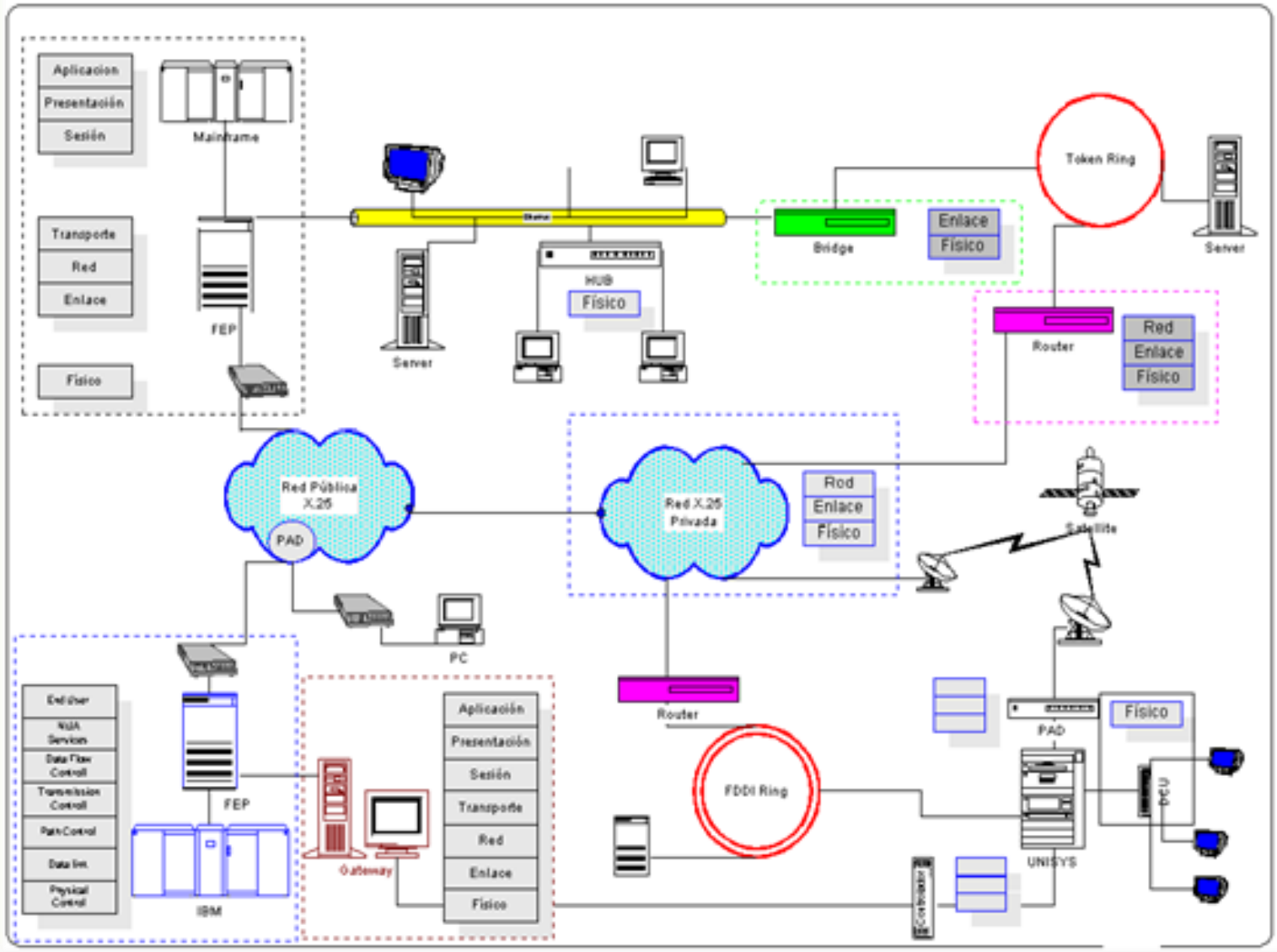
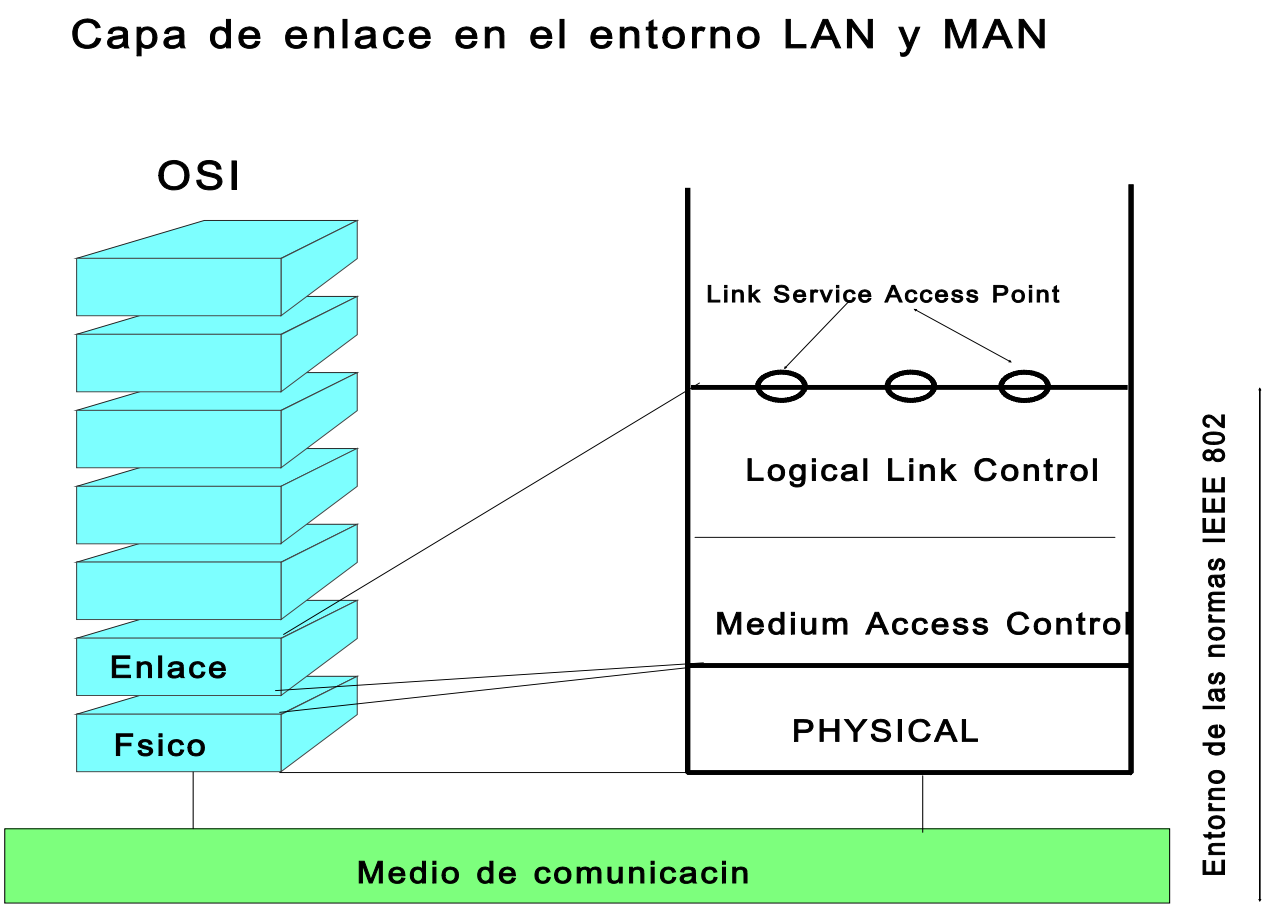
MODELO OSI , REDES y EQUIPOS DE COMUNICACIÓN

ENTORNO DE REDES Y EL MODELO OSI



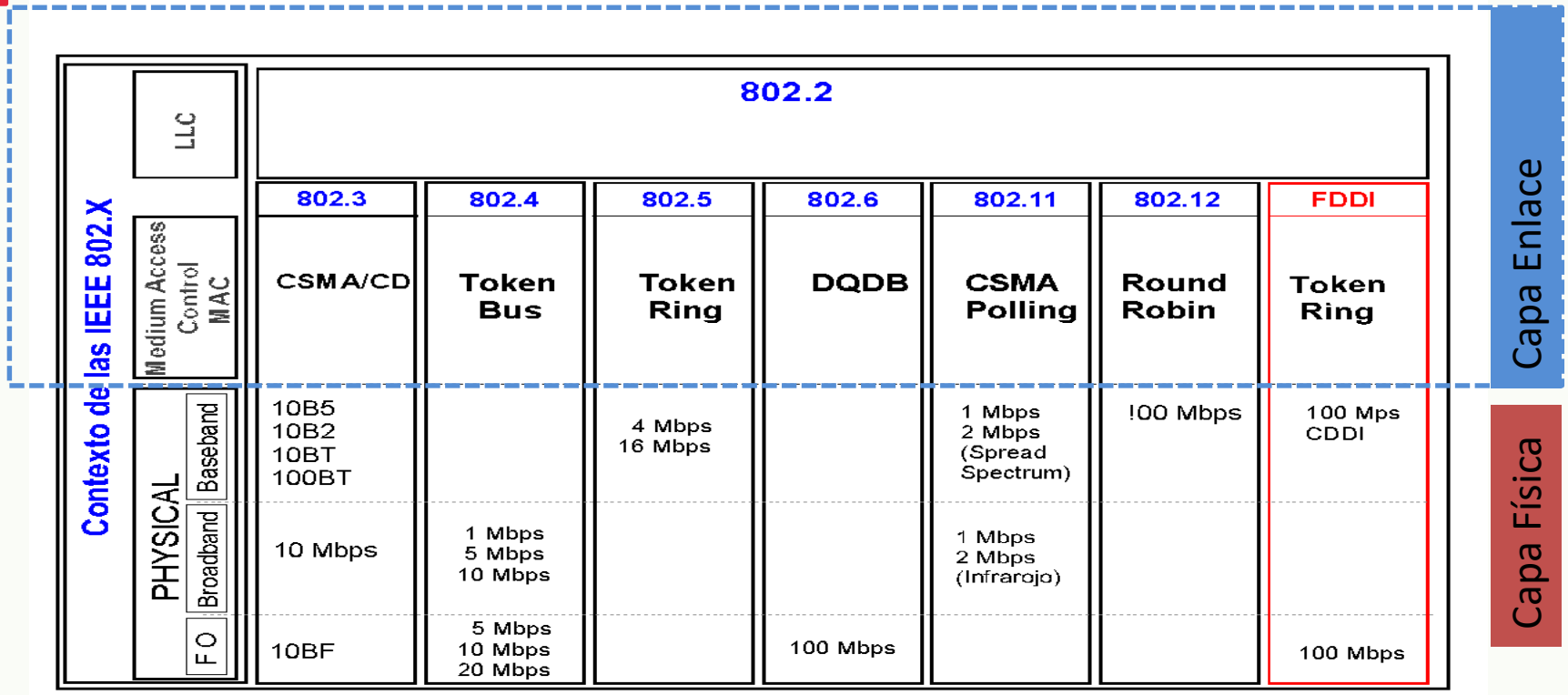
Protocolos de entorno LAN



Costó mucho estandarizar las redes LAN, cuando se logró se siguió dividiendo la fisica y de de enlace de datos subcapas, esta última en una lógica común a todas las redes y una parte específica para cada una de ellas según el protocolo de acceso al medio (cómo cada estacion accede al medio)

Fig lan01

CAPA DE ENLACE EN REDES LAN según IEEE.



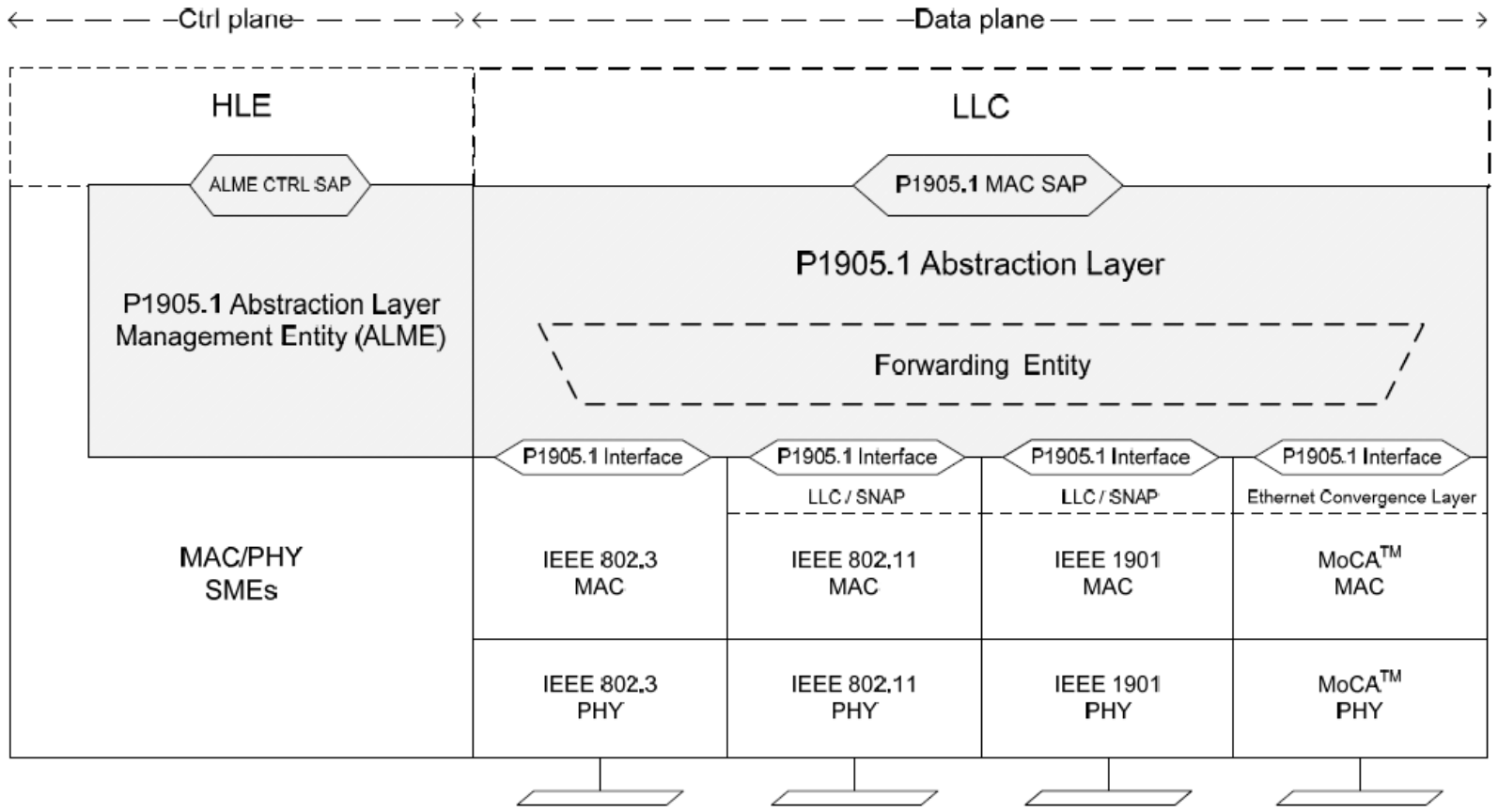
802.2

This is the interface between the network layer and the specific network environments at the physical layer. The IEEE has divided the data link layer in the OSI model into two sub layers – the media access MAC sub layer, and the logical link layer LLC. The logical link control protocol is common for all IEEE 802 standard network types. This provides a common interface to the network layer of the protocol stack. The protocol used at this sub layer is based on IBM's SDLC protocol, and can be used in three modes, or types.
These are:

- Type 1: Unacknowledged connectionless link service
- Type 2: Connection oriented link service
- Type 3: Acknowledged connectionless link service, used in real time applications such as manufacturing control

P1905.1 Abstraction Layer Model

Este es un proyecto para como juntar esas diferentes redes en un solo tipo de red pero quedó ahí



HLE = Higher Layer Entity
SME = Station Management Entity

IEEE 802 Organization

EXECUTIVE COMMITTEE (EC)

CHAIR
Paul Nikolich

Working Group/TAG Chairs

802.1 BRIDGING/ARCH Tony Jeffree	802.3 Ethernet David Law	802.11 WLAN Bruce Kraemer
802.15 WPAN Bob Heile	802.16 BWA Roger Marks	802.18 TAG Radio Regulatory Mike Lynch
802.19 Coexistence Steve Shellhammer	802.21 Media indep. handover Subir Das	802.22 WRAN Apurva Mody

Hibernating WG Chairs
(non voting)

- 802.17 Resilent Packet Ring John Lemon
- 802.20 MBWA Mark Klerer

Appointed Officers

1st VICE CHAIR Pat Thaler	2nd VICE CHAIR Mat Sherman
EXECUTIVE SECY Jon Rosdahl	RECORDING SECY James Gilb
TREASURER Bob Grow	

Appointed Officers
(non voting)

MEETING MGR MEMBER EMERITUS Buzz Rigsbee	MEMBER EMERITUS Geoff Thompson

DISBANDED

802.2 LLC	802.4 Token Bus	ECSG TV Whitespace
802.5 Token Ring	802.6 DQDB	ECSG Emergency Services
802.7 Broadband TAG	802.8 Fiber Optic TAG	802.23 Emergency Services
802.9 ISLAN	802.10 Security	
802.12 Demand Priority	802.14 CATV	

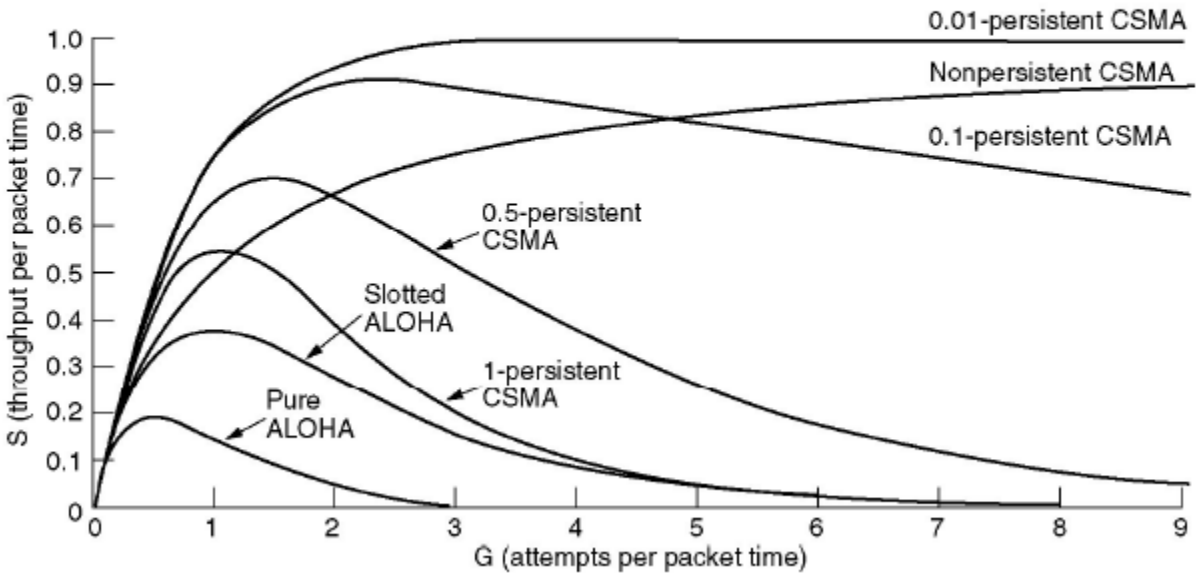
Los comienzo de Ethernet : RED ALOHA

Abramson Norman (1970), Universidad de Hawai :
ALOHANET una red por contienda (fr)

Teoria de colas : Proceso de Poisson ; caso especial de MARKOV(sin memoria)

$$S = N\,p\,(1-p)^{(N-1)}$$ *N cantidad de nodos*

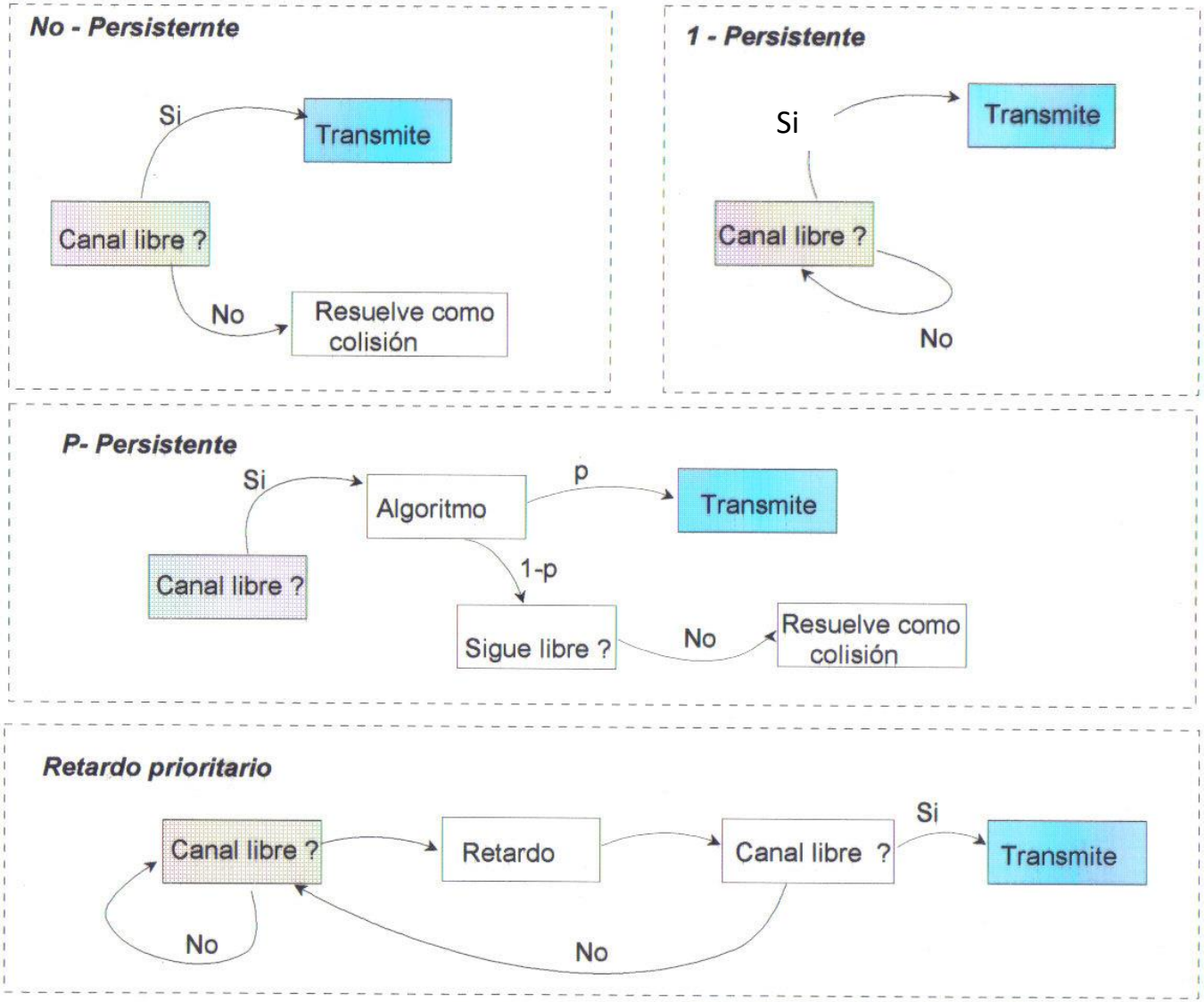
Persistent and Nonpersistent CSMA



- *$S = G\, e^{-2G}$, where S is the throughput (rate of successful transmissions) and G is the offered load.*
- *$S = S_{max} = 1/2e = 0.184$ for G=0.5.*

Protocolo de contienda

TECNICAS DE ACCESO ALEATORIO CON DETECCION DE CARRIER



Ethernet : Configuración básica (1983)

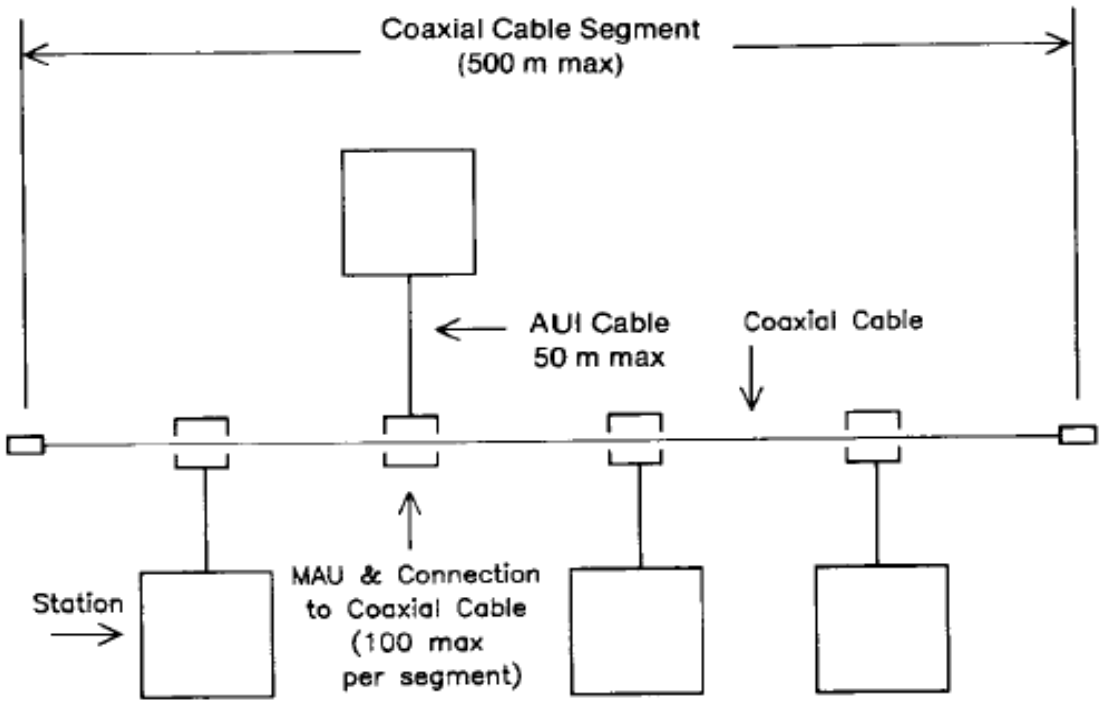
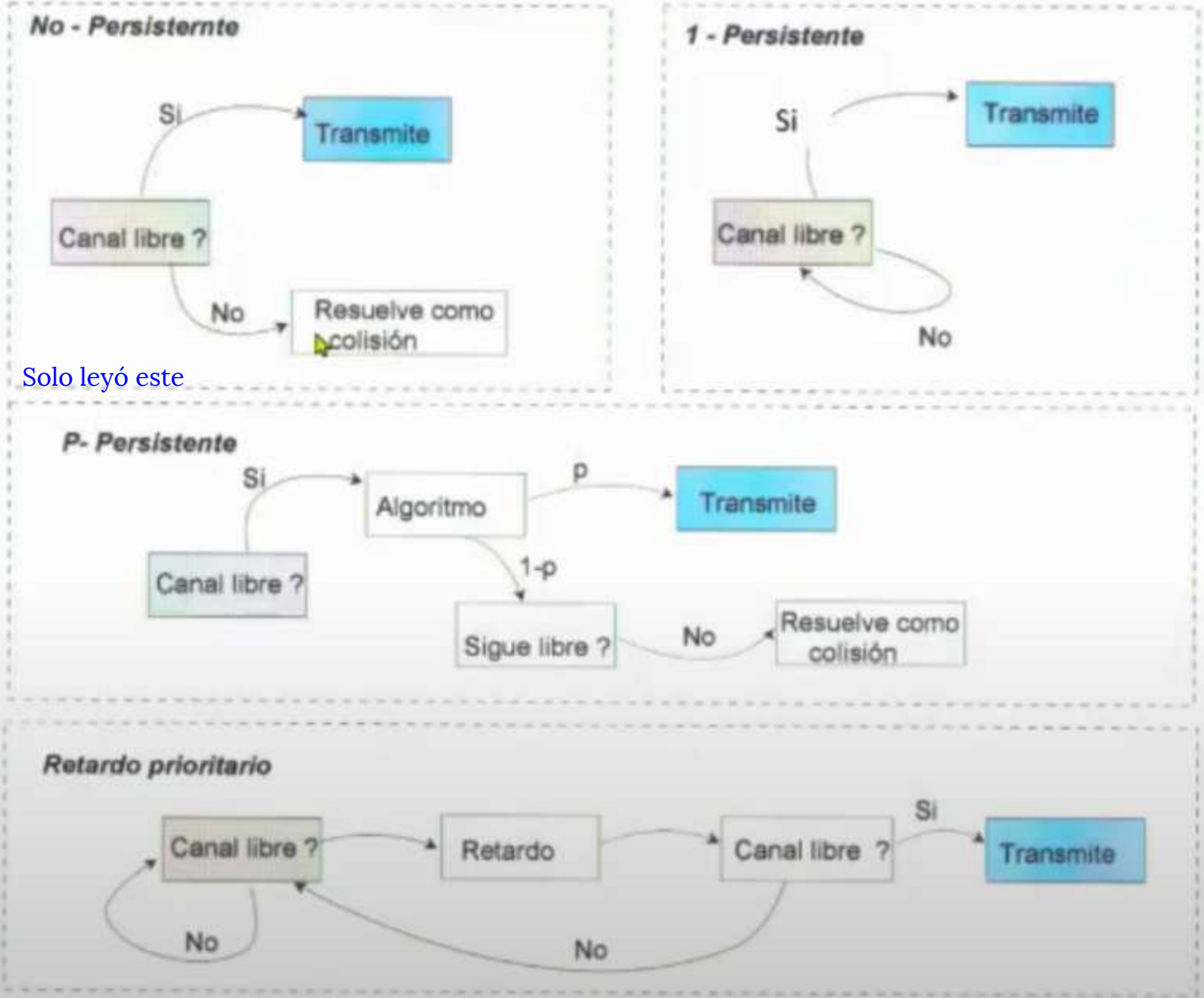


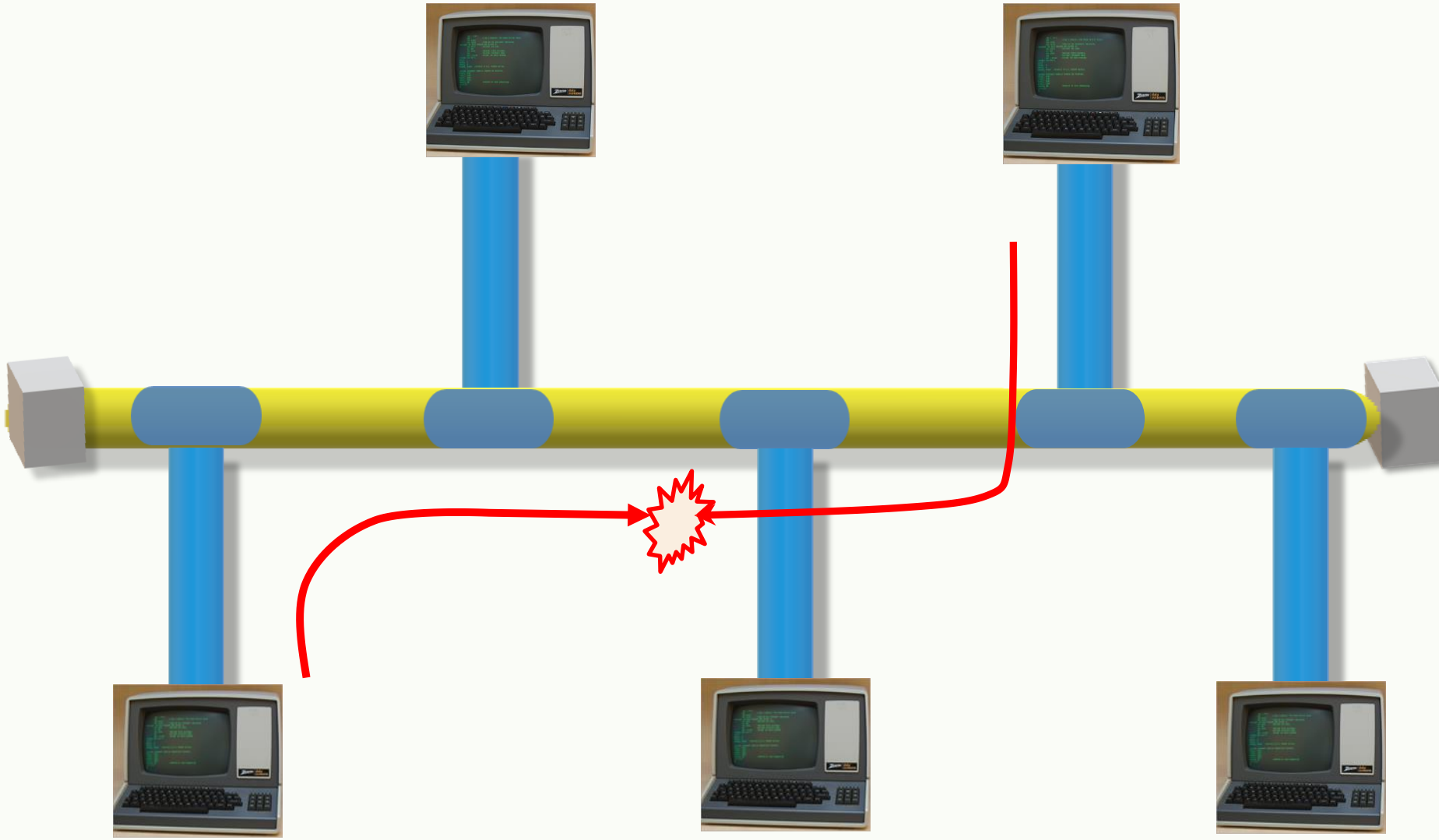
Fig 8-11
Minimal System Configuration

TECNICAS DE ACCESO ALEATORIO CON DETECCION DE CARRIER

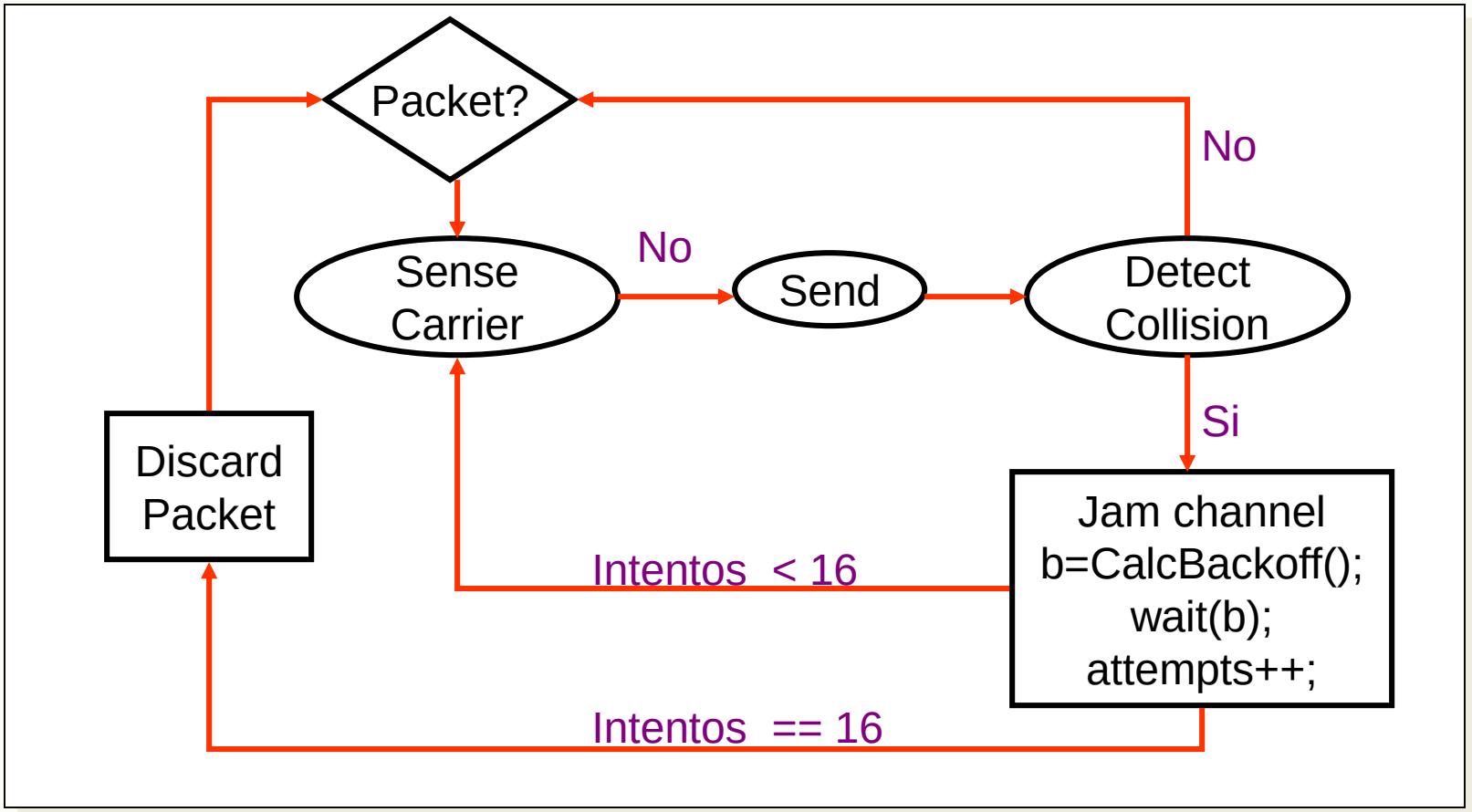


Solo leyó este

Ethernet : Configuración básica (1983)



Carrier Sense Multiple Access/Collision Detection



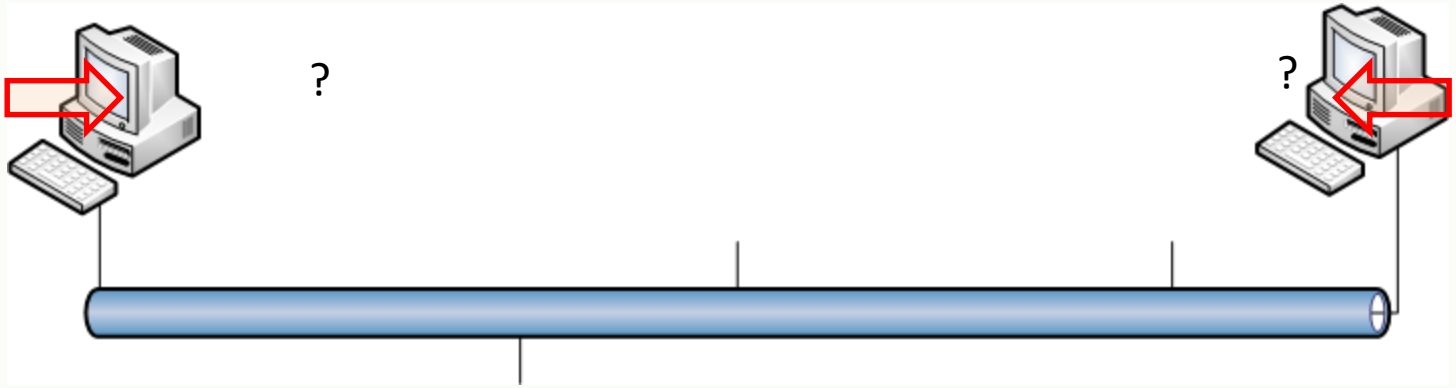
Ethernet Backoff Calculation

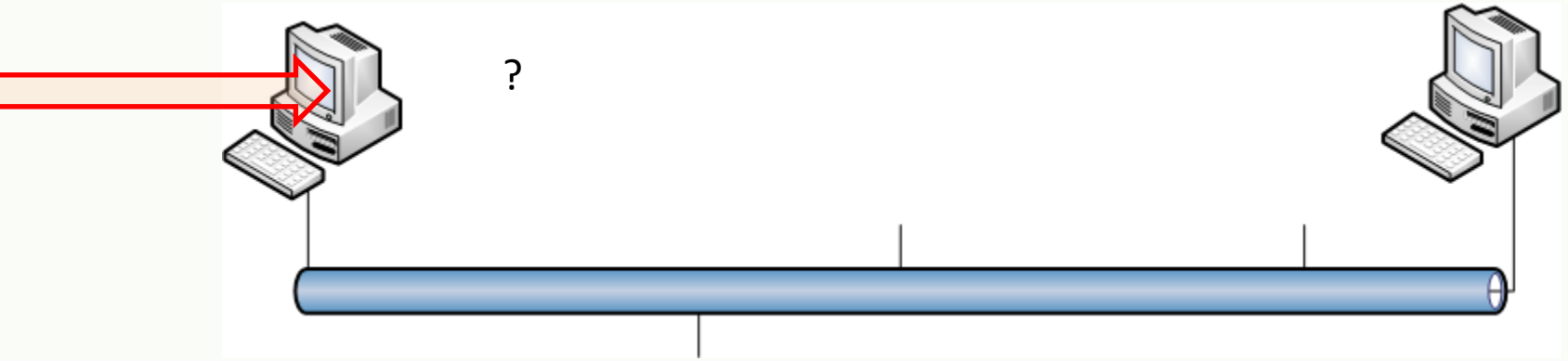
- *Exponentially increasing random delay*
  - *Infer senders from # of collisions*
  - *More senders → increase wait time*
- *First collision: choose K from {0,1}; delay is K x 512 bit transmission times*
- *After second collision: choose K from {0,1,2,3}…*
- *After ten or more collisions, choose K from {0,1,2,3,4,…,1023}*

Sniffer Truncated Binary Exponential Backoff

Retry	Random Time Range	Retry	Random Time Range
1	2^1 = 0....2 x 51.2 µsec	9	29 = 0...512 x 51.2 µsec
2	2^2 = 0....4 x 51.2 µsec	10	210 = 0....1024 x 51.2 µsec
3	2^3 = 0....8 x 51.2 µsec	11	210 = 0....1024 x 51.2 µsec
4	2^4 = 0....16 x 51.2 µsec	12	210 = 0....1024 x 51.2 µsec
5	2^5 = 0....32 x 51.2 µsec	13	210 = 0....1024 x 51.2 µsec
6	2^6 = 0....64 x 51.2 µsec	14	210 = 0....1024 x 51.2 µsec
7	2^7 = 0....128 x 51.2 µsec	15	210 = 0....1024 x 51.2 µsec
8	2^8 = 0...256 x 51.2 µsec	16	210 = 0....1024 x 51.2 µsec

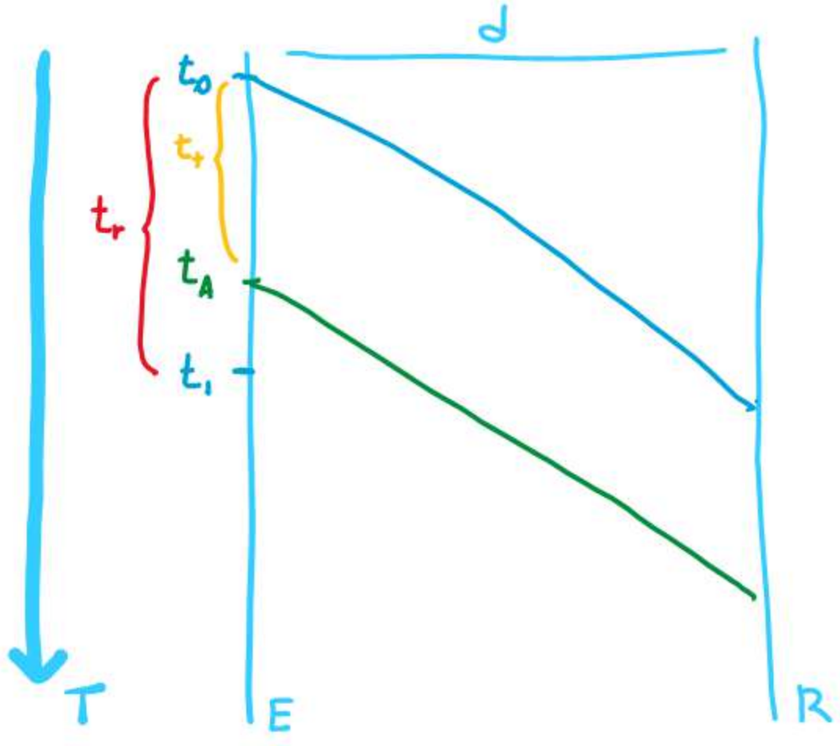
El porque de la distancia en 10B5





Long del cable < long de la trama! ¿A que es igual?

¿Cómo determino el largo de la trama en ethernet?



$$t_r = \frac{d}{V_p} = t_1 - t_0$$

$$t_t = \frac{l}{V_p}$$

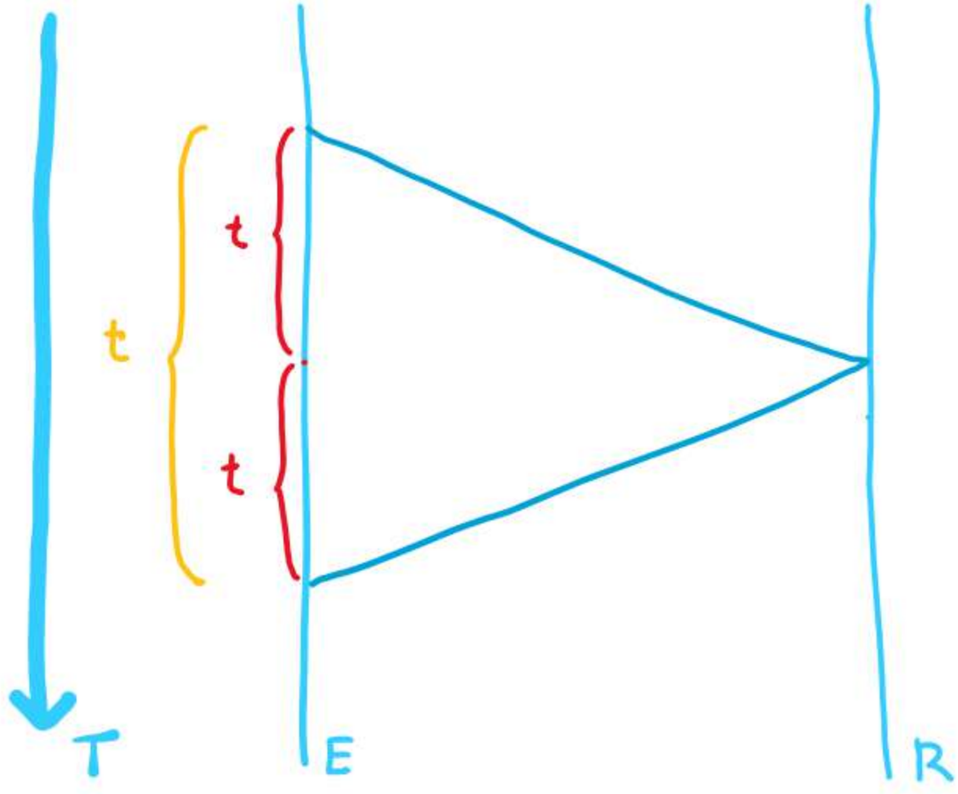
Tr: tiempo en el que el 1er bit de la trama llega al receptor

Tt: tiempo entre que el emisor transmite la primer trama y la última

Vp: velocidad de propagación

l: longitud de la trama en bits

Lo que buscamos



Ethernet : Configuración extendida (1983)

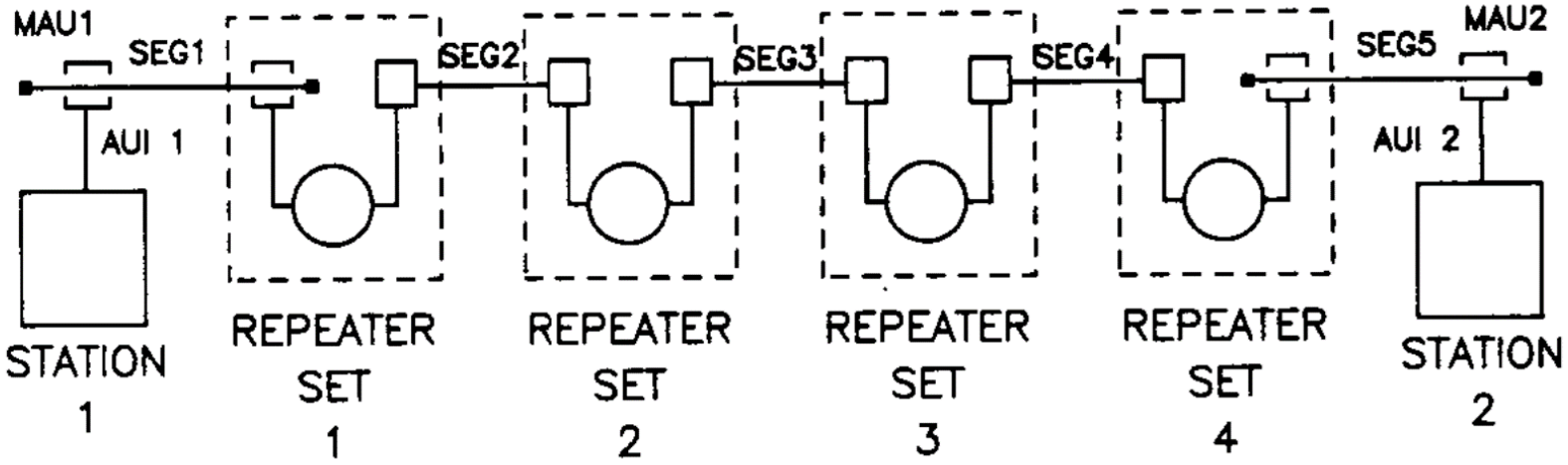


Fig 8-10
Maximum Transmission Path

Cual es la mínima trama que debe tener Ethernet ?

Fig 8-10
Maximum Transmission Path

τp

Cual es la mínima trama que debe tener Ethernet ?

- Cada nodo transmisor debe detectar si su trama ha colisionado antes de dejar de transmitir .

- 2 * retardo de propagación
  - Maxima configuración : 2500 m (500m cada segmento)
  - 4 repetidores.
  - C = $3*10^8$ m/s.
  - Velocidad de Propagación : $2*10^8$ m/s.
  - Retardo :
    - 25 μs (del cable)
    - 25 μs en los repetidores, retardo total $\approx$ 51.2 μs

  ➢ Cuanto debe tener la longitud de la trama en bits (byte)?

La trama de Ethernet y 802.3

Parameters	MAC data rate			
	Up to and including 100 Mb/s	**1 Gb/s**	**2.5 Gb/s, 5 Gb/s, 25 Gb/s, 40 Gb/s, 100 Gb/s, 200 Gb/s, and 400 Gb/s**	**10 Gb/s**
slotTime	512 bit times	4096 bit times	not applicable	not applicable
interPacketGap[a]	96 bits	96 bits	96 bits	96 bits
attemptLimit	16	16	not applicable	not applicable
backoffLimit	10	10	not applicable	not applicable
jamSize	32 bits	32 bits	not applicable	not applicable
maxBasicFrameSize	1518 octets	1518 octets	1518 octets	1518 octets
maxEnvelopeFrameSize	2000 octets	2000 octets	2000 octets	2000 octets
minFrameSize	512 bits (64 octets)	512 bits (64 octets)	512 bits (64 octets)	512 bits (64 octets)
burstLimit	not applicable	65 536 bits	not applicable	not applicable
ipgStretchRatio	not applicable	not applicable	not applicable	104 bits

[a]References to interFrameGap or interFrameSpacing in other clauses (e.g., Clause 13, Clause 35, and Clause 42) shall be interpreted as interPacketGap.

La trama de Ethernet y 802.3

4.2.3.2.2 Interpacket gap

As defined in 4.2.3.2.1, the rules for deferring to passing packets ensure a minimum interpacket spacing of interPacketGap bit times. This is intended to provide interpacket recovery time for other CSMA/CD sublayers and for the physical medium.

Note that interPacketGap is the minimum value of the interpacket gap. If necessary for implementation reasons, a transmitting sublayer may use a larger value with a resulting decrease in its throughput. The larger value is determined by the parameters of the implementation, see 4.4.

A larger value for interpacket gap is used for dynamically adapting the nominal data rate of the MAC sublayer to SONET/SDH data rates (with packet granularity) for WAN-compatible applications of this standard. While in this optional mode of operation, the MAC sublayer counts the number of bits sent during a frame's transmission. After the packet's transmission has been completed, the MAC sublayer extends the minimum interpacket gap by a number of bits that is proportional to the length of the previously transmitted packet. For more details, see 4.2.7 and 4.2.8.

La trama de Ethernet y 802.3

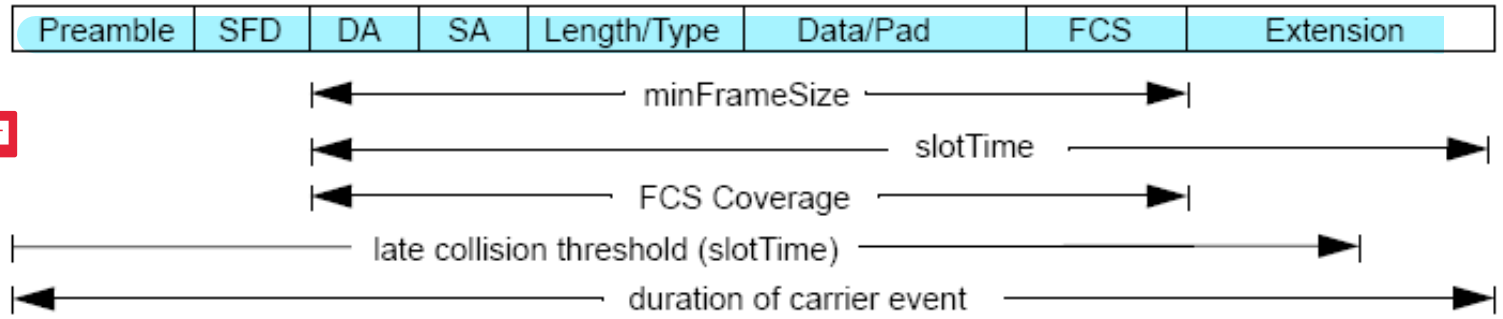


Figure 4–5—Frame with carrier extension

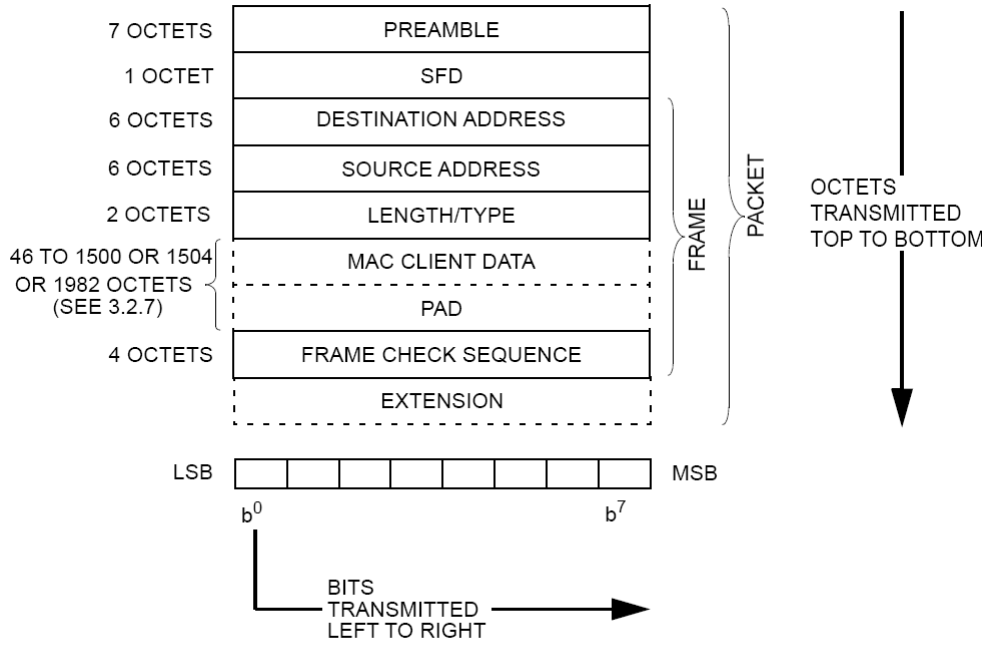
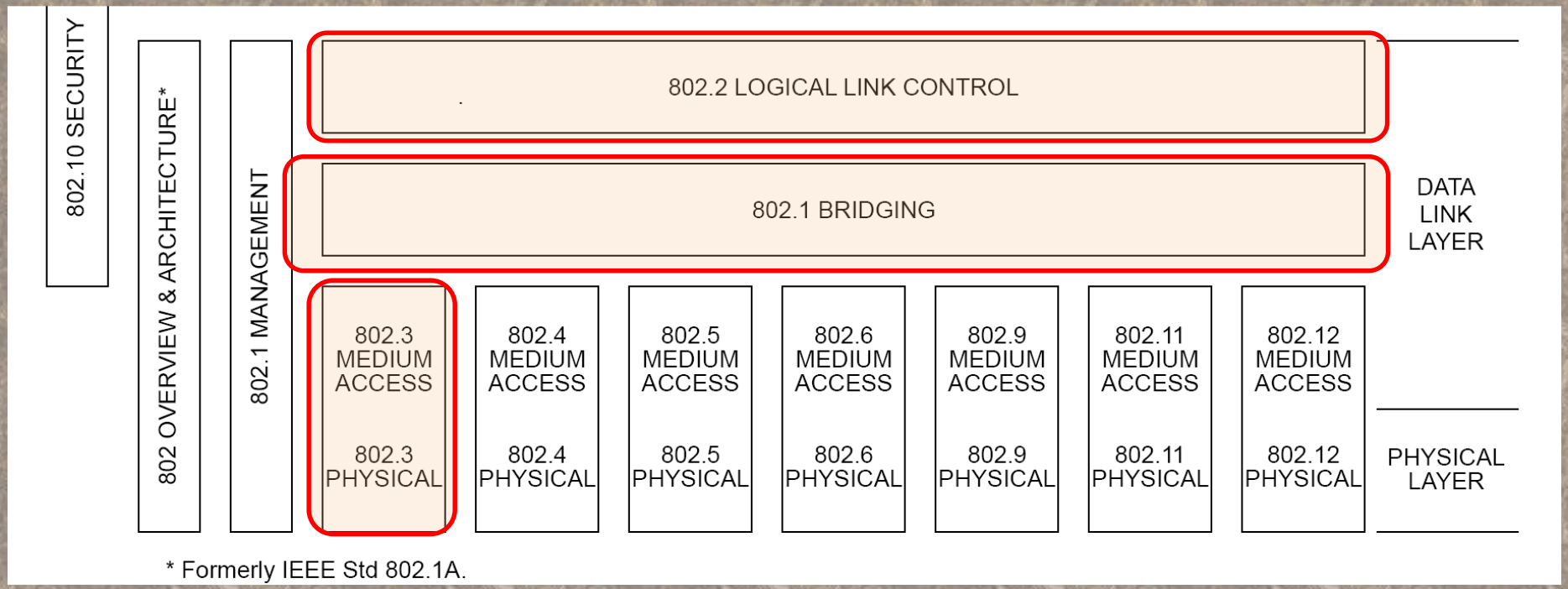
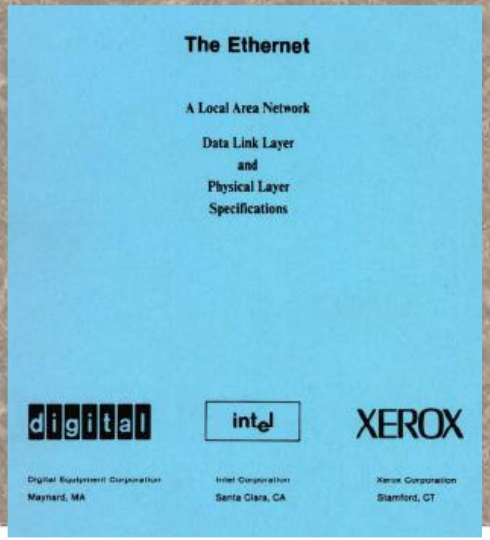


Figure 3–1—Packet format

Los standard del IEEE en 802



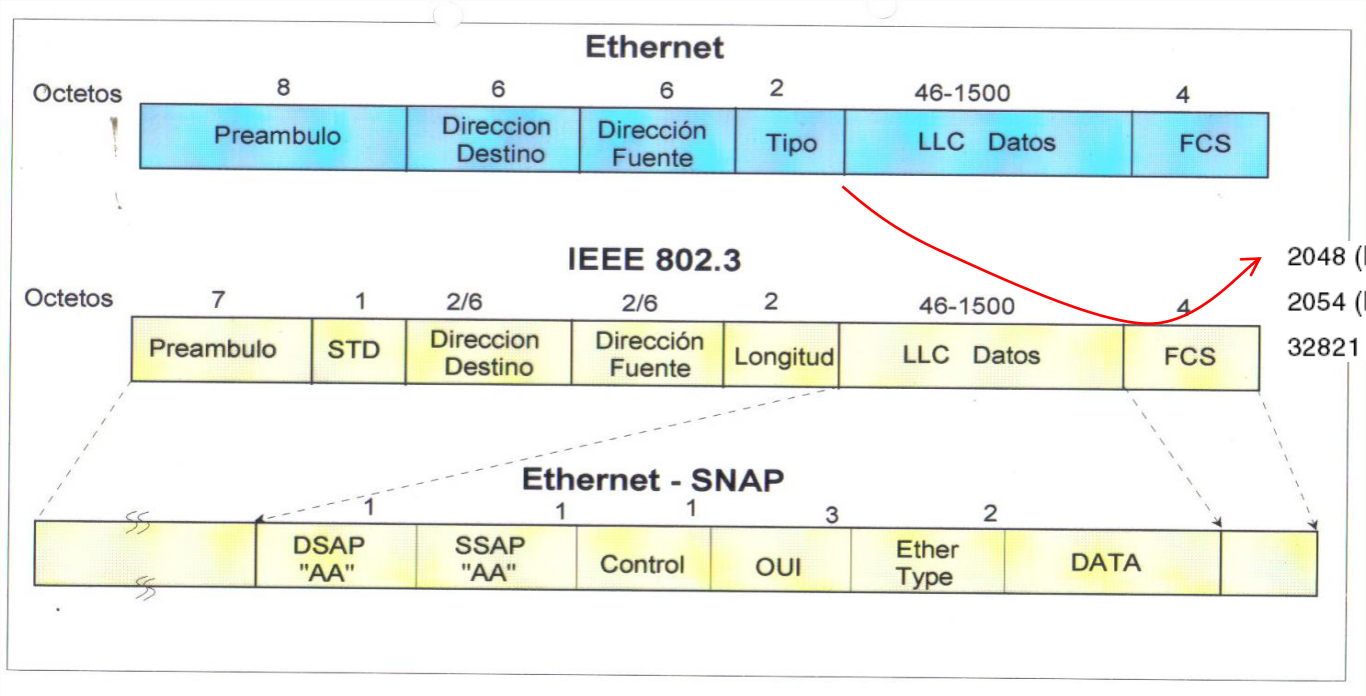
* Formerly IEEE Std 802.1A.



36 años

IEEE Std 802.3™-2018
(Revision of
IEEE Std 802.3-2015)

La trama de Ethernet y 802.3



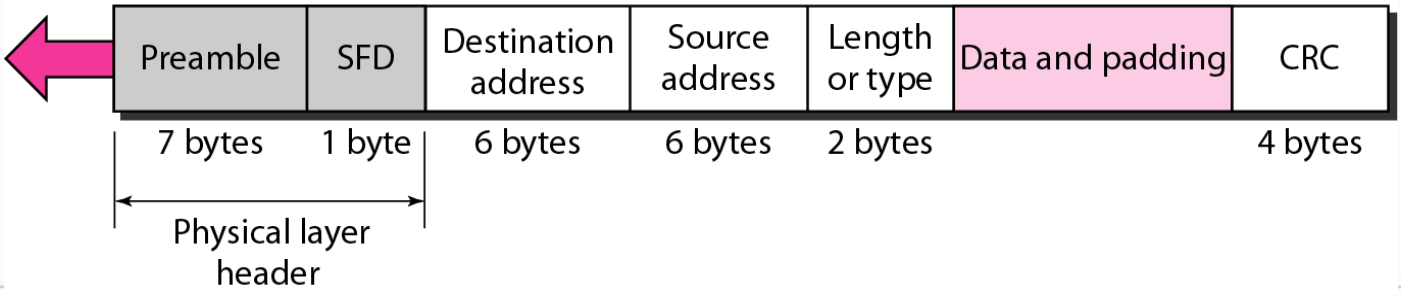
Tipo :

2048 (hex 0800), for IP datagrams
2054 (hex 0806), for ARP datagrams
32821 (hex 8035), for RARP datagrams

Preámbulo :

Preamble: 56 bits of alternating 1s and 0s.

SFD: Start frame delimiter, flag (10101011)



La trama de Ethernet y 802.3

4.2.5 Preamble generation

In a LAN implementation, most of the Physical Layer components are allowed to provide valid output some number of bit times after being presented valid input signals. Thus it is necessary for a preamble to be sent before the start of data, to allow the PLS circuitry to reach its steady state. Upon request by TransmitLinkMgmt to transmit the first bit of a new frame, PhysicalSignalEncap shall first transmit the preamble, a bit sequence used for physical medium stabilization and synchronization, followed by the Start Frame Delimiter. If, while transmitting the preamble or Start Frame Delimiter, the collision detect variable becomes true, any remaining preamble and Start Frame Delimiter bits shall be sent. The preamble pattern is:

10101010 10101010 10101010 10101010 10101010 10101010 10101010

The bits are transmitted in order, from left to right. The nature of the pattern is such that, for Manchester encoding, it appears as a periodic waveform on the medium that enables bit synchronization. It should be noted that the preamble ends with a "0."

4.2.6 Start frame sequence

The receiveDataValid signal is the indication to the MAC that the frame reception process should begin. Upon reception of the sequence 10101011 following the assertion of receiveDataValid, PhysicalSignalDecap shall begin passing successive bits to ReceiveLinkMgmt for passing to the MAC client.

La trama de Ethernet y 802.3

3.2.9 Frame Check Sequence (FCS) field

A cyclic redundancy check (CRC) is used by the transmit and receive algorithms to generate a CRC value for the FCS field. The FCS field contains a 4-octet (32-bit) CRC value. This value is computed as a function of the contents of the protected fields of the MAC frame: the Destination Address, Source Address, Length/ Type field, MAC Client Data, and Pad (that is, all fields except FCS). The encoding is defined by the following generating polynomial.

$$G(x) = x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$$

O sea que tenemos cubiertos errores de hasta 32 bits seguidos

Mathematically, the CRC value corresponding to a given MAC frame is defined by the following procedure:

a) The first 32 bits of the frame are complemented.
b) The n bits of the protected fields are then considered to be the coefficients of a polynomial $M(x)$ of degree $n - 1$. (The first bit of the Destination Address field corresponds to the $x^{(n-1)}$ term and the last bit of the MAC Client Data field (or Pad field if present) corresponds to the x^0 term.)
c) $M(x)$ is multiplied by x^{32} and divided by $G(x)$, producing a remainder $R(x)$ of degree ≤ 31.
d) The coefficients of $R(x)$ are considered to be a 32-bit sequence.
e) The bit sequence is complemented and the result is the CRC.

The 32 bits of the CRC value are placed in the FCS field so that the x^{31} term is the left-most bit of the first octet, and the x^0 term is the right most bit of the last octet. (The bits of the CRC are thus transmitted in the order $x^{31}, x^{30}, \ldots, x^1, x^0$.) See Hammond, et al. [B34].

La trama de Ethernet y 802.3

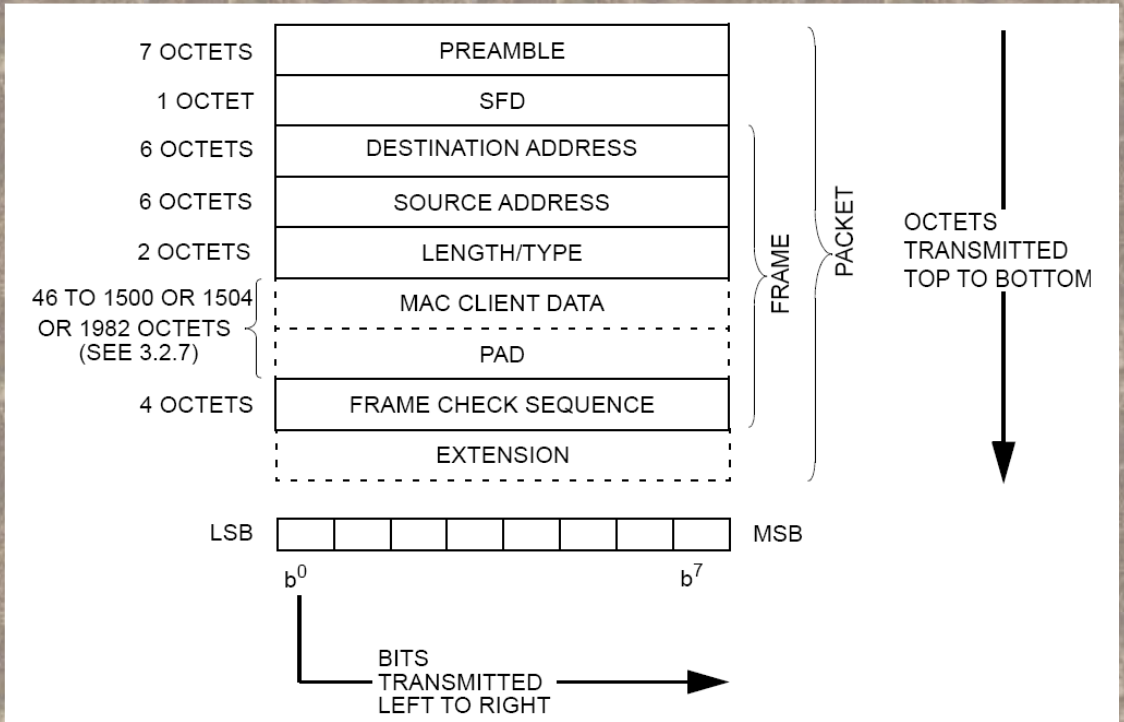


Figure 3–1—Packet format

Campo Direcciones : Ethernet

6.2.1 Address Fields

Data link addresses are 6 octets (48 bits) in length. There are two types of data link addresses.

Physical address: The unique address associated with a particular station on the Ethernet. A station's physical address should be distinct from the physical address of any other station on *any* Ethernet. Physical addresses of Ethernet stations must be displayed in human readable form, by either a tag or label, an LED display, a properly documented software command, or some other well-defined method.

Multicast address: A multi-destination address, associated with one or more stations on a given Ethernet. There are two kinds of multicast addresses:

- *Multicast-group address:* An address associated by higher-level convention with a group of logically related stations.
- *Broadcast address:* A distinguished, predefined multicast address which always denotes the set of *all* stations on a given Ethernet. The broadcast address should be used only when strictly necessary: excessive broadcasting of packets can overload some stations.

6.4.1.2.1 Physical Addresses

The Data Link recognizes and accepts any frame whose destination field contains the physical address of the station.

The physical address of each station is set by network management to a unique value associated with the station, and distinct from the address of any other station on any Ethernet. The setting of the station's physical address by network management allows multiple data link controllers connected to a single station to respond to the same physical address. The procedures for allocating unique addresses are discussed in Appendix B.

IEEE 802 Addresses

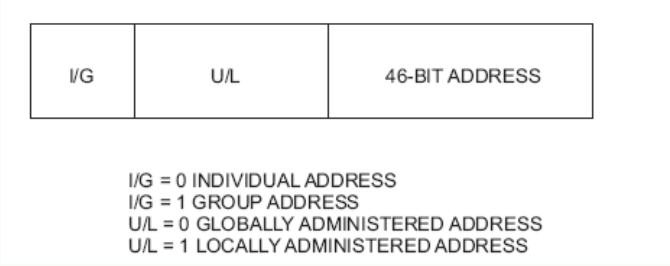
- IEEE 802 defines Universal Addresses and Local Addresses
  - 48-bit and 64-bit addresses are defined.
  - Most usage up to now has been universal addresses
- Universal addresses
  - Have U/L bit set to 0
  - Called an Extended Unique Identifier (EUI-48 or EUI-64)
  - IEEE 802.16 uses EUI-64, other IEEE 802 standards use EUI-48
- Local addresses
  - Have the U/L bit set to set to 1
  - No other defined structure

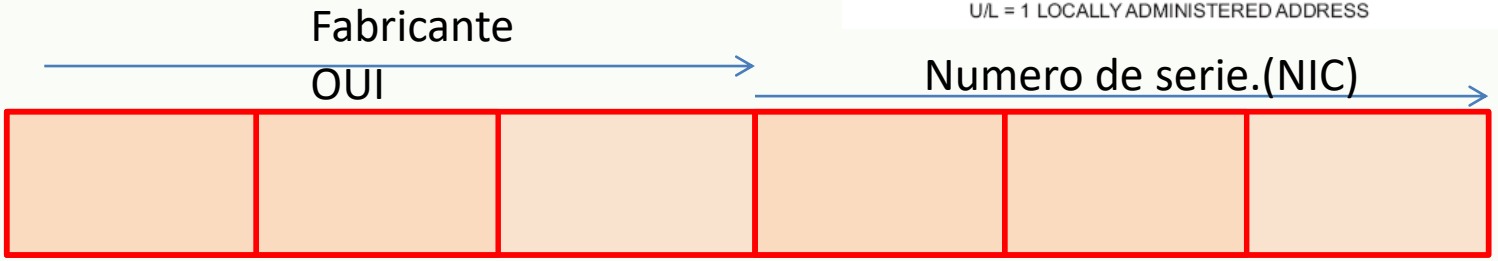
17 July 2016

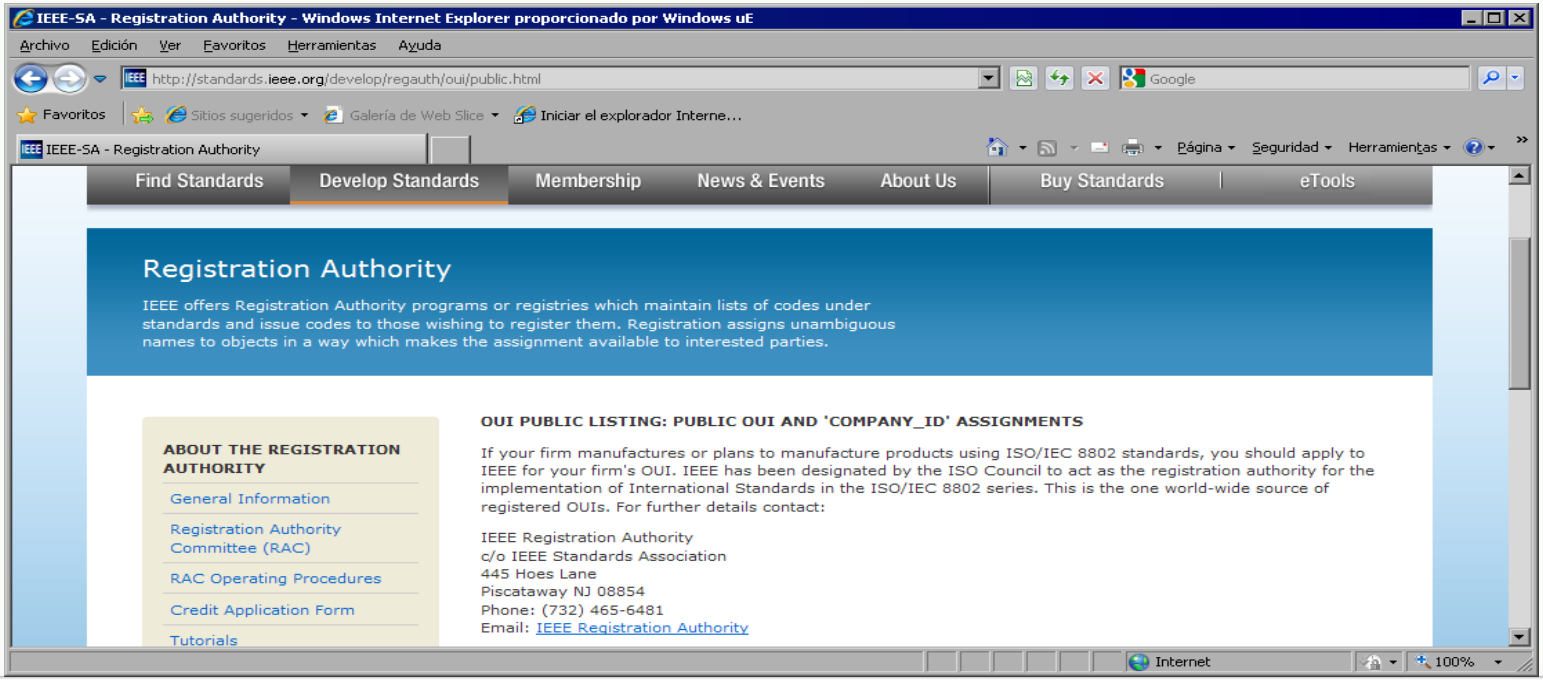
Direcciones físicas … "MAC "

Ethernet soporta:

- **Unicast**: Direccionar un nodo. Cada NIC tiene su MAC.
- **Multicast:** Direccionar un grupo de nodos.
- **Broadcast:** Enviar a todo los nodos . FF-FF-FF-FF-FF-FF







Direcciones físicas … "MAC "

Por mas de 30 años los 2 ^{46} de direccionamiento fue suficiente, por

- Década 80: Computadoras, ,PC , Laptop
- Década 2010 : Celulares, PC, impresoras, Tv, Wireless , sensores….

Guidelines for Use of EUI, OUI, and CID

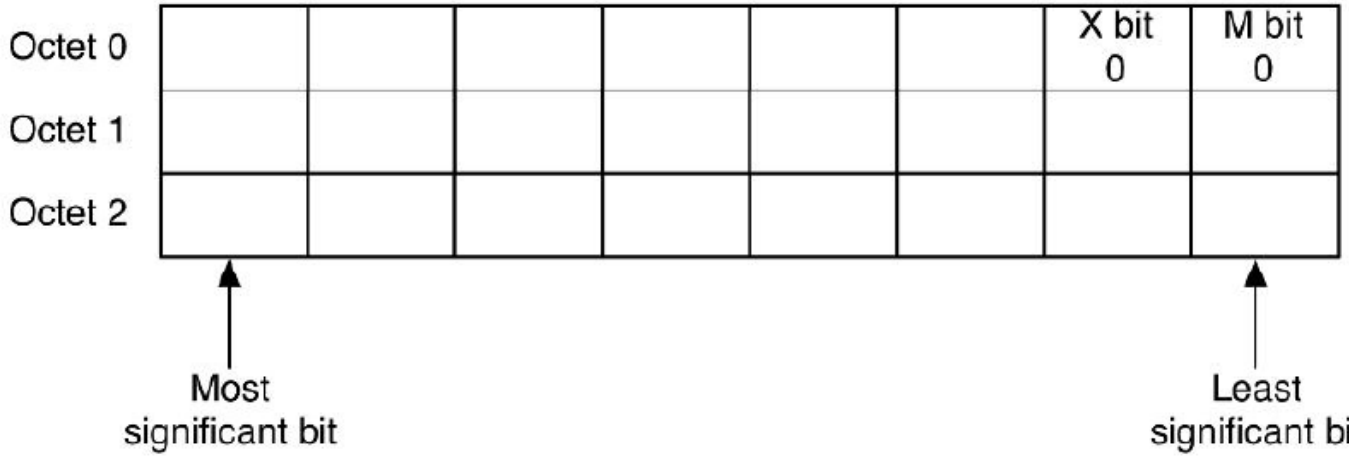


Figure 1: Structure of an OUI

Los primeros octetos de las direcciones MAC : fabricante.

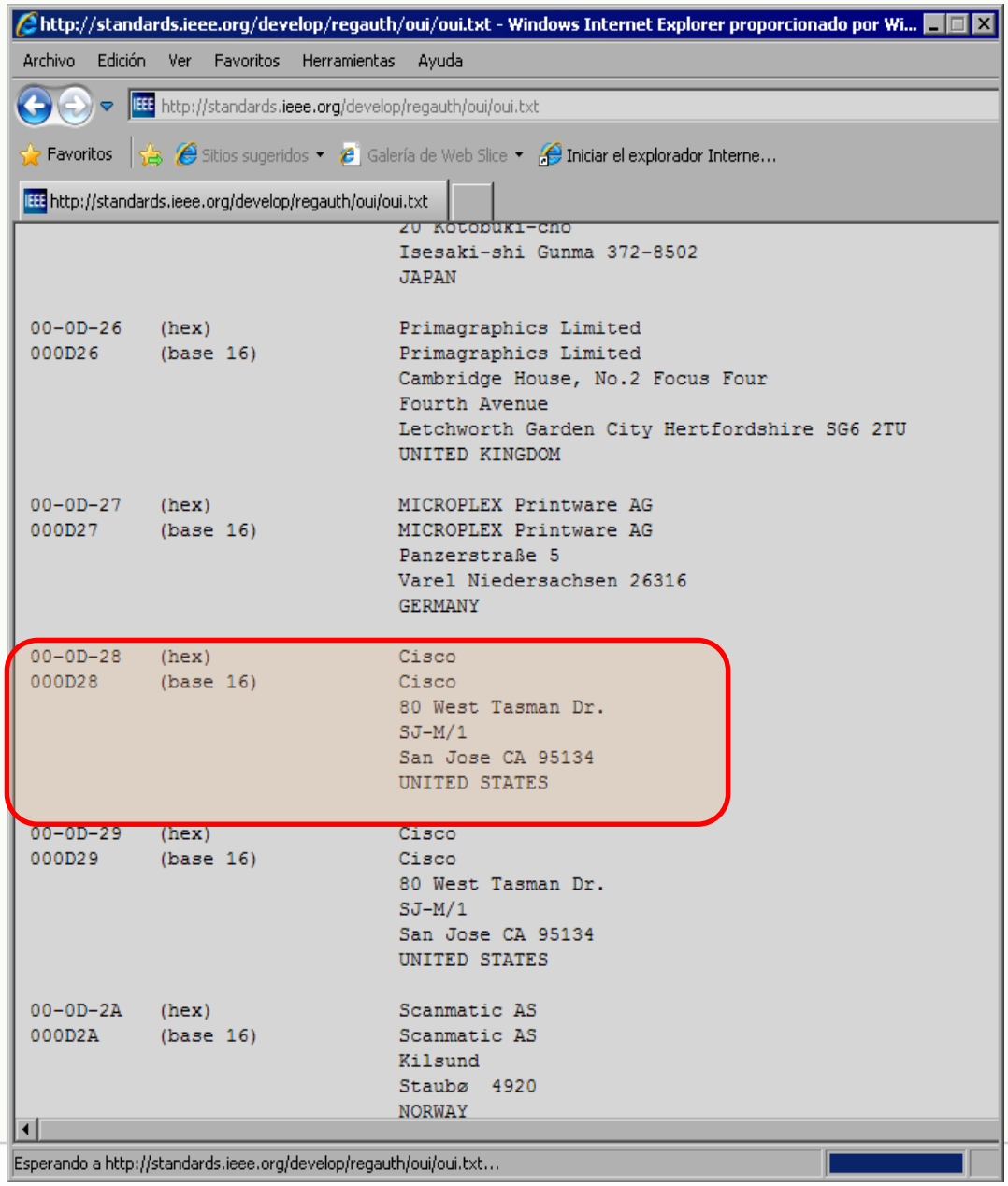


TABLE 4.1 Representative Ethernet NIC Manufacturer IDs

NIC Manufacturer	Three-Byte Identifier
Cisco	00-00-0C
Fujitsu	00-00-0E
Cabletron	00-00-1D
NeXT	00-00-0F
TRW	00-00-2A
Hughes LAN Systems (formerly Sytek)	00-00-10
Tektronix	00-00-11
Datapoint Corporation	00-00-15
Olicom	00-00-24
AT&T	00-00-3D
NEC	00-00-4C
Network General	00-00-65
MIPS	00-00-6B
Madge Networks	00-00-6F
MIPS	00-00-77
Proteon	00-00-93
Cross Com Communications (now part of Olicom)	00-00-98
Wellfleet (now Bay Networks)	00-00-A2
Xerox	00-00-AA
RND (RAD Network Devices)	00-00-B0
Western Digital	00-00-C0
Emulex	00-00-C9
Develcon Electronics, Ltd.	00-00-D0
Adaptec, Inc.	00-00-D1
Gandalf Data Ltd.	00-00-F3
Allied Telesis, Inc.	00-00-F4

Direcciones físicas … "MAC "

Table 6: Structure of EUI-48

octet identifier	MSB 0	1	2	3	4	5 LSB
MA-L	24-bit OUI			24-bit extension		
MA-M	28-bit MA-M base				20-bit extension	
MA-S	36-bit OUI-36					12-bit extension
example value (hex)	AC	DE	48	23	45	67
example value (binary)	1010 : 1100	1101 : 1110	0100 : 1000	0010 : 0011	0100 : 0101	0110 : 0111

- ODI: 24-bit Organizational Defined Identifier (uniqueness by the Organization)
- OUI: 24-bit Organizational Unique Identifier (purchased from IEEE)

Direcciones físicas … "MAC "

Table 7: Structure of EUI-64

octet identifier	MSB 0	1	2	3	4	5	6	LSB 7
MA-L	24-bit OUI			40-bit extension				
MA-M	28-bit MA-M base			36-bit extension				
MA-S	36-bit OUI-36			28-bit extension				
example value (hex)	AC	DE	48	23	45	67	01	9F
example value (binary)	1010 1100	1101 1110	0100 1000	0010 0011	0100 0101	0110 0111	0000 0001	1001 1111

El *Logic Link Control*

Subcapa Logic Link Control

El PDU completo de la capa de enlace en LAN

Preambulo	DIRECCIONES Y OTROS	LLC(DATA)	FCS	END

La disposición de la trama PDU del Logic Link Control, LLC

1 byte	1	1-2	n
DSAP	SSAP	Control	DATA

D S A P		S S A P	
I/G	DSAP valor	C/R	SSAP valor

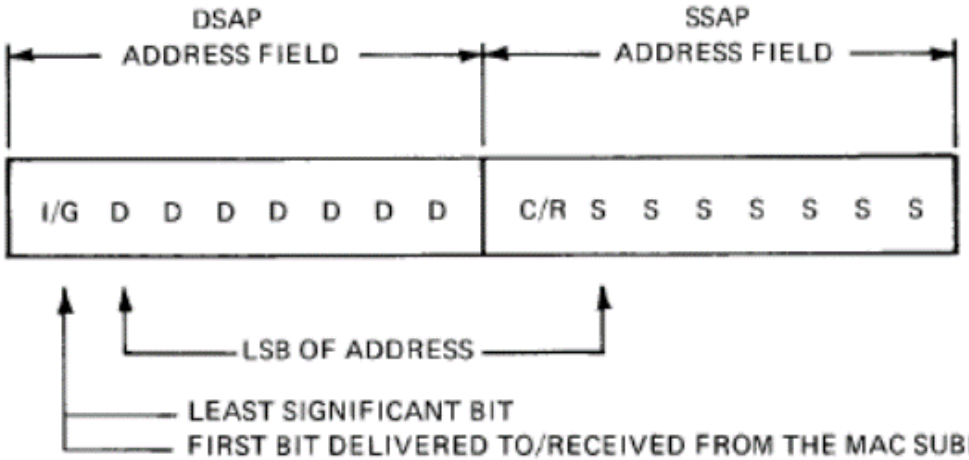
bits	1	2	3	4	5	6	7	8	9	10	16
Trasnf. información	0	N(S)							P/F	N(R)	
Supervisión	1	0	S	S	X	X	X	X	P/F	N(R)	
Sin numerar	1	1	M	M	P/F	M	M	M			

Los comandos y repuesta en el campo de control son :

Nombre	Código	Formato	Comand	Repuesta	Tipo1	Tipo 2
Información	I	I	X	X		X
Recepción lista	RR	S	X	X		X
Recepción no lista	RNR	S	X	X		X
Rechazar	REJ	S	X	X		X
Información no numerada	UI	U	X		X	
Desconectar	DISC	U	X			X
Modo asíncrono balanceado extendido	SABME	U	X			X
Prueba	TEST	U	X	X	X	
Reconocimiento no numerado	UA	U		X		X
Modo Desconexión	DM	U		X		X
Rechazar Trama	FRMR	U		X		X

Tipo 1: no orientados a la conexión , tipo 2: orientado a la conexión .

El *Logic Link Control*



I/G = 0 INDIVIDUAL DSAP
I/G = 1 GROUP DSAP
C/R = 0 COMMAND
C/R = 1 RESPONSE

XODDDDDD DSAP ADDRESS
XOSSSSSS SSAP ADDRESS

X1DDDDDD
X1SSSSSS RESERVED FOR IEEE 802 DEFINITION

Table 7-9—Standard LLC address assignment

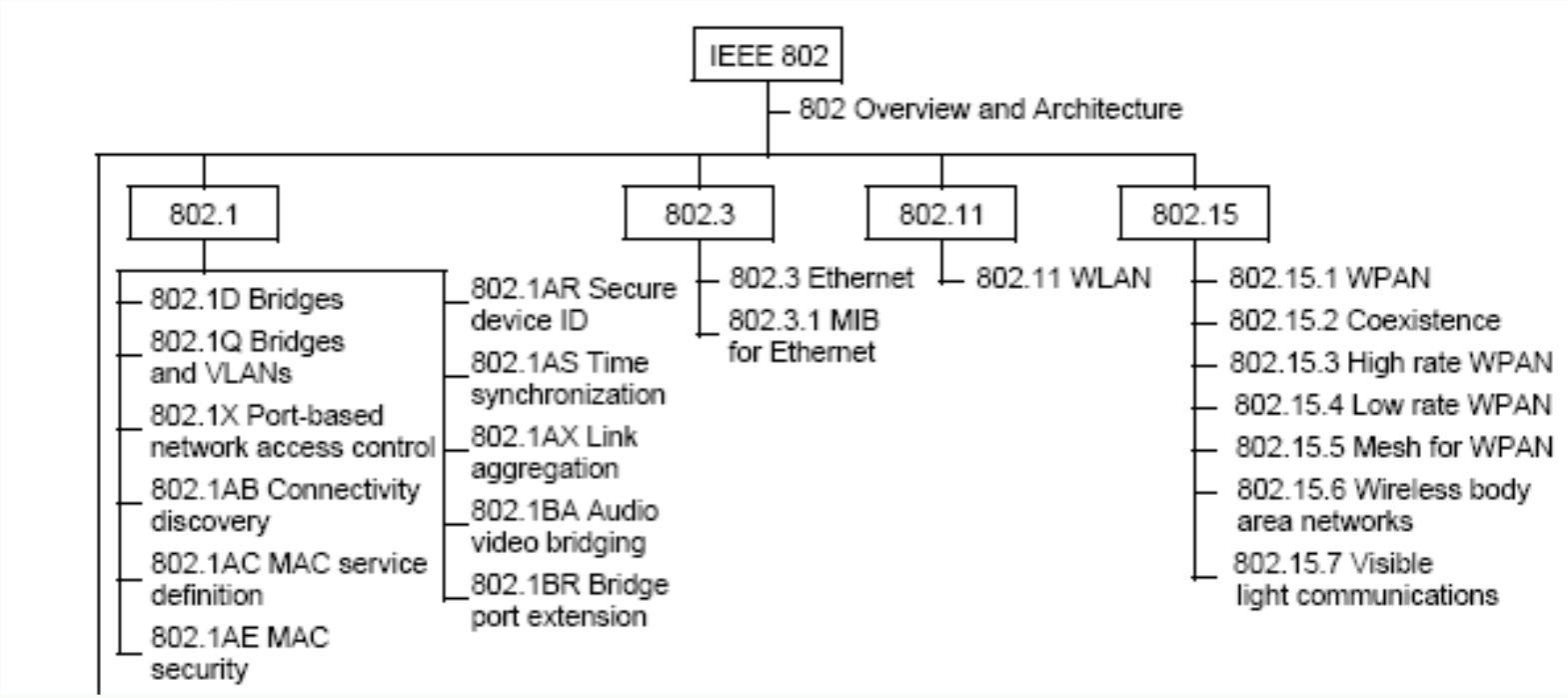
Assignment	Value
Bridge Spanning Tree Protocol	01000010

El campo de TYPE en Ethernet

TABLE 4.2 Representative Ethernet Type Field Assignments

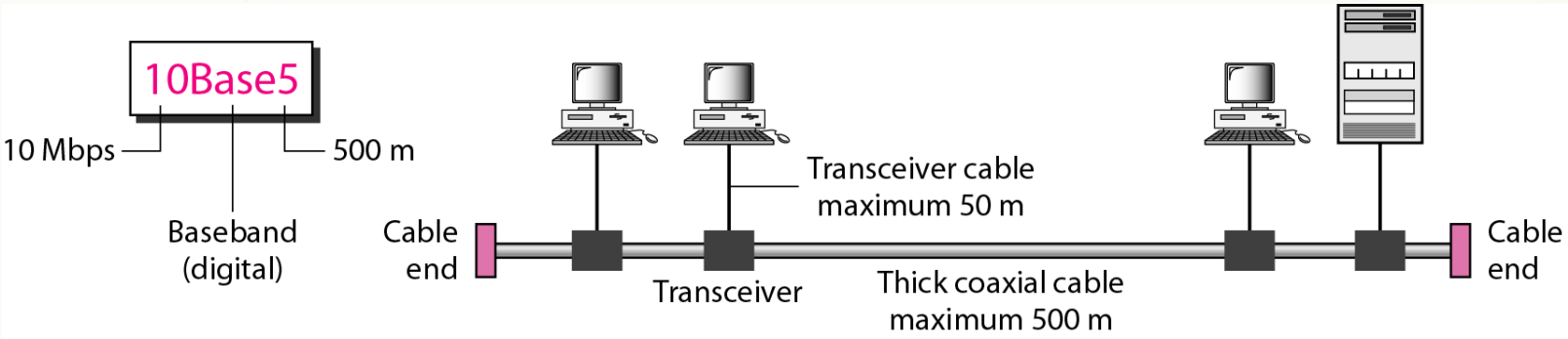
Protocol	Hex Value Assigned
Experimental	0101-DIFF
Xerox XNS	0600
IP	0800
X.75 Internet	0801
NBS Internet	0802
ECMA Internet	0803
CHAOSmet	0804
X.25 Level 3	0805
Address Resolution Protocol	0806
XNS Compatibility	0807
Banyan Systems	0BAD
BBN Simnet	5208
DEC MOP Dump/Load	6001
DEC MOP Remote Console	6002
DEC DECNET Phase IV Route	6003
DEC LAT	6004
DEC Diagnostic Protocol	6005
3Com Corporation	6010–6014
Proteon	7030
AT&T	8008
Excelan	8010
Tymshare	802E
DEC LANBridge	8038
DEC Ethernet Encryption	803D
AT&T	8046–8047
AppleTalk	809B
IBM SNA Service on Ethernet	80D5
AppleTalk ARP	80F3
Wellfleet	80FF–8103
NetWare IPX/SPX	8137–8138
SNMP	814C

Los standard del IEEE en 802



- The ones with capital letters, e.g. 802.1Q or 802.1AX are independent standards
- Amendments to these standards are identified by lower case letters e.g. 802.1ah, 802.1Qbg or 802.1AEbn
- Periodically the amendments get merged into a revision of the main standard, e.g. 802.1ah and 802.1Qay are part of 802.1Q-2014
- 802.1Q can be considered as many individual standards integrated into a single document

Los standard del IEEE en 802.3



Ethernet Standard	Date	Description
Experimental Ethernet	1972	2.94 Mbit/s (367 kB/s) over coaxial cable (coax) cable bus
Ethernet II (DIX v2.0)	1982	10 Mbit/s (1.25 MB/s) over thin coax (thinnet) - Frames have a Type field. This frame format is used on all forms of Ethernet by protocols in the Internet protocol suite.
IEEE 802.3	1983	10BASE5 10 Mbit/s (1.25 MB/s) over thick coax - same as DIX except Type field is replaced by Length, and an 802.2 LLC header follows the 802.3 header
802.3a	1985	10BASE2 10 Mbit/s (1.25 MB/s) over thin Coax (thinnet or cheapernet)
802.3b	1985	10BROAD36
802.3c	1985	10 Mbit/s (1.25 MB/s) repeater specs
802.3d	1987	FOIRL (Fiber-Optic Inter-Repeater Link)
802.3e	1987	1BASE5 or StarLAN
802.3i	1990	10BASE-T 10 Mbit/s (1.25 MB/s) over twisted pair
802.3j	1993	10BASE-F 10 Mbit/s (1.25 MB/s) over Fiber-Optic
802.3u	1995	100BASE-TX, 100BASE-T4, 100BASE-FX Fast Ethernet at 100 Mbit/s (12.5 MB/s) w/autonegotiation
802.3x	1997	Full Duplex and flow control; also incorporates DIX framing, so there's no longer a DIX/802.3 split
802.3y	1998	100BASE-T2 100 Mbit/s (12.5 MB/s) over low quality twisted pair
802.3z	1998	1000BASE-X Gbit/s Ethernet over Fiber-Optic at 1 Gbit/s (125 MB/s)
802.3-1998	1998	A revision of base standard incorporating the above amendments and errata
802.3ab	1999	1000BASE-T Gbit/s Ethernet over twisted pair at 1 Gbit/s (125 MB/s)

Los standard del IEEE en 802.3

802.3ac	1998	Max frame size extended to 1522 bytes (to allow "Q-tag") The Q-tag includes 802.1Q VLAN information and 802.1p priority information.
802.3ad	2000	Link aggregation for parallel links
802.3-2002	2002	A revision of base standard incorporating the three prior amendments and errata
802.3ae	2003	10 Gbit/s (1,250 MB/s) Ethernet over fiber; 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-SW, 10GBASE-LW, 10GBASE-EW
802.3af	2003	Power over Ethernet
802.3ah	2004	
802.3ak	2004	10GBASE-CX4 10 Gbit/s (1,250 MB/s) Ethernet over twin-axial cable
802.3-2005	2005	A revision of base standard incorporating the four prior amendments and errata.
802.3an	2006	10GBASE-T 10 Gbit/s (1,250 MB/s) Ethernet over unshielded twisted pair(UTP)
802.3ap	2007	Backplane Ethernet (1 and 10 Gbit/s (125 and 1,250 MB/s) over printed circuit boards)
802.3aq	2006	10GBASE-LRM 10 Gbit/s (1,250 MB/s) Ethernet over multimode fiber
802.3ar	On Hold	Congestion management
802.3as	2006	Frame expansion
802.3at	exp. 2008	Power over Ethernet enhancements
802.3au	2006	Isolation requirements for Power Over Ethernet (802.3-2005/Cor 1)
802.3av	exp. 2009	10 Gbit/s EPON
802.3aw	2007	Fixed an equation in the publication of 10GBASE-T (released as 802.3-2005/Cor 2)
802.3ax	exp 2008	Move Link aggregation out of 802.3 to IEEE 802.1
802.3ay	exp 2008	Maintenance to base standard
802.3ba	exp. 2009	Higher Speed Study Group. 40 Gbit/s over 1m backplane, 10m Cu cable assembly (4x25 Gbit or 10x10 Gbit lanes) and 100 m of MMF and 100 Gbit/s up to 10 m or Cu cable assembly, 100 m of MMF or 40 km of SMF respectively

Las normativas 802.1… Bridged

IEEE
Std 802-2014

IEEE STANDARD FOR LOCAL AND METROPOLITAN AREA NETWORKS

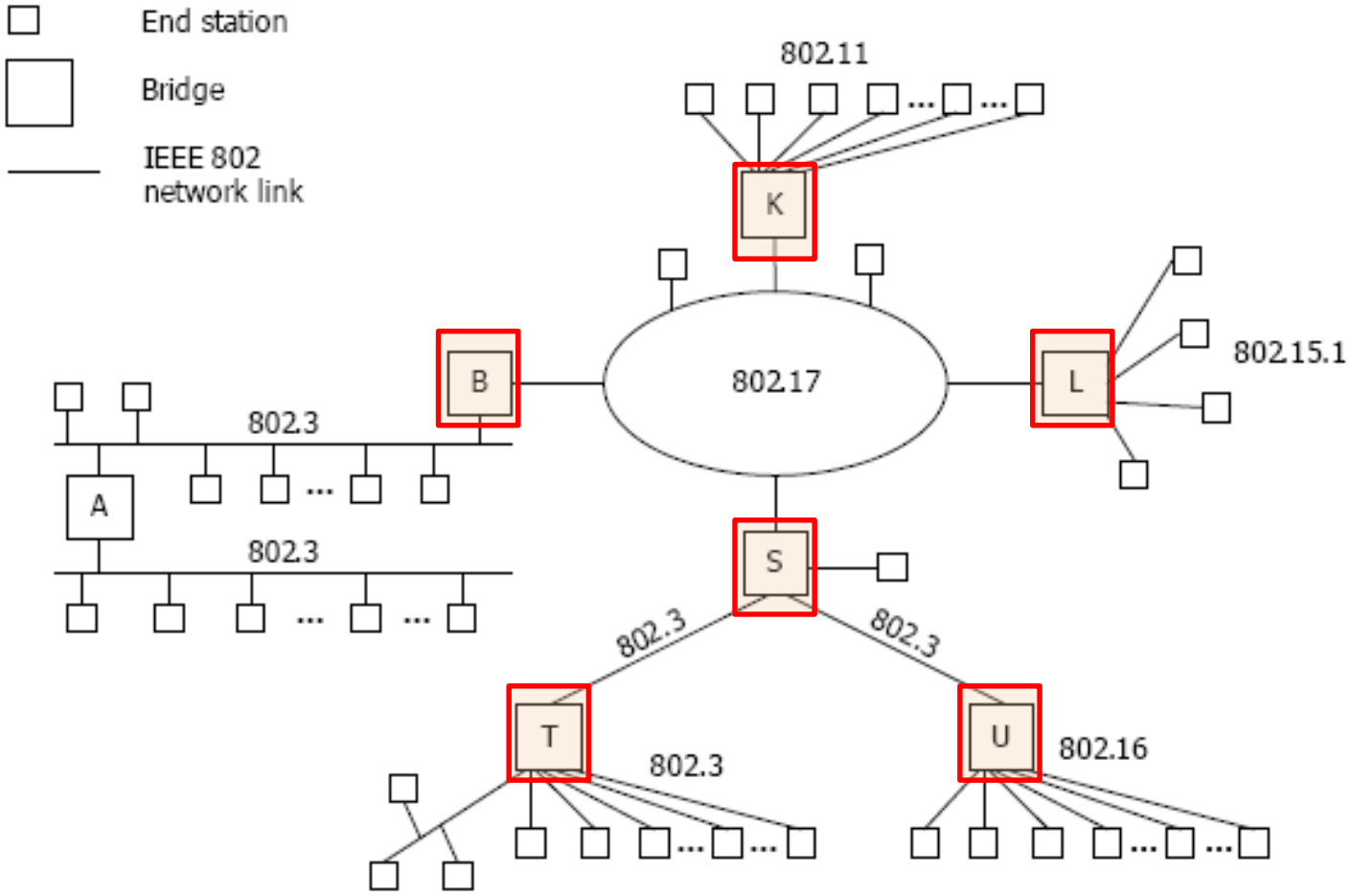


Figure 8—An example of a bridged IEEE 802 network

Las normativas 802.1…

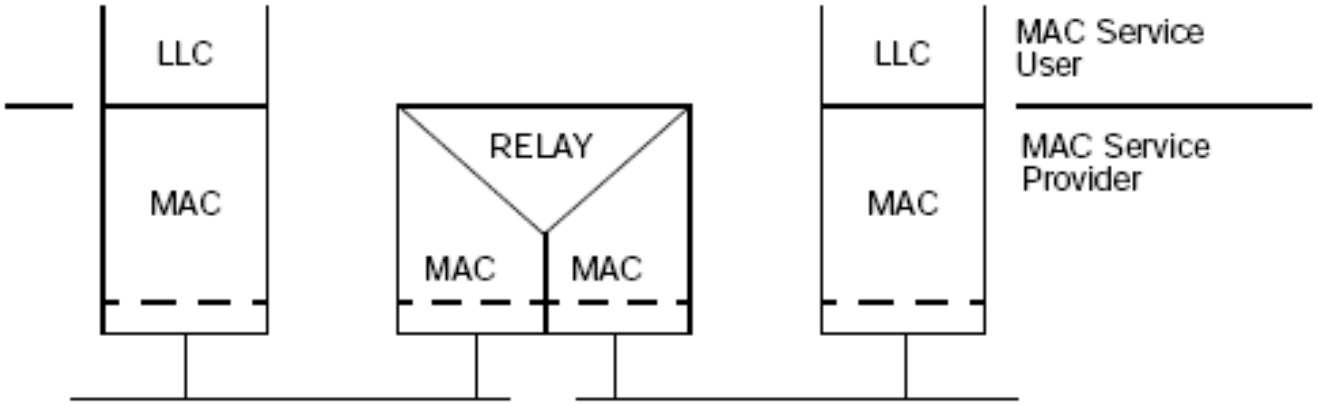


Figure 6-1—Internal organization of the MAC sublayer

This clause discusses the following aspects of service provision:

a) Provision of the MAC Service to end stations.
b) Preservation of the MAC Service.
c) Maintenance of QoS.
d) Provision of the Internal Sublayer Service within the MAC Bridge.
e) Support of the Internal Sublayer Service by specific MAC procedures.
f) Filtering services.

Las normativas 802.1…

- **Interworking**
  - 802-REV - Overview & Architecture - Revision
  - 802.1AB-REV - Station and Media Access Control Connectivity Discovery Revision
  - 802.1H-REV - Recommended Practice for MAC Bridging of Ethernet in LANs
  - 802.1AC - Media Access Control Service revision
  - 802.1ag - Connectivity Fault Management
  - 802.1ah - Provider Backbone Bridges
  - 802.1aj - Two-port MAC Relay
  - 802.1ak - Multiple Registration Protocol
  - 802.1ap - VLAN Bridge MIBs
  - 802.1aq - Shortest Path Bridging
  - 802.1Qaw - Management of Data-Driven and Data-Dependent Connectivity Faults
  - 802.1Qay - Provider Backbone Bridge Traffic Engineering
- **Security**
  - **802.1X-REV - Port-based Network Access Control**
  - 802.1AR - Secure Device Identity

- **Audio/Video Bridging**
  - 802.1AS - Timing and Synchronization
  - 802.1Qat - Stream Reservation Protocol
  - 802.1Qav - Forwarding and Queuing Enhancements for Time-Sensitive Streams

- **Data Center Bridging**
  - 802.1Qau - Congestion Notification
  - 802.1Qaz - Enhanced Transmission Selection

Continuación….

- 802 - Overview & Architecture
- 802a - Playpen Ethertypes
- 802b - Registration of Object Identifiers
- 802.1D (1998) - MAC bridges
- **802.1D (2004) - MAC Bridges**
- 802.1G - Remote MAC bridging
- 802.1p - Traffic Class Expediting and Dynamic Multicast Filtering (published in 802.1D-1998)
- 802.1Q - Virtual LANs
- **802.1Q-REV - 802.1Q Revision 2005**
- 802.1s - Multiple Spanning Trees
- 802.1t - 802.1D Maintenance
- 802.1u - 802.1Q Maintenance
- 802.1v - VLAN Classification by Protocol and Port
- **802.1w - Rapid Reconfiguration of Spanning Tree**
- 802.1aa - 802.1X Maintenance
- 802.1X-2001 - Port Based Network Access Control
- 802.1af - MAC Key Security
- **802.1X-2004 - Port Based Network Access Control**
- 802.1y - 802.1D Maintenance (published under 802.1D(2004))
- 802.1z - 802.1Q Maintenance - withdrawn
- 802.1AB - Station and Media Access Control Connectivity Discovery
- 802.1ad - Provider Bridges
- 802.1AE - MAC Security

Las normativas 802.1…

IMPORTANT NOTICE: IEEE Standards documents are not intended to ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. Implementers of IEEE Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.

IEEE Std 802.1Qbe™-2011	Multiple I-SID Registration Protocol
IEEE Std 802.1Qbc™-2011	Provider Bridging—Remote Customer Service Interfaces
IEEE Std 802.1Qbb™-2011	Priority-based Flow Control
IEEE Std 802.1Qaz™-2011	Enhanced Transmission Selection for Bandwidth Sharing Between Traffic Classes
IEEE Std 802.1Qbf™-2011	PBB-TE Infrastructure Segment Protection
IEEE Std 802.1Qbg™-2012	Edge Virtual Bridging
IEEE Std 802.1aq™-2012	Shortest Path Bridging
IEEE Std 802.1Q-2011/Cor 2-2012	Technical and editorial corrections
IEEE Std 802.1Qbp™-2014	Equal Cost Multiple Paths (ECMP)

The 2011 revision of this standard incorporated the text of the following amendments i
IEEE Std 802.1Q-2005.

IEEE Std 802.1ad™-2005	Provider Bridges
IEEE Std 802.1ak™-2007	Multiple Registration Protocol
IEEE Std 802.1ag™-2007	Connectivity Fault Management
IEEE Std 802.1ah™-2008	Provider Backbone Bridges
IEEE Std 802-1Q-2005/Cor-1-2008	Corrections to the Multiple Registration Protocol
IEEE Std 802.1ap™-2008	Management Information Base (MIB) Definitions for VLAN Bridges
IEEE Std 802.1Qaw™-2009	Management of Data Driven and Data Dependent Connectivity Faults
IEEE Std 802.1Qay™-2009	Provider Backbone Bridge Traffic Engineering
IEEE Std 802.1aj™-2009	Two-Port Media Access Control (MAC) Relay
IEEE Std 802.1Qav™-2009	Forwarding and Queuing Enhancements for Time-Sensitive Streams
IEEE Std 802.1Qau™-2010	Congestion Notification
IEEE Std 802.1Qat™-2010	Stream Reservation Protocol

Relationship between IEEE Std 802.1D and IEEE Std 802.1Q

Another IEEE standard, IEEE Std 802.1Q™-2003, extends the concepts of MAC Bridging and filtering services to support the definition and management of Virtual LANs (VLANs).

The capabilities defined in IEEE Std 802.1Q-2003 include the definition of a VLAN frame format that is able to carry VLAN identification and user priority information over LAN technologies, such as CSMA/CD, that have no inherent capability to signal priority information. This information is carried in an additional header field, known as the *Tag Header*, which is inserted immediately following the Destination MAC Address, and Source MAC Address (and Routing Information field, if present) of the original frame. IEEE Std 802.1Q-2003 extends the priority handling aspects of this standard to make use of the ability of the VLAN frame format to carry user priority information end to end across any set of concatenated underlying MACs.

The VLAN Bridging specification contained in IEEE Std 802.1Q-2003 is independent of this standard, in the sense that IEEE Std 802.1Q-2003 contains its own statement of the conformance requirements for VLAN Bridges. However, IEEE Std 802.1Q-2003 makes use of many of the elements of the specification contained in this standard, in particular

a) The Bridge architecture
b) The Internal Sublayer Service, and the specification of its provision by IEEE 802 LAN MACs
c) The major features of the operation of the forwarding process
d) The Rapid Spanning Tree Protocol
e) The Generic Attribute Registration Protocol (GARP)

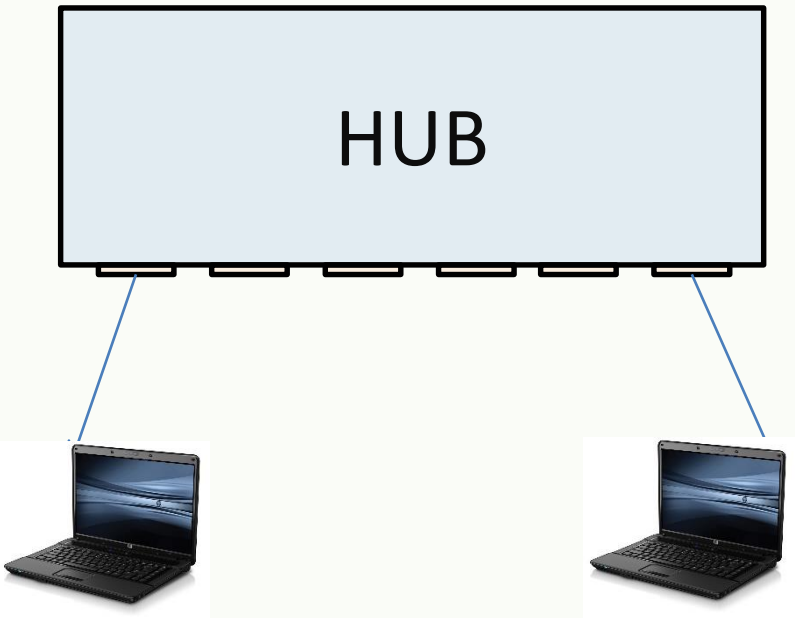
Calidad de servicio : Qos

The following list of traffic types, each of which can benefit from simple segregation from the others, seems to command widespread support:

a) Network Control—characterized by a "must get there" requirement to maintain and support the network infrastructure.
b) "Voice"—characterized by less than 10 ms delay, and hence maximum jitter (one way transmission through the LAN infrastructure of a single campus).
c) "Video"—characterized by less than 100 ms delay.
d) Controlled Load—important business applications subject to some form of "admission control," from pre-planning of the network requirement at one extreme to bandwidth reservation per flow at the time the flow is started at the other.
e) Excellent Effort—or "CEO's best effort," the best-effort type services that an information services organization would deliver to its most important customers.
f) Best Effort—LAN traffic as we know it today.
g) Background—bulk transfers and other activities that are permitted on the network but that should not impact the use of the network by other users and applications.

Equipamiento : HUB ; BRIDGE y SWITCH

EL Hub … similar al MAU de IBM



IEEE Std 802.3-2018, IEEE Standard for Ethernet
SECTION ONE

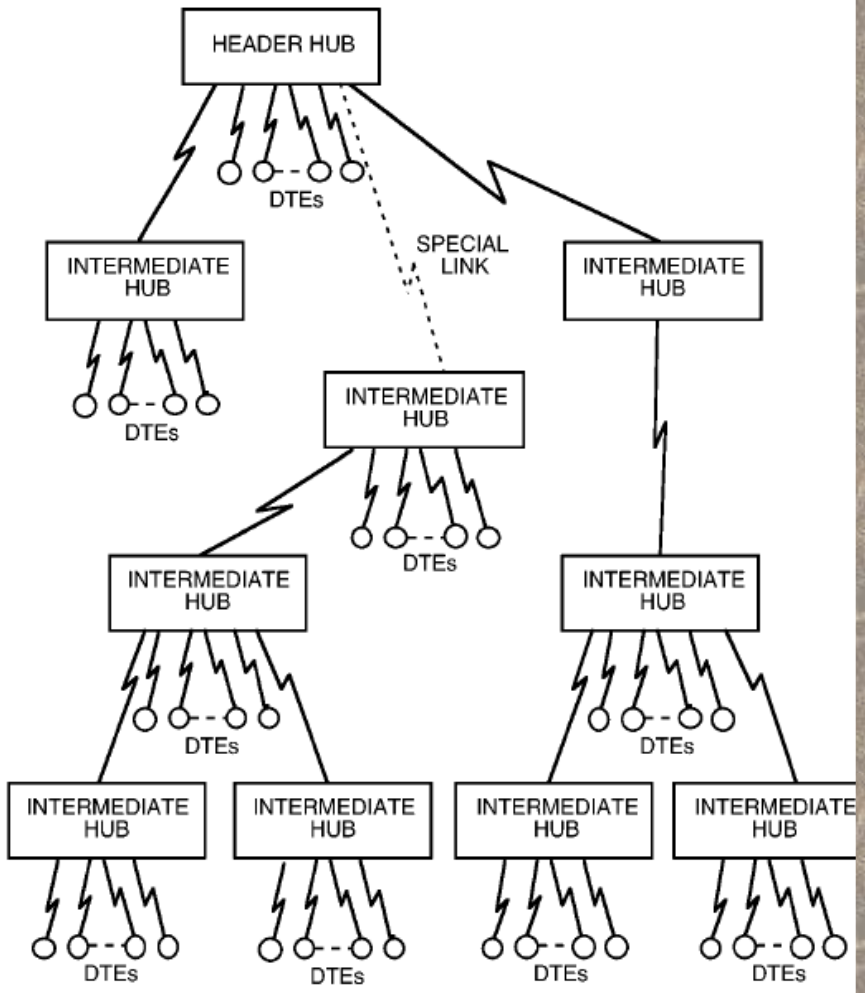
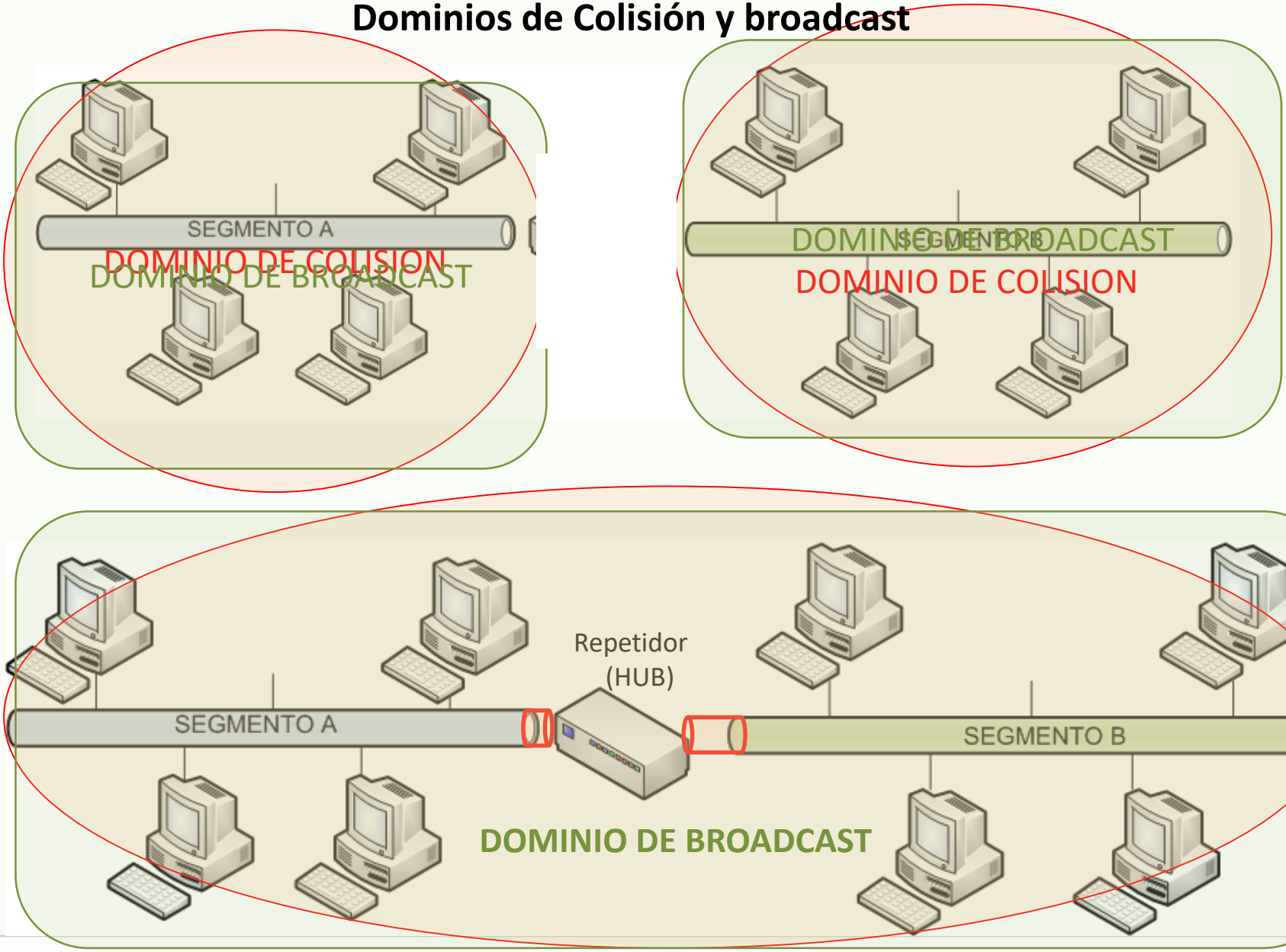


Figure 12–4—Network with four levels of hubs

Equipamiento : HUB

Equipamiento : HUB

Dominios de Colisión y broadcast



3Com® OfficeConnect® Hubs

DATA SHEET

Key Benefits

Easy to Install and Use
Enjoy plug-and-play simplicity.

Simple Troubleshooting
Get at-a-glance network status information from front-panel diagnostic LEDs.

3 Year Hardware Warranty
Ensures peace of mind when purchasing 3Com® OfficeConnect® products.

Engineered for Small-Business Needs
The OfficeConnect family is the first solu tion designed specifically for small-office

Specifications

OfficeConnect hubs come with a user guide, power adapter, one-piece clipping system, and rubber feet.

OfficeConnect Ethernet Hub 4 (10BASE-T Hub) 3C16704A

Connectors:
4 RJ-45 ports for 10BASE-T twisted pair

Dimensions:
Width: 228 mm (9.1 in)
Height: 41.8 mm (1.6 in)
Depth: 135.4 mm (5.3 in)
Weight: 500 g (1.1 lb)

Power: 2.33 VA

Functional:
ISO 8802/3; IEEE 802.3

EMC:
EN 55022 Class B; EN 55024; EN 61000-3-2, EN 61000-3-3; FCC Part 15 Class B; ICES-003 Class B; VCCI Class B; AS/NZS 3548 Class B

Environmental: EN 60068 (IEC 68)

OfficeConnect Ethernet Hub 8 (10BASE-T Hub) 3C16700A

Connectors:
8 RJ-45 ports for 10BASE-T twisted pair

Dimensions:
Width: 228 mm (9.1 in)
Height: 41.8 mm (1.6 in)
Depth: 135.4 mm (5.3 in)
Weight: 500 g (1.1 lb)

Power: 3.13 VA

Functional:
ISO 8802/3; IEEE 802.3;

EMC:
EN 55022 Class B; EN 55024; EN 61000-3-2, EN 61000-3-3; FCC Part 15 Class B; ICES-003 Class B; VCCI Class B; AS/NZS 3548 Class B

Environmental: EN 60068 (IEC 68)

Safety:
UL 1950; EN 60950; CSA 22.2 #950, IEC 60950

Model GS7000 Optical Hub Data Sheet

Updated: July 12, 2019

Contacte a Cisco

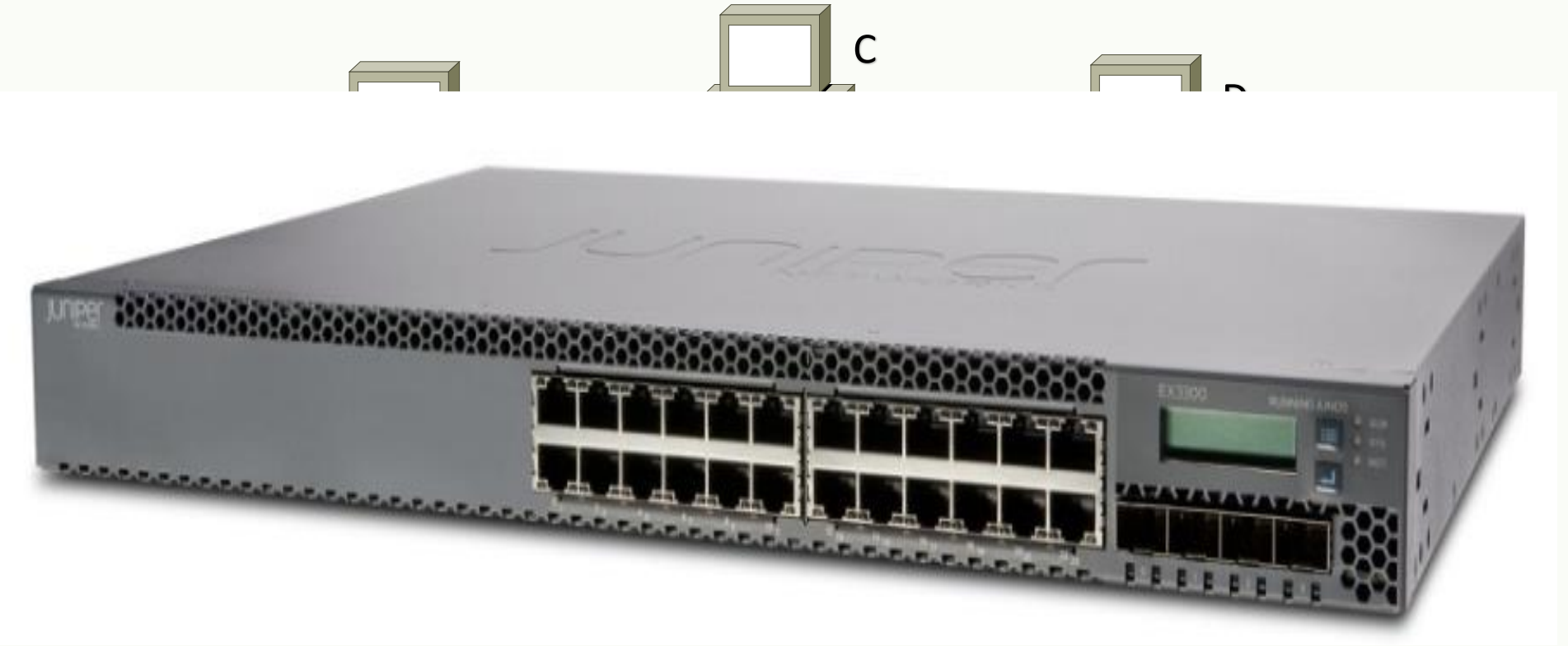
Benefits

Table of Contents

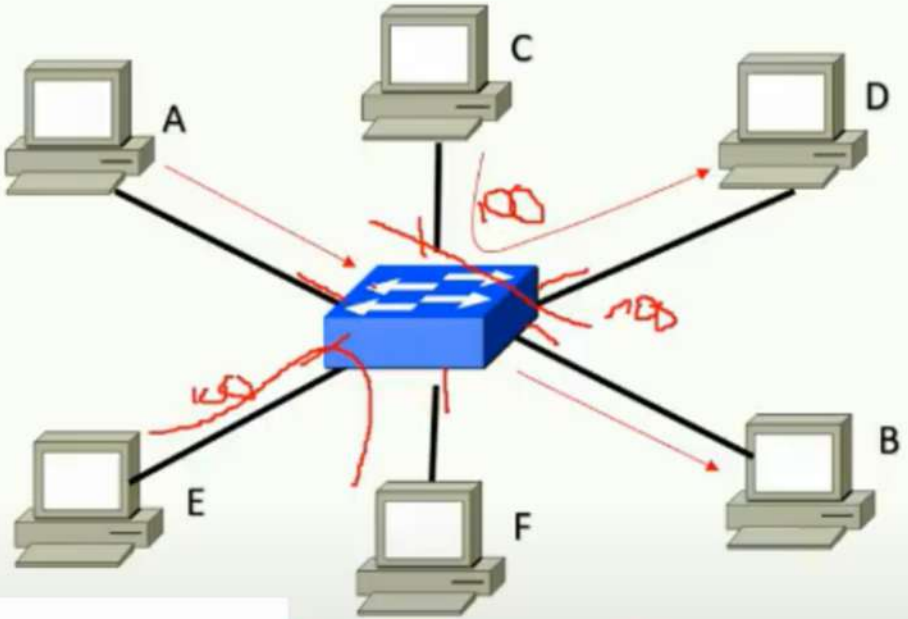
Share Download Print

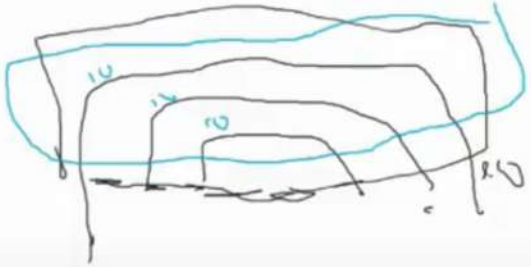
As operators migrate to architectures with deeper fiber reach, there is an increased need for flexible design options and efficient fiber utilization in the optical network. The Model GS7000 Optical Hub addresses those needs by providing multiple options for optical amplification, filtering, splitting, and combining, all in a field-proven Model GS7000 station.

Equipamiento : BRIDGE y SWITCH



Equipamiento : BRIDGE y SWITCH





Esto tiene que ver con lo que hablamos de capacidad de switch, cuando entra una comunicación por ejemplo e1 se comunica con e3 pero eso no quiere decir que e2 no pueda comunicarse con e1

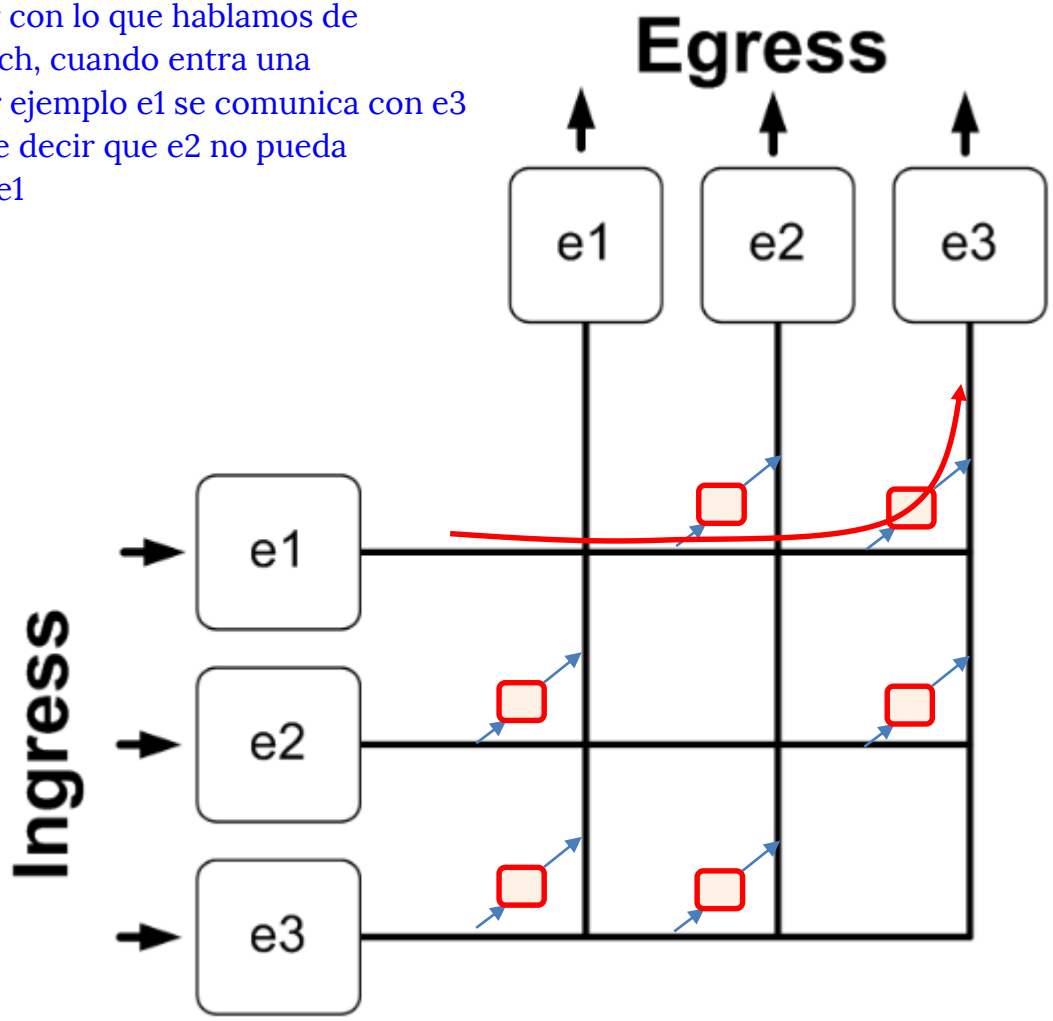
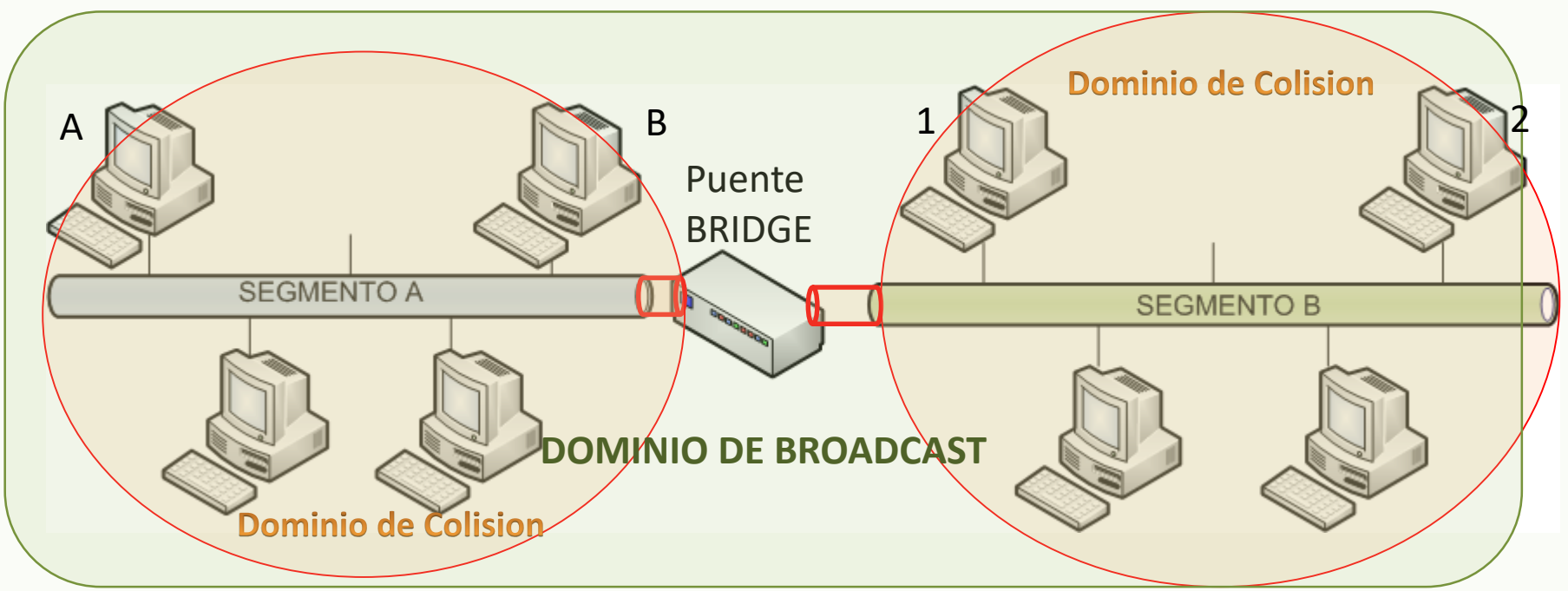
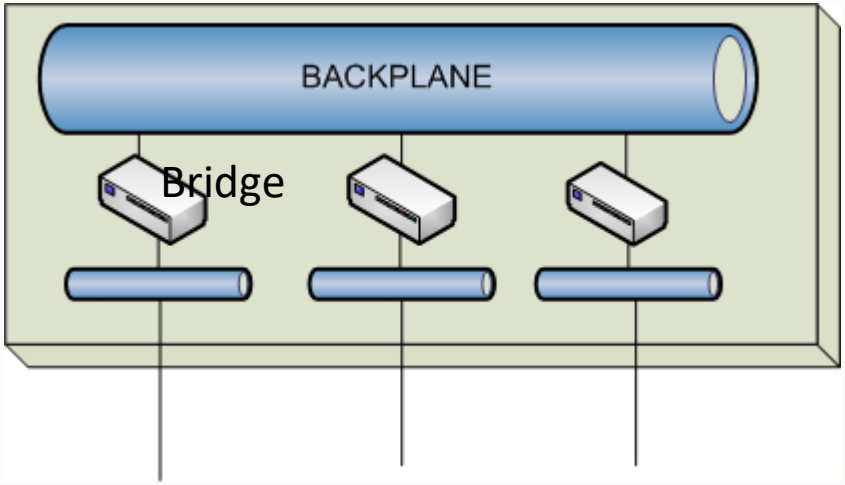


Figure 4-1. Simple three-port switch fabric

Equipamiento : HUB ; BRIDGE y SWITCH



SWITCH



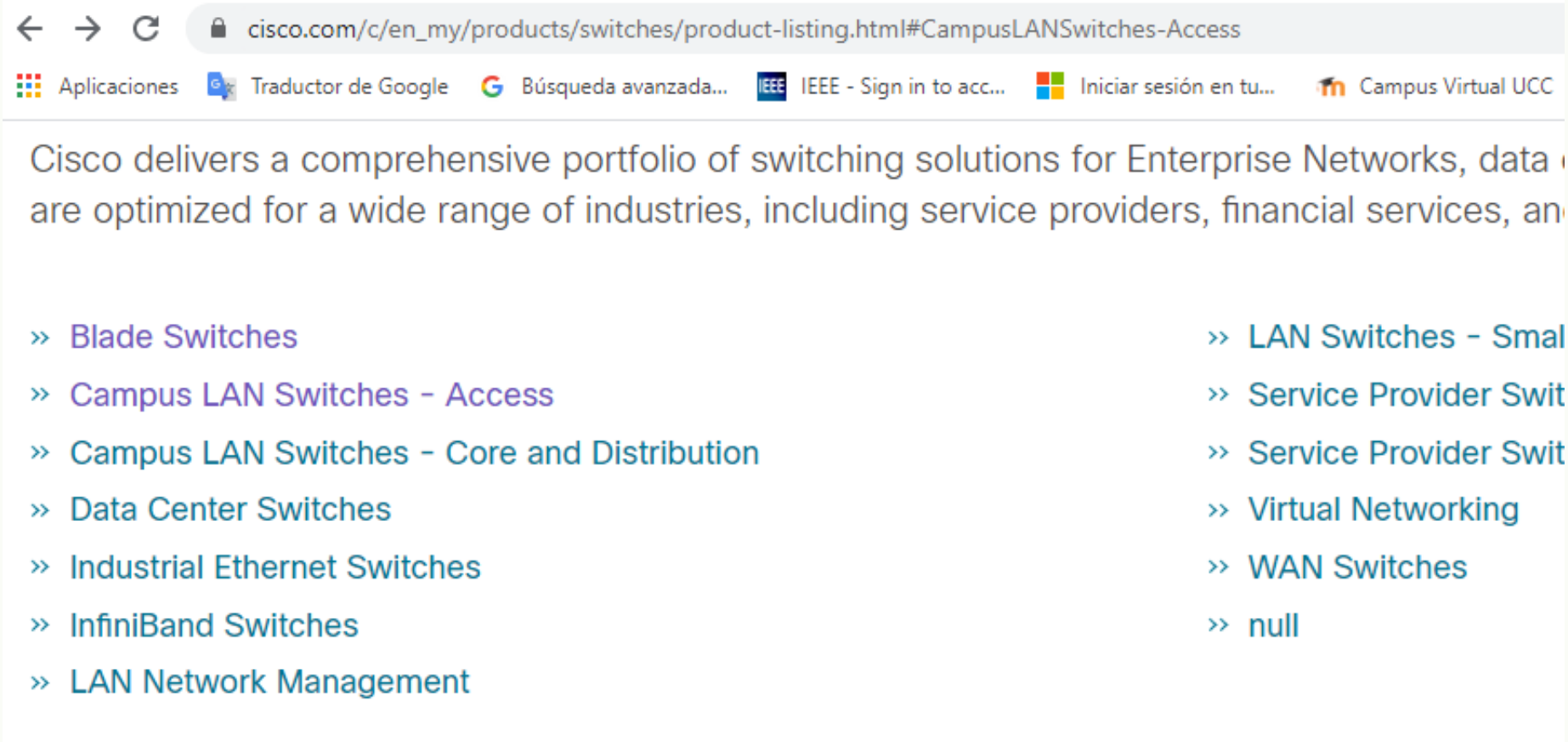
Equipamiento : HUB ; BRIDGE y SWITCH

Características de un Switch :

Funcionalidades :

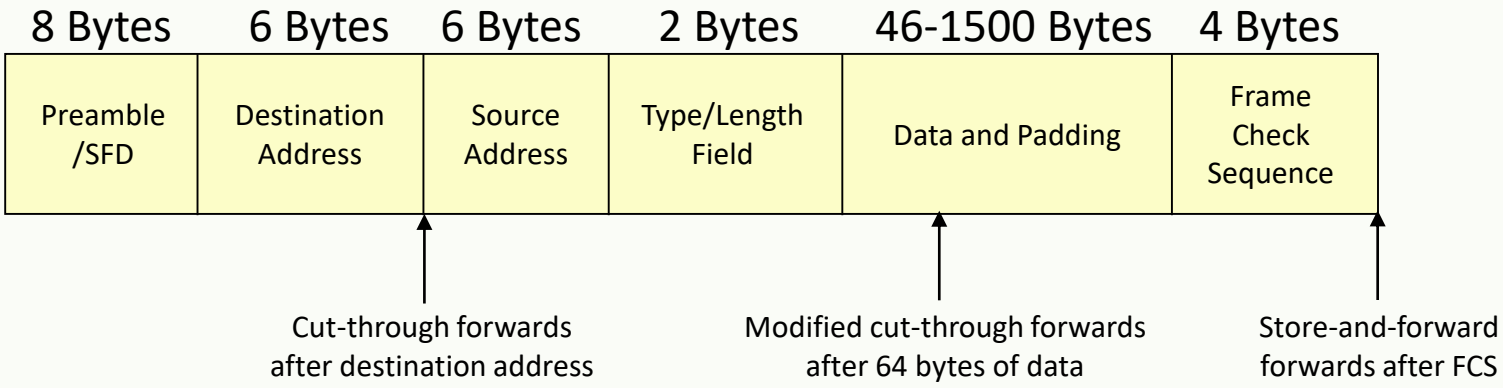
- Conmutación de tramas
  - Cantidad de bocas y características
- Latencia
- Almacenamiento de MAC por boca
- Acorde a las normativas de la IEEE
- Extras…

https://www.cisco.com/c/en_my/products/switches/product-listing.html#LANSwitches-SmallBusiness



Funcionamiento de los switch

- Dos métodos de switching : **store-and-forward and cut-through switching**

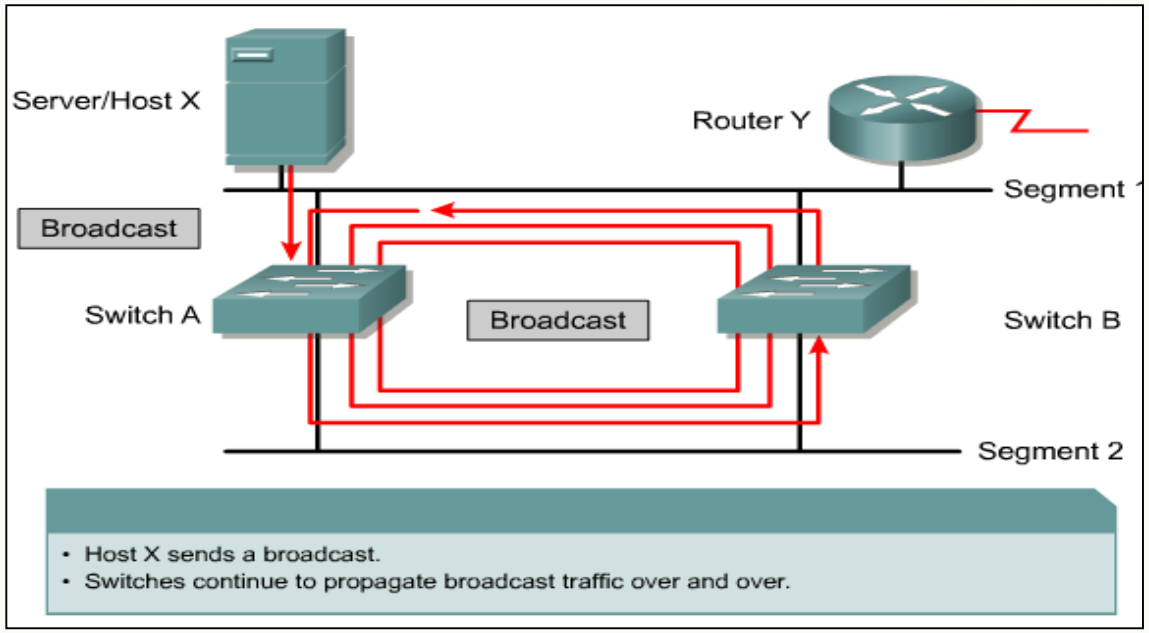


- Switches should employ store-and-forward exclusively (cut-through propagates bad packets)

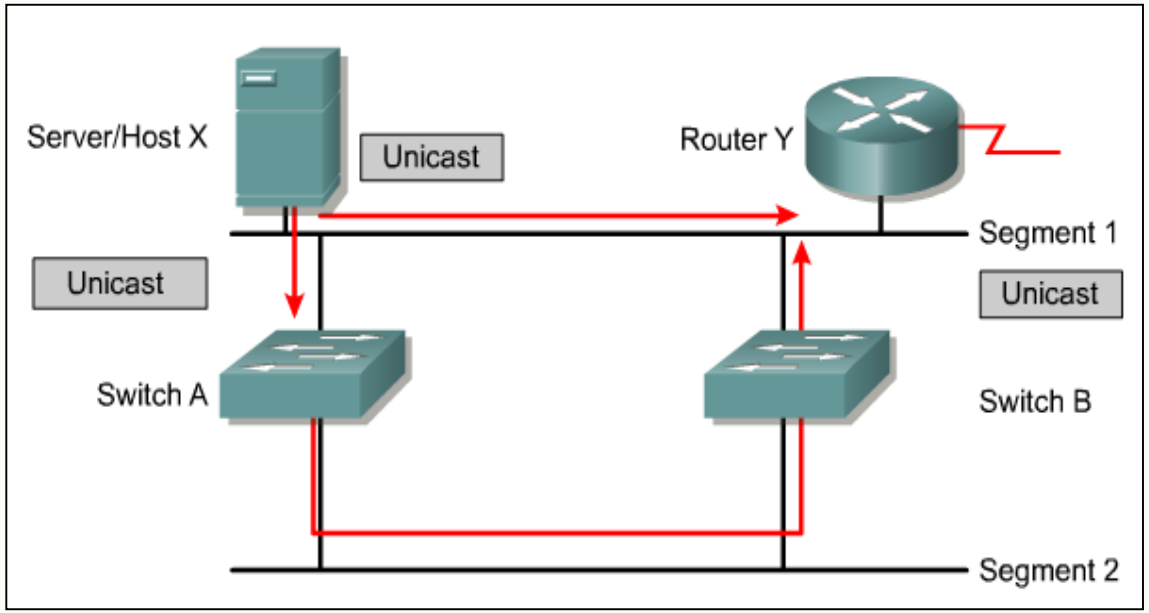
Problemas con los Bridge en lazo..

Con Broadcast

En LAN capa 2, no hay un TTL (time to live!)



Con duplicación ..



Spanning Tree Protocol (STP)

- En las redes de tipo Ethernet no pueden existir loops, porque los frames circularían por ellas sin solución de continuidad.
- Para poder generar esquemas redundantes, tales como topologías de tipo anillo o enlaces duplicados para alta disponibilidad se creo el protocolo Spanning Tree.

Spanning Tre

- Pensado para cor switches, se lo de 802.1d.
- Utiliza un frame e BPDU (Bridge Pro circula por la red.
- Si algún equipo d deshabilita una d involucradas.

Es la 802.1d que lo hace es permitirnos conectar en lazos pero el switch inteligentemente abre una boca para abrir el bucle y evitar que se propagan eternamente los broadcast

Hay una versión mejorada del spanning tree que es el RSTP, porque le spanning tree es lento

RSTP

- Los tiempos de convergencia de STP eran excesivamente lentos (orden del minuto)
- Se lo mejoró con la aparición de RSTP (Rapid Spanning Tree Protocol)
- Los tiempos de convergencia bajaron al orden del segundo.

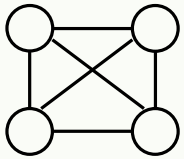
MS

- En redes muy grandes, ter
resulta en tiempos de con
- También había que poder
diferentes VLANs (exceso
- Con MSTP (Multiple Spann
standard 802.1s, es posibl
evitar loops de múltiples V
de una única instancia STP
- También es posible definir
STP que controlen diferent
afectarse unas a otras.

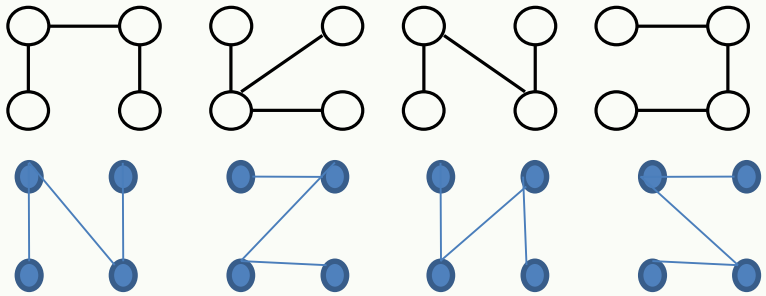
Solución : **Spanning Tree Protocol (STP)**

Se recurre a un procedimiento que recurre al ***Minimum Spanning Trees*** para evitar los lazos.

El ***spanning tree*** de un grafico es aquel árbol que contiene todos sus vértices



A connected, undirected graph



Distintos tipos de algoritmo solucionan el MSP :

- Prim's algorithm : rediscovered in 1957 by Robert C. Prim Choose an arbitrary start node v.
- Kruskal's Algorithm: Created in 1957 by Joseph Kruskal
- **Boruvka's Algorithm:** The original paper was written in Czech in 1926.

El procedimiento utilizado en los switch llamado *spanning tree protocol* y se implementa a través de intercambio de tramas denominadas ***BDPU.***

Spanning tree es simple , pero no siempre resuelve la mejor ruta.

Spanning Tree Protocol (STP) : 802.1

An algorithm,…, used to prevent logic loops in a bridged network by creating a spanning tree… When multiple paths exist,…, STA lets a bridge use only the most efficient one. If that path fails, STA automatically reconfigures the network to make another path become active, sustaining network operations

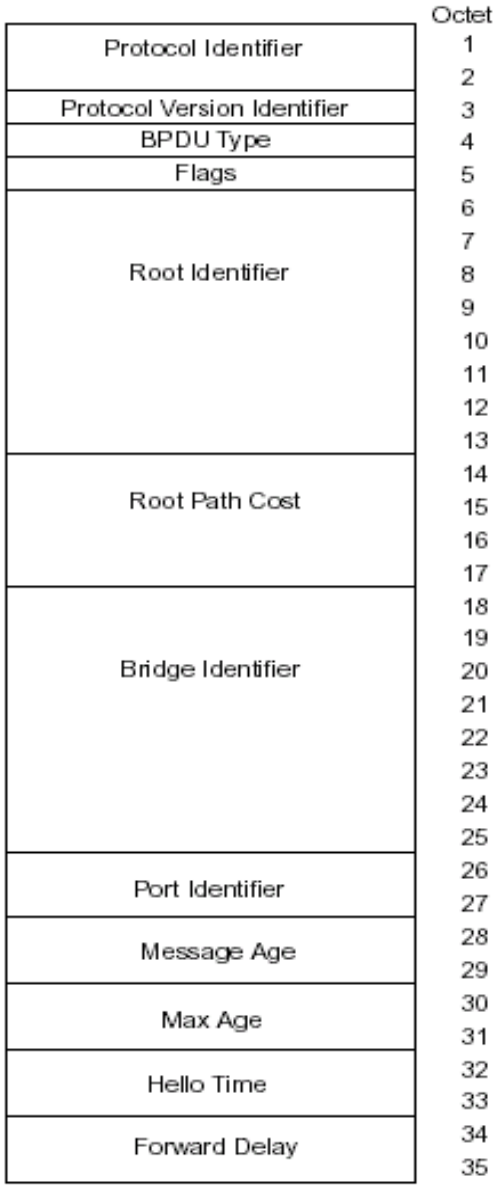


Figure 9-1—Configuration BPDU parameters and format

The Protocol Identifier is the same as for legacy STP. The Version number is 2, since Version number 1 was reserved for 802.1G. The Version 1 Length is as required by 802.1G for versions of 1 or higher.
The flags field contains the following information:

Bit1 : Topology Change Flag

Bit2 : Topology Change Notification Flag

Bits 3 (less significant) and 4:

Encode the following port roles:

0 Unknown

1 Alternate Port (or Backup)

2 Root Port

3 Designated Port

Bit 5 : Learning

Bit 6 : Forwarding

Bit 7 : In Sync

(operational state matches administrative state, prior root ports retired or confirmed)

Bit 8 : Topology Change Acknowledge Flag.

Steps of Spanning Tree Algorithm

1. Determine the root bridge
2. Determine the root port on all other bridges
3. Determine the designated port on each LAN

Los switches intercambian Bridge Protocol Data

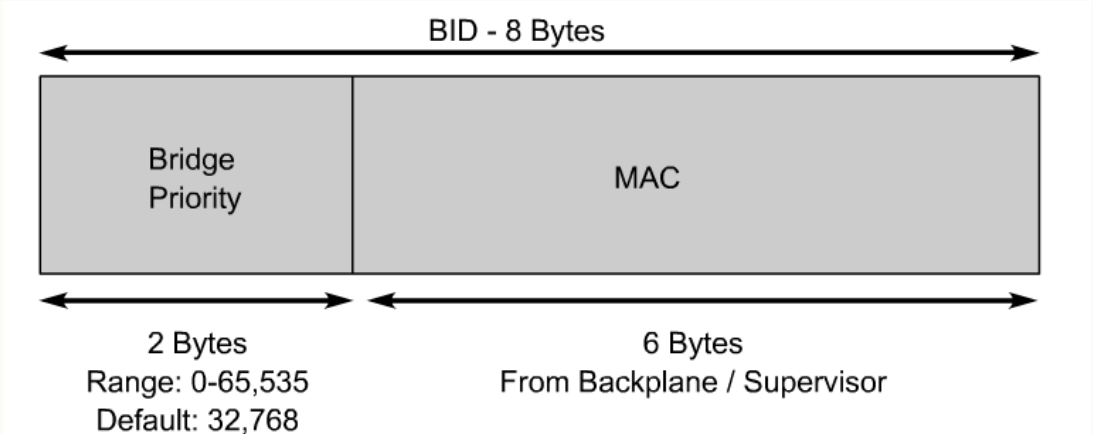
Units para determinar el estado de los puertos.

Define estados para los puertos :

- Blocking: No pasa frames pero escucha BPDU. (RTSP new)
- Listening: No pasa frames pero los escucha. (RTSP new)
- Learning: No pasa frames pero aprende direcciones. (RTSP new)
- Forwarding: pasa frames y aprende direcciones.
- Disabled: No pasa frames y no escucha BPDU.

- Se reservó el grupo de direcciones MAC: 01-80-C2-00-00-00 para el envio de BPDU. Actualmente se usa: 01-80-C2-00-00-01

Path Cost

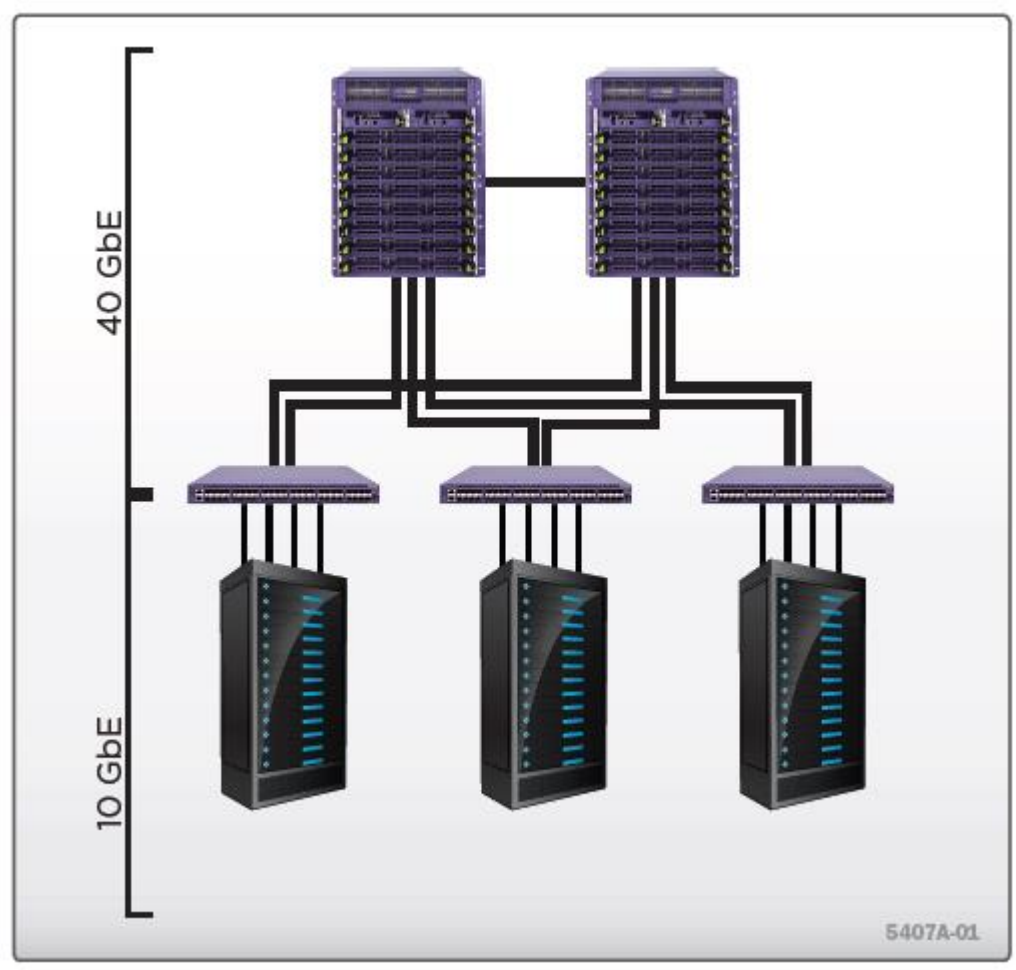


Link Speed	Cost(Revised IEEE Spec)	Cost (Previous IEEE Spec)
10 Gbps	2	1
1 Gbps	4	1
100 Mbps	19	10
10 Mbps	100	100

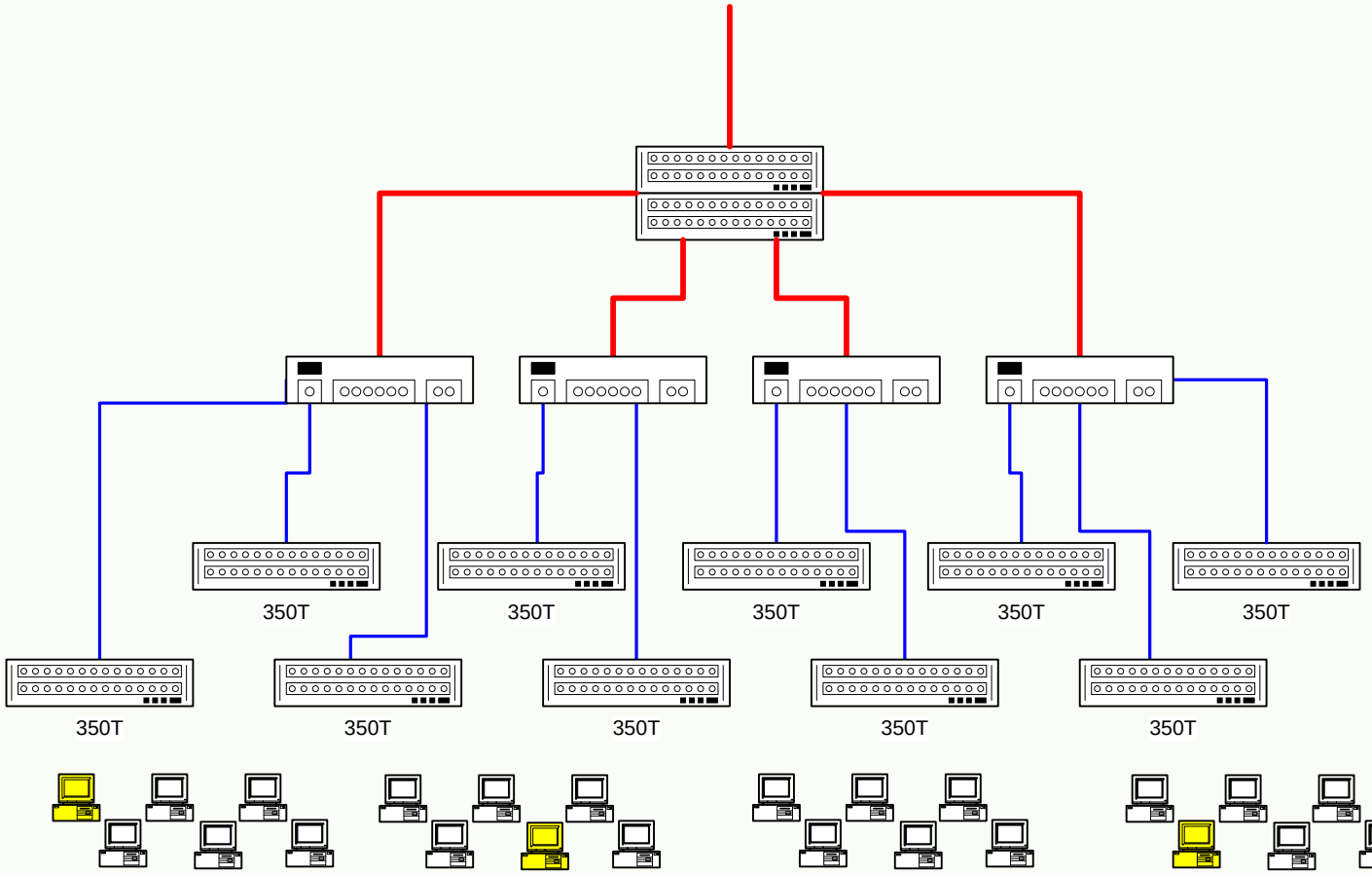
- You can modify the path cost by modifying the cost of a port.
  - Exercise caution when you do this!
- BID and Path Cost are used to develop a loop-free topology .
- Coming very soon!
- But first the **Four-Step STP Decision Sequence**

- IEEE modified the most to use a non-linear scale with the new values of:
  - 4 Mbps 250 (cost)
  - 10 Mbps 100 (cost)
  - 16 Mbps 62 (cost)
  - 45 Mbps 39 (cost)
  - 100 Mbps 19 (cost)
  - 155 Mbps 14 (cost)
  - 622 Mbps 6 (cost)
  - 1 Gbps 4 (cost)
  - 10 Gbps 2 (cost)

Distintos tipos de switch : ?



TOPOLOGIA DE UNA RED LAN ETHERNET



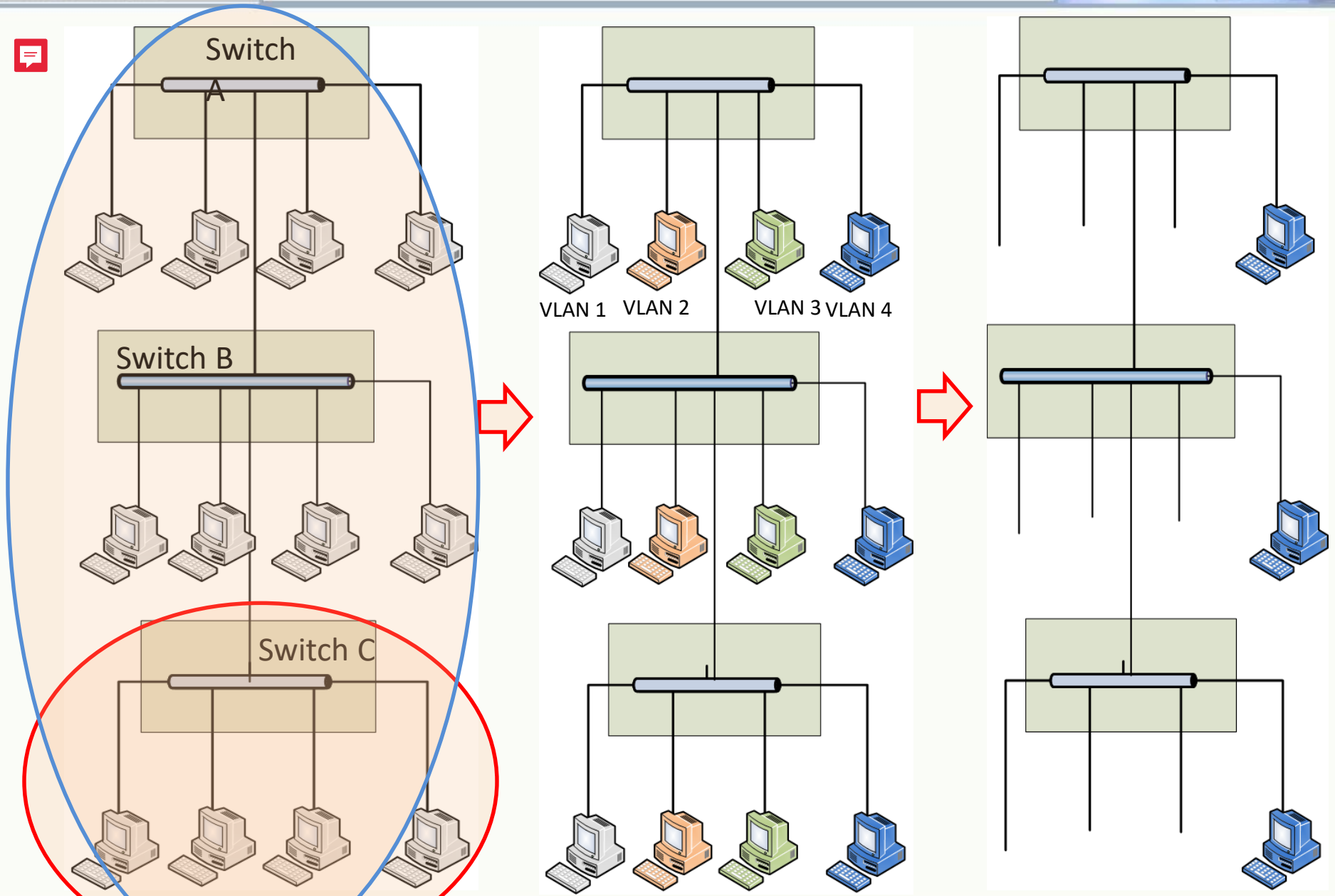
Gigabit Ethernet Switch

100/Giga Ethernet Switch

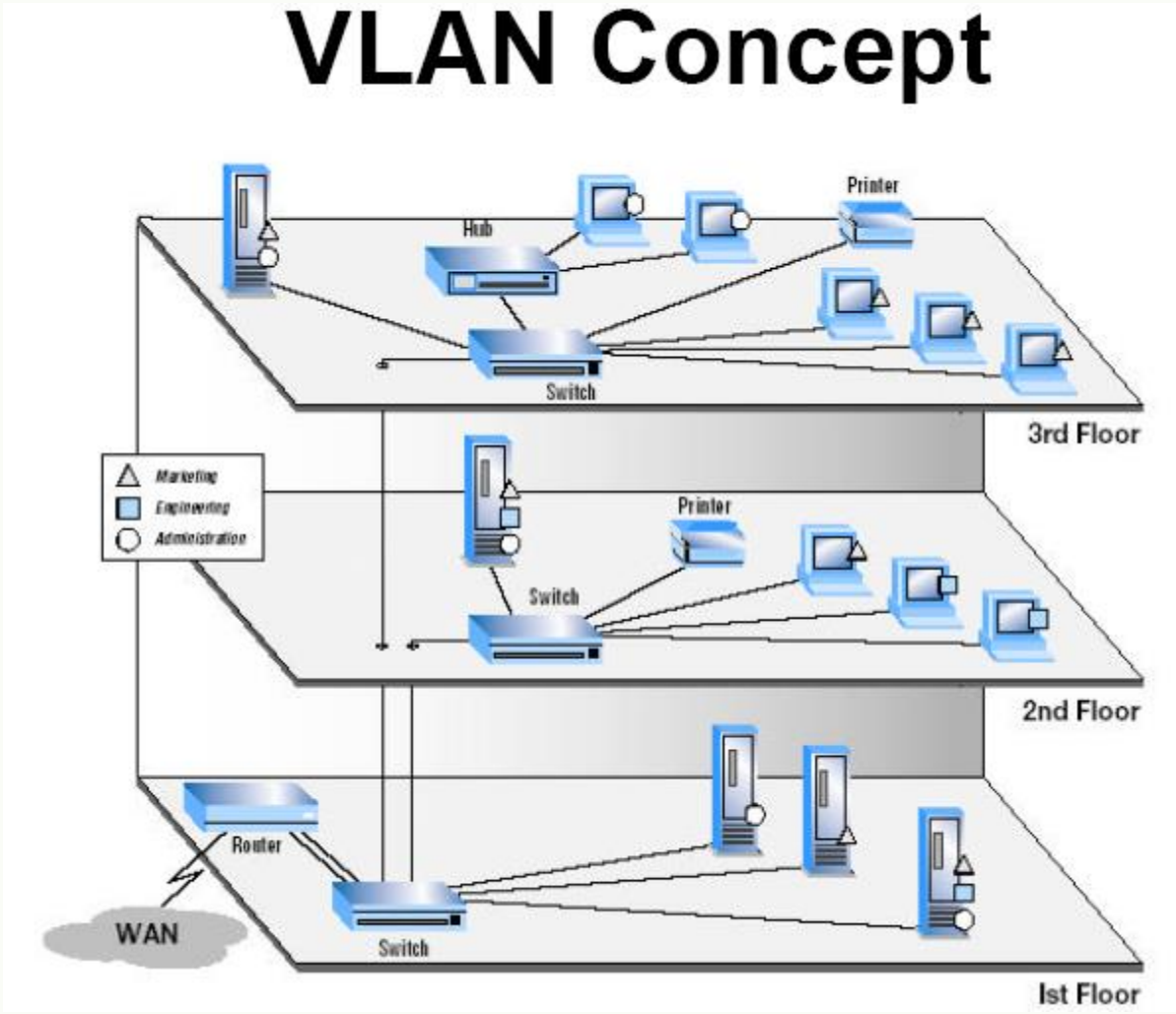
100 Mbps Ethernet Switch

10 /100Mbps Ethernet Host

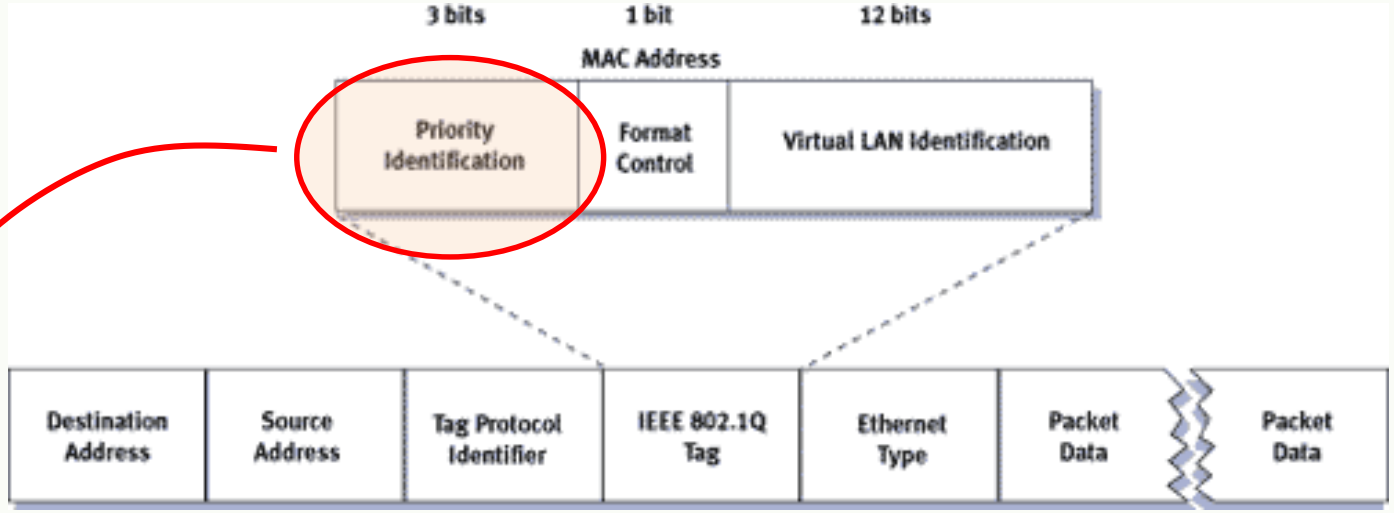
VIRTUAL LAN , VLAN : 802.1Q



VLAN Concept



VIRTUAL LAN , VLAN



802.1p Traffic Class Expediting and Dynamic Multicast Filtering

802.1d Annex G

0 Best Effort
3 Images
5 AV
6 Voice
7 Network Control

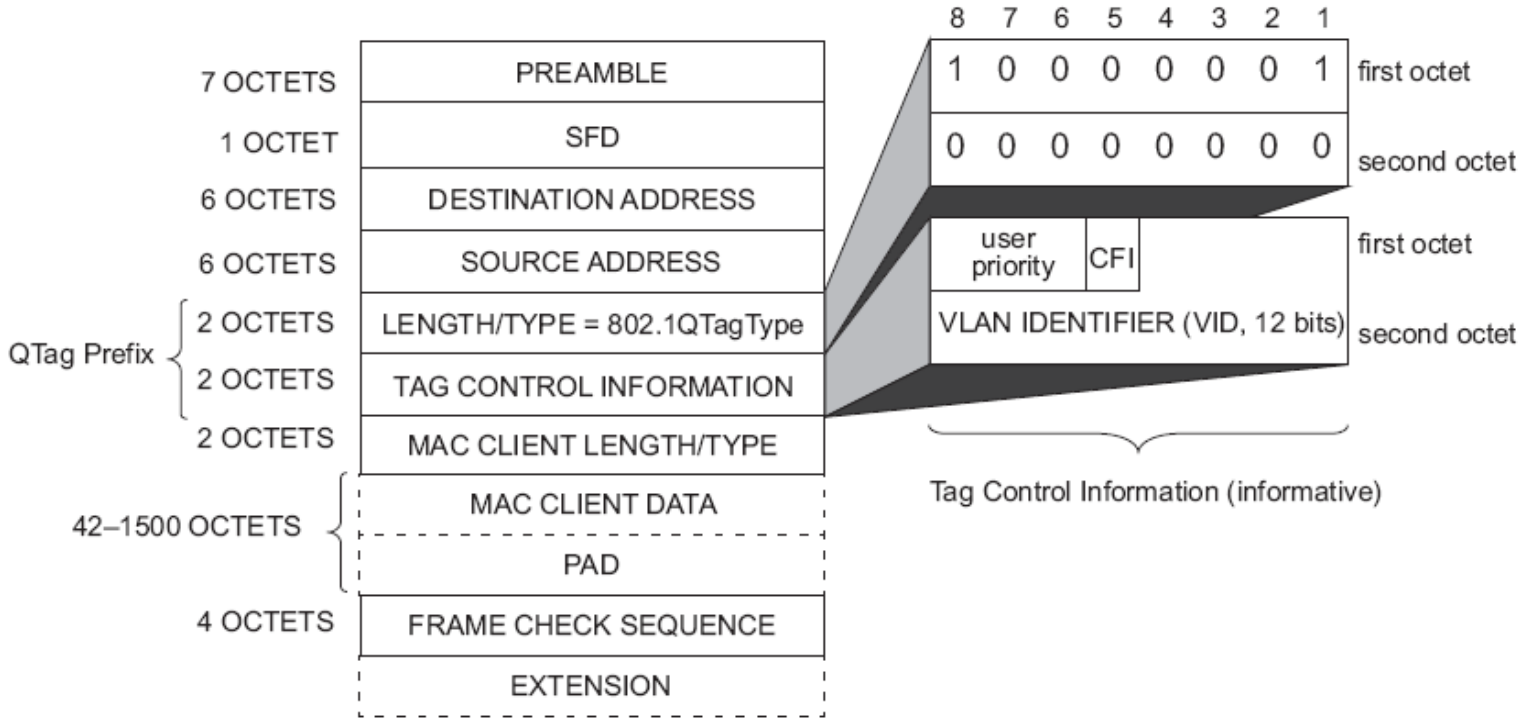


Figure 3–3—Tagged MAC frame format

VIRTUAL LAN POR PORT , VLAN

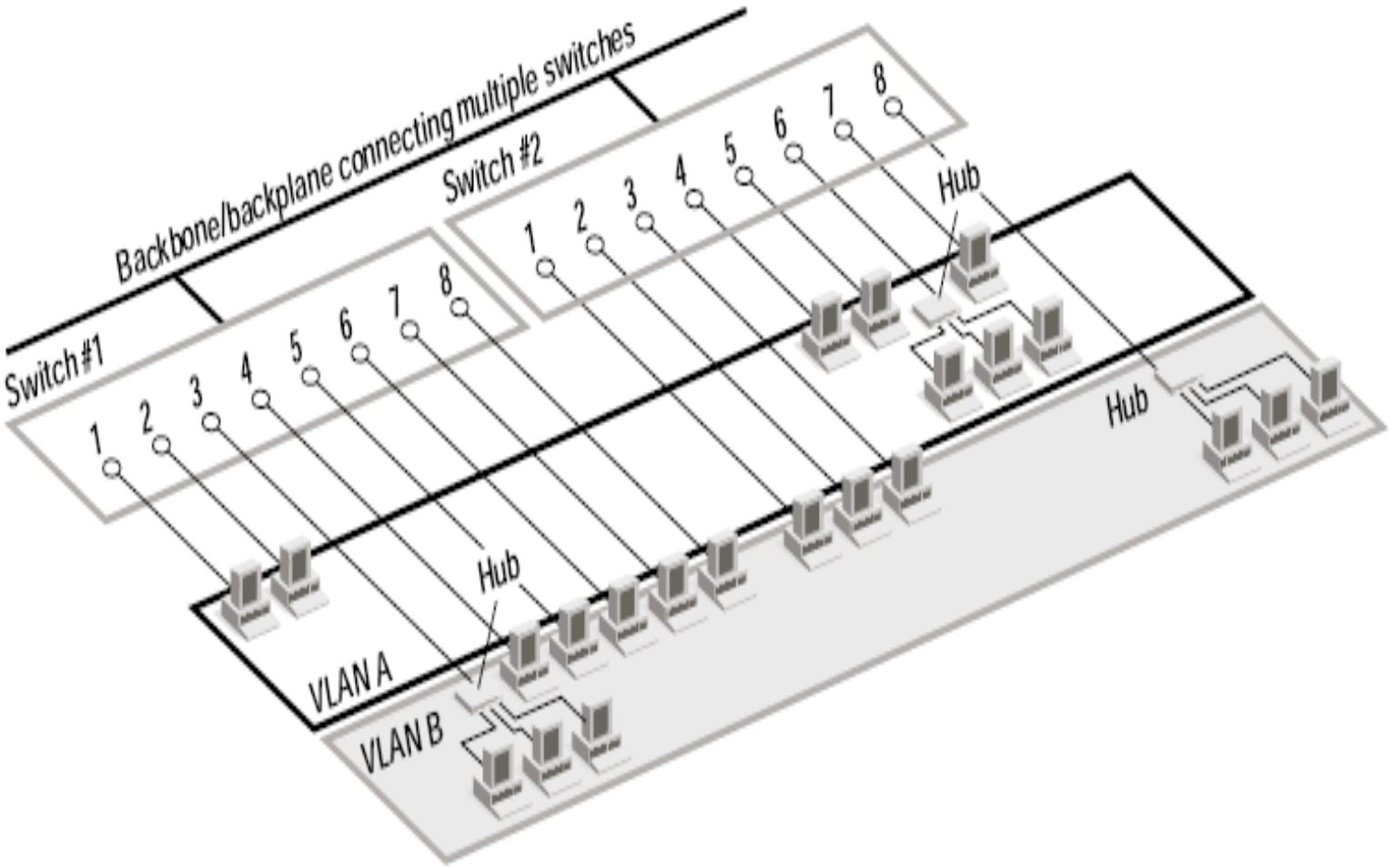
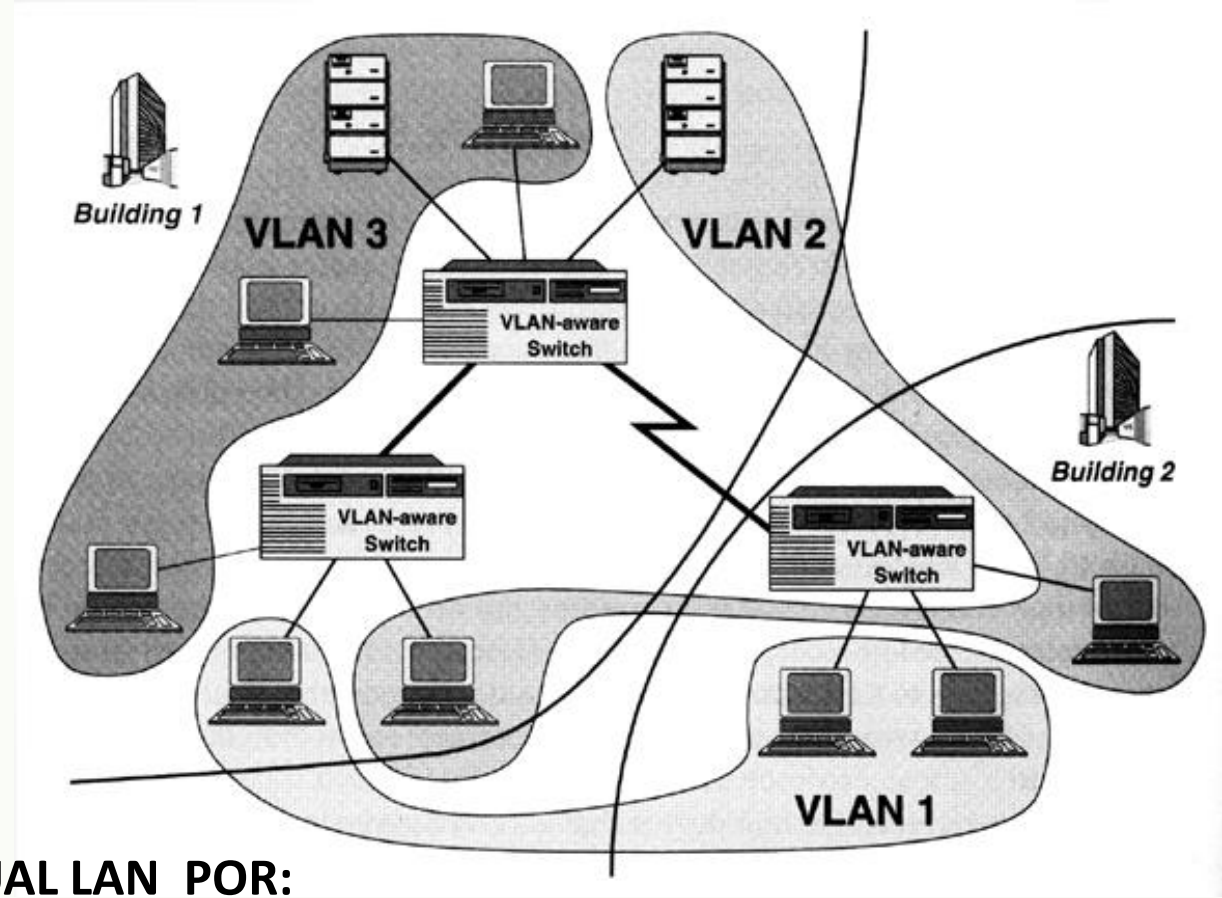


Figure 1. *VLANs Defined by Port Group*



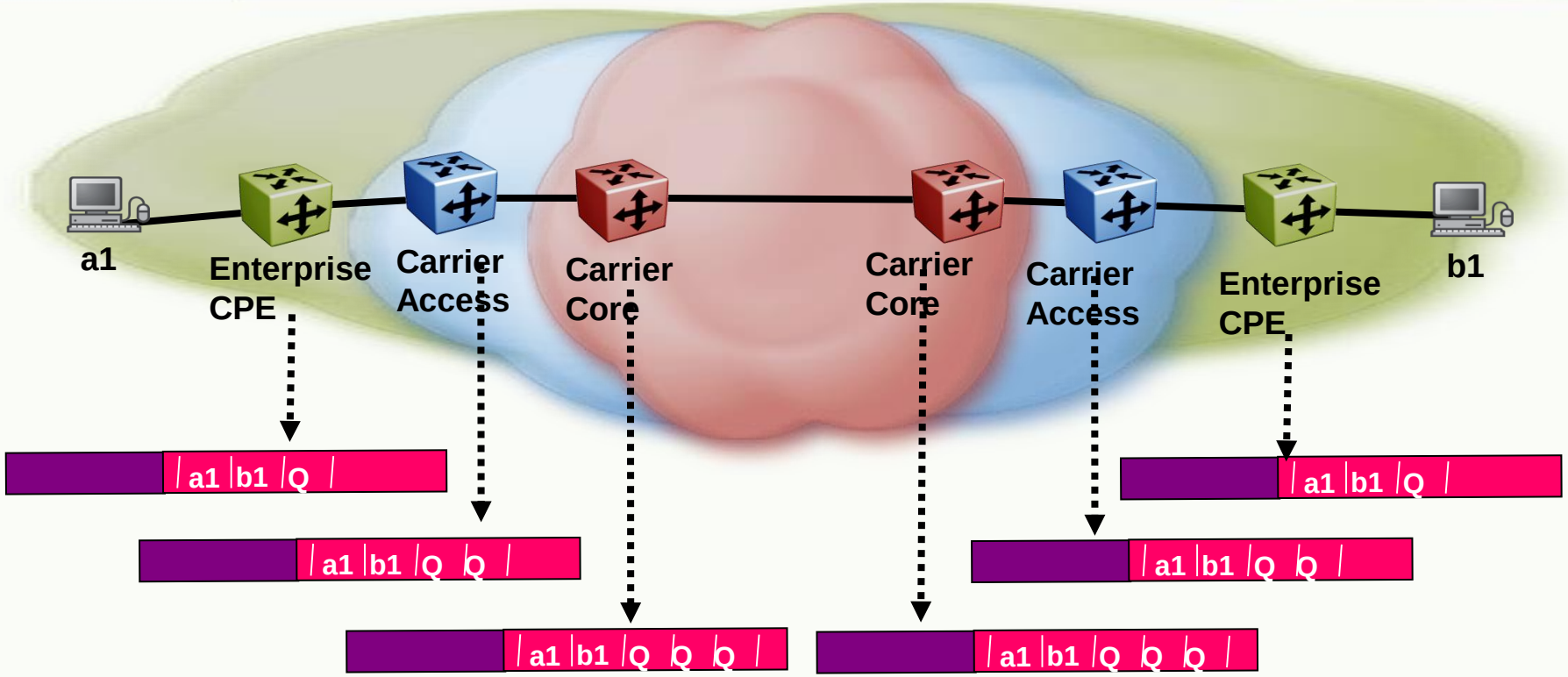
VIRTUAL LAN POR:

1. **PORT.**
2. **MAC address.**
3. **Protocolo de capa 3 (IP, IPX,…).**
4. **Dirección (subnet) de red IP.**

Contemplados en las normativa de la IEEE

Las VLAN se interconectan a nivel 3

IEEE802.1ad QinQ (Stacked VLAN)

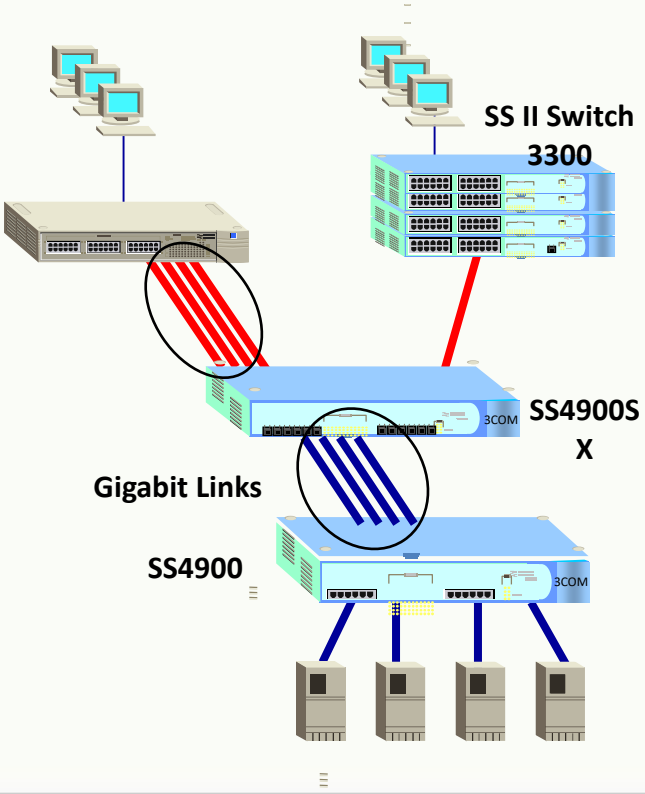


Service Class	Service Characteristics	CoS ID	Bandwidth Profile per EVC per CoS ID	Service Performance
Premium	Real-time IP telephony or IP video applications	6, 7	CIR > 0 EIR = 0	Delay < 5ms Jitter < 1ms Loss < 0.001%
Silver	Bursty mission critical data applications requiring low loss and delay (e.g., Storage)	4, 5	CIR > 0 EIR ≤ UNI Speed	Delay < 5ms Jitter = N/S Loss < 0.01%
Bronze	Bursty data applications requiring bandwidth assurances	3, 4	CIR > 0 EIR ≤ UNI Speed	Delay < 15ms Jitter = N/S Loss < 0.1%
Standard	Best effort service	0, 1, 2	CIR=0 EIR=UNI speed	Delay < 30ms Jitter = N/S Loss < 0.5%

Metro Ethernet Forum

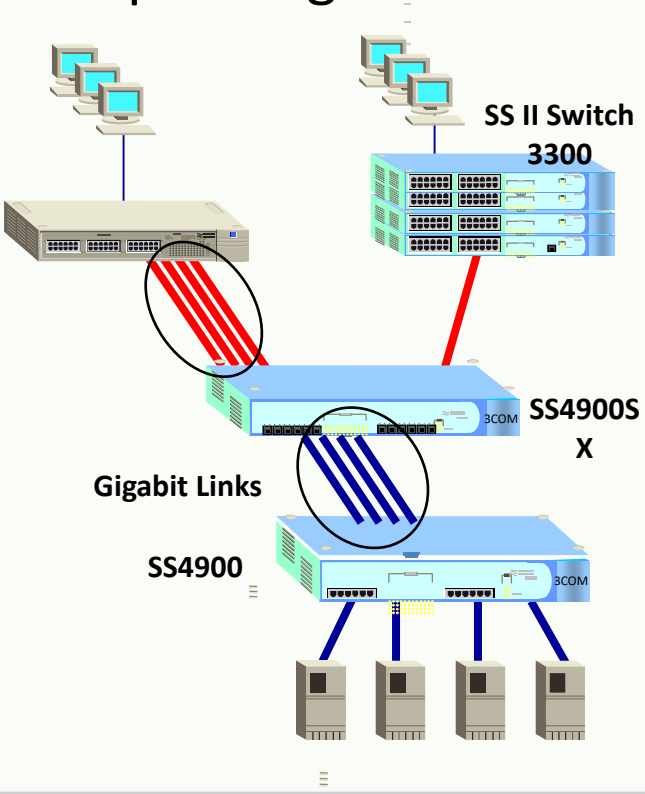
AGREGACION (TRUNKING)

- Norma: 802.3ad
- Agrupación de varios enlaces para incrementar la capacidad.
- Requiere deshabilitar el Spanning Tree.



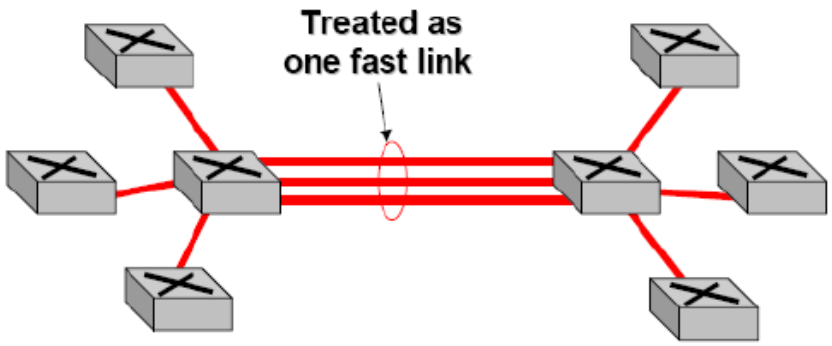
AGREGACION (TRUNKING)

- Norma: 802.3ad
- Agrupación de varios enlaces para incrementar la capacidad.
- Requiere deshabilitar el Spanning Tree.



Incremento del Ancho de Banda

10 Gigabit Ethernet and Standard Link Aggregation



Add bandwidth with minimal network disruption

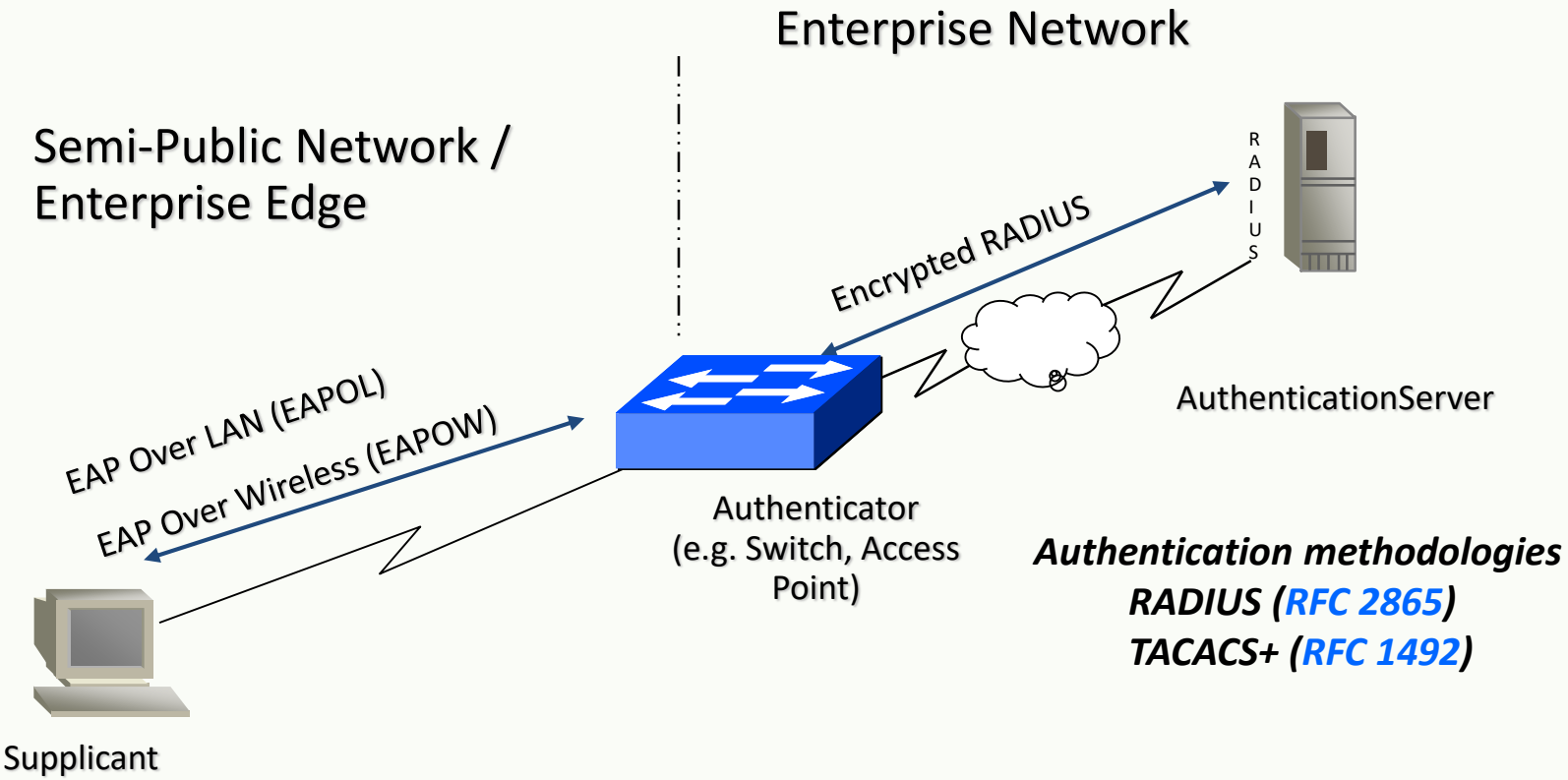
802.3ad

Seguridad en CAPA 2 -LAN

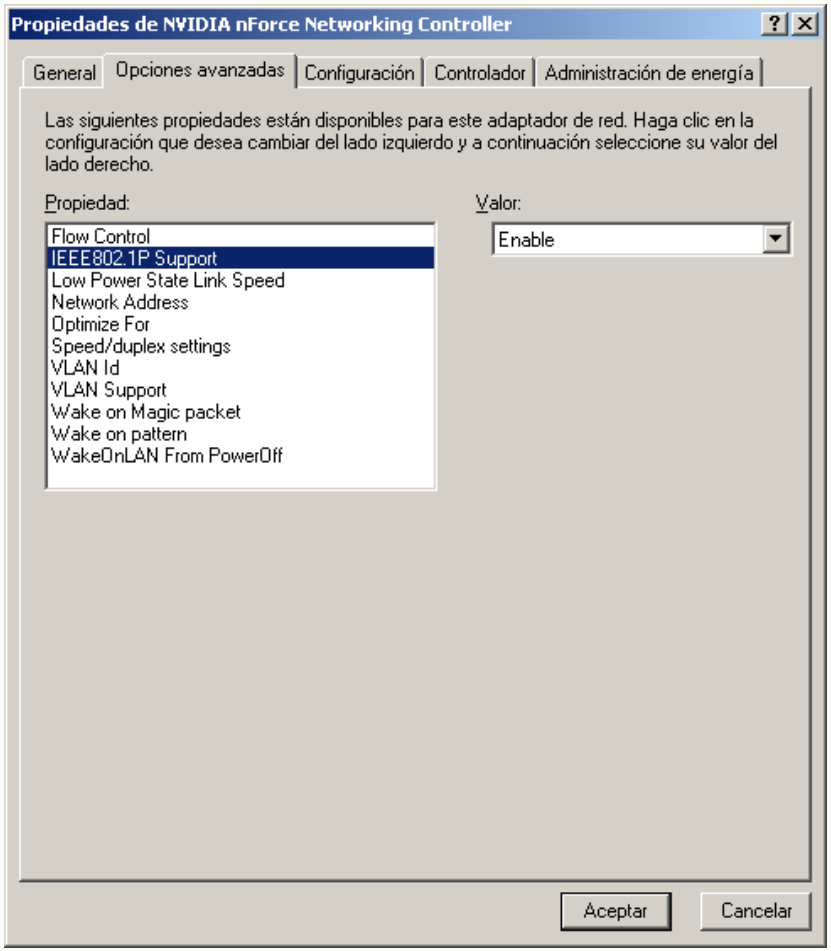
Tipos de ataques :

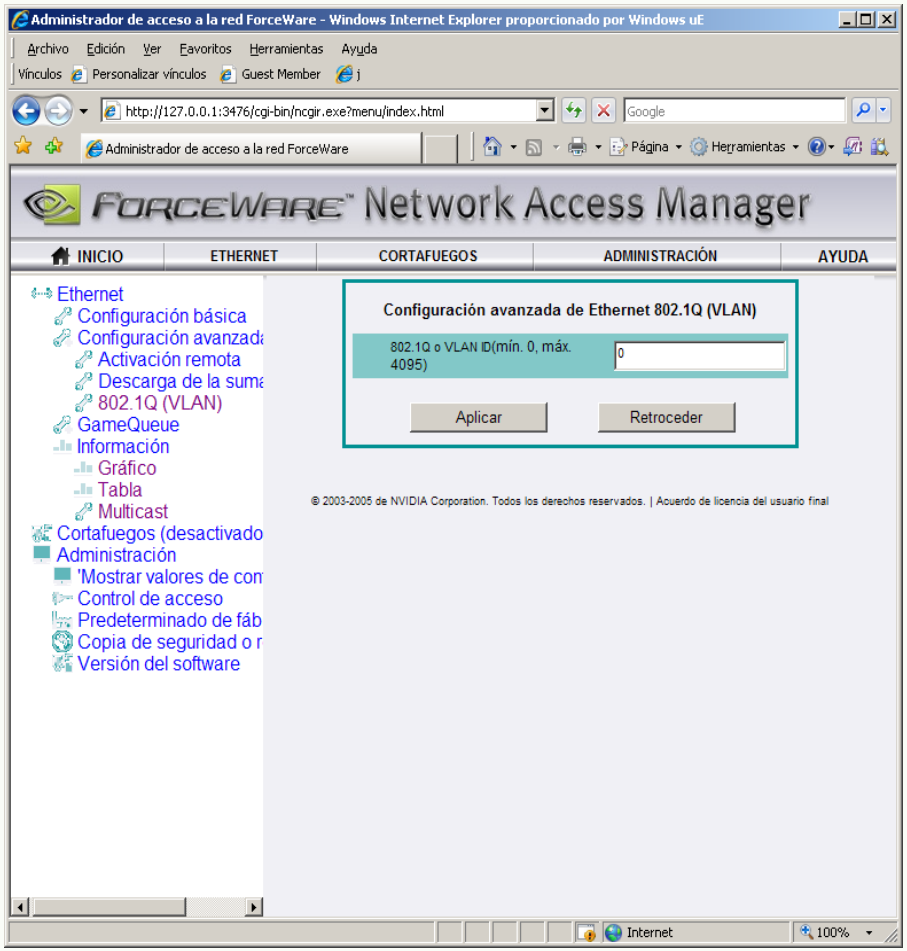
- CAM table overflow
- Media Access Control (MAC) address spoofing (ARP)

IEEE 802.1X Terminology



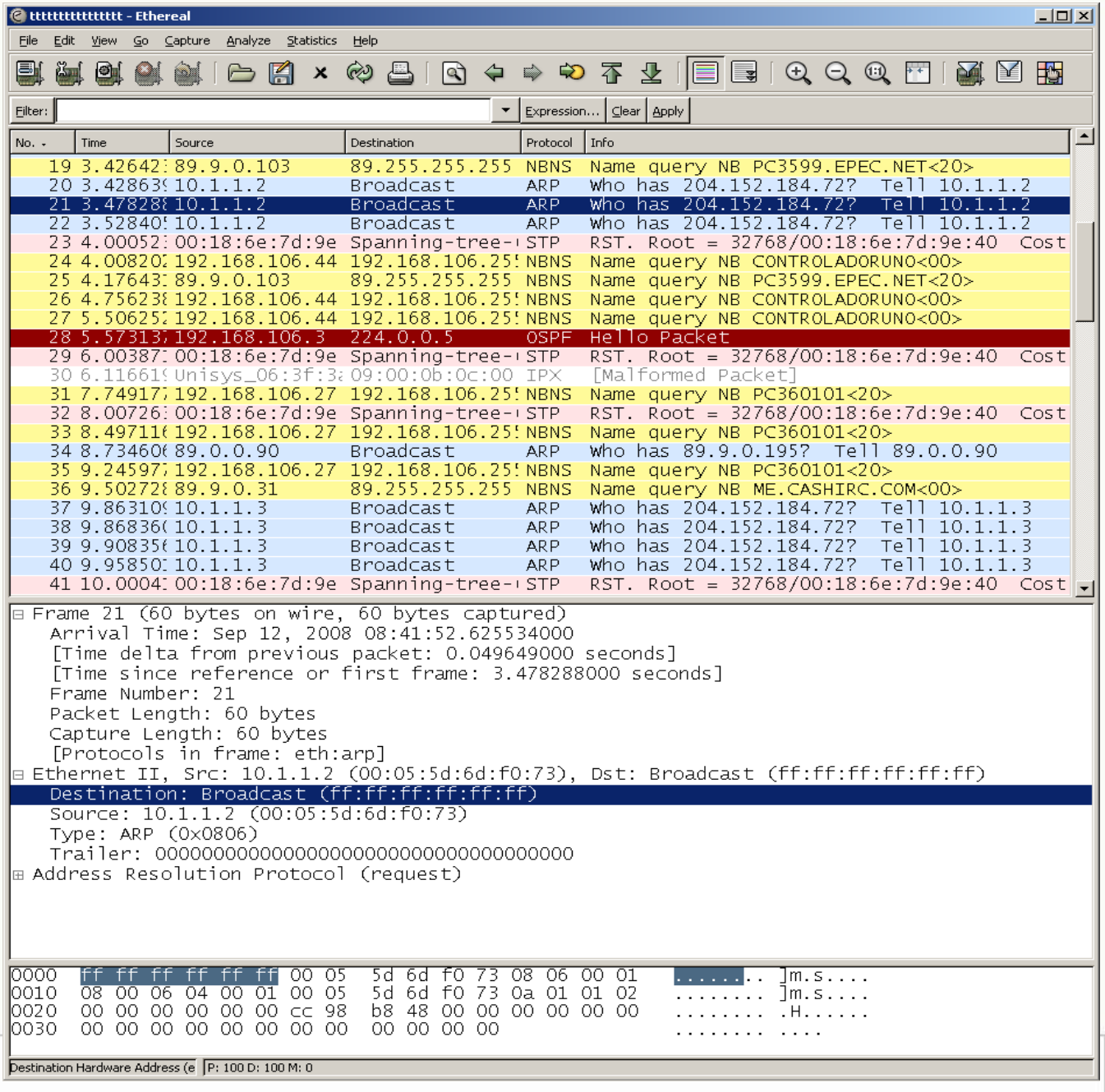
En la PC…


Propiedades de NVIDIA nForce Networking Controller
General
Opciones avanzadas
Configuración
Controlador
Administración de energía
Las siguientes propiedades están disponibles para este adaptador de red. Haga clic en la configuración que desea cambiar del lado izquierdo y a continuación seleccione su valor del lado derecho.
Propiedad:
Valor:
Flow Control
IEEE802.1P Support
Low Power State Link Speed
Network Address
Optimize For
Speed/duplex settings
VLAN Id
VLAN Support
Wake on Magic packet
Wake on pattern
WakeOnLAN From PowerOff
Enable
Aceptar
Cancelar

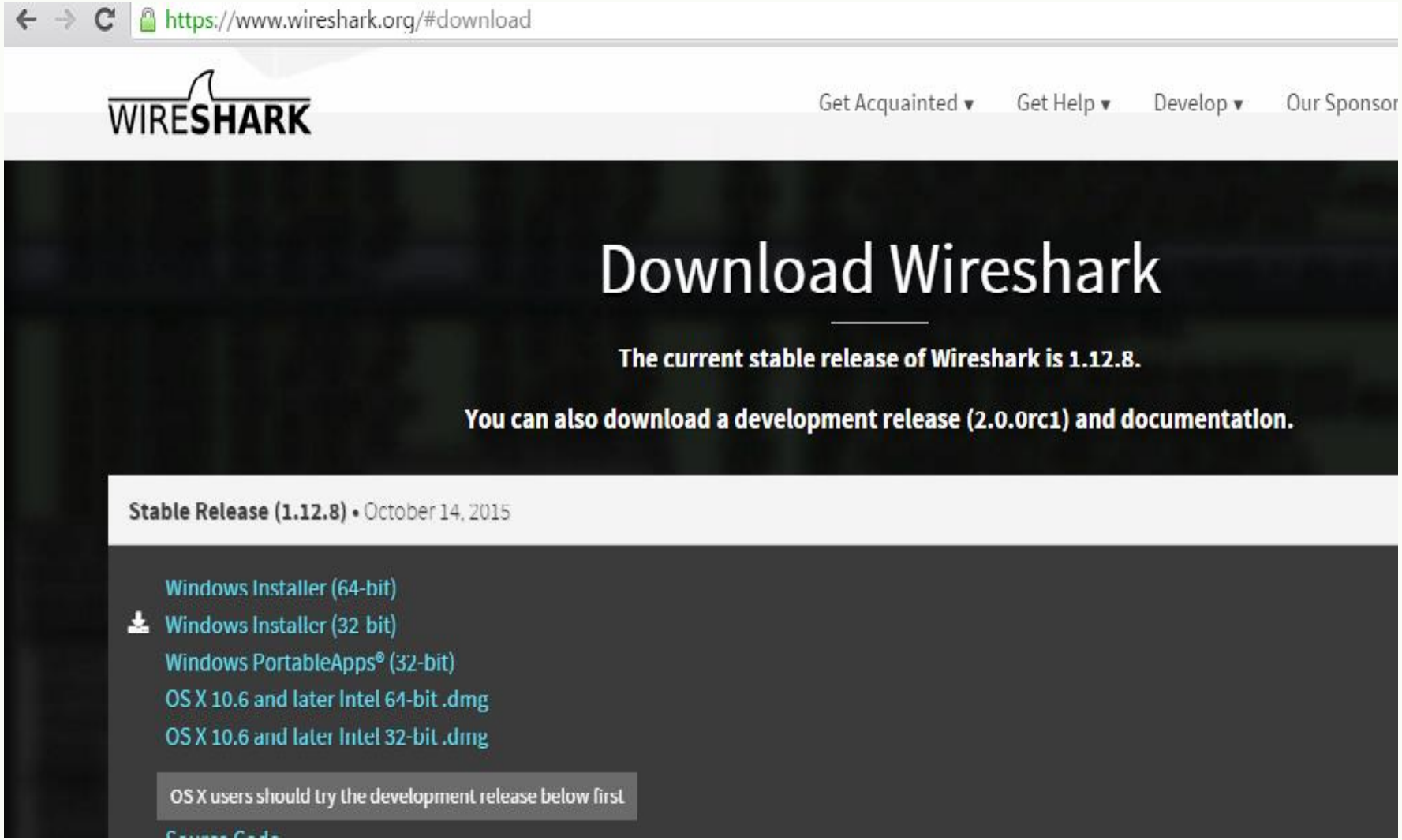

Administrador de acceso a la red ForceWare - Windows Internet Explorer proporcionado por Windows uE
Archivo Edición Ver Favoritos Herramientas Ayuda
Vínculos Personalizar vínculos Guest Member
http://127.0.0.1:3476/cgi-bin/ncgir.exe?menu/index.html
Administrador de acceso a la red ForceWare
ForceWare Network Access Manager
INICIO
ETHERNET
CORTAFUEGOS
ADMINISTRACIÓN
AYUDA
Ethernet
Configuración básica
Activación remota
802.1Q (VLAN)
GameQueue
Información
Gráfico
Tabla
Multicast
Cortafuegos (desactivado
Administración
Control de acceso
Versión del software
Configuración avanzada de Ethernet 802.1Q (VLAN)
802.1Q o VLAN ID(mín. 0, máx. 4095)
Aplicar
Retroceder
© 2003-2005 de NVIDIA Corporation. Todos los derechos reservados. | Acuerdo de licencia del usuario final
Internet
100%

Analizadores de red Ethernet

Ethereal



http://ethereal.archive.sunet.se


https://www.wireshark.org/#download
WIRESHARK
Get Acquainted ▾
Get Help ▾
Develop ▾
Our Sponsor
Download Wireshark
The current stable release of Wireshark is 1.12.8.
You can also download a development release (2.0.0rc1) and documentation.
Stable Release (1.12.8) • October 14, 2015
Windows Installer (64-bit)
Windows Installer (32 bit)
Windows PortableApps® (32-bit)
OS X 10.6 and later Intel 64-bit .dmg
OS X 10.6 and later Intel 32-bit .dmg
OS X users should try the development release below first

MetroEthernet : Ethernet en MAN y WAN

http://www.metroethernetforum.org

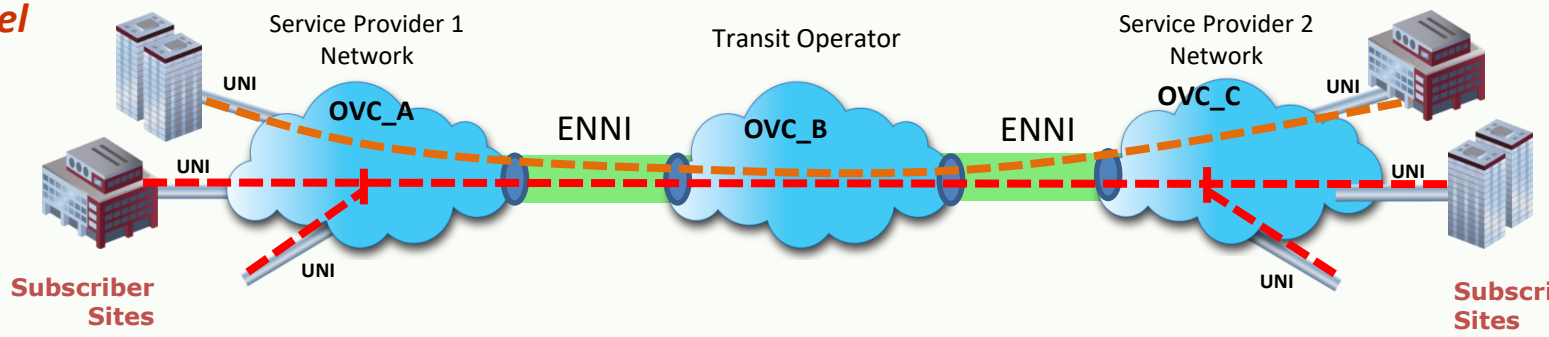
CARRIER ETHERNET MEF Certified Compliant ™

About the MEF … The MEF, as the defining body for Carrier Ethernet is a global industry alliance comprising more than 175 organizations including telecommunications service providers, cable MSOs, network equipment/software manufacturers, semiconductors vendors and testing organizations. The MEF's mission is to accelerate the worldwide adoption of Carrier-class Ethernet networks and services. The MEF develops Carrier Ethernet technical specifications and implementation agreements to promote interoperability and deployment of Carrier Ethernet worldwide.

Purpose The MEF develops technical specifications and implementation agreements to promote interoperability and deployment of Carrier Ethernet worldwide.

Mission **The MEF's mission is to accelerate the worldwide adoption of Carrier-class Ethernet networks and services**

Transit Model



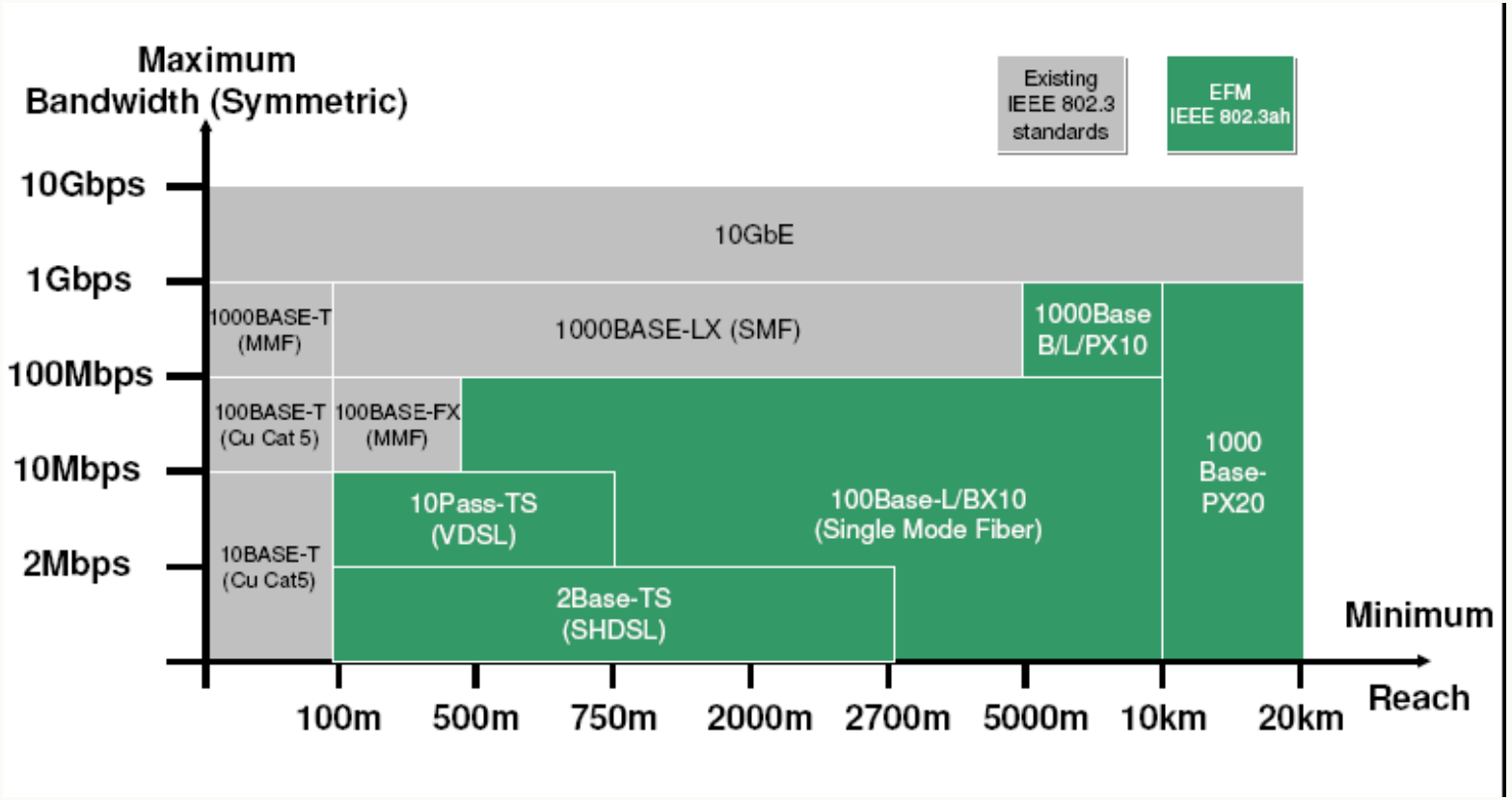
Ethernet in the First Mile

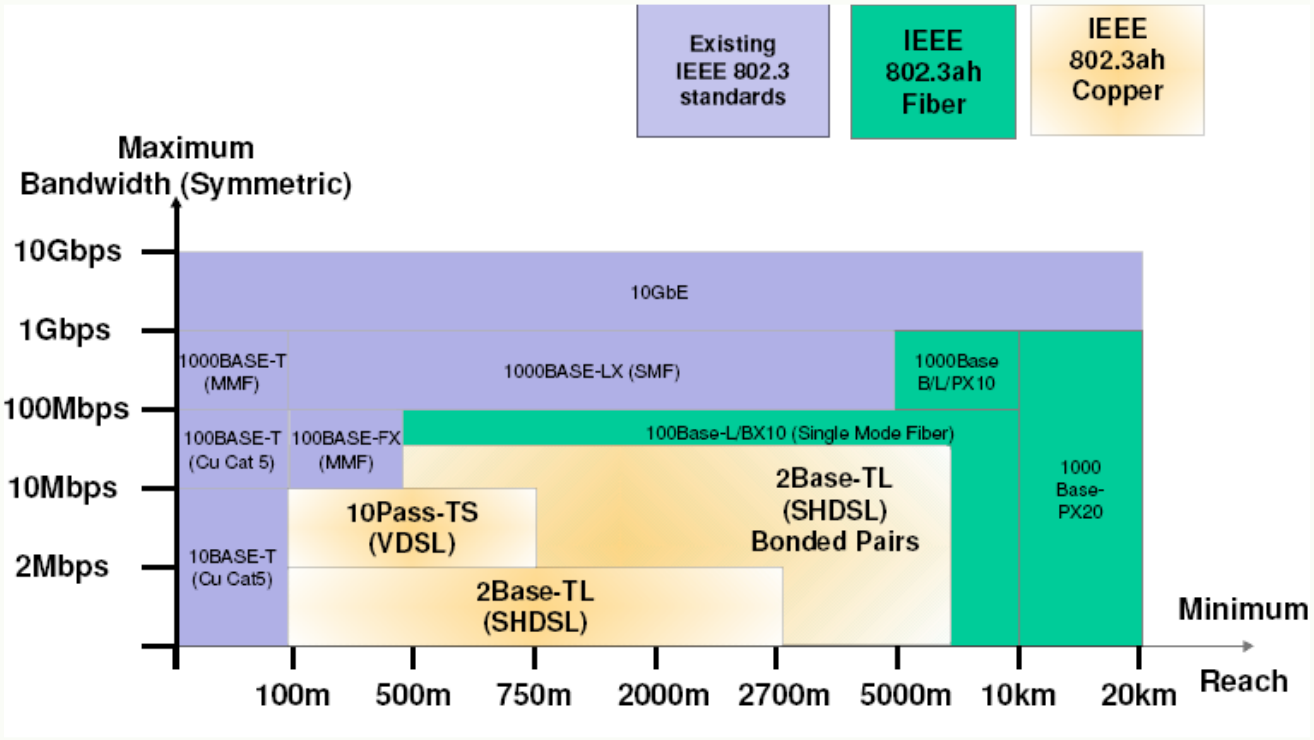
802.3ah

Ethernet in the First Mile (**EFM**), también conocido como

IEEE 802.3ah

es una colección de protocolos incorporados al standard IEEE 802.3 (versión 2005) que definen Ethernet en las redes de acceso (Primera/Ultima Milla)


Maximum
Bandwidth (Symmetric)
Existing
IEEE 802.3
standards
EFM
IEEE 802.3ah
10Gbps
1Gbps
100Mbps
10Mbps
2Mbps
10GbE
1000BASE-T
(MMF)
1000BASE-LX (SMF)
1000Base
B/L/PX10
100BASE-T
(Cu Cat 5)
100BASE-FX
(MMF)
1000
Base-
PX20
10Pass-TS
(VDSL)
100Base-L/BX10
(Single Mode Fiber)
10BASE-T
(Cu Cat5)
2Base-TS
(SHDSL)
Minimum
Reach
100m
500m
750m
2000m
2700m
5000m
10km
20km


Existing IEEE 802.3 standards
IEEE 802.3ah Fiber
IEEE 802.3ah Copper
Maximum Bandwidth (Symmetric)
10Gbps
1Gbps
100Mbps
10Mbps
2Mbps
10GbE
1000BASE-T (MMF)
1000BASE-LX (SMF)
1000Base B/L/PX10
100BASE-T (Cu Cat 5)
100BASE-FX (MMF)
100Base-L/BX10 (Single Mode Fiber)
1000 Base-PX20
10Pass-TS (VDSL)
2Base-TL (SHDSL) Bonded Pairs
10BASE-T (Cu Cat5)
2Base-TL (SHDSL)
Minimum
100m
500m
750m
2000m
2700m
5000m
10km
20km
Reach

Members

Dr. Robert M. Metcalfe
Ethernet Inventor, 3Com Founder,
Polaris Ventures Partner
Advisory Director, MEF

Nan Chen
President and Director
MEF

Dennis R. Kruse
Chairman of the Board, MEF
Vice President
Network Solutions
Orange Business Services

Ralph Santitoro
Director, MEF
Fujitsu Network
Communications

Margaret T. Chiosi
Director, MEF
Executive Director of Optics and
Ethernet Development
AT&T

Robert Kuse
Director, MEF
Transport Planning &
Architecture
Cox Communications

Matt Squire
Director, MEF
Chief Technology Officer,
Hatteras Networks

Arie Goldberg
Director MEF
Founder & CEO
Omnitron Systems

Kevin O'Toole
Director, MEF
Vice President, Business
Products & Strategy, Comcast

Lionel Florit
Director, MEF
Senior Manager,
Cisco Systems

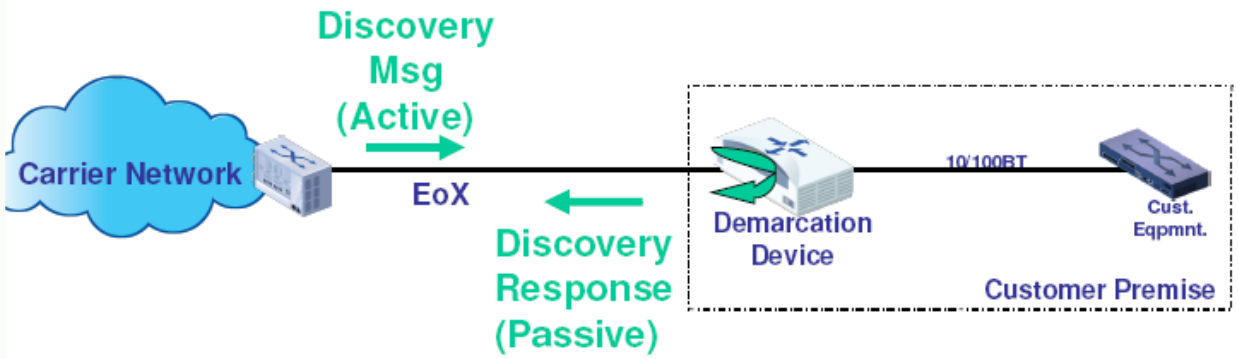
Michael Volgende
Director, MEF
Director Global Ethernet
Services
Verizon

Craig Easley
Director, MEF
Vice President, Marketing
Matisse Networks

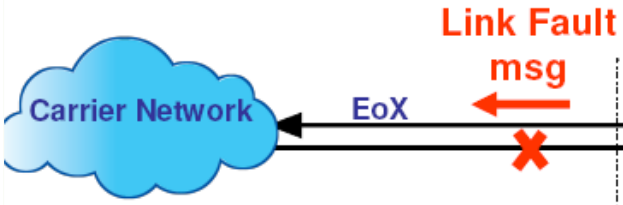
Huiling Zhao
Director, MEF
Vice President, Marketing
Matisse Networks

Facultad de Ingeniería
Universidad de Buenos Aires

Discovery - EFM



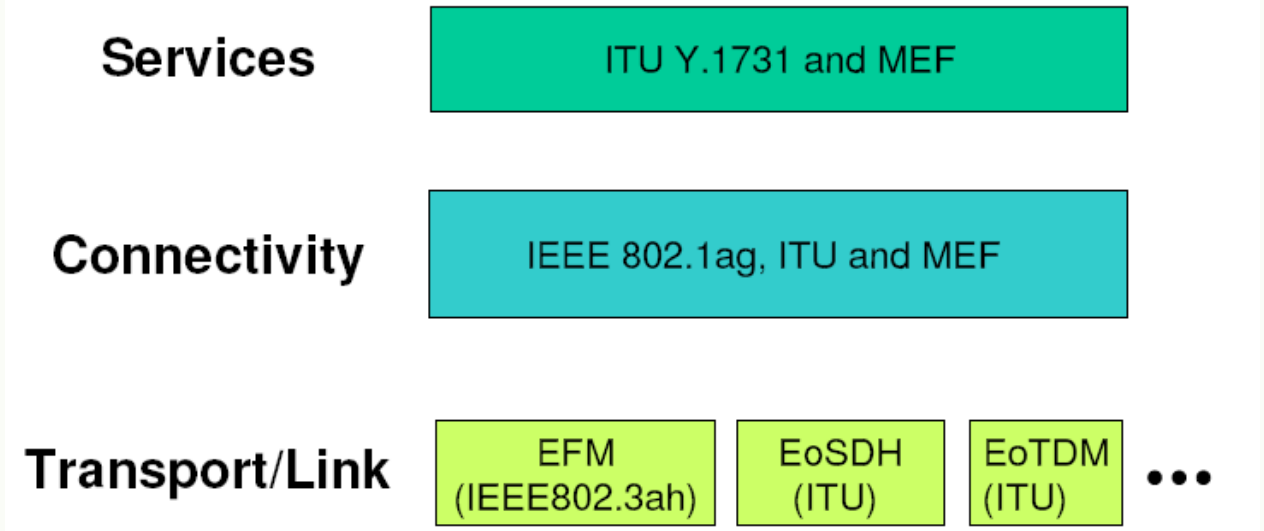
- Permite al Switch PE determinar la capacidad para OAM del dispositivo de demarcación.
- El soporte de 802.3ah OAM es “opcional”
- Si ambos extremos soportan OAM, entonces intercambian estado y configuración.



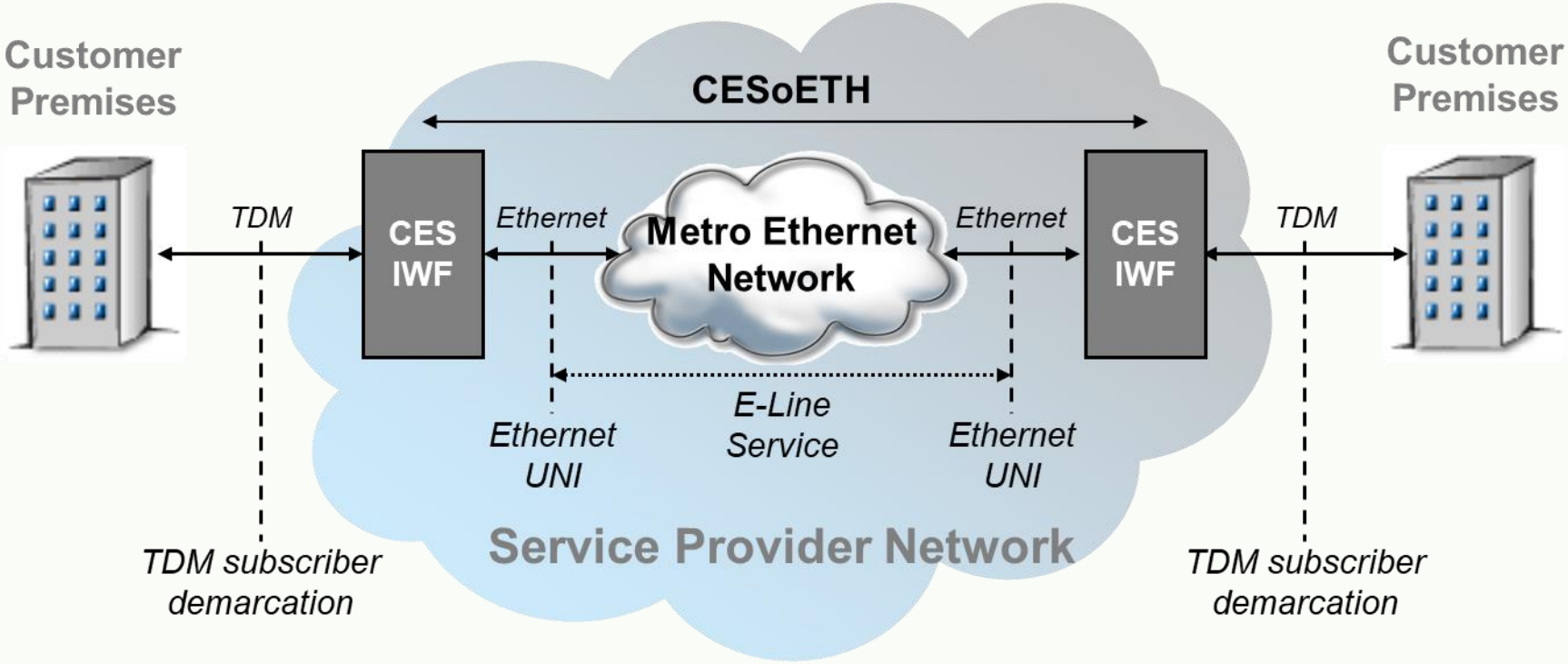
- **Link Fault – Por ejemplo por el receptor**
  - **Transmitido una vez po**
- **Critical Event – Falla es o alarma de software.**
  - **Transmitido inmediata**

Facultad de Ingeniería
Universidad de Buenos Aires

Ethernet OAM Layers



- **TDM Line Service (T-Line):**
  - Application: Leased line replacement



Carrier Ethernet Terminology

- UNI (User-to-Network Interface)
  - Physical interface/demarcation between service provider and subscriber
  - Service start/end point
- **Ethernet Virtual Connection (EVC)**
  - An association of two or more UNIs
- **Three types of EVC**
  - **Point-to-Point**
  - **Multipoint-to-Multipoint**
  - **Rooted Multipoint (Point-to-Multipoint)**
- EVCs and Services

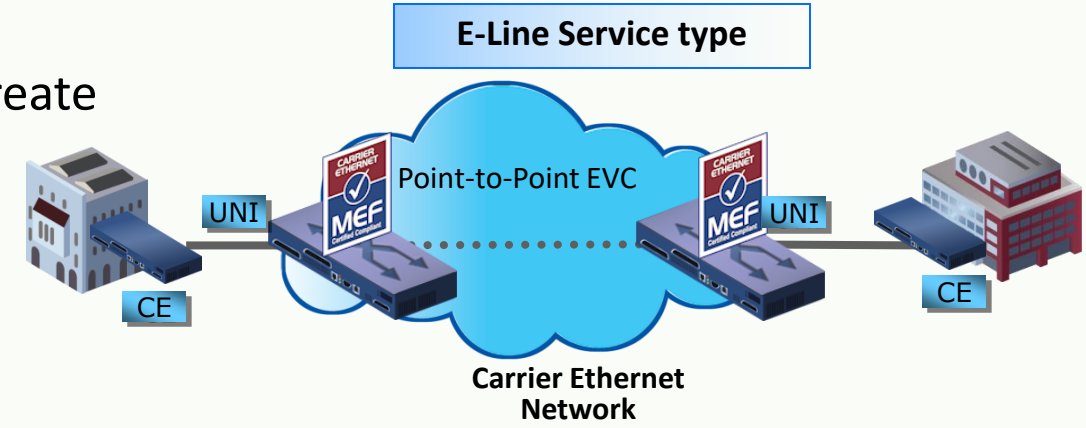
  In a Carrier Ethernet network, data is transported across Point-to-Point, Point-to-Multipoint and Multipoint-to-Multipoint EVCs according to the attributes and definitions of the E-Line and E-LAN services
- NNI (Network-to-Network Interface)
  - Demarcation/peering point
    - Between service providers (E-NNI)
    - Between service provider internal networks (I-NNI)

For full presentation of Ethernet Services visit
www.MetroEthernetForum.org/presentations.htm

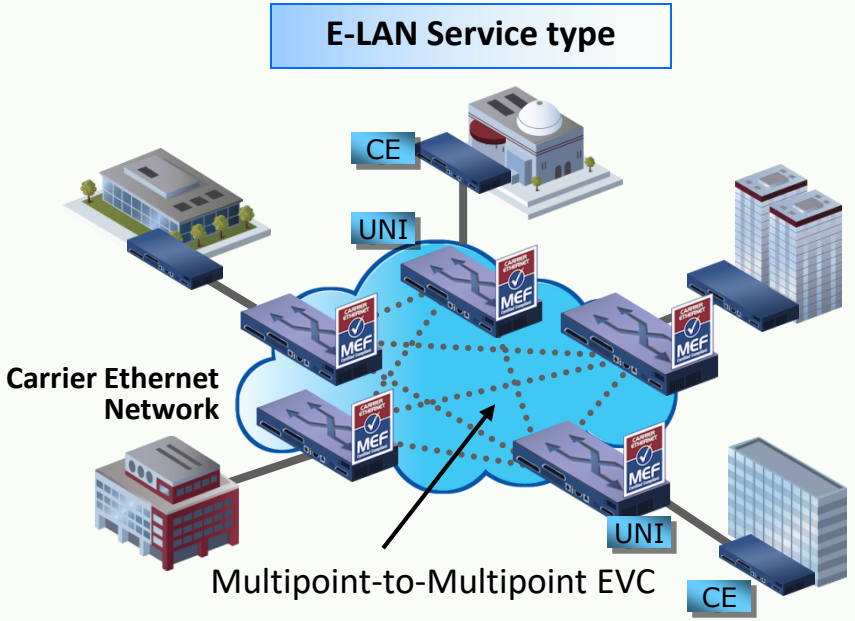
TIPOS de SERVICIOS

Service Type	Port-Based (All-to-One Bundling)	VLAN-Based (Service Multiplexed)
E-Line **(Point-to-Point EVC)**	Ethernet Private Line **(EPL)**	Ethernet Virtual Private Line **(EVPL)**
E-LAN **(multipoint-to-multipoint EVC)**	Ethernet Private LAN **(EP-LAN)**	Ethernet Virtual Private LAN **(EVP-LAN)**
E-Tree **(rooted multipoint EVC)**	Ethernet Private Tree **(EP-Tree)**	Ethernet Virtual Private Tree **(EVP-Tree)**

- **E-Line** Service used to create
  - Ethernet Private Lines
  - Virtual Private Lines
  - Ethernet Internet Access

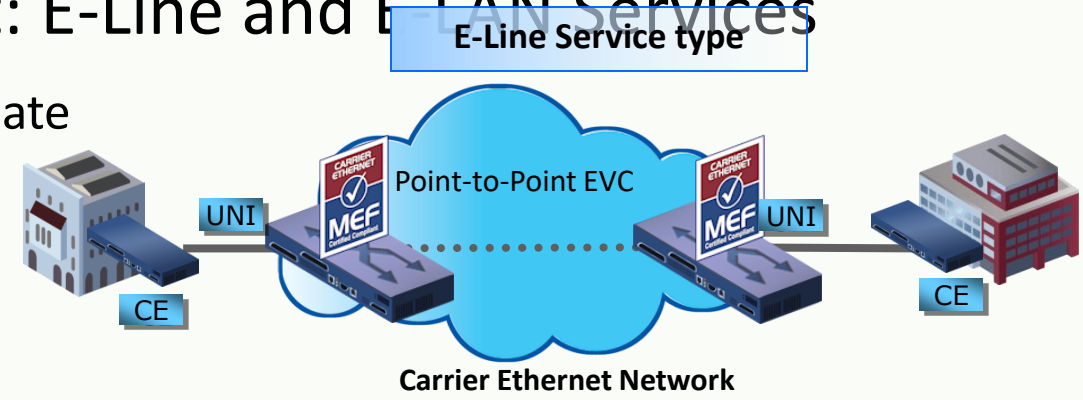


- **E-LAN** Service used to create
  - Multipoint L2 VPNs
  - Transparent LAN Service
  - Foundation for IPTV and Multicast networks etc.

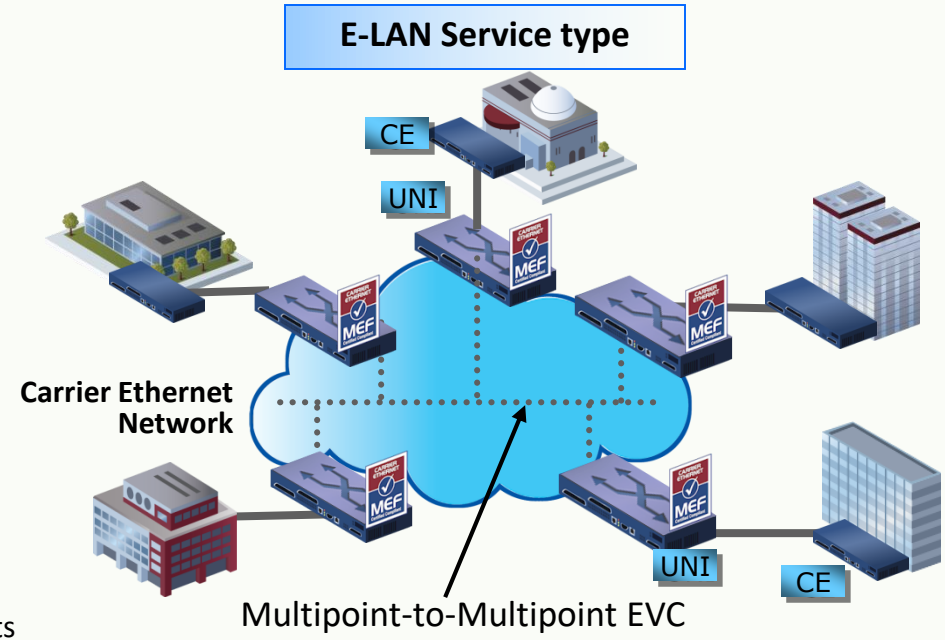


Carrier Ethernet: E-Line and E-LAN Services

- **E-Line** Service used to create
  - Ethernet Private Lines
  - Virtual Private Lines
  - Ethernet Internet Access



- **E-LAN** Service used to create
  - Multipoint L2 VPNs
  - Transparent LAN Service
  - Foundation for IPTV and Multicast networks etc.

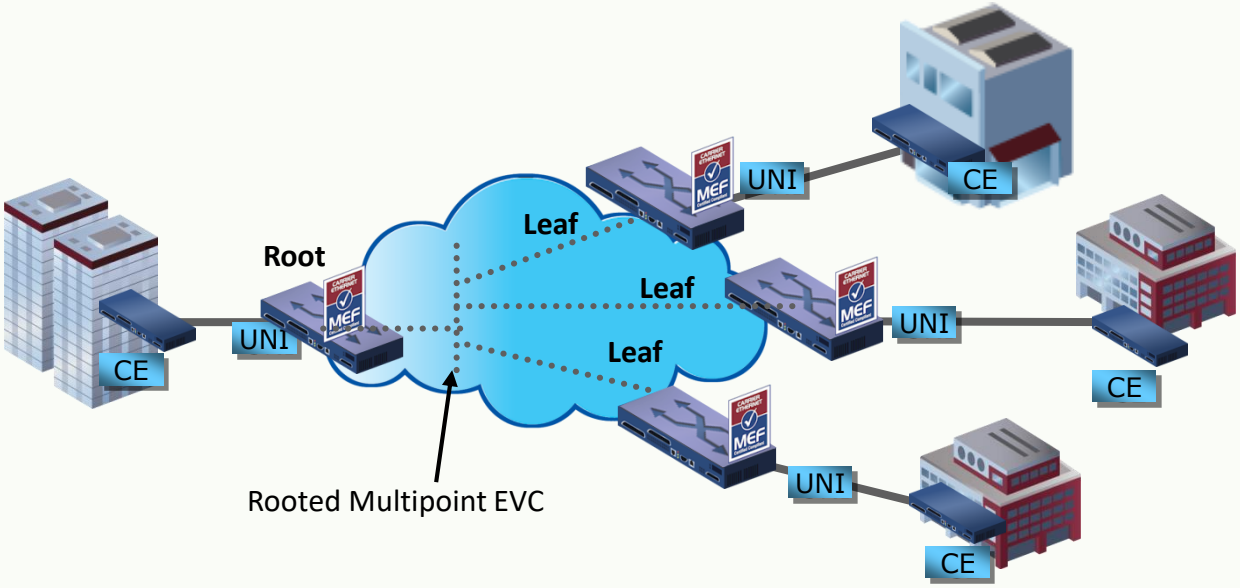


MEF certified Carrier Ethernet products

UNI: User Network Interface, **CE**: Customer Equipment, **EVC**: Ethernet Virtual Connection

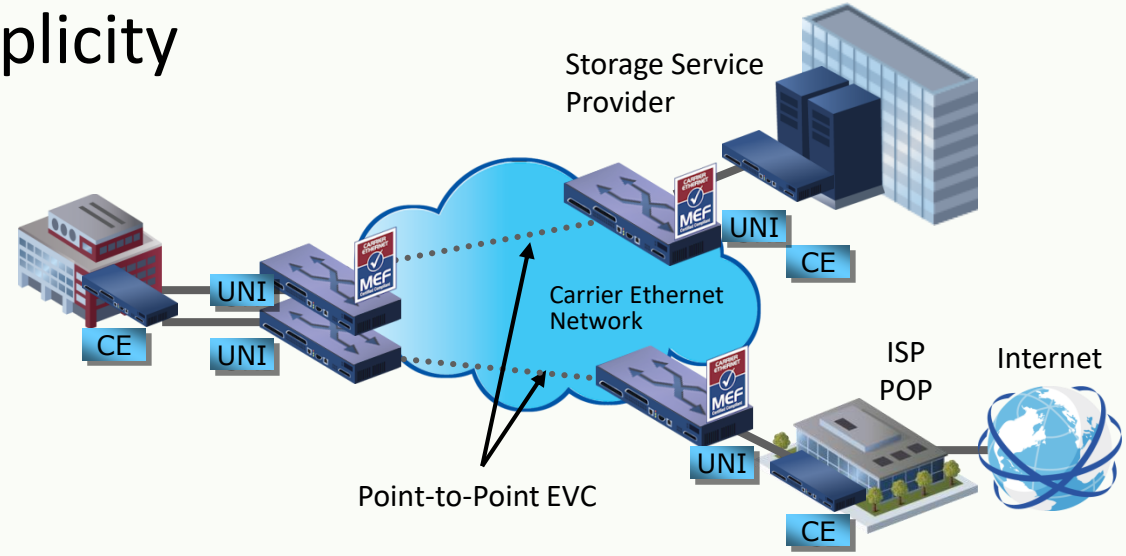
Carrier Ethernet: E-Tree Service

- Used for Applications requiring Point-to-Multipoint topology
  - Video on demand, internet access, triple play backhaul, mobile cell site backhaul, franchising applications
- Provides traffic separation between 'Leaf' UNIs
  - Traffic from any "leaf" UNI can be sent/received to/from "Root" UNI(s) but never being forwarded to other "Leaf" UNIs



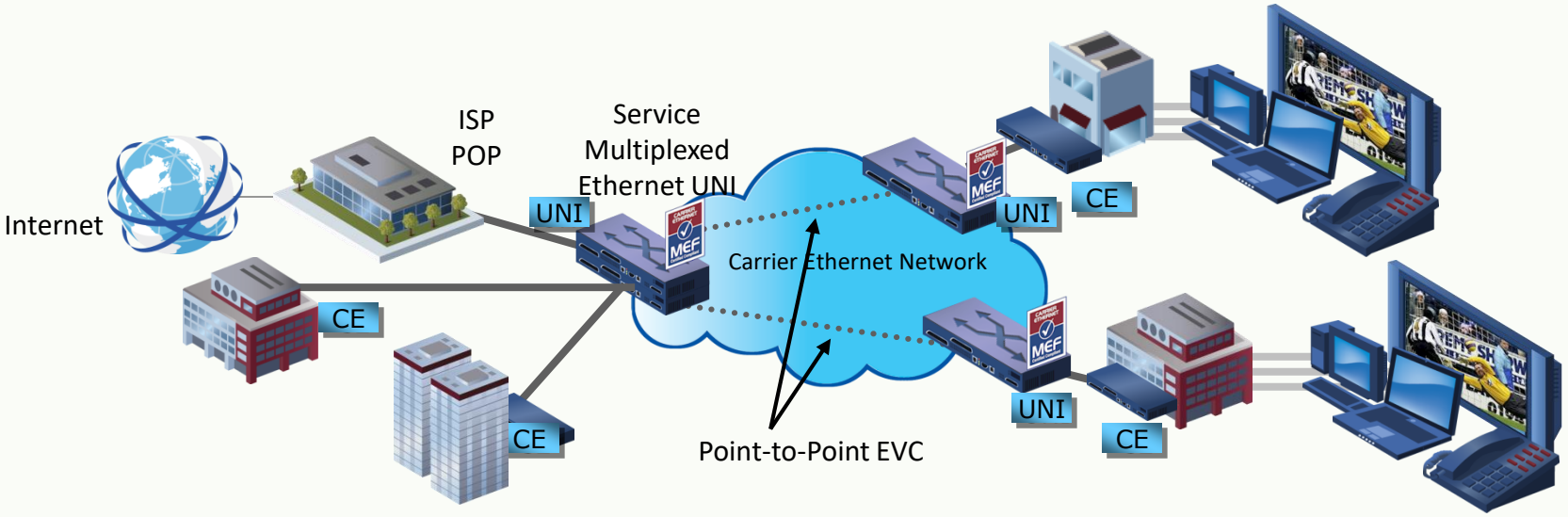
Services Using E-Line Service Type

- Ethernet Private Line (EPL)
  - Replaces a TDM Private line
  - Dedicated UNIs for Point-to-Point connections
  - Single Ethernet Virtual Connection (EVC) per UNI
  - The most popular Ethernet service due to its simplicity



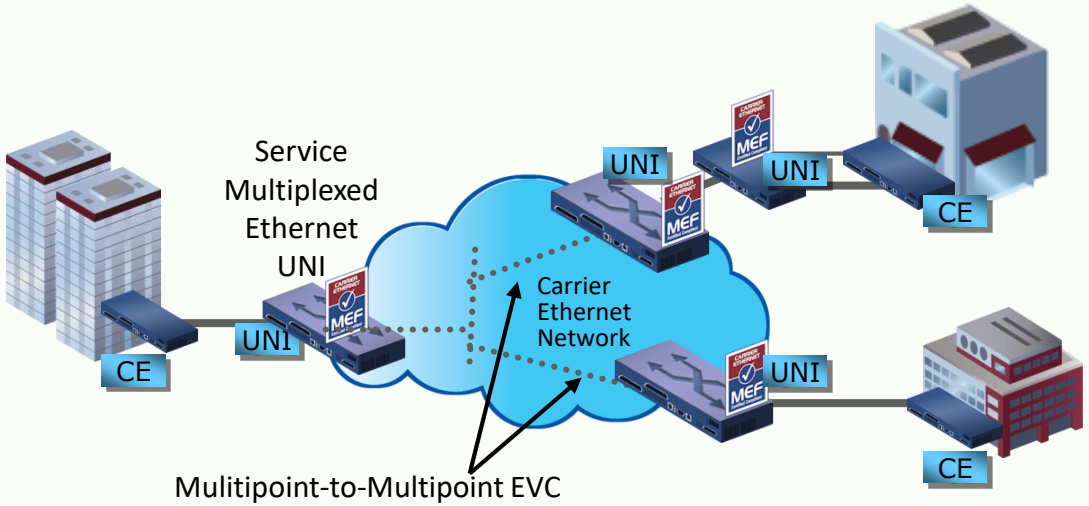
Services Using E-Line Service Type

- Ethernet Virtual Private Line (EVPL)
  - Replaces Frame Relay or ATM services
  - Supports Service Multiplexed UNI (i.e. multiple EVCs per UNI)
  - Allows single physical connection (UNI) to customer premise equipment for multiple virtual connections

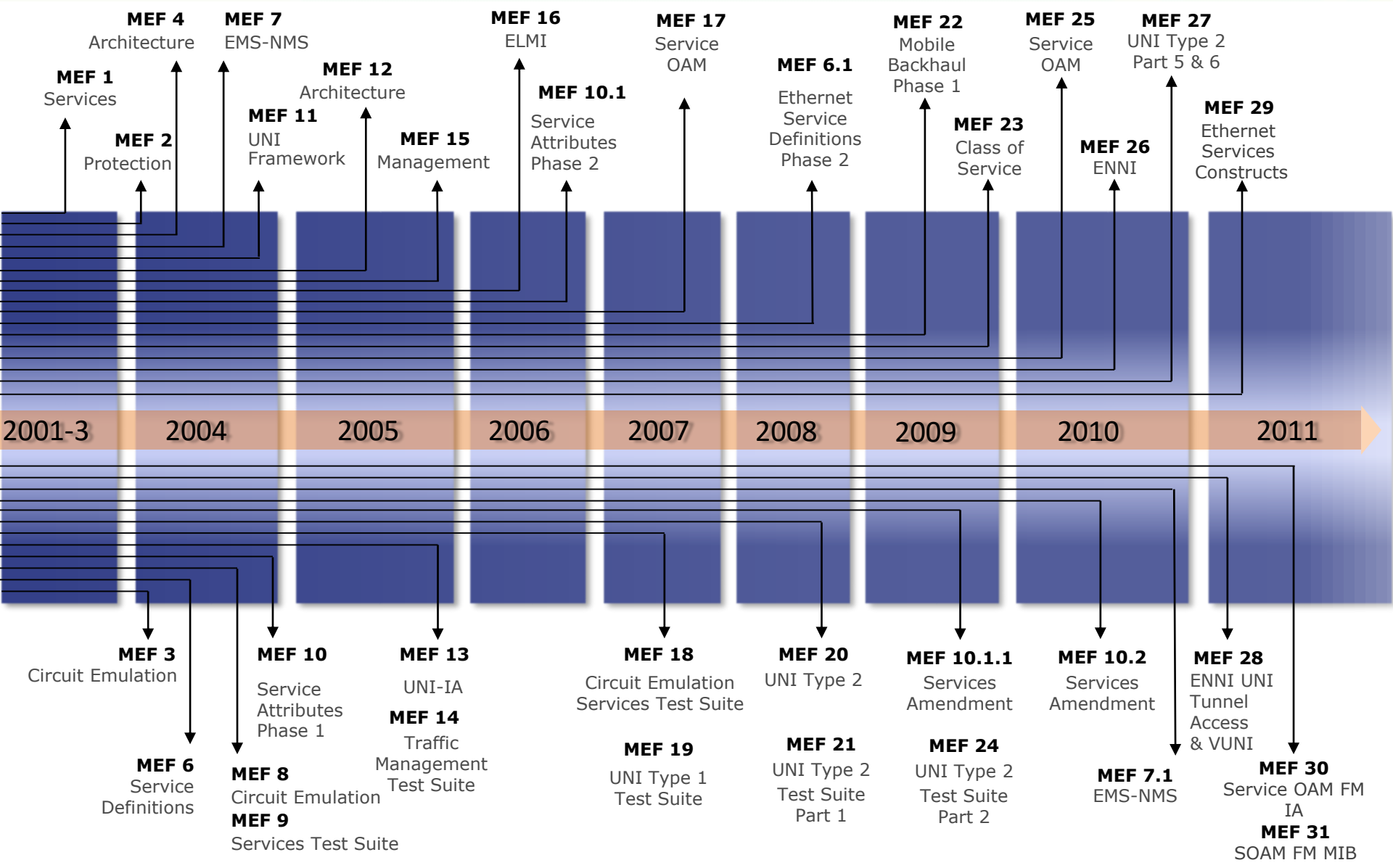


Services Using E-LAN Service Type

- Ethernet Private LAN (EP-LAN) and Ethernet Virtual Private LAN (EVP-LAN) Services
  - Supports dedicated or service-multiplexed UNIs
  - Supports transparent LAN services and multipoint Layer 2 VPNs



MEF Specifications Timeline



Ethernet Standards Summary

Standards Body	Ethernet Services	Architecture/Control	Ethernet OAM	Ethernet Interfaces
IEEE	-	802.3 – MAC 802.3ar – Congestion Management 802.1D/Q – Bridges/VLAN 802.17 - RPR 802.1ad – Provider Bridges .1ah – Provider Backbone Bridges .1ak – Multiple Registration Protocol .1aj – Two Port MAC Relay .1AE/af – MAC / Key Security .1aq – Shortest Path Bridging	802.3ah – EFM OAM 802.1ag – CFM 802.1AB - Discovery 802.1ap – VLAN MIB	802.3 – PHYs 802.3as - Frame Expansion
MEF	MEF 10.2 – Service Attributes MEF 3 – Circuit Emulation MEF 6.1 – Service Definition MEF 8 – PDH Emulation MEF 9 – Tests: Eth Services MEF 14 – Tests: Traffic Mgmt. MEF 22 - Mobile Backhaul MEF 28 – UTAS and Virtual UNI	MEF 4 – Generic Architecture MEF 2 – Protection Req & Framework MEF 11 – UNI Req & Framework MEF 12 – Layer Architecture MEF 20 – UNI Type 2 MEF 23 – Class of Service	MEF 7– EMS-NMS Info Model MEF 15– NE Mgmt Reqrmts. MEF 17 – Service OAM Requirements & Framework Service OAM Protocol – Ph. 1 Performance Monitoring MEF 21 – Tests: Link OAM MEF 24 – Tests: UNI T2/E-LMI MEF 30 – SOAM IA MEF 31– SOAM MIB	MEF 13 - UNI Type 1 MEF 16 – ELMI MEF 26 – ENNI MEF 29 - ESC
ITU	G.8011 – Services Framework G.8011.1 – EPL Service G.8011.2 – EVPL Service G.asm – Service Mgmt Arch G.smc – Service Mgmt Chnl	G.8010 – Layer Architecture G.8021 – Equipment model G.8010v2 – Layer Architecture G.8021v2 – Equipment model Y.17ethmpls - ETH-MPLS Interwork	Y.1730 – Ethernet OAM Req Y.1731 – OAM Mechanisms G.8031 – Protection Y.17ethqos – QoS Y.ethperf - Performance	G.8012 – UNI/NNI G.8012v2 – UNI/NNI
TMF	-	-	•TMF814 – EMS to NMS Model	-

ITU-T Recommendations……

G.8001 – EoT definitions

G.8010 – Ethernet layer network architecture

G.8011 – Ethernet over Transport services framework

G.8011.1 – Ethernet private line service

G.8011.2 – Ethernet virtual private line service

G.8012 – Ethernet UNI and NNI

G.8021 – Ethernet transport equipment characteristics

G.8031 – Ethernet protection switching

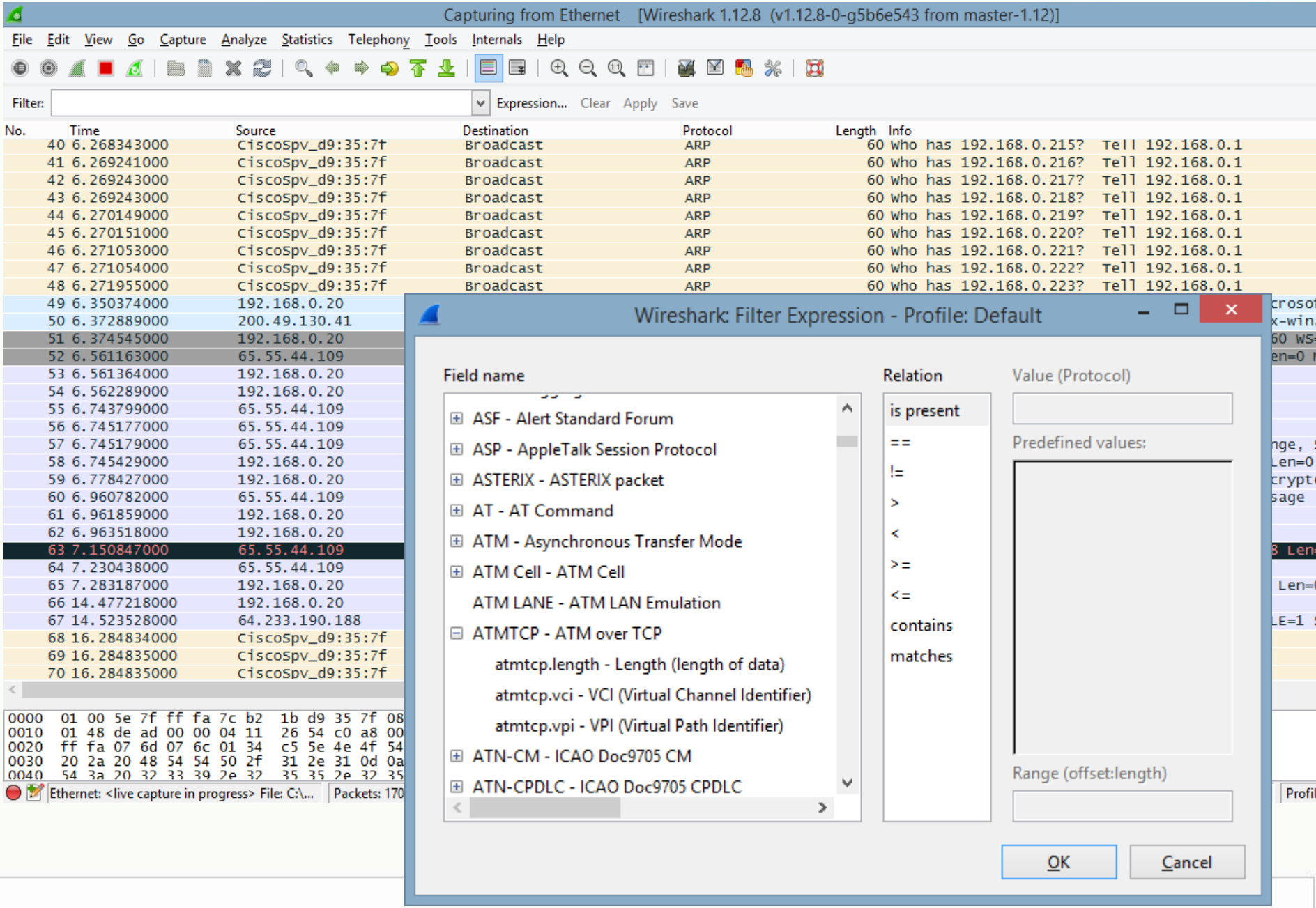
Y.1730 – Ethernet OAM - requirements

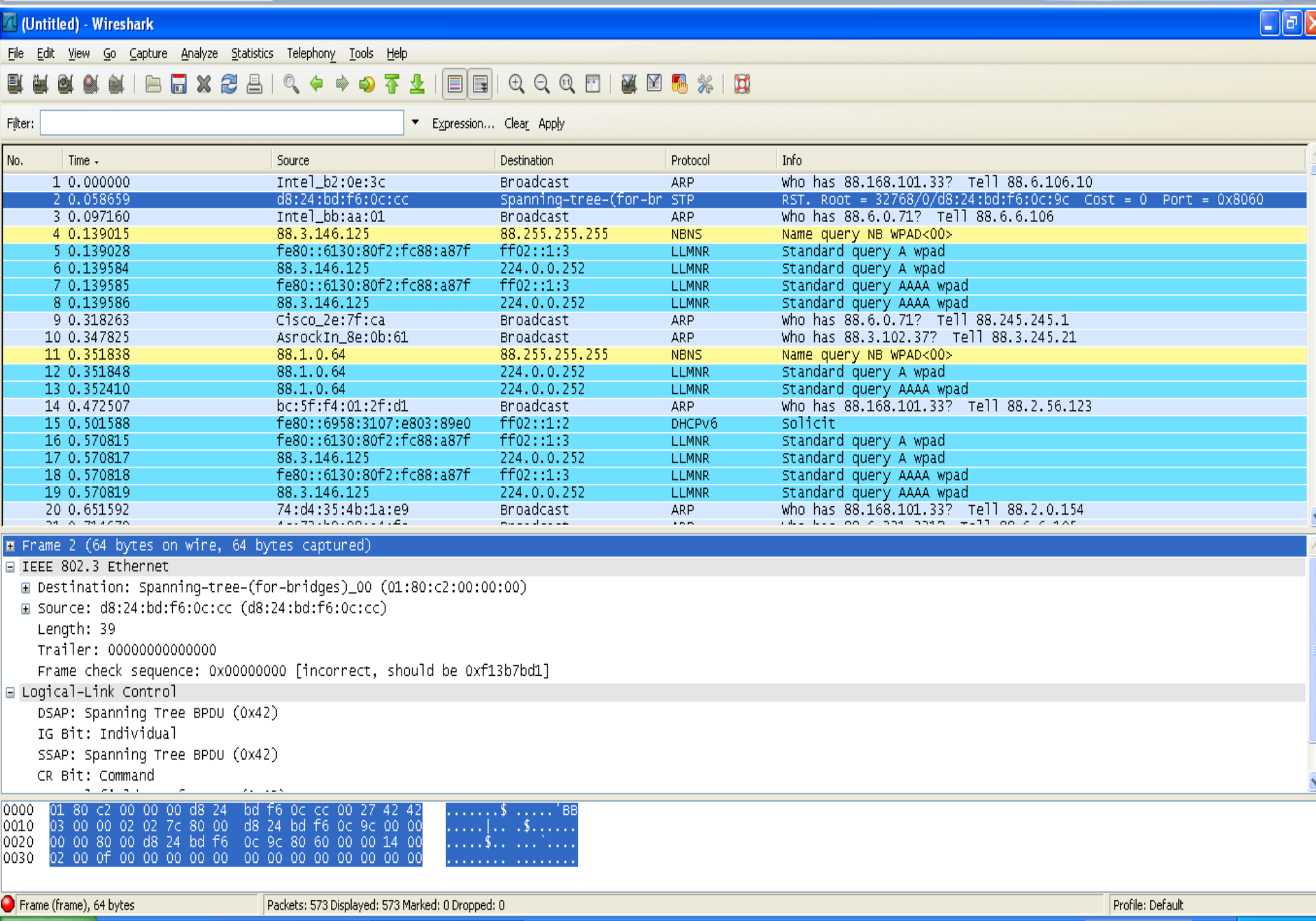
Y.1731 – Ethernet OAM

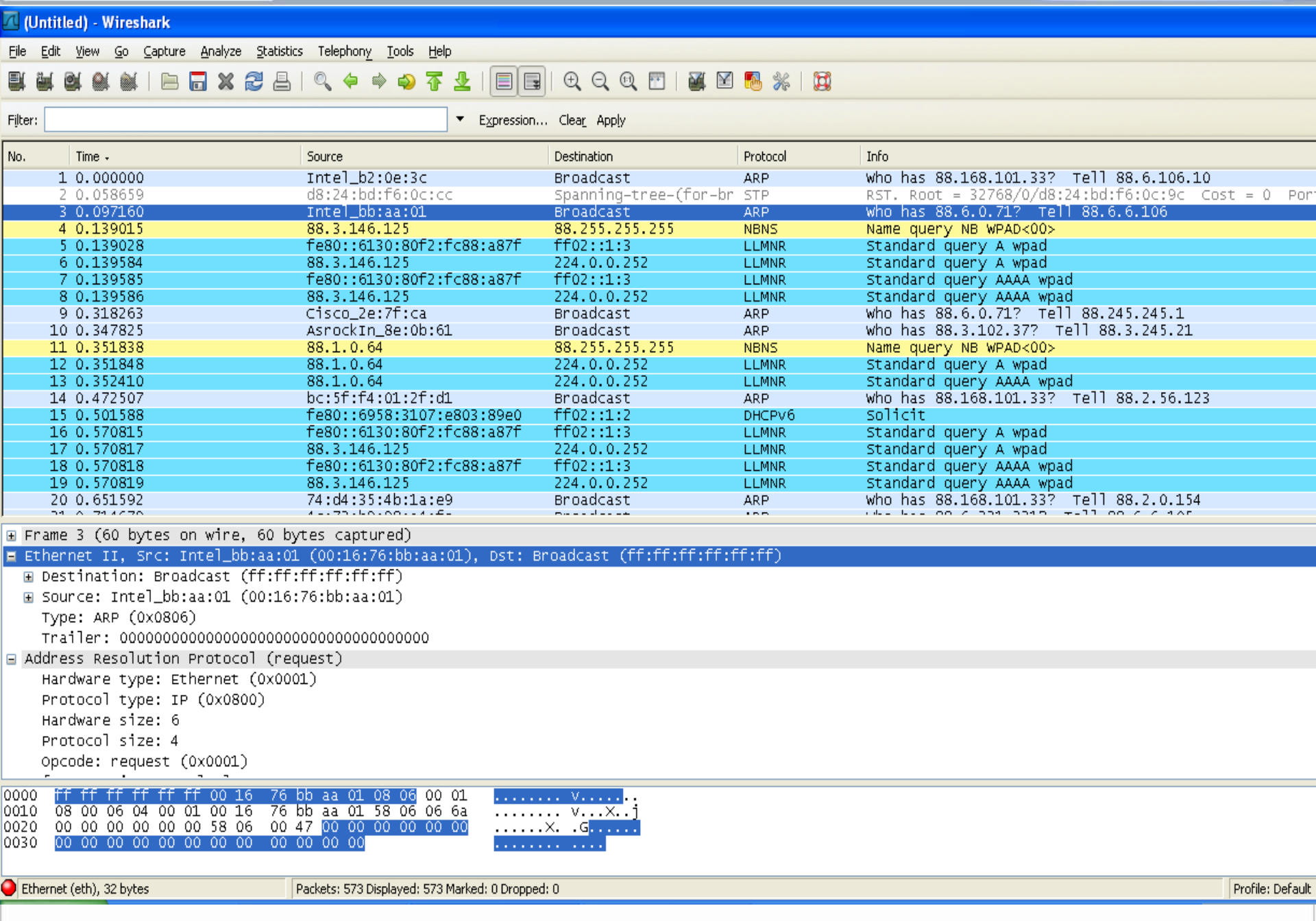
EoS

- EoS es un conjunto de estándares de la industria que han sido desarrollados para el transporte óptimo de Ethernet sobre topologías de conmutación de circuitos (SDH/Sonet)

- Hay técnicas de encapsulación disponibles:
  - Las técnicas *virtual concatenation* (**VCAT**) y el *link capacity adjustment scheme* (**LCAS**), que definen el método de transporte,
  - Las técnicas *generic framing procedure* (**GFP**) y *link access procedure for SDH* (**LAPS**), que son protocolos de adaptación de capa 1 de transporte.


Capturing from Ethernet [Wireshark 1.12.8 (v1.12.8-0-g5b6e543 from master-1.12)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: Expression... Clear Apply Save
No. Time Source Destination Protocol Length Info
40 6.268343000 CiscoSpv_d9:35:7f Broadcast ARP 60 Who has 192.168.0.215? Tell 192.168.0.1
41 6.269241000 CiscoSpv_d9:35:7f Broadcast ARP 60 Who has 192.168.0.216? Tell 192.168.0.1
42 6.269243000 CiscoSpv_d9:35:7f Broadcast ARP 60 Who has 192.168.0.217? Tell 192.168.0.1
43 6.269243000 CiscoSpv_d9:35:7f Broadcast ARP 60 Who has 192.168.0.218? Tell 192.168.0.1
44 6.270149000 CiscoSpv_d9:35:7f Broadcast ARP 60 Who has 192.168.0.219? Tell 192.168.0.1
45 6.270151000 CiscoSpv_d9:35:7f Broadcast ARP 60 Who has 192.168.0.220? Tell 192.168.0.1
46 6.271053000 CiscoSpv_d9:35:7f Broadcast ARP 60 Who has 192.168.0.221? Tell 192.168.0.1
47 6.271054000 CiscoSpv_d9:35:7f Broadcast ARP 60 Who has 192.168.0.222? Tell 192.168.0.1
48 6.271955000 CiscoSpv_d9:35:7f Broadcast ARP 60 Who has 192.168.0.223? Tell 192.168.0.1
49 6.350374000 192.168.0.20
50 6.372889000 200.49.130.41
51 6.374545000 192.168.0.20
52 6.561163000 65.55.44.109
53 6.561364000 192.168.0.20
54 6.562289000 192.168.0.20
55 6.743799000 65.55.44.109
56 6.745177000 65.55.44.109
57 6.745179000 65.55.44.109
58 6.745429000 192.168.0.20
59 6.778427000 192.168.0.20
60 6.960782000 65.55.44.109
61 6.961859000 192.168.0.20
62 6.963518000 192.168.0.20
63 7.150847000 65.55.44.109
64 7.230438000 65.55.44.109
65 7.283187000 192.168.0.20
66 14.477218000 192.168.0.20
67 14.523528000 64.233.190.188
68 16.284834000 CiscoSpv_d9:35:7f
69 16.284835000 CiscoSpv_d9:35:7f
70 16.284835000 CiscoSpv_d9:35:7f
0000 01 00 5e 7f ff fa 7c b2 1b d9 35 7f 08
0010 01 48 de ad 00 00 04 11 26 54 c0 a8 00
0020 ff fa 07 6d 07 6c 01 34 c5 5e 4e 4f 54
0030 20 2a 20 48 54 54 50 2f 31 2e 31 0d 0a
0040 54 3a 20 32 33 39 2e 32 35 35 2e 32 35
Ethernet: <live capture in progress> File: C:\...
Packets: 170
Wireshark: Filter Expression - Profile: Default
Field name
Relation
Value (Protocol)
ASF - Alert Standard Forum
ASP - AppleTalk Session Protocol
ASTERIX - ASTERIX packet
AT - AT Command
ATM - Asynchronous Transfer Mode
ATM Cell - ATM Cell
ATM LANE - ATM LAN Emulation
ATMTCP - ATM over TCP
atmtcp.length - Length (length of data)
atmtcp.vci - VCI (Virtual Channel Identifier)
atmtcp.vpi - VPI (Virtual Path Identifier)
ATN-CM - ICAO Doc9705 CM
ATN-CPDLC - ICAO Doc9705 CPDLC
is present
==
!=
>
<
>=
<=
contains
matches
Predefined values:
Range (offset:length)
OK
Cancel


(Untitled) - Wireshark
File Edit View Go Capture Analyze Statistics Telephony Tools Help
Filter: Expression... Clear Apply
No. Time Source Destination Protocol Info
1 0.000000 Intel_b2:0e:3c Broadcast ARP Who has 88.168.101.33? Tell 88.6.106.10
2 0.058659 d8:24:bd:f6:0c:cc Spanning-tree-(for-br STP RST. Root = 32768/0/d8:24:bd:f6:0c:9c Cost = 0 Port = 0x8060
3 0.097160 Intel_bb:aa:01 Broadcast ARP Who has 88.6.0.71? Tell 88.6.6.106
4 0.139015 88.3.146.125 88.255.255.255 NBNS Name query NB WPAD<00>
5 0.139028 fe80::6130:80f2:fc88:a87f ff02::1:3 LLMNR Standard query A wpad
6 0.139584 88.3.146.125 224.0.0.252 LLMNR Standard query A wpad
7 0.139585 fe80::6130:80f2:fc88:a87f ff02::1:3 LLMNR Standard query AAAA wpad
8 0.139586 88.3.146.125 224.0.0.252 LLMNR Standard query AAAA wpad
9 0.318263 Cisco_2e:7f:ca Broadcast ARP Who has 88.6.0.71? Tell 88.245.245.1
10 0.347825 AsrockIn_8e:0b:61 Broadcast ARP Who has 88.3.102.37? Tell 88.3.245.21
11 0.351838 88.1.0.64 88.255.255.255 NBNS Name query NB WPAD<00>
12 0.351848 88.1.0.64 224.0.0.252 LLMNR Standard query A wpad
13 0.352410 88.1.0.64 224.0.0.252 LLMNR Standard query AAAA wpad
14 0.472507 bc:5f:f4:01:2f:d1 Broadcast ARP Who has 88.168.101.33? Tell 88.2.56.123
15 0.501588 fe80::6958:3107:e803:89e0 ff02::1:2 DHCPv6 Solicit
16 0.570815 fe80::6130:80f2:fc88:a87f ff02::1:3 LLMNR Standard query A wpad
17 0.570817 88.3.146.125 224.0.0.252 LLMNR Standard query A wpad
18 0.570818 fe80::6130:80f2:fc88:a87f ff02::1:3 LLMNR Standard query AAAA wpad
19 0.570819 88.3.146.125 224.0.0.252 LLMNR Standard query AAAA wpad
20 0.651592 74:d4:35:4b:1a:e9 Broadcast ARP Who has 88.168.101.33? Tell 88.2.0.154
Frame 2 (64 bytes on wire, 64 bytes captured)
IEEE 802.3 Ethernet
Destination: Spanning-tree-(for-bridges)_00 (01:80:c2:00:00:00)
Source: d8:24:bd:f6:0c:cc (d8:24:bd:f6:0c:cc)
Length: 39
Trailer: 00000000000000
Frame check sequence: 0x00000000 [incorrect, should be 0xf13b7bd1]
Logical-Link Control
DSAP: Spanning Tree BPDU (0x42)
IG Bit: Individual
SSAP: Spanning Tree BPDU (0x42)
CR Bit: Command
0000 01 80 c2 00 00 00 d8 24 bd f6 0c cc 00 27 42 42
0010 03 00 00 02 02 7c 80 00 d8 24 bd f6 0c 9c 00 00
0020 00 00 80 00 d8 24 bd f6 0c 9c 80 60 00 00 14 00
0030 02 00 0f 00 00 00 00 00 00 00 00 00 00 00 00 00
Frame (frame), 64 bytes
Packets: 573 Displayed: 573 Marked: 0 Dropped: 0
Profile: Default


(Untitled) - Wireshark
File Edit View Go Capture Analyze Statistics Telephony Tools Help
Filter: Expression... Clear Apply
No. Time Source Destination Protocol Info
1 0.000000 Intel_b2:0e:3c Broadcast ARP Who has 88.168.101.33? Tell 88.6.106.10
2 0.058659 d8:24:bd:f6:0c:cc Spanning-tree-(for-br STP RST. Root = 32768/0/d8:24:bd:f6:0c:9c Cost = 0
3 0.097160 Intel_bb:aa:01 Broadcast ARP Who has 88.6.0.71? Tell 88.6.6.106
4 0.139015 88.3.146.125 88.255.255.255 NBNS Name query NB WPAD<00>
5 0.139028 fe80::6130:80f2:fc88:a87f ff02::1:3 LLMNR Standard query A wpad
6 0.139584 88.3.146.125 224.0.0.252 LLMNR Standard query A wpad
7 0.139585 fe80::6130:80f2:fc88:a87f ff02::1:3 LLMNR Standard query AAAA wpad
8 0.139586 88.3.146.125 224.0.0.252 LLMNR Standard query AAAA wpad
9 0.318263 Cisco_2e:7f:ca Broadcast ARP Who has 88.6.0.71? Tell 88.245.245.1
10 0.347825 AsrockIn_8e:0b:61 Broadcast ARP Who has 88.3.102.37? Tell 88.3.245.21
11 0.351838 88.1.0.64 88.255.255.255 NBNS Name query NB WPAD<00>
12 0.351848 88.1.0.64 224.0.0.252 LLMNR Standard query A wpad
13 0.352410 88.1.0.64 224.0.0.252 LLMNR Standard query AAAA wpad
14 0.472507 bc:5f:f4:01:2f:d1 Broadcast ARP Who has 88.168.101.33? Tell 88.2.56.123
15 0.501588 fe80::6958:3107:e803:89e0 ff02::1:2 DHCPv6 Solicit
16 0.570815 fe80::6130:80f2:fc88:a87f ff02::1:3 LLMNR Standard query A wpad
17 0.570817 88.3.146.125 224.0.0.252 LLMNR Standard query A wpad
18 0.570818 fe80::6130:80f2:fc88:a87f ff02::1:3 LLMNR Standard query AAAA wpad
19 0.570819 88.3.146.125 224.0.0.252 LLMNR Standard query AAAA wpad
20 0.651592 74:d4:35:4b:1a:e9 Broadcast ARP Who has 88.168.101.33? Tell 88.2.0.154
Frame 3 (60 bytes on wire, 60 bytes captured)
Ethernet II, Src: Intel_bb:aa:01 (00:16:76:bb:aa:01), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
Destination: Broadcast (ff:ff:ff:ff:ff:ff)
Source: Intel_bb:aa:01 (00:16:76:bb:aa:01)
Type: ARP (0x0806)
Trailer: 000000000000000000000000000000000000
Address Resolution Protocol (request)
Hardware type: Ethernet (0x0001)
Protocol type: IP (0x0800)
Hardware size: 6
Protocol size: 4
Opcode: request (0x0001)
0000 ff ff ff ff ff ff 00 16 76 bb aa 01 08 06 00 01 .... v.....
0010 08 00 06 04 00 01 00 16 76 bb aa 01 58 06 06 6a .... v...X..j
0020 00 00 00 00 00 00 58 06 00 47 00 00 00 00 00 00 ......X. .G......
0030 00 00 00 00 00 00 00 00 00 00 00 00 ....
Ethernet (eth), 32 bytes
Packets: 573 Displayed: 573 Marked: 0 Dropped: 0
Profile: Default