



Next-generation Wi-Fi for ever more demanding applications

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FITCE - 5G for Belgium – 2022-10-13



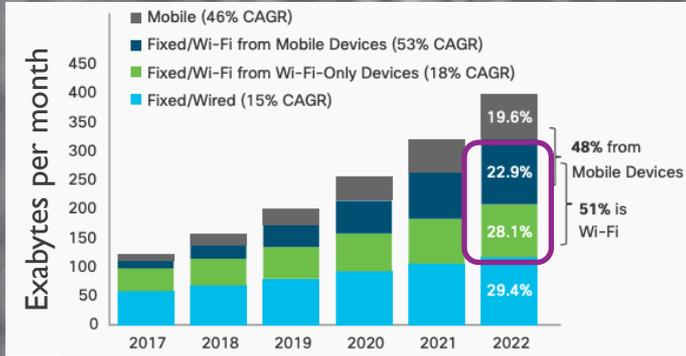
5G

WAN tech
Licensed spectrum

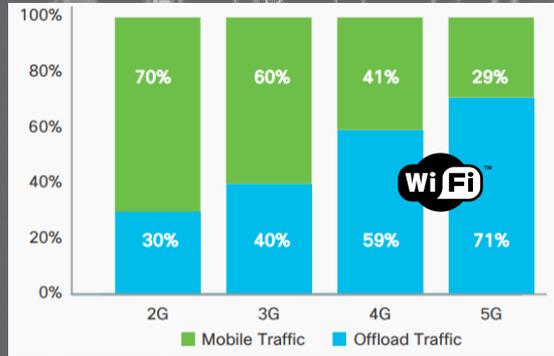


LAN tech
Unlicensed spectrum

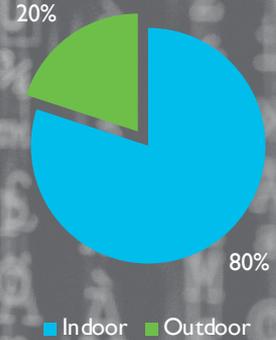
Relevance of Wi-Fi



1) IP traffic by access technology



2) Mobile and offload traffic from mobile connected devices



3) Data origin

Source 1) & 2): Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2017–2022
 Source 3) <https://www.abiresearch.com/press/abi-research-anticipates-building-mobile-data-traf/>



IEEE 802.11-1997

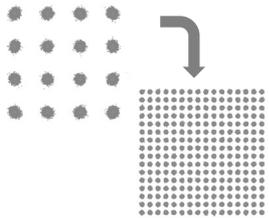
IEEE Standard for Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications

Evolution of Wi-Fi from 1997 until 2013 (Wi-Fi 5)

Focus on speed

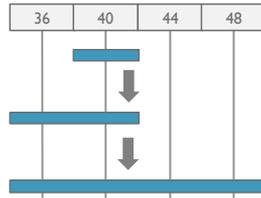
1.

Modulation and coding



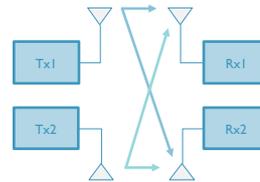
2.

Bandwidth



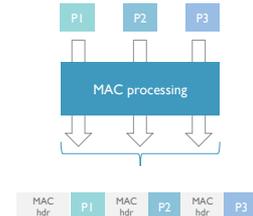
3.

Spatial Streams



4.

Aggregation



Evolution of Wi-Fi from 1999 until 2013 (Wi-Fi 5)

Focus on speed

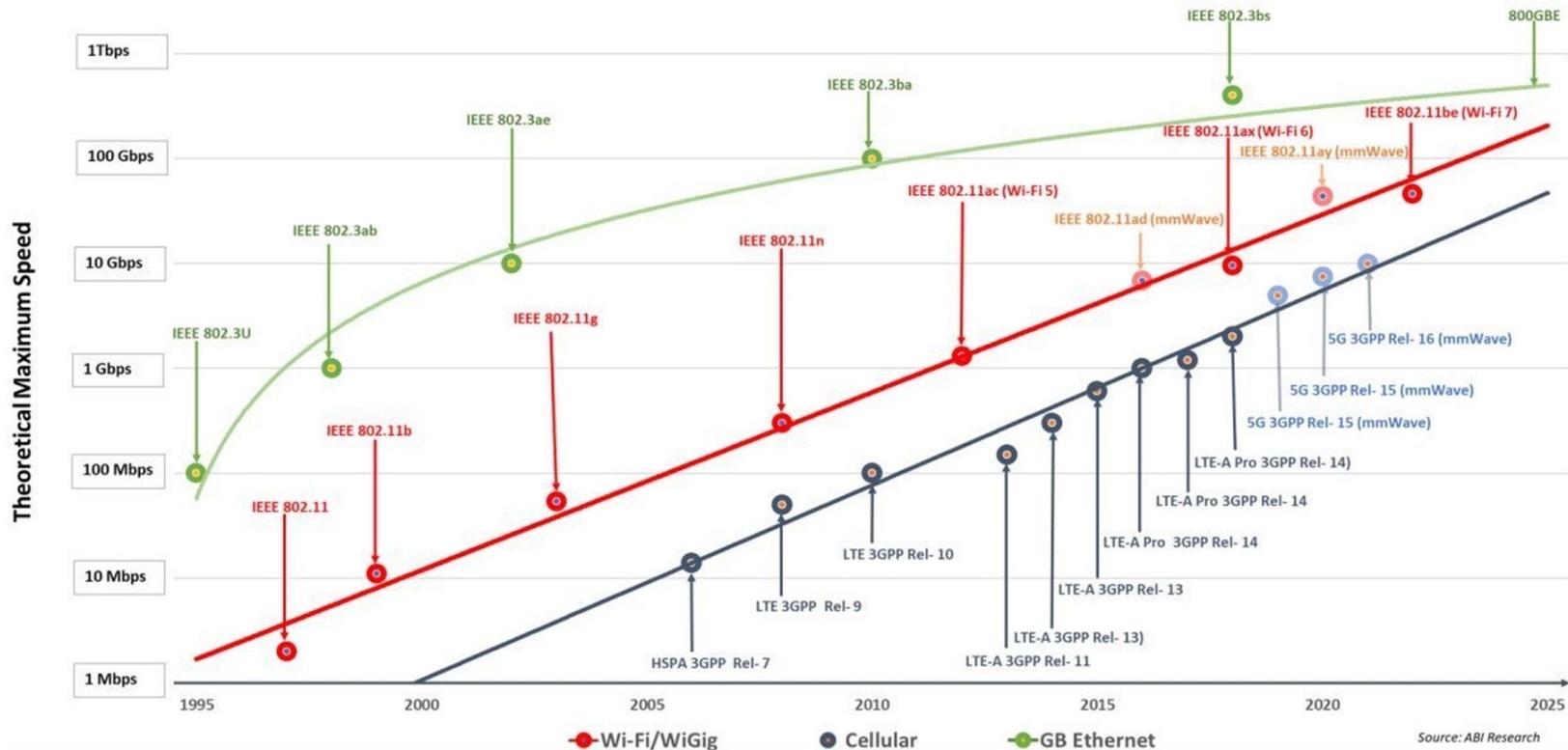
Year	Amendment	RF / Modulation	Channel width	2.4 5 6 GHz	Max. streams	Data rate
1997	802.11 legacy	DSSS, FHSS	20 MHz	✓ X X	1 (SISO)	1-2 Mbps
1999	802.11b	HR-DSSS	20 MHz	✓ X X	1 (SISO)	1-11 Mbps
1999	802.11a	OFDM 64-QAM	20 MHz	X ✓ X	1 (SISO)	6-54 Mbps
2003	802.11g	OFDM 64-QAM	20 MHz	✓ X X	1 (SISO)	6-54 Mbps
2009	802.11n 	OFDM 64-QAM	20/40 MHz	✓ ✓ X	4 (SU-MIMO)	Up to 600 Mbps
2013	802.11ac 	OFDM 256-QAM	20/40/80/ 160MHz or 80+80MHz	X ✓ X	8 (DL MU-MIMO)	Up to 6.93 Gbps

Wi-Fi 6(E) (802.11ax) and beyond

More speed?

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2019	802.11ax 	OFDM(A) 1024-QAM	20/40/80/160 80+80	✓ ✓ ✓	8 (UL/DL MU-MIMO)	Up to 9.60 Gbps
2024	802.11be 	OFDM(A) 4096-QAM	Up to 320MHz	✓ ✓ ✓	16 (UL/DL MU-MIMO)	Up to 40Gbps

Potential of Ethernet, Wi-Fi and cellular



Limited gains for higher spectrum bands

2019

802.11ax



OFDM(A) 1024-QAM

20/40/80/160
80+80



8 (UL/DL MU-
MIMO)

Up to 9.60
Gbps



CONDITIONS

- Short distances
- Multiple antennas at Tx and Rx
- Need for large channels
- Large data frames and aggregation, else large PHY/MAC header overhead
- Little contention



2019

802.11ax



OFDM(A) 1024-QAM

20/40/80/160
80+80



8 (UL/DL MU-
MIMO)

Up to 9.60
Gbps



CONDITIONS THAT ARE RARE!

- Short distances
- Multiple antennas at Tx and Rx
- Need for large channels
- Large data frames and aggregation, else large PHY/MAC header overhead
- Little contention

REALITY

- Contention overhead
- Bulk of frames are small
- Control and management frames consuming lot of airtime
- Dense, co-located access points
- Retransmissions
- Legacy devices



802.11ax or Wi-Fi 6

Paradigm shift: more than just speed

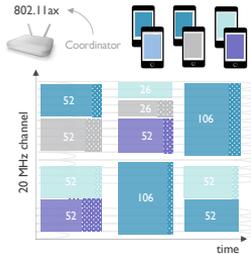
Amendment that defines
modifications to the
PHY and MAC sublayer for
high efficiency operations
in frequency bands between
1 GHz and 6 GHz

Wi-Fi 6

Focus on efficiency – 3 examples

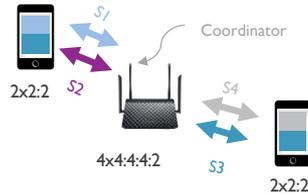
1.

Multi-user support
by means of UL/DL OFDMA



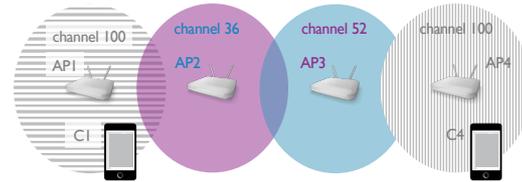
2.

Multi-user support
by means of UL/DL MIMO



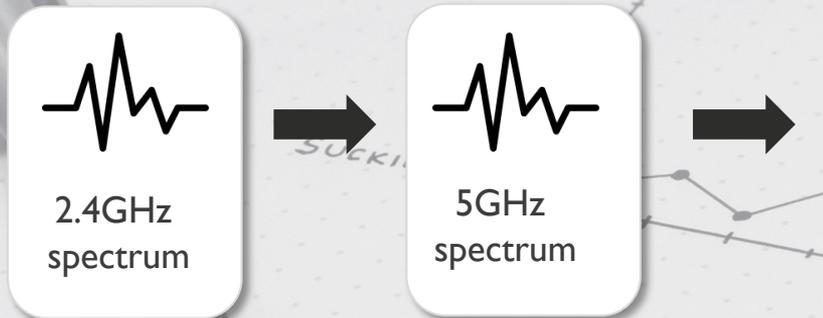
3.

Better spatial reuse
by means of BSS Coloring



Wi-Fi 6E

New deployment options



It's official: EU releases 480 MHz of 6 GHz spectrum to Wi-Fi – finally

June 30, 2021 | Breaking News | by Claus Hetting, Wi-Fi NOW CEO & Chairman



By Claus Hetting, Wi-Fi NOW CEO & Chairman

Europeans should be celebrating today – and not (at least not yet) because of the football: The European Commission today formally released the lower 6 GHz band to Wi-Fi. The decision was formally announced in the Official Journal of the European Union and is now binding for EU member states. At the global level the EU is still far behind the Americas, the Middle East, and parts of Asia in allocating 6 GHz spectrum.

The European Commission today formally released 480 MHz of (low) 6 GHz spectrum to Wi-Fi. **The announcement came in the form of publication of the new rules in the Official Journal of the European Union here.** The decision is binding for all EU member states. This in practice means that every EU member state must update their national frequency allocation plans to reflect the 6 GHz decision before December 1, 2021, sources say.

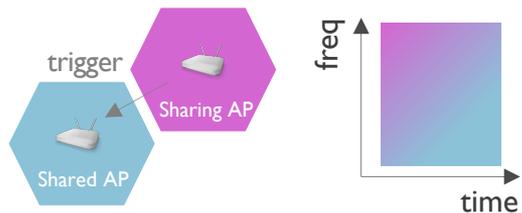
Wi-Fi 7+

Some upcoming features*

* Details of specifications subject to change

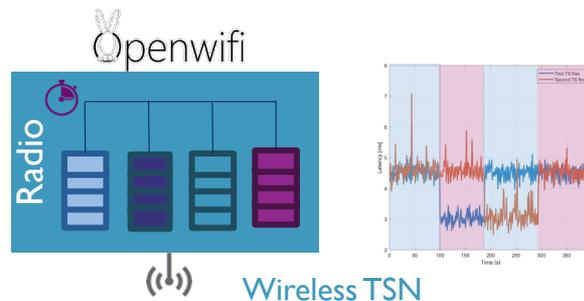
1.

Multi-AP coordination
of OFDMA, spatial reuse, TDMA, beamforming...



2.

Deterministic low latency
Scheduled channel access (TSN), preemption...



Ever increasing data rates

Efficiency & determinism

Opportunities of new 6GHz spectrum

Ever increasing data rates

Ultra-reliable low-latency communication

(local) 5G private networks



Unlicensed LAN

T
S
N



Licensed WAN



Unlicensed
LAN



Scope of deployment

Criticality of
services

End device
availability

Total cost of ownership

Regulation and spectrum

Ease of integration



Licensed
WAN



PNF | panel session

Critical and complementary – setting the record straight on 5G and Wi-Fi

*Experts say private 5G and Wi-Fi 6/7 are not, and never will be,
mutually exclusive, writes James Blackman*



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