

COMPUTER NETWORKS AND INTERNET PROTOCOLS

IP Routing - III [Autonomous System (AS), Path Vector Routing]

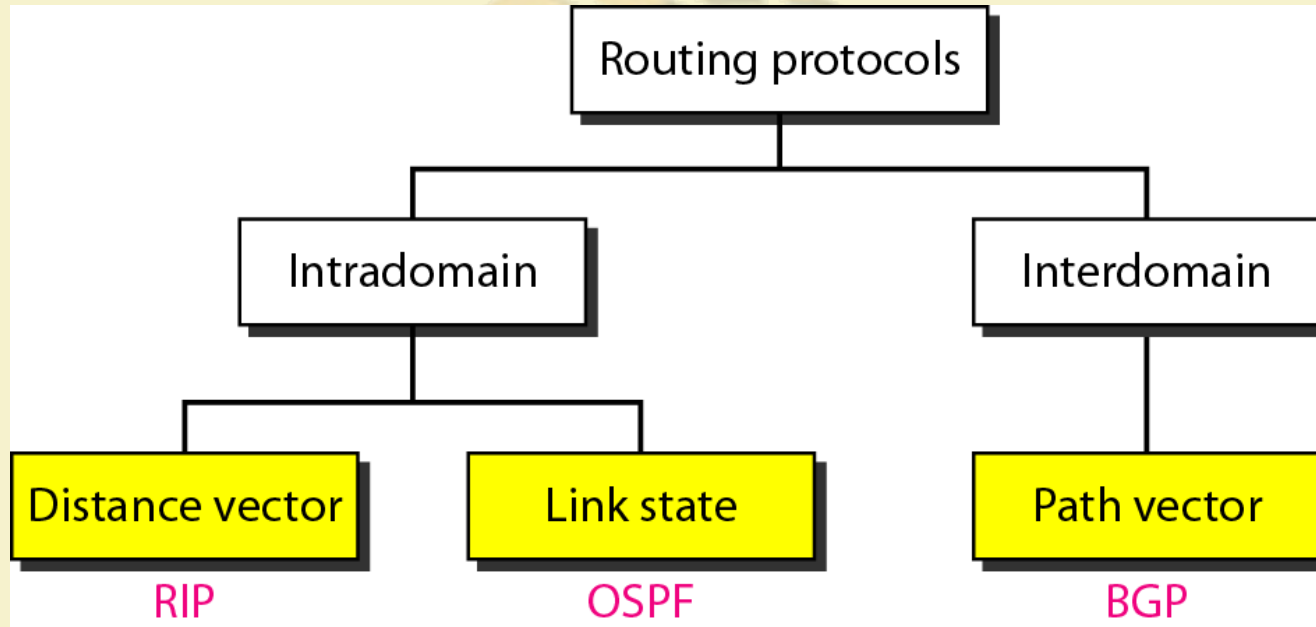
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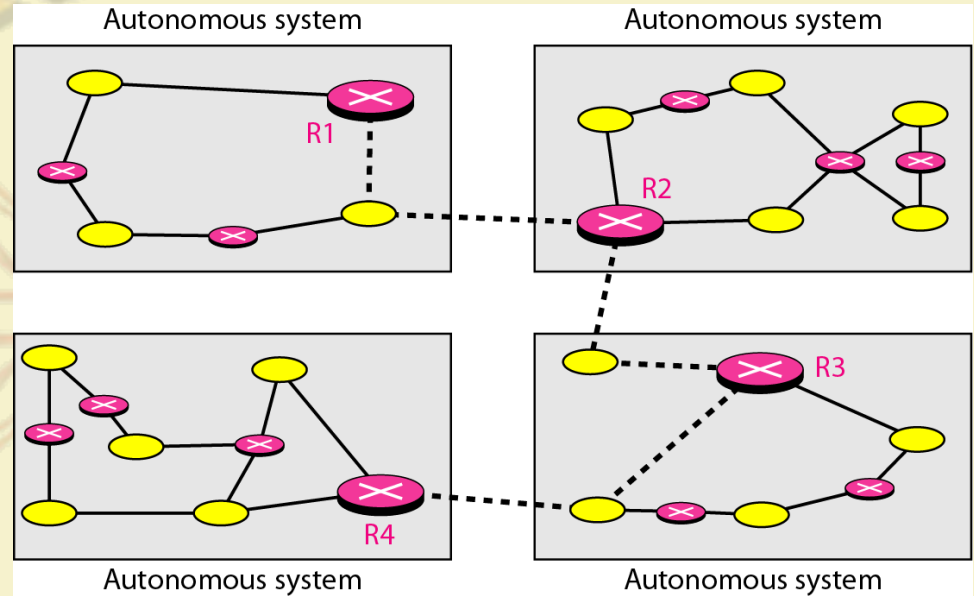
Dynamic Routing Protocols



Ref: Data communications and networking by Behrouz A. Forouzan; TCP/IP Tutorials and Technical Overview, IBM Redbooks

Autonomous System (AS)

AS is a logical portion of a larger IP network. An AS normally consists of an internetwork within an organization. It is administered by a single management authority. An AS can connect to other autonomous systems managed by the same organization or other public or private networks.



Ref: Data communications and networking by Behrouz A. Forouzan; TCP/IP Tutorials and Technical Overview, IBM Redbooks

Routing Protocols in AS

Two sets routing protocols are used – (i) to determine routing paths within an AS; (ii) others are used to interconnect a set of autonomous systems:

Interior Gateway Protocols (IGPs): Interior Gateway Protocols allow routers to exchange information within an AS. Examples of these protocols are Open Short Path First (OSPF) and Routing Information Protocol (RIP).

Exterior Gateway Protocols (EGPs): Exterior Gateway Protocols allow the exchange of summary information between autonomous systems. An example of this type of routing protocol is Border Gateway Protocol (BGP).

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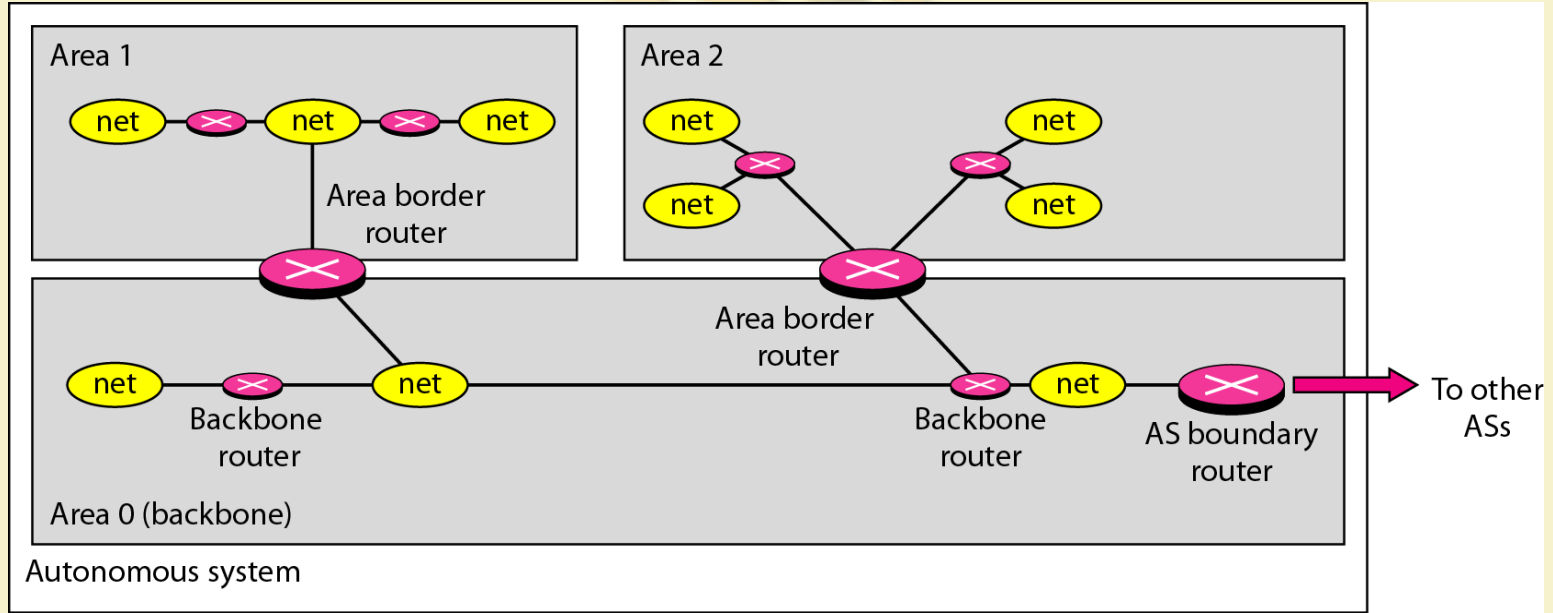
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Areas in AS

- **Area** is a collection of routers, networks and hosts within an AS. Each area is an area identification.
- An AS can be divided into different Areas. All network inside an area must be connected
- Routers inside an area flood the area with routing information. Special routers called **Border Area Routers** summarize the information about the area and send it other areas
- **Backbone** area – Special area inside AS. All areas in AS must be connected to the backbone. Backbone area acts as primary area and other areas as secondary.
- Routers within the backbone area are called **backbone routers**. A backbone router can also be a area border router.

Ref: Data communications and networking by Behrouz A. Forouzan

Areas in AS



Ref: Data communications and networking by Behrouz A. Forouzan

Path Vector Routing

- In Path Vector routing, the routing table contains <destination address>, <next router> and the <path to reach the destination>
- Path is defined as an ordered list of Autonomous Systems (ASs) that the packet need to travel through.

Path Vector Messages

- AS routers that participate in path vector routing advertise the reachability of the networks in their ASs to neighbors autonomous boundary routers. Two autonomous boundary routers connected to the same network are neighbors.
- Autonomous boundary routers receive information from interior routing protocols, like RIP, OSPF
- Each router that receives a path vector verifies that the advertised path is in agreement with the defined policy

Loop Prevention

- When a router receives a message, if there is loop, the message is ignored.

Policy Routing

- Policy routing can be implemented in path vector routing.

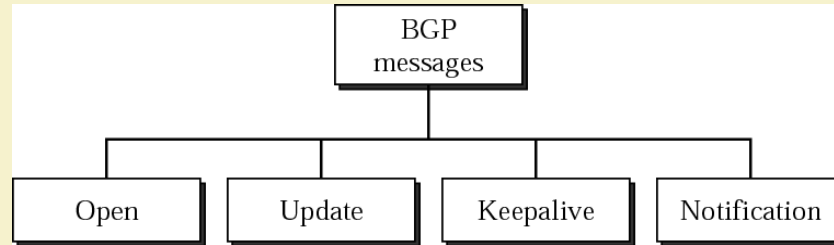
Path Attributes

- Two broad categories: (i) Well-known attribute; (ii) Optional attribute
- Well-known attribute: Should be recognized by every BGP router. Well-known attribute: Mandatory and Discretionary

Border Gateway Protocol (RFC 1771)

- Based on the path vector routing.
- Distance-vector protocol not preferred for inter-AS routing (exterior routing protocol)
 - Assumes all routers have a common distance metrics to judge route preferences.
 - If routers have different meanings of a metric, it may not be possible to create stable, loop free routes.
 - A given AS may have different priorities from another AS.
 - Gives no information about the ASs that will be visited.
- Link-state routing protocol
 - Different metrics.
 - Flooding is not realistic.
- Path vector routing
 - No metrics,
 - Information about which networks can be reached by a given router and ASs to be crossed.
- Differs from DVA
 - Path vector approach does not include a distance or cost estimate
 - Lists all of the ASs visited to reach destination network.

BGP (continued)



- Messages are sent over TCP connections on port 179.
- Functional procedures
 - Neighbor acquisition (open message, acceptance through Keepalive message)
 - Neighbor reachability (periodic Keepalive messages)
 - Network reachability (broadcast an update message)
 - Each routers maintains a database of networks that can be reached
 - + preferred route to this network.
- RFC does not address
 - How a router knows the address of another router.
 - Up to network admin.

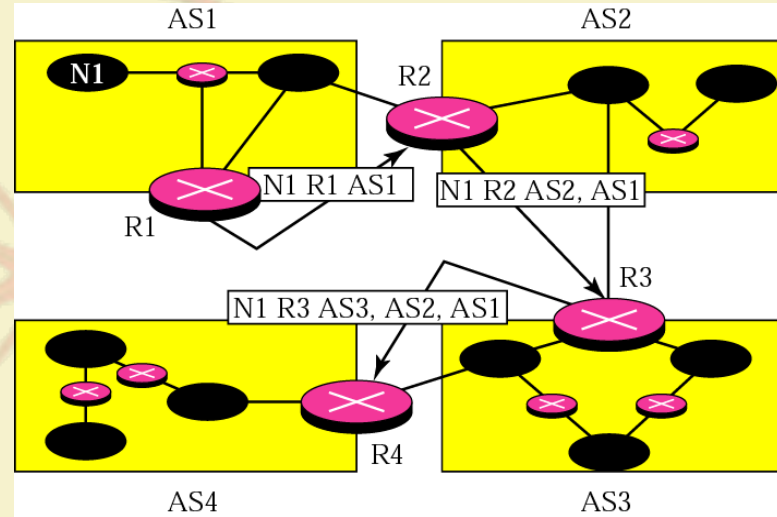
BGP (cont.)

Example of Network Reachability

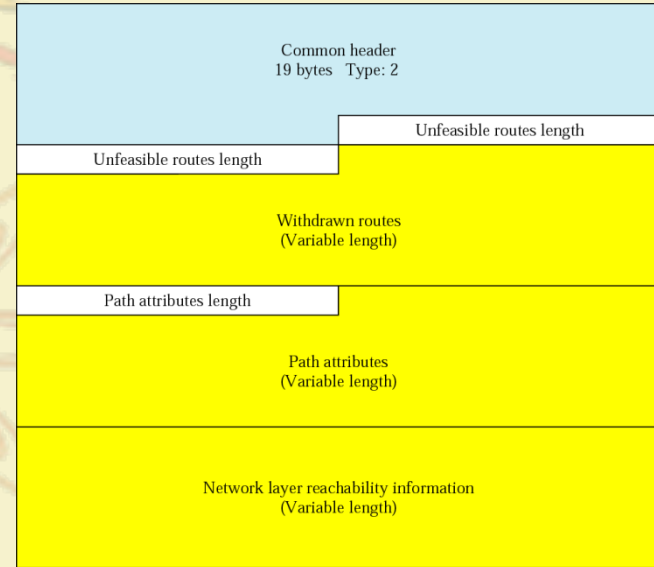
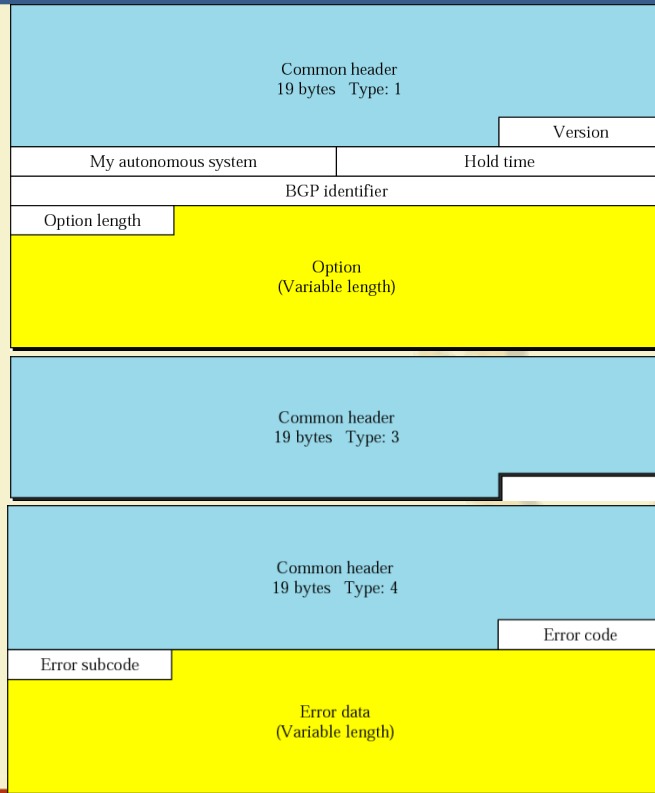
Network	Next router	Path
N1	R1	AS14,AS23,AS67
N2	R5	AS22,AS67,AS5,AS89
N3	R6	AS67,AS89,AS9,AS34
N4	R12	AS62,AS2,AS9

- Loop Prevention in BGP:
 - Checks the Path before updating its database. (If its AS is in the path ignore the message)
- Policy Routing:
 - If a path consist of an AS against the policy of the current AS, message discarded.

Example of Message advertisements

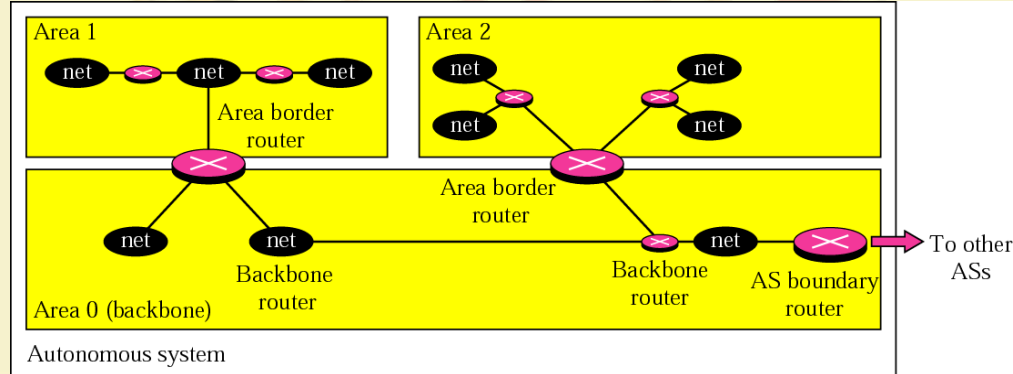


BGP message format (Open, Keepalive, Update, Notification)

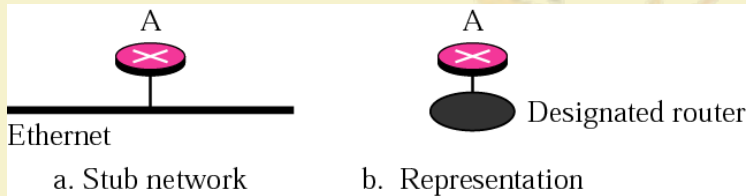
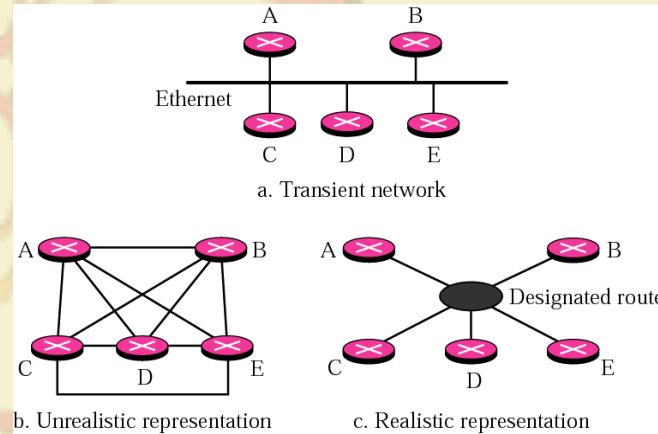
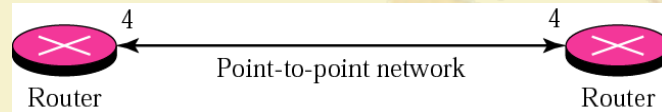
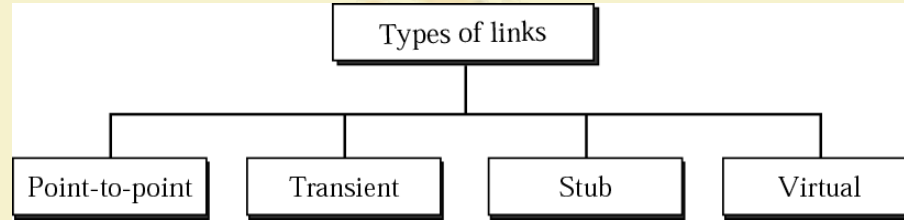


Open Shortest Path First (RFC 1247)

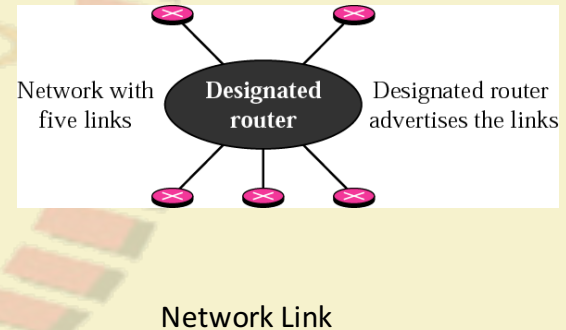
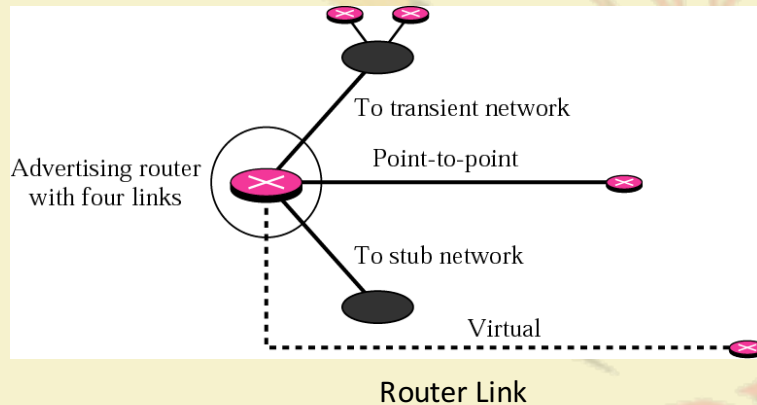
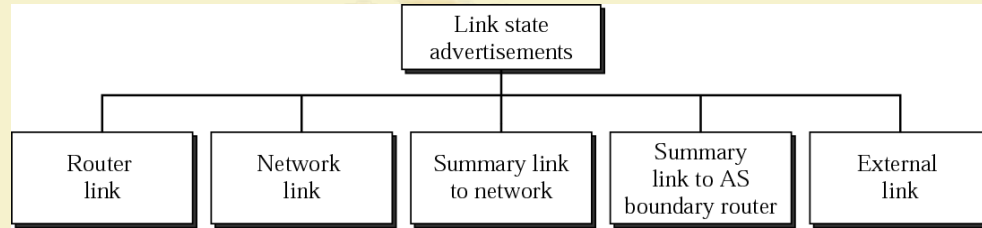
- Uses IP, has a value in the IP Header (8 bit protocol field)
- Interior routing protocol, its domain is also an autonomous system (AS)
- Special routers (autonomous system boundary routers) or backbone routers responsible to dissipate information about other AS into the current system.
- Divides an AS into areas
- Metric based on type of service
 - Minimum delay (RTT), maximum throughput, reliability, etc..



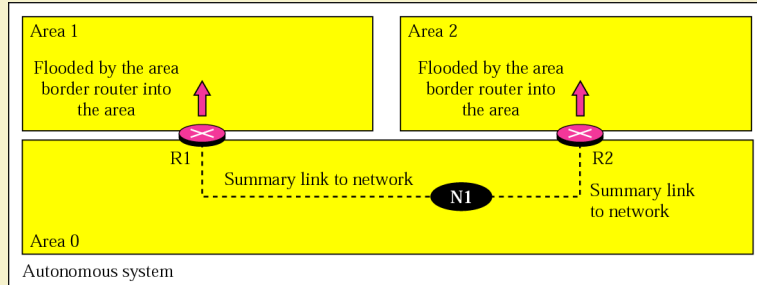
OSPF (Type of Links)



OSPF (Link State Advertisement)

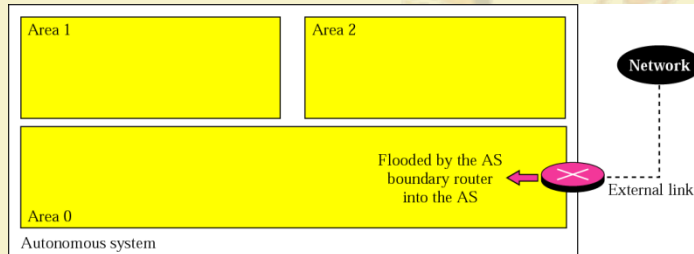


OSPF (LSA cont.)

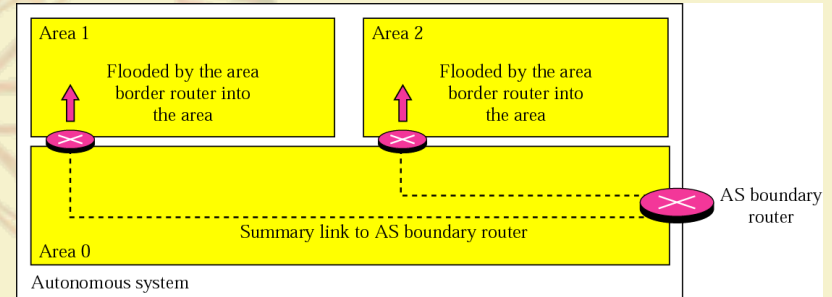


Summary link to Network

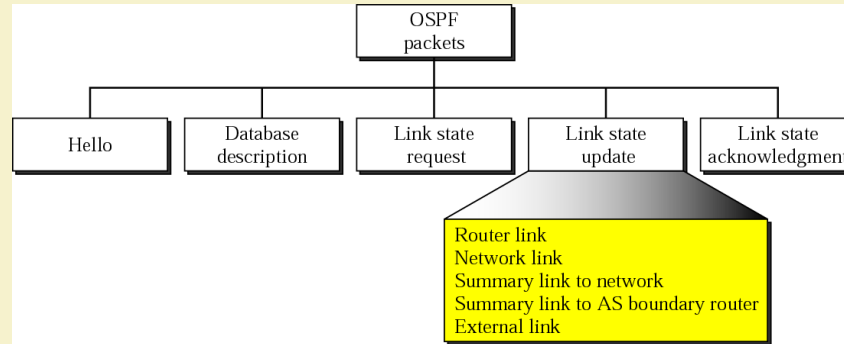
Summary link to AS boundary router



External Link

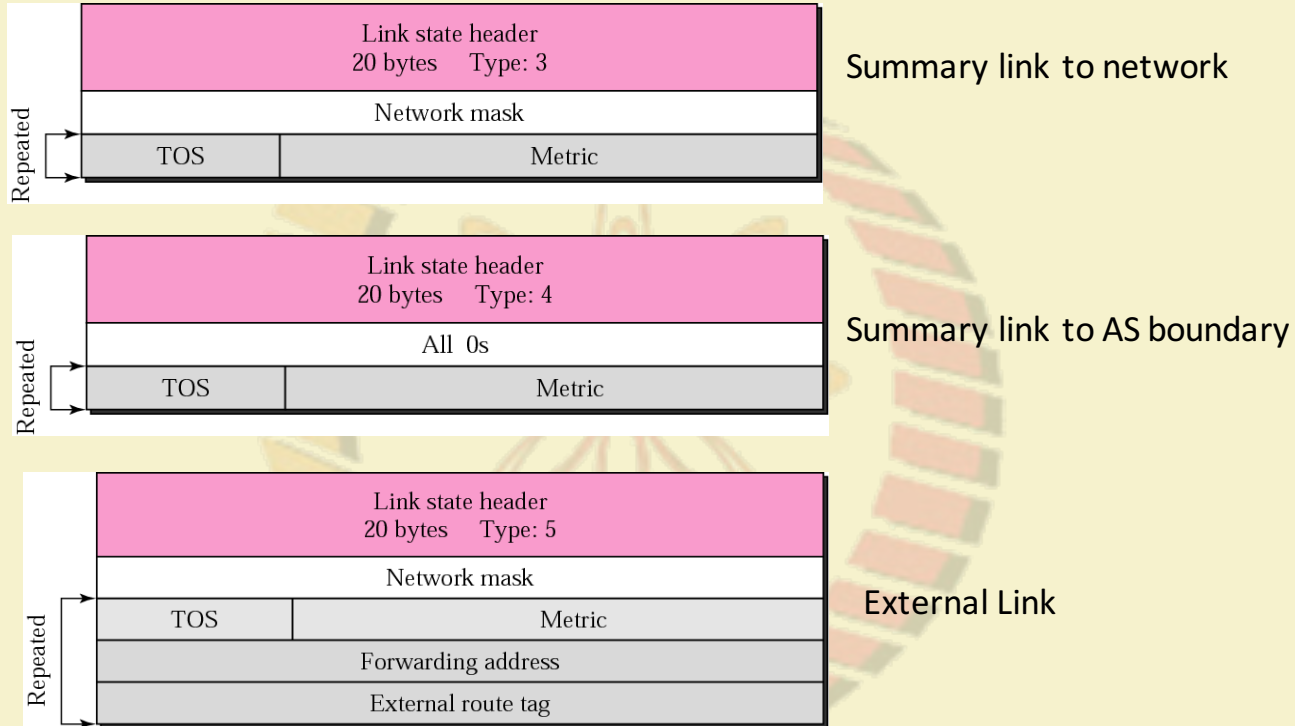


Types of OSPF Packets



Version	Type	Message length
Source router IP address		
Checksum		Authentication type
Authentication		

Links state Advertisements - Summary



Thank you!

