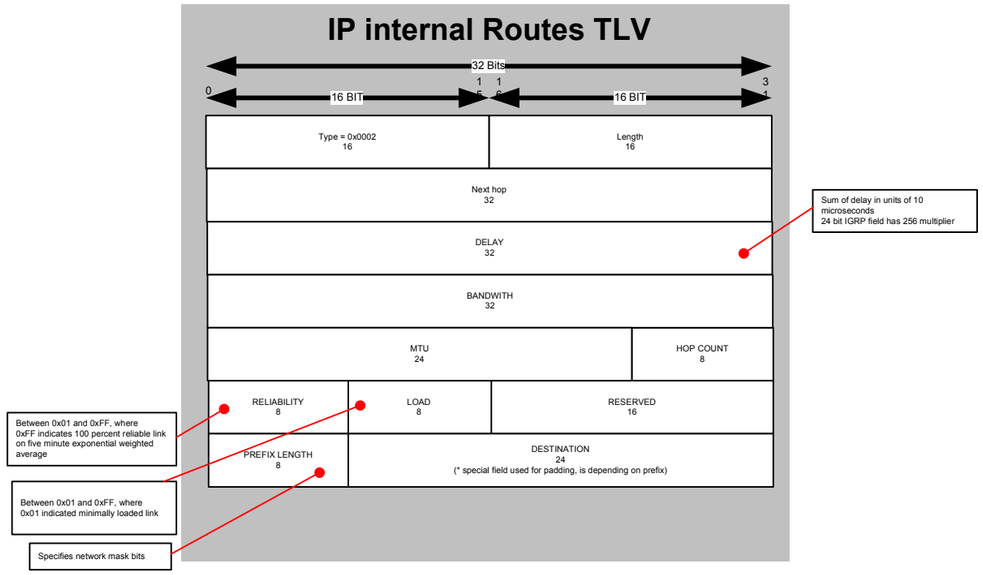
Version 03

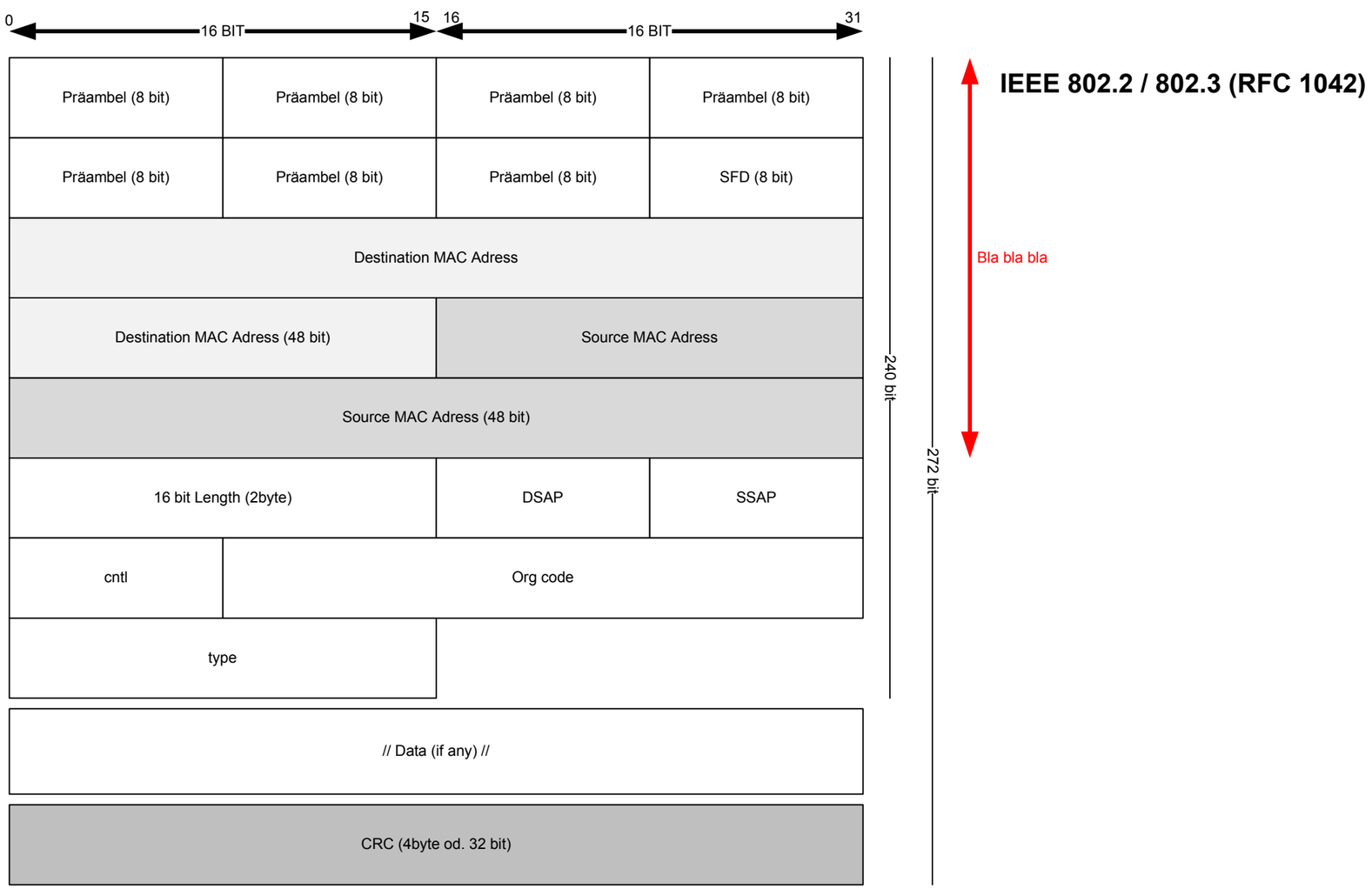
Learning TCP / IP headers

with
www.flashcardguy.ch

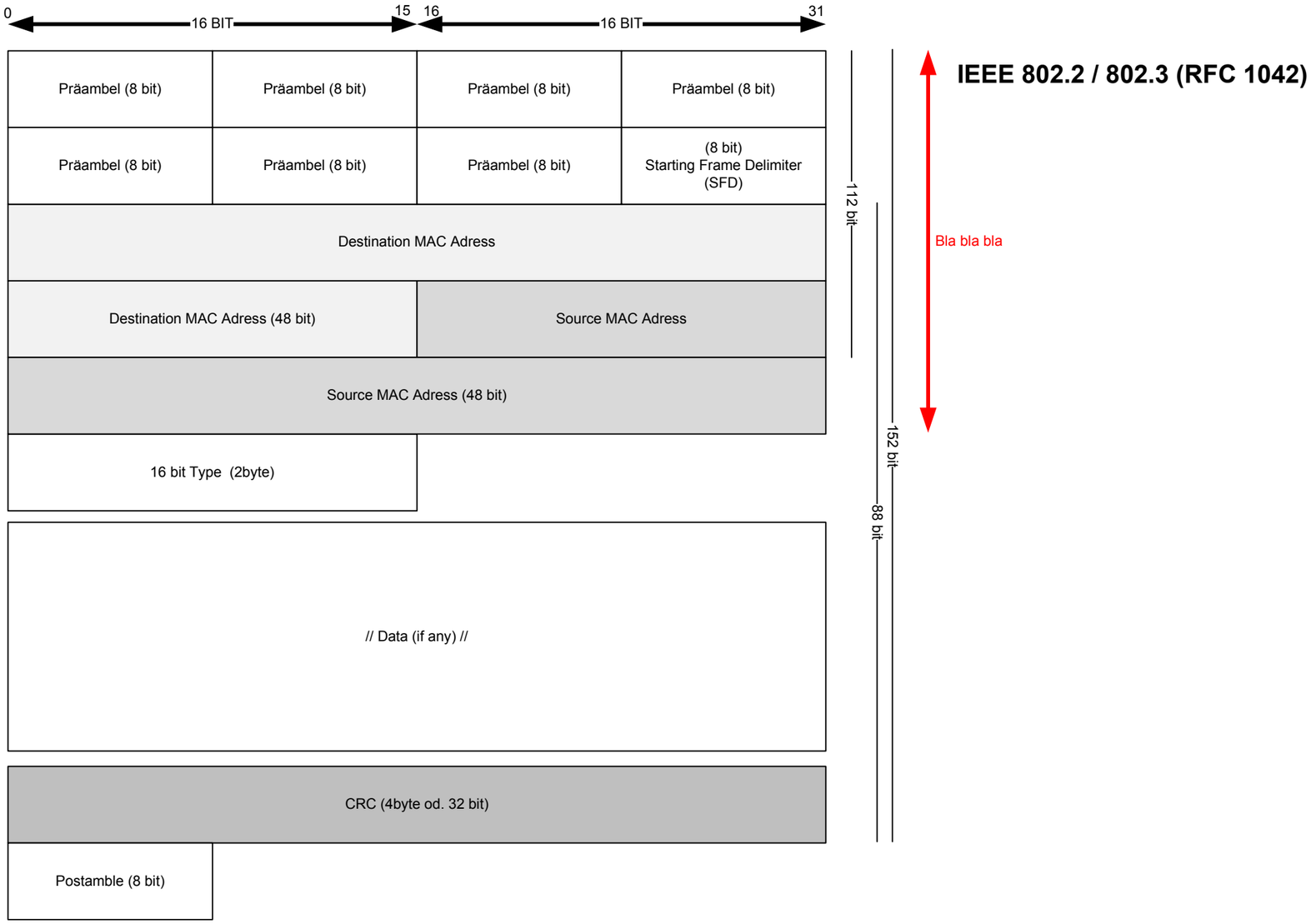
Page	Topic/Header
2	802.1
3	Ethernet II
4	ARP
5	IP
6	ICMP
7	UDP
8	TCP
9	RIPv1
10	RIPv2
11	RIP authentication
12	EIGRP
13	EIGRP TLVs
14-25	OSPFv2
25-end	OSPFv3
Soon	BGPv4
Soon	LDP (MPLS)
Soon	RSVP
Soon	IGMPv1
Soon	IGMPv2
Soon	IGMPv3
Soon	CGMP
Soon	PIMv2
Soon	MSDP
Soon	Syslog
Soon	SNMPv1
Soon	SNMPv2
Soon	SNMPv3



802.2

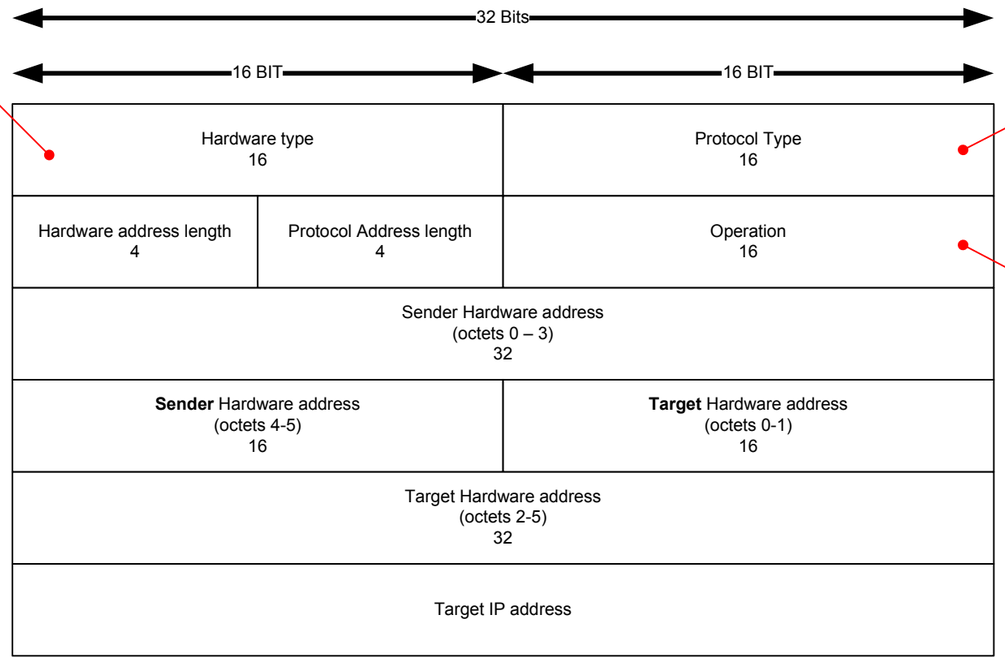


Ethernet II



ARP

Number	Hardware Type
1	Ethernet
3	X.25
4	Proteon ProNET Token Ring
6	IEEE 802 Networks
7	ARCnet
11	Apple LocalTalk
14	SMDS
15	Frame Relay
16	ATM
17	HDLC
18	Fibre Channel
19	ATM
20	Serial Link

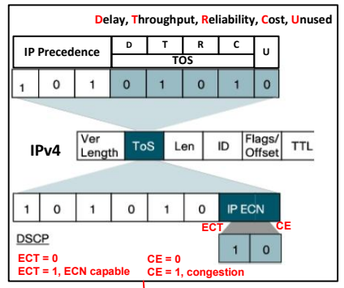


Protocol Type:

0x0800 IPv4

Code	Operation
1	ARP request
2	ARP reply
3	Reverse ARP request
4	Reverse ARP reply
8	Inverse ARP request
9	Inverse ARP reply

IPv4



Reserved-Bit
Don't fragment-bit
More fragments

32 Bits

0 — 16 BIT — 15 | 16 — 16 BIT — 31

Version 4	header length 4	type of service (TOS) 8	total length (of packet in bytes) 16
Identification 16		Flags 3	fragment offset 13
time to live (TTL) 8	Protocol 8	header checksum 16	
source IP address 32			
destination IP address 32			
Options (if any)			
// Data (if any) //			

20 bytes
160 bit

IP Version Number

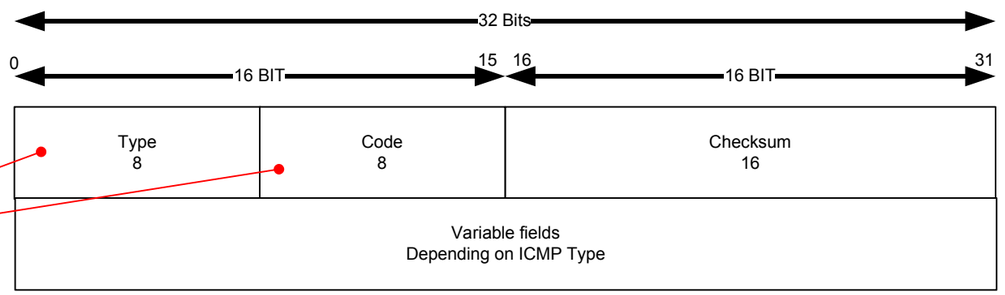
Number	Version
0	Reserved
1-3	Unassigned
4	Internet Protocol version 4 (IPv4)
5	ST Datagram Mode
6	Simple Internet Protocol (SIP)
6	Internet Protocol version 6 (IPv6)
7	TP/IX
8	P Internet Protocol (PIP)
9	TCP and UDP over Bigger Addresses (TUBA)
10-14	Unassigned
15	Reserved

Protocol Number	Host-to-Host Layer Protocol
1	Internet Control Message Protocol (ICMP)
2	Internet Group Management Protocol (IGMP)
4	IP in IP (encapsulation)
6	Transmission Control Protocol (TCP)
17	User Datagram Protocol (UDP)
45	Inter-Domain Routing Protocol (IDRP)
46	Resource Reservation Protocol (RSVP)
47	Generic Routing Encapsulation (GRE)
54	NBMA Next Hop Resolution Protocol (NHRP)
88	Cisco Internet Gateway Routing Protocol (IGRP)
89	Open Shortest Path First (OSPF)

Options:

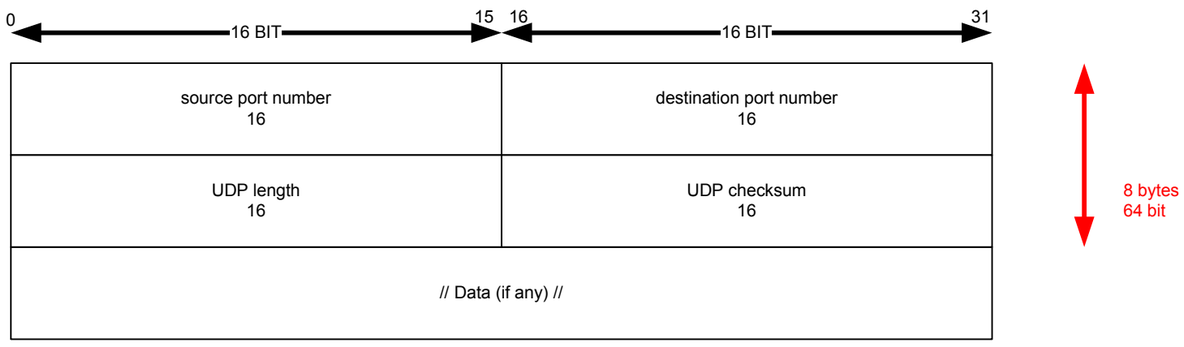
Loose source routing	Packet must pass through that series of IP addresses
Strict source routing	Packet must pass through exactly that list in order listed
Record route	each passed through router records its ip address into that field
Timestamp	Similar to Record route, but router enters an additional timestamp

ICMP



Type	Code	Name
0	0	ECHO REPLY
3	-	DESTINATION UNREACHABLE
3	0	Network unreachable
3	1	Host unreachable
3	2	Protocol unreachable
3	3	Port unreachable
3	4	Fragmentation Needed and don't fragment flag is set
3	5	Source route failed
3	6	Destination Network unknown
3	7	Destination Host unknown
3	8	Source Host Isolated
3	9	Destination Network administratively prohibitated
3	10	Destination Host administratively prohibitated
3	11	Destination Network unreachable for type of service
4	0	SOURCE QUENCH (deprecated)
5	-	REDIRECT
5	0	Redirect Datagram for the Network (or Subnet)
5	1	Redirect Datagram for the Host
5	2	Redirect Datagram for the Network and Type of Service
5	3	Redirect Datagram for the Host and Type of Service
6	0	ALTERNATE HOST ADDRESS
8	0	ECHO
9	0	ROUTER ADVERTISEMENT
10	0	ROUTER SELECTION
11	-	TIME EXCEEDED
11	0	Time to Live Exceeded in Transit
11	1	Fragment Reassembly Time Exceeded
12	-	PARAMETER PROBLEM
12	0	Pointer Indicates the error
12	1	Missing a Required option
12	2	Bad Length
13	0	TIMESTAMP
14	0	TIMESTAMP REPLY
15	0	INFORMATION Request (obsolete)
16	0	INFORMATION Reply (obsolete)
17	0	Address mask request (near-obsolete)
18	0	Address mask reply (near-obsolete)
30	-	TRACEROUTE

UDP



TCP

Sequence number:

- Number of previous segment was 1343
- Current segment contains 512 bytes of data

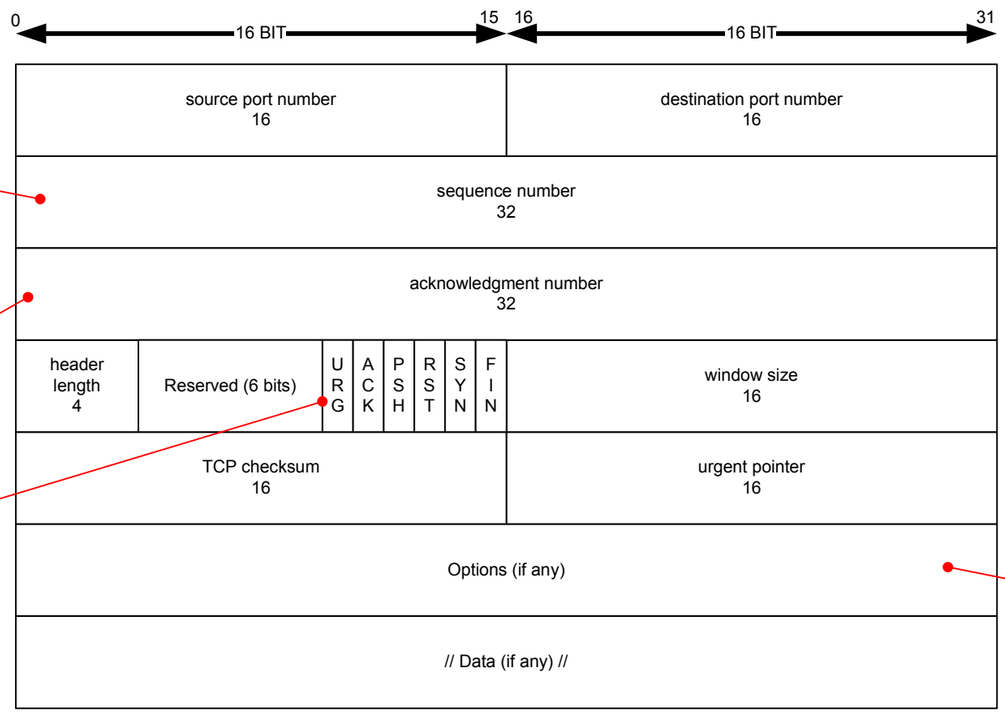
Next segment sequence would be:

1343 + 512 + 1 = 1856

IF NO RANDOMIZATION IS USED, which would be a bit old school...

If the ack number is not the expected next sequence number, or not the current ack number, TCP knows that the last packet was lost, and will initiate a re-transmit.

URG	Urgent
ACK	Acknowledgement
PSH	Push
RST	Reset
SYN	Synchronise
FIN	Final
CWR	Congestion Window Reduced
ECN-ECE	ECN-ECHO

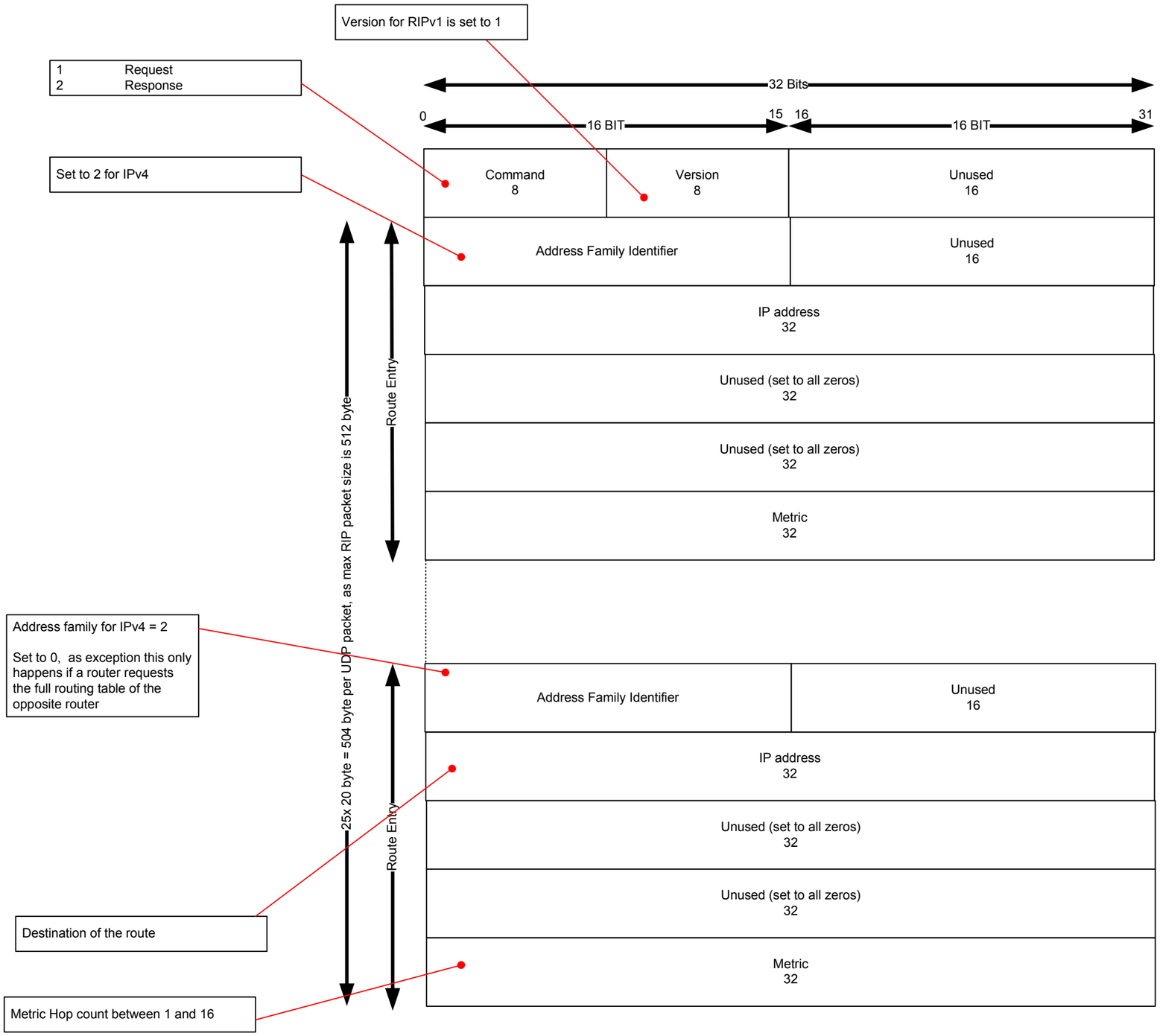


20 bytes
160 bit

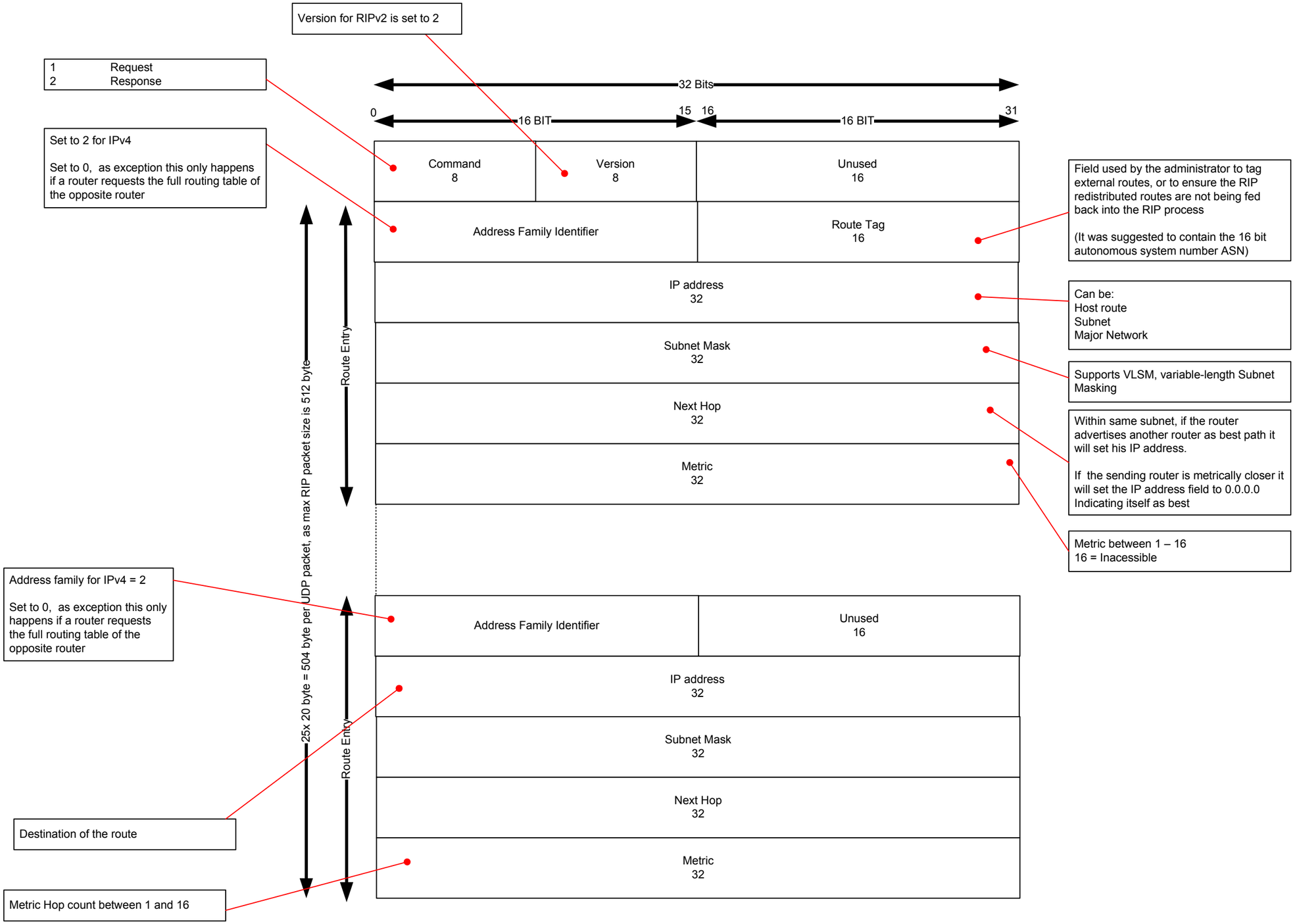
Maximum Segment Size MSS

Padding if required to fill the the multiple of 32 bits of the packet

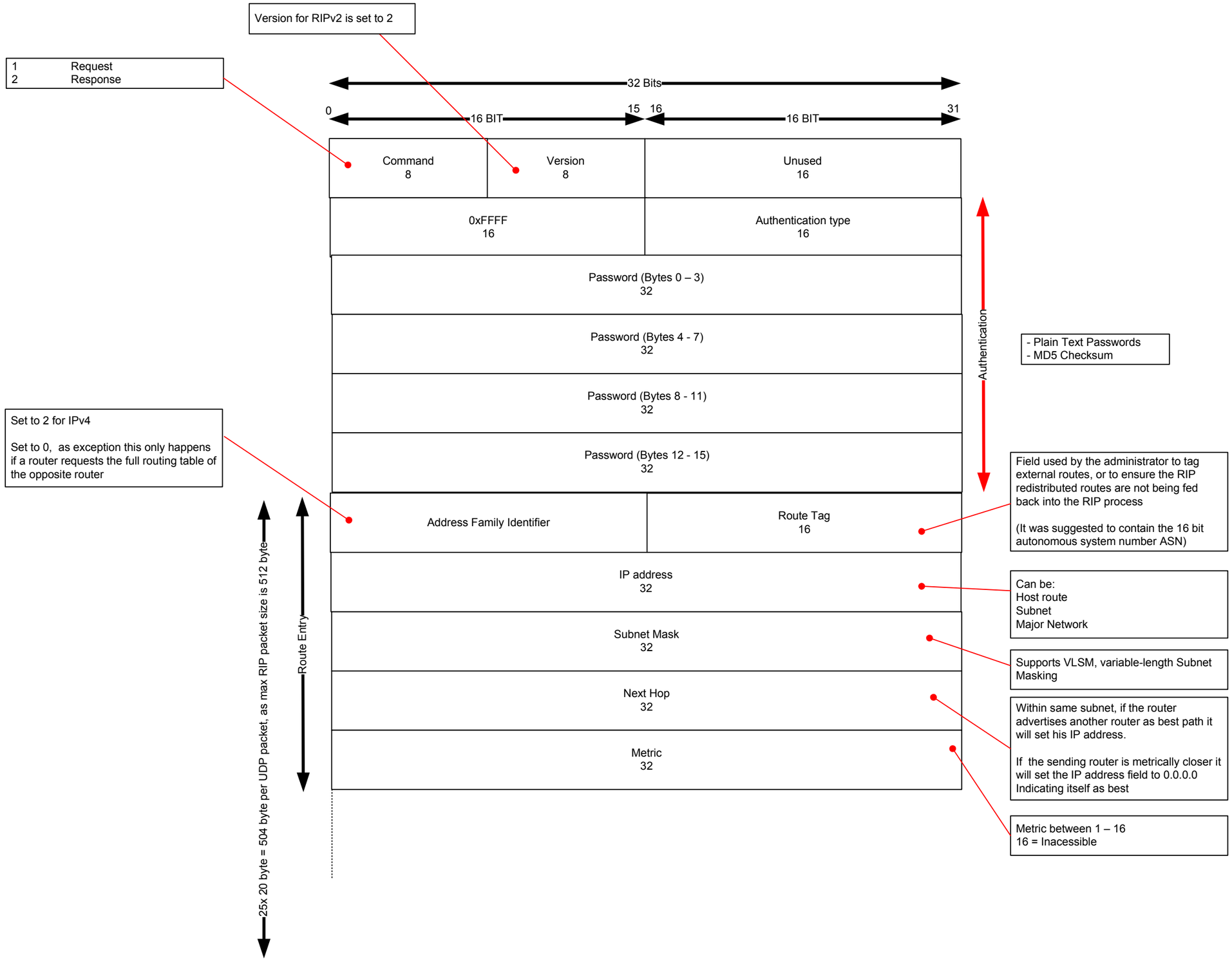
RIPv1



RIPv2



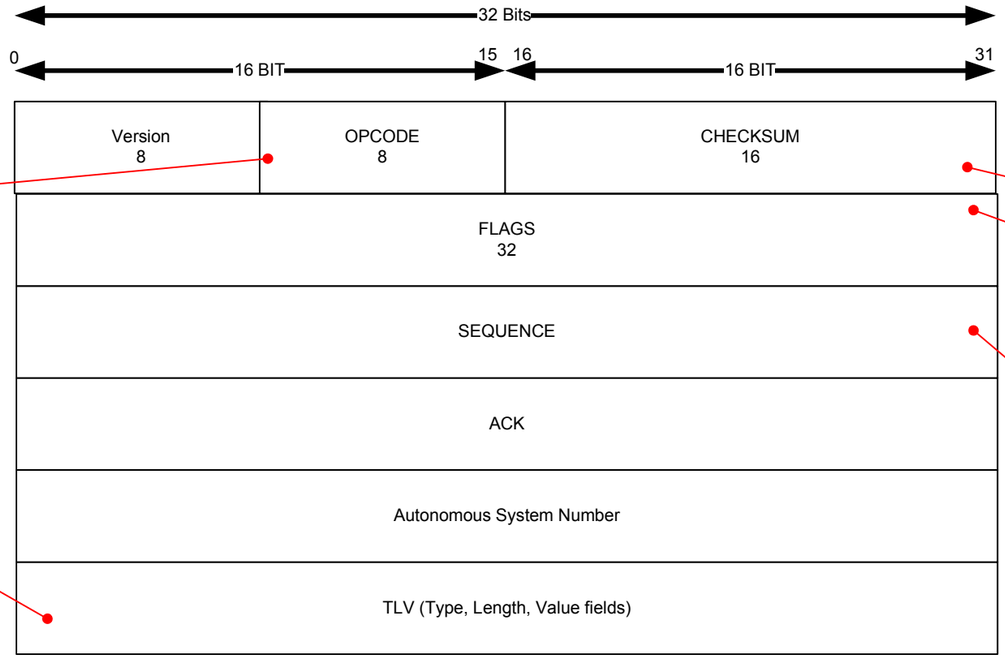
RIP authentication



EIGRP

Number	TLV Type
General TLV Types	
0x0001	EIGRP Parameters
0x0003	Sequence
0x0004	Software Version
0x0005	Next Multicast Sequence
IP Specific TLV Types	
0x0102	IP Internal Routes
0x0103	IP External Routes
AppleTalk Specific TLV Types	
0x0202	AppleTalk Internal Routes
0x0203	AppleTalk External Routes
0x0204	AppleTalk Cable Configuration
IPX Specific TLV Types	
0x0302	IPX Internal Routes
0x3003	IPX External Routes

OPCODE	Type
1	Update
3	Query
4	Reply
5	Hello
6	IPX SAP
10	SIA Query
11	SIA Reply



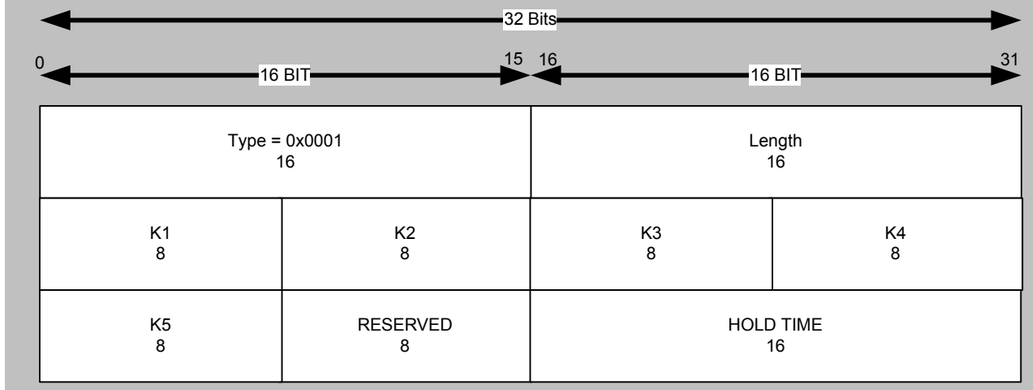
Covering the entire EIGRP packet, but excludes the IP header

0x00000001 indicates right-most bit = Init, route entries are first in a new neighbor relationship

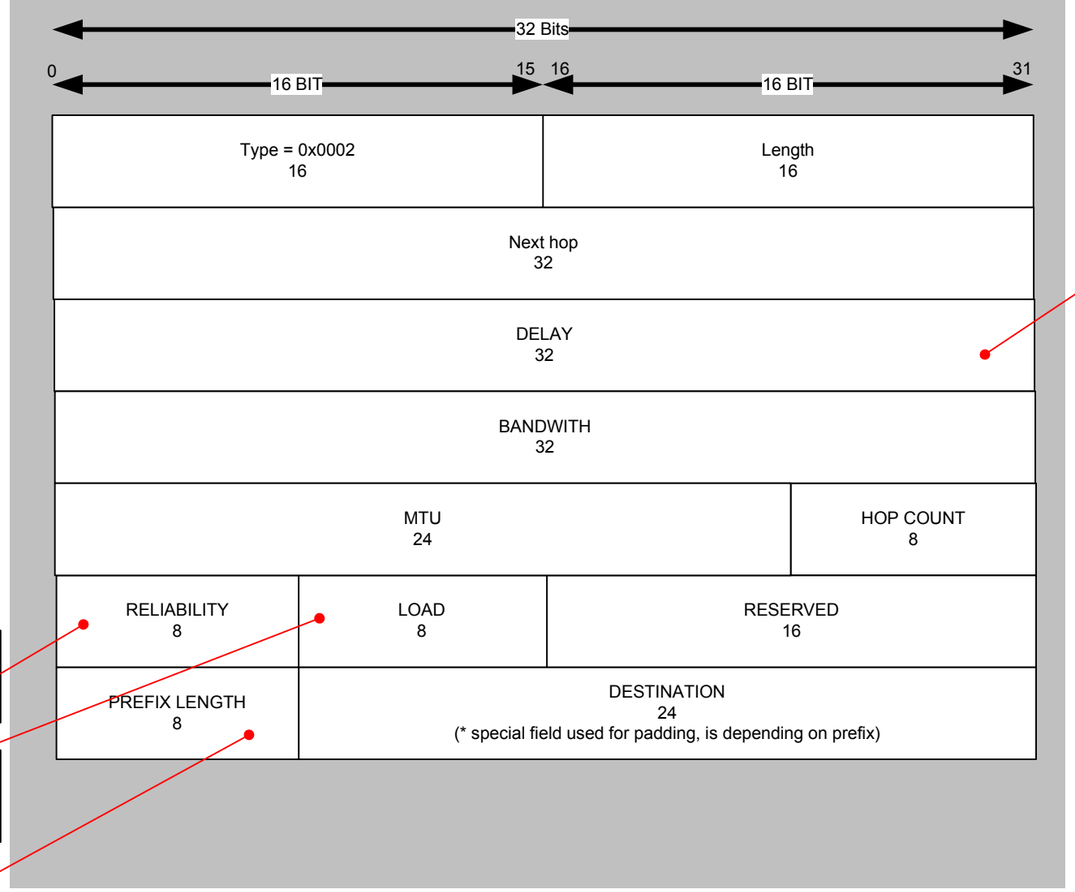
0x00000002 Conditional Receive bit, used in Reliable Multicasting algorythm.

Used by RTP

EIGRP Parameter Type Length Value (TLV)



IP internal Routes TLV



Sum of delay in units of 10 microseconds
24 bit IGRP field has 256 multiplier

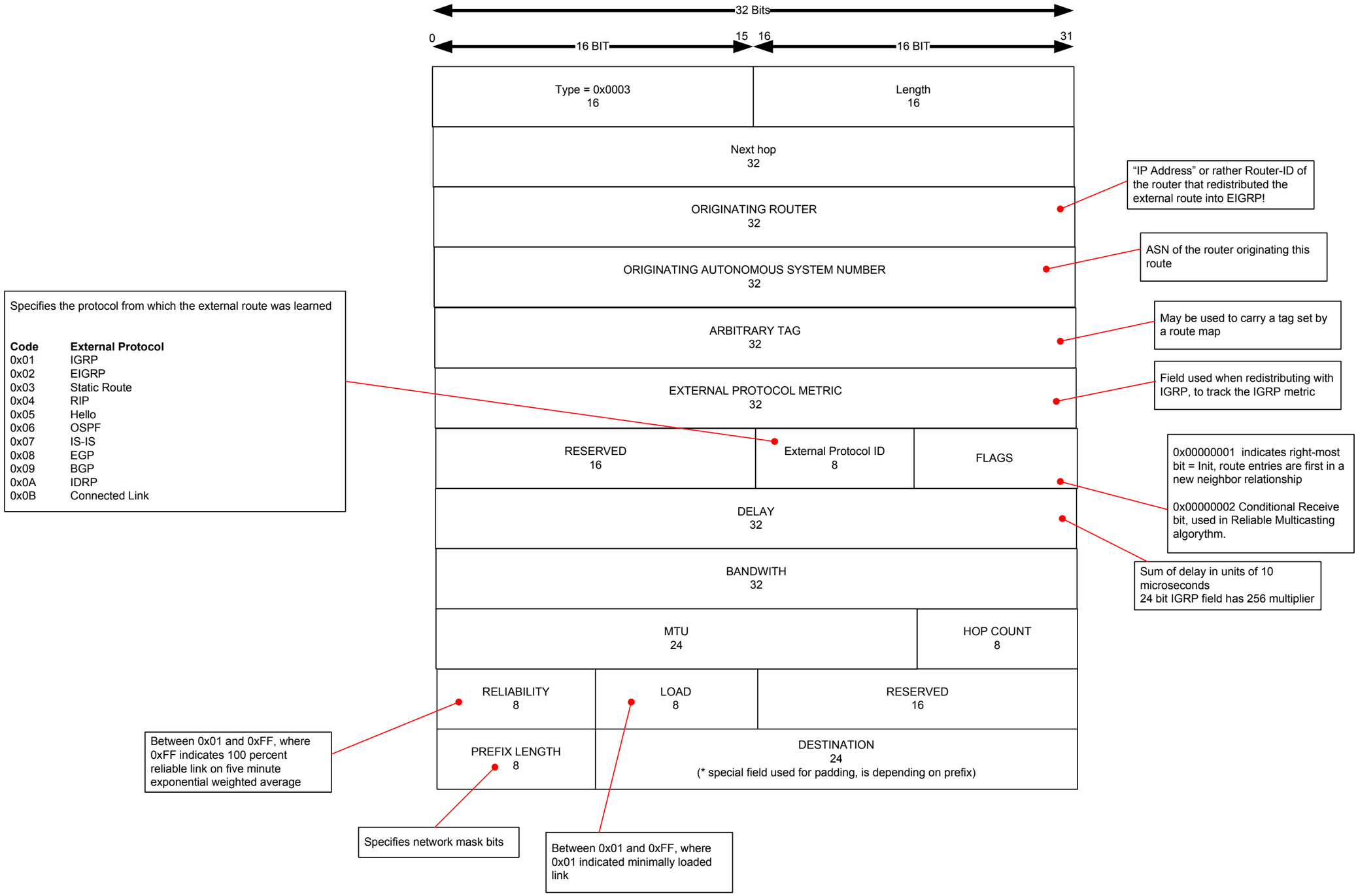
Between 0x01 and 0xFF, where 0xFF indicates 100 percent reliable link on five minute exponential weighted average

Between 0x01 and 0xFF, where 0x01 indicated minimally loaded link

Specifies network mask bits

EIGRP

IP external Routes TLV



OSPFv2
LSA Types

Area Type	1+2	3	4	5	7
Backbone	yes	yes	yes	yes	yes
Non-Backbone Non-stub	yes	yes	yes	yes	yes
Stub	yes	yes	no	no	no
Totally Stubby	yes	no*	no	no	no
Not so stubby	yes	yes	yes	no	no

Type Code	Description
1	Hello
2	Database Description
3	Link State Request
4	Link State Update
5	Link State Acknowledgement

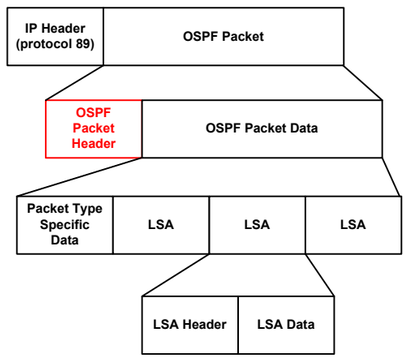
32 Bits

0 — 16 BIT — 15 16 — 16 BIT — 31

Version 8	Type 8	Packet Length 16
Router ID 32		
Area ID 32		
Checksum 16	Authentication Type 16	
Authentication* 32		
Authentication* 32		
Packet Data		

IP Version Number	
Number	Version
0	Reserved
1-3	Unassigned
4	Internet Protocol version 4 (IPv4)
5	ST Datagram Mode
6	Simple Internet Protocol (SIP)
6	Internet Protocol version 6 (IPv6)
7	TP/IX
8	P Internet Protocol (PIP)
9	TCP and UDP over Bigger Addresses (TUBA)
10-14	Unassigned
15	Reserved

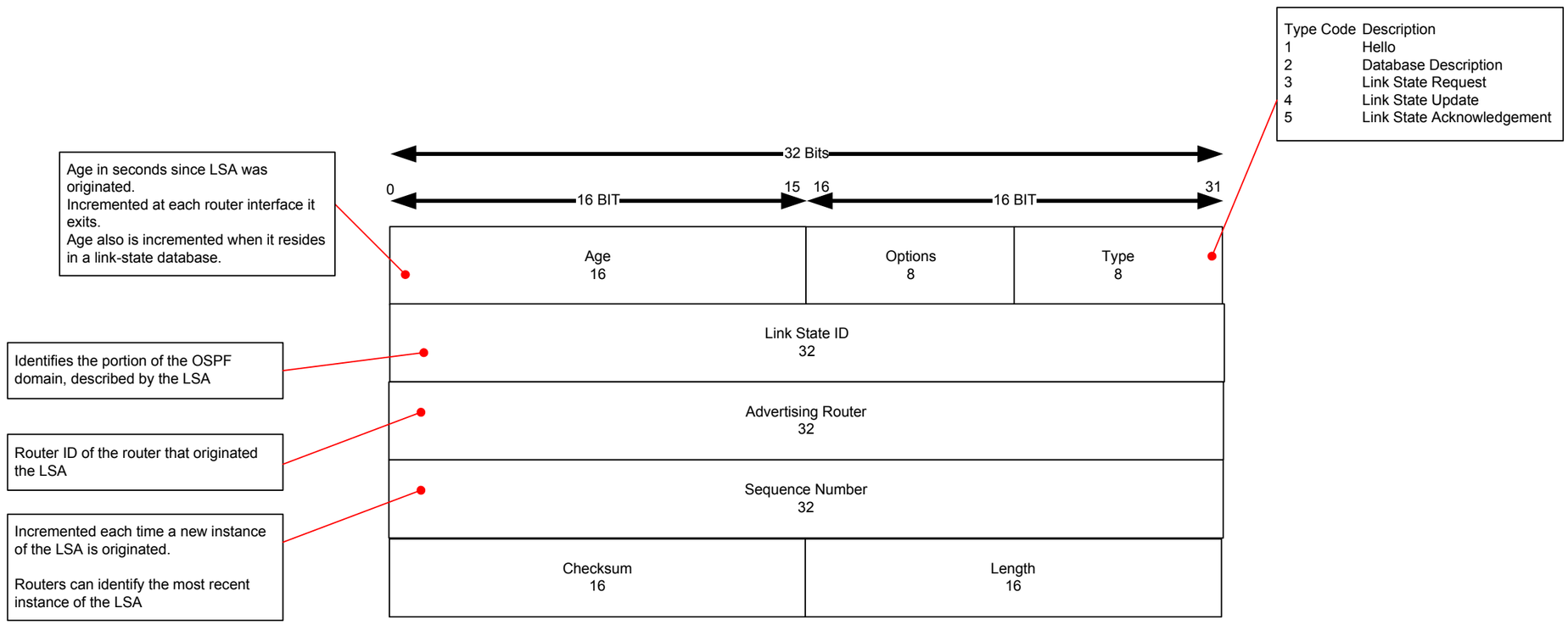
AuType	Authententication Type
0	Null (no authentication)
1	Simple (clear text) Password Authentication
2	Cryptographic (MD5) Checksum

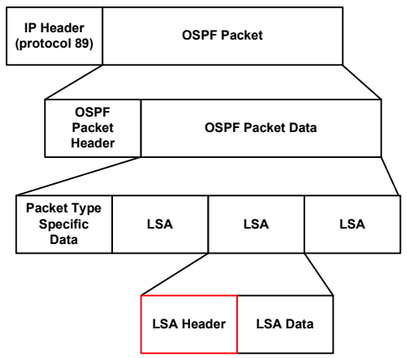


If Authentication type is set to 2:

0x0000 16	Key ID 8	Authentication Data Length
Cryptographic Sequence Number 32		

OSPFv2
LSA Header

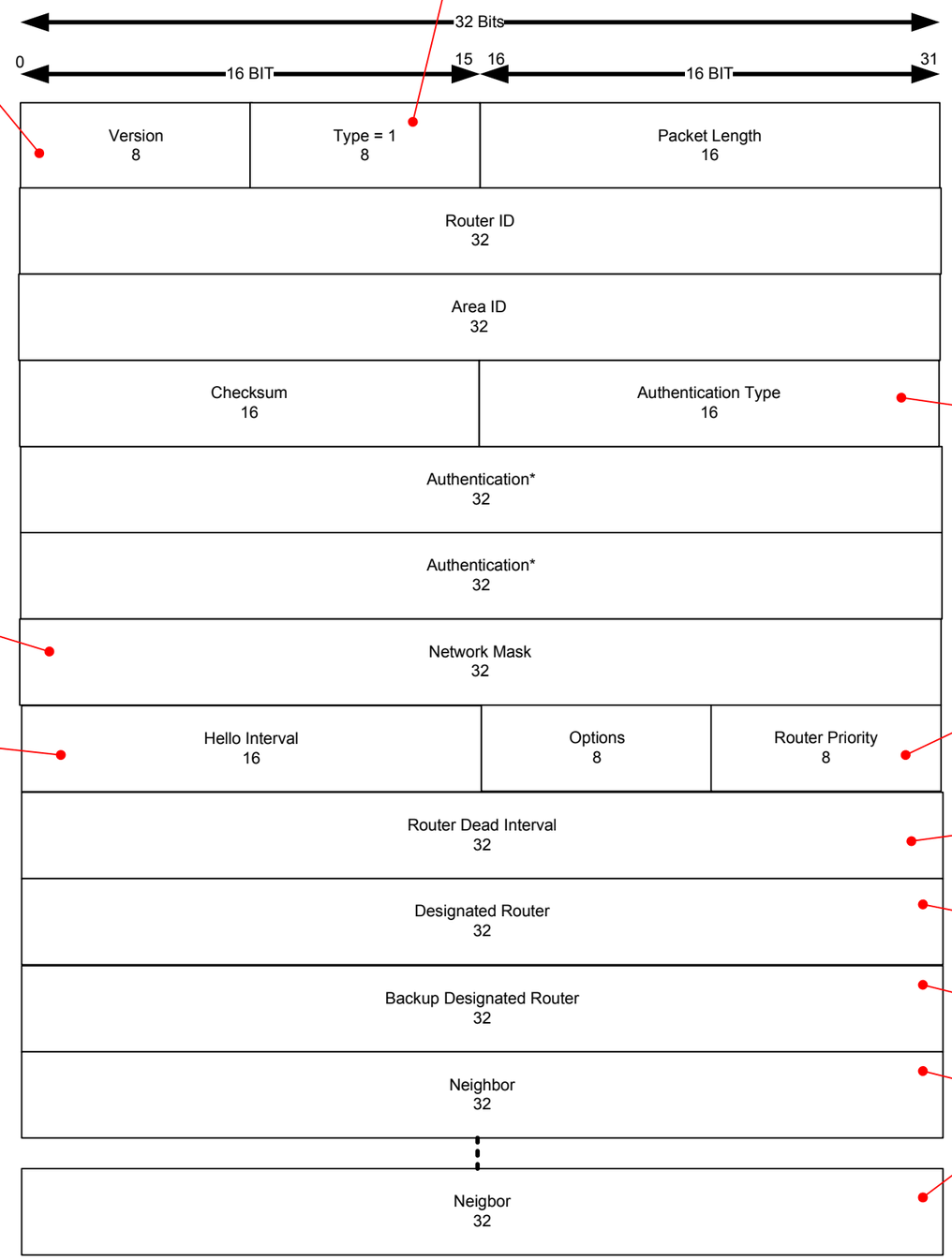




OSPFv2
Hello packet

IP Version Number	
Number	Version
0	Reserved
1-3	Unassigned
4	Internet Protocol version 4 (IPv4)
5	ST Datagram Mode
6	Simple Internet Protocol (SIP)
6	Internet Protocol version 6 (IPv6)
7	TP/IX
8	P Internet Protocol (PIP)
9	TCP and UDP over Bigger Addresses (TUBA)
10-14	Unassigned
15	Reserved

Type Code	Description
1	Hello
2	Database Description
3	Link State Request
4	Link State Update
5	Link State Acknowledgement



AuType	Authententication Type
0	Null (no authentication)
1	Simple (clear text) Password Authentication
2	Cryptographic (MD5) Checksum

If the received packet does not contain the same mask, the packet will be dropped

If Authentication type is set to 2:

In seconds

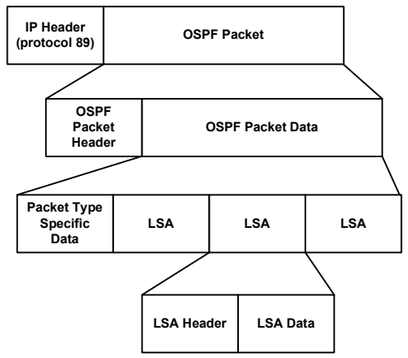
Higher the better, wins the DR elections

In seconds, will waite for a hello before declaring the neighbor dead

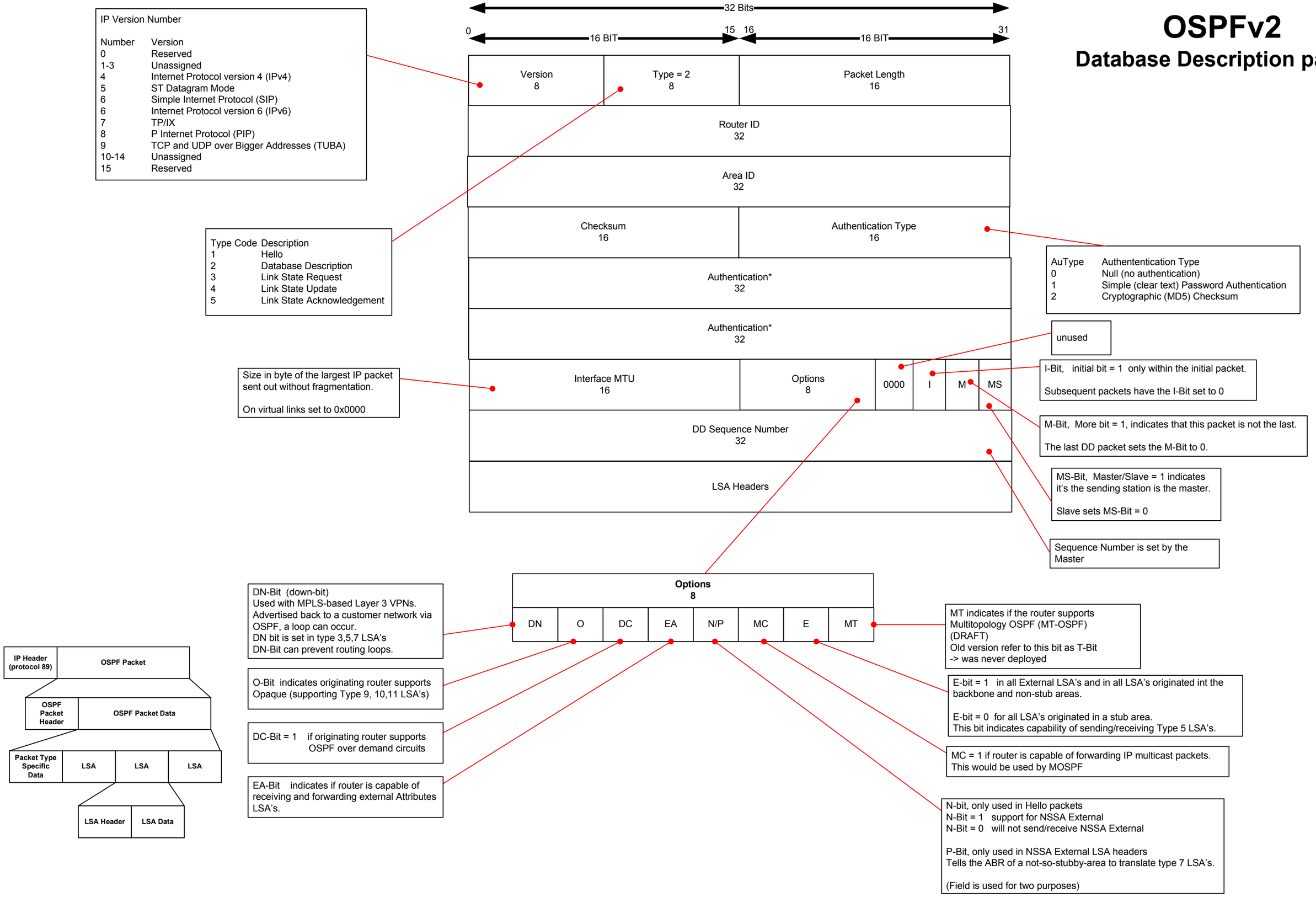
The “IP” or rather router-ID of the DR

The “IP” or rather router-ID of the BDR

Lists all Router ID’s of all neighbors from which the router has received a valid Hello within the past RouterDeadInterval



OSPFv2
Database Description packet

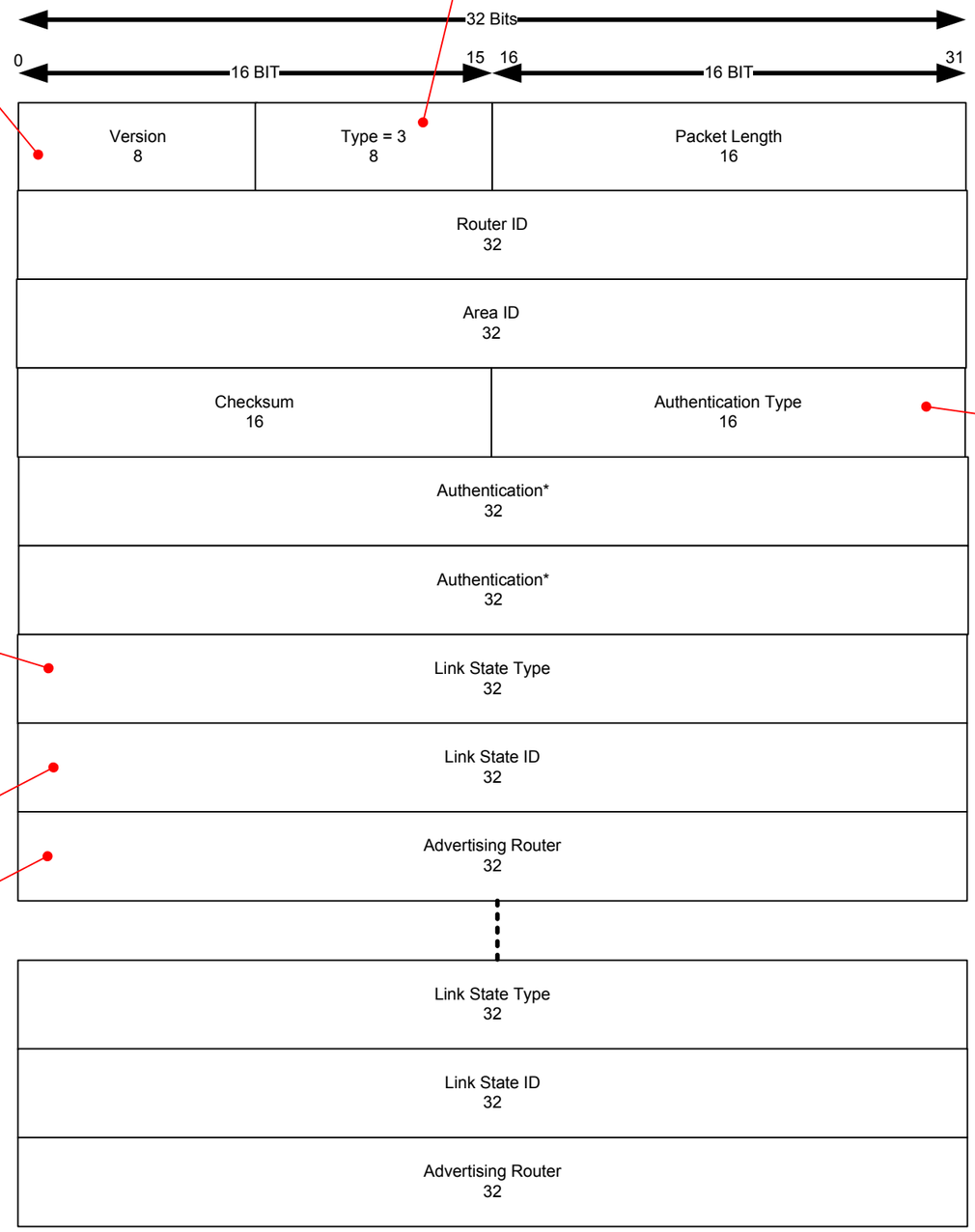


OSPFv2
Link state request

IP Version Number

Number	Version
0	Reserved
1-3	Unassigned
4	Internet Protocol version 4 (IPv4)
5	ST Datagram Mode
6	Simple Internet Protocol (SIP)
6	Internet Protocol version 6 (IPv6)
7	TP/IX
8	P Internet Protocol (PIP)
9	TCP and UDP over Bigger Addresses (TUBA)
10-14	Unassigned
15	Reserved

Type Code	Description
1	Hello
2	Database Description
3	Link State Request
4	Link State Update
5	Link State Acknowledgement



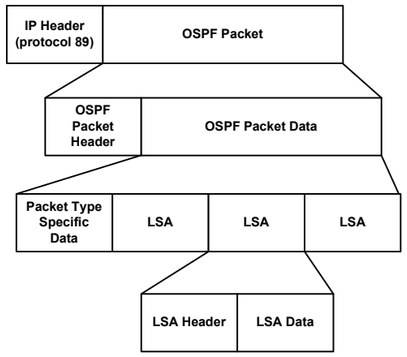
AuType	Authententication Type
0	Null (no authentication)
1	Simple (clear text) Password Authentication
2	Cryptographic (MD5) Checksum

LSA Types

Type Code	Description
1	Router LSA
2	Network LSA
3	Network Summary LSA
4	ASBR Summary LSA
5	AS External LSA
6	Group Membership LSA (Multicast, MOSPF)
7	NSSA External LSA
8	External Attributes LSA
9	Opaque LSA (link-local scope) IPv6
10	Opaque LSA (area-local scope) IPv6
11	Opaque LSA (AS scope) IPv6

Type dependant field

Router ID of the router that originated the LSA

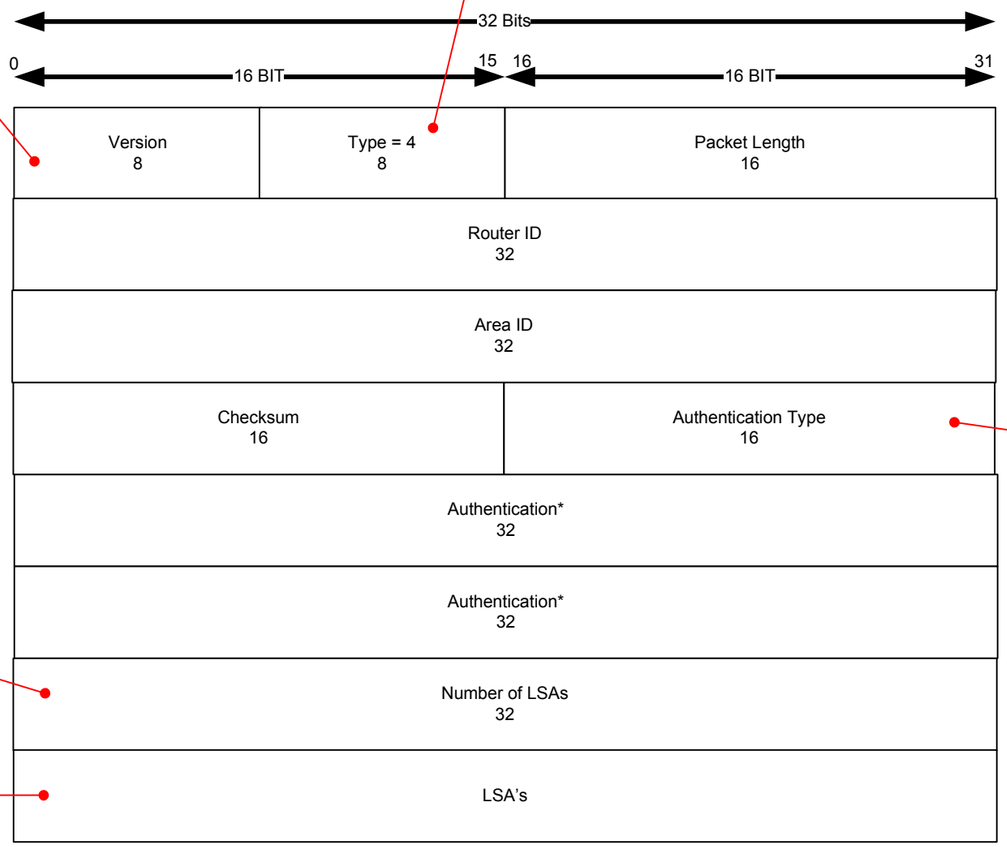


OSPFv2
Link state update

IP Version Number

Number	Version
0	Reserved
1-3	Unassigned
4	Internet Protocol version 4 (IPv4)
5	ST Datagram Mode
6	Simple Internet Protocol (SIP)
6	Internet Protocol version 6 (IPv6)
7	TP/IX
8	P Internet Protocol (PIP)
9	TCP and UDP over Bigger Addresses (TUBA)
10-14	Unassigned
15	Reserved

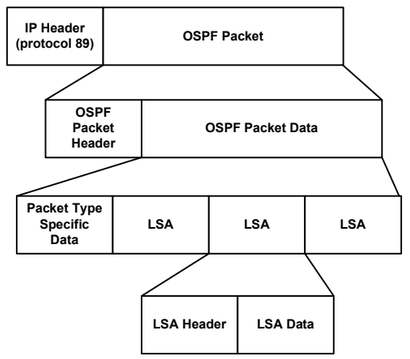
Type Code	Description
1	Hello
2	Database Description
3	Link State Request
4	Link State Update
5	Link State Acknowledgement



Number of LSAs included in this packet

Each packet can contain multiple LSAs

AuType	Authententication Type
0	Null (no authentication)
1	Simple (clear text) Password Authentication
2	Cryptographic (MD5) Checksum

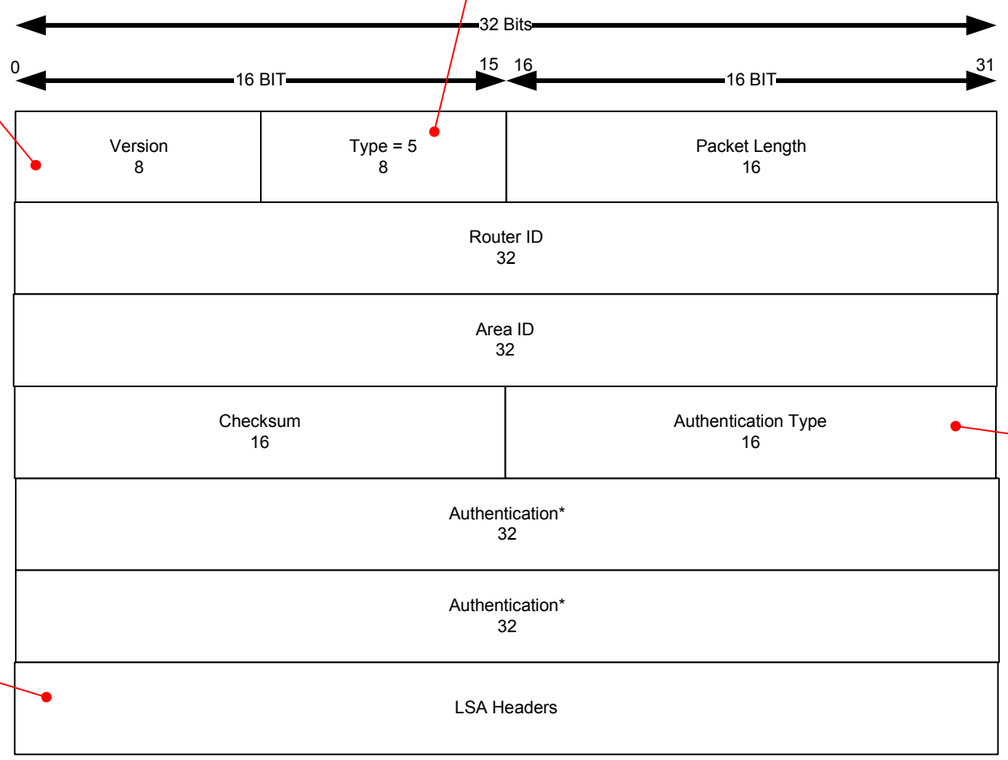


OSPFv2
Link State Acknowledgement packet

IP Version Number

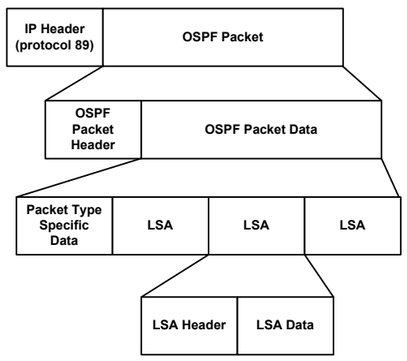
Number	Version
0	Reserved
1-3	Unassigned
4	Internet Protocol version 4 (IPv4)
5	ST Datagram Mode
6	Simple Internet Protocol (SIP)
6	Internet Protocol version 6 (IPv6)
7	TP/IX
8	P Internet Protocol (PIP)
9	TCP and UDP over Bigger Addresses (TUBA)
10-14	Unassigned
15	Reserved

Type Code	Description
1	Hello
2	Database Description
3	Link State Request
4	Link State Update
5	Link State Acknowledgement

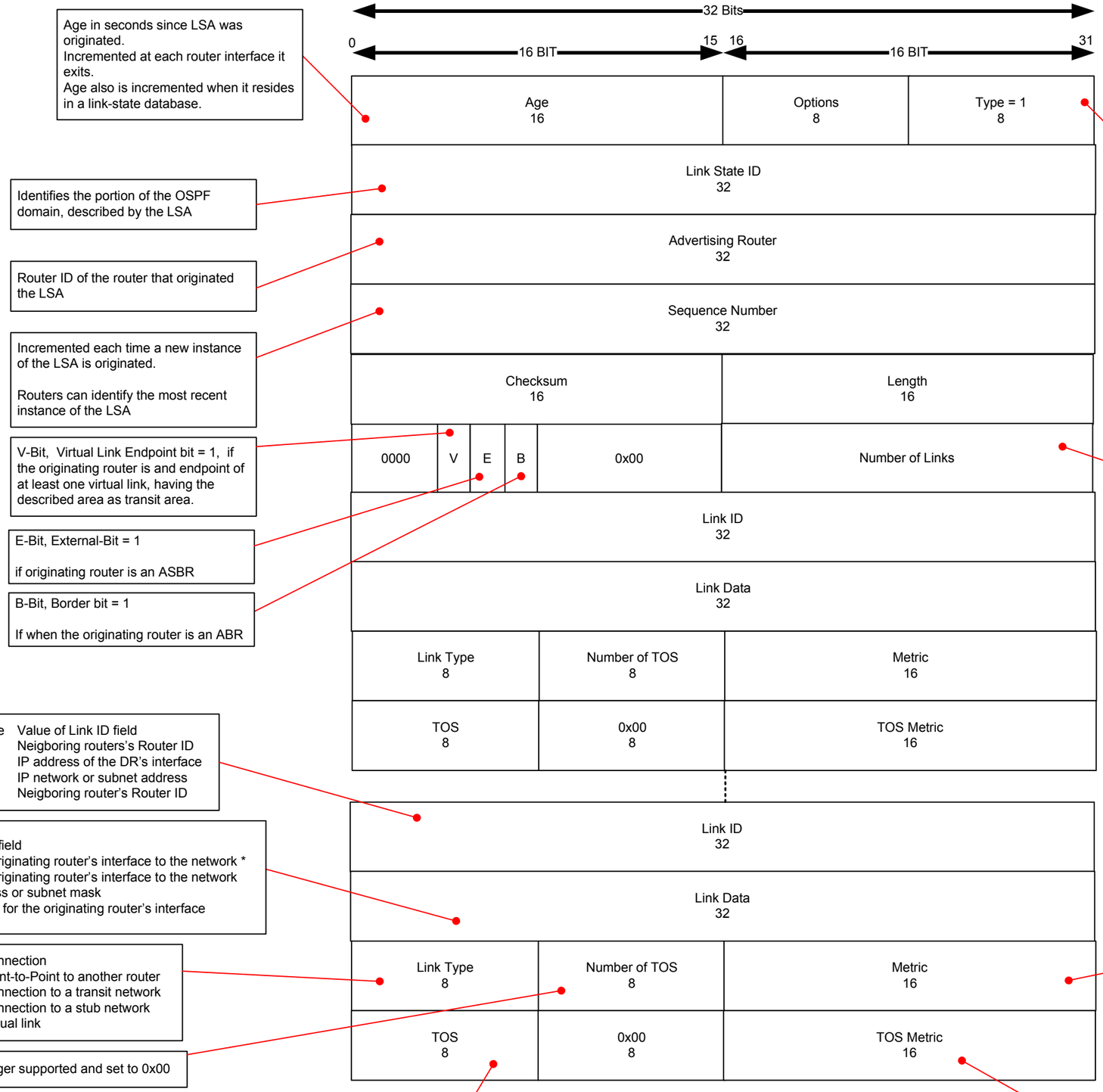


AuType	Authententication Type
0	Null (no authentication)
1	Simple (clear text) Password Authentication
2	Cryptographic (MD5) Checksum

List of LSA headers



OSPFv2 Router LSA



Age in seconds since LSA was originated.
Incremented at each router interface it exits.
Age also is incremented when it resides in a link-state database.

Identifies the portion of the OSPF domain, described by the LSA

Router ID of the router that originated the LSA

Incremented each time a new instance of the LSA is originated.

Routers can identify the most recent instance of the LSA

V-Bit, Virtual Link Endpoint bit = 1, if the originating router is and endpoint of at least one virtual link, having the described area as transit area.

E-Bit, External-Bit = 1

if originating router is an ASBR

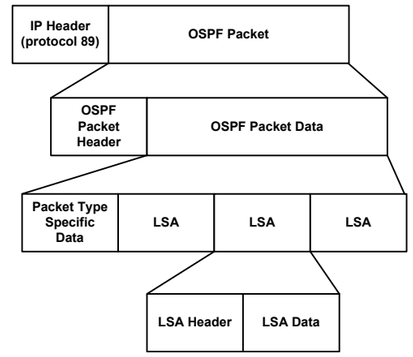
B-Bit, Border bit = 1

If when the originating router is an ABR

LSA Types

Type Code	Description
1	Router LSA
2	Network LSA
3	Network Summary LSA
4	ASBR Summary LSA
5	AS External LSA
6	Group Membership LSA (Multicast, MOSPF)
7	NSSA External LSA
8	External Attributes LSA
9	Opaque LSA (link-local scope) IPv6
10	Opaque LSA (area-local scope) IPv6
11	Opaque LSA (AS scope) IPv6

Router describes all of the originating router's links, or interfaces



Link Type	Value of Link ID field
1	Neigboring routers's Router ID
2	IP address of the DR's interface
3	IP network or subnet address
4	Neigboring router's Router ID

Link Type	Value of Link Data field
1	IP address of the originating router's interface to the network *
2	IP address of the originating router's interface to the network
3	Networks IP address or subnet mask
4	MIB-II Ifindex value for the originating router's interface

Link Type	Connection
1	Point-to-Point to another router
2	Connection to a transit network
3	Connection to a stub network
4	Virtual link

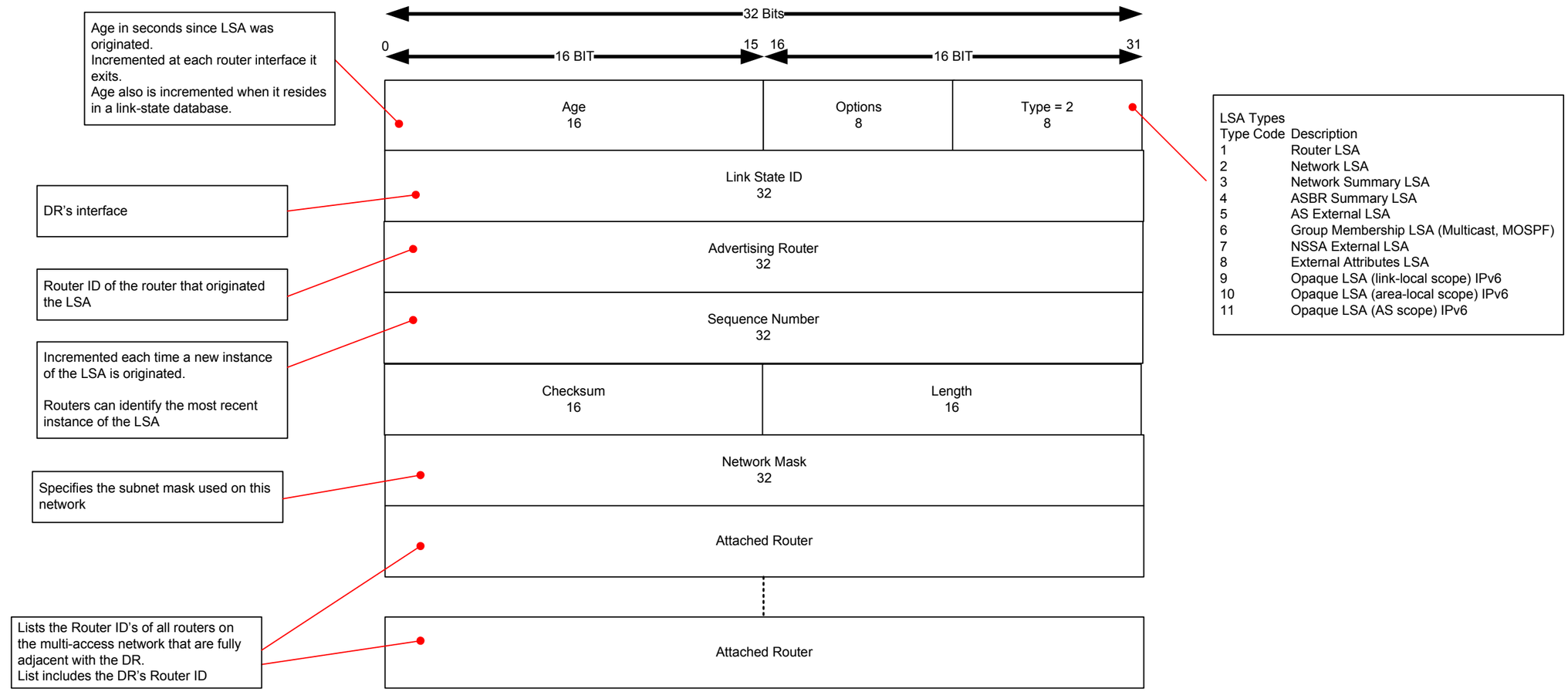
Field is no longer supported and set to 0x00

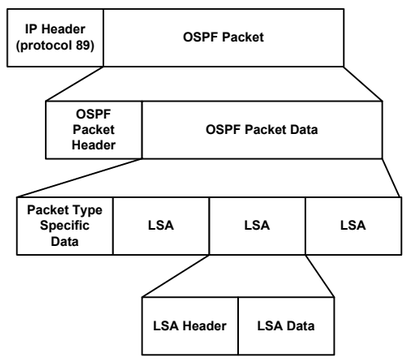
Cost of the link (interface)

Is the metric associated with the specified TOS value

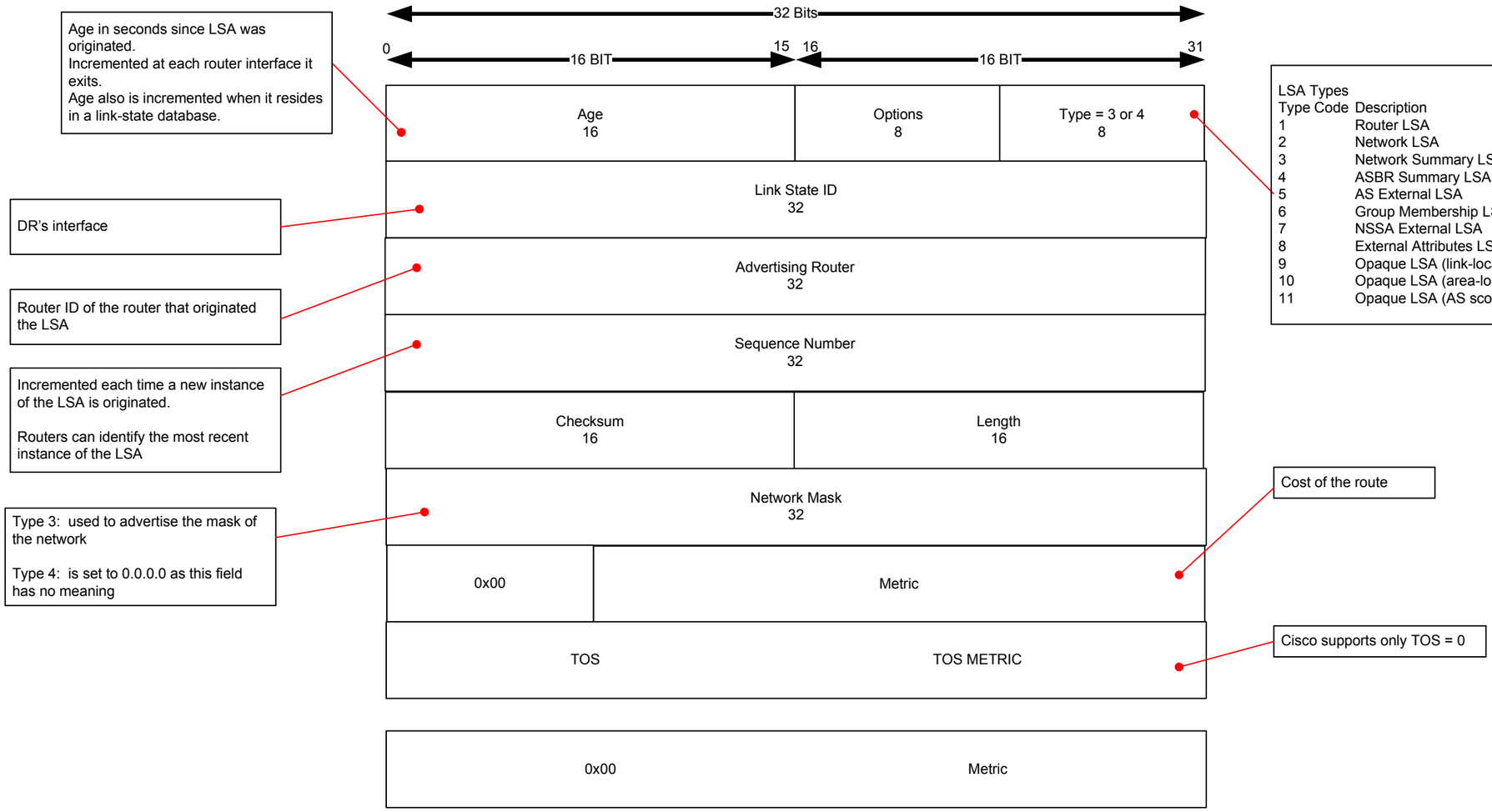
RFC TOS Value	IP header TOS field	OSPF TOS encoding
Normal Service	0000	0
Minimize Monetary Cost	0001	2
Maximize Reliability	0010	4
Maximize Througput	0100	8
Minimize Delay	1000	16

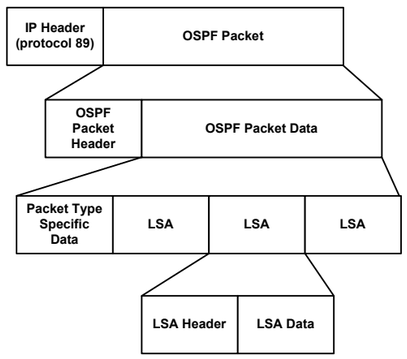
OSPFv2
Network LSA



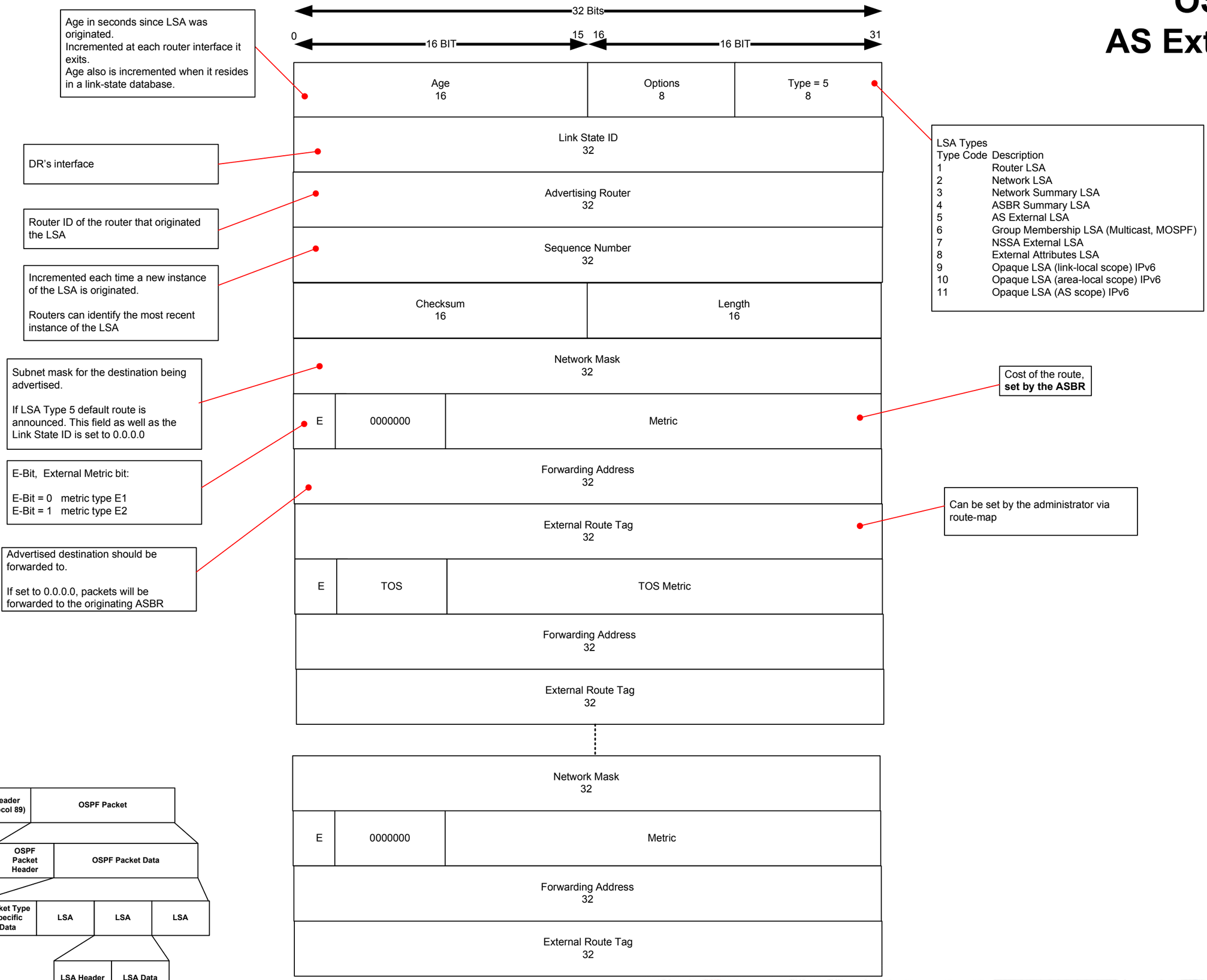


OSPFv2
Network ASBR summary

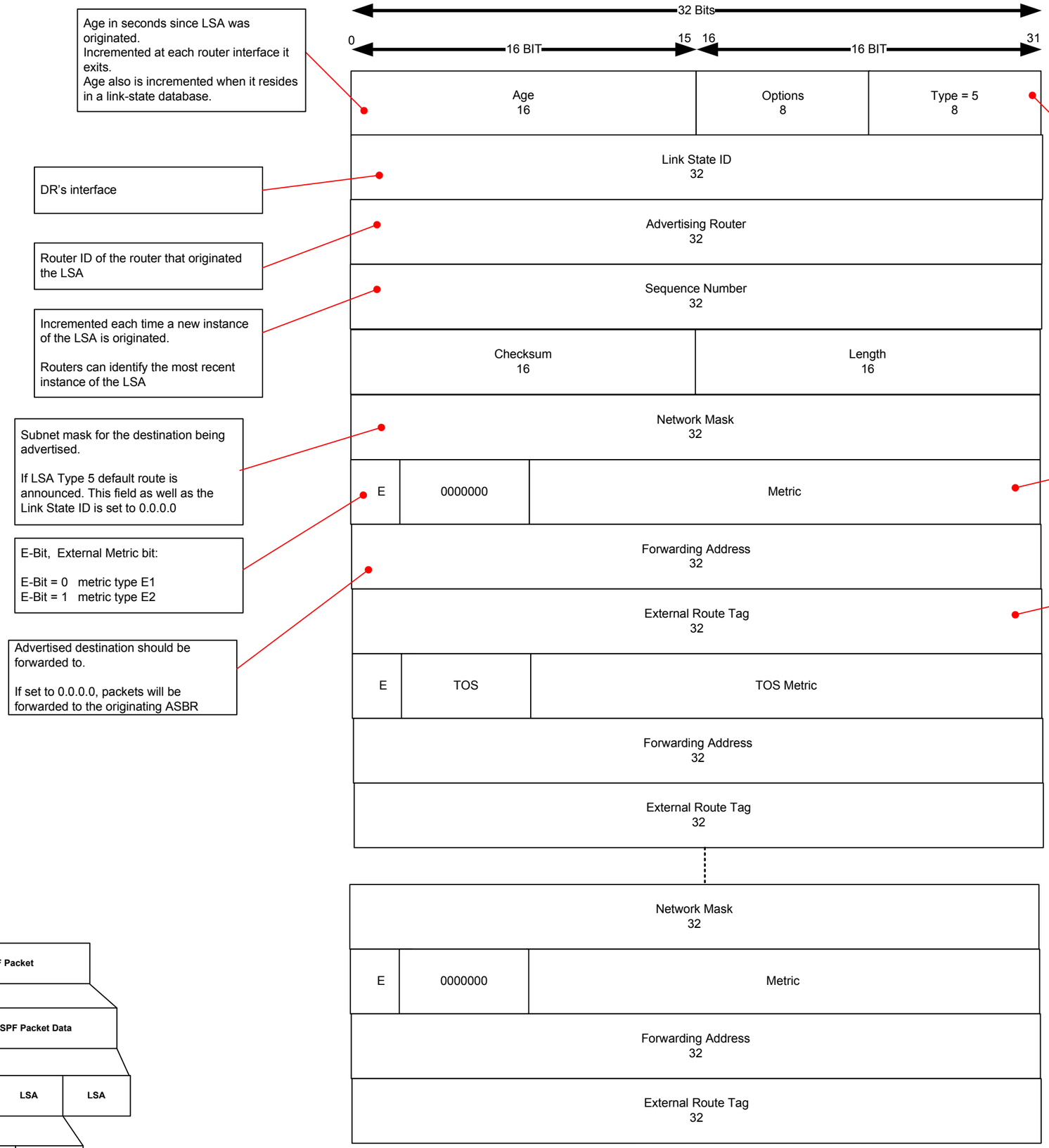




OSPFv2
AS External LSA



OSPFv2
NSSA External



Age in seconds since LSA was originated.
Incremented at each router interface it exits.
Age also is incremented when it resides in a link-state database.

DR's interface

Router ID of the router that originated the LSA

Incremented each time a new instance of the LSA is originated.

Routers can identify the most recent instance of the LSA

Subnet mask for the destination being advertised.

If LSA Type 5 default route is announced. This field as well as the Link State ID is set to 0.0.0.0

E-Bit, External Metric bit:

E-Bit = 0 metric type E1
E-Bit = 1 metric type E2

Advertised destination should be forwarded to.

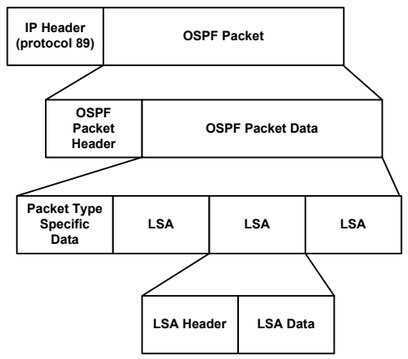
If set to 0.0.0.0, packets will be forwarded to the originating ASBR

LSA Types

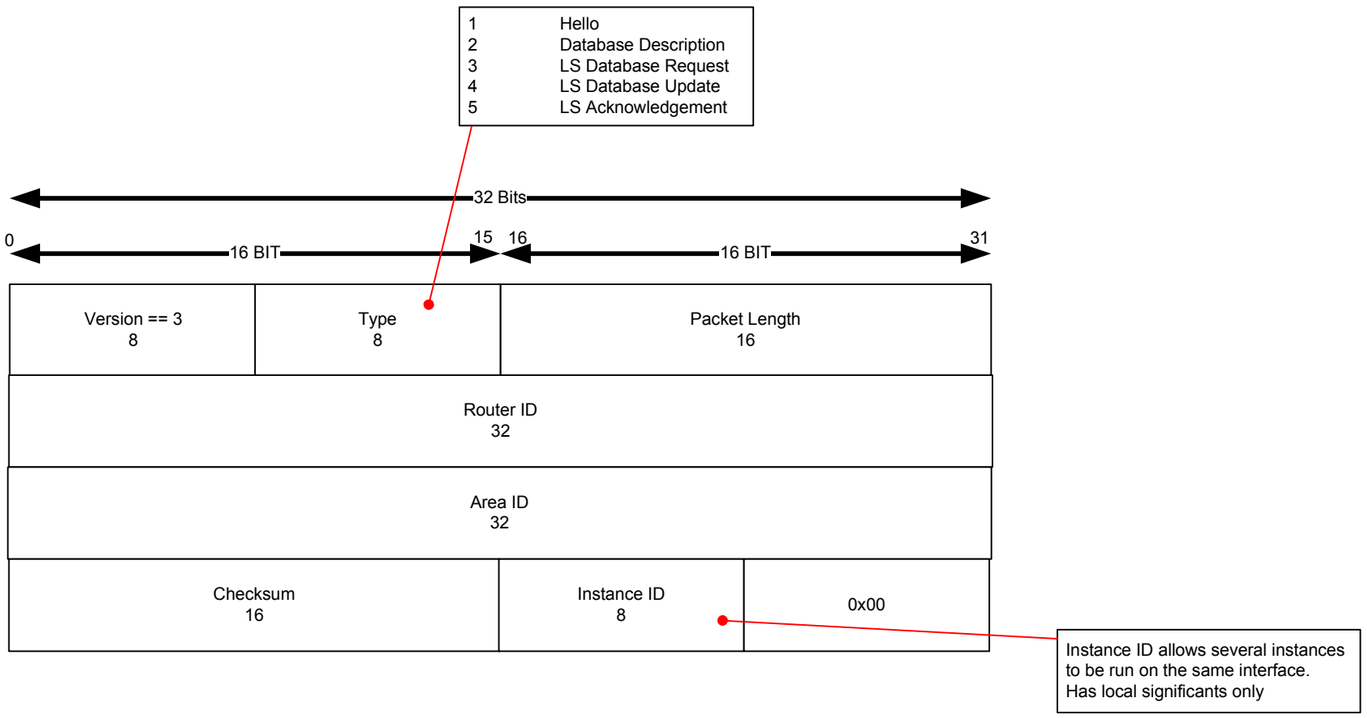
Type Code	Description
1	Router LSA
2	Network LSA
3	Network Summary LSA
4	ASBR Summary LSA
5	AS External LSA
6	Group Membership LSA (Multicast, MOSPF)
7	NSSA External LSA
8	External Attributes LSA
9	Opaque LSA (link-local scope) IPv6
10	Opaque LSA (area-local scope) IPv6
11	Opaque LSA (AS scope) IPv6

Cost of the route, **set by the ASBR**

Can be set by the administrator via route-map

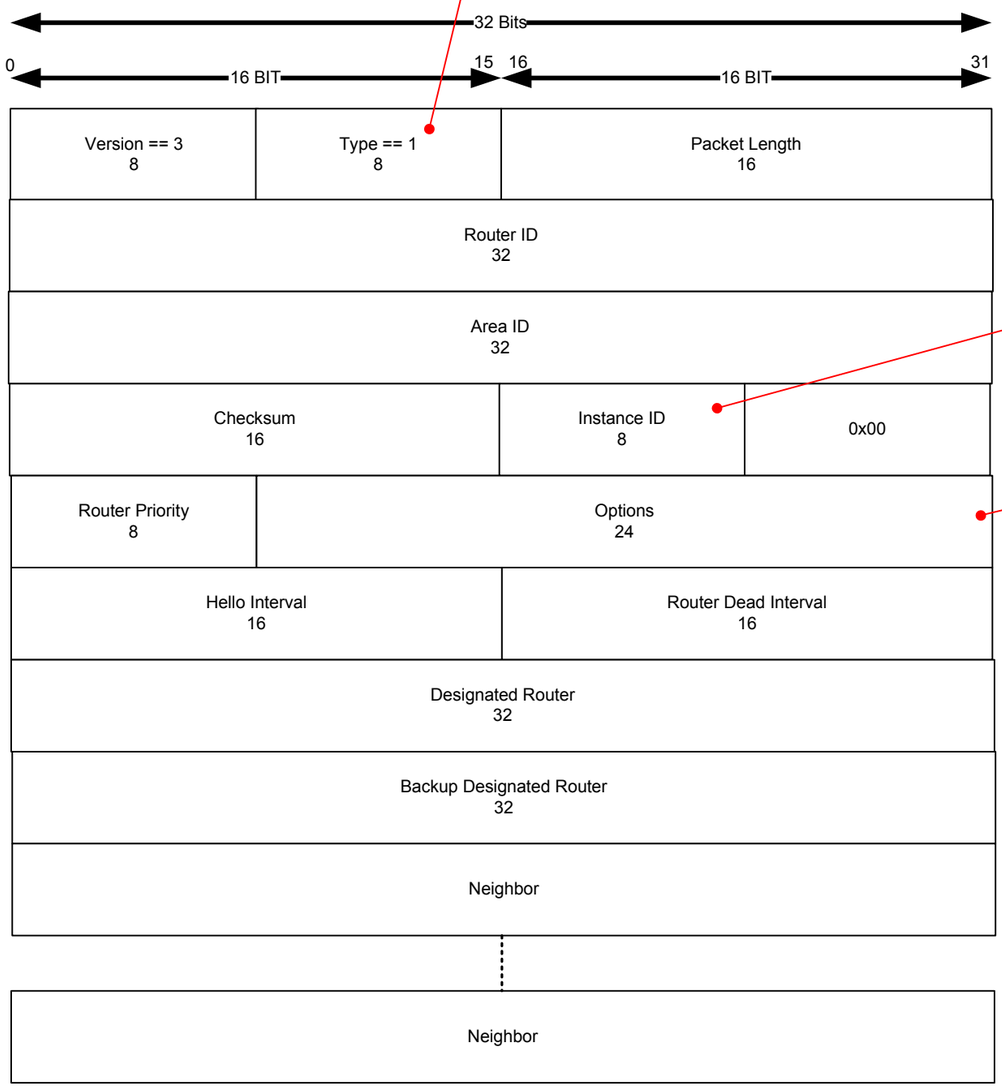


OSPFv3
Packet Header

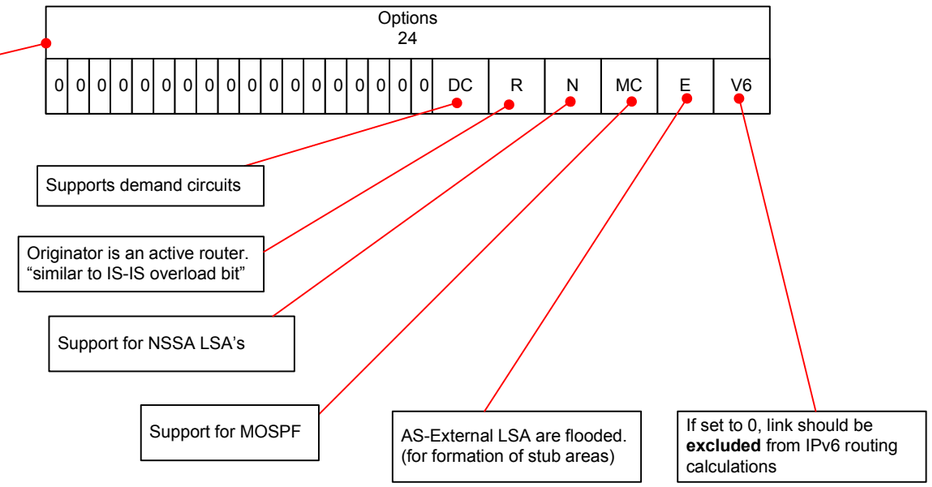


OSPFv3
Hello Packet

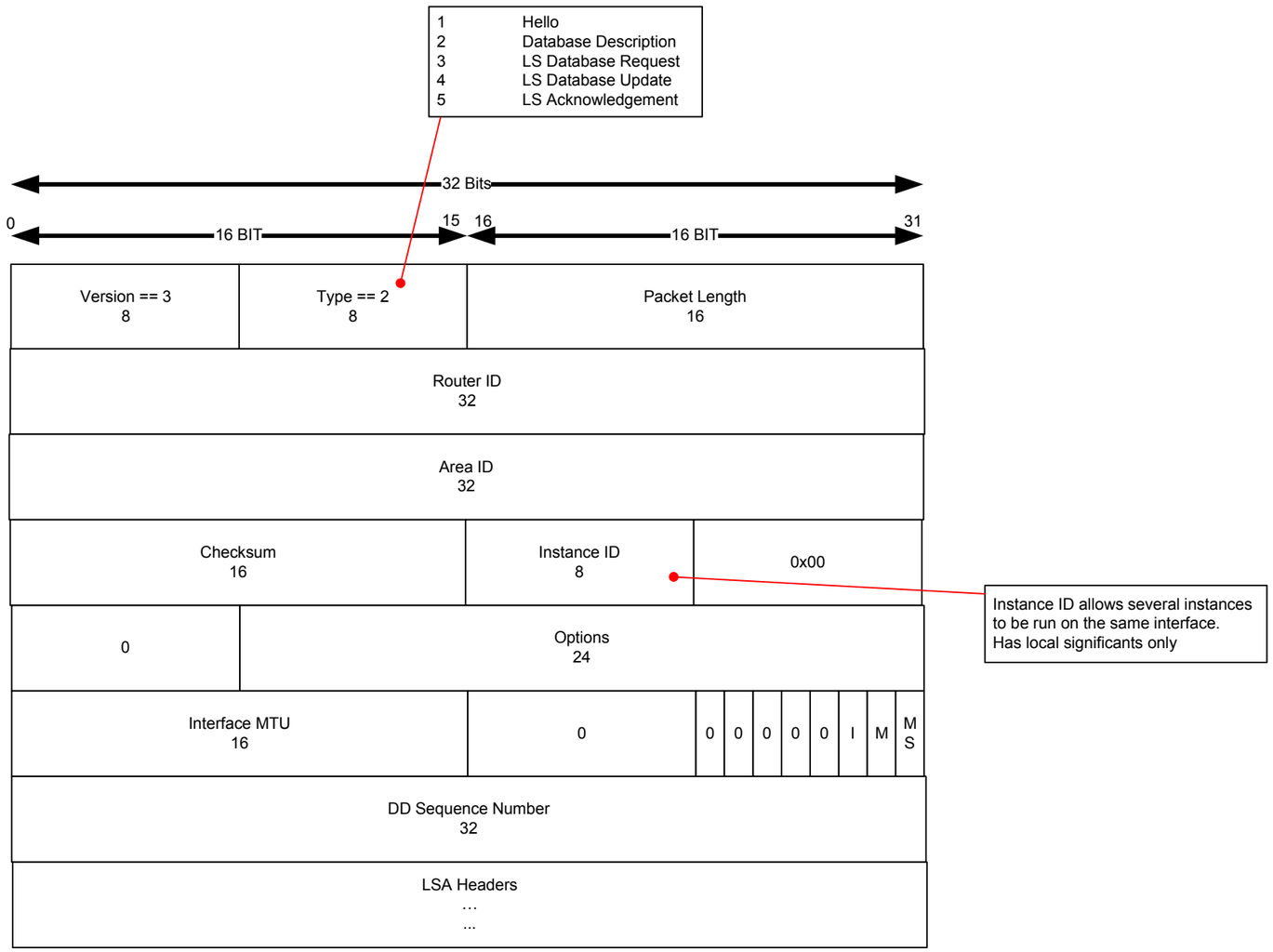
1	Hello
2	Database Description
3	LS Database Request
4	LS Database Update
5	LS Acknowledgement



Instance ID allows several instances to be run on the same interface. Has local significants only



OSPFv3
Database Description Packet



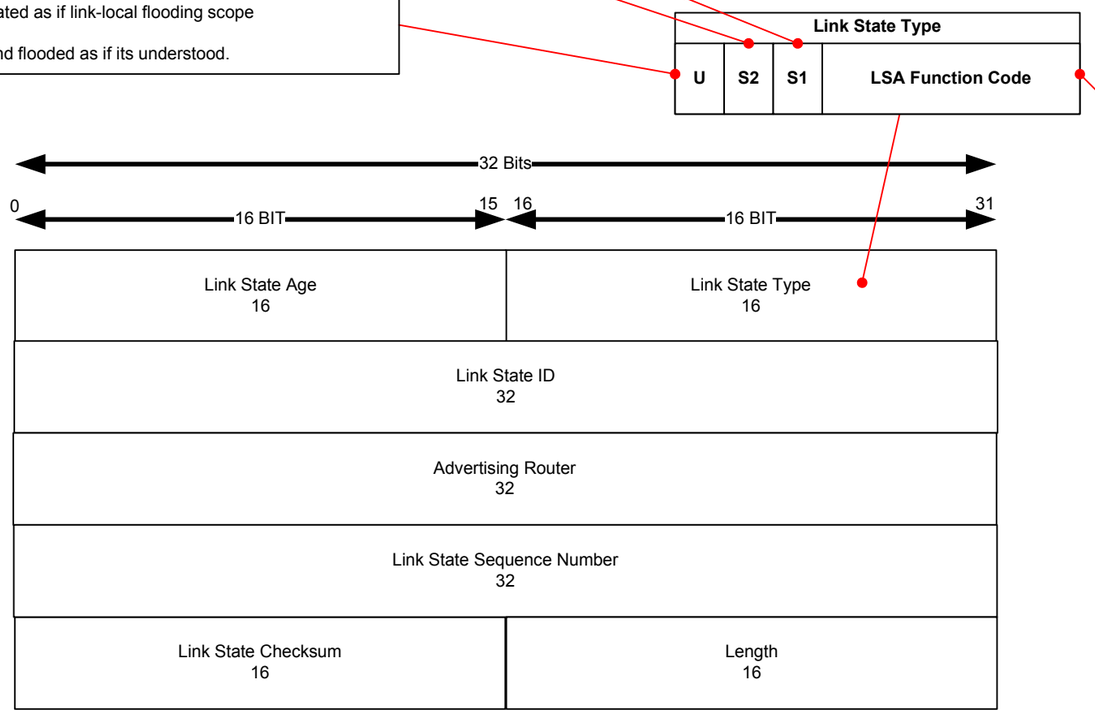
OSPFv3
LSA Header

S2	S1	
0	0	Link Local
0	1	Area
1	0	AS (routing domain)
1	1	Reserved

U-Bit indicates how a route should handle a LSA if it does not recognize the Code.

U-Bit = 0 unknown LSA, to be treated as if link-local flooding scope

U-Bit = 1 unknown LSA, stored and flooded as if its understood.



LS Type	Name
0x2001	Router LSA
0x2002	Network LSA
0x2003	Inter-Area Prefix LSA
0x2004	Inter-Area Router LSA
0x2005	AS-External-LSA
0x2006	Group Membership LSA
0x2007	Type-7 LSA
0x2008	Link LSA
0x2009	Intra-Area Prefix LSA

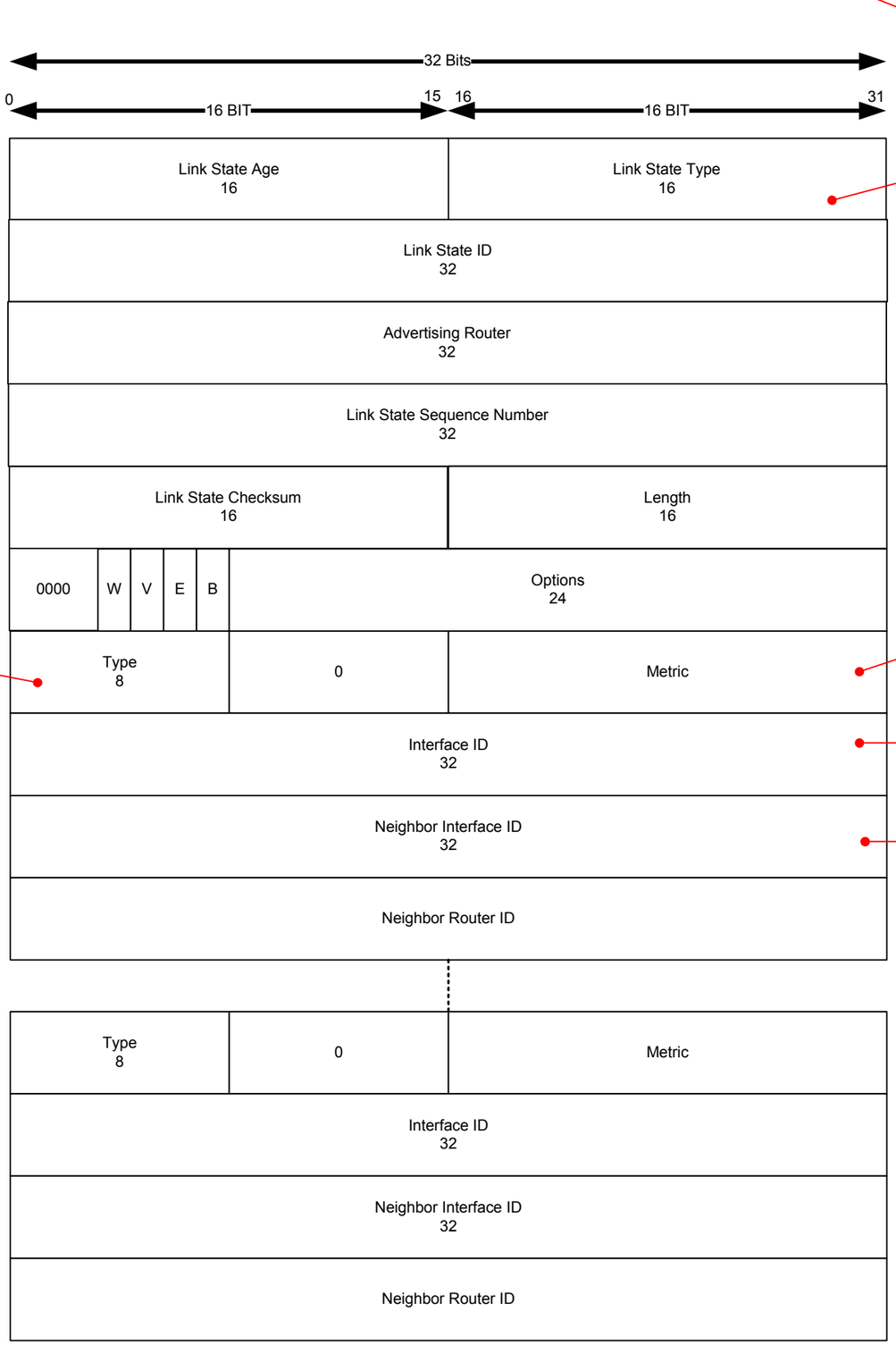
OSPFv3 Router LSA

U-Bit indicates how a route should handle a LSA if it does not recognize the Code.

U-Bit = 0 unknown LSA, to be treated as if link-local flooding scope

U-Bit = 1 unknown LSA, stored and flooded as if its understood.

S2	S1	
0	0	Link Local
0	1	Area
1	0	AS (routing domain)
1	1	Reserved



Link State Type

U	S2	S1	LSA Function Code

LS Type	Name
0x2001	Router LSA
0x2002	Network LSA
0x2003	Inter-Area Prefix LSA
0x2004	Inter-Area Router LSA
0x2005	AS-External-LSA
0x2006	Group Membership LSA
0x2007	Type-7 LSA
0x2008	Link LSA
0x2009	Intra-Area Prefix LSA

Type	Description
1	Point-to-Point
2	Connection to transit network
3	Reserved
4	Virtual Link

Specifiecs the outbound cost of the interface

Value to distinguish from other interfaces on the originating router

Interface ID of their neigbors

Describes the originating router and its links to neighbors.

Prefix information is carried in the intra-area prefix lsa.

OSPFv3 Network LSA

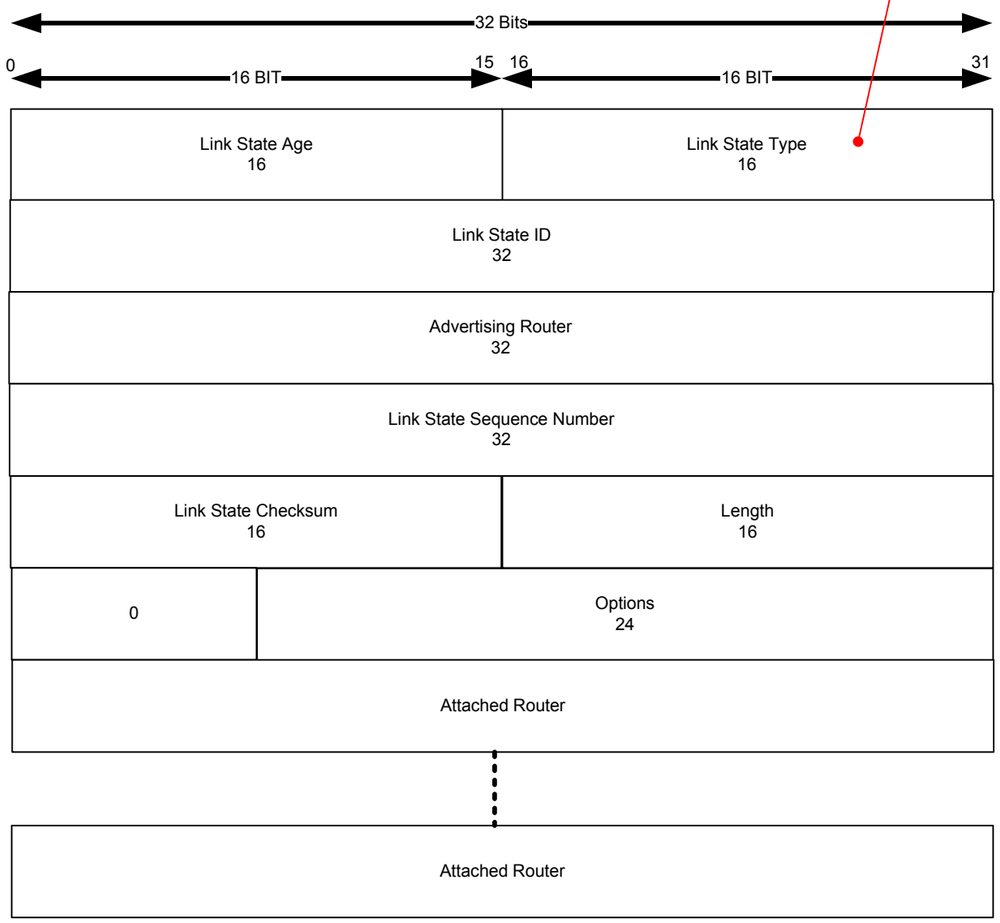
S2	S1	
0	0	Link Local
0	1	Area
1	0	AS (routing domain)
1	1	Reserved

U-Bit indicates how a route should handle a LSA if it does not recognize the Code.

U-Bit = 0 unknown LSA, to be treated as if link-local flooding scope

U-Bit = 1 unknown LSA, stored and flooded as if its understood.

LS Type	Name
0x2001	Router LSA
0x2002	Network LSA
0x2003	Inter-Area Prefix LSA
0x2004	Inter-Area Router LSA
0x2005	AS-External-LSA
0x2006	Group Membership LSA
0x2007	Type-7 LSA
0x2008	Link LSA
0x2009	Intra-Area Prefix LSA



Originated by the DR of the segment

OSPFv3
inter-area prefix LSA

S2	S1	
0	0	Link Local
0	1	Area
1	0	AS (routing domain)
1	1	Reserved

U-Bit indicates how a route should handle a LSA if it does not recognize the Code.

U-Bit = 0 unknown LSA, to be treated as if link-local flooding scope

U-Bit = 1 unknown LSA, stored and flooded as if its understood.

Link State Type			
U	S2	S1	LSA Function Code

LS Type	Name
0x2001	Router LSA
0x2002	Network LSA
0x2003	Inter-Area Prefix LSA
0x2004	Inter-Area Router LSA
0x2005	AS-External-LSA
0x2006	Group Membership LSA
0x2007	Type-7 LSA
0x2008	Link LSA
0x2009	Intra-Area Prefix LSA

32 Bits

0 — 16 BIT — 15 16 — 16 BIT — 31

Link State Age 16	Link State Type 16
Link State ID 32	
Advertising Router 32	
Link State Sequence Number 32	
Link State Checksum 16	Length 16
0	Metric 24
Prefix Length 8	Prefix Options 8	0
Address Prefix	

ABR originates a separate inter-area prefix lsa for each IPv6 prefix that must be advertised into an area

An ABR can also originate an Inter-Area default route into a stub area.

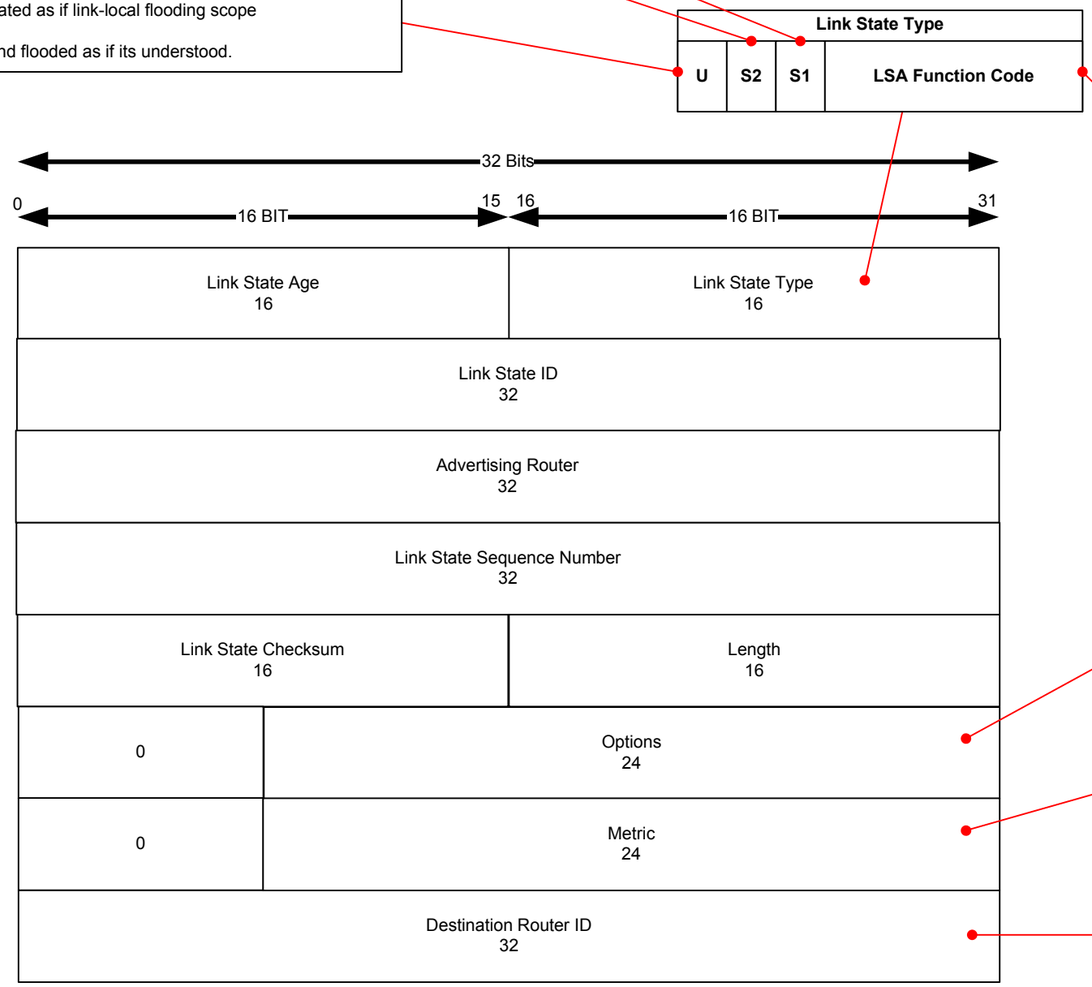
OSPFv3
Inter-area router LSA

S2	S1	
0	0	Link Local
0	1	Area
1	0	AS (routing domain)
1	1	Reserved

U-Bit indicates how a route should handle a LSA if it does not recognize the Code.

U-Bit = 0 unknown LSA, to be treated as if link-local flooding scope

U-Bit = 1 unknown LSA, stored and flooded as if its understood.



LS Type	Name
0x2001	Router LSA
0x2002	Network LSA
0x2003	Inter-Area Prefix LSA
0x2004	Inter-Area Router LSA
0x2005	AS-External-LSA
0x2006	Group Membership LSA
0x2007	Type-7 LSA
0x2008	Link LSA
0x2009	Intra-Area Prefix LSA

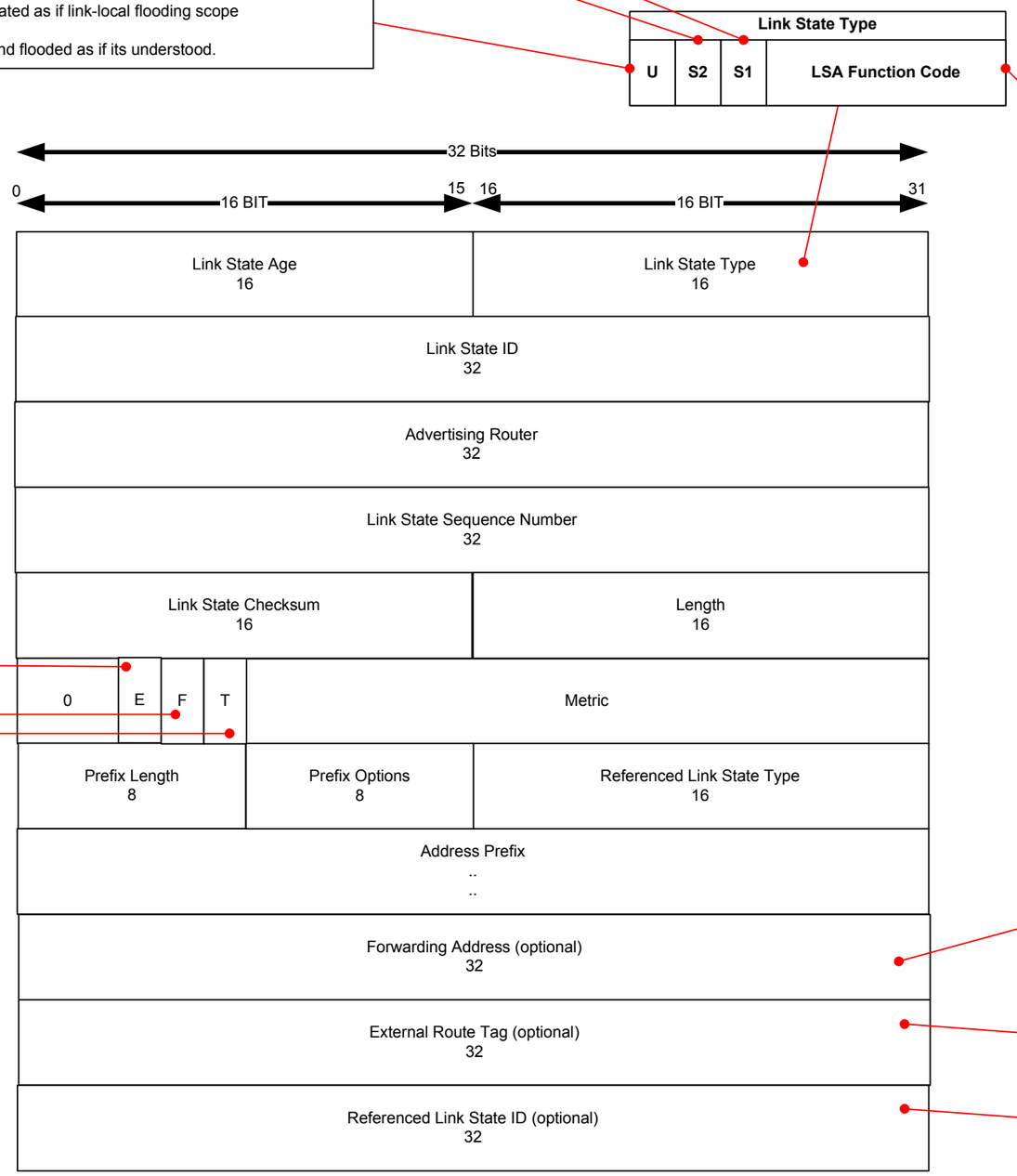
OSPFv3
AS External LSA

S2	S1	
0	0	Link Local
0	1	Area
1	0	AS (routing domain)
1	1	Reserved

U-Bit indicates how a route should handle a LSA if it does not recognize the Code.

U-Bit = 0 unknown LSA, to be treated as if link-local flooding scope

U-Bit = 1 unknown LSA, stored and flooded as if its understood.



LS Type	Name
0x2001	Router LSA
0x2002	Network LSA
0x2003	Inter-Area Prefix LSA
0x2004	Inter-Area Router LSA
0x2005	AS-External-LSA
0x2006	Group Membership LSA
0x2007	Type-7 LSA
0x2008	Link LSA
0x2009	Intra-Area Prefix LSA

E-flag = 1 metric type 2
E-flag = 0 metric type 1

F-flag = 1 forwarding address inluded in LSA

T-flag = 1 external route tag included in the LSA

Next-hop address if F-flag is = 1

External route tag set to value by admin. Value present if the T-flag is = 1

Allows the prefix to be included in another LSA

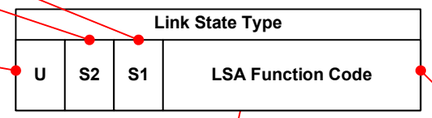
OSPFv3 Link LSA

S2	S1	
0	0	Link Local
0	1	Area
1	0	AS (routing domain)
1	1	Reserved

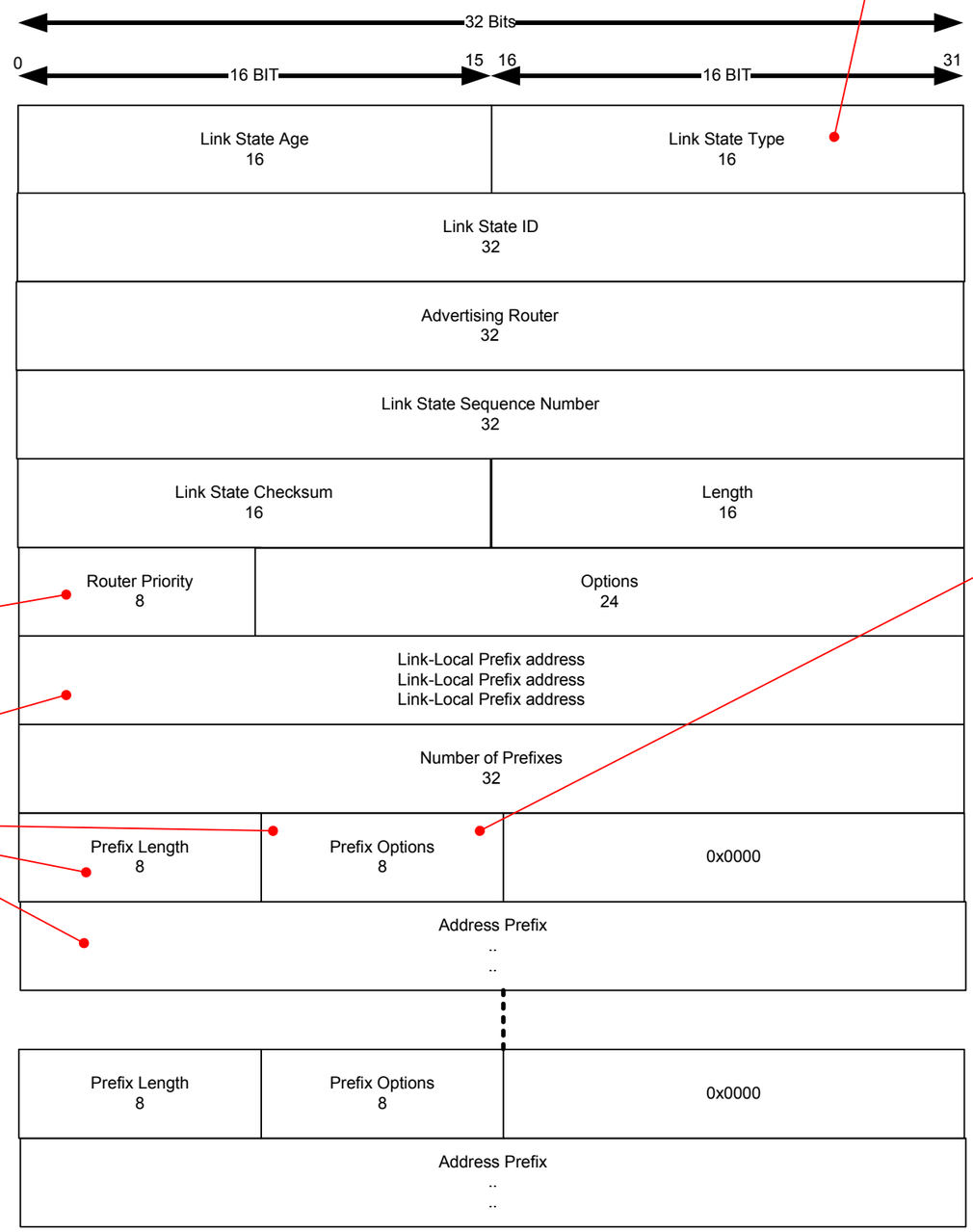
U-Bit indicates how a route should handle a LSA if it does not recognize the Code.

U-Bit = 0 unknown LSA, to be treated as if link-local flooding scope

U-Bit = 1 unknown LSA, stored and flooded as if its understood.



LS Type	Name
0x2001	Router LSA
0x2002	Network LSA
0x2003	Inter-Area Prefix LSA
0x2004	Inter-Area Router LSA
0x2005	AS-External-LSA
0x2006	Group Membership LSA
0x2007	Type-7 LSA
0x2008	Link LSA
0x2009	Intra-Area Prefix LSA

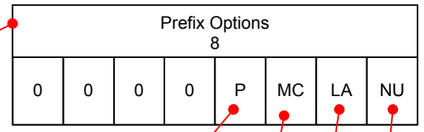


Router priority of originating router

128-bit link local address attached to this link

Combination fields describes a prefix

Provides originating router's link-local address to all other routers attached to the link



P-Bit propagate-bit = 1
Set on NSSA area prefixes that should be re-advertised at the NSSA area border

MC-bit multicast-bit = 1
Prefix should be included in multicast routing calculations

LA-bit local address bit = 1
Specifies that the prefix is an interface address of the advertising router

NU-bit No Unicast bit = 1
Prefix should be excluded from the unicast route calculations

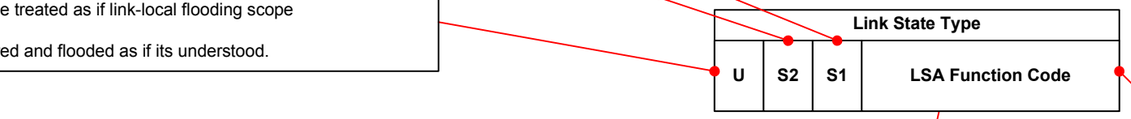
OSPFv3
Intra-area prefix LSA

S2	S1	
0	0	Link Local
0	1	Area
1	0	AS (routing domain)
1	1	Reserved

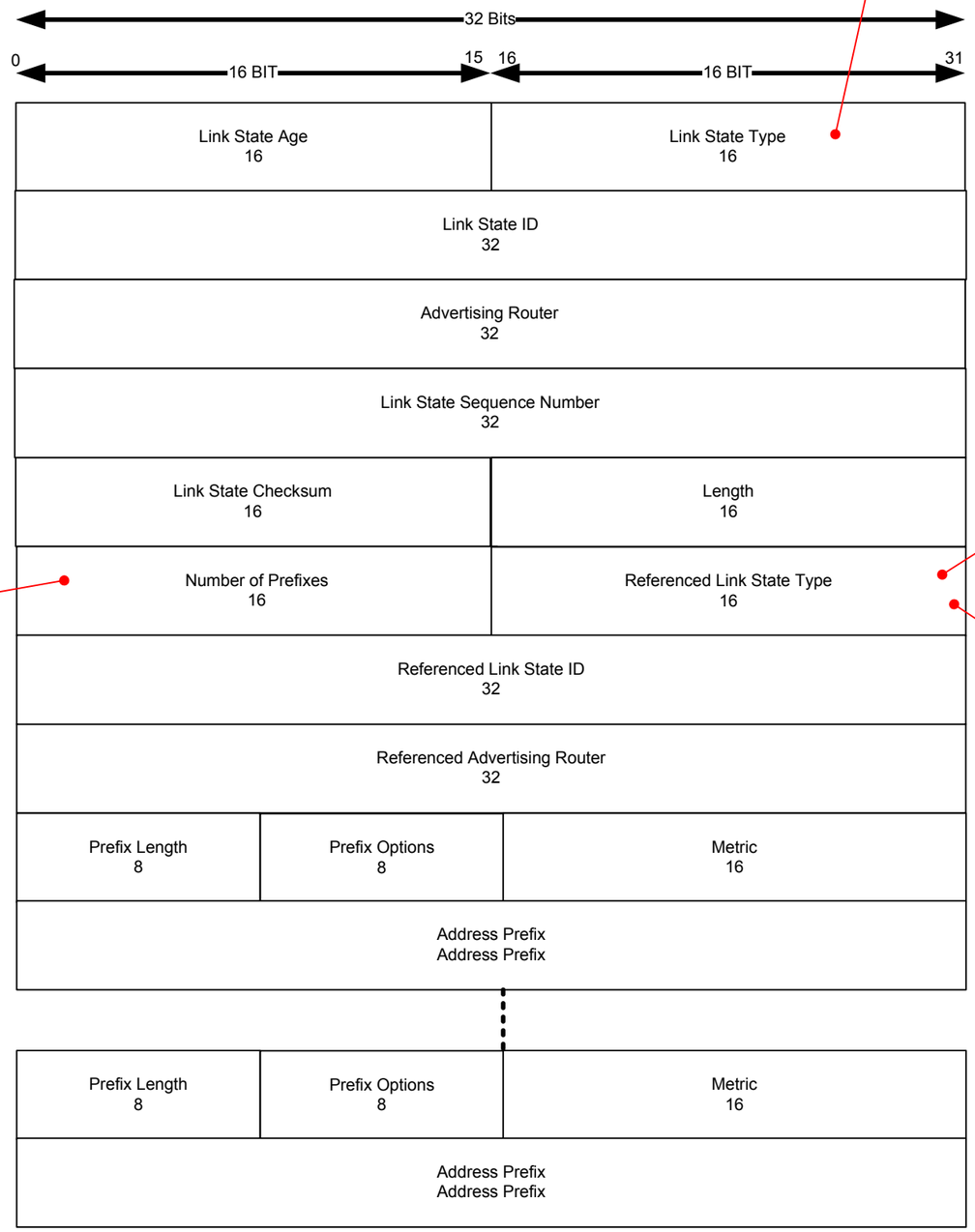
U-Bit indicates how a route should handle a LSA if it does not recognize the Code.

U-Bit = 0 unknown LSA, to be treated as if link-local flooding scope

U-Bit = 1 unknown LSA, stored and flooded as if its understood.



LS Type	Name
0x2001	Router LSA
0x2002	Network LSA
0x2003	Inter-Area Prefix LSA
0x2004	Inter-Area Router LSA
0x2005	AS-External-LSA
0x2006	Group Membership LSA
0x2007	Type-7 LSA
0x2008	Link LSA
0x2009	Intra-Area Prefix LSA



Specifies number of prefixes in the LSA

Referenced Link State Type = 1,
Then Referenced Link State ID is = 0
And the referenced advertising router is RID of the originating router.

If prefixes should be associated with a network LSA then:
Reference Link State Type = 2

Referenced Link State ID is interface ID of the links DR and advertising router is the RID of the DR