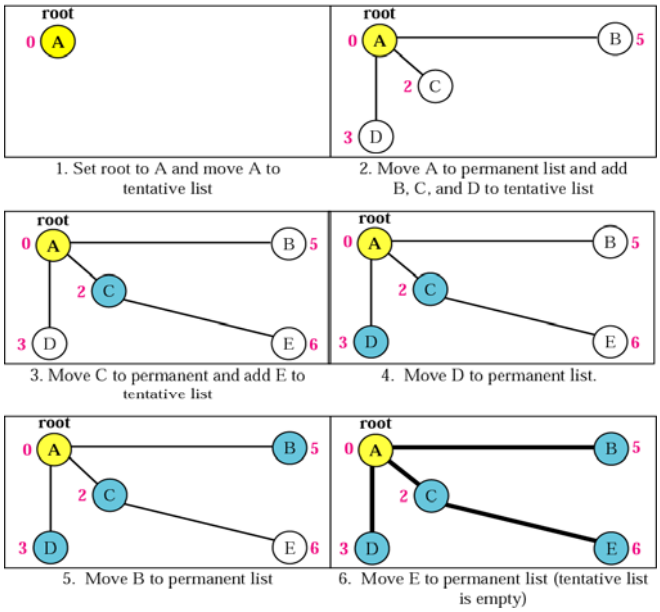
Dijkstra algorithm



Example of formation of shortest path tree



Example of formation of shortest path tree



Routing table for node A

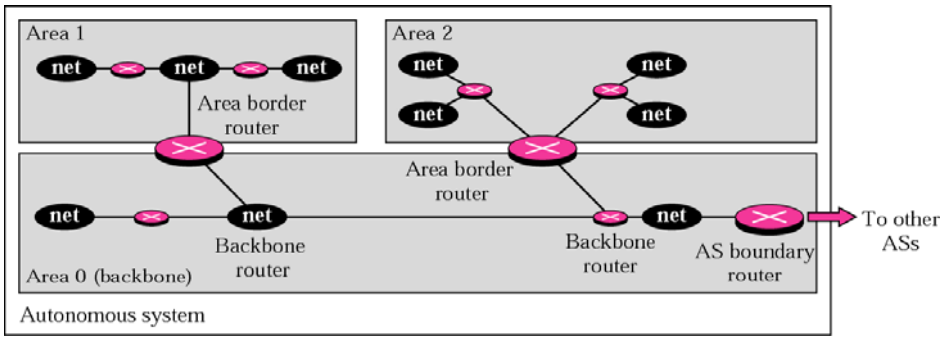
Node	*Cost*	*Next Router*
A	0	—
B	5	—
C	2	—
D	3	—
E	6	C

OSPF

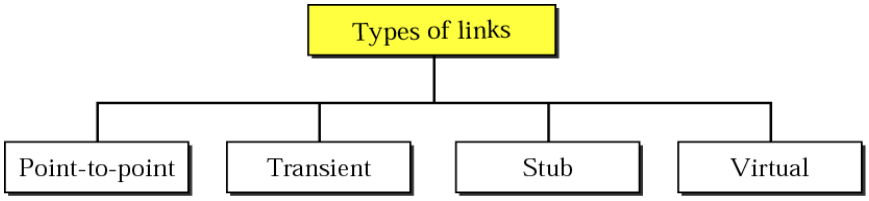
The Open Shortest Path First (OSPF) protocol is an intradomain routing protocol based on link state routing. Its domain is also an autonomous system.

- Areas
- Metric
- Types of Links
- Graphical Representation
- OSPF Packets
- Link State Update Packet
- Other Packets
- Encapsulation

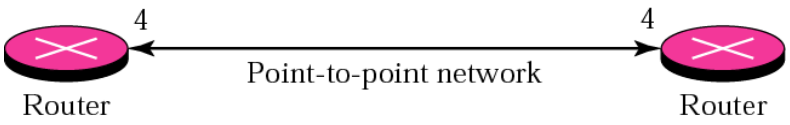
Areas in an autonomous system



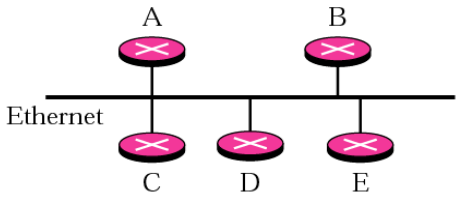
Types of links



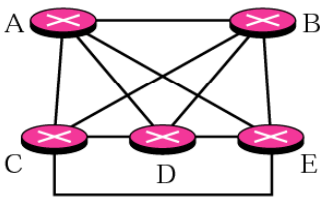
Point-to-point link



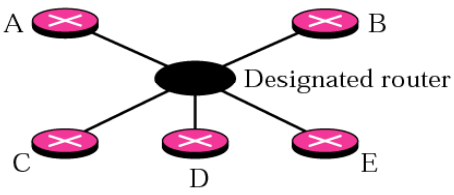
Transient link



a. Transient network



b. Unrealistic representation

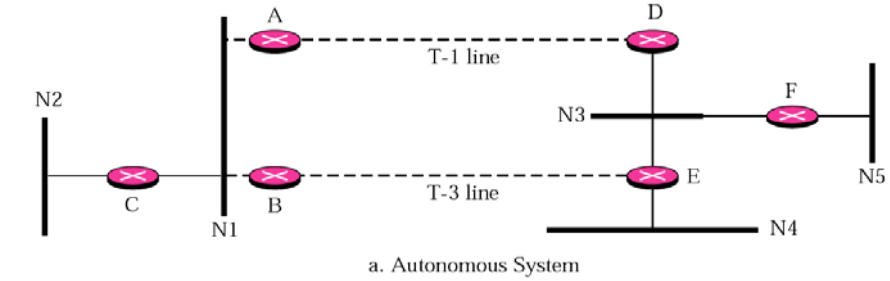


c. Realistic representation

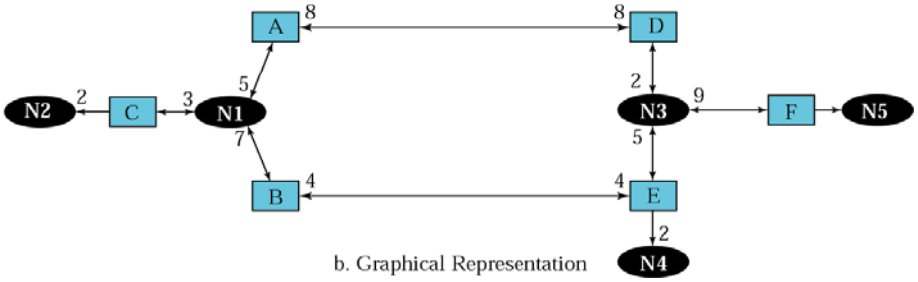
Stub link

a. Stub network b. Representation

Example of an AS and its graphical representation in OSPF

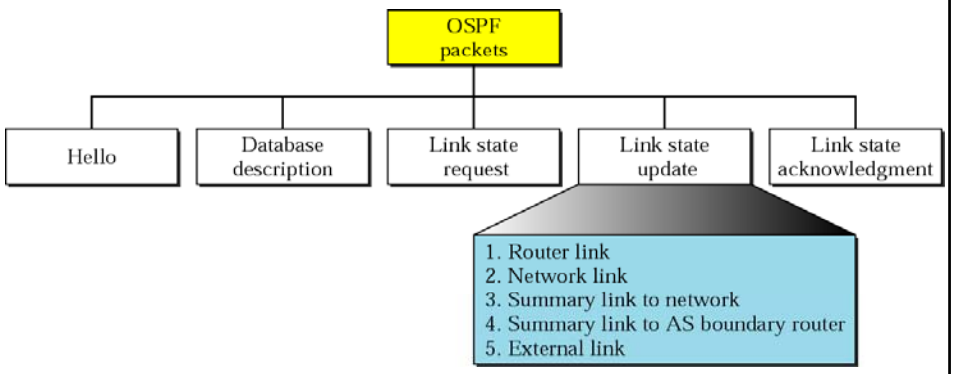


a. Autonomous System

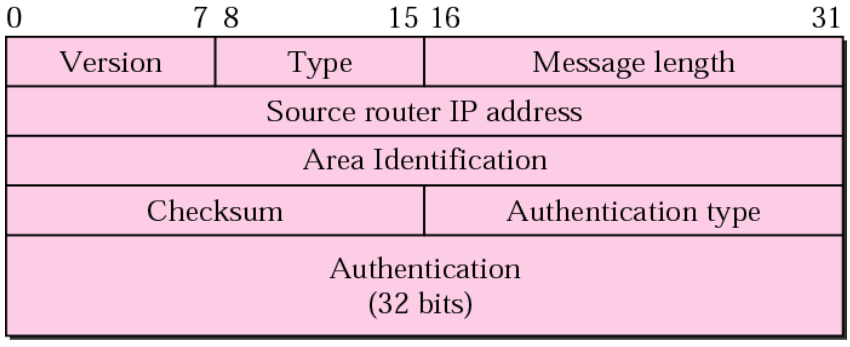


b. Graphical Representation

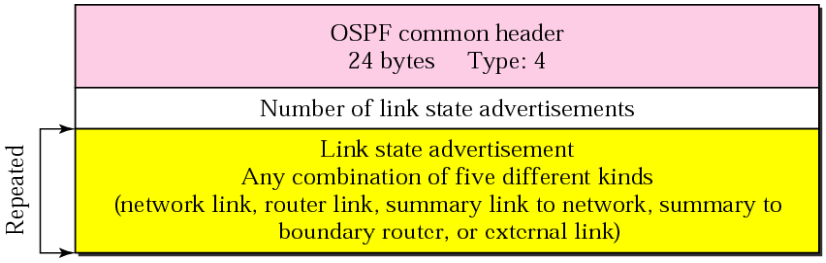
Types of OSPF packets



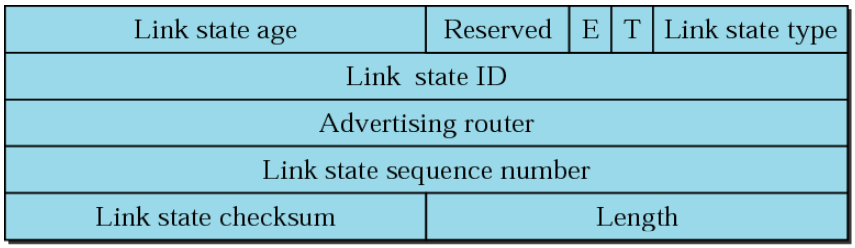
OSPF common header



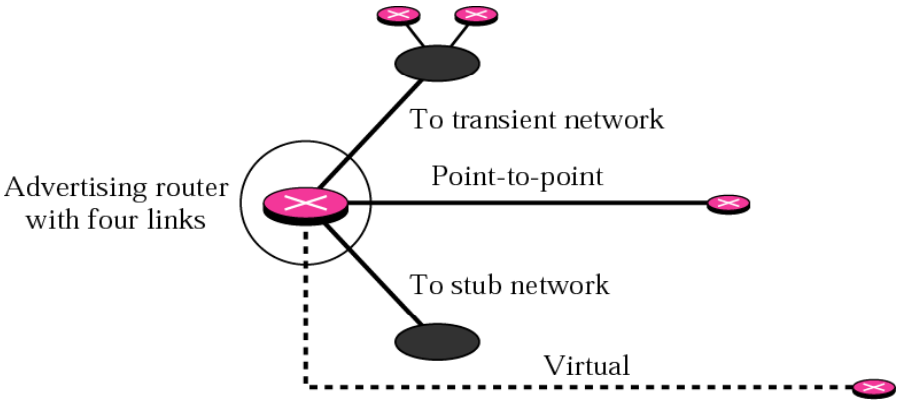
Link state update packet



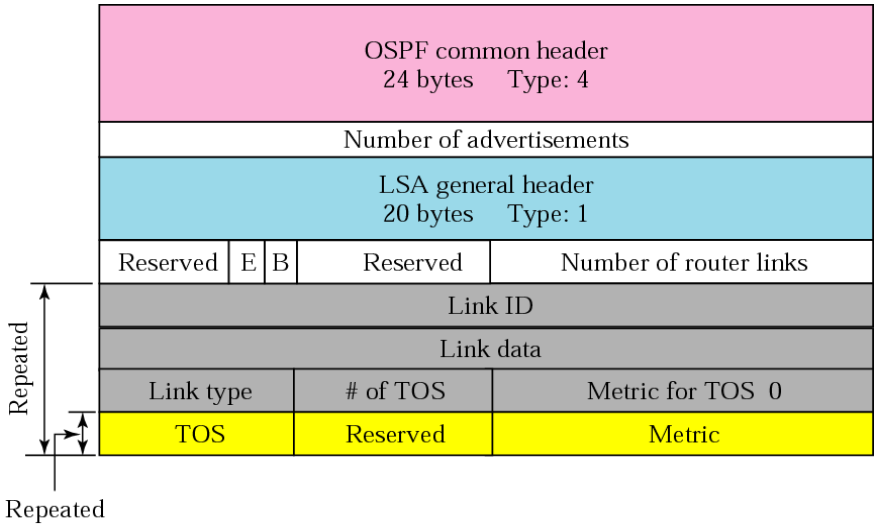
LSA general header



Router link



Router link LSA



Link types, link identification, and link data

Link Type	*Link Identification*	*Link Data*
Type 1: Point-to-point	Address of neighbor router	Interface number
Type 2: Transient	Address of designated router	Router address
Type 3: Stub	Network address	Network mask
Type 4: Virtual	Address of neighbor router	Router address

Example

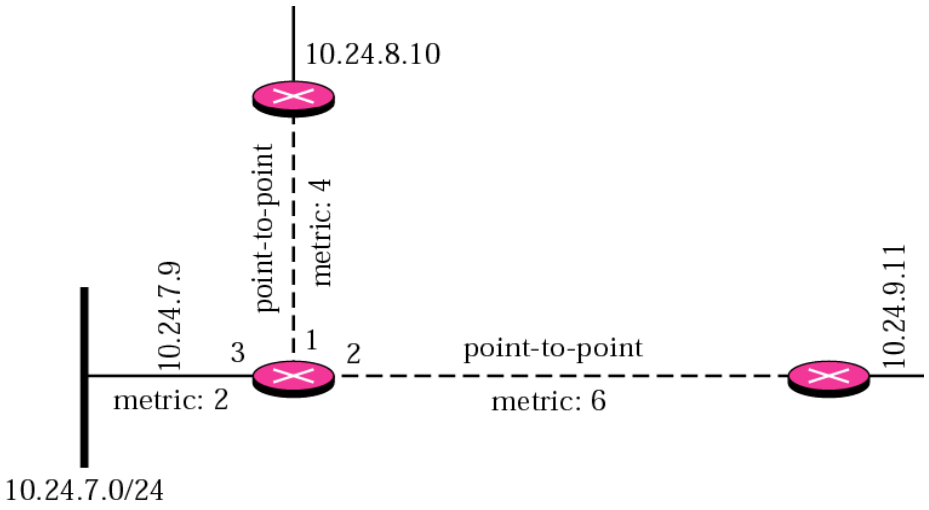
Give the router link LSA sent by router 10.24.7.9 in Figure.

Solution

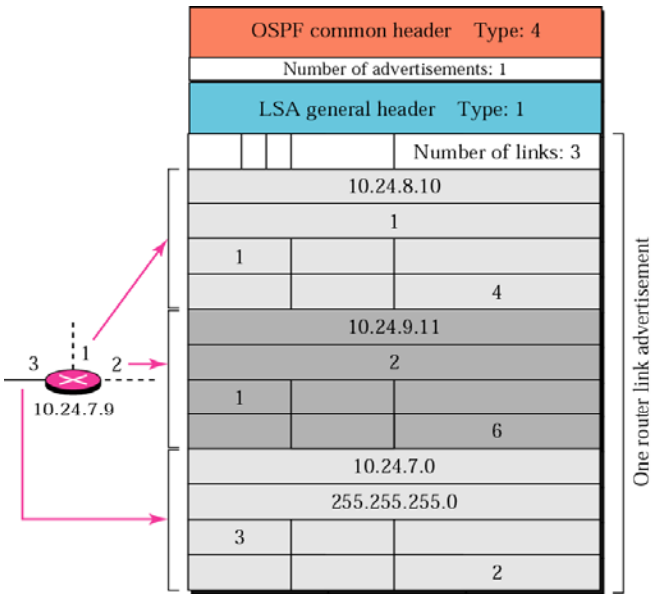
This router has three links: two of type 1 (point-to-point) and one of type 3 (stub network).

Figure shows the router link LSA.

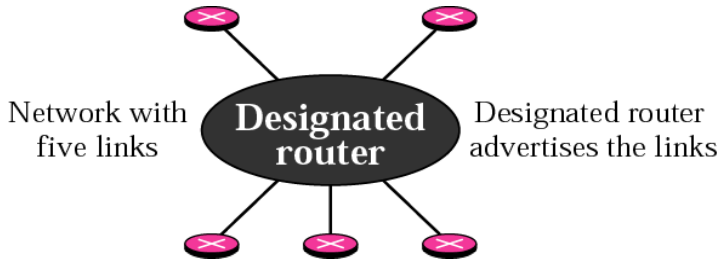
Example



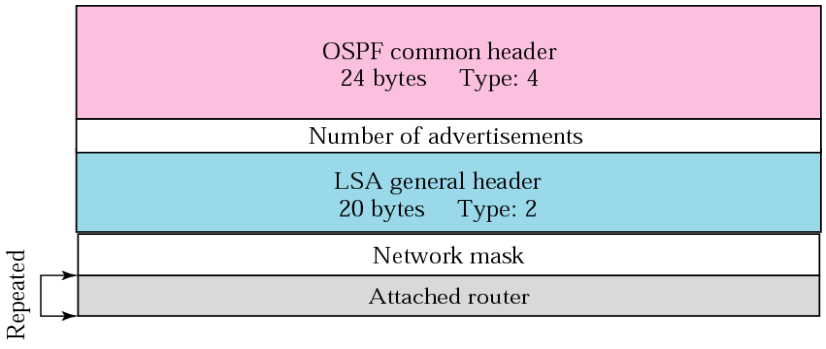
Solution:



Network link

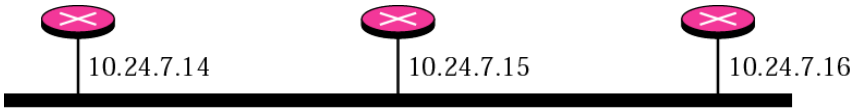


Network link advertisement format



Example

Give the network link LSA in Figure.

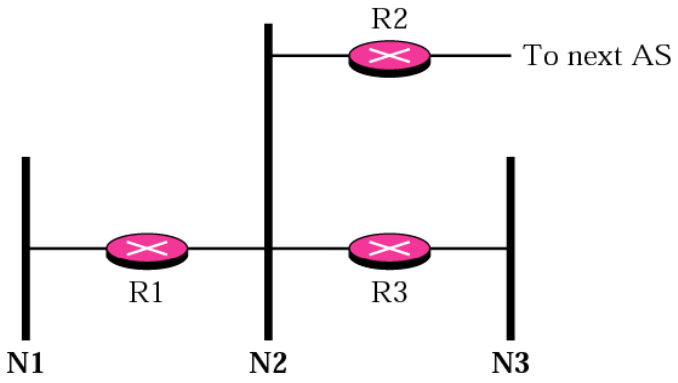


Solution:

OSPF common header Type: 4
Number of advertisements: 1
LSA general header Type: 2
255.255.255.0
10.24.7.14
10.24.7.15
10.24.7.16

Example

In Figure, which router(s) sends out router link LSAs?



Example

Solution

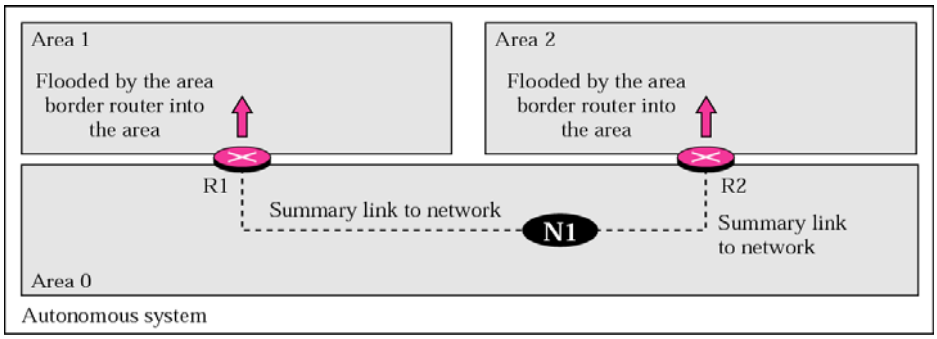
All routers advertise router link LSAs.

a. R1 has two links, N1 and N2.

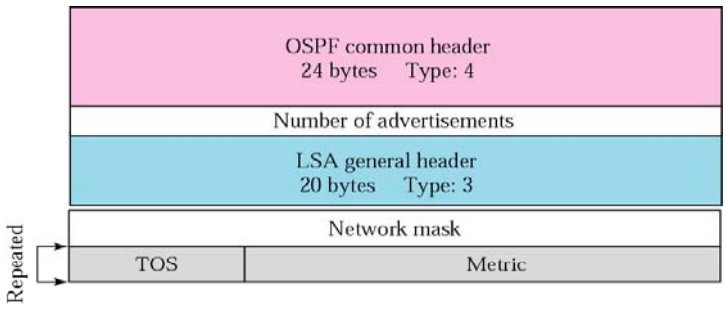
b. R2 has one link, N1.

c. R3 has two links, N2 and N3.

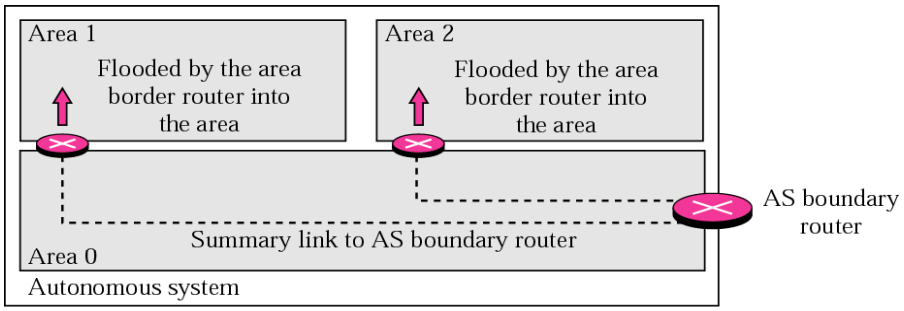
Summary link to network



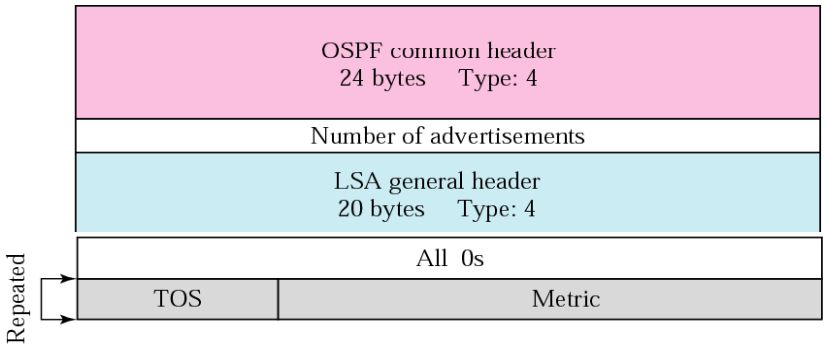
Summary link to network LSA



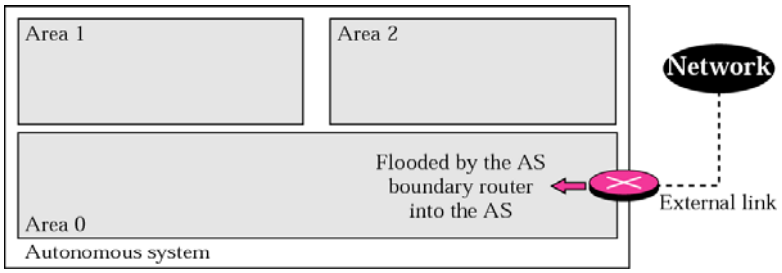
Summary link to AS boundary router



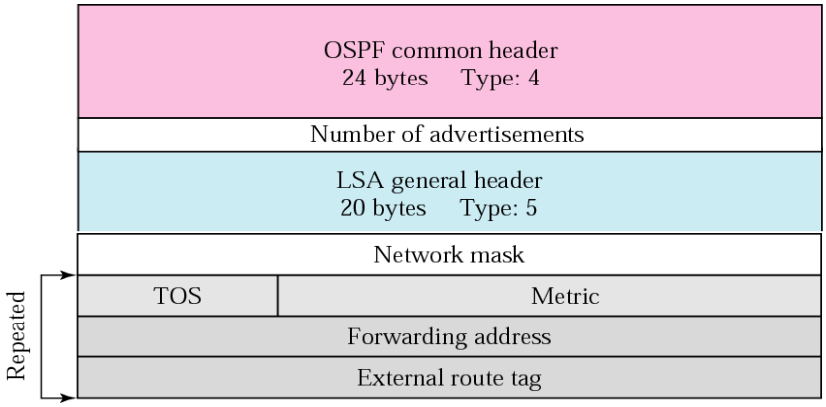
Summary link to AS boundary router LSA



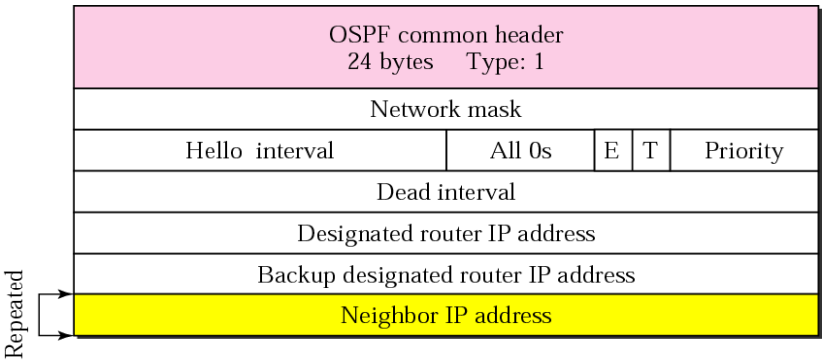
External link



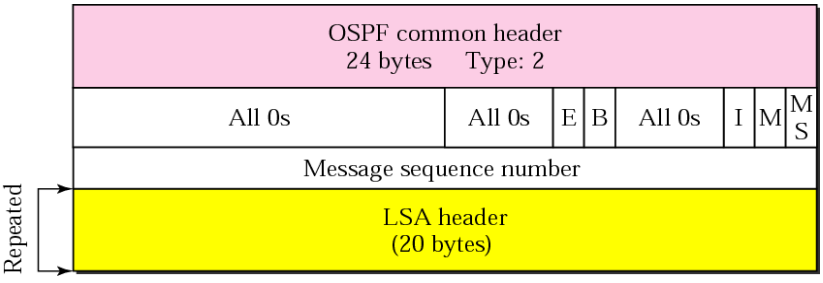
External link LSA



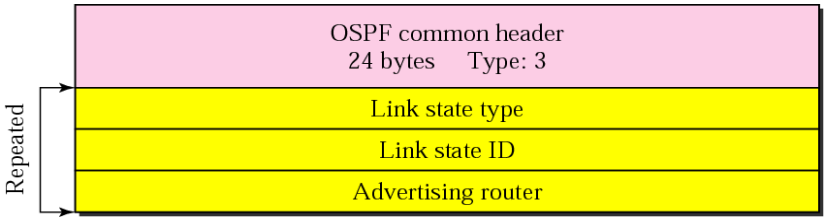
Hello packet



Database description packet



Link state request packet



Link state acknowledgment packet