

# Routing Information Protocols

## 1. Introducción

### Routing Tables

Routing with partial information: **Default Route**

**Static vs Dinamic Routing** (Propagación automática de rutas)

### Vector Distance Routing

- Destination Network & Distance (in hops) pairs

- Every Gateway periodically propagates its routing table information

- Every Gateway receives routing info update its routing table with shorter paths to destinations

- Easy implementation

- Slow convergence, low scalability & high volume of information exchange

### Link-State Routing (SPF: Shortest Path First)

- Gateways: nodes in a graph

- Networks: edges (links) between nodes

- Link state test (up/down)

  - periodic exchange of reachability messages between neighbors

  - k-out-of-n rule

- Links Status messages

  - each gateway periodically broadcast messages with links status

  - only status of direct connections

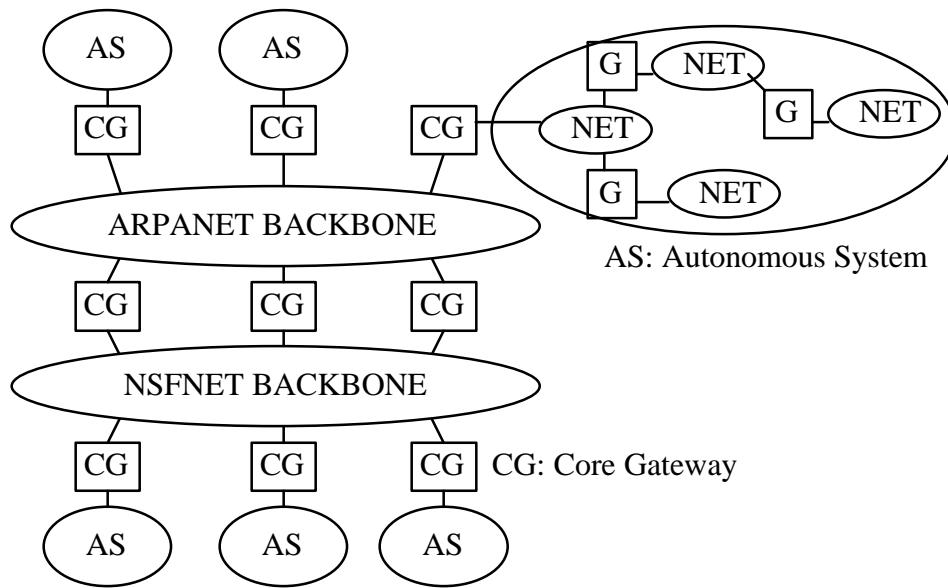
  - less information propagation ==> better scalability

- Recomputing routes

  - each gateway recomputes routes whenever link status changes

  - Dijkstra shortest path algorithm

  - faster convergence



## Internet Core Architecture

**Backbone Networks** (ARPANET & NSFNET)

**Core Gateways**

Internet globally consistent routing

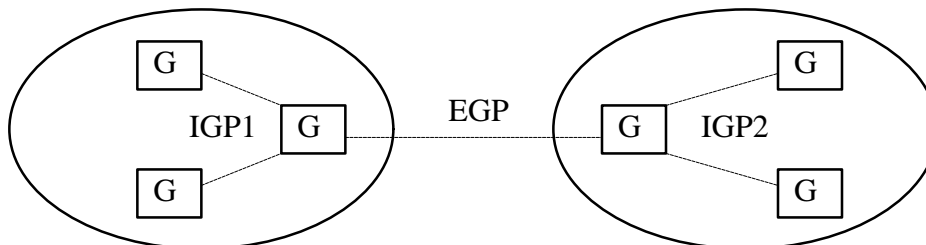
Gateway-To-Gateway Protocol (**GGP**) (vector distance)

**SPREAD** Protocol (SPF)

## Autonomous Systems

autonomous system number

## Internal & External Gateway Protocols



**EGP** (Exterior Gateway Protocol)

IGPs (Internal Gateway Protocols)

**RIP** (Routing Information Protocol)

**Hello**

**OSPF** (Open SPF Protocol)

## **2. Interior Gateway Protocols**

IGPs with **vector-distance** or **SPF** algorithm

IGPs & **default route**

### **2.1. Routing Information Protocol (RIP)**

#### **4BSD Unix**

Derived from XNS RIP

**routed & UDP port 520**

**Vector distance** routing protocol

vector: **destination address**

distance: **hop count metric** (direct connection: 1)

#### **Active & passive RIP systems**

usually gateways are active and hosts passive

in active mode: propagate and listen/update routing table

in passive mode: only listen/update routing table

**Broadcast** RIP messages every **30 seconds**

**Route** becomes **invalid** after **180 seconds** without advertising.

Existing routes should be retained until **new route has strictly lower cost**

#### **Slow convergence** (count to infinity) & **routing loops**

"Good news travels quickly; bad news travels slowly"

**Infinity distance=16**

Possible solutions:

split horizon update

hold down

poison reverse

triggered updates

## RIP message Format

0	8	16	31
COMMAND	VERSION(1)	NULLs	
DESTINATION 1 FAMILY		NULLs	
DESTINATION 1 IP ADDRESS			
NULLs			
NULLs			
DISTANCE TO DESTINATION 1			
DESTINATION 2 FAMILY		NULLs	
DESTINATION 2 IP ADDRESS			
NULLs			
NULLs			
DISTANCE TO DESTINATION 2			
...			

### Commands

- 1: Request routing information
- 2: Response/propagate routing information (V,D) pairs

### Address family & multiple routable protocols

- up to 14 octets addresses
- IP address family=2
- IP address length=4 octets

Default route IP address=0.0.0.0

### Distance to destination

- hop count=1..15
- infinity=16

## **2.2. OSPF (Open SPF Protocol)**

### **SPF route propagation algorithm**

proposed by Internet Engineering Task Force: open standard & free license

Includes **Type of service** routing (low delay, high throughput,...)

Provides **load balancing**.

Allows partitioning into **areas**.

Support a variety of **authentication** schemes

Supports **host-specific routes** as well as network-specific routes.

Every multi-access network (Ethernet) has a **designated gateway** that sends link-status messages.

Allows specification of **virtual network topology**.

Allows gateways **to exchange routing info learned from external** sites.

**OSPF message header format**

0	8	16	31
VERSION(1)		TYPE	MESSAGE LENGTH
SOURCE GATEWAY IP ADDRESS			
AREA ID			
CHECKSUM		AUTHENTICATION TYPE	
AUTHENTICATION (octets 0-3)			
AUTHENTICATION (octets 4-7)			

Type:

- 1: Hello
- 2: Database description
- 3: Link status request
- 4: Link status update
- 5: Link status acknowledgement

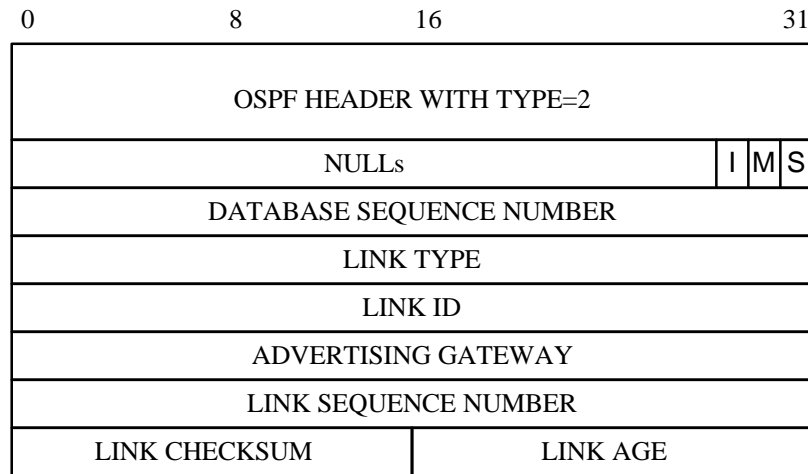
**OSPF Hello message format**

A pair of neighbor gateways exchange these messages periodically **to test reachability**.

0	8	16	31
OSPF HEADER WITH TYPE=1			
NETWORK MASK			
DEAD TIMER		HELLO INTER	GWAY PRIO
DESIGNATED GATEWAY			
BACKUP DESIGNATED GATEWAY			
NEIGHBOR1 IP ADDRESS			
NEIGHBOR2 IP ADDRESS			
...			
NEIGHBORN IP ADDRESS			

## OSPF Database Description message format

A pair of neighbor gateways exchange these messages **to initialize their network topology database.**



...

One gateway serves as a **master**, the other as **slave**. The slave acknowledges each db description message with a response.

S=1 ==> Message sent by Master

S=0 ==> Message sent by Slave

Topology DB may be broken into **several messages**

I=1 ==> Initial message

M=1 ==> More messages

DB Seq Nbr ==> receiver can detect if one message was missed

Link Type

1: Gateway link

2: Network link

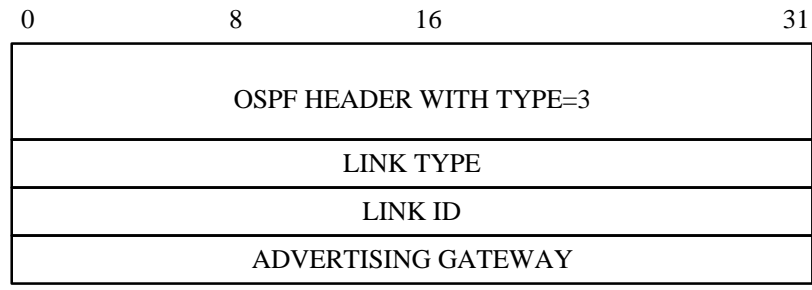
3: Summary link (IP network)

4: Summary link (link to border gateway)

5: External link (link to another site)

### OSPF Link Status Request message format

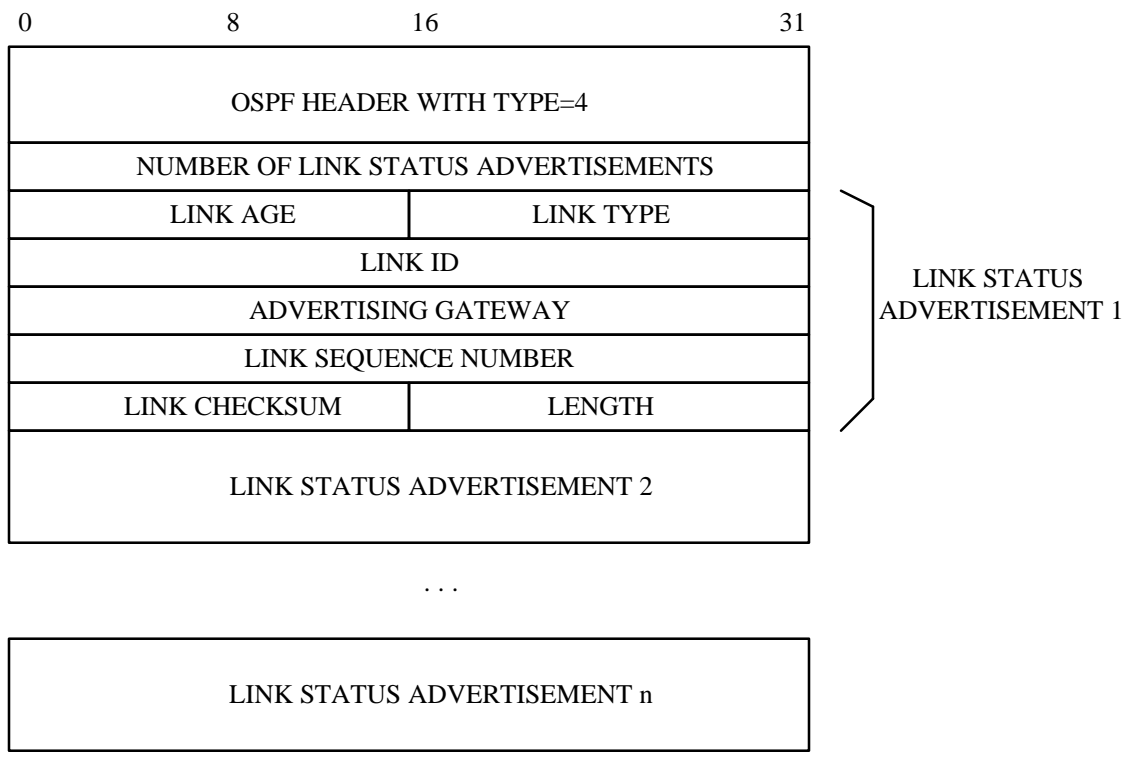
A gateway sends to a neighbor gateway this message **to request updated information** about several links.



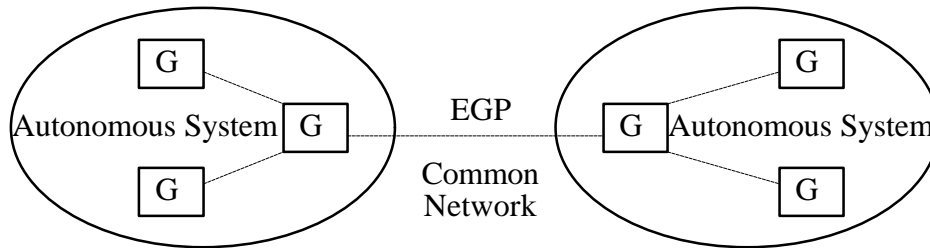
...

### OSPF Link Status Update message format

A gateway send this message **to broadcast the status links**.



### 3. EGP (Exterior Gateway Protocol)



Each exterior gateway gathers routing information about its autonomous system.

The exterior neighbor gateways exchange routing information reports.

Main EGP features:

- **neighbor** (or peer) **acquisition** mechanism  
Hello interval & Poll interval
- **neighbor reachability** test  
Active mode: Hello & I Heard You  
Passive mode: Status field  
k-out-of-n rule,  $j \sim k+2$
- **routing update** exchange  
poll request/response  
IP source network: common source network  
reports distances from the common source network.  
provides Network reachability

Restrictions/Limitations:

1. EGP **does not interpret any of the distances metrics** that appear in routing update messages. A network with distance of 255 is considered unreachable, but other values are only comparable if they refer to gateways in the same autonomous system. In other words, EGP **only provides reachability information**.
2. EGP restricts an exterior gateway (noncore) to **advertise only those networks reachable entirely from within its autonomous system**. That is the restriction limits gateways to advertising only those destinations for which it is an authority.
3. EGP routing update message could contain a long list of reachable networks, but **the routing update information cannot be divided into multiple messages** (EGP2? EGP3?).

Another external gateway protocol: **BGP** (Border Gateway Protocol)

**Unix daemons**

**egpup & gated**

EGP neighbor acquisition messages:

0	8	16	24	31
VERSION	TYPE(3)	CODE	STATUS	
CHECKSUM		AUTONOMOUS SYSTEM NBR		
SEQUENCE NBR		HELLO INTERVAL		
POLL INTERVAL				

<u>Type</u>	<u>Code</u>	<u>Message</u>	<u>Description</u>
3	0	Acquisition Request	Requests gateway become a neighbor (peer)
3	1	Acquisition Confirm	Positive response to acquisition request
3	2	Acquisition Refuse	Negative response to acquisition request
3	3	Cease Request	Requests termination of neighbor relationship
3	4	Cease Confirm	Confirmation response to cease request

EGP neighbor reachability messages:

0	8	16	24	31
VERSION	TYPE(5)	CODE	STATUS	
CHECKSUM		AUTONOMOUS SYSTEM NBR		
SEQUENCE NBR				

<u>Type</u>	<u>Code</u>	<u>Message</u>	<u>Description</u>
5	0	Hello	Requests neighbor to respond if alive
5	1	I Heard You	Response to hello

EGP poll request messages:

0	8	16	24	31
VERSION	TYPE(2)	CODE	STATUS	
CHECKSUM		AUTONOMOUS SYSTEM NBR		
SEQUENCE NBR		Reserved		
IP SOURCE NETWORK				

<u>Type</u>	<u>Code</u>	<u>Message</u>	<u>Description</u>
2	0	Poll Request & Hello	Requests routing update & Hello request
2	1	Poll Request & I Heard You	Requests routing update & response to hello

EGP Routing update (poll response) message:

0	8	16	24	31
VERSION		TYPE(1)		CODE(0)
CHECKSUM		AUTONOMOUS SYSTEM NBR		
SEQUENCE NBR		# INT.GWYS	# EXT.GWYS	
IP SOURCE NETWORK				
GATEWAY 1 IP HOST NBR				
# DISTANCES				
DISTANCE D11		# NETS AT D11		
NETWORK 1 AT D11 (NET NBR)				
NETWORK 2 AT D11 (NET NBR)				
...				
DISTANCE D12		# NETS AT D12		
NETWORK 1 AT D12 (NET NBR)				
NETWORK 2 AT D12 (NET NBR)				
...				
...				
GATEWAY n IP HOST NBR				
# DISTANCES				
DISTANCE Dn1		# NETS AT Dn1		
NETWORK 1 AT Dn1 (NET NBR)				
NETWORK 2 AT Dn2 (NET NBR)				
...				
...				

**Referencias Bibliográficas**

1. Comer D., "Internetworking with TCP/IP", Prentice-Hall, 1991
2. Hunt C., "TCP/IP Network Administration", O'Reilly & Associates, March 1993
3. Black U. "TCP/IP and Related Protocols", Mc Graw Hill, 1992