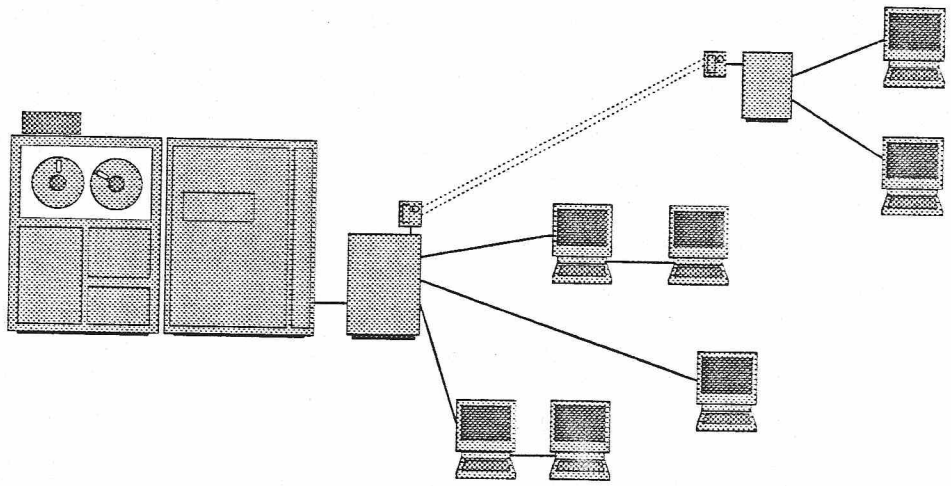
Internetworking

LAN's, Repeaters, Bridges, Routers ...

Primer Seminario de Perfeccionamiento
en Redes Académicas
Universidad Nacional de La Plata
8 - 12 Diciembre, 1992
Buenos Aires, Argentina.

Jorge M. Amodío <pete@atina.ar>

Evolución de las redes de datos
1960 - 1975



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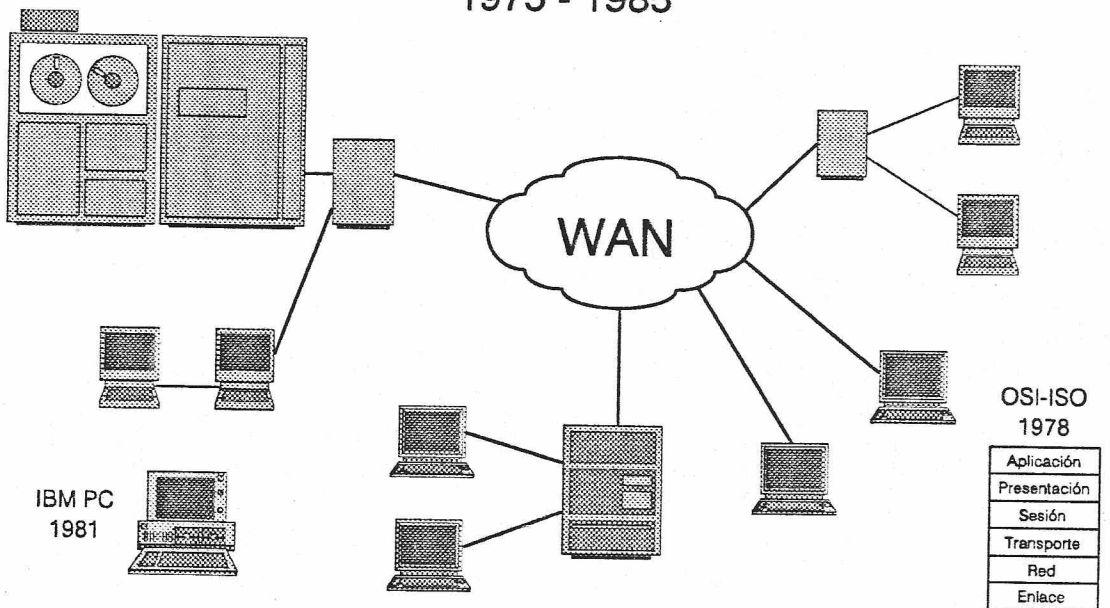
Evolución de las redes de datos
1975 - 1985



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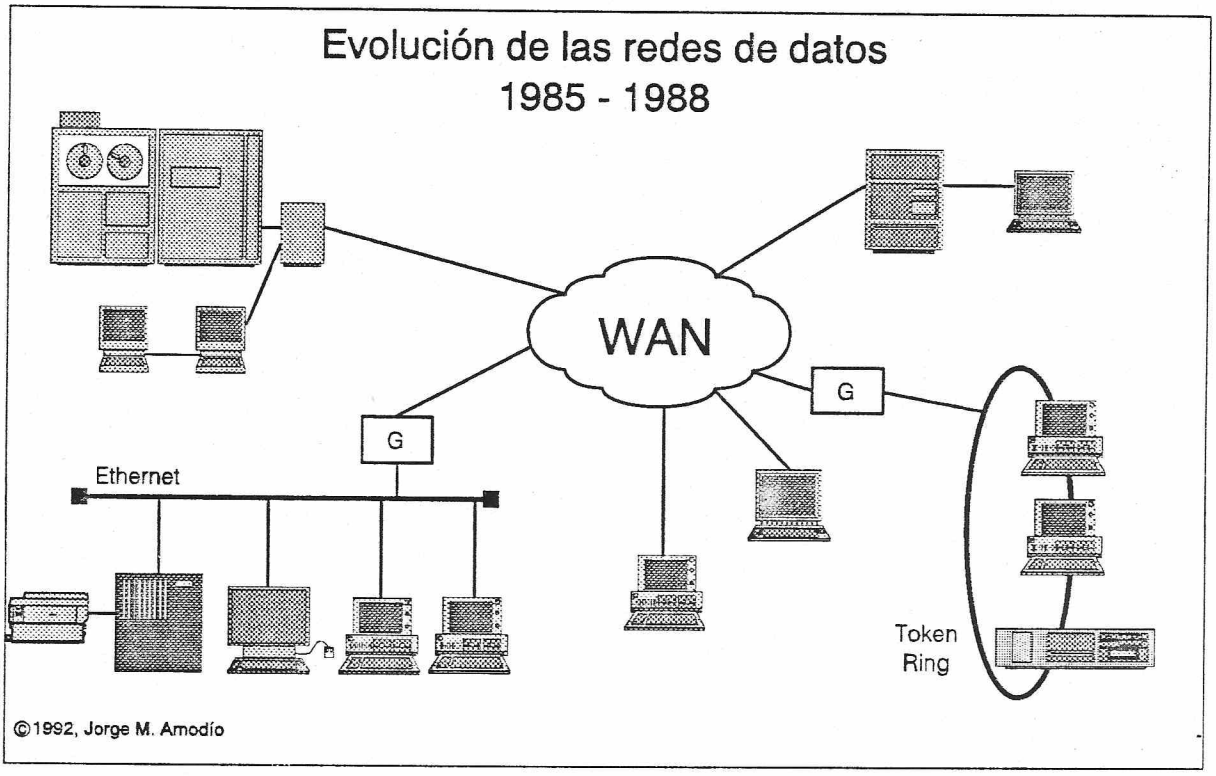
Evolución de las redes de datos
1985 - 1988
WAN
G
G
Ethernet
Token
Ring
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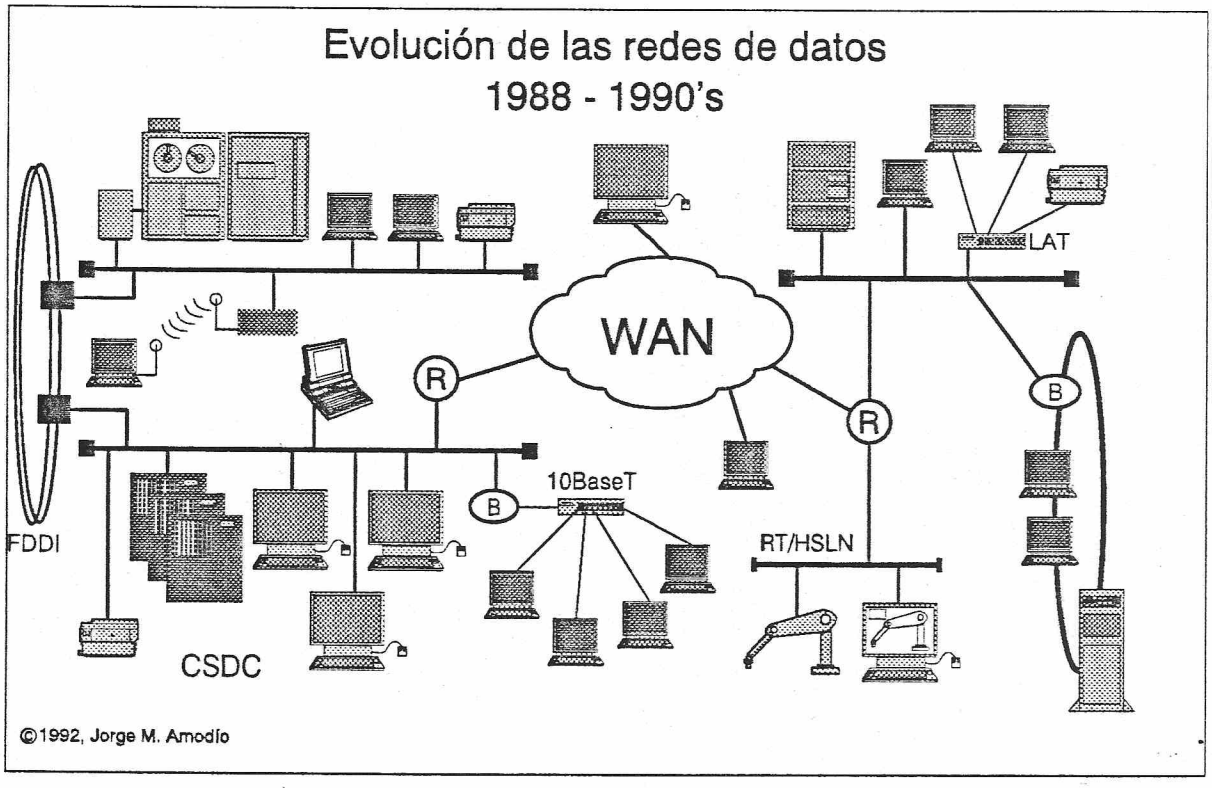
Evolución de las redes de datos
1988 - 1990's
WAN
R
R
B
B
LAT
10BaseT
RT/HSLN
FDDI
CSDC
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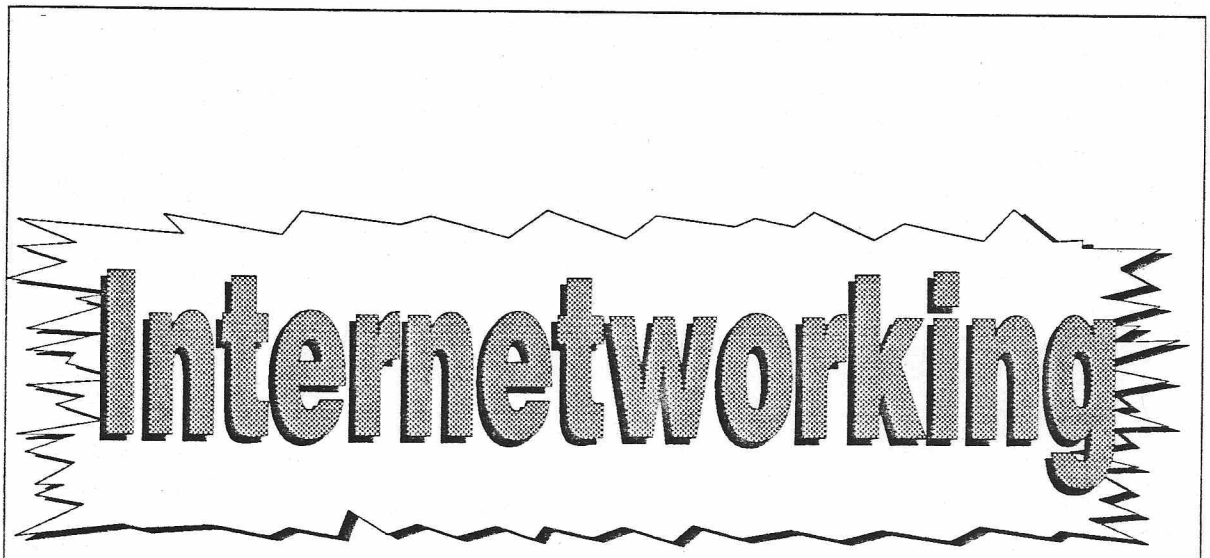

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Modelo ISO de interconexión de Sistemas Abiertos (OSI)

Aplicación	Establece, mantiene, y termina las conexiones entre los sistemas, eligiendo el camino más económico. Provee independencia a los niveles superiores, sobre la tecnología utilizada para interconectar los sistemas.
Presentación	
Sesión	
Transporte	
Red	Provee el mecanismo para la transferencia de información en forma confiable y libre de error por medio del enlace físico. Envía bloques de datos (tramas) con la necesaria sincronización, control de error y de flujo.
Enlace	
Físico	Provee la transferencia de flujos de bits entre sistemas sobre el medio físico. Se refiere a las características mecánicas, eléctricas y funcionales para acceder al mismo.

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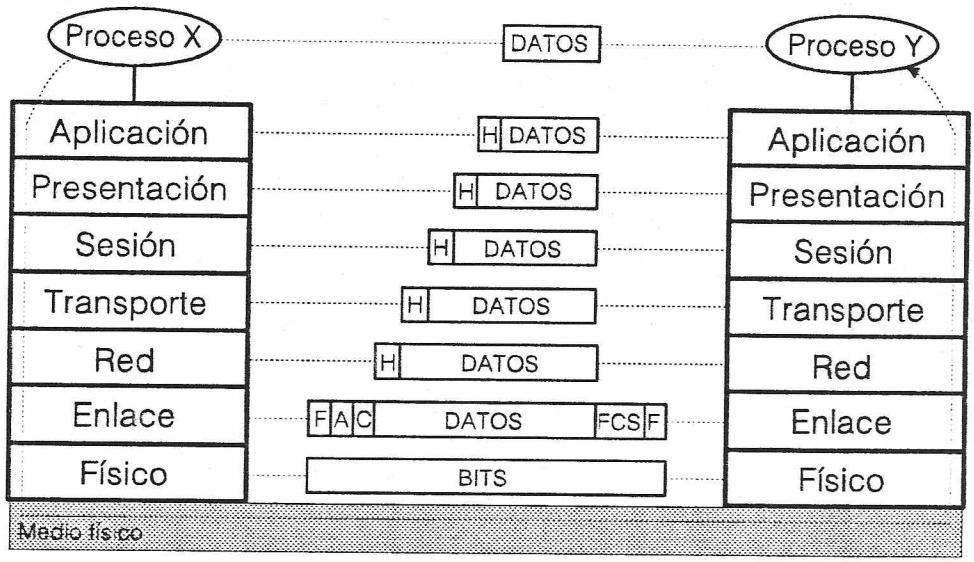
Transmisión de una trama



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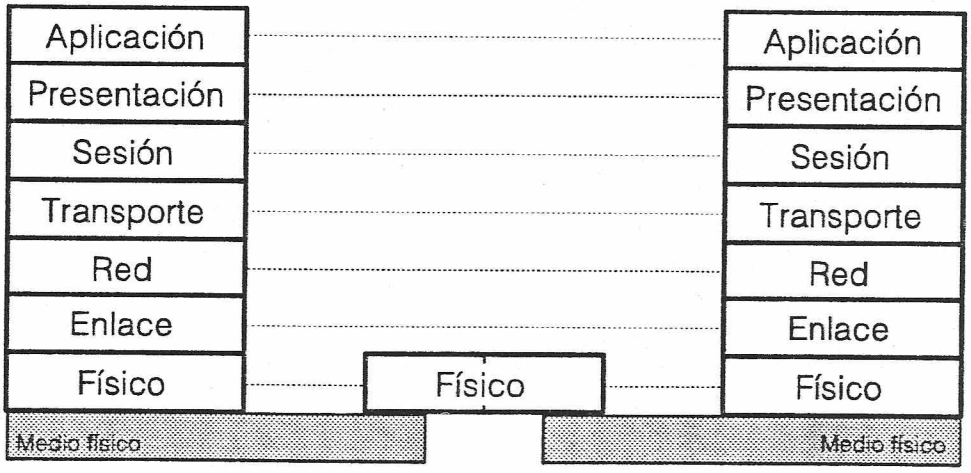
Sistema Intermedio
Nivel 1



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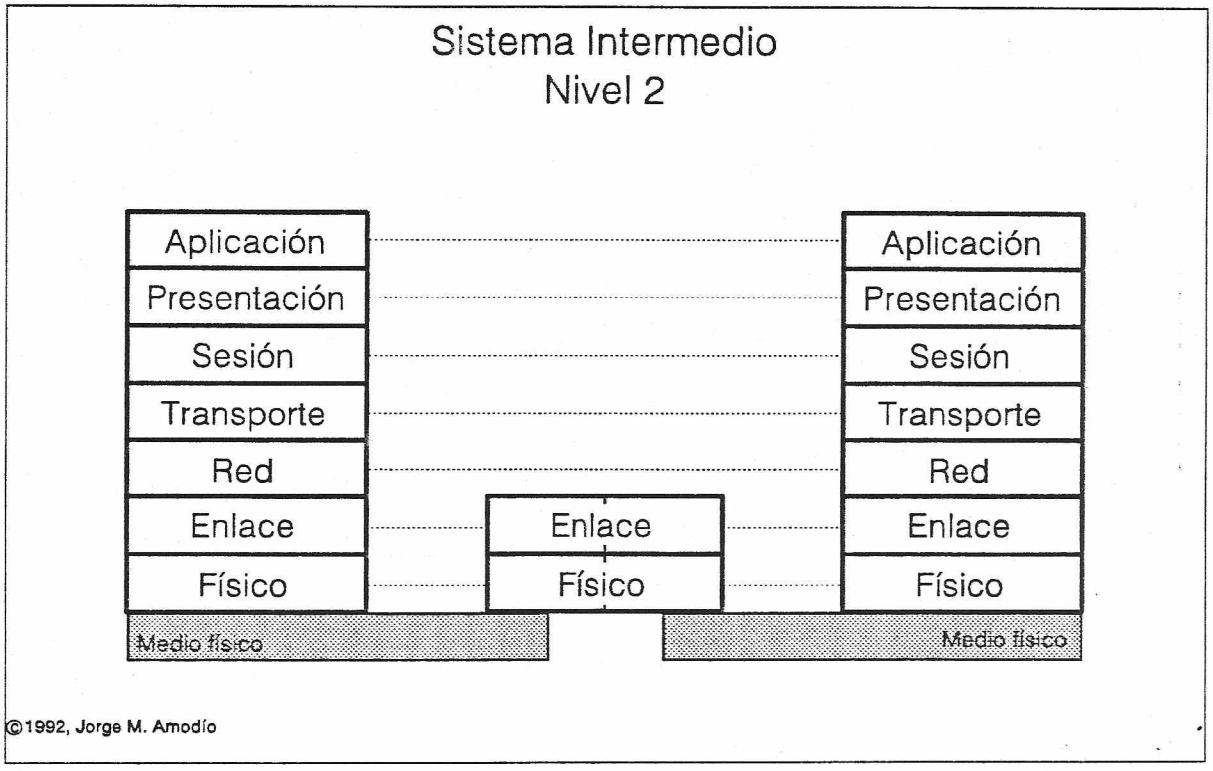
Sistema Intermedio
Nivel 2
Aplicación
Presentación
Sesión
Transporte
Red
Enlace
Físico
Medio físico
Enlace
Físico
Aplicación
Presentación
Sesión
Transporte
Red
Enlace
Físico
Medio físico
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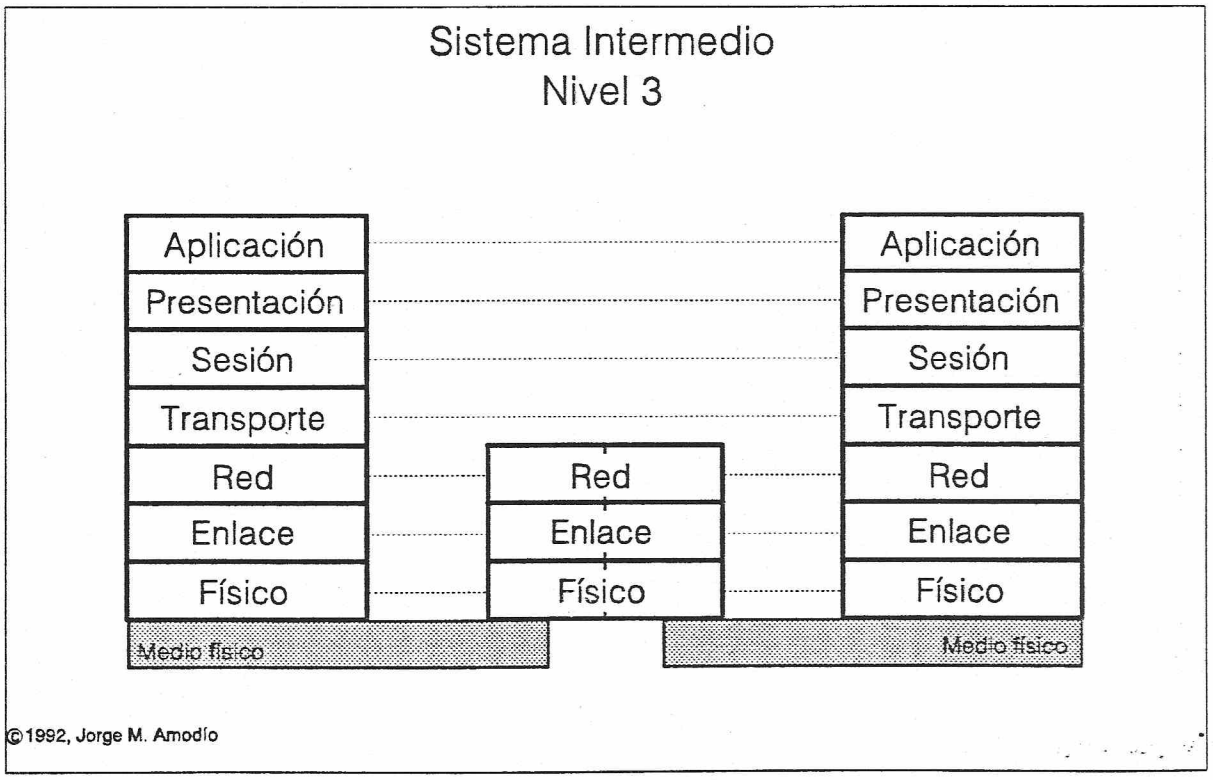
Sistema Intermedio
Nivel 3
Aplicación
Presentación
Sesión
Transporte
Red
Enlace
Físico
Medio físico
Red
Enlace
Físico
Aplicación
Presentación
Sesión
Transporte
Red
Enlace
Físico
Medio físico
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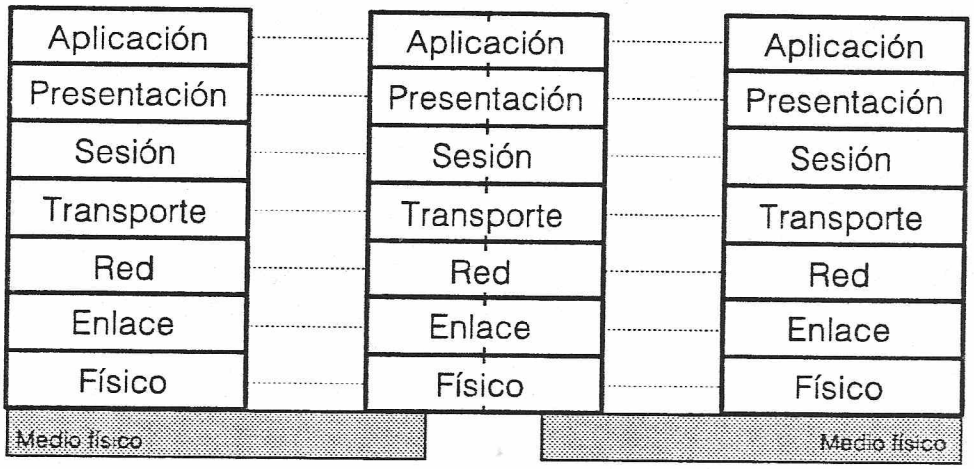
Sistema Intermedio
Nivel 7



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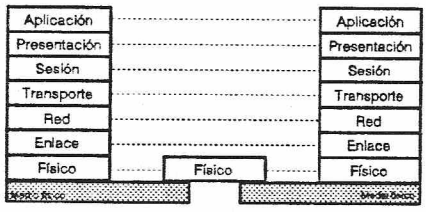
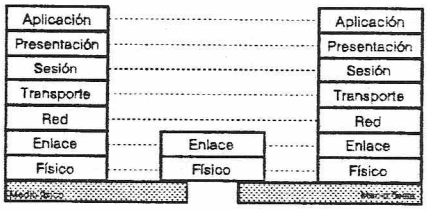
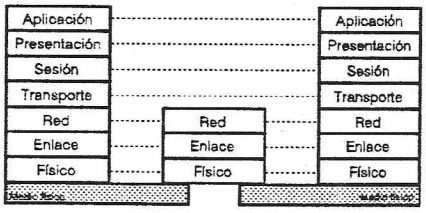
Sistemas Intermedios



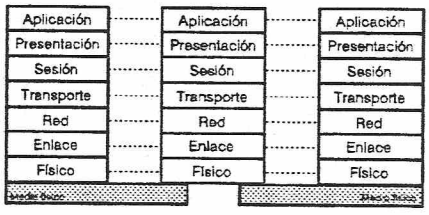
Repeater



Bridge



Router



Gateway

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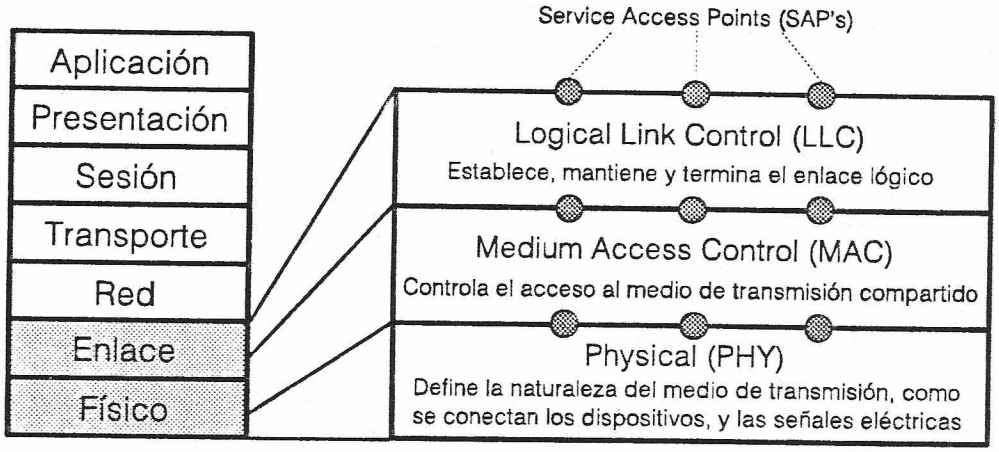
IEEE 802 vs MODELO OSI



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PROTOCOLOS ISO

Aplicación	ISO 9040/9041 VT	ISO 8831/8832 JTM	ISO 8571/8572 FTAM	ISO 9595/9596 CMIP
Presentación	ISO 8823/CCITT X.226 Connection-Oriented Presentation Protocol			
Sesión	ISO 8327/CCITT X.225 Connection-Oriented Session Protocol			
Transporte	ISO 8073/CCITT X.224 Connection-Oriented Transport Protocol			
Red	ISO 8473 Connectionless Network Service		ISO 8208/CCITT X.25 Packet Level Protocol	
Enlace	ISO 8802-2			ISO 7776 CCITT X.25 LAP/LAPB / ISO 7809 HDLC
	ISO 9314-2 FDDI	ISO 8802-3 CSMA/CD BUS	ISO 8802-2 TOKEN BUS	ISO 8802-5 TOKEN RING
Físico	Distintas alternativas, EIA, CCITT, IEEE, etc.			

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PROTOCOLOS TCP/IP

Aplicación	Transferencia Archivos	Correo Electrónico	Emulación Terminal	Administración Red
Presentación	File Transfer Protocol (FTP) RFC 959	Simple Mail Transfer Protoc. (SMTP) RFC 821	TELNET Protocol RFC 854	Simple Network Management Protocol (SNMP) RFC 1098
Sesión				
Transporte	Transmission Control Protocol (TCP) RFC 793		User Datagram Protocol (UDP) RFC 768	
Red	Adress Resolution ARP/RARP RFC 826/903	Internet Protocol (IP) RFC 791	Internet Control Message Protocol (ICMP) RFC 792	
Enlace	Interfaces de Red: Ethernet, StarLAN, Token Ring, etc. RFC 894, RFC 1042, RFC 1051			
Físico	Medios de Transmisión: Par Trenzado, Coaxil, Fibra Optica, etc.			

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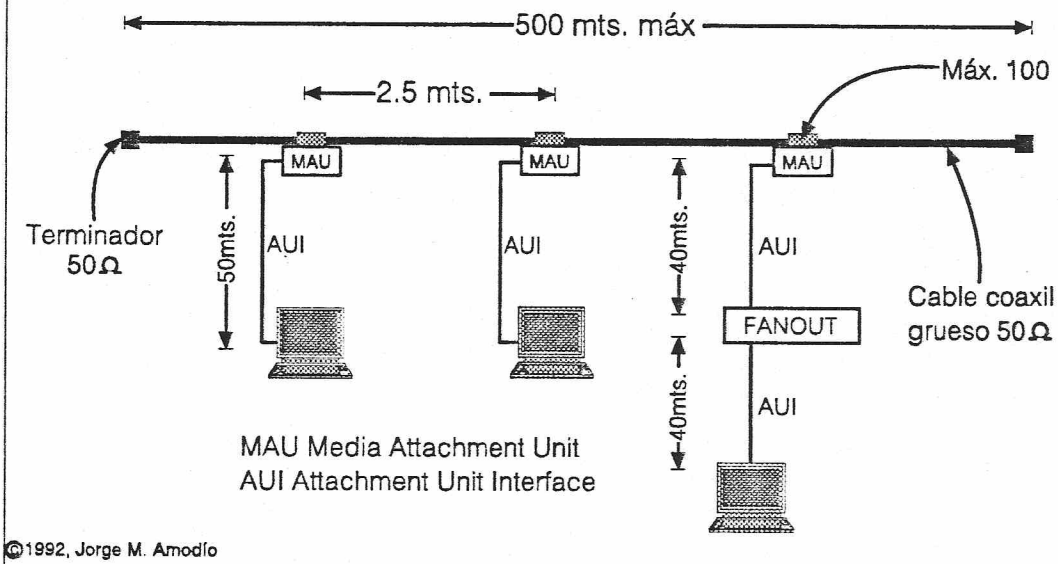
IEEE 802.3 10 Base 5
(Thick Ethernet)



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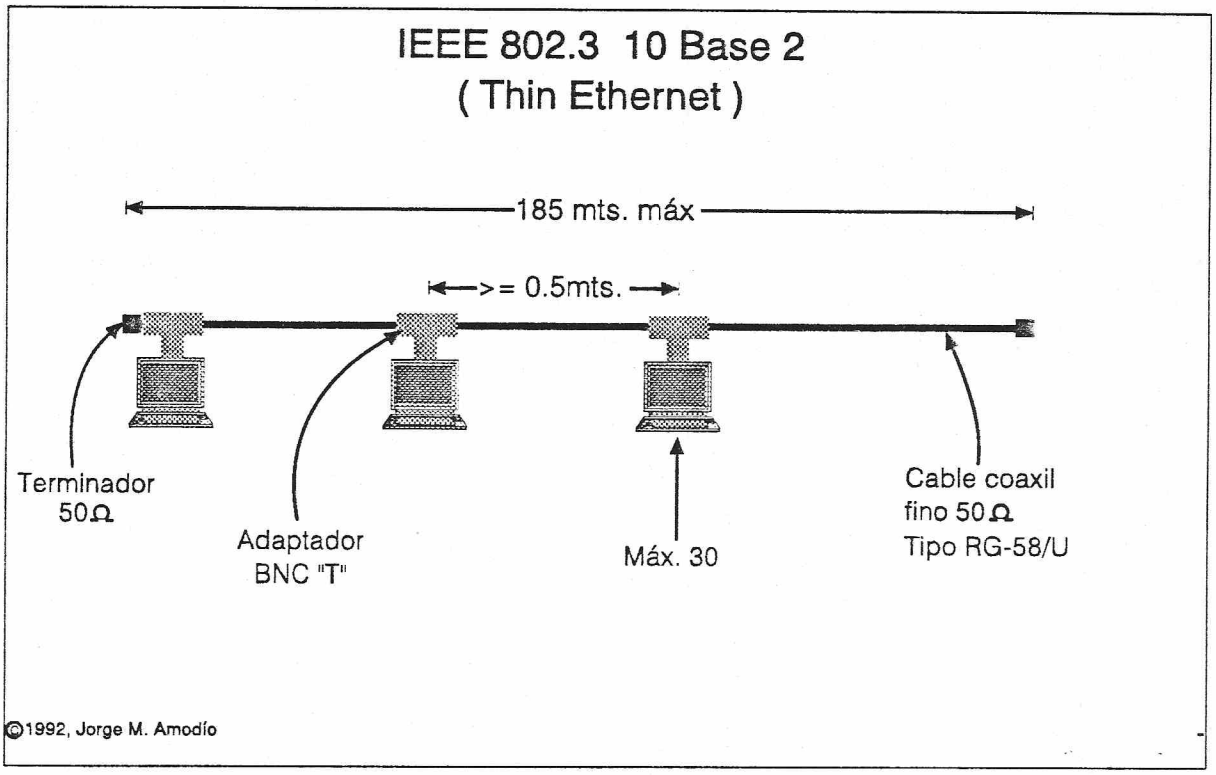
IEEE 802.3 10 Base 2
(Thin Ethernet)
185 mts. máx
>= 0.5mts.
Terminador
50Ω
Adaptador
BNC "T"
Máx. 30
Cable coaxil
fino 50Ω
Tipo RG-58/U
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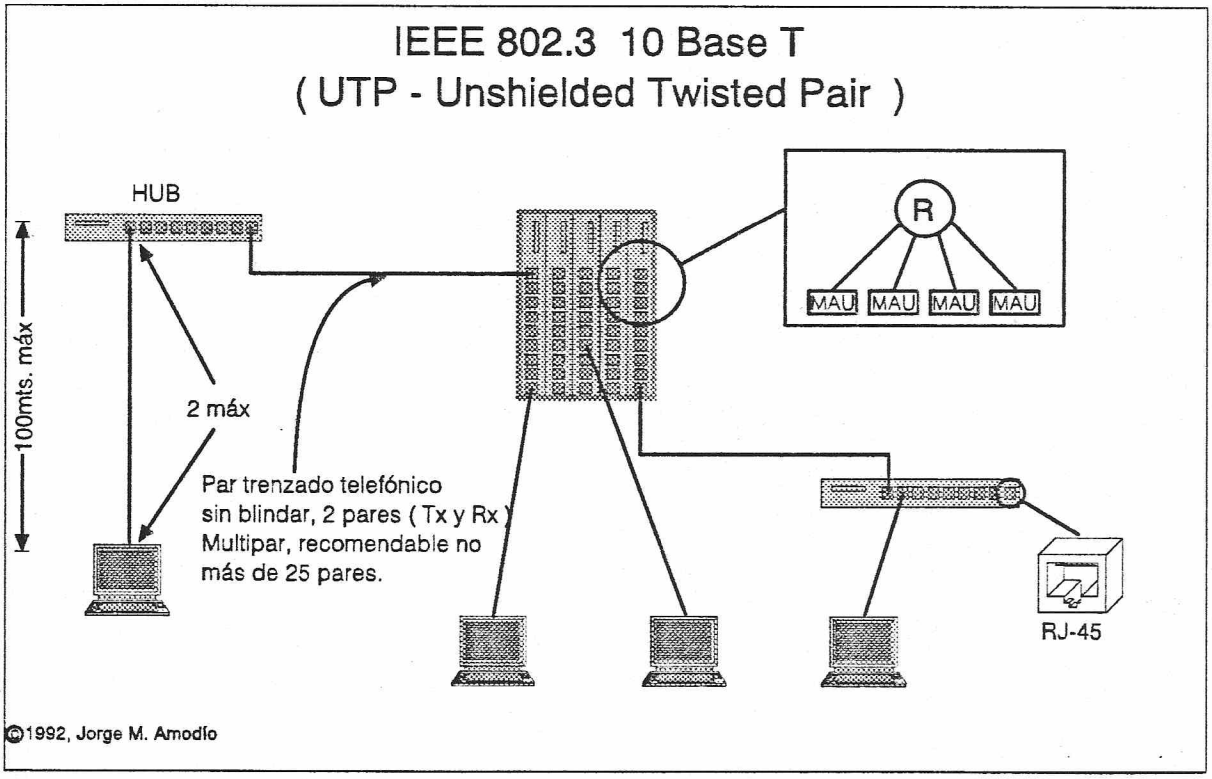
IEEE 802.3 10 Base T
(UTP - Unshielded Twisted Pair)
HUB
100mts. máx
2 máx
Par trenzado telefónico
sin blindar, 2 pares (Tx y Rx)
Multipar, recomendable no
más de 25 pares.
R
MAU
MAU
MAU
MAU
RJ-45
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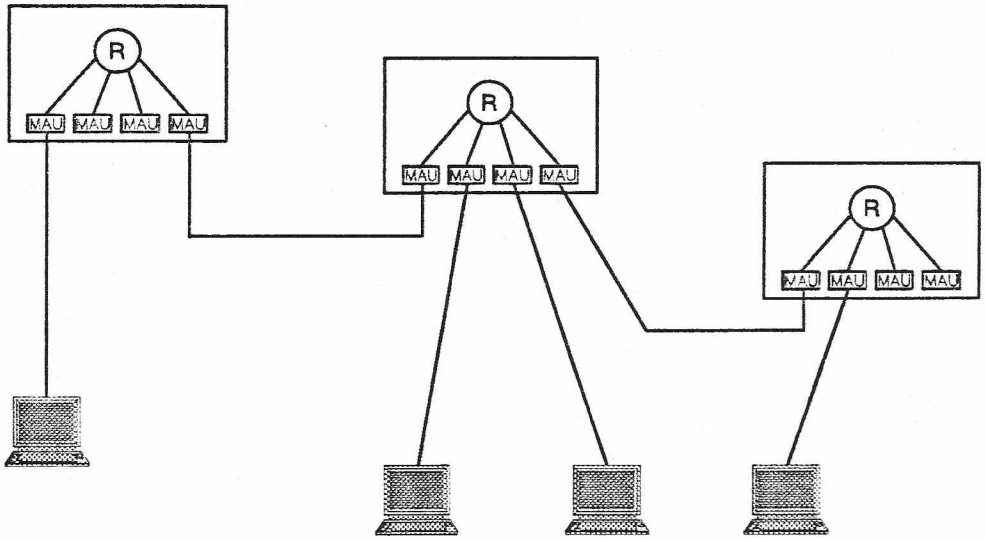
IEEE 802.3 10 Base T
(UTP - Unshielded Twisted Pair)



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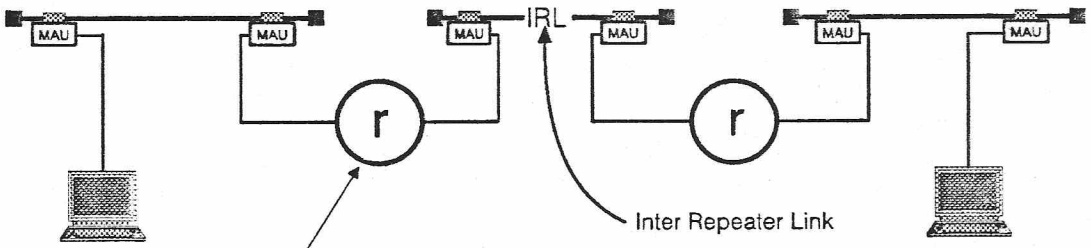
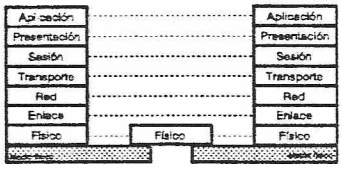
REPEATERS



Dispositivo utilizado para extender la longitud, topología, o conectividad del medio físico, más alla de lo impuesto para un segmento simple, hasta la longitud máxima permisible extremo a extremo de la linea de transmisión. Los repeaters recuperan, la amplitud de señal, forma de onda, y temporización, aplicable a las señales normales de datos y colisión.

Tipos
- Dual port, Multiport
- Half, Full
- Unbuffered, Buffered



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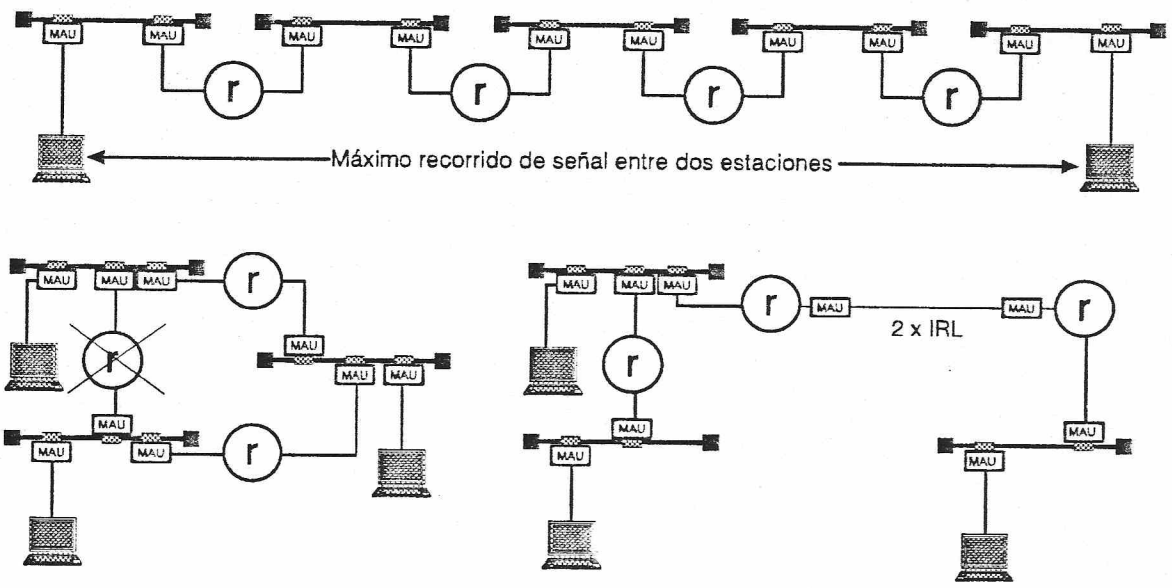
Utilización de Repeaters



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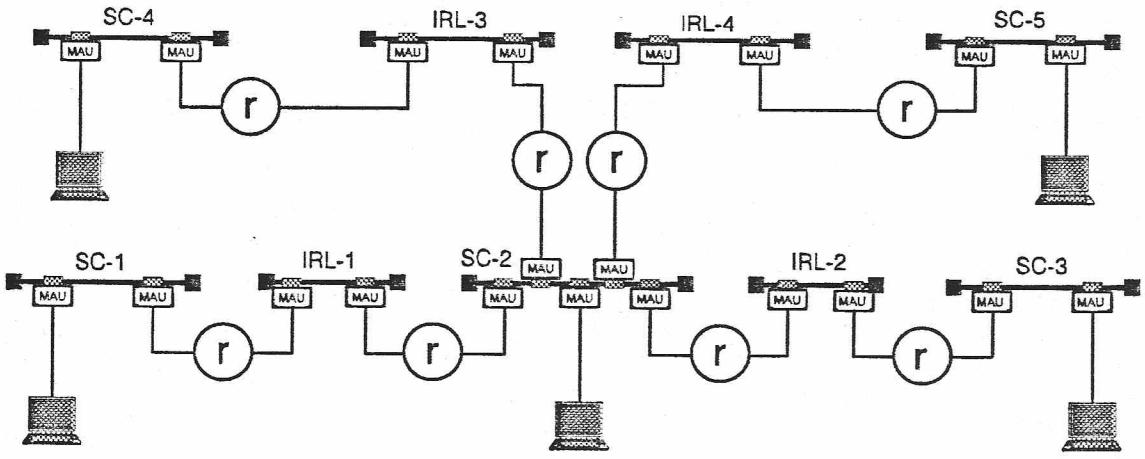
Utilización de Repeaters

Máximo recorrido de señal en redes de gran extensión



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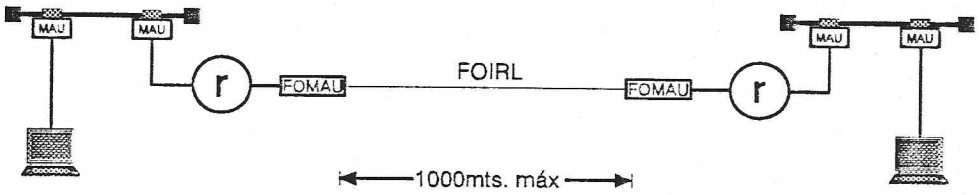
Utilización de Repeaters

Interconexión de segmentos utilizando fibra óptica



FOIRL Fiber Optic Inter Repeater Link
FOMAU Fiber Optic Media Attachment Unit

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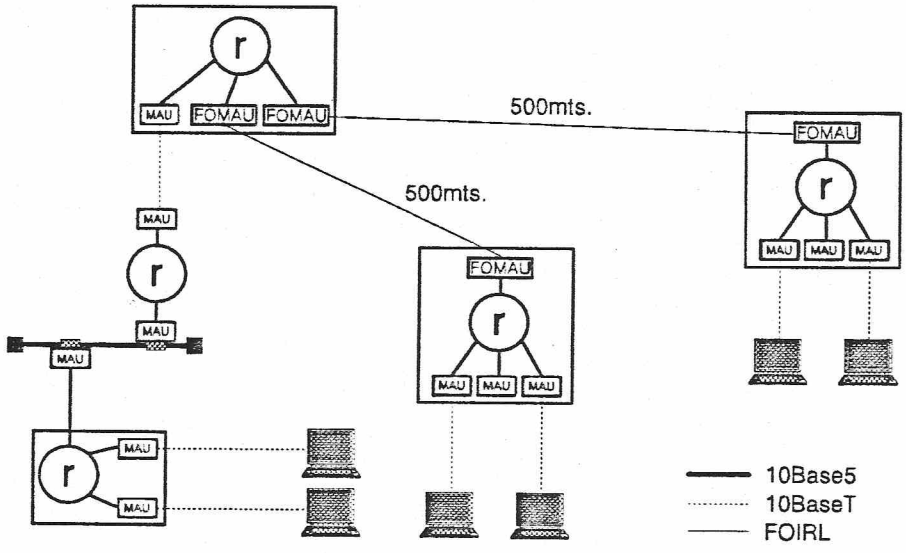
Utilización de Repeaters

Combinación 10BaseT, FOIRL, 10Base5



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IEEE 802.3 - Medios de Transmisión

	10Base5	10Base2	10BaseT	FOIRL
Medio Transmisión	Coaxil grueso 50 ohms	Coaxil fino 50 ohms	Par trenzado telefónico	Fibra óptica
Velocidad	10 Mbps	10 Mbps	10 Mbps	10 Mbps
Máx.Long.Segmento	500 mts.	185 mts.	100 mts.	1000 mts.
Máx. MAU's por Segmento	100	30	2	2
Min.Vel.Propagación	.77c	.65c	.59c	.66c
Máx. Delay medio por segmento	2165ns	950ns	1000ns	5000ns
Máx. Extensión de Red	2500 mts.	925 mts.	500 mts.	
Costo Cable x metro (USA U$S)	~ 3.5	~ 1	~ 0.16	~ 2
Dificultad de Instalación	Compleja	Moderada	Sencilla	Moderada Elevada
Inmunidad al Ruido	Buena	Buena	Pobre	Excelente

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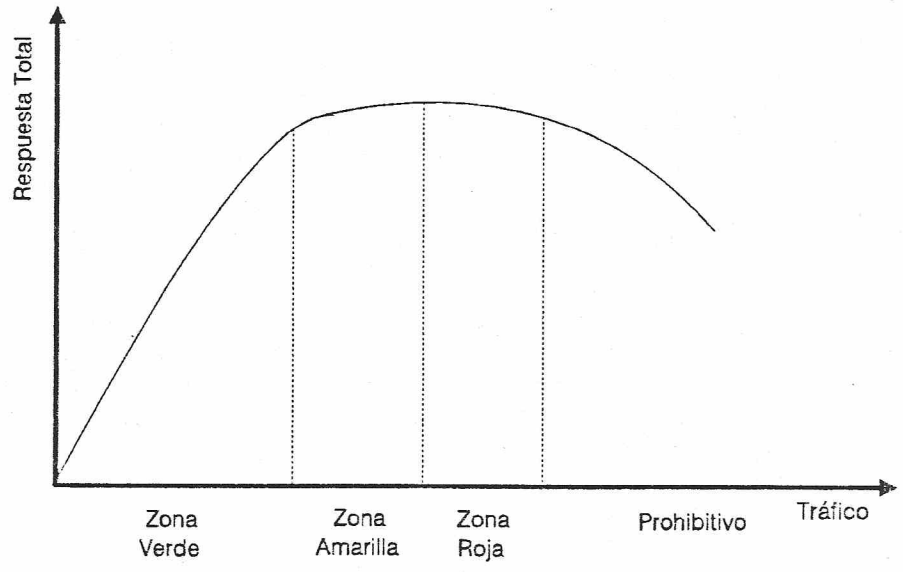
CSMA/CD - Respuesta vs Tráfico



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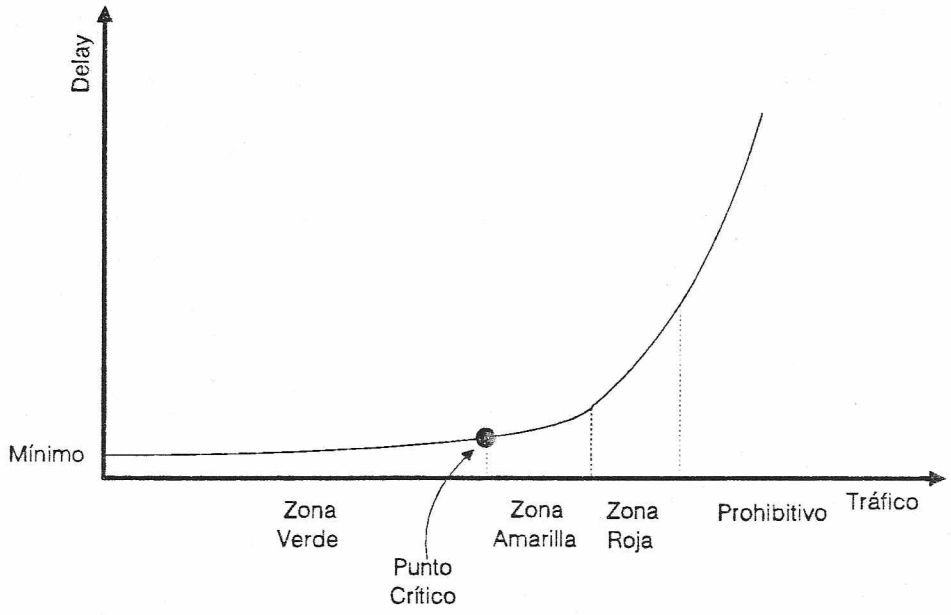
CSMA/CD - Delay vs Tráfico



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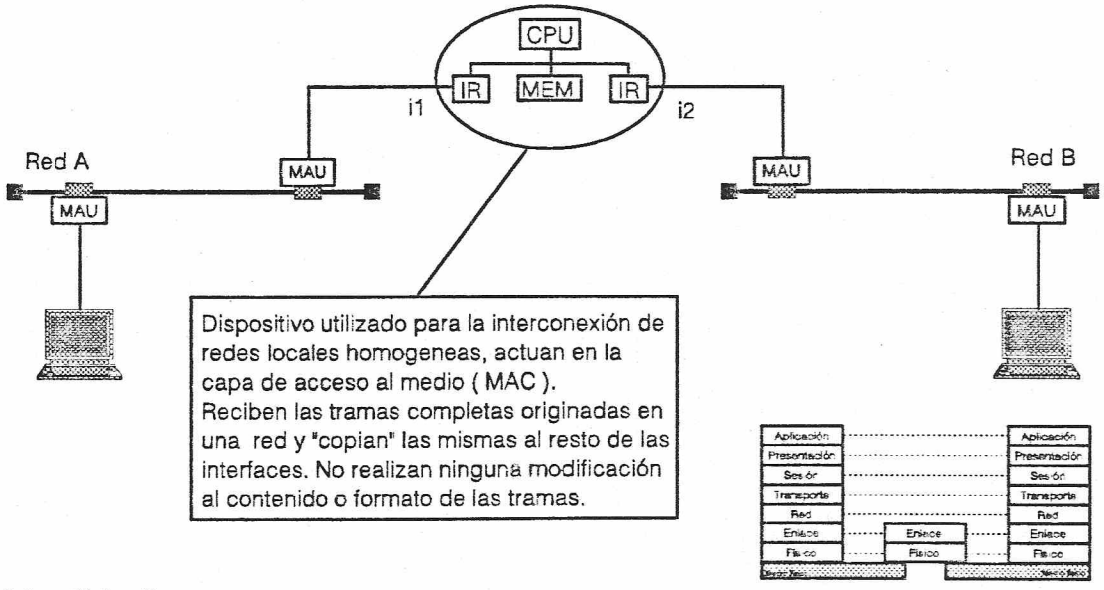
Bridges



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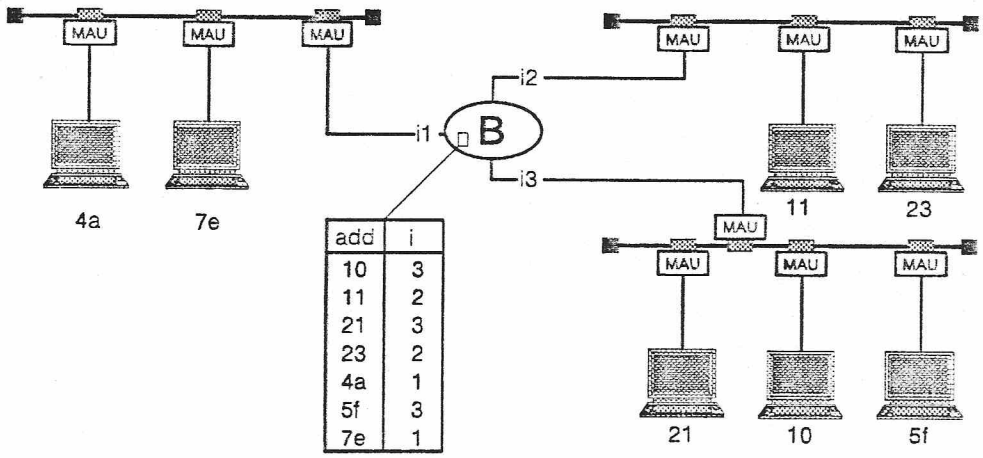
Bridges
Algoritmo Adaptivo (Learning)



add	i
10	3
11	2
21	3
23	2
4a	1
5f	3
7e	1

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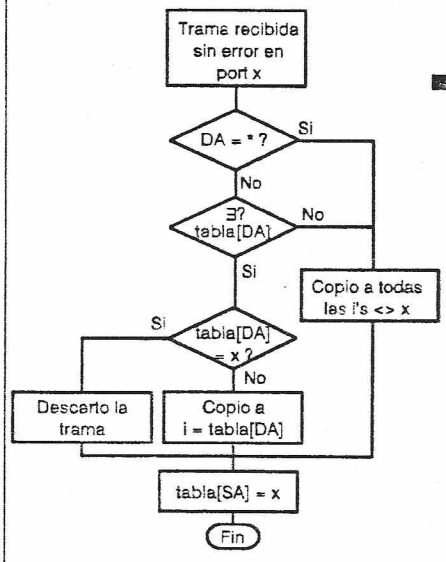
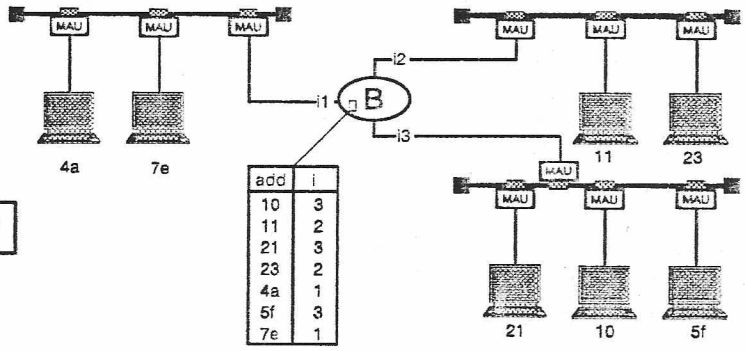
Bridges - Algoritmo Adaptivo (Learning)





add	i
10	3
11	2
21	3
23	2
4a	1
5f	3
7e	1

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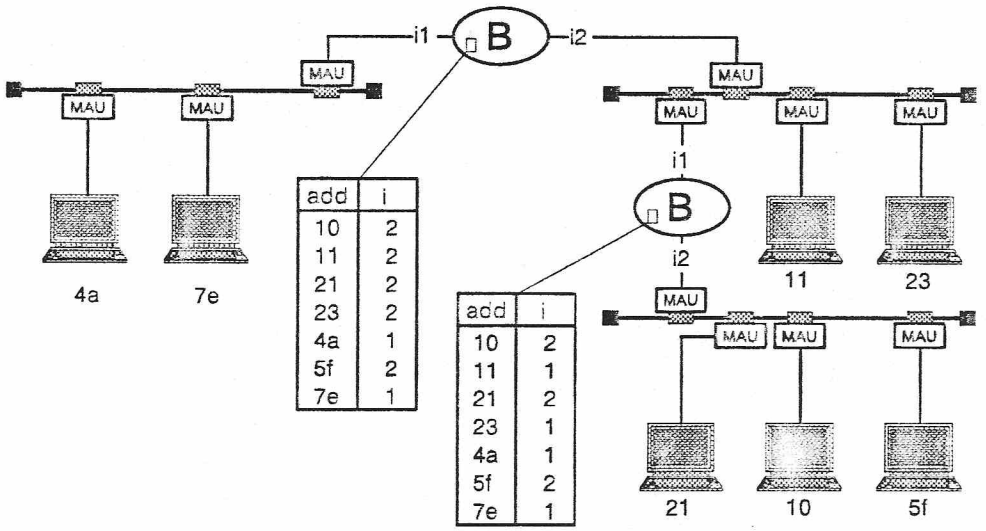
Bridges
Algoritmo Adaptivo (Learning)



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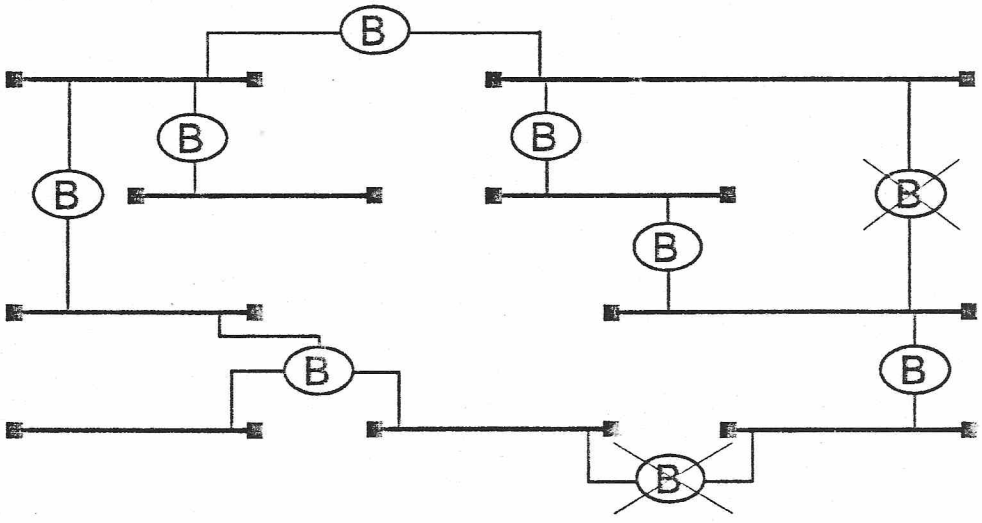
Bridges - Topologías



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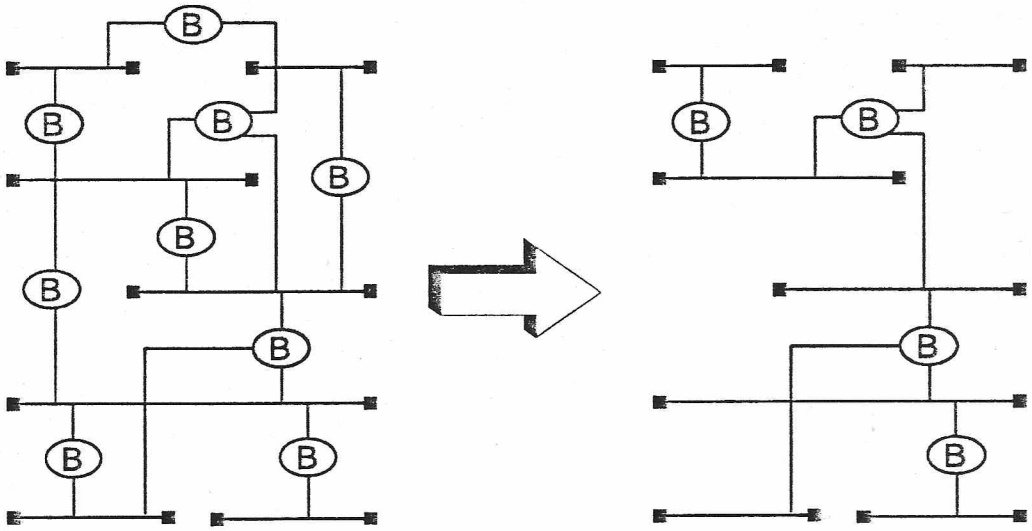
Bridge
Algoritmo Spanning Tree



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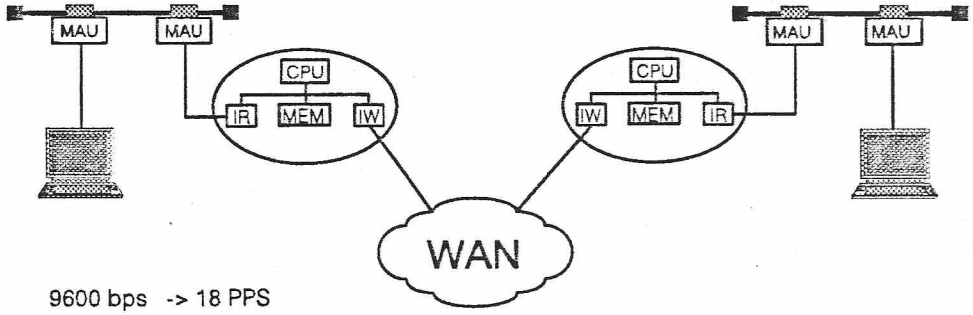
Bridges Remotos



9600 bps -> 18 PPS
19200 bps -> 37 PPS
57600 bps -> 109 PPS
T1 (1.54 Mbps) -> 3015 PPS
10 Mbps -> 19351 PPS

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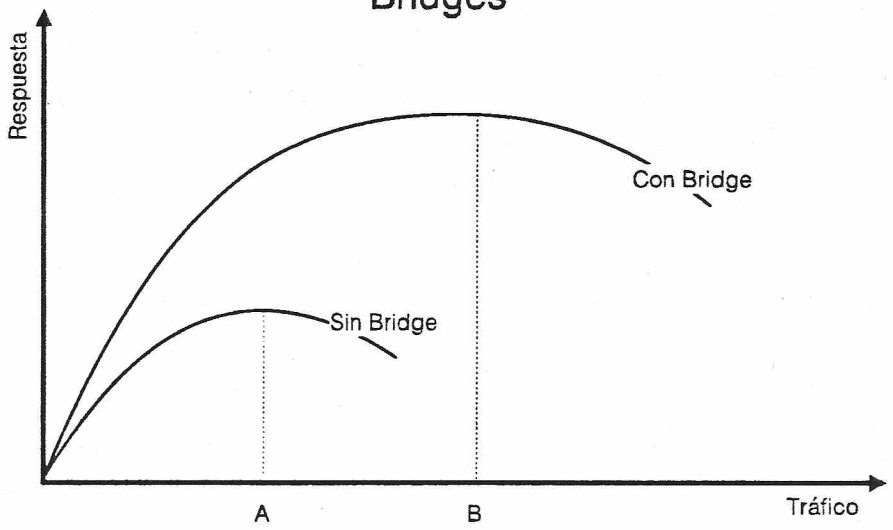
CSMA/CD - Respuesta utilizando Bridges



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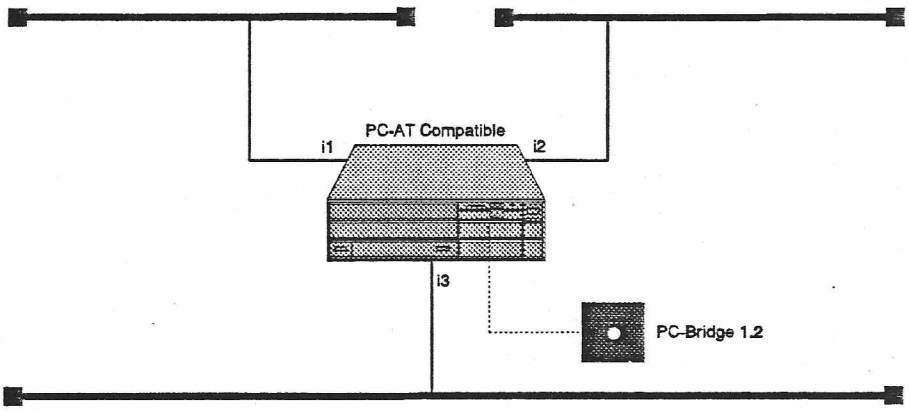
PC-Bridge



Software de dominio público que implementa un bridge adaptivo (no posee spanning tree), requiere como mínimo una PC-XT con 256K.
La distribución se realiza en código fuente (Turbo Assembler).

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Bridges

Marca y modelo	Filtering (PPS)	Forwarding (PPS)	Costo (U$S)
PCBridge en XT a 4.77Mhz	4080	1677	600
PCBridge en XT a 10Mhz	8000	3000	700
PCbridge en AT a 12Mhz	20000	11000	1400
PCBridge en AT a 16Mhz	26214	5832	1200
Cabletron NB20E	15000	11600	3000
Cabletron NB25E	28000	11600	5500
Retix 2244	10000	6000	2000
RACAL Internal INX400/L	23000	12000	3200
Harris Adacom SNB/LE	30000	14000	4400
BICC Isolan 1400	17100	13000	2200
BICC Isolan 1410	21800	13600	4000

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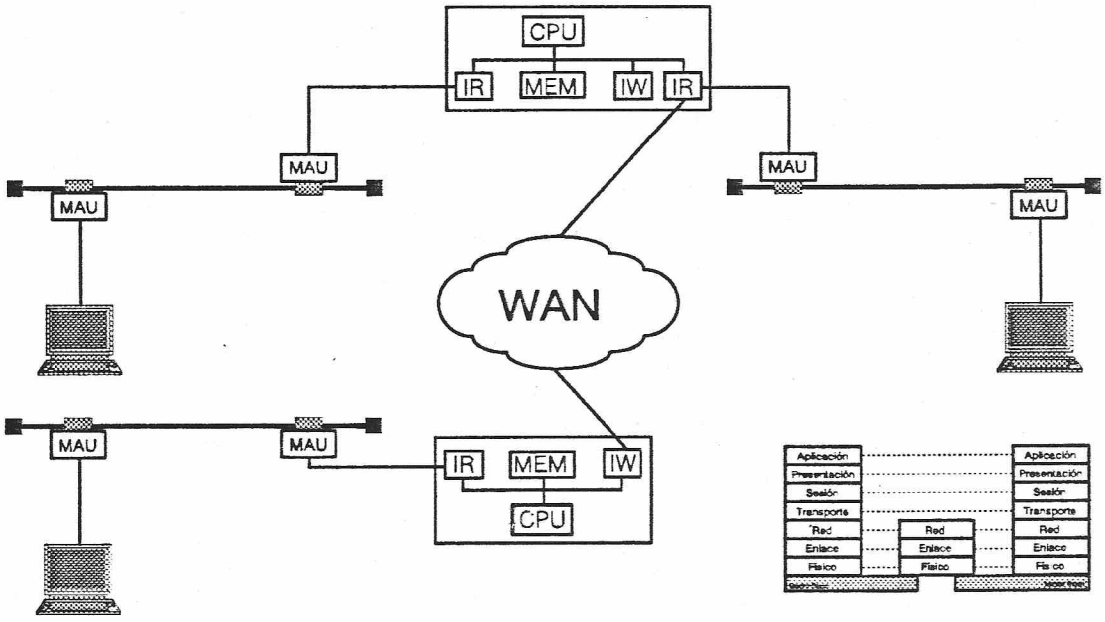
Routers



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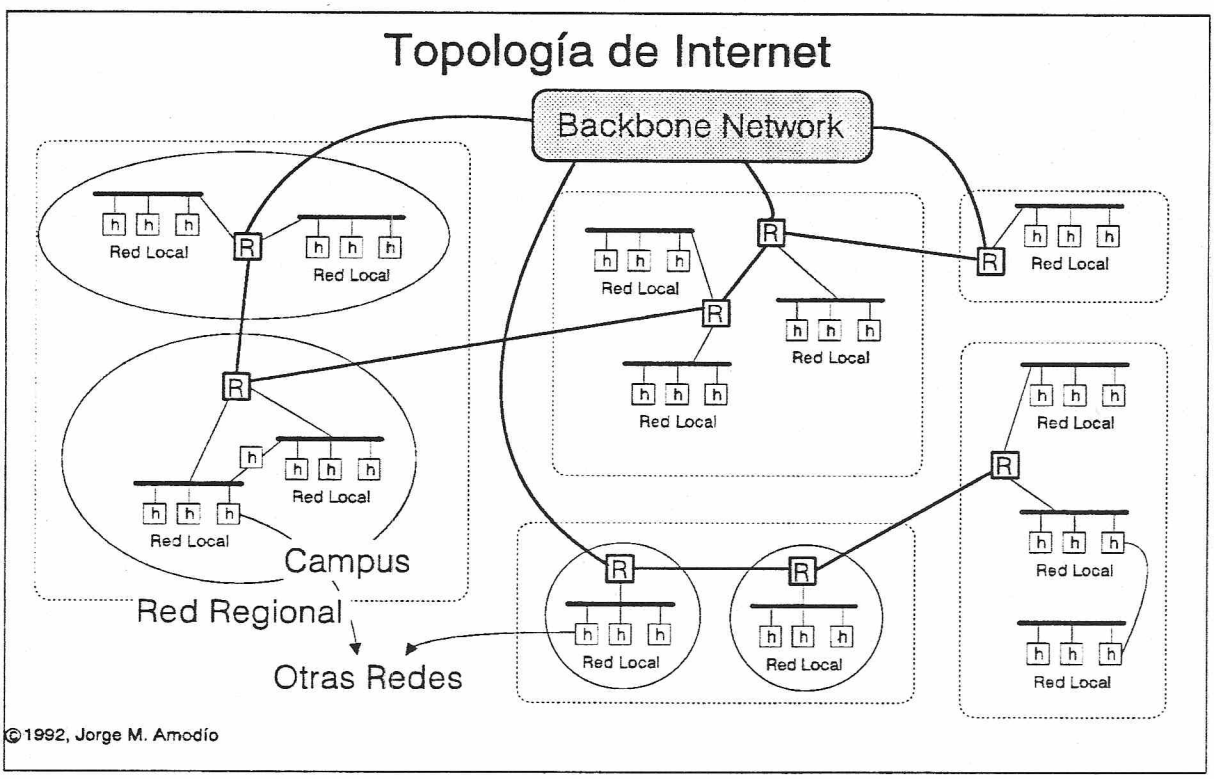
Topología de Internet
Backbone Network
Red Local
Campus
Red Regional
Otras Redes
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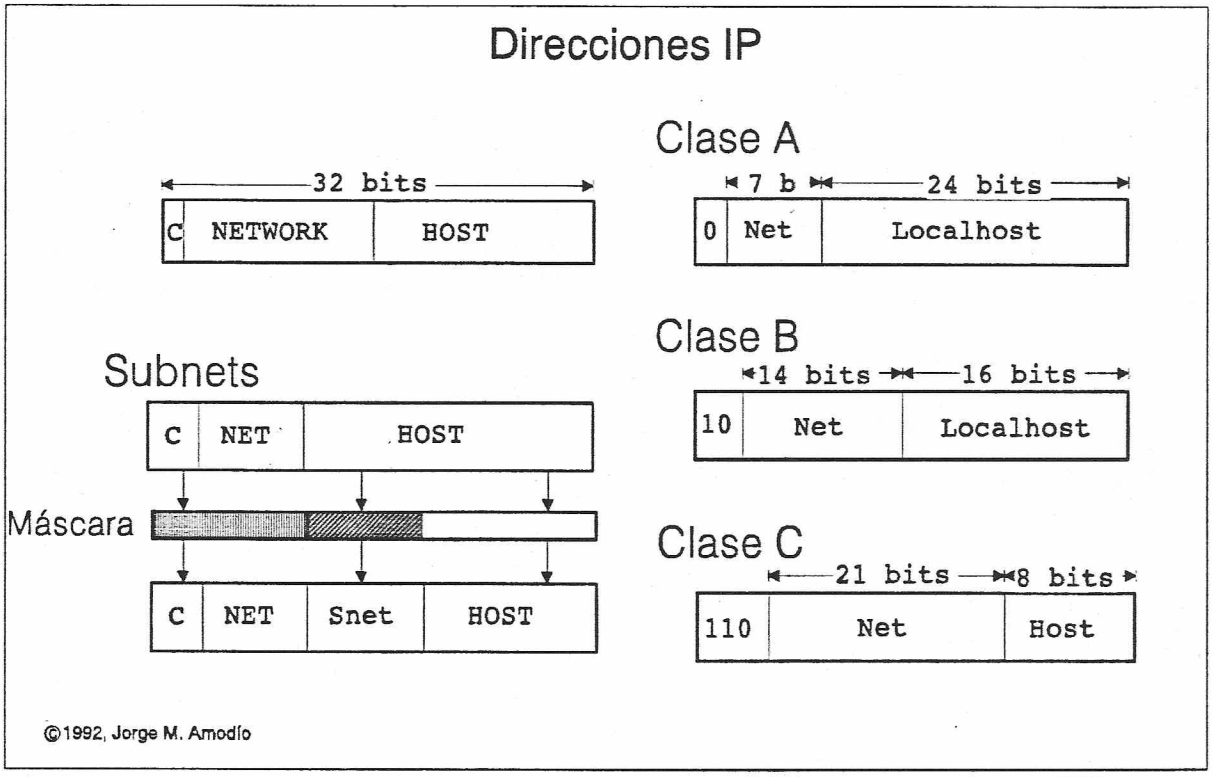
Direcciones IP
32 bits
C NETWORK HOST
Subnets
C NET HOST
Máscara
C NET Snet HOST
Clase A
7 b
24 bits
0 Net Localhost
Clase B
14 bits
16 bits
10 Net Localhost
Clase C
21 bits
8 bits
110 Net Host
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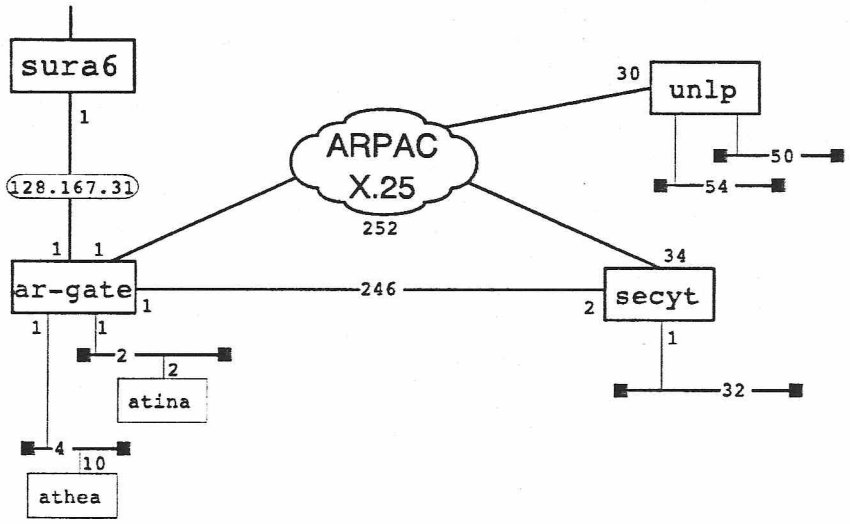
Topología TCP/IP



11/1992, C. Sarmiento RECyT

```
ar-gate>sho route

Codes: I - IGRP derived, R - RIP derived, H - HELLO derived
       C - connected, S - static, E - EGP derived, B - BGP derived
       * - candidate default route

Gateway of last resort is 128.167.31.1 to network 129.140.0.0

S*Net 129.140.0.0 via 128.167.31.1, 506064 uses
C Net 128.167.0.0 is subnetted (mask is 255.255.255.0), 3 subnets
S     128.167.1.0 via 128.167.31.1, 444 uses
C     128.167.31.0 is directly connected, 377223 uses, Serial0
C Net 140.191.0.0 is subnetted (mask is 255.255.254.0), 18 subnets
S     140.191.50.0 via 140.191.252.30, 0 uses
S     140.191.54.0 via 140.191.252.30, 0 uses
S     140.191.52.0 via 140.191.252.30, 441 uses
S     140.191.32.0 via 140.191.246.2, 14944 uses
C     140.191.2.0 is directly connected, 413023 uses, Ethernet0
C     140.191.4.0 is directly connected, 16053 uses, Ethernet1
R     140.191.8.0 [120/2] via 140.191.2.3, 20 sec, 0 uses, Ethernet0
C     140.191.246.0 is directly connected, 4560 uses, Serial3
R     140.191.250.0 [120/1] via 140.191.2.3, 20 sec, 266 uses, Ethernet0
C     140.191.248.0 is directly connected, 1784 uses, Serial1
S Net 157.92.0.0 via 140.191.252.32, 0 uses
```

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```
ar-gate>sho ip cache
IP routing cache version is 218

 Destination      Interface Type MAC Header
*149.155.27.21    Serial0   HDLC 0F000800
*129.81.224.50    Serial0   HDLC 0F000800
*16.1.0.19        Serial0   HDLC 0F000800
*131.175.1.2      Serial0   HDLC 0F000800
*131.178.1.1      Serial0   HDLC 0F000800
*129.240.64.2     Serial0   HDLC 0F000800
*140.191.2.2      Ethernet0 ARPA 0000C0130B1100000C0029B90800
*140.191.4.10     Ethernet1 ARPA 0000C0E8A92D00000C0029BA0800
*128.32.149.117   Serial0   HDLC 0F000800
*128.130.71.4     Serial0   HDLC 0F000800
*128.32.149.116   Serial0   HDLC 0F000800
*134.192.1.5      Serial0   HDLC 0F000800
*128.83.185.41    Serial0   HDLC 0F000800
*143.53.240.2     Serial0   HDLC 0F000800
*129.171.97.1     Serial0   HDLC 0F000800
*130.206.1.1      Serial0   HDLC 0F000800
*128.83.139.9     Serial0   HDLC 0F000800
*131.211.20.16    Serial0   HDLC 0F000800
*157.88.111.254   Serial0   HDLC 0F000800
*157.88.110.254   Serial0   HDLC 0F000800
```

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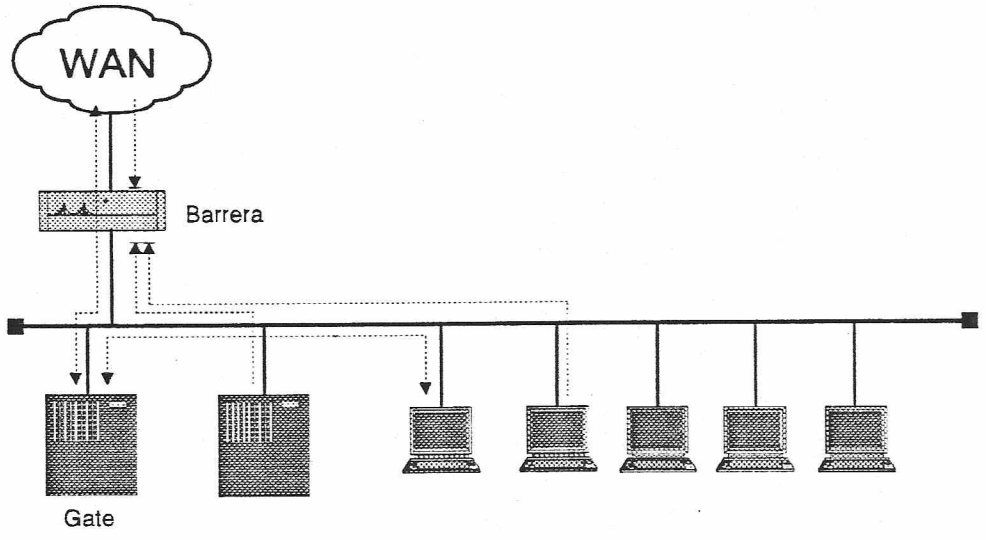
FireWalls



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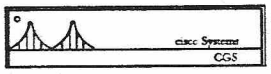
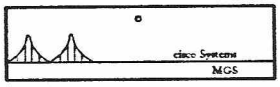
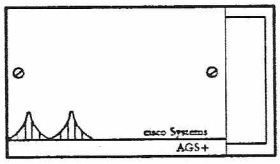
cisco Systems

Modelo	Interfaces	Slots cBus	Multibus	slots interfaces	Appliques	Precio
 CGS	4 2 Ethernet 2 Serial 2 Token Ring		2	1	RS-232,RS-449, V.35,X.21.AUI, TR,10BaseT	~ 6500
 MGS	11 6 Ethernet 10 Serial 6 Token Ring		4	3	RS-232,RS-449, V.35,X.21.AUI, TR,10BaseT	~ 11000
 AGS+	32 28 Ethernet 28 Serial 14 Token Ring 4 FDDI	5	9	3	RS-232,RS-449, V.35,X.21.AUI, TR,10BaseT, FDDI. HSSI	~ 14000

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Protocolos Soportados
- TCP/IP
- OSI CLNS (ISO 8473)
- OSI CMNS (ISO 8880)
- DECnet Phase IV y V
- Novell IPX
- AppleTalk Phase 1 y 2
- Banyan Vines
- 3Com XNS
- Xerox XNS
- Ungerman-Bass XNS
- Apollo Domain
- Xerox PUP
- CHAOSnet
- HP Advancenet

Soporte WAN
- HDLC
- HSSI
- PPP
- X.25
- DDN X.25
- Frame Relay
- SMDS
- TCP/IP HC
- Dial Back-Up

Bridging
- IEEE 802.1 Spanning Tree
- DEC Spanning Tree
- SRT
- Ethernet to Token Ring
- FDDI Encapsulation
- FDDI Traslation

Protocolos de ruteo
- IGRP (IP y OSI)
- RIP (IP)
- OSPF (IP)
- BGP (IP)
- EGP (IP)
- ES-IS (OSI)
- IS-IS (OSI)
- *

Management
- SNMP

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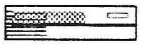
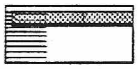
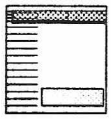
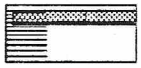
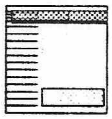
WellFleet Systems

	 Feeder Node	 Link Node	 Concentrator Node	 Backbone Link Node	 Backbone CN
Mod.Proc.	1	1 - 4	1 - 13	1 - 4	1 - 13
Interfaces	2 Ethernet 2 Token Ring 2 WAN	16 Ethernet 8 Token Ring 2 FDDI 16 WAN	52 Ethernet 26 Token Ring 4 FDDI 52 WAN	16 Ethernet 8 Token Ring 4 FDDI 16 WAN	52 Ethernet 26 Token Ring 13 FDDI 52 WAN
Protocolos	TCP/IP, DECnet Pashe IV,OSI, XNS, Novel IPX, Apple Talk Pahse 2, Learning Bridge, Source Routing, SNA/SDLC, X.25, Frame Relay, SMDS, PPP, SNMP				
Precio	~ 7000	~ 9000	~ 18000		

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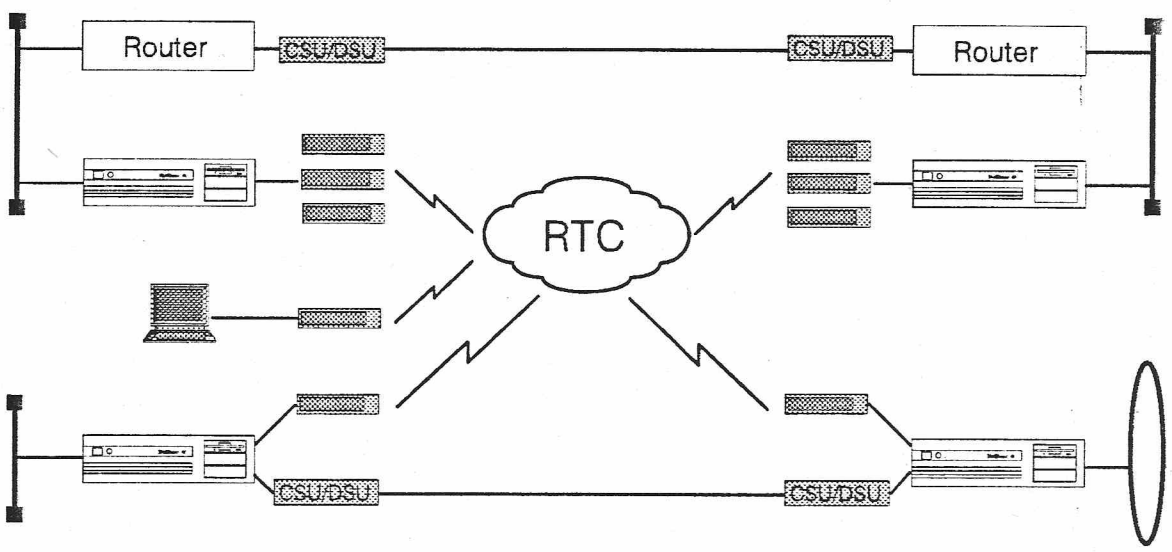
Telebit NetBlazer



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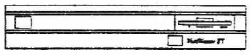
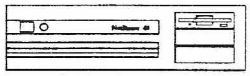
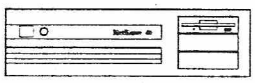
Telebit NetBlazer

Modelo	Slots	Std.Ports	Sinc.Ports	Asinc.Ports	LAN Ports	Precio
 NetBlazer ST	3	2 Asinc. 1 Consola 1 Printer	1 utilizando tarjeta sincrónica	16 utilizando dos tarjetas multiport	3 Ethernet o Token Ring 1 tarjeta c/u	3899 NS10-1E
 NetBlazer Standard	6	2 Asinc. 1 Consola 1 Printer	1 utilizando tarjeta sincrónica	24 utilizando tres tarjetas multiport	3 Ethernet o Token Ring 1 tarjeta c/u	3799 N10-1E
 NetBlazer 40	6	2 Asinc. 1 Consola 1 Printer	1 utilizando tarjeta sincrónica	24 utilizando tres tarjetas multiport	3 Ethernet o Token Ring 1 tarjeta c/u	6097 NB40 + NE1 + NM8

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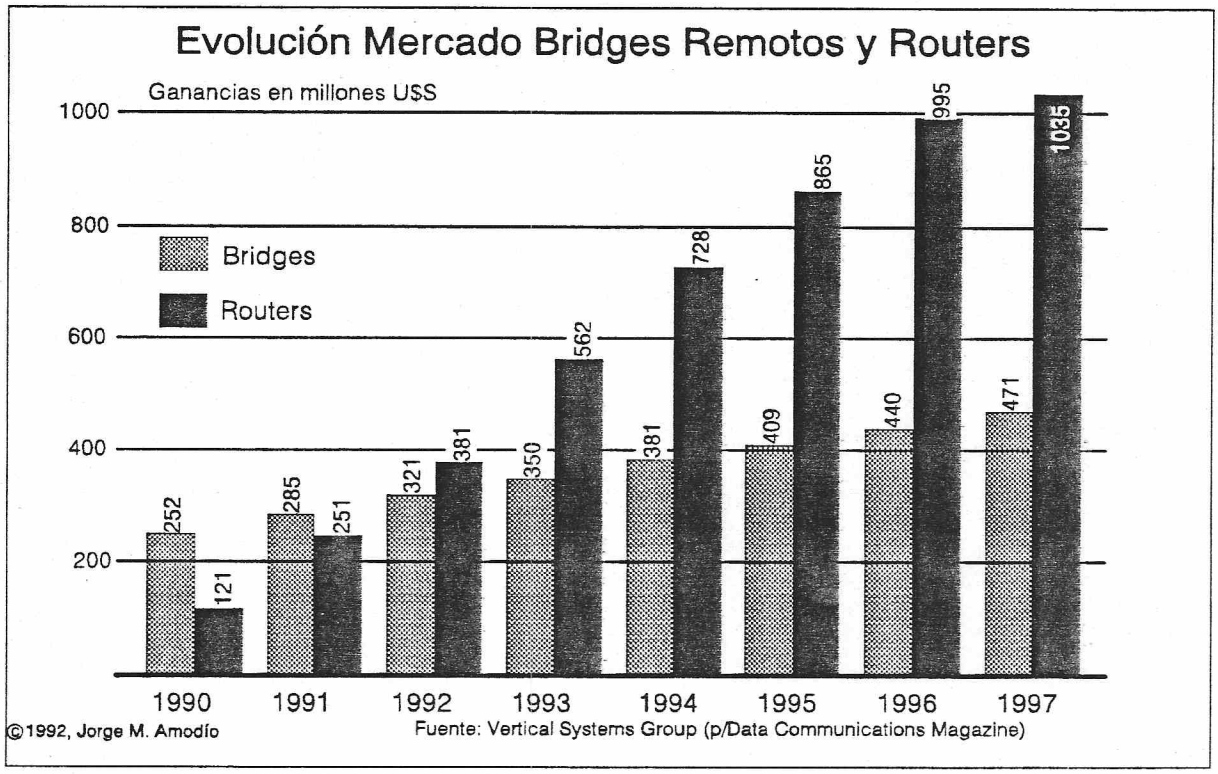
Evolución Mercado Bridges Remotos y Routers
Ganancias en millones U$S
1000
800
600
400
200
Bridges
Routers
252
121
285
251
321
381
350
562
381
728
409
865
440
995
471
1035
1990
1991
1992
1993
1994
1995
1996
1997
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Fuente: Vertical Systems Group (p/Data Communications Magazine)

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