

# Otras modificaciones a Ethernet

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

Grado en Ingeniería en Tecnologías de  
Telecomunicación, 3º

# Temario

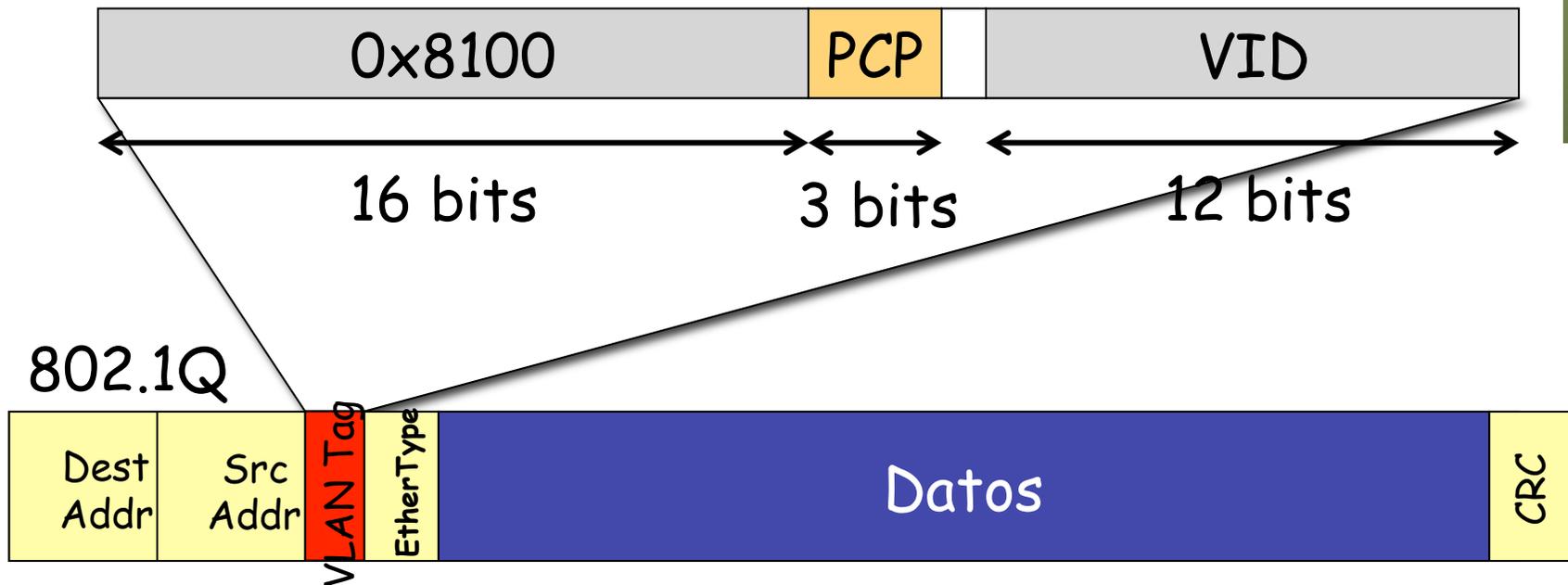
1. Introducción
2. **Tecnologías LAN**
  - Tecnologías Ethernet
  - Conmutación Ethernet
  - VLANs
  - Spanning Tree Protocol
  - **Otros mecanismos en LANs Ethernet**
  - WiFi
  - Diseño de redes campus
3. Tecnologías WAN
4. Redes de acceso

# Objetivos

- Conocer algunas modificaciones y extensiones a Ethernet para mejoras de rendimiento y gestión

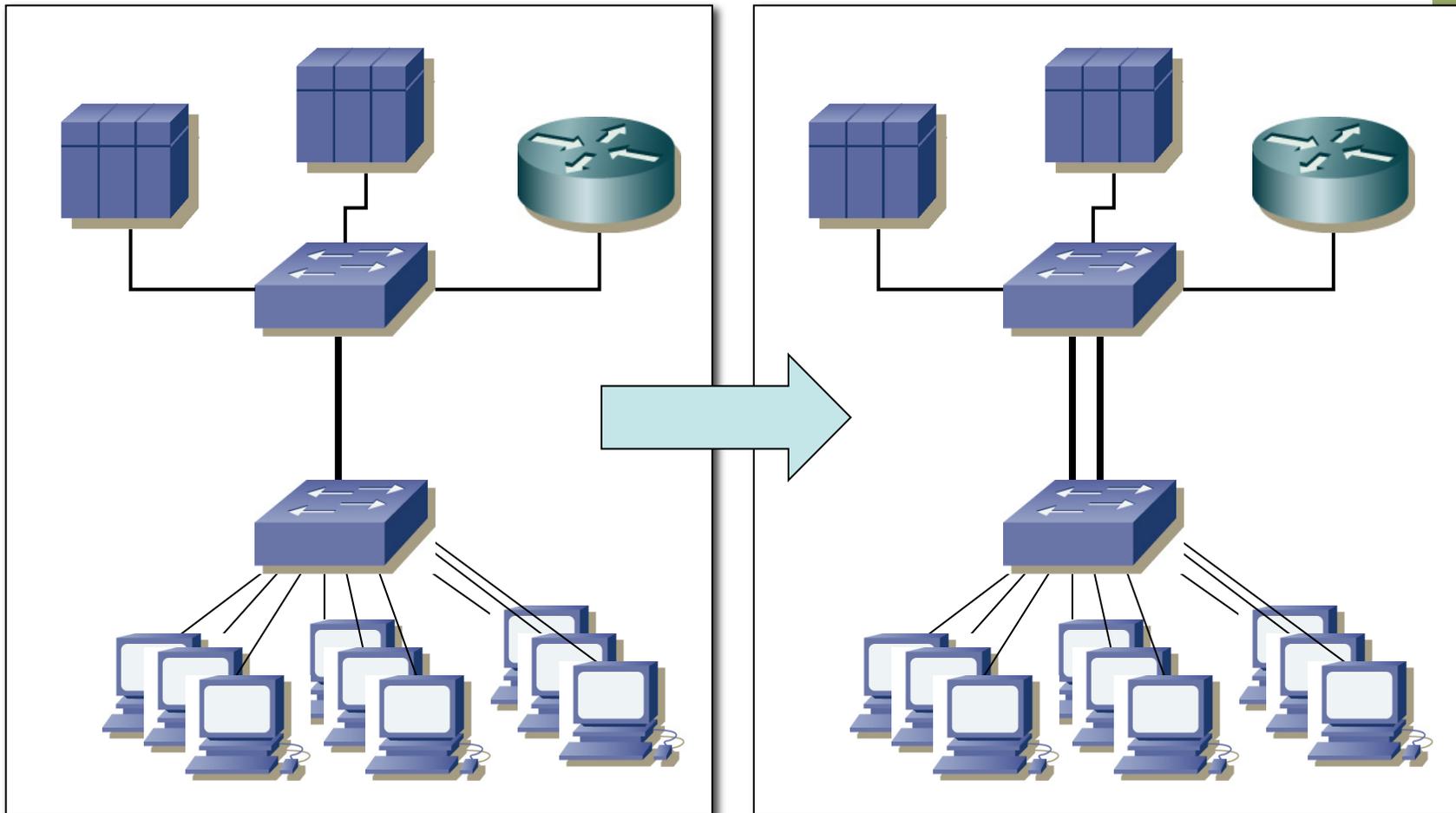
# Frame Priority

- IEEE 802.1p (ahora parte de 802.1D)
- Classes of Service (CoS)
- PCP = Priority Code Point
- Permite aplicar técnicas de planificación
- Si VID=0 solo se indica la prioridad



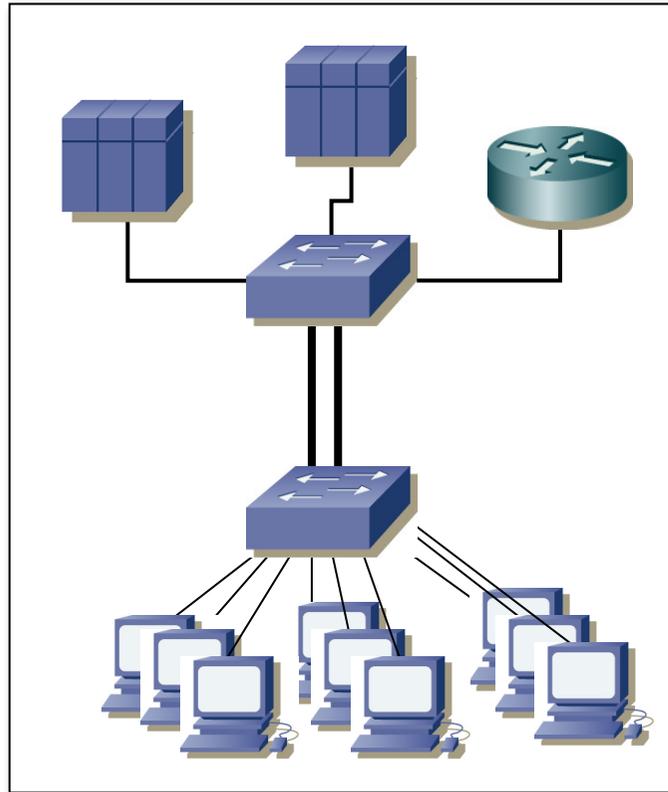
# Link Aggregation

- IEEE 802.3ad
- Ahora 802.1AX



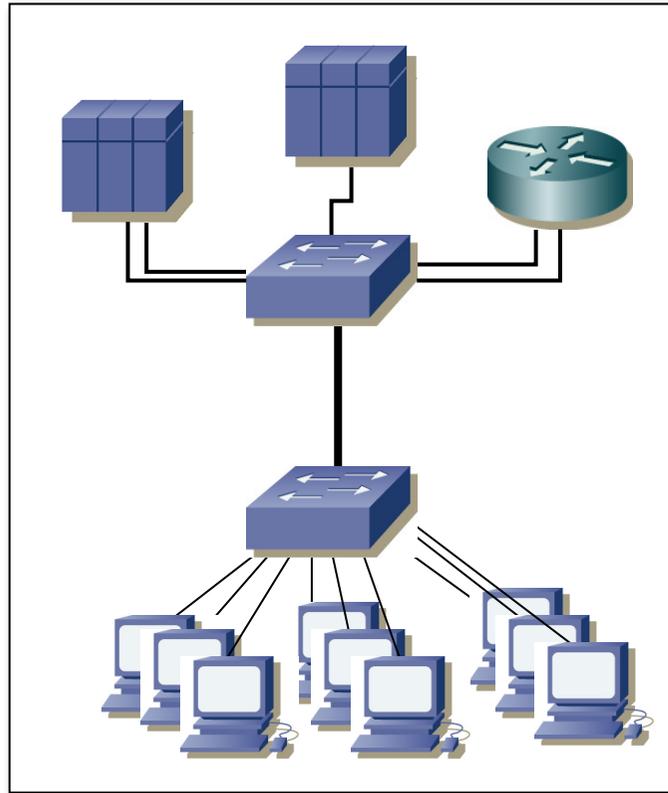
# Link Aggregation

- Tipos de agregación:
  - *Switch-to-switch*



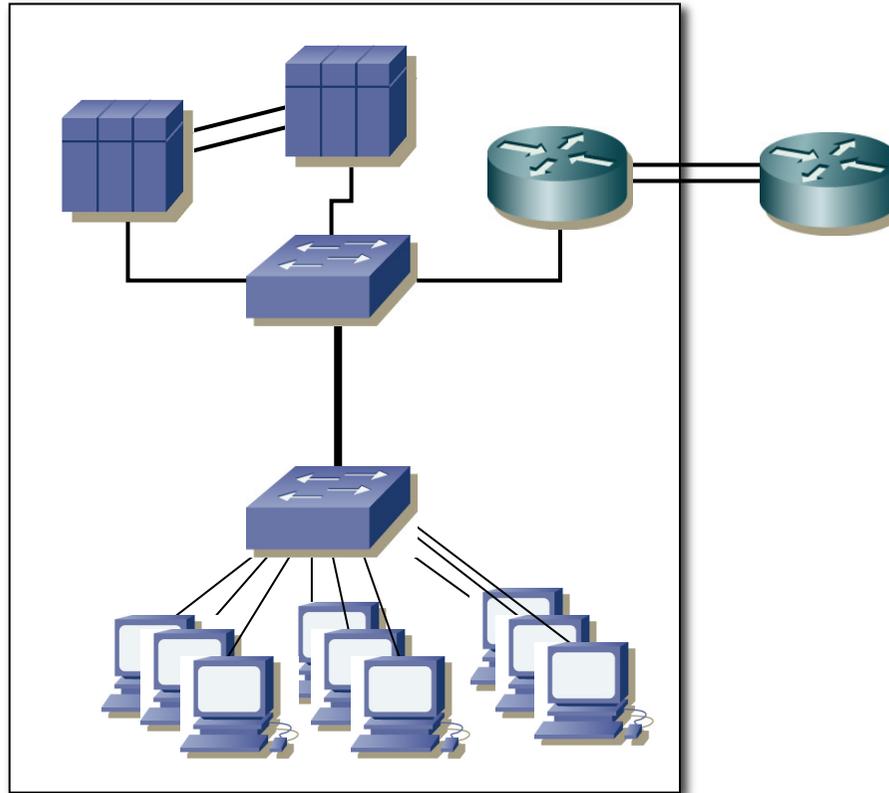
# Link Aggregation

- Tipos de agregación:
  - *Switch-to-station*



# Link Aggregation

- Tipos de agregación:
  - *Station-to-station*



# Link Aggregation

- Implementado entre el subnivel MAC y el LLC
- Los enlaces se agregan en Grupos
- El agregado: como un solo interfaz
- Conversación: tramas de la misma MAC → MAC y prioridad
- Mantiene el orden de las tramas de la misma conversación
- ¿Cómo? (...)

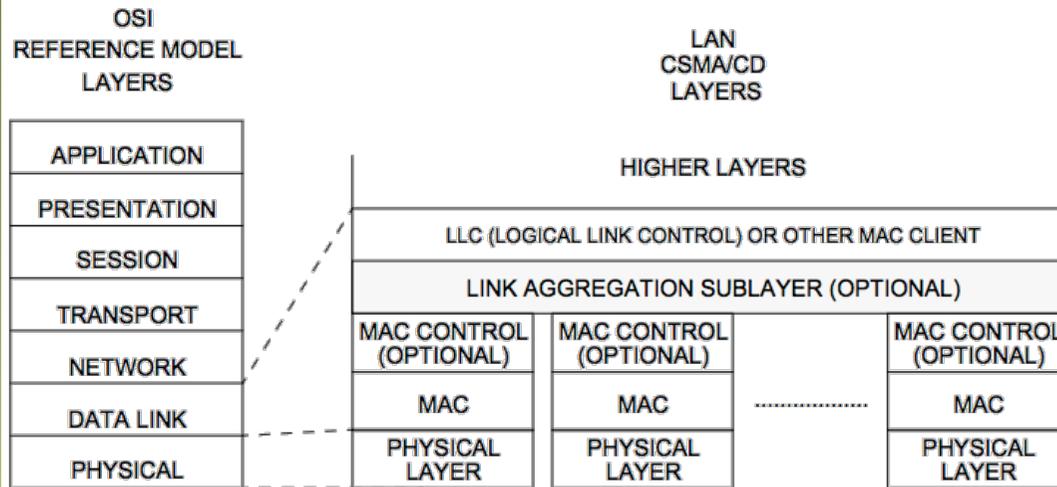
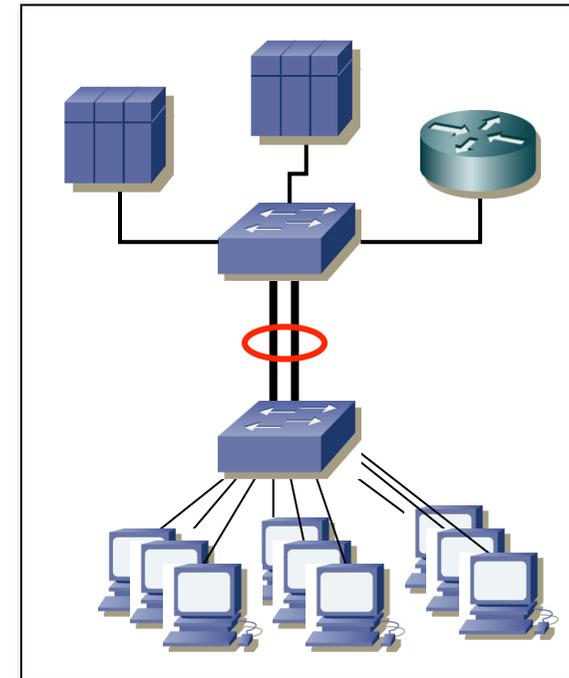


Figure 5-2—Architectural positioning of Link Aggregation sublayer  
 IEEE 802.1AX



# Link Aggregation

- Implementado entre el subnivel MAC y el LLC
- Los enlaces se agregan en Grupos
- El agregado: como un solo interfaz
- Conversación: tramas de la misma MAC→MAC y prioridad
- Mantiene el orden de las tramas de la misma conversación
- ¿Cómo? Mandándolas siempre por el mismo enlace del grupo

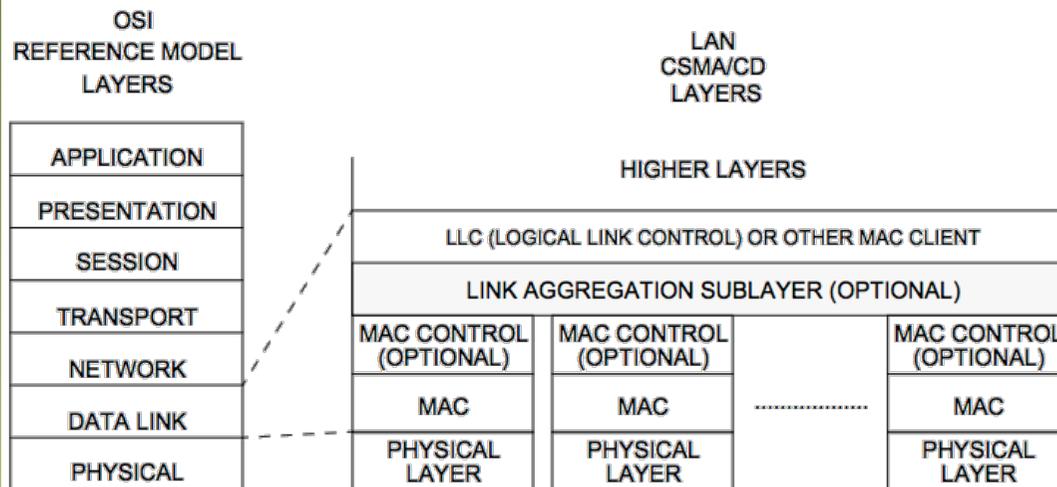
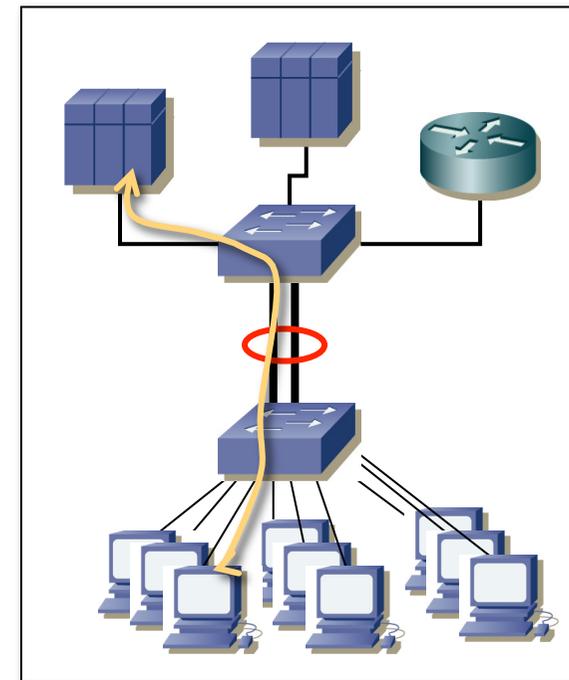
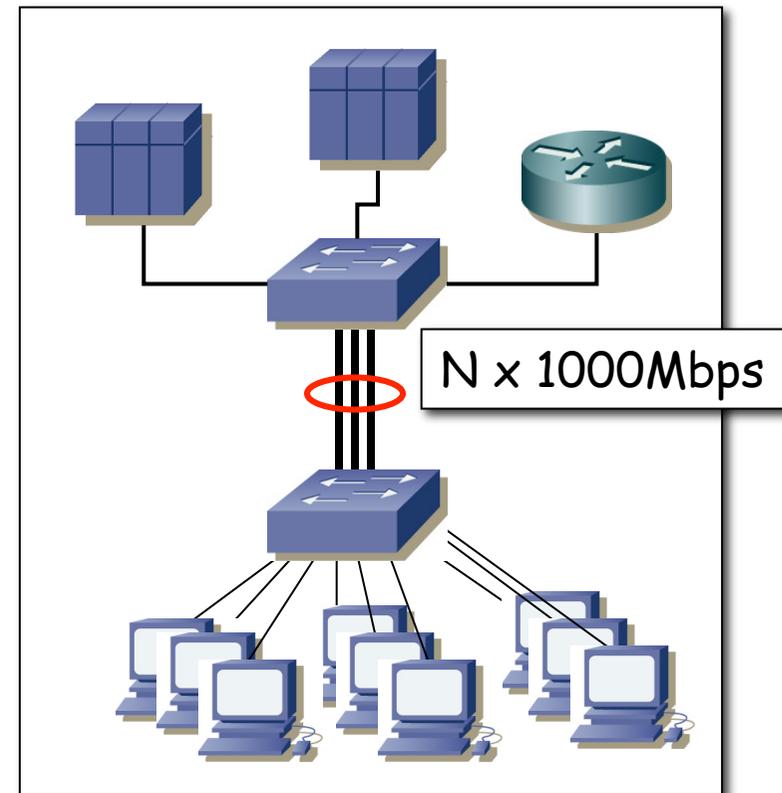


Figure 5-2—Architectural positioning of Link Aggregation sublayer  
 IEEE 802.1AX



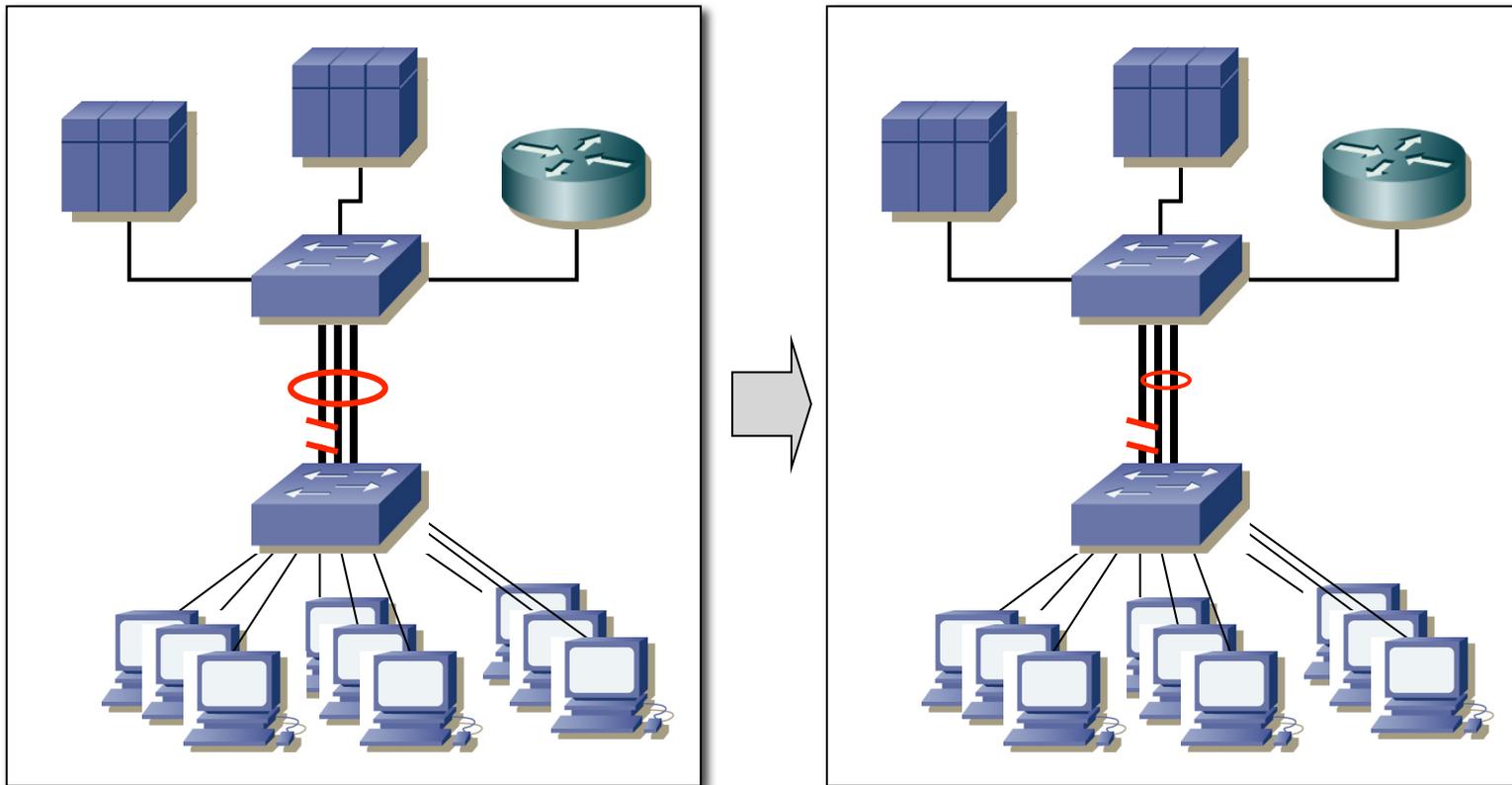
# Link Aggregation

Mayor ancho de banda



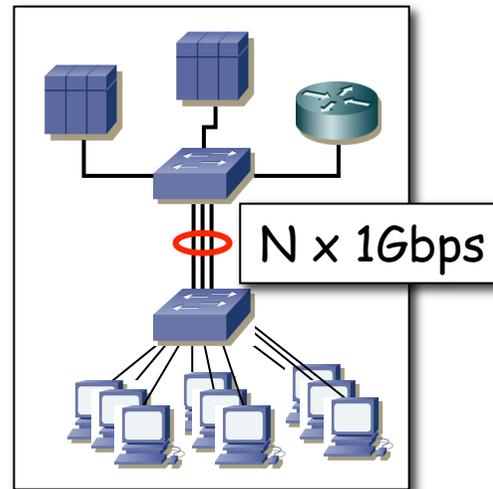
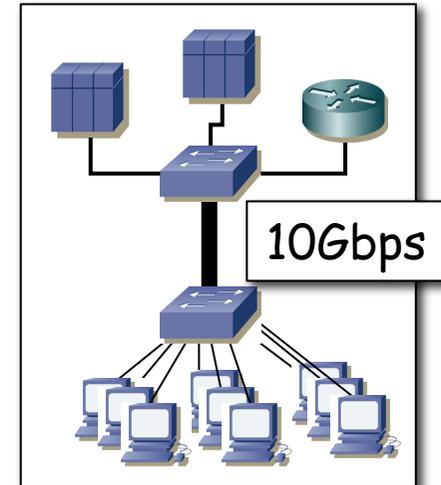
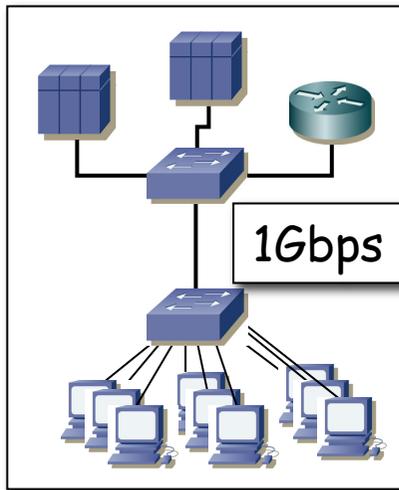
# Link Aggregation

## Mayor disponibilidad



# Link Aggregation

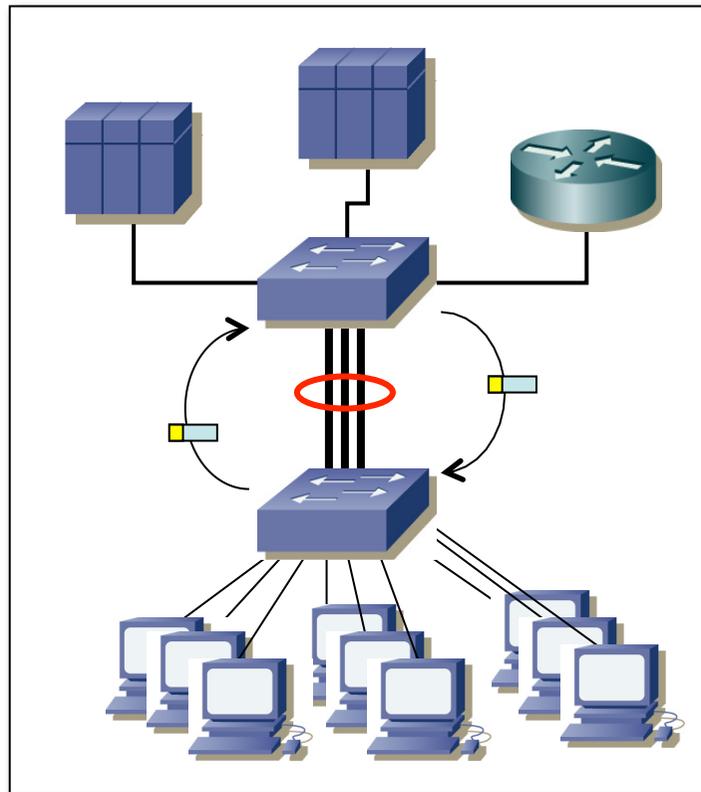
## Mayor granularidad



# Link Aggregation

## Configuración automática

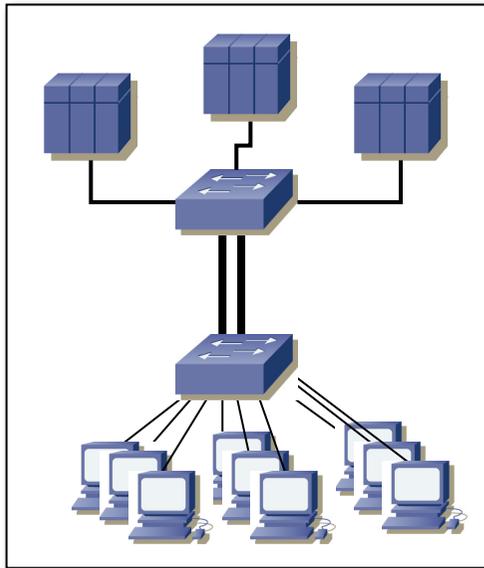
- Link Aggregation Control Protocol (LACP)
- Rápida reconfiguración (<1seg)



# Link Aggregation

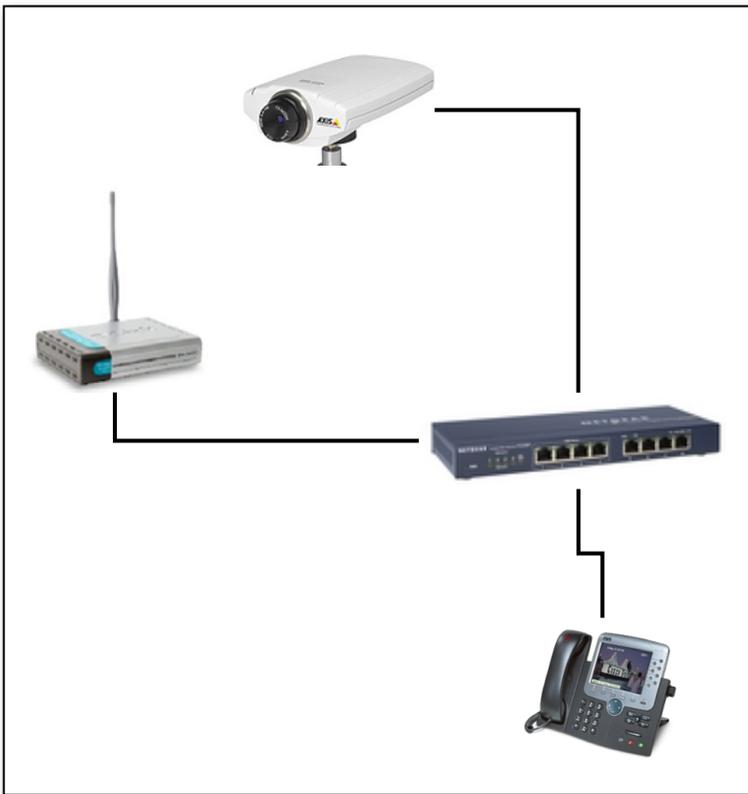
## Limitaciones:

- No más de 2 extremos
- Solo 802.3 (ej. no FDDI)
- No soporta enlaces half-duplex
- No puede agregar enlaces de diferentes velocidades
- Si la conversación es directamente  $A \rightarrow B$  no puede repartir el flujo en más de un enlace (salvo con información de niveles superiores)

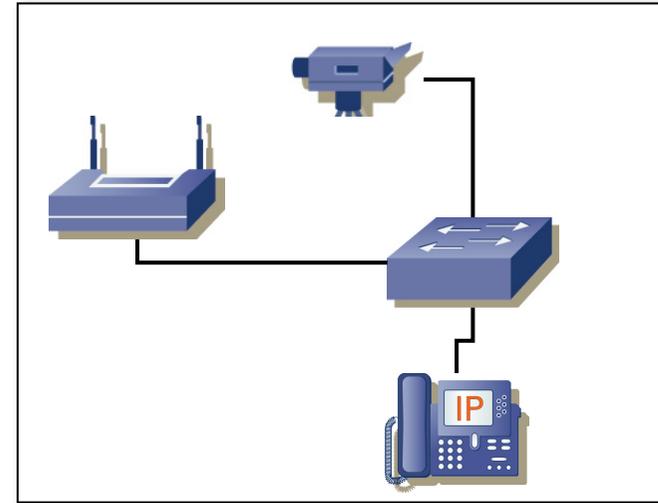


# Power over Ethernet (PoE)

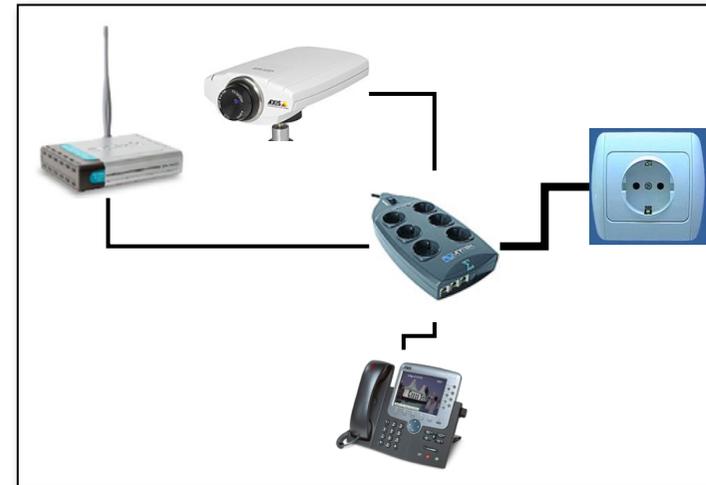
- IEEE 802.3af (cláusula 33 de 802.3-2005)
- Además de datos, corriente sobre cable Cat.3 ó 5 (15.4 W)
- PoE+ (802.3at) (30W)



=



+



# 802.3x

- Flow-control en el nivel de enlace
- Para enlaces full-duplex
- Cuando receptor cerca de saturación de buffer
- Envía trama Ethernet PAUSE que indica al otra extremo que detenga toda transmisión
- Son tramas de control MAC (Ethertype 0x8808)
- Emplea un campo de 2 bytes para indicar el tiempo de pausa
- Una unidad de pausa es el tiempo de transmisión de 512 bits
- Tramas enviadas a MAC multicast reservada (01:80:C2:00:00:01) que no son reenviadas

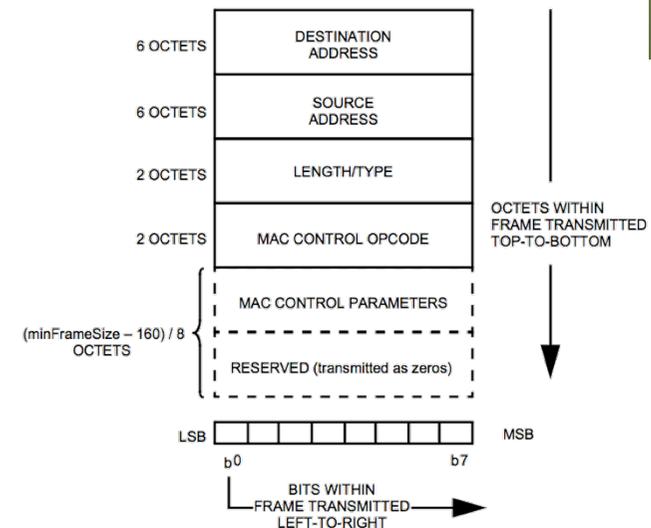


Figure 31-3—MAC Control frame format

# GARP (802.1D-2004)

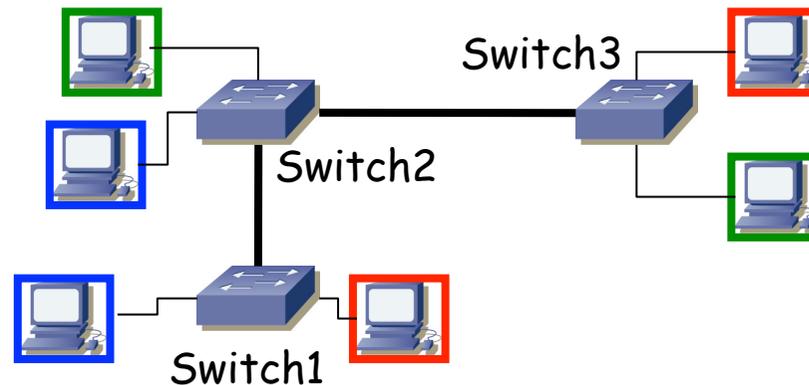
- Generic Attribute Registration Protocol
- Permite a los participantes registrar atributos en otros participantes en la Bridged LAN
- Los puentes distribuyen estos registros
- Los participantes pueden comprobar el estado de registros en un dispositivo
- Emplea LLC Type 1
- Se han reservado direcciones MAC 01:80:C2:00:00:20 hasta 01:80:C2:00:00:2F para diferentes aplicaciones GARP que se vayan definiendo
- El puente que implemente esas aplicaciones no reenviará directamente esas tramas sino que las procesará
- El puente que no las implemente las reenviará como cualquier otra trama multicast
- GMRP usa 01:80:C2:00:00:20
- GVRP usa 01:80:C2:00:00:21

# GMRP

- GMRP = GARP Multicast Registration Protocol
- GMRP ofrece mecanismos para que los hosts y puentes registren que desean recibir un flujo multicast
- Empleando estos registros y filtrado se limita el multicast a los segmentos que llevan a máquinas que han mostrado interés
- Los grupos son abiertos = cualquiera puede enviar a él
- Hosts pueden acceder a esta info de registro y si son fuente del grupo decidir no enviar si no hay destinatarios declarados (*source pruning*)

# GVRP

- GARP VLAN Registration Protocol
- Permite registrar de forma dinámica que por un puerto se puede alcanzar a hosts de una VLAN
- Dispositivos que soportan GVRP pueden conocer las VLANs que tienen miembros y a través de qué puertos se les alcanza
- Permite que un switch conozca la existencia de una VLAN y conmute tramas de la misma sin necesidad de crear esa VLAN en el switch ni asignar puertos manualmente
- Ejemplo 1: Switch 2 aprende mediante GVRP la existencia de la VLAN roja y sus puertos a Switch 1 y 3 reenviarán sus tramas
- Ejemplo 2: Switch 1 no tiene hosts de VLAN verde. Switch 2 no necesita reenviarle *floodings* a esa VLAN (broadcast o búsqueda de host)

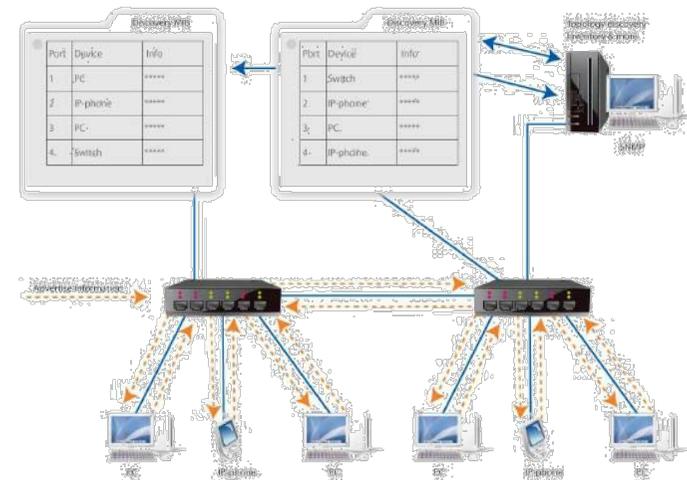


# 802.1ak-2007

- Modifica a 802.1Q-2005
- Para escenarios MAN/WAN
- Reemplaza GARP y sus aplicaciones
- En redes grandes GVRP y GMRP tardan demasiado en recuperación ante fallos
- MRP (Multiple Registration Protocol) sustituye a GARP
- MVRP (Multiple VLAN Registration Protocol) sustituye a GVRP
- MMRP (Multiple MAC Registration Protocol) sustituye a GMRP

# LLDP

- Link Layer Discovery Protocol
- 802.1ab Station and Media Access Control Connectivity Discovery
- Equipos implementan un agente
- Permite anunciar a vecinos en la LAN
  - Un identificador de equipo (chassis) y de puerto
  - Nombre y descripción del equipo
  - Capacidades del equipo (incluido por ejemplo si es un host, un puente, un router...)
  - Dirección para gestionarlo
  - VLAN del puerto y su nombre
  - Estado de negociación de duplex, velocidad y agregación de enlaces
  - Si ofrece alimentación
  - Máximo tamaño de trama
- Existían soluciones propietarias (ej: CDP)
- Protocolo de nivel de enlace



# LLDP

- One way: se envía y/o se recibe pero no hay forma de solicitar la información
- Envía periódicamente o cuando se producen cambios de estado
- Equipos almacenan esta información de vecinos en una MIB
- Se envía a MAC multicast reservada que no es reenviada por puentes (01:80:C2:00:00:0E)
- Ethertype 0x88CC

# Equipos

# Conmutador gestionable

- D-Link DES-1210-28/52



# D-Link DES-1210-28/52

## Overview

The D-Link® DES-1210 Series is the latest generation of Web Smart Switches. Equipped with 24 or 48 10/100Mbps ports, two 10/100/1000BASE-T ports, and two combo 10/100/1000BASE-T/SFP ports, the series integrates advanced management and security functions to provide performance and scalability. While easy to use, the DES-1210 Series provides a complete and affordable solution for small and medium businesses. Management options for the switches include SNMP, Web Management, SmartConsole Utility, and compact Command Lines. The series also supports ACL filtering and the D-Link Safeguard Engine™. Furthermore, the DES-1210 Series uses Auto Voice VLAN, ensuring higher priority for voice traffic. Both models come with an innovative fanless design in 19" metal cases.

## Seamless Integration

The Web Smart Switches are designed to provide SMB users complete control over the network. With Ethernet and Gigabit copper ports capable of connecting to existing Cat.5 twisted-pair cables, these switches eliminate the need for a complex reconfiguration process. The DES-1210 Series allows for a flexible connection to a backbone or servers. Additionally, all ports support auto-negotiation of MDI/MDI-X crossover, or configurable auto MDI, and therefore do away with crossover cables or uplink ports. This brings inexpensive and easy connectivity to your desktop.

## Extensive Layer 2 Features

Equipped with a complete lineup of L2 features, these switches include IGMP Snooping, Port Mirroring, Spanning Tree and Link Aggregation Control Protocol (LACP). The IEEE 802.3x Flow Control function allows servers to directly connect to the switch for fast, reliable data transfer. At 2000Mbps Full Duplex, the Gigabit ports provide high-speed data pipes to servers with minimum data transfer loss. Network maintenance features include Loopback Detection and Cable Diagnostics. Loopback Detection is used to detect loops created by a specific port and automatically shut down the affected port. Cable Diagnostics are designed for network administrators to quickly examine the quality of the copper cables and determine the type of cable error.

## QoS, Bandwidth Control

The switches are perfect for deployment in a VoIP environment, as they support Auto Voice VLAN and Differentiated Services Code Point (DSCP) QoS for VoIP application. Auto Voice VLAN will automatically place voice traffic from an IP phone to an assigned VLAN and by doing so enhance the VoIP service.



# D-Link DES-1210-28/52

With a higher priority and individual VLAN, this feature guarantees the quality and security of VoIP traffic.

DSCP marks parts of an IP packet, enabling different levels of service to be assigned for network traffic. With Bandwidth Control, the network administrator can reserve bandwidth for important functions that require a larger bandwidth or might have high priority.

## Secure Your Network

The innovative D-Link Safeguard Engine function protects the switches against traffic flooding caused by virus attacks. The switches support 802.1X port-based authentication, allowing the network to be authenticated through external RADIUS servers. In addition, the Access Control List (ACL) feature enhances network security and helps to protect the internal IT network by allowing an administrator to restrict the access of a network through a variety of means including MAC address, IP, UDP/TCP, and even VLAN ID.



## Fanless Design

- Provides silent operation
- Saves energy while lowering costs
- Provides continuous, reliable and eco-friendly operation

## Security Features

- Access Control List secures network
- D-Link Safeguard Engine™ protects CPU from Broadcast/Multicast/Unicast flooding
- Port security supports 64 MACs per port

## Intuitive Management

- Manage using SmartConsole or web-based GUI
- Built-in MIB browser for SNMP Management
- D-View 6.0 module support
- Compact CLI through Telnet

## VoIP Deployment

- Highest priority for VoIP services
- Auto Voice VLAN

## QoS

- Ensure time-sensitive data gets delivered efficiently
- Supports IEEE 802.1p QoS up to four 802.1p Priority Queues
- DSCP QoS

## Trap & Logs

- SNMP Trap supports link and STP state change
- Trap for SmartConsole Utility

## Advanced Features

- Loopback detection auto disables port when loop is detected
- Cable Diagnostics allows administrator to determine cable status
- Configurable MDI/MDI-X

## Online Help

- Link to local support web site
- Downloadable user guide
- Real-time manual checks

# D-Link DES-1210-28/52

Technical Specifications		
	DES-1210-28	DES-1210-52
Number of Ports	<ul style="list-style-type: none"> <li>• 24 10/100Mbps</li> <li>• 2 10/100/1000BASE-T</li> <li>• 2 combo 10/100/1000BASE-T/SFP</li> </ul>	<ul style="list-style-type: none"> <li>• 48 10/100Mbps</li> <li>• 2 10/100/1000BASE-T</li> <li>• 2 combo 10/100/1000BASE-T/SFP</li> </ul>
Port Standards & Functions	<ul style="list-style-type: none"> <li>• IEEE 802.3 10BASE-T Ethernet (twisted-pair copper)</li> <li>• IEEE 802.3u 100BASE-TX Fast Ethernet (twisted-pair copper)</li> <li>• IEEE 802.3ab 1000BASE-T Gigabit Ethernet (twisted-pair copper)</li> <li>• IEEE 802.3z Gigabit Ethernet (fiber) ANSI/IEEE 802.3</li> <li>• Auto-negotiation</li> <li>• IEEE 802.3x Flow Control</li> </ul>	<ul style="list-style-type: none"> <li>• IEEE 802.3 10BASE-T Ethernet (twisted-pair copper)</li> <li>• IEEE 802.3u 100BASE-TX Fast Ethernet (twisted-pair copper)</li> <li>• IEEE 802.3ab 1000BASE-T Gigabit Ethernet (twisted-pair copper)</li> <li>• IEEE 802.3z Gigabit Ethernet (fiber) ANSI/IEEE 802.3</li> <li>• Auto-negotiation</li> <li>• IEEE 802.3x Flow Control</li> </ul>
Network Cables	<ul style="list-style-type: none"> <li>• UTP Cat.5, Cat.5e (100m max)</li> <li>• EIA/TIA-568 100-ohm STP (100m max)</li> </ul>	<ul style="list-style-type: none"> <li>• UTP Cat.5, Cat.5e (100m max)</li> <li>• EIA/TIA-568 100-ohm STP (100m max)</li> </ul>
Full/Half Duplex	<ul style="list-style-type: none"> <li>• Full/half duplex for 10/100Mbps speeds</li> <li>• Full duplex for Gigabit speed</li> </ul>	<ul style="list-style-type: none"> <li>• Full/half duplex for 10/100Mbps speeds</li> <li>• Full duplex for Gigabit speed</li> </ul>
Media Interface Exchange	<ul style="list-style-type: none"> <li>• Auto MDI/MDI-X adjustment for all twisted pair ports</li> </ul>	<ul style="list-style-type: none"> <li>• Auto MDI/MDI-X adjustment for all twisted pair ports</li> </ul>
Switching Capacity	• 12.8Gbps	• 17.6Gbps
Transmission Method	• Store-and-forward	• Store-and-forward
MAC Address Table	• 8K entries per device	• 8K entries per device
MAC Address Update	<ul style="list-style-type: none"> <li>• Up to 256 static MAC entries</li> <li>• Enable/disable auto-learning of MAC addresses</li> </ul>	<ul style="list-style-type: none"> <li>• Up to 256 static MAC entries</li> <li>• Enable/disable auto-learning of MAC addresses</li> </ul>
Maximum 64 bytes packet forwarding rate	• 9.5Mpps	• 13.1Mpps



# D-Link DES-1210-28/52

RAM Buffer	• 512KB per device	• 1MB per device
AC Input	• 100 to 240 VAC 50/60 internal universal power supply	• 100 to 240 VAC 50/60 internal universal power supply
Maximum Power Consumption	• 17.6W	• 28.9W
Standby Power Consumption	• 7.6W/110V, 7.9W/240V	• 13.2W/110V, 13.3W/240V
Fan Quantity	• 0	• 0
Acoustics	• 0dBA	• 0dBA
Heat Dissipation	• 60.05 BTU/hr	• 98.61 BTU/hr
Operating Temperature	• 32o to 104oF (0o to 40oC)	• 32° to 104°F (0° to 40°C)
Storage Temperature	• 14o to 158oF (-10o to 70oC)	• 14° to 158°F (-10° to 70°C)
Operating Humidity	• 10% to 95% non-condensing	• 10% to 95% non-condensing
Storage Humidity	• 5% to 95% non-condensing	• 5% to 95% non-condensing
Dimensions	• 17.3in x 8.3in x 1.7in (440mm x 210mm x 44mm) • 19-inch standard rack mounting width, 1U height	• 17.4in x 9.8in x 1.7in (441mm x 250mm x 44mm) • 19-inch standard rack mounting width, 1U height
Weight	• 5.73 lbs (2.6kg)	• 7.27 lbs (3.3kg)
Diagnostic LEDs	• Power (per device) • Link/Activity/Speed (per 10/100/1000Mbps port, per 10/100Mbps port, per SFP port)	• Power (per device) • Link/Activity/Speed (per 10/100/1000Mbps port, per 10/100Mbps port, per SFP port)
Emission (EMI)	• FCC Class A, CE Class A, VCCI Class A, C-Tick	• FCC Class A, CE Class A, VCCI Class A, C-Tick
MTBF	• 419,467 hours	• 289,012 hours
Safety	• cUL, LVD	• cUL, LVD



# D-Link DES-1210-28/52

## Software Features

### L2 Features

MAC Address Table	• 8K	
Flow Control	• 802.3x Flow Control	• HOL Blocking Prevention
IGMP Snooping	• IGMP v1/v2 Snooping • Supports at least 64 static multicast addresses • Supports IGMP Snooping Querier	• Supports 256 IGMP groups • IGMP per VLAN
Spanning Tree Protocol	• 802.1D STP	• 802.1w RSTP
Loopback Detection	• Yes	
802.3ad Link Aggregation	• 8 groups per device/8 ports per group	
Port Mirroring	• One-to-One, Many-to-One, Supports Mirroring for Tx/Rx/Both	
Cable Diagnostics	• Yes	
Configurable Auto MDI/MDI-X	• Yes	

### VLAN

802.1Q	• 2003 Edition
VLAN Group	• Max 256 static VLAN groups, max 4094 VID
Management VLAN	• Supports 1 Management VLAN
Asymmetric VLAN	• Yes
Auto Voice VLAN	• Max. 10 user defined OUI, Max. 8 default OUI

### QoS (Quality of Service)

802.1p Quality of Service	• 4 Queues per port
Queue Handling	• Strict, Weighted Round Robin (WRR)
CoS based on	• 802.1p Priority Queues, DSCP
Bandwidth Control	• Port-based (Ingress/Egress, min. granularity 64 Kb/s)



# D-Link DES-1210-28/52

## Access Control List

Maximum profiles	• 50
Maximum rules shared by profiles	• 240
ACL based on	• MAC Address, IPv4 Address (ICMP/IGMP/TCP/UDP), VLAN ID, 802.1p Priority, DSCP
ACL Actions	• Permit, Deny

## Security

802.1X Port-based Access Control	• Default 802.1X forwarding
Port Security	• Supports up to 64 MAC addresses per port
Traffic Control	• Broadcast/Multicast/Unicast Storm Control
Static MAC	• Supports 256 Static MAC entries
D-Link Safeguard Engine	• Yes

## MIB

MIB	• 1213 MIB II, 1493 Bridge MIB, 1907 SNMP v2 MIB, 1215 Trap Convention MIB, 2233 Interface Group MIB, D-Link Private MIB
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## RFC Standard Compliance

RFC	• RFC 768 UDP, RFC 791 IP, RFC 792 ICMP, RFC 793 TCP, RFC 826 ARP, RFC 854 Telnet Server, RFC 855 Telnet Server, RFC 856 Telnet Binary Transmission, RFC 858 Telnet Server, RFC 896 Congestion Control in TCP/IP Network, RFC 903 Reverse Address Resolution Protocol, RFC 951 BootP Client, RFC 1155 MIB, RFC 1157 SNMP v1, RFC 1191 Path MTU Discovery, RFC 1212 Concise MIB Definition, RFC 1213 MIB II, IF MIB, RFC 1215 Traps for use with the SNMP, RFC 1239 Standard MIB, RFC 1350 TFTP, RFC 1493 Bridge MIB, RFC 1519 CIDR, RFC 1945 HTTP/1.0, RFC 2131 DHCP, RFC 2132 DHCP Options and BOOTP Vendor Extensions, RFC 2138 Radius Authentication, RFC 2233 Interface MIB, RFC 2578 Structure of Management Information Version 2 (SMIv2), RFC 2647 802.1p, RFC 3416 SNMP, RFC 3417 SNMP
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## Ordering Information

Part Number	Description
DES-1210-28	• Web Smart 24-Port 10/100 Switch, 4GbE, 2 Combo SFP Slots
DES-1210-52	• Web Smart 48-Port 10/100 Switch, 4GbE, 2 Combo SFP Slots
DEM-211	• 100BASE-FX Multimode LC Transceiver, up to 2Km
DEM-310GT	• 1000BASE-LX SFP Module, up to 10Km
DEM-311GT	• 1000BASE-SX SFP Module, up to 550m



# Resumen

- Prioridades (802.1p)
- Agregación de enlaces (802.1ad)
- PoE (802.3af)
- 802.3x
- GARP/GMRP/GVRP
- MRP/MMRP/MVRP