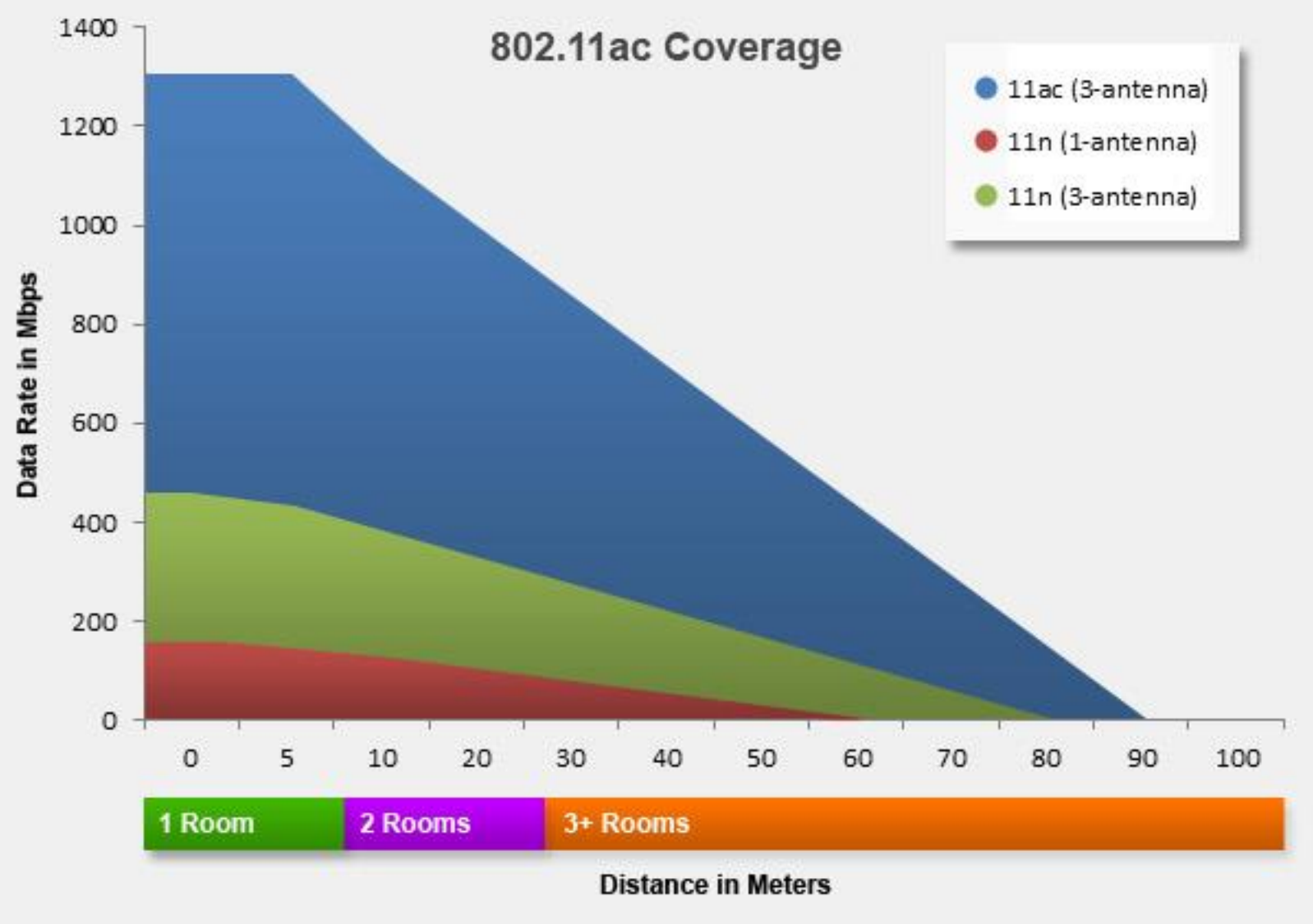
Ingeniería de Redes
Redes IEEE 802.11ac (5G WiFi)

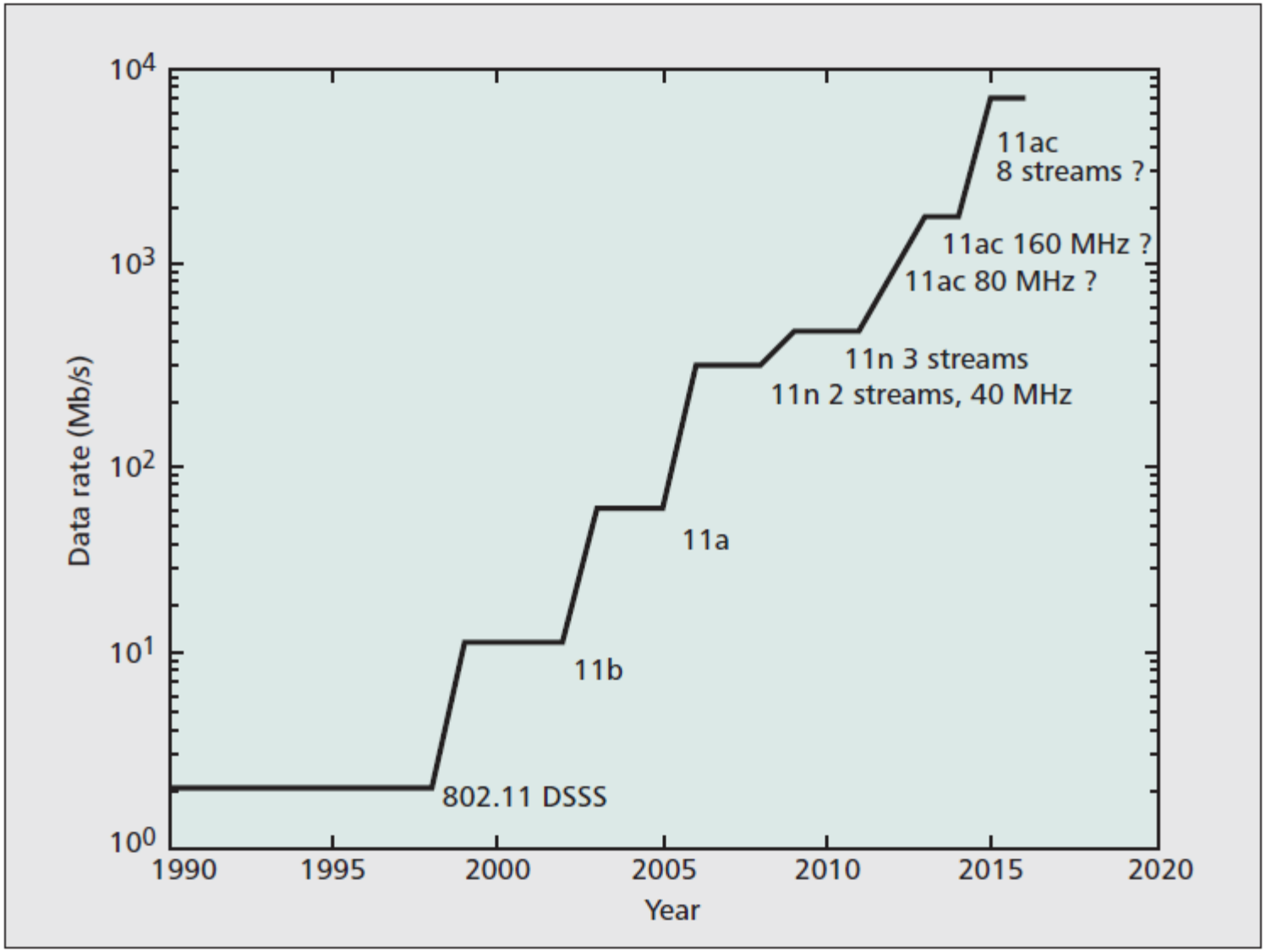
Roberto García Fernández

Universidad de Oviedo

Área de Ingeniería Telemática

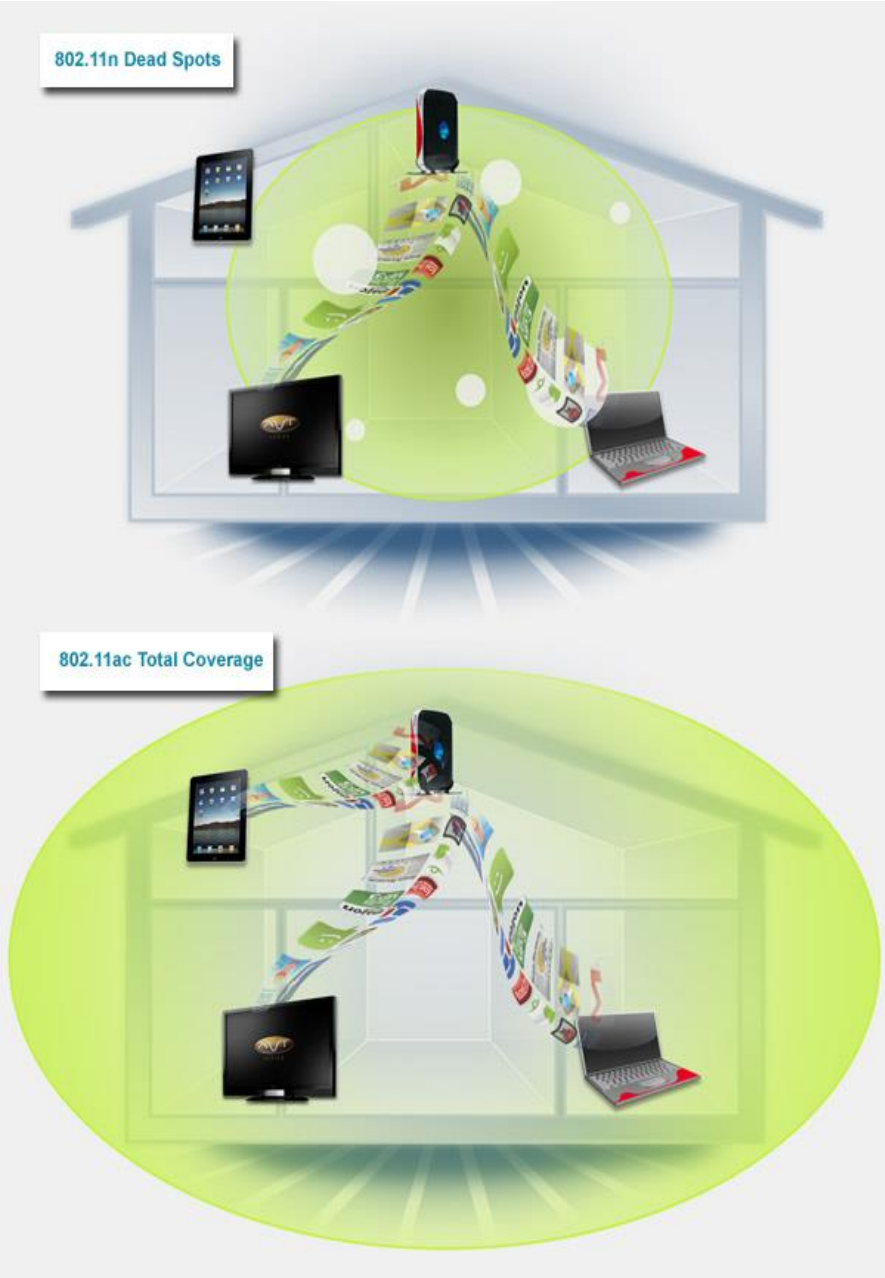
- IEEE 802.11ac
- El estándar para 5G WiFi
- Al menos, 3 veces más rápido que 802.11n


802.11ac Coverage
11ac (3-antenna)
11n (1-antenna)
11n (3-antenna)
Data Rate in Mbps
1400
1200
1000
800
600
400
200
0
0
5
10
20
30
40
50
60
70
80
90
100
1 Room
2 Rooms
3+ Rooms
Distance in Meters


Data rate (Mb/s)
10^4
10^3
10^2
10^1
10^0
1990
1995
2000
2005
2010
2015
2020
Year
802.11 DSSS
11b
11a
11n 2 streams, 40 MHz
11n 3 streams
11ac 80 MHz ?
11ac 160 MHz ?
11ac
8 streams ?

5G WiFi

- Mejoras considerables
  - Fiabilidad
  - Rango
  - Cobertura
- *30 feet away from an 802.11ac access point and get the same data throughput that you would if you were 10 feet from an 802.11n transmitter*
- Mejora la eficiencia de la batería



5G WiFi

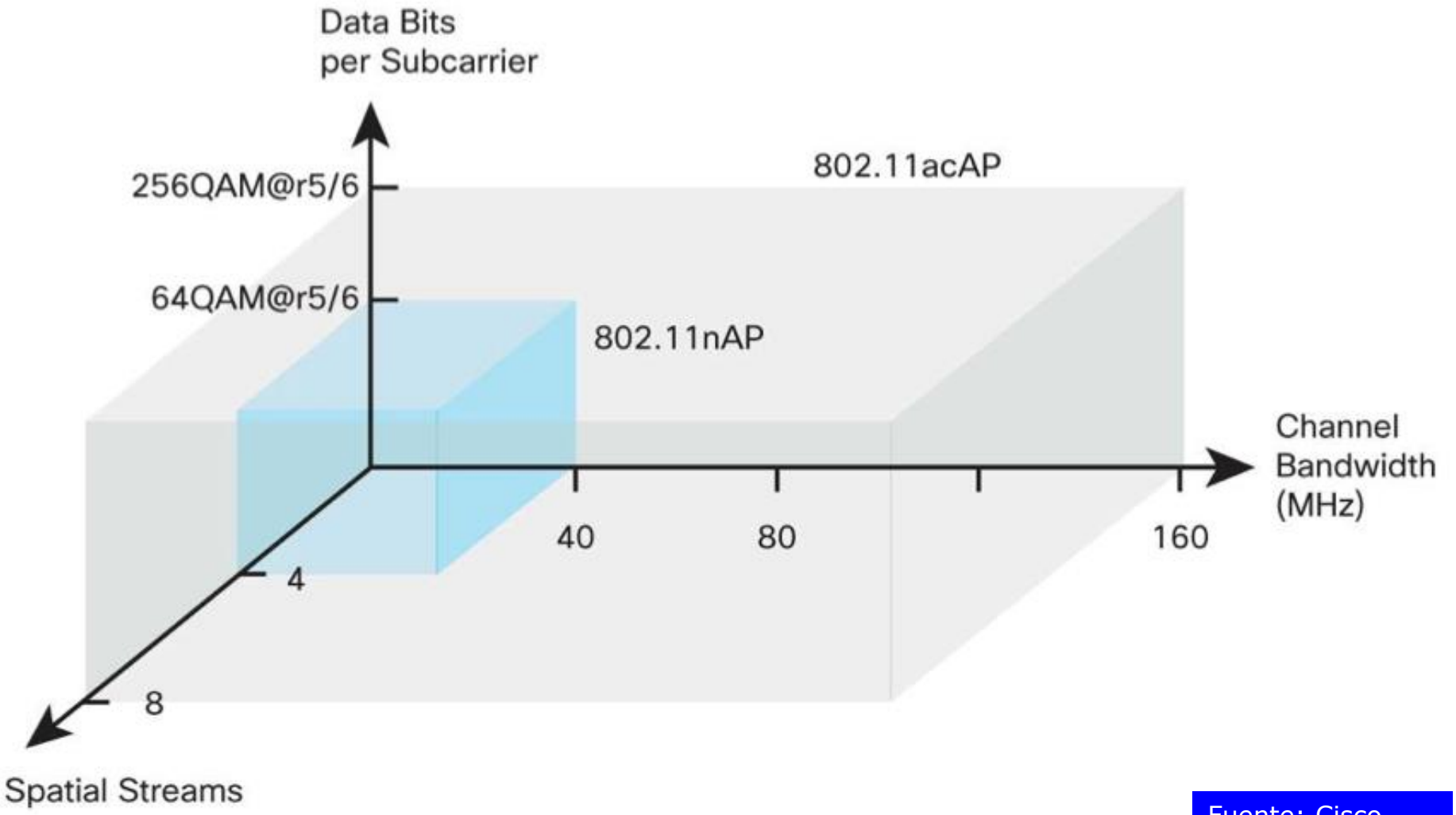
- 802.11ac: "Very High Throughput in 5GHz“
- 802.11ac: “multi-user multiple-input multiple-output” (MU-MIMO)
- Standard to trigger an explosion in Wi-Fi-enabled cellular devices
- Shipments exceeding 650 million by 2015
- In the same year, 802.11ac is also projected to reach one out of every four notebooks. And attach rates for 802.11ac are predicted to skyrocket in consumer electronics devices - especially those involving **video delivery**

802.11ac vs 802.11n

- **Mayores anchos de banda**
  - 802.11n
    - Canales de 40MHz
  - 802.11ac
    - Canales de 80MHz o 160MHz (117% - 333% *speed-ups*)
- **Modulaciones más densas**
  - 802.11n
    - 64QAM
  - 802.11ac
    - 256QAM (33% *speed-up*)
- **MIMO**
  - 802.11n
    - Hasta 4x4
  - 802.11ac
    - Hasta 8x8 (100% *speed-up*)

Fuente: Cisco 2012 White Paper

802.11ac vs 802.11n



Fuente: Cisco
2012 White Paper

Calculando velocidad PHY 802.11ac-802.11n

PHY	Bandwidth (as Number of Data Subcarriers)		Number of Spatial Streams		Data Bits per Subcarrier		Time per OFDM Symbol		PHY Data Rate (bps)
11n or 11ac	56 (20 MHz)	×	1 to 4	×	Up to 5/6×$\log_2(64)$ = 5	+	3.6 µs (short guard interval)	=	
	108 (40 MHz)						4 µs (long guard interval)		
11ac only	234 (80 MHz)		5 to 8		Up to 5/6×$\log_2(256)$ ≈ 6.67				
	2×234 (160 MHz)								

Ejemplo: Transmisión a 80MHz con 256QAM y 3 streams espaciales con tiempo de guarda corto:

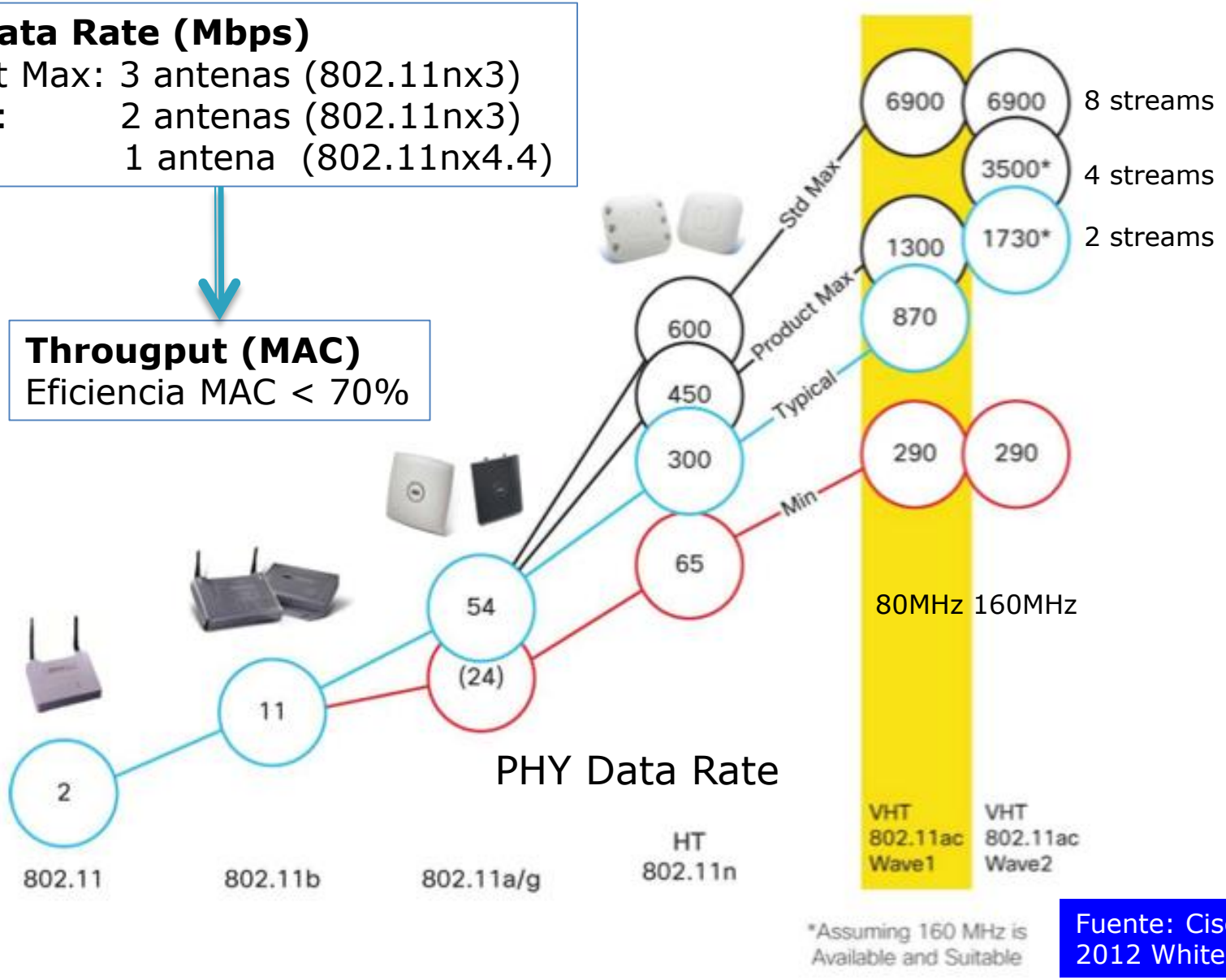
PHY_Rate = 234×3×5/6×8 bits/3.6 µs = 1300 Mbps.

Fuente: Cisco 2012 White Paper

Evolución de CISCO APs

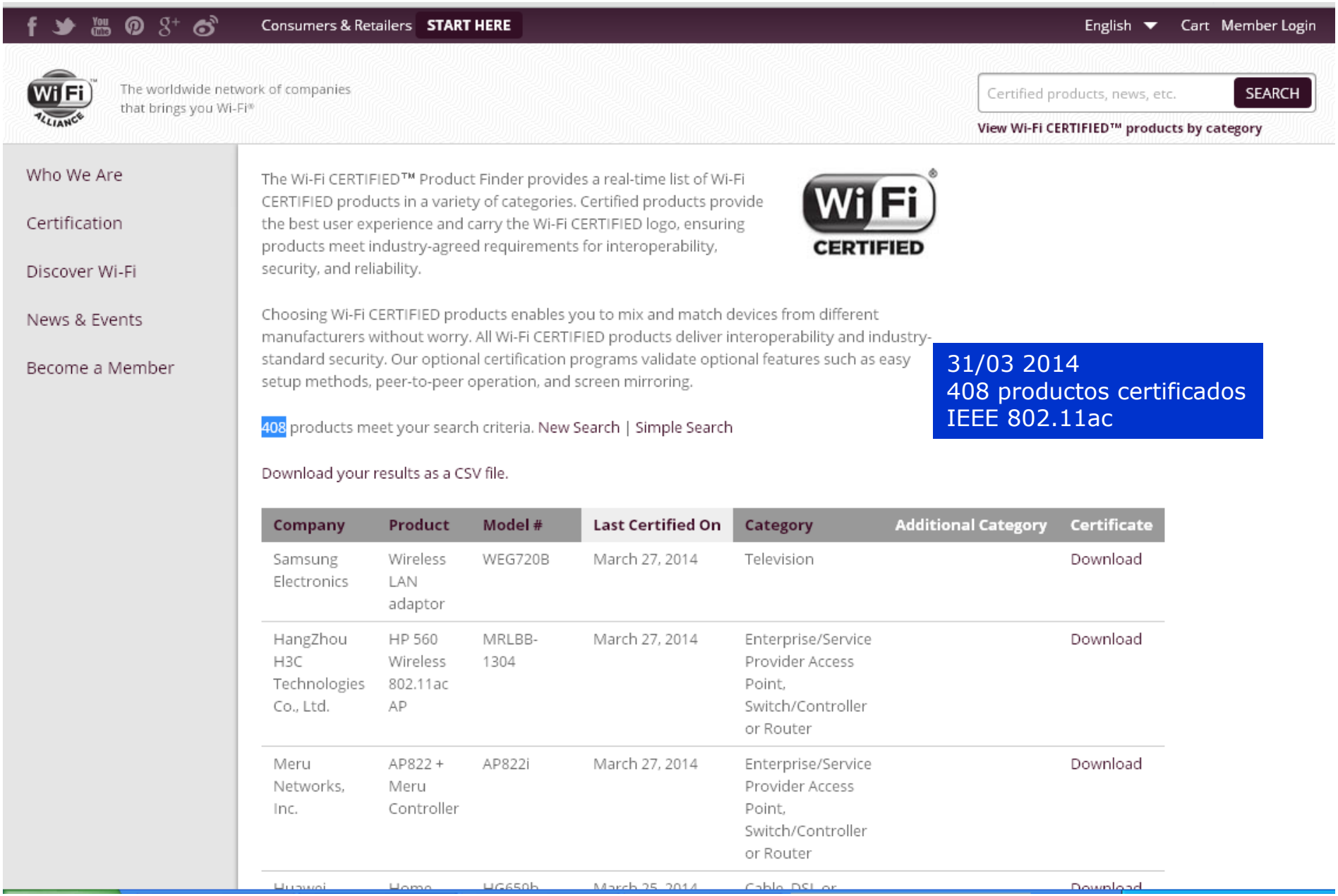
PHY Data Rate (Mbps)
Product Max: 3 antenas (802.11nx3)
Typical: 2 antenas (802.11nx3)
Min: 1 antena (802.11nx4.4)

Througput (MAC)
Eficiencia MAC < 70%



Fuente: Cisco 2012 White Paper

Certificación IEEE 802.11ac



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31/03 2014
408 productos certificados
IEEE 802.11ac

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Company	Product	Model #	Last Certified On	Category	Additional Category	Certificate
Samsung Electronics	Wireless LAN adaptor	WEG720B	March 27, 2014	Television		Download
HangZhou H3C Technologies Co., Ltd.	HP 560 Wireless 802.11ac AP	MRLBB-1304	March 27, 2014	Enterprise/Service Provider Access Point, Switch/Controller or Router		Download
Meru Networks, Inc.	AP822 + Meru Controller	AP822i	March 27, 2014	Enterprise/Service Provider Access Point, Switch/Controller or Router		Download
Huawei	Home	HG650b	March 25, 2014	Cable, DSL or		Download

Certificación IEEE 802.11ac

Wi-Fi CERTIFIED™ Interoperability Certificate

This certificate lists the features that have successfully completed Wi-Fi Alliance interoperability testing.
Learn more: www.wi-fi.org/certification/programs

Certification ID: WFA53520 — **Page 1 of 2**

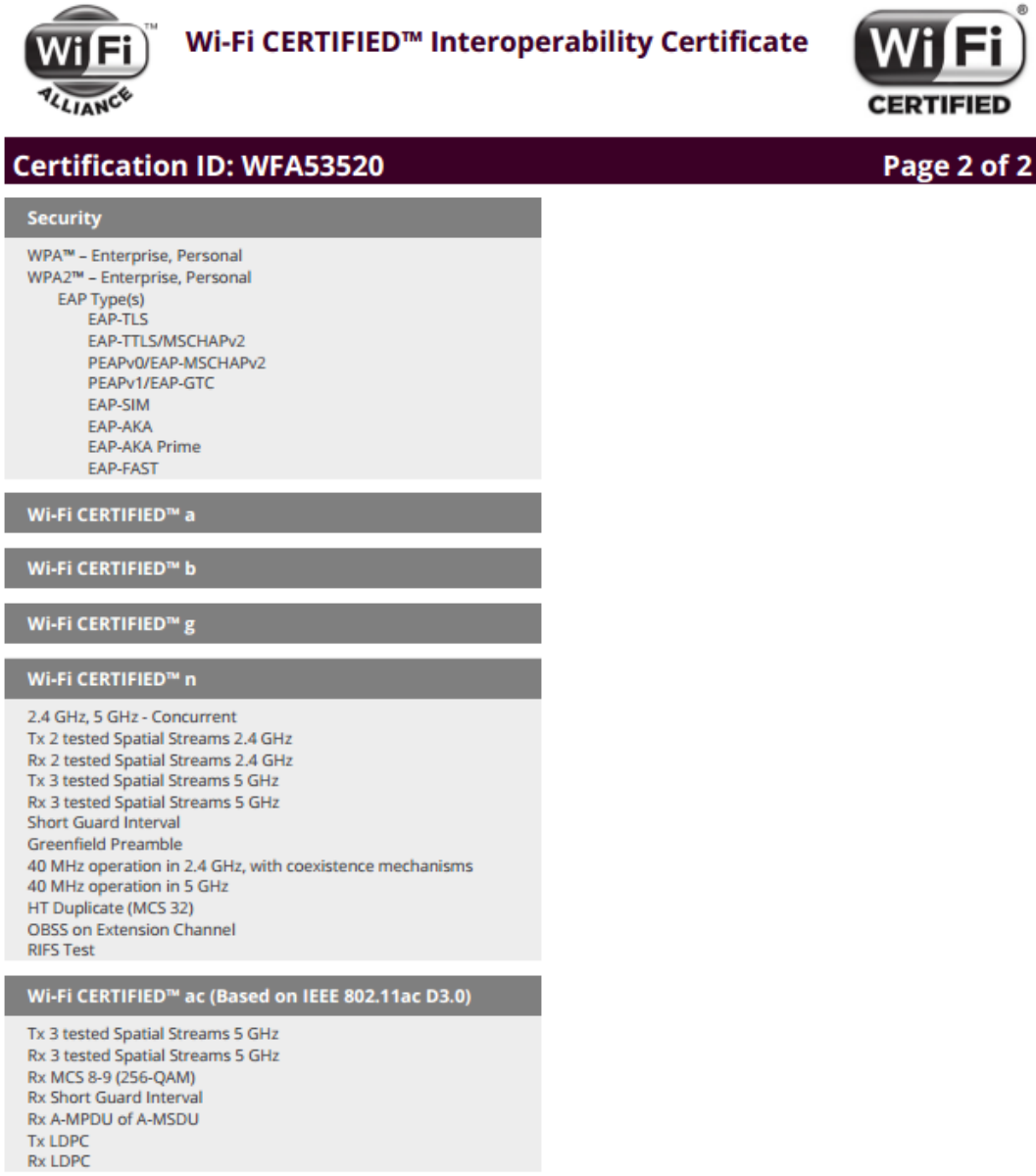
Date of Last Certification	March 18, 2014
Company	Cisco Systems
Product	Wireless-AC/N Dual Radio Access Point with Single Point Setup
Model Number	WAP371
Product Identifier(s)	
Category	Enterprise/Service Provider Access Point, Switch/Controller or Router
Hardware Version	Product: 3763-50300103R, Wi-Fi Component: Broadcom43460
Firmware Version	Product: 1.0.0.9, Wi-Fi Component: 1.0.0.9
Operating System	Windows XP
Frequency Band(s)	2.4 GHz, 5 GHz - Concurrent

Summary of Certifications

CLASSIFICATION	PROGRAM
Connectivity	Wi-Fi CERTIFIED™ a, b, g, n, ac
	WPA™ – Enterprise, Personal
	WPA2™ – Enterprise, Personal
Optimization	WMM®

17/03 2014
AP 802.11ac

Certificación IEEE 802.11ac



Wi-Fi CERTIFIED™ Interoperability Certificate

Certification ID: WFA53520 Page 2 of 2

Security

WPA™ – Enterprise, Personal
WPA2™ – Enterprise, Personal
EAP Type(s)
EAP-TLS
EAP-TTLS/MSCHAPv2
PEAPv0/EAP-MSCHAPv2
PEAPv1/EAP-GTC
EAP-SIM
EAP-AKA
EAP-AKA Prime
EAP-FAST

Wi-Fi CERTIFIED™ a

Wi-Fi CERTIFIED™ b

Wi-Fi CERTIFIED™ g

Wi-Fi CERTIFIED™ n

2.4 GHz, 5 GHz - Concurrent
Tx 2 tested Spatial Streams 2.4 GHz
Rx 2 tested Spatial Streams 2.4 GHz
Tx 3 tested Spatial Streams 5 GHz
Rx 3 tested Spatial Streams 5 GHz
Short Guard Interval
Greenfield Preamble
40 MHz operation in 2.4 GHz, with coexistence mechanisms
40 MHz operation in 5 GHz
HT Duplicate (MCS 32)
OBSS on Extension Channel
RIFS Test

Wi-Fi CERTIFIED™ ac (Based on IEEE 802.11ac D3.0)

Tx 3 tested Spatial Streams 5 GHz
Rx 3 tested Spatial Streams 5 GHz
Rx MCS 8-9 (256-QAM)
Rx Short Guard Interval
Rx A-MPDU of A-MSDU
Tx LDPC
Rx LDPC

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AP 802.11ac

IEEE 802.11ac

- Tasas de transmisión hasta 7Gbps
- Mejoras en:
  - Codificación para corrección de errores
  - Mayores anchos de banda por canal
    - 802.11n 40MHz
    - 802.11ac 160MHz
  - Más streams espaciales
    - 8 en lugar de 4
- http://www.webtorials.com/discussions/2012/04/8021 1ac-multi-user-mimo.html

Bibliografía

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  - Cisco Technical White Paper
- Breaking The Gigabit-per-second Barrier With 802.11ac
  - Richard Van Nee, Qualcomm Inc.
  - IEEE Wireless Communications • April 2011
- http://www.5gwifi.org/

- NTT Network Innovation Laboratories