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Versiones de Ethernet

Area de Ingeniería Telemática
http://www.tlm.unavarra.es

Grado en Ingeniería en Tecnologías de Telecomunicación, 3º

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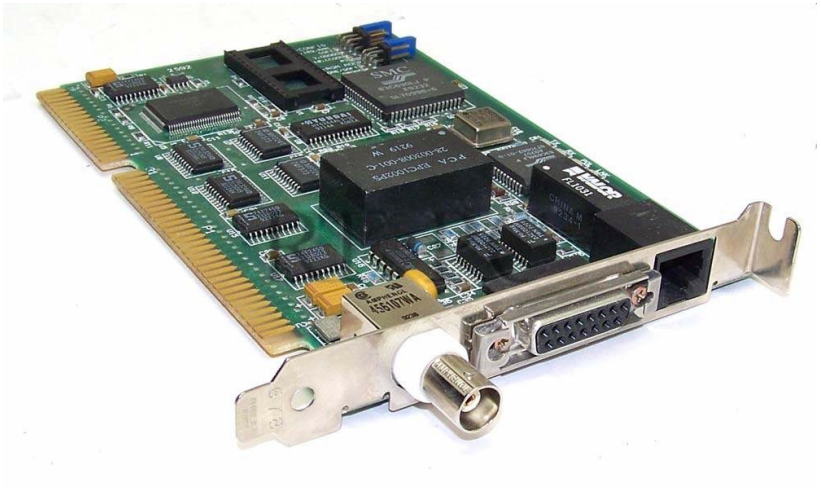
Ethernet “everywhere”

Ethernet hoy en día

- Comienzos tasa de transmisión de 2.94 Mbps
- Primera versión comercial a 10Mb/s (coaxial)
- Hoy en día se vende a 10Gb/s, 40Gb/s y 100Gb/s y sigue subiendo...
- Sobre par trenzado (de distintos tipos) y fibra óptica principalmente

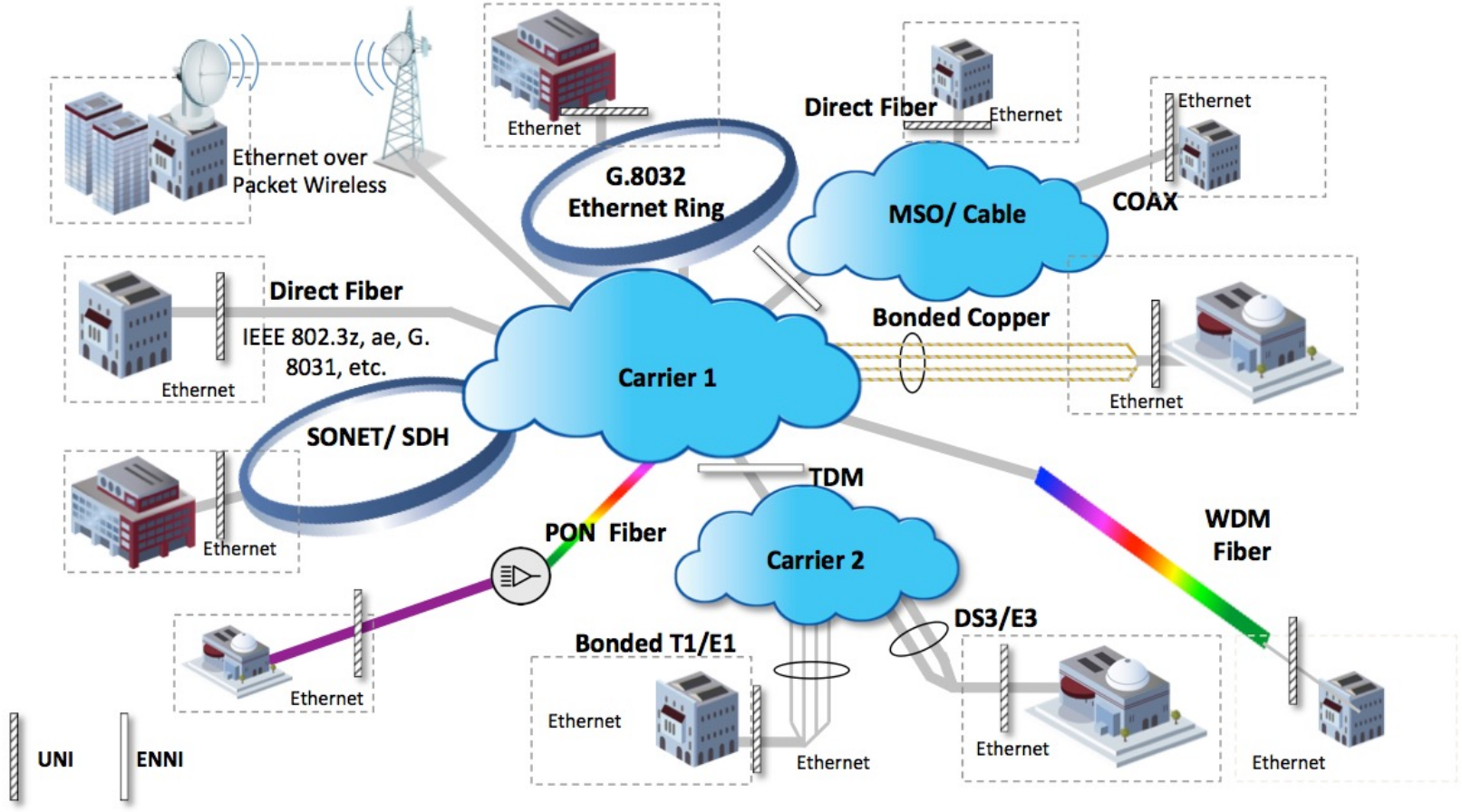


NIC Ethernet a 10Mbps
Conectores AUI, BNC y RJ-45

Transceiver 100GBASE-LR4
100Gbps Eth a 10Km sobre f.o. monomodo

Ethernet hoy en día

- Surgió para LAN y ya se emplea en WAN
- Y ofrece servicios para operadoras y para el acceso (primera milla)



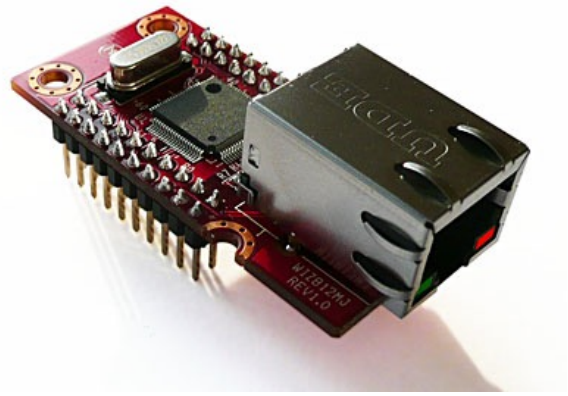
http://metroethernetforum.org

Ethernet hoy en día

- Nació para LAN coaxial, aunque basada en ALOHA, y ha vuelto a inalámbrico (WiFi)

Ethernet hoy en día

- Empezó para PCs e impresoras y ahora se emplea en WANs pero también en microcontroladores en coches, aviones, hogares, industria...



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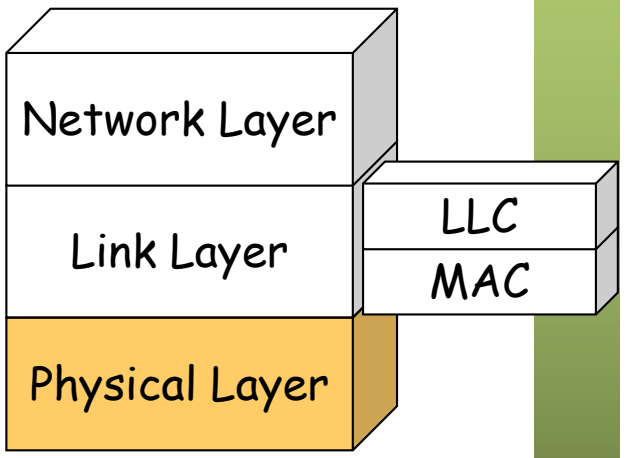
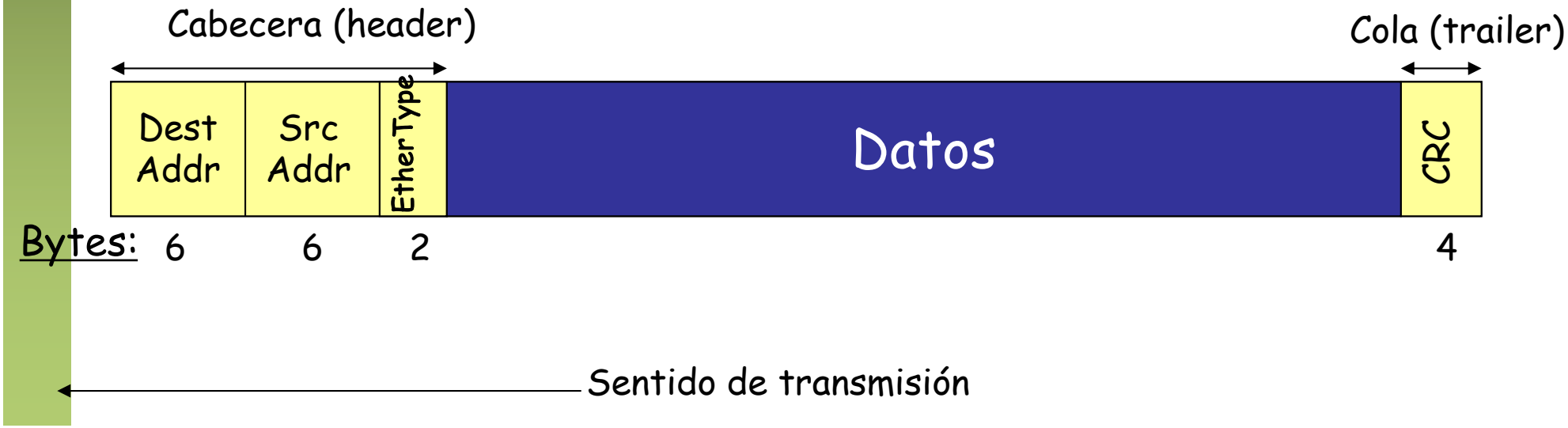
Nivel MAC Ethernet original

Nivel MAC

- PDU del nivel de enlace = Trama (*Frame*)
- Formato de la trama (estándar DIX)
  - Direcciones MAC
  - *Ethertype*
  - Datos
  - CRC
- Hoy en día recogido también en el IEEE 802.3





Trama DIX

No.	Time	Source	Destination	Total L	Source Port	Request Method	Status Code	Info
5	1628304369…	0.0.0.0	255.255.255.2…	313				DHCP Discover - Trans

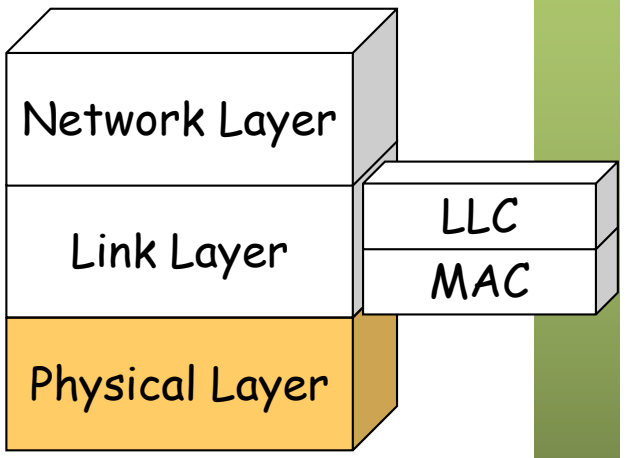
```
> Frame 5: 327 bytes on wire (2616 bits), 327 bytes captured (2616 bits)
v Ethernet II, Src: PcsCompu_bb:01:05 (08:00:27:bb:01:05), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
    > Destination: Broadcast (ff:ff:ff:ff:ff:ff)
    > Source: PcsCompu_bb:01:05 (08:00:27:bb:01:05)
      Type: IPv4 (0x0800)
> Internet Protocol Version 4, Src: 0.0.0.0, Dst: 255.255.255.255
> User Datagram Protocol, Src Port: 68, Dst Port: 67
> Dynamic Host Configuration Protocol (Discover)
```

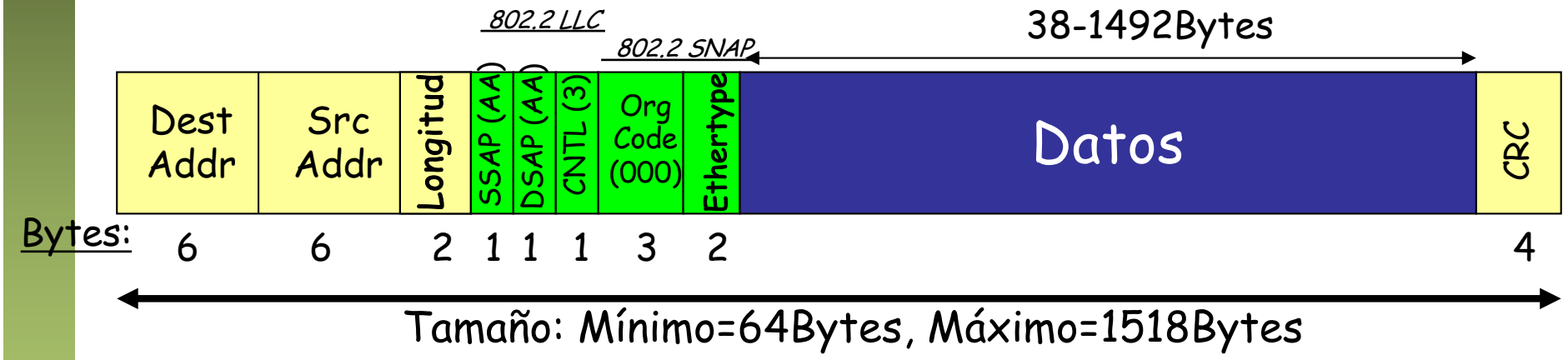
```
0000  ff ff ff ff ff ff 08 00  27 bb 01 05 08 00 45 00   ........ '.....E.
0010  01 39 00 00 00 00 40 11  79 b5 00 00 00 00 ff ff   .9....@. y.......
0020  ff ff 00 44 00 43 01 25  b4 02 01 01 06 00 d3 59   ...D.C.% .......Y
0030  62 22 0d 81 00 00 00 00  00 00 00 00 00 00 00 00   b"...... ........
0040  00 00 00 00 00 00 08 00  27 bb 01 05 00 00 00 00   ........ '.......
0050  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
0060  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
0070  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
0080  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
0090  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
00a0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
00b0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
00c0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
00d0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
00e0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
00f0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
0100  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
0110  00 00 00 00 00 00 63 82  53 63 35 01 01 3d 07 01   ......c. Sc5..=..
0120  08 00 27 bb 01 05 39 02  02 40 37 07 01 03 06 0c   ..'...9. .@7.....
0130  0f 1c 2a 3c 0c 75 64 68  63 70 20 31 2e 32 30 2e   ..*<.udh cp 1.20.
0140  32 0c 03 62 6f 78 ff                              2..box.
```

```
Ethernet (eth),14 bytes        Packets: 9 · Displayed: 1 (11.1%)        Profile: Default
```

Trama IEEE

- IEEE 802.3 + 802.2 (LLC/SNAP)
- Campo de **Longitud** (hace referencia a todo lo que le sigue, sin contar el CRC)
- Los *Ethertype* son > 1500 por lo que ambos formatos son compatibles (en realidad ≥1536)
- IP sobre 802 en RFC 1042





DIX (Ethernet II)

LLC/SNAP

No.	Time	Source	Destination	Total L	Source Port	Request Method	Status Code	Info
1	1164034146…	Cisco_d5:d5:…	CDP/VTP/DTP/P…					Device ID: R1 Port 1

```
> Frame 1: 300 bytes on wire (2400 bits), 300 bytes captured (2400 bits)
v IEEE 802.3 Ethernet
  > Destination: CDP/VTP/DTP/PAgP/UDLD (01:00:0c:cc:cc:cc)
  > Source: Cisco_d5:d5:15 (00:e0:1e:d5:d5:15)
    Length: 286
v Logical-Link Control
  > DSAP: SNAP (0xaa)
  > SSAP: SNAP (0xaa)
  > Control field: U, func=UI (0x03)
    Organization Code: 00:00:0c (Cisco Systems, Inc)
    PID: CDP (0x2000)
> Cisco Discovery Protocol
```

```
0000  01 00 0c cc cc cc 00 e0  1e d5 d5 15 01 1e aa aa   ........ ........
0010  03 00 00 0c 20 00 01 b4  df f0 00 01 00 06 52 31   .... ... ......R1
0020  00 02 00 11 00 00 00 01  01 01 cc 00 04 c0 a8 0a   ........ ........
0030  01 00 03 00 0d 45 74 68  65 72 6e 65 74 30 00 04   .....Eth ernet0..
0040  00 08 00 00 00 01 00 05  00 d8 43 69 73 63 6f 20   ........ ..Cisco
0050  49 6e 74 65 72 6e 65 74  77 6f 72 6b 20 4f 70 65   Internet work Ope
0060  72 61 74 69 6e 67 20 53  79 73 74 65 6d 20 53 6f   rating S ystem So
0070  66 74 77 61 72 65 20 0a  49 4f 53 20 28 74 6d 29   ftware . IOS (tm)
0080  20 31 36 30 30 20 53 6f  66 74 77 61 72 65 20 28    1600 So ftware (
0090  43 31 36 30 30 2d 4e 59  2d 4c 29 2c 20 56 65 72   C1600-NY -L), Ver
00a0  73 69 6f 6e 20 31 31 2e  32 28 31 32 29 50 2c 20   sion 11. 2(12)P,
00b0  52 45 4c 45 41 53 45 20  53 4f 46 54 57 41 52 45   RELEASE  SOFTWARE
00c0  20 28 66 63 31 29 0a 43  6f 70 79 72 69 67 68 74    (fc1)·C opyright
00d0  20 28 63 29 20 31 39 38  36 2d 31 39 39 38 20 62    (c) 198 6-1998 b
00e0  79 20 63 69 73 63 6f 20  53 79 73 74 65 6d 73 2c   y cisco  Systems,
00f0  20 49 6e 63 2e 0a 43 6f  6d 70 69 6c 65 64 20 54    Inc.·Co mpiled T
0100  75 65 20 30 33 2d 4d 61  72 2d 39 38 20 30 36 3a   ue 03-Ma r-98 06:
```

Logical-Link Control (llc),8 bytes — Packets: 1 · Displayed: 1 (100.0%) — Profile: Default

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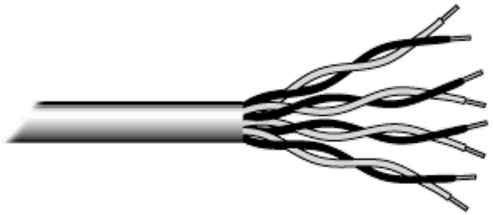
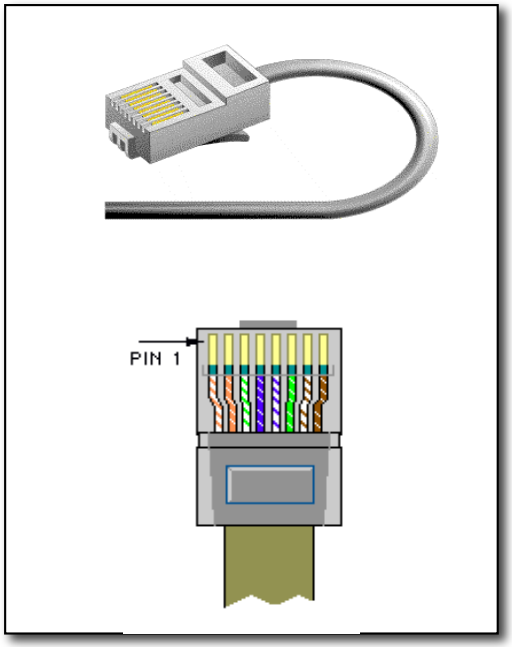
Versiones de Ethernet (10Mb/s)

Ethernet sobre pares de cobre

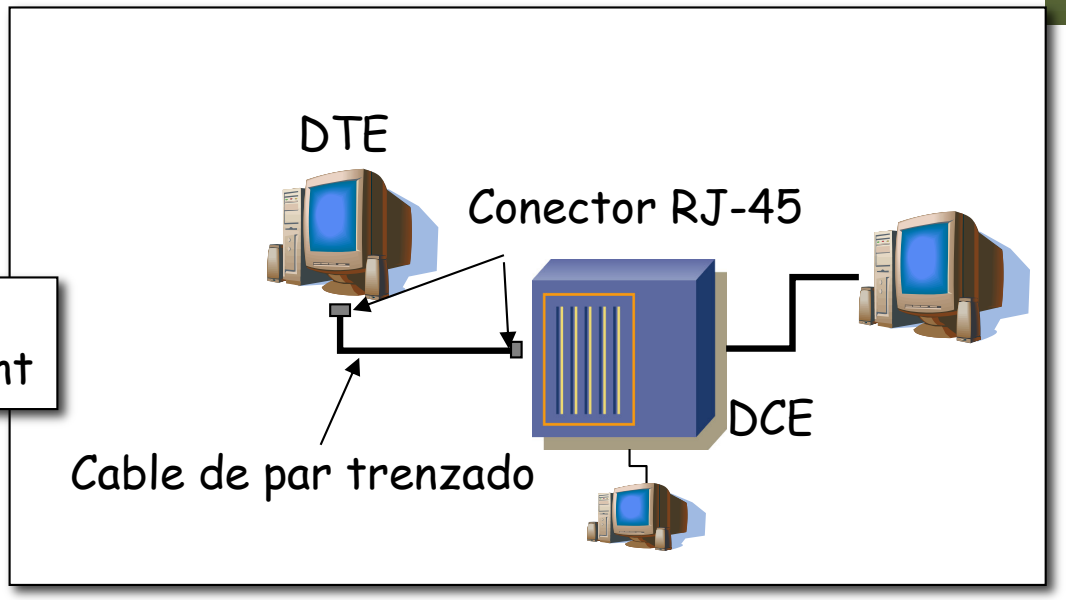
10Base-T



- IEEE 802.3i
- Cables de par trenzado al menos cat. 3
- Emplea 2 pares de hilos
- Topología física en estrella (con “Hub”)
- Topología lógica en bus
- Conector RJ-45
- Cable máximo 100 m

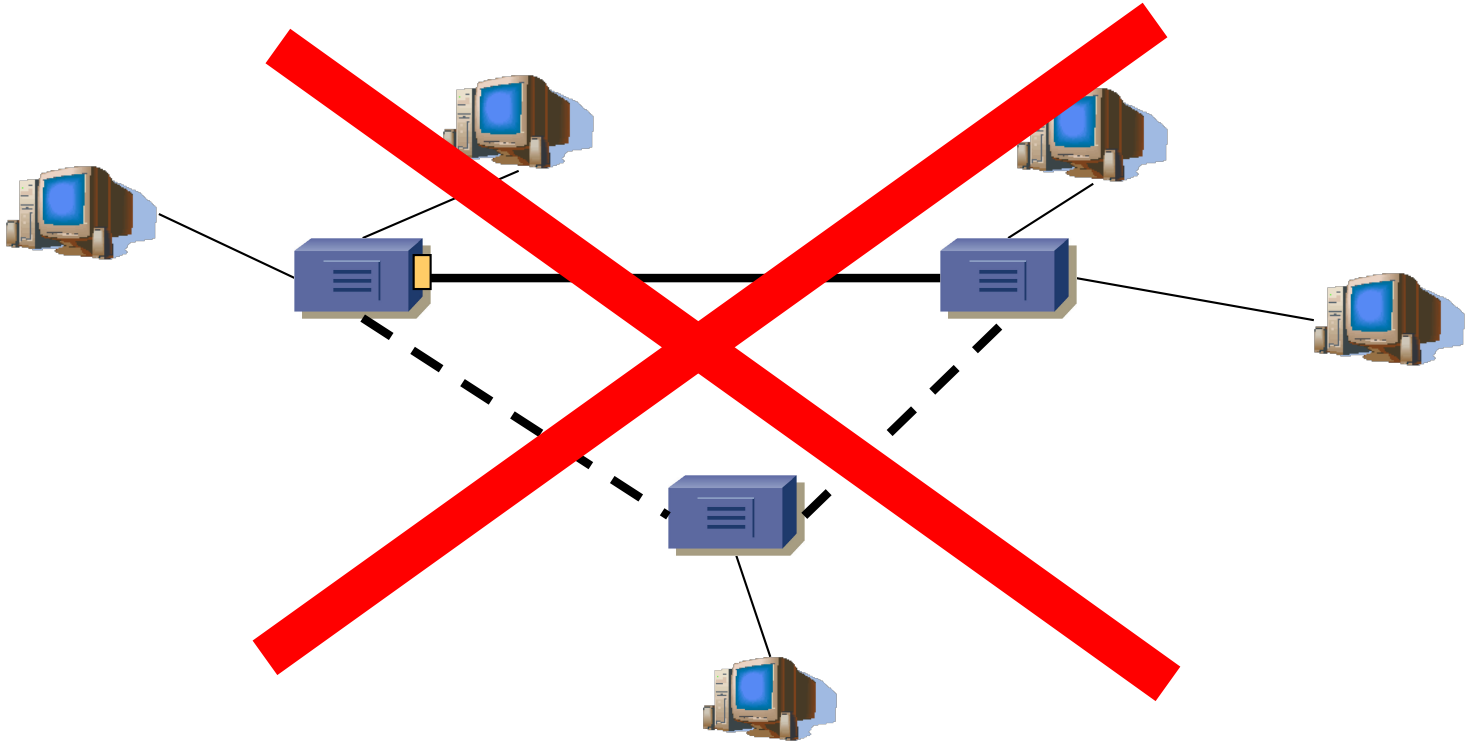


DTE = Data Terminal Equipment
DCE = Data Communications Equipment



Hubs Ethernet

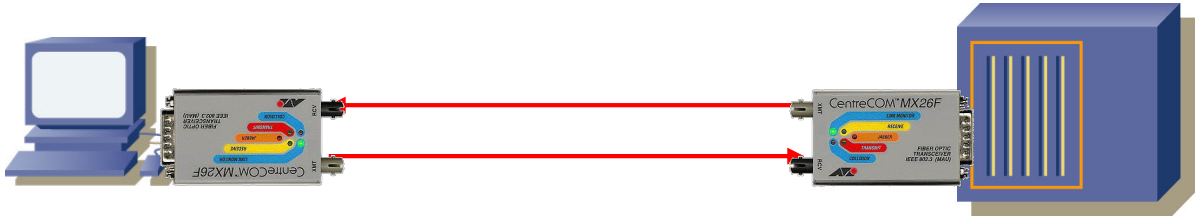
- Ya no se venden y es mprobable que los encontréis instalados
- Apariencia externa igual que un switch Ethernet
- La diferencia es que el medio es compartido (CSMA/CD)
- Half-dúplex
- Nunca formar un bucle con hubs



Ethernet sobre fibra óptica

10BaseFL

- Fibra óptica multimodo (50 o 62.5 µm)
- Dos hilos de fibra (lo más habitual en LAN)
- IEEE 802.3j
- Inmune a interferencias electromagnéticas
- Hasta 2 Km
- Usado en:
  - El *backbone* de una LAN
  - Cableado vertical
  - Larga distancia a un host



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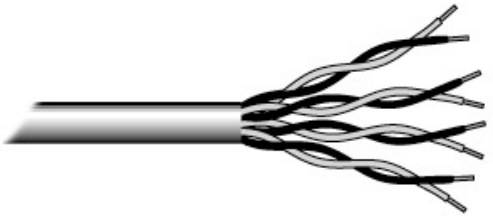
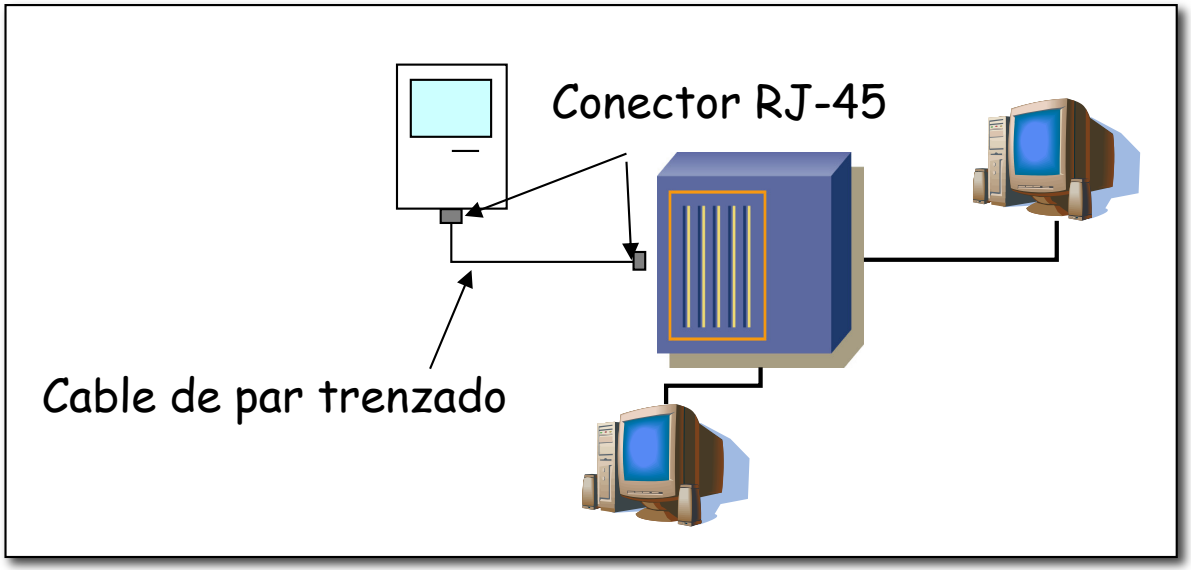
Fast Ethernet

Fast Ethernet

100Base-TX



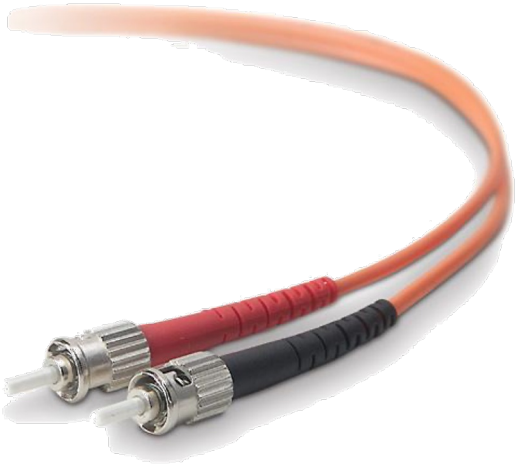
- IEEE 802.3u
- Cables de par trenzado Cat.5 o superior (100m)
- Usa 2 pares de hilos
- Conector RJ-45
- Hubs a 100Mb/s (incompatibles con transmisión a 10Mb/s)

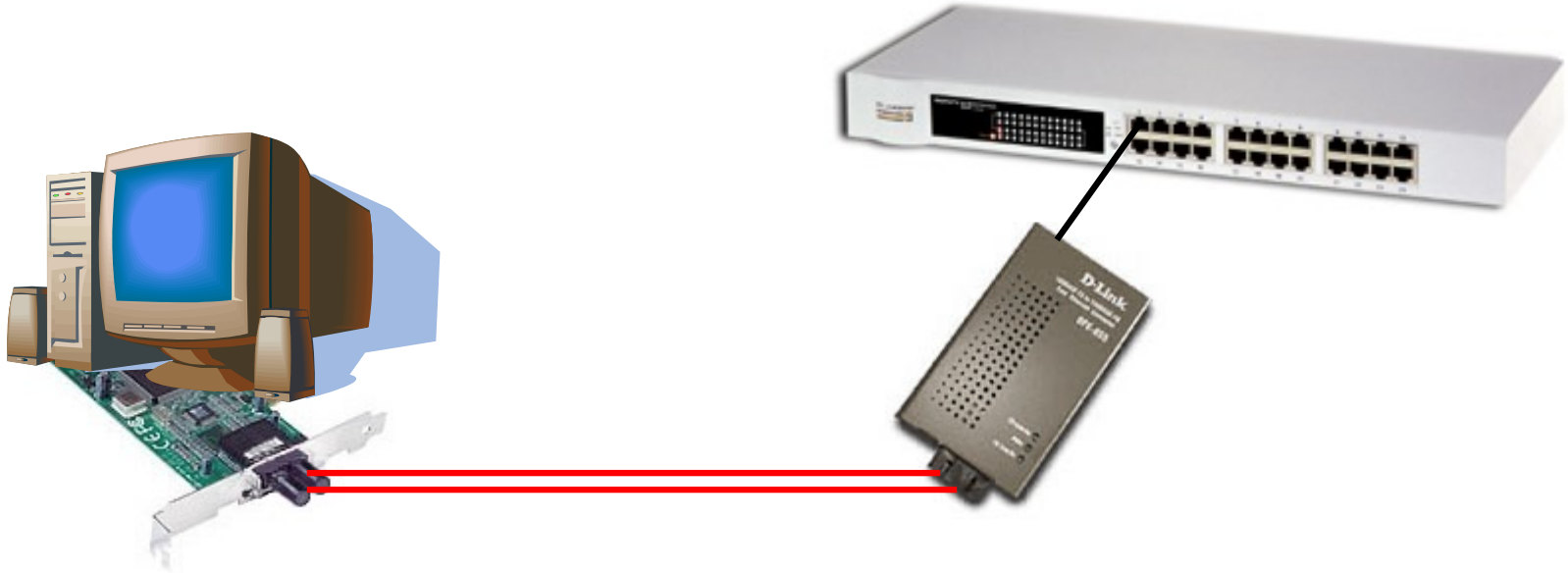


Fast Ethernet

100Base-FX

- Fibra multimodo (50 ó 62.5 µm)
- Dos hilos de fibra
- 2 Km (full-duplex)
- 412 m (half-duplex)



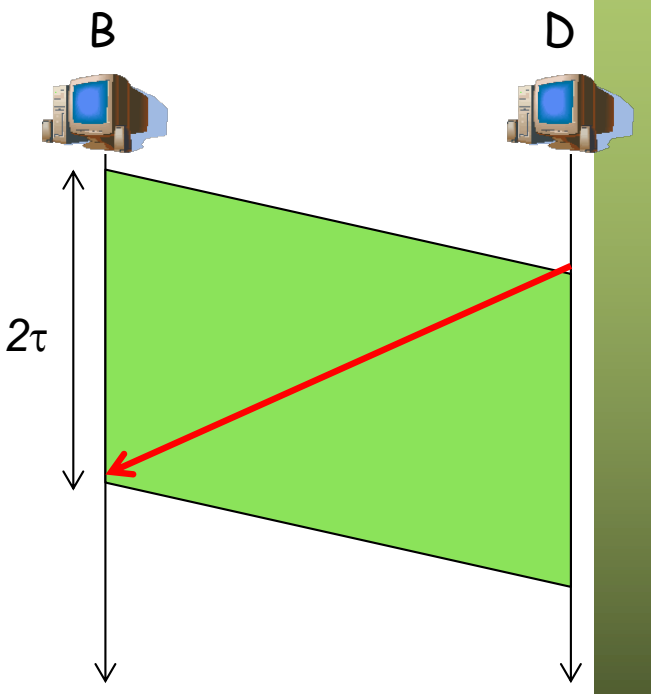


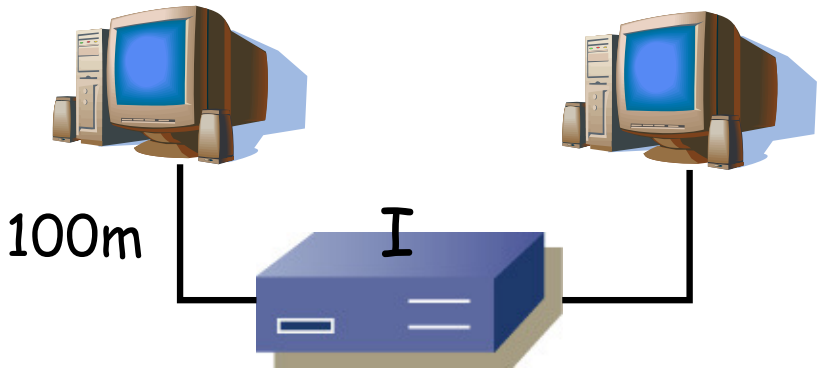
Repetidores Fast Ethernet

- Solo 1 (ó 2) entre cualquier par de hosts con 100m al hub

¿ Por qué tan corta distancia ?

- CSMA/CD
- FastEthernet mantiene la longitud mínima de la trama (64 bytes)
- *Collision Window* ↓ (menor tiempo de transmisión)
- Elección: Aumentar el tamaño mínimo o reducir el diámetro máximo
- Se redujo el diámetro: speed x10 ⇒ diámetro ÷10

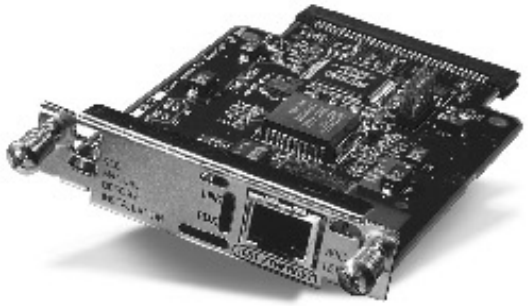




Tamaño de trama (bytes)	Tiempo de Tx (μseg) 10Mbps	Tiempo de Tx (μseg) 100Mbps
64	51.2	5.12
512	409.6	40.96
1000	800	80
1518	1214.4	121.44

Autonegociación

- Opcional en IEEE 802.3u (Fast Ethernet)
- Extendida a 10Base-T
- Obligatorio en 1000Base-T
- Permite negociar:
  - Half/Full-Duplex
  - 10/100/1000 Mbps
- Mediante pulsos que se envían cuando no hay tramas
- Si un extremo lo soporta y otro no:
  - Extremo que lo soporta puede detectar la velocidad
  - No detecta el *duplex* así que escoge *half-duplex*



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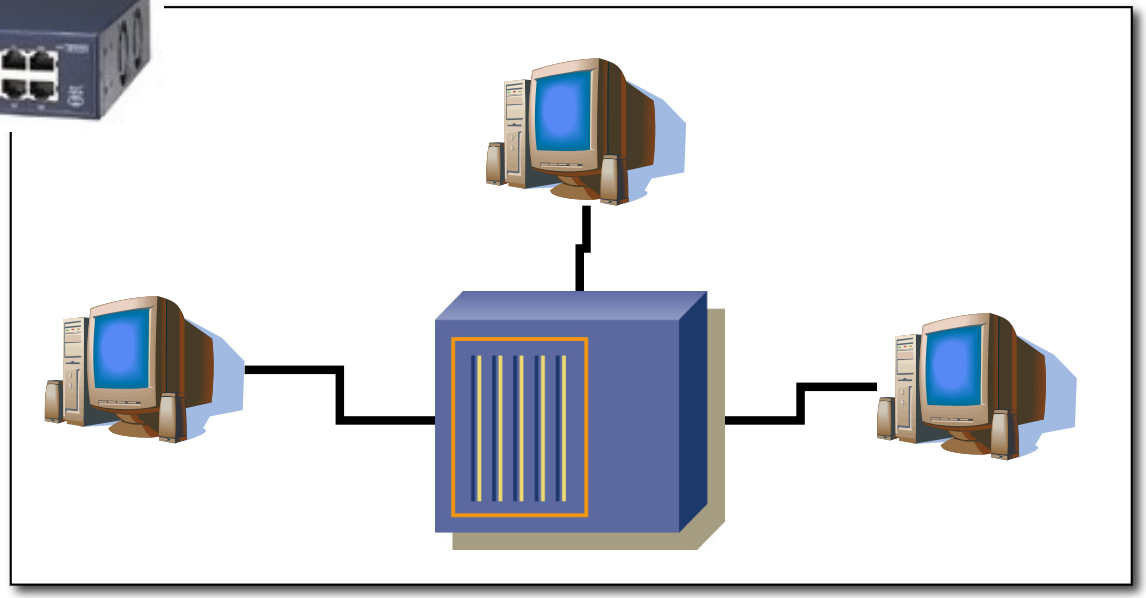
Gigabit Ethernet

Gigabit Ethernet

1000Base-T

- IEEE 802.3ab
- 4 pares Cat.5 (100m)
- El *hub* existe en el estándar pero no se utiliza

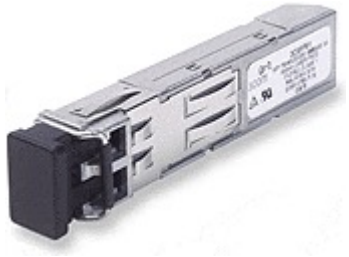
GMII = Gigabit Medium Independent Interface



Gigabit Ethernet

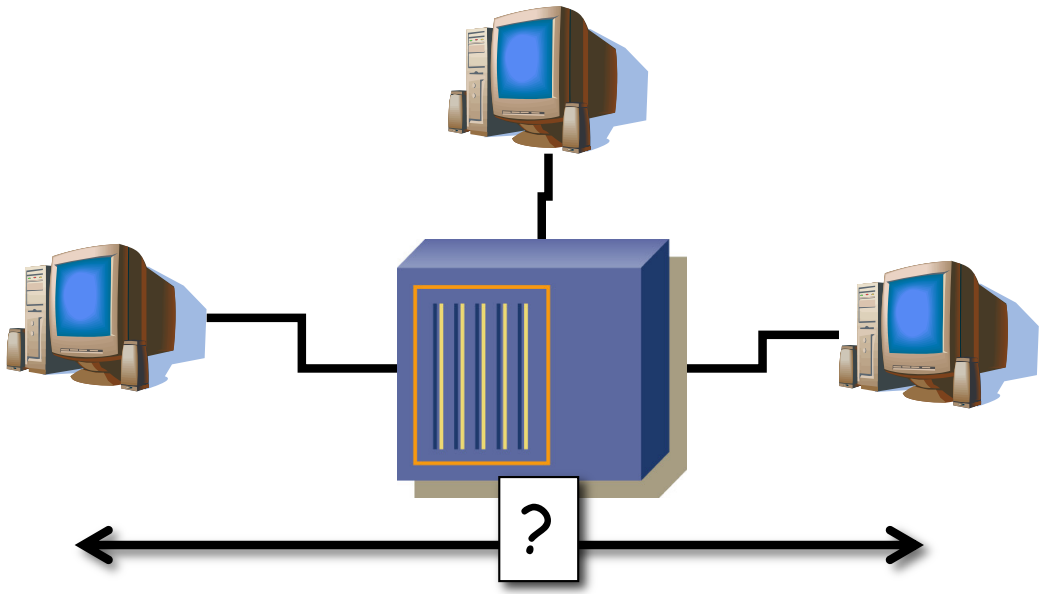
1000Base-X

- IEEE 802.3z
- 1000Base-SX : Fibra multimodo (200-500 m)
- 1000Base-LX : Fibra monomodo (5-10 Km)
- Otras variantes (según fabricante, durante procesos de estandarización, para primera milla, etc)



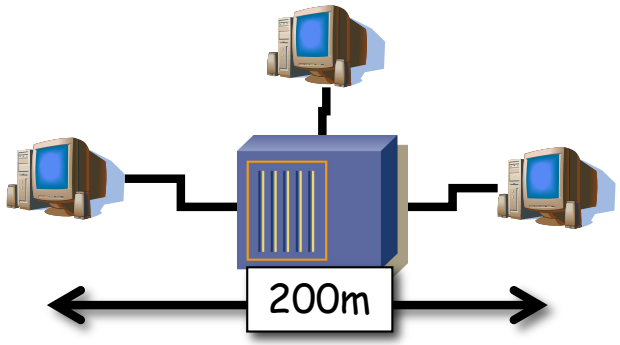
Gigabit Ethernet

- Existe el *Hub* Gigabit
- Velocidad x10 frente a FastEthernet
- ¿ Diámetro ÷10 ?



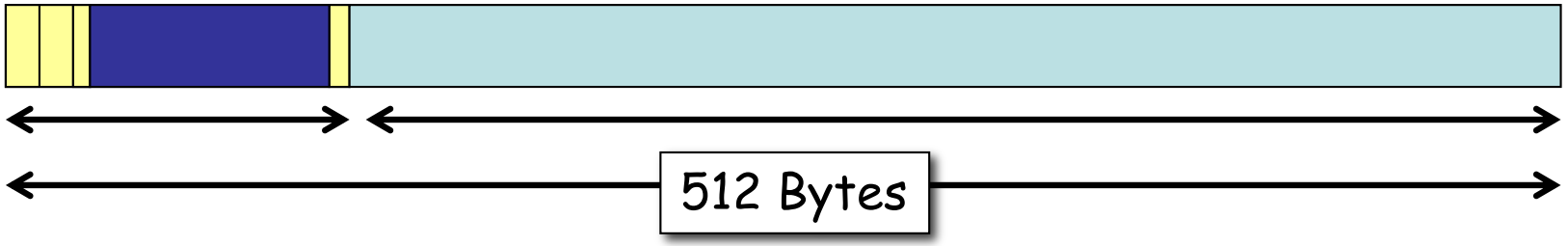
Gigabit Ethernet

- ¿ Diámetro ÷10 ? **NO**



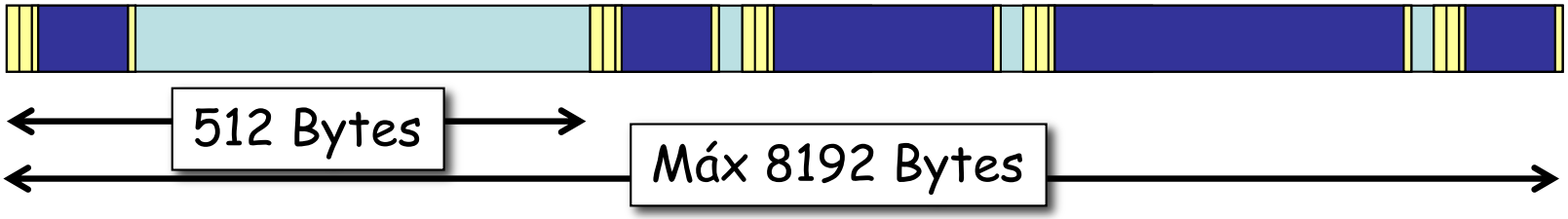
Carrier Extension

- Mínimo tamaño 512 Bytes



Frame Bursting

- Puede trasmitir varias tramas seguidas
- Sin liberar el canal
- Hasta 8192 bytes
- La primera trama, si es demasiado corta, requiere extensión de portadora



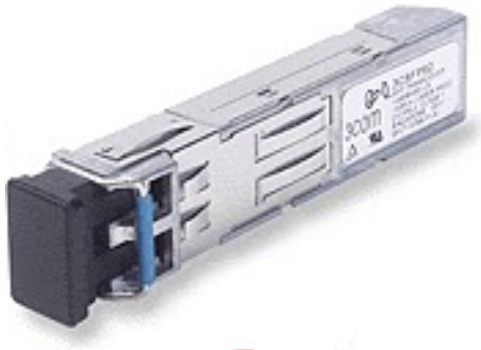
Gigabit Ethernet

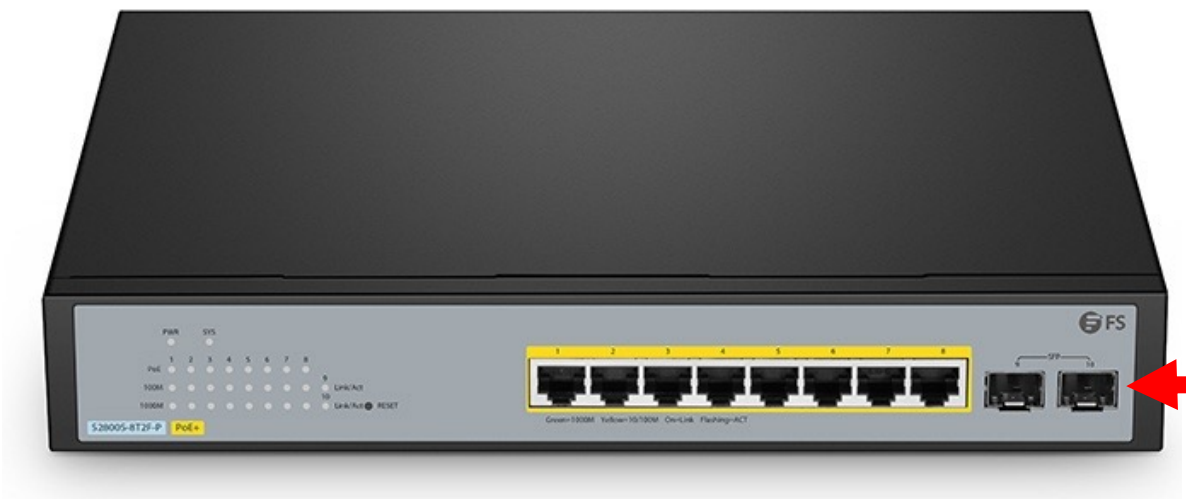
- Se emplean switches (próxima clase)
- Full Duplex
- No-CSMA/CD
- Así que no hacen falta las extensiones

Gigabit Ethernet

SFP

- Small Formfactor Pluggable transceiver
- *Hot-swappable Transceiver*





Gigabit Ethernet

¿ Jumbo Frames ?

- MTU tradicional 1500 bytes
- *Jumbo Frames* la aumentan a unos 9 KBytes
- Reduce la carga de procesamiento (pkts/sec)

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Ethernet > 1Gbps

Ethernet a 10Gb/s

10GBase-X

- IEEE 802.3ae
- 10GBase-SR : F.O. Multimodo (30m con FDDI-grade, 300m con OM3)
- 10GBase-LR : F.O. Monomodo (10-20Km)
- 10GBase-ER : F.O. Monomodo (40Km)
- 10GBase-SW/LW/EW : WAN PHY (9.58Gbps), para mapearse directamente en un contenedor SONET/SDH (VC-4-64c)

Ethernet a 10Gb/s

10GBase-T

- IEEE 802.3an
- Cable Categoría 6 (55m)
- Cable Categoría 6 aumentada o Cat.7 (100m)
- 10 Gigabit Ethernet solo Full-Duplex

Otras velocidades

- 40 Gb/s, IEEE 802.3ba (2010)
  - Backplane (1m, solo 40Gb/s), cobre (10m) y fibra óptica
  - Emplea varias wavelengths, Ejemplo: 40GBASE-LR4
- 100 Gb/s, IEEE 802.3ba (2010)
  - Fibra óptica
- 2.5 Gb/s y 5 Gb/s, 802.3bz (2016)
  - “Multigigabit Ethernet”
  - Cat. 5e y 6
- 25 Gb/s, 802.3by (2016)
  - Cable twinaxial y fibra óptica
- 200 Gb/s y 400 Gb/s, 802.3bs (2017), 802.3cm (2020)
  - Fibra óptica
- 50 Gb/s, 802.3cn (2019)
  - Fibra óptica

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Equipos

NIC

- https://eu.dlink.com/es/es/-/media/business_products/dge/dge-528t/datasheet/dge_528t_c1_datasheet_en.pdf

Product Highlights

Upgrade to Gigabit

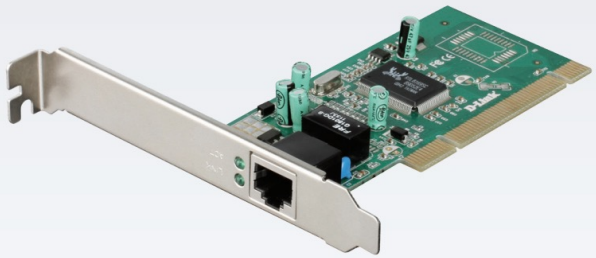
Enjoy lightning-fast data rates of up to 2 Gbps with a simple, economical upgrade

Saves Power Automatically

Consumes less energy by automatically lowering power consumption when traffic is low

Remote Bootup

Support for ACPI 2.0 Wake-on-LAN allows you to boot your PC remotely for convenient access and management



Features

High-Performance:

- 10/100/1000 Mbps
- Auto-Negotiation
- PCI Interface
- Plug-and-Play

Advanced Standards Based Enterprise Features:

- IEEE 802.1p Priority Tagging
- IEEE 802.1Q VLAN Tagging
- IEEE 802.3x Flow Control
- Jumbo Frame Support (up to 7K bytes)
- ACPI 2.0 WOL Power Management

Módulo SFP o SFP+

- https://eu.dlink.com/es/es/-/media/business_products/dem/dem-431xt/datasheet/dem_400-series-datasheet-en-eu.pdf

Product Highlights

Covers Vast Distances

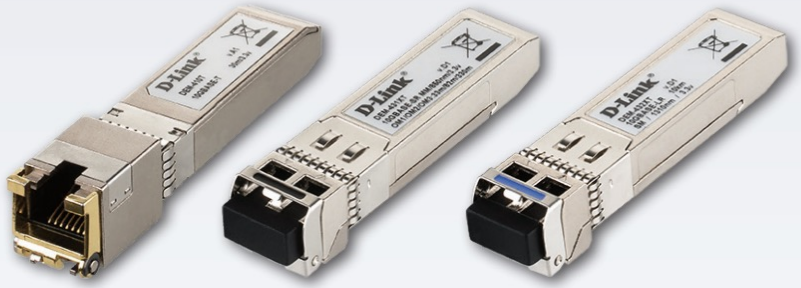
Support for maximum fibre lengths of up to 10 km, ideal for businesses spanning multiple premises, as well as copper lengths of up to 30 m

High Performance

Full duplex Gigabit data transfer rates provide the network transmission speeds that business environments demand

Hot Pluggable

Easily switch out transceivers while the power is on, facilitating network maintenance and minimising downtime



DEM-400 Series

10 Gigabit SFP Transceivers

Features

- Enhanced Small Form-Pluggable (SFP+) form factor
- Hot pluggable
- Support 10G Ethernet
- Support fibre cables up to 10 km
- Support copper cables up to 30 m
- RoHS Compliant
- Compliant with MSA (Multiple Source Agreement)
- Compliant with IEEE802.3ae standard

Puertos para módulo SFP/SFP+