The HISTORY and FUTURE of Wi-Fi

HOME AND OFFICE NETWORKS

M2M AND IoT NETWORKS

ROOM AND DESK AREA NETWORKS

VEHICLE NETWORKS

Learn more about IEEE 802.11 testing:
www.rohde-schwarz.com/wlan

WaveLAN, the starting point for Wi-Fi development, was used for wirelessly connecting cashing machines.

802.11 b
Higher speed physical layer extension in the 2.4 GHz band

Spatial streams: 1x1 SISO	Modulation type: CCK
Channel bandwith: 22 MHz	Bands: 2.4 GHz
Transmission/access method: CSMA/DSSS	

Need for faster speed and better distance coverage.

802.11 a
High speed physical layer in the 5 GHz band

Spatial streams: 1x1 SISO	Modulation type: 64QAM
Channel bandwith: 20 MHz	Bands: 5 GHz
Transmission/access method: CSMA/OFDM	

The ability to connect to the internet via mobile devices and the rising number of smart-phones on the market required the introduction of features like MIMO.

802.11 g
Further higher data rate extension

Spatial streams: 1x1 SISO	Modulation type: 64QAM
Channel bandwith: 20 MHz	Bands: 2.4 GHz
Transmission/access method: CSMA/OFDM	

More and more people wanted Wi-Fi at home and at work. High speed Wi-Fi was therefore required in the 5 GHz spectrum to relieve the over-crowded 2.4 GHz spectrum.

802.11 n
Enhancements for higher throughput (HT)

Spatial streams: 4x4 SU-MIMO	Modulation type: 64QAM
Channel bandwith: 40 MHz	Bands: 2.4/5 GHz
Transmission/access method: CSMA/OFDM	

802.11 ac
Enhancements for very high throughput (VHT)

Spatial streams: 8x8 DL-MU-MIMO	Modulation type: 256QAM
Channel bandwith: 160 MHz	Bands: 5 GHz
Transmission/access method: CSMA/OFDM	

Designed for in-room/desk network applications requiring very high data rates such as for HD video streaming.

802.11 ad
Directional multi-gigabit (DMG) in the 60 GHz band

Spatial streams: 1x1 SISO	Modulation type: 64QAM
Channel bandwith: 2.16 MHz	Bands: 60 GHz
Transmission/access method: CSMA/SC	

Achieves up to 20 Gbit/s throughput and enables extended distances for enlarged application space.

802.11 ay
Enhanced DMG (EDMG) in bands above 45 GHz

Spatial streams: 8x8 MU-MIMO	Modulation type: 64QAM
Channel bandwith: 8.64 MHz	Bands: > 45 GHz
Transmission/access method: CSMA/OFDM	

Enables use of the sub GHz spectrum for IoT and remote internet applications.

The heavy use of Wi-Fi meant that a new approach was required. OFDMA allows multiple devices to communicate simultaneously.

802.11 af
Television very high throughput (TVHT)

Spatial streams: 4x4 DL-MU-MIMO	Modulation type: 256QAM
Channel bandwith: 6/7/8 MHz	Bands: sub GHz
Transmission/access method: CSMA/OFDM	

802.11 ah
Sub 1 GHz License exempt

Spatial streams: 4x4 DL-MU-MIMO	Modulation type: 256QAM
Channel bandwith: 1/2/4/8/16 MHz	Bands: sub GHz
Transmission/access method: CSMA/OFDM	

802.11 p
Wireless access in vehicular environments

Spatial streams: 1x1 SISO	Modulation type: 64QAM
Channel bandwith: 10 MHz	Bands: 5.9 GHz
Transmission/access method: CSMA/OFDM	

Provide Wi-Fi based car-to-car communications to enable emerging intelligent traffic services.

Meet today's and tomorrow's rising demands on V2X communications on the way to fully autonomous vehicles.

802.11 bd
Enhancements for next generation vehicular (NGV)

Spatial streams: 2x2 SU-MIMO	Modulation type: 256QAM
Channel bandwith: 10, 20 MHz	Bands: 5.9/60 GHz
Transmission/access method: CSMA/OFDM	

802.11 ax
Enhancement for high efficiency (HE) Wi-Fi

Spatial streams: 8x8 MU-MIMO	Modulation type: 1024QAM
Channel bandwith: 160 MHz	Bands: 2.4/5/6 GHz
Transmission/access method: CSMA/OFDM/OFDMA	

The advent of home office and schooling as well as industrial applications require improved data throughput, reduced latency and efficiency.

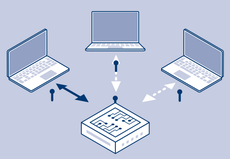
802.11 be
Enhancements for extreme high throughput (EHT)

Spatial streams: 16x16 MU-MIMO	Modulation type: 4096QAM
Channel bandwith: 320 MHz	Bands: 2.4/5/6 GHz
Transmission/access method: CSMA/OFDM/OFDMA	

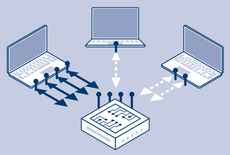
Multi-antenna transceiver methods

The evolution from SISO to single-user and multi-user MIMO was essential to meet data throughput demands.

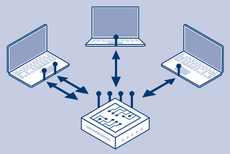
Single input single output (SISO)
Use of a single antenna on access points and devices for sequential communications of the access point with connected devices, applying a carrier sense multiple access (CSMA) scheme to control spectrum access.



Single-user multiple input multiple output (SU-MIMO)
Use of multiple antennas to improve data throughput, applying a carrier sense multiple access (CSMA) scheme to control spectrum access.



Multi-user MIMO
Based on OFDMA, MU-MIMO allows simultaneous communications of stations in parallel. Beamforming enables multiple users to apply individual MIMO schemes at the same time to ensure efficient communi-cations.



Test and measurement solutions from Rohde & Schwarz

R&S®CMW270 wireless connectivity tester
The non-cellular expert designed for testing Wi-Fi access points (AP) and stations (STA) in signaling and non-signaling mode.

R&S®CMW100 communications manufacturing test set
Ultra-compact, non-signaling tester optimized for production line testing including 4G, 5G and Wi-Fi 6 wireless technologies.

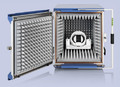
R&S®SMW200A vector signal generator
The fine art of signal generation – supports Wi-Fi modulation at full bandwidth and enables MIMO testing with real-time fading.

R&S®SMBV100B vector signal generator
The new benchmark in its class with up to 500 MHz modulation bandwidth and perfect accuracy even at high output power levels.

R&S®FSW signal and spectrum analyzer
Setting standards in innovation and usability for testing Wi-Fi devices with 800 MHz real-time analysis bandwidth.

R&S®FSVA3000 signal and spectrum analyzer
The right choice for Wi-Fi 6E spectrum and signal analysis in R&D. Supports 400 MHz analysis bandwidth.

R&S®TS8997 regulatory test system for wireless devices
Testing of wireless devices operating in the ISM bands in line with ETSI and FCC standards.



R&S®DST200 RF diagnostic chamber
Ideal environment for RF analysis during development. Supports a wide range of radiated test applications for Wi-Fi devices.

Wi-Fi® is a registered trademark of Wi-Fi Alliance®

ROHDE&SCHWARZ
Make ideas real

PD 3608.6206.62 V01.01