

802: Cambios físicos recientes

IEEE 802

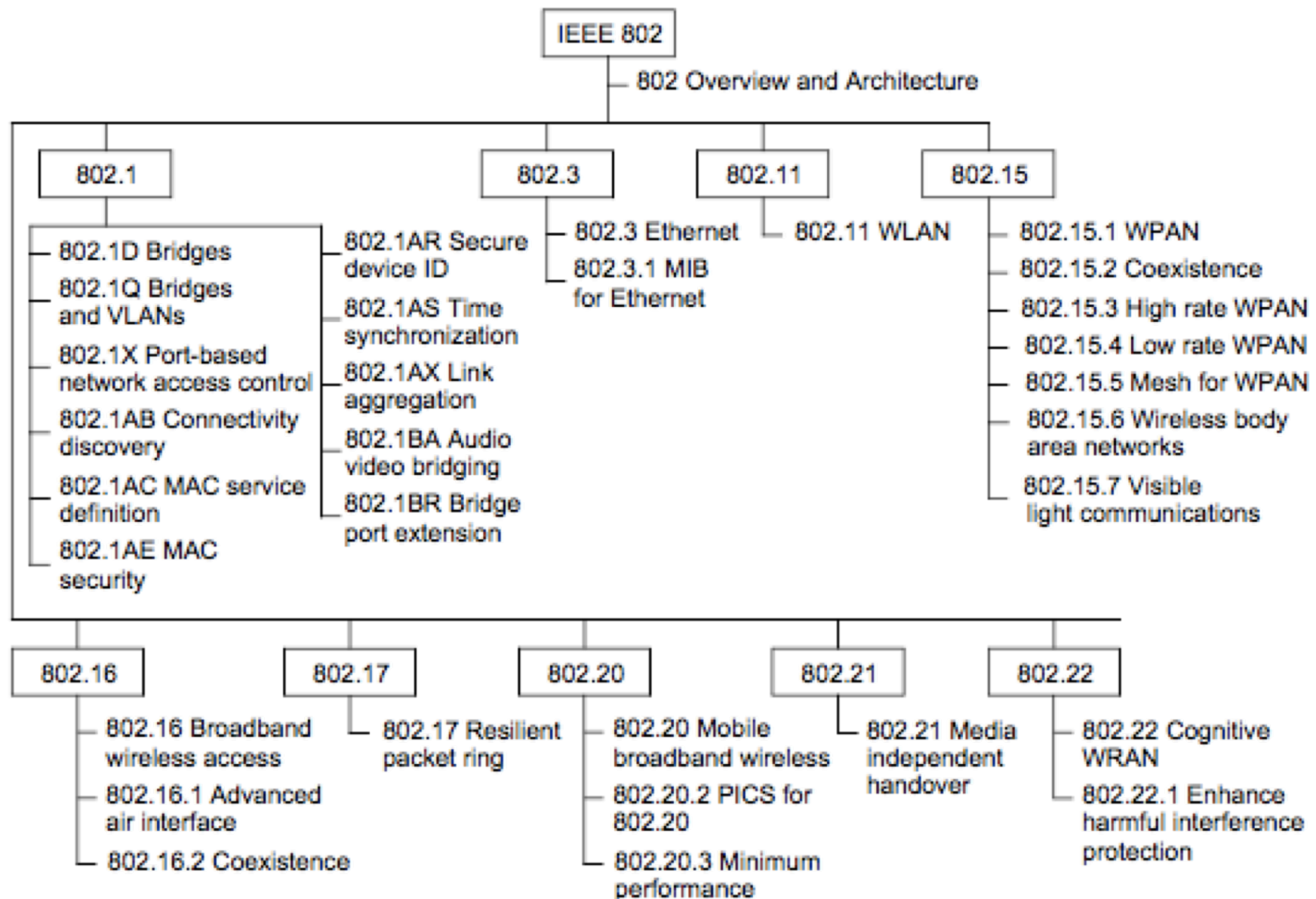


Figure 1—Current family of IEEE 802 standards and recommended practices

802.3

Tecnologías Ethernet

100Base-X

1000Base-X

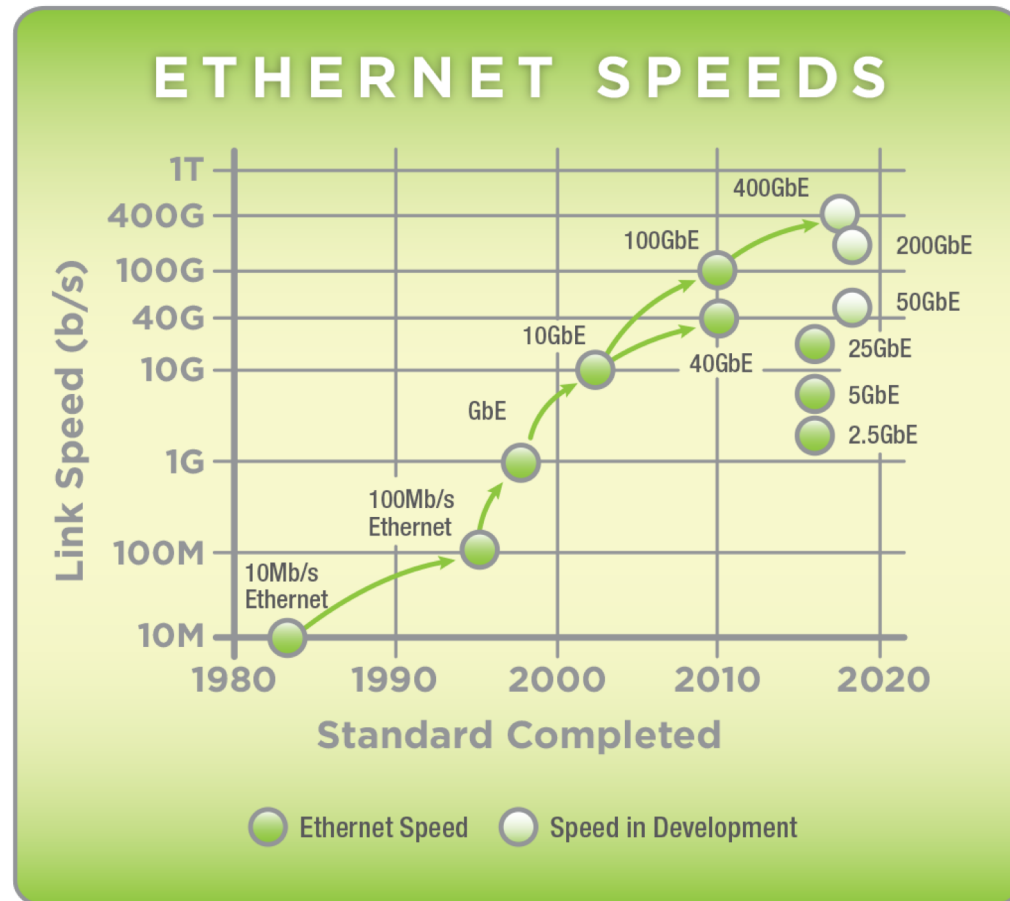
10GBase-X

40GBase-X

100GBase-X

200GBase-X

400GBase-X



Nuevas versiones

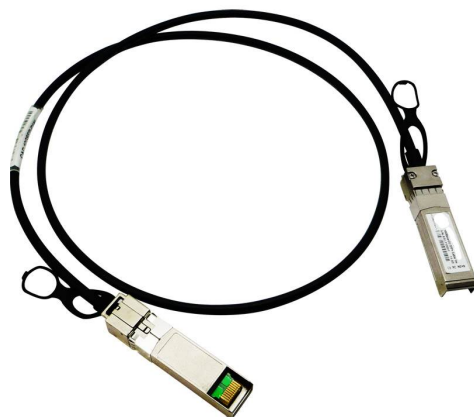
- **802.3bz (2016)**
 - 2.5GBase-T y 5GBase-T
 - Empleando cat. 5e y 6 (gran planta instalada)
 - Útil para salidas de Access Points
 - 802.11n: 600Mbps
 - 802.11ac (wave 1, wave 2): 3.47 – 6.93 Gbps
 - Hace falta el 75% de la tasa inalámbrica en el cableado
- **802.3cb-2018**
 - 2.5Gb/s y 5Gb/s en backplane

Cable	1 Gbps	2.5 Gbps	5 Gbps	10 Gbps
Category 5e	✓	✓	✓	Not Supported
Category 6	✓	✓	✓	✓ (55m)
Category 6a	✓	✓	✓	✓



Nuevas versiones













- **25GBase-CR, 25GBase-SR**
 - Sobre twinaxial cable (5m) o fibra multimodo (802.3by-2016)
 - Más eficiente que 40G (40G es 4x10G, 25G es 1 lane)
 - Mejor utilización de capacidad de conmutación de ASICs (2015 ya a 3.2Tbps)
- **25GBase-LR, 25GBase-ER**
 - 802.3cc-2017
 - 10 ó 40Km sobre fibra óptica monomodo



Physical Layer Reach	1 m Backplane	3 m Copper Cable	5 m Copper Cable	30 m Twisted-Pair	70 m OM3 / 100 m OM4
Name	25GBASE-KR	25GBASE-CR-S	25GBASE-CR	25GBASE-T	25GBASE-SR
Standard	September 2016 IEEE 802.3by	September 2016 IEEE 802.3by	September 2016 IEEE 802.3by	March 2016 IEEE 802.3bq	September 2016 IEEE 802.3by
Electrical Signaling (Gb/s)	1 x 25	1 x 25	1 x 25	1 x 25	1 x 25
Media Signaling (Gb/s)	1 x 25	1 x 25	1 x 25	1 x 25	1 x 25
Media Type	Backplane	Twinax Copper	Twinax Copper	Cat 8	Duplex MMF
Module Type	Backplane	SFP28	SFP28	RJ45	SFP28

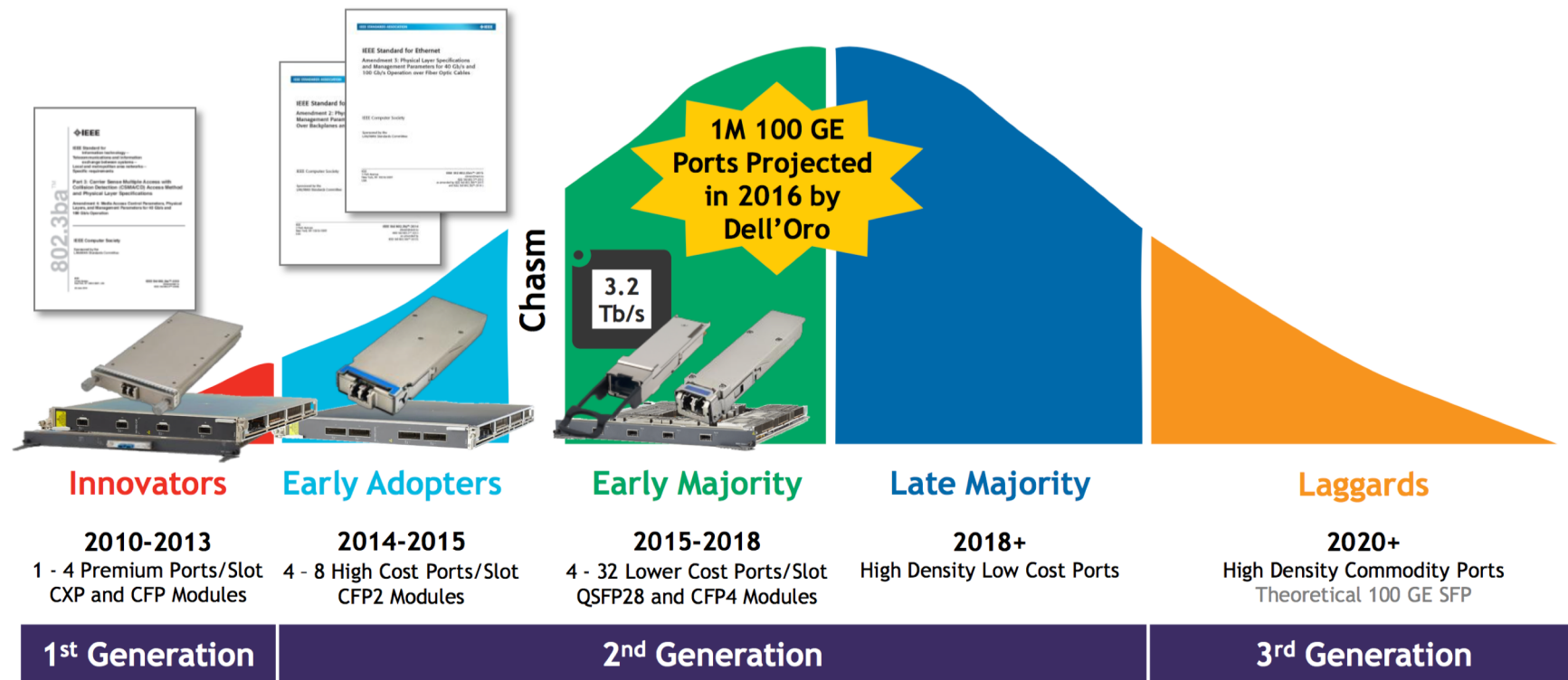
Nuevas versiones

- **25GBase-T, 40GBase-T**
 - 30 metros sobre par trenzado categoría 8 (802.3bq-2016)

	Data Center Server and Access 40 GE to 4 x 10 GE Breakout			Aggregation and Core Native 40 GE		
Physical Layer Reach	10 m Passive Copper Cable	100 m OM3/OM4	7 m Passive Copper Cable	100 m OM3/ 150 m OM4	10 km SMF	40 km SMF
Pluggable Module	 10GSFP+Cu	 10GBASE-SR	 40GBASE-CR4	 40GBASE-SR4	 40GBASE-LR4	 40GBASE-ER4
Media	 Integrated Twinax (QSFP+ to 4 x SFP+)	 Parallel MMF (MPO to 4 x Duplex LC)	 Integrated Twinax (QSFP+ to QSFP+)	 Parallel MMF (12-Fiber MPO)	 Duplex SMF (LC)	 Duplex SMF (LC)
Standard	July 2009 SFF-8431	June 2002 IEEE 802.3ae	June 2010 IEEE 802.3ba	June 2010 IEEE 802.3ba	June 2010 IEEE 802.3ba	February 2015 IEEE 802.3bm

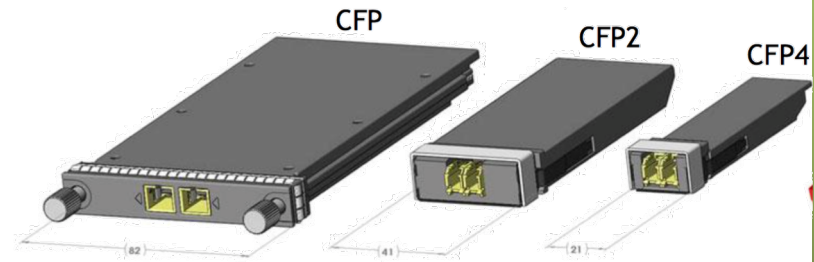
100G

- Primera generación eran 10x10Gbps
- Segunda generación 4x25Gbps (menor tamaño y consumo)



100G

- Se está reduciendo el tamaño de los módulos
- Eso permite mayor densidad de puertos



Physical Layer Reach	1 m Backplane	5 m Copper Cable	7 m Copper Cable	70 m OM3 / 100 m OM4	100 m OM3 / 150 m OM4	2 km SMF	10 km SMF	40 km SMF		
Name	100GBASE-KP4 100GBASE-KR4	100GBASE-CR4	100GBASE-CR10	100GBASE-SR4	100GBASE-SR10	10x10-2km	10x10-10km	100GBASE-LR4	10x10-40km	100GBASE-ER4*
Standard	June 2014 IEEE 802.3bj	June 2014 IEEE 802.3bj	June 2010 IEEE 802.3ba	February 2015 IEEE 802.3bm	June 2010 IEEE 802.3ba	March 2011 10x10 MSA	August 2011 10x10 MSA	June 2010 IEEE 802.3ba	August 2011 10x10 MSA	June 2010 IEEE 802.3ba
Electrical Signaling (Gb/s)	4 x 25	4 x 25	10 x 10	4 x 25	10 x 10	10 x 10	10 x 10	10 x 10	10 x 10	10 x 10
Media Signaling (Gb/s)	4 x 25 NRZ and PAM-4	4 x 25	10 x 10	4 x 25 850 nm	10 x 10 850 nm	10 x 10 1310 nm λs	10 x 10 1310 nm λs	4 x 25 1550 nm λs	10 x 10 1310 nm λs	4 x 25 1550 nm λs
Media Type	Backplane	Twinax Copper	Twinax Copper	Parallel MMF (12-Fiber MPO)	Parallel MMF (24-Fiber MPO)	Duplex SMF	Duplex SMF	Duplex SMF	Duplex SMF	Duplex SMF
Module Type	Backplane	CFP2, CFP4, QSFP28	CXP, CFP2, CFP4, QSFP28	CFP2, CFP4, CPAK, QSFP28	CFP, CFP2, CFP4, CPAK, CXP	CFP	CFP	CFP, CFP2, CFP4, CPAK, QSFP28	CFP	CFP, CFP2
Market Availability	2014+	2014+	2010	2015+	2012	2011	2011	2010	TBD	2012

> 100 Gb/s

- **802.3cd-2018**

- 50Gb/s, 100Gb/s y 200Gb/s Ethernet
- Sobre twinaxial, fibra o backplane
- 50GBASE-CR, 50GBASE-FR, 50GBASE-KR, 50GBASE-LR, 50GBASE-SR, 100GBASE-DR, 100GBASE-KR2, 100GBASE-SR2, 200GBASE-CR4, 200GBASE-KR4, 200GBASE-SR4

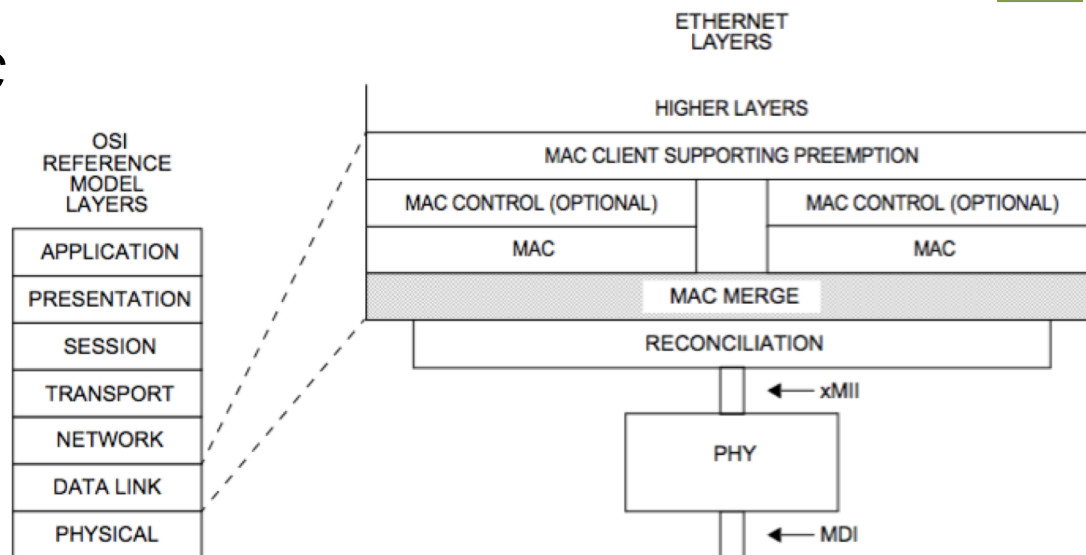
400 Gb/s

- **802.3bs-2017**
 - 200Gb/s y 400Gb/s
 - 400GBase-SR8, 400GBase-DR4, 400GBase-XDR4, 400GBase-FR4, etc
- **802.3cm-2020**
 - 400GBASE-SR4.2 y 400GBASE-SR8
 - 2 pares y 8 pares de fibra multimodo respectivamente, 100m
- **802.3cn-2019**
 - 50 Gb/s, 200 Gb/s y 400 Gb/s sobre fibra monomodo

Physical Layer Reach	100 m MMF	500 m SMF	2 km SMF	10 km SMF
25 Gb/s NRZ	16 λ x 16 MMF			
50 Gb/s NRZ		2 λ x 4 SMF	8 λ x 1 SMF	8 λ x 1 SMF
50 Gb/s PAM-4			8 λ x 1 SMF	8 λ x 1 SMF
100 Gb/s PAM-4		1 λ x 4 SMF	4 λ x 1 SMF	
100 Gb/s DMT				4 λ x 1 SMF

802.3br-2016

- “Specification and Management Parameters for Interspersing Express Traffic”
- Latencia para iniciar la transmisión de un paquete *express* debe ser < 2 veces el tiempo del paquete mínimo + IPG
- Añade soporte para tráfico preemptivo
- *eMAC* = *express MAC*
- *pMAC* = *preemptable MAC*



NOTE—In this figure, the xMII is used as a generic term for the Media Independent Interfaces for implementations of 100 Mb/s and above. For example: for 100 Mb/s implementations this interface is called MII; for 1 Gb/s implementations it is called GMII; for 10 Gb/s implementations it is called XGMII; etc.

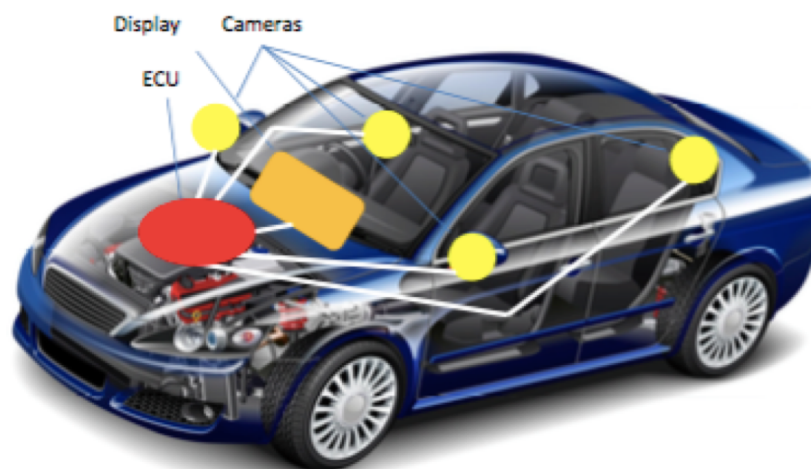
MAC = MEDIA ACCESS CONTROL
xMII = MEDIA INDEPENDENT INTERFACE

MDI = MEDIUM DEPENDENT INTERFACE
PHY = PHYSICAL LAYER DEVICE

Figure 99-1—Relationship of MAC Merge sublayer to the ISO/IEC Open Systems Interconnection (OSI) reference model and the IEEE 802.3 Ethernet model

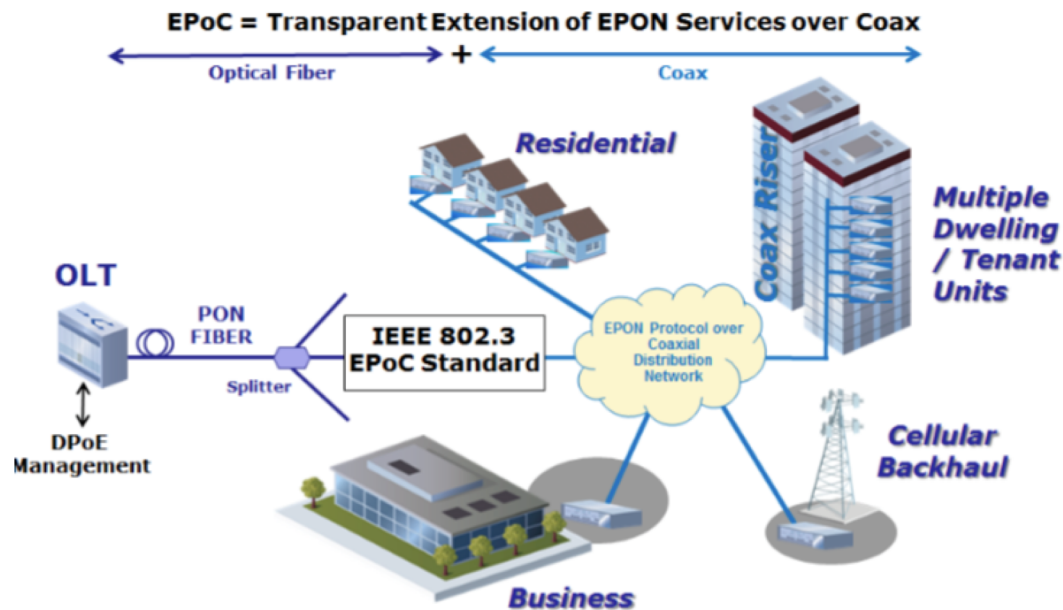
Otras

- **802.3bw-2015**
 - 100Base-T1 Ethernet sobre un solo par trenzado balanceado (15m)
- **802.3bp-2016**
 - 1000Base-T1 Ethernet sobre un solo par trenzado (15m)
- **802.3ch-2020**
 - 2.5 Gb/s, 5 Gb/s y 10 Gb/s sobre par balanceado para aplicaciones de automoción



Otras

- **802.3bn-2016**
 - 10GPass-XR
 - EPON sobre coaxial
- **802.3ca-2020**
 - EPON compatible con 10Gb/s EPON
 - 25/10 Gb/s, 25/25 Gb/s, 50/10 Gb/s, 50/25 Gb/s y 50/50 Gb/s
 - 20 km, Split ratio 1:32





802.11





802.11



Wi-Fi 4

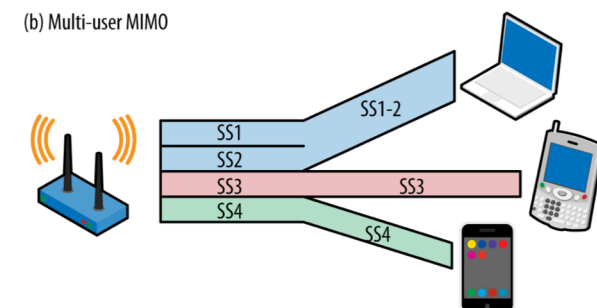
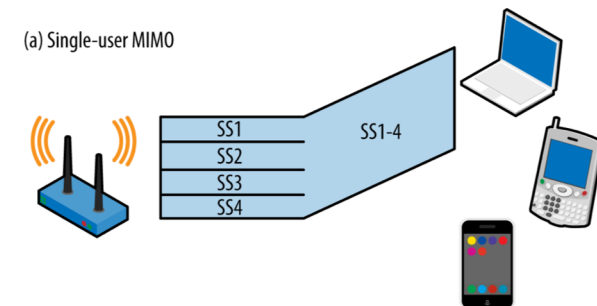
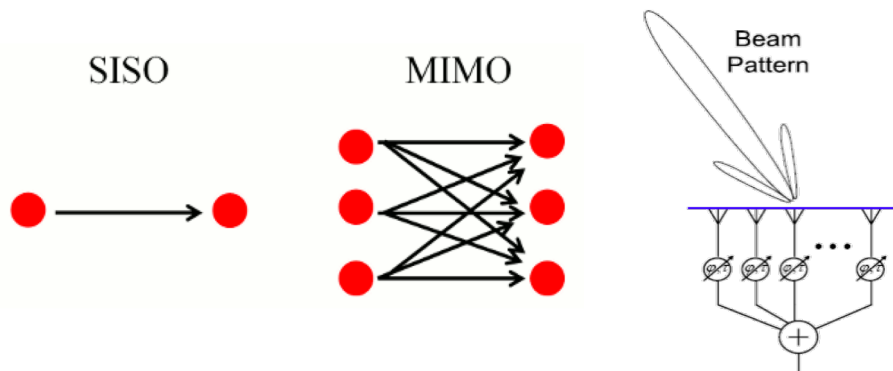


- Tanto en 2.4 GHz como 5 GHz
- Compatible con 802.11a/b/g
- Canales de 20MHz o 40 MHz
- MIMO
- Hasta 4 *streams* espaciales
- Streams de 150 Mb/s
- Permite *beamforming*
- Trae mejoras en MAC como la agregación de PDUs

Wi-Fi 5



- En 5 GHz
- Canales 20, 40, 80 ó 160 MHz
- Los dispositivos suelen a la vez soportar 802.11n
- *Beamforming*
- Hasta 8 *streams* espaciales
- MU-MIMO (máx. a 4 clientes)



Waves 802.11ac

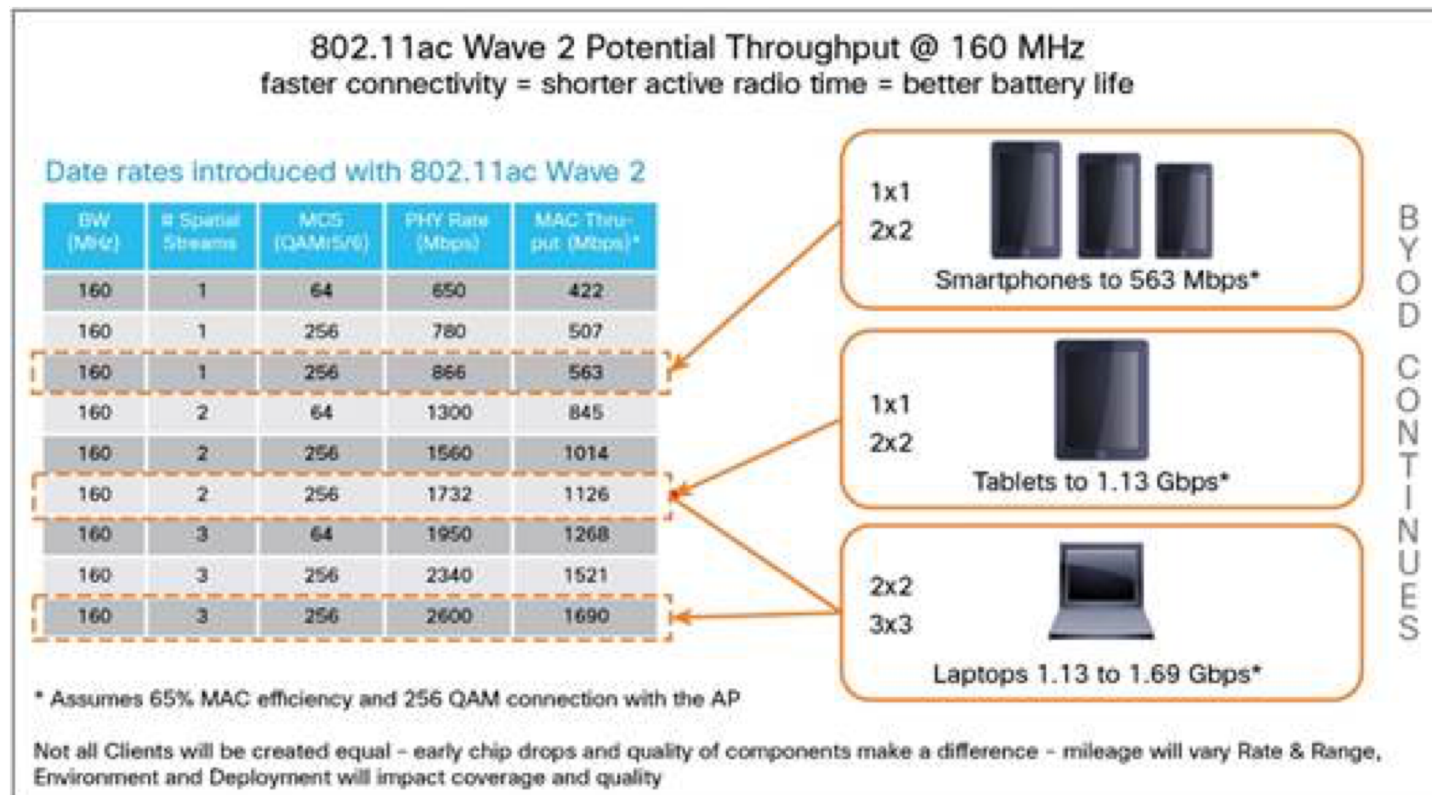
Wave 1

- 1.3 Gbps
- SU-MIMO
- Canal de 20 MHz, 40 MHz ó 80 MHz
- Aprox. 25, 12 ó 6 canales
- 3 streams espaciales

Waves 802.11ac

Wave 2

- 2.6 Gbps
 - MU-MIMO (solo downlink)
 - Canal hasta 160 MHz
 - Hasta 4 streams espaciales
- AP 4x4 puede enviar a 4 clientes 1x1 simult.
 - Evita que desaprovechen el tiempo de uso del medio
 - Requiere explicit transmit beamforming



802.11ax (Wi-Fi 6)



- Se espera para mediados o finales de 2020
- Finales de 2018 primeros equipos pre-estándar
- 2.4 GHz y 5 GHz
- Busca mejora 4x
- Wave 1 puede soportar 8 streams. Beamforming
- Multiuser (OFDMA o MU-MIMO hasta 8 clientes, en wave 2 también en uplink)
- Hasta 1024-QAM

If the most advanced technology a device supports is ...	Then it shall be identified as generation
802.11ax	Wi-Fi 6
802.11ac	Wi-Fi 5
802.11n	Wi-Fi 4

PHY	Bandwidth (as number of data subcarriers)	Data bits per subcarrier	Time per OFDM symbol (800ns GI)	1 SS	3 SS	4 SS	8 SS
802.11ac	234 (80 MHz)	$5/6 \times \log_2(256)$ ≈ 6.67	4 μ s	390 Mbps	1.17 Gbps	1.56 Gbps	-
	2 x 234 (160 MHz) X	/	=	780 Mbps	-	3.12 Gbps	-
802.11ax	980 (80 MHz)	$5/6 \times \log_2(1024)$ ≈ 8.33	13.6 μ s	600 Mbps	1.8 Gbps	2.4 Gbps	4.8 Gbps
	2 x 980 (160 MHz)			1.2 Gbps	3.6 Gbps	4.8 Gbps	-

802.11ax (Wi-Fi 6)



- **Wi-Fi 6E**

- 6 GHz sin licencia (más de 1GHz de BW)
- Hasta 6 canales de 160 MHz no interferentes
- MU-MIMO uplink



Wi-Fi CERTIFIED 6™:
Worldwide Wi-Fi 6E
interoperability



Otras

802.11ah (2016)

- “Sub 1GHz License Exempt Operation”
- Alcance de hasta 1km
- Canales de 1, 2, 4, 8 y 16 MHz
- Tasa al menos 100Kb/s

802.11af

- Banda TV VHF/UHF (54-790MHz según el país)

