Introduction of Wi-Fi standardization and Interoperability Certification Test

Zhifang Feng
CTTL-Terminals,CAICT
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Course Objectives:

Introduce the Background and Deployment of Wi-Fi Technology. Tell the Main Scheme and Capabilities of Wi-Fi Network .

Take a quick glance of the most famous Global Industry Organization :Wi-Fi Alliance, and Introduce their core works.

Help the Audience quickly build the conception of Wireless Local Access Network;

Agenda

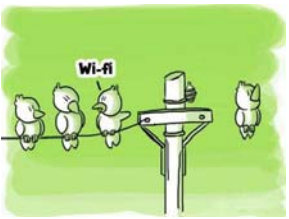
- Wi-Fi Introduction and Standardization Overview
- Wi-Fi Alliance Introduction
- Wi-Fi Interoperability Test Programs Focus

01

Wi-Fi Introduction and Standardization Overview

What is Wi-Fi and Why Wi-Fi?

Wi-Fi is a local area network set up by using radio signal frequency to communicate among computers and other network devices, Liberate Communication from Connected devices to Connected People.



Mobility

Wireless Network user can connect computers anywhere in home, office or Coffee shop and move free in the network converge, without the need for wires.

Flexibility

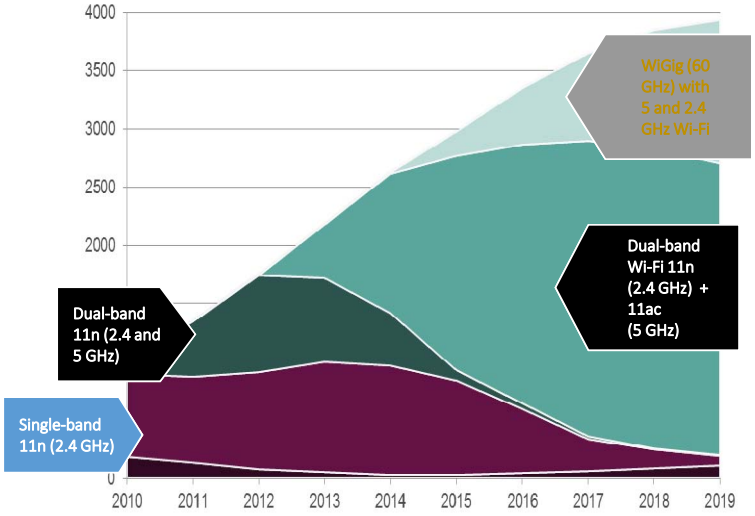
Wireless networks allow users to quickly form a small group networks for a meeting.
Expansion with wireless networks is easy.
Flexibility is the big selling point for the " hot spot" market.

Cost

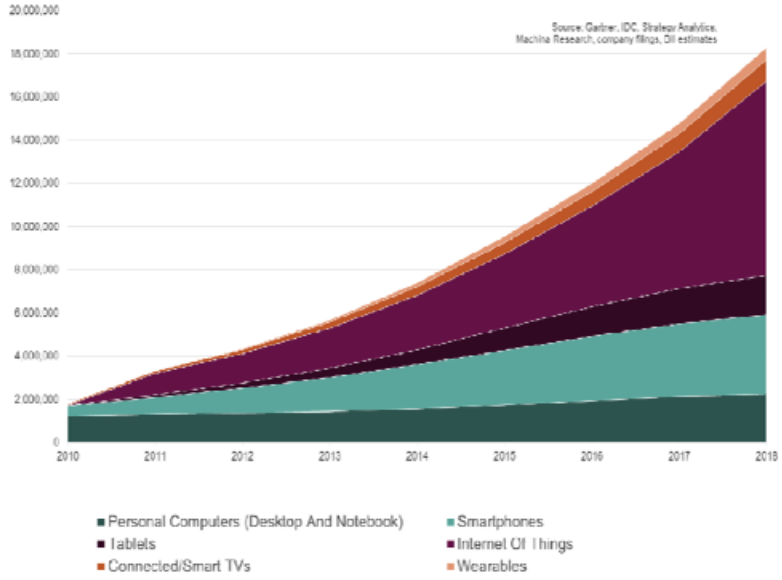
Setting up a wireless bridge network costs can be reduced and the Wi-Fi equipment’s is far more cheaper than the telephone networking system.

Trend of Wi-Fi Product and Industry

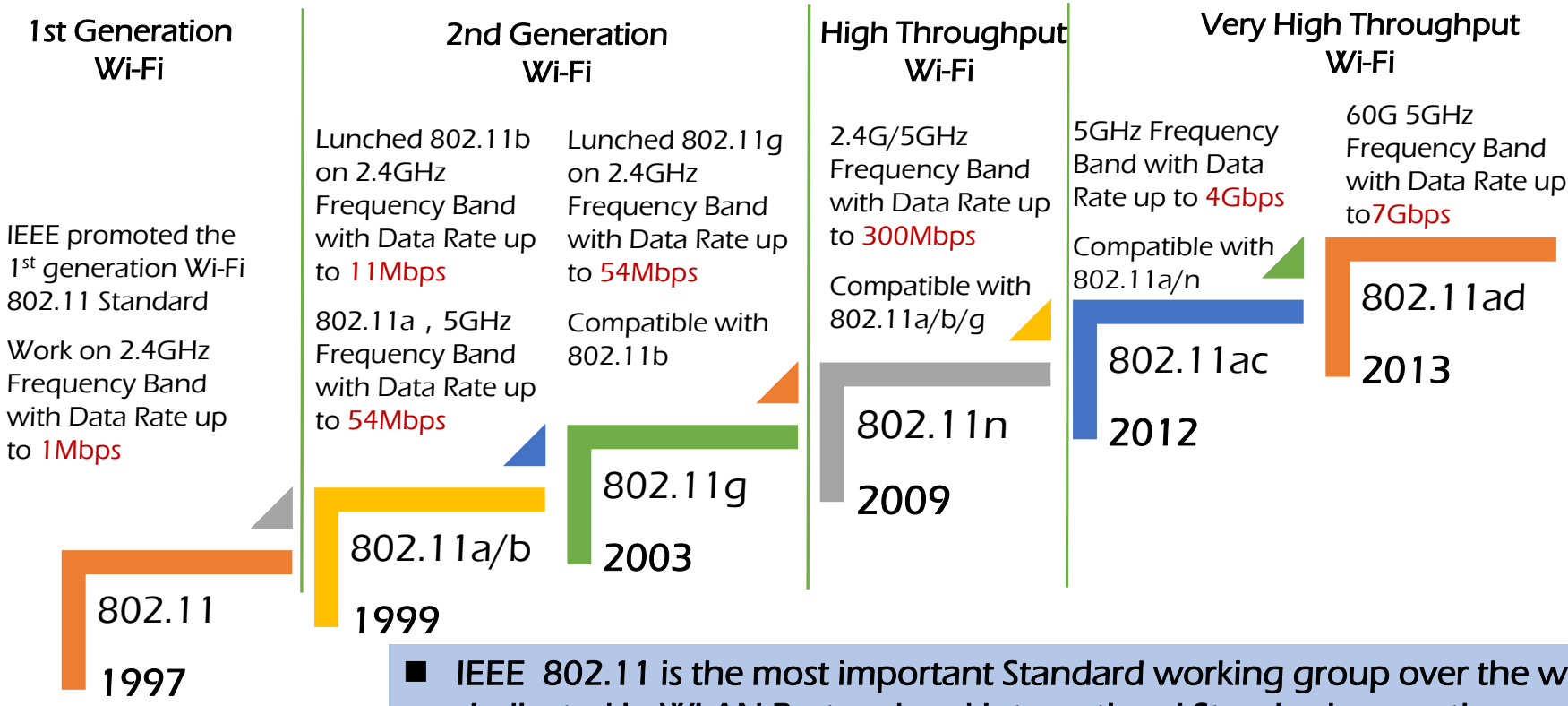
As Expected, Wi-Fi products shipments will be 18 billion in 2018. The world will enter the era of triple frequency in the feature. Wi-Fi products have been deep into all aspects of our work and life.



Global Internet Device Installed Radix Forecast



Wi-Fi Industry and Standardization Overview



- IEEE 802.11 is the most important Standard working group over the world that dedicated in WLAN Protocol and International Standard promotion.

IEEE 802.11 Standards Family Tree

- **Competitive Coverage**

  Currently, WLAN Technology could offer a 30m-100m coverage，which will be available to support indoor wireless communications or public wireless communications with less mobility

- **Simplified Network Topology**

  Wi-Fi Network setting cost is further cheaper than Cellular Networks Since the Simplified Network Topology

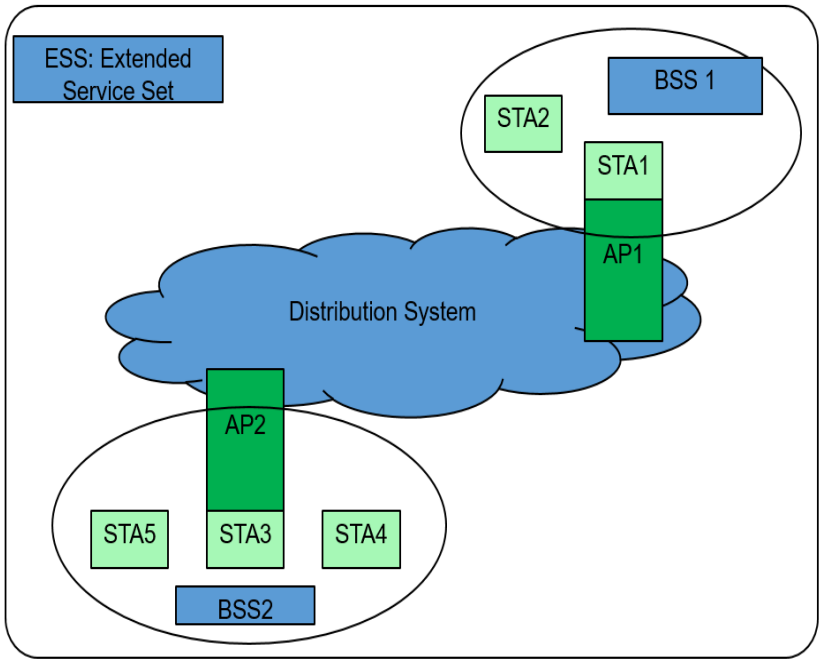
- **Wi-Fi is Allowed to occupy the common frequency bands Resource**

  Wi-Fi get permit to be used in the global common frequency band; Get Bandwidth up to 40MHz in 2.4GHz and 160MHz in 5GHz band.

Standard ID	Description
IEEE802.11a	5GHz Wireless MAC and PHY Layer Specifications
IEEE802.11b	2.4GHz MAC and PHY Layer Specifications
IEEE802.11e	WLAN MAC Quality of Service Enhancements Specification
IEEE802.11g	Further Higher Data Rate Extension in the 2.4 GHz Band
IEEE802.11h	Spectrum and Transmit Power Management Extensions in 5GHz band
IEEE802.11i	WLAN MAC Security Enhancement Specification
IEEE802.11k	Radio Resource Measurement of WLAN
IEEE802.11n	2.4GHz and 5GHz High Speed MAC and PHY Layer Specifications
IEEE802.11p	Wireless Access in Vehicular Environments
IEEE802.11r	Fast Basic Service Set Transition
IEEE802.11ac	Very High Speed 5GHz MAC and PHY Layer Specifications
IEEE802.11ad	Enhancements for Very High Throughout in 60GHz Band
IEEE802.11ax	Next Generation High-Efficiency Very High Throughput WLAN

The Key Components of Wi-Fi Network

Architecture Components	Description
Station (STA)	A device that has implemented standard IEEE 802.1 1 Media Access Control (MAC) and Physical (PHY) layers.
Access Point (AP)	A device that has implemented station's functionalities and provided an interface for other associated wireless stations to access a Distribution System.
Basic Service Set (BSS)	A group of stations managed by a single coordination function.
Distribution System (DS)	A system which connects multiple Basic Service Sets and/or integrates with other networking technologies
Extended Service Set (ESS)	BSSs can create coverage in small offices and homes, but they cannot provide network coverage to larger areas. 802.11 allows wireless networks of arbitrarily large size to be created by linking BSSs into an extended service set (ESS). An ESS is created by chaining BSSs together with a backbone network.



Wi-Fi the Core MAC Scheme

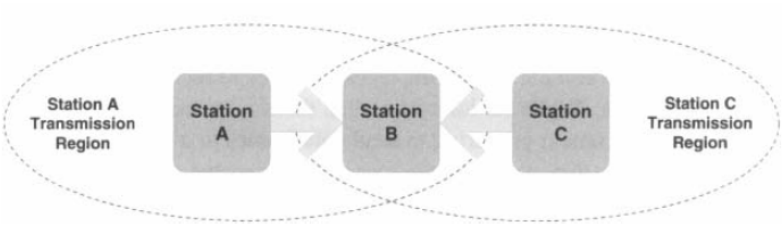
Wi-Fi superficially similar to Ethernet, but there is a additional background we need to know how Wi-Fi adapts traditional Ethernet technology to a wireless world.

To account for the differences between wired networks and the wireless media used by Wi-Fi , a number of additional management features were added. At the heart of Wi-Fi is the media access control (MAC).

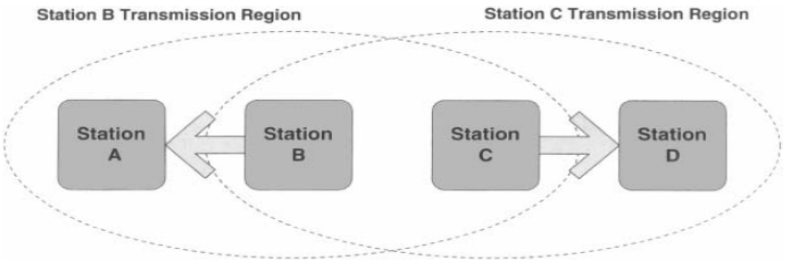
Wireless network cards are assigned 48-bit MAC addresses, which will offer a interface between TCP/UDP service and the wireless RF interface that it could works like Ethernet network cards.

Wi-Fi standard successfully adapts Ethernet-style networking to radio links. Like Ethernet, Wi-Fi uses a carrier sense multiple access (CSMA) scheme to control access to the transmission medium.

However, collisions waste the valuable transmission capacity, Especially for a wireless PHY. So rather than the collision detection (CSMA/CD) employed by Ethernet, Wi-Fi uses collision avoidance (CSMA/CA) scheme.



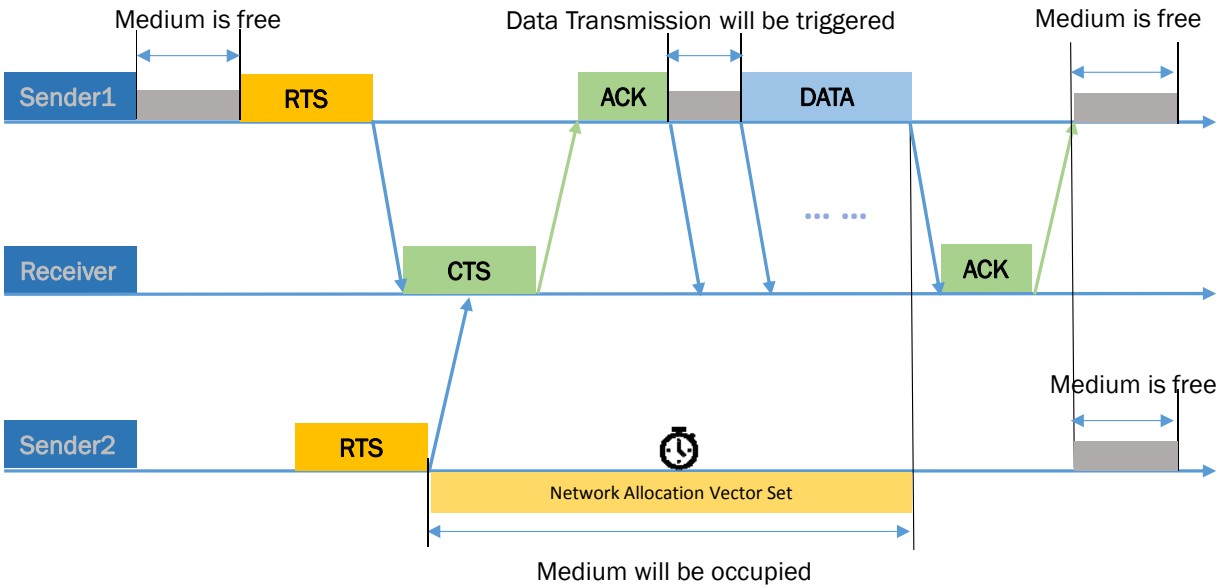
Hidden Terminal Problem



Exposed Terminal Problem

CSMA/CA focus on Hidden/ Exposed Terminal Problems

Wi-Fi MAC CSMA/CA Scheme



- CSMA/CA RTS & CTS Control Frames to manage the Wi-Fi medium resource;
- RTS is sent by Transmitter applied Wi-Fi Data transmission time slot, and CTS is design to access the application, and offer a permitted transmit duration information;
- During the transmission time slot, other senders should held and wait until the wireless medium is free. The transmitter must update its Network Allocation Vector (NAV) and waiting until the NAV is cleared.

Wi-Fi Protocol Frame Type

- 802.11 frames type
  - ✓Control Frame

    Control frames are used to perform area clearing, channel acquisition and maintenance functions, as well as positive acknowledgment of received data.
  - ✓Management Frame

    Management frames are used to establish or maintain a Wi-Fi Communication.
  - ✓Data Frame

    Data frame is used to packing and carry the workload information.

Type Value b3 b2	Type Description	Subtype Value b7 b6 b5 b4	Subtype Description
00	Management	0000	Association Request
00	Management	0001	Association Response
00	Management	0010	Reassociation Request
00	Management	0011	Reassociation Response
00	Management	0100	Probe Request
00	Management	0101	Probe Response
00	Management	0110-0111	Reserved
00	Management	1000	Beacon
00	Management	1001	ATIM
00	Management	1010	Disassociation
00	Management	1011	Authentication
00	Management	1100	Deauthentication
00	Management	1101-1111	Reserved
01	Control	0000-1001	Reserved
01	Control	1010	PS-Poll
01	Control	1011	RTS
01	Control	1100	CTS
01	Control	1101	ACK
01	Control	1110	CF End
01	Control	1111	CF End + CF-ACK
10	Data	0000	Data
10	Data	0001	Data + CF-Ack
10	Data	0010	Data + CF-Poll
10	Data	0011	Data + CF-Ack + CF-Poll
10	Data	0100	Null Function (no data)
10	Data	0101	CF-Ack (no data)
10	Data	0110	CF-Poll (no data)
10	Data	0111	CF-Ack + CF-Poll (no data)
10	Data	1000-1111	Reserved
11	Reserved	0000-1111	Reserved

Wi-Fi Protocol Frame Type-Control Frame

- Request to Send (RTS) frame: A station may need send a RTS frame to another station to apply for the wireless medium occupation before sending a data frame.

- Clear to Send (CTS) frame: A station responds to with a CTS frame, providing clearance for the requesting station to send a data frame. The CTS includes a time value that causes all other stations (including hidden stations) to hold off transmission of frames for a time period waiting the requesting station to send its frame.

- Acknowledgement (ACK) frame: After receiving a data frame, the receiving station will utilize an error checking processes to detect the presence of received data errors. The receiving station will send an ACK frame to the sending station if no errors are found.

Wi-Fi Protocol Frame Type-Management Frame

- Beacon frame: The access point periodically sends a beacon frame to announce its presence and relay information, such as timestamp, SSID, and other parameters to STA that are within range.
- Probe request frame: A station sends a probe request frame when it needs to obtain information from another station.
- Probe response frame: A station will respond with a probe response frame, containing capability information, supported data rates, etc., when after it receives a probe request frame.
- Authentication frame: 802.11 authentication is a process whereby the access point either accepts or rejects the identity of a STA.
- De-authentication frame: A station sends a de-authentication frame to another station if it wishes to terminate secure communications.
- Association（ Re-association ） request frame: 802.11 association enables the access point to allocate resources for and synchronize with STA.
- Association （ Re-association ） response frame: An access point sends an association response frame containing an acceptance or rejection notice to the STA requesting association.
- Disassociation frame: A station sends a disassociation frame to another station if it wishes to terminate the association.

02

Wi-Fi Alliance Introduction

Background of the Wi-Fi Alliance

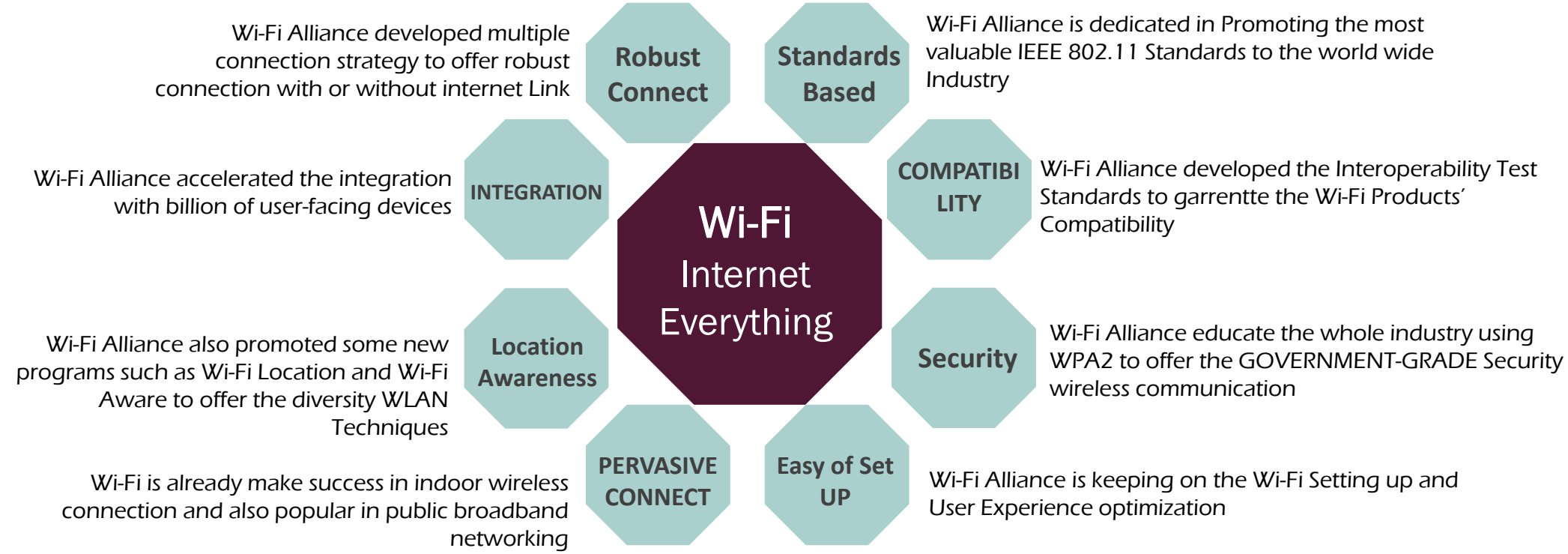
Established in 1999, The Most popular industry Organization dedicated in IEEE 802.11 Technology Promotion

Guarantee the Interoperability and Compatibility of varied Wi-Fi products. Certification Programs Accepted by Retailers, Operators, Enterprise IT Managers and customers

More than 650 member companies in the world, and More than 25,000 Wi-Fi certified products in the world

Build Technic Task Groups by itself to improve the Wi-Fi User Experience. More than 20 different technical working groups

Today's Wi-Fi Alliance



Wi-Fi Alliance Released Programs

New PHY

- Wi-Fi Certified a/b/g/n
- Wi-Fi Direct
- Wi-Fi Certified ac
- WiGig

Security

- WPA2
- Protected Management Frames(PMF)

Network Access

- Passpoint R2
- WPS 2.0
- IBSS

New Service:

- Miracast
- Direct Service
- Voice-Enterprise
- Voice-Personal
- Wi-Fi Aware

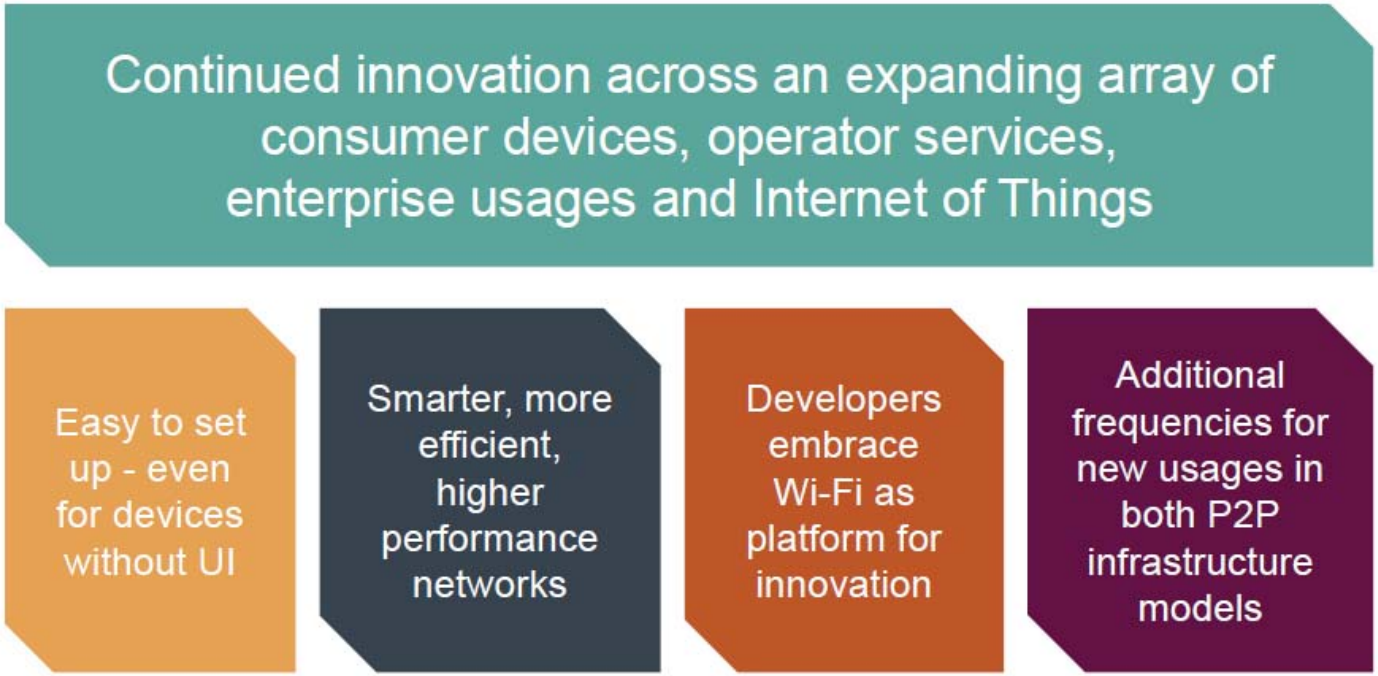
Optimizing & Managing Network

- WMM
- WMM-PS
- WMM-AC
- TDLS

RF and Coexistence

- CWG

Wi-Fi Roadmap at a glance



03

Wi-Fi Interoperability Test Programs

Wi-Fi Interoperability Test Programs Focus

Wi-Fi Alliance Released Test Programs

Wi-Fi Alliance have released about 20 certification programs during the past 17 years. And more than 25,000 products be certified. All of the certified products have to meet the referred Interoperability、Security and Performance requirement through the Wi-Fi Alliance Test Plan.

01

Interoperability

The most key point of Wi-Fi Testing program is interoperability, Compatibility for the Long-lived Legacy Products

02

Security

Wi-Fi Testing will check all the product to make sure they can support WPA2 as the Mandatory encryption Strategy

03

Performance

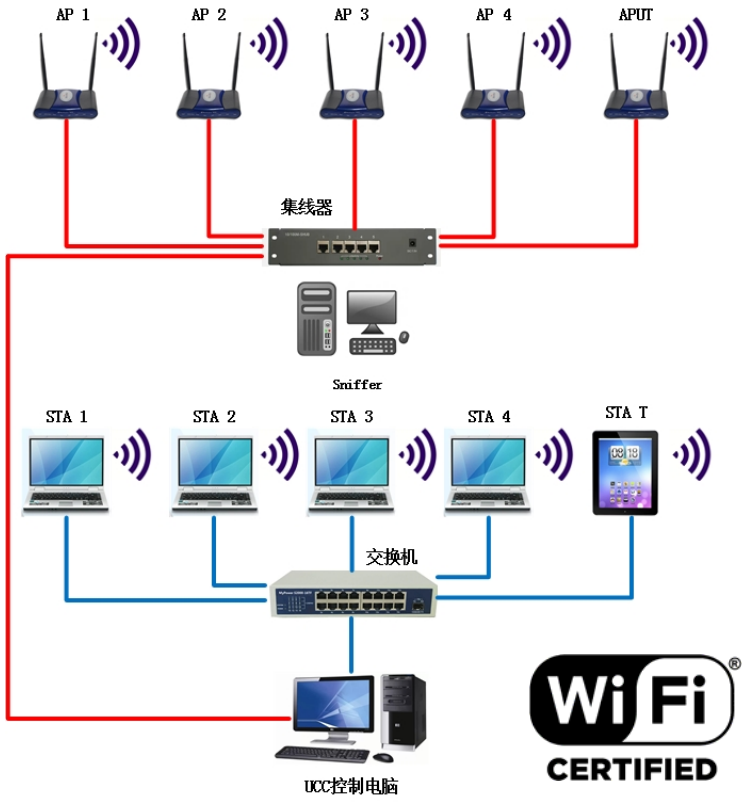
Throughput, the most important Wi-Fi Performance Character is also one of the Key point of Wi-Fi Testing

Wi-Fi CERTIFIED 11n

Wi-Fi CERTIFIED 11n is released in 2009，following IEEE 802.11n standard and emphasized the interoperability requirement.

◘ Test Items：

- Device interoperability with varied Golden Samples from the world wide most popular chipset manufactures
- Device interoperability with old designed legacy products,(include in 802.11a/b/g Legacy devices)
- Device 802.11n Protocol and Feature compliance
- Device Wireless Multimedia and QoS compliance
- Device WPA2 Encryption and Decryption compliance
- Device 802.11a/b/g/n Wireless Throughput and Performance compliance



IEEE802.11a/b/g ，Modulation Scheme

Legacy Mode	Band (MHz)	Modulation	Speed (Mbps)
802.11b	2400 - 2483.5 (ISM)	BPSK/Barker QPSK/Barker QPSK/CCK(4-bit, 8-bit)	1 2 5.5,11
802.11g	2400 - 2483.5 (ISM)	CCK/Barker OFDM *PBCC*	1,2,5.5,11 6,9,12,18,24,36,48,54 *5.5,11,22,33*
802.11a	5725 - 5850	OFDM	6,9,12,18,24,36,48,54

Wi-Fi CERTIFIED 11n Modulation Scheme

MCS	Modulation	Coding rate	Spatial Stream	802.11n data rate			
				20MHz		40MHz	
				Full GI	Short GI	Full GI	Short GI
0	BPSK	1/2	1	6.5	7.2	13.5	15
1	QPSK	1/2	1	13	14.4	27	30
2	QPSK	3/4	1	19.5	21.7	40.5	45
3	16-QAM	1/2	1	26	28.9	54	60
4	16-QAM	3/4	1	39	43.3	81	90
5	64-QAM	2/3	1	52	57.8	108	120
6	64-QAM	3/4	1	58.5	65	122	135
7	64-QAM	5/6	1	65	72.2	135	150
8	BPSK	1/2	2	13	14.4	27	30
9	QPSK	1/2	2	26	28.9	54	60
10	QPSK	3/4	2	39	43.3	81	90
11	16-QAM	1/2	2	52	57.8	108	120
12	16-QAM	3/4	2	78	86.7	162	180
13	64-QAM	2/3	2	104	116	216	240
14	64-QAM	3/4	2	117	130	243	270
15	64-QAM	5/6	2	130	144	270	300

Wi-Fi CERTIFIED ac

2013 Released the First Version，2016 Released wave 2.

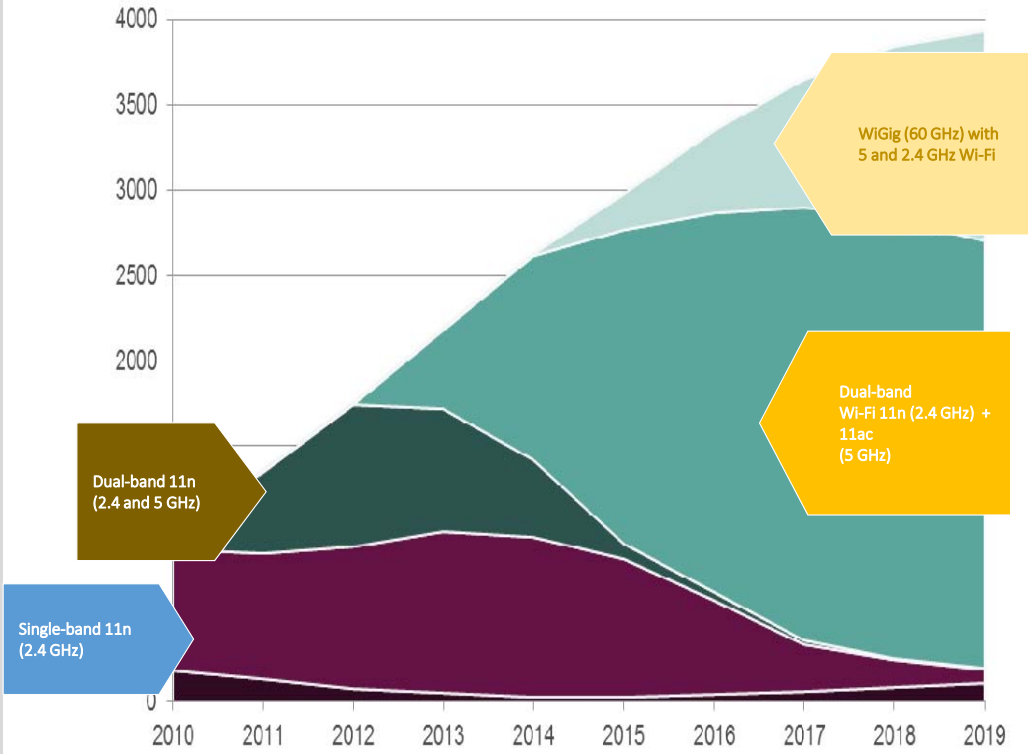
□Advantage：

- Stream up to three lightly compressed HD video streams, rapidly synch large files, and connect for demanding applications at gigabit data rates

- Wi-Fi CERTIFIED ac technology builds on Wi-Fi CERTIFIED n and interoperates with legacy 5 GHz Band devices
- Dual-band (2.4 and 5 GHz Band) networking products are expected to be very widespread, keeping legacy devices connected

□Trend of development：

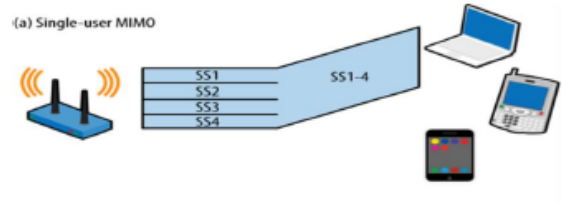
- More than 2000 Product pass Wi-Fi Alliance certification.
- As Wi-Fi Alliance predict, in 2019 Most Wi-Fi product will support Dual band and 802.11ac will be widely used

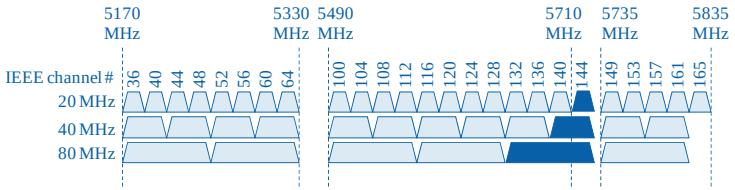


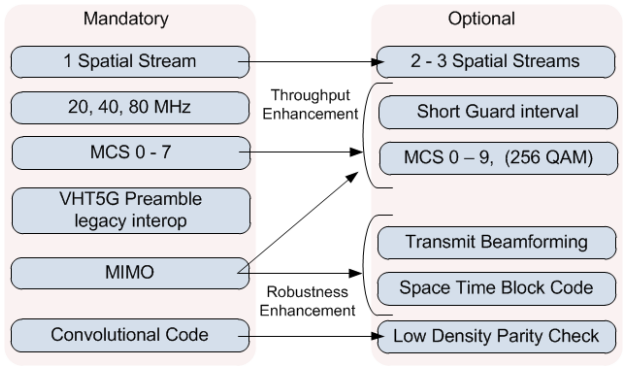
Wi-Fi CERTIFIED ac Evolution 1

- VHT Wave 1 : 2013 Released

- Supporting TX-3SS and RX-2SS space stream
- Support Maximum 80MHz Network bandwidth
- Use highest to QAM-256 modulation，the codec rate and data rate is improved
- Improve the MAC Layer MPDU package encapsulation capability to (2^20)-1bit，improved the package loading ratio
- The highest transmission rate up to1.3Gbps
- MU-MIMO and Beam forming strategy have not be used
- Keeping the interoperability in 5GHz band with 802.11n designed legacy devices



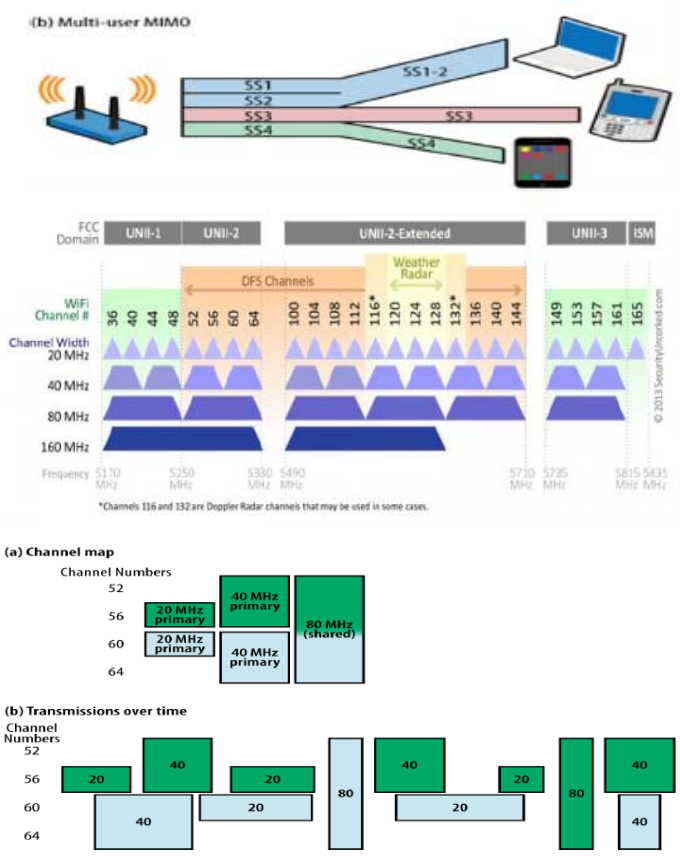




Wi-Fi CERTIFIED ac Evolution 2

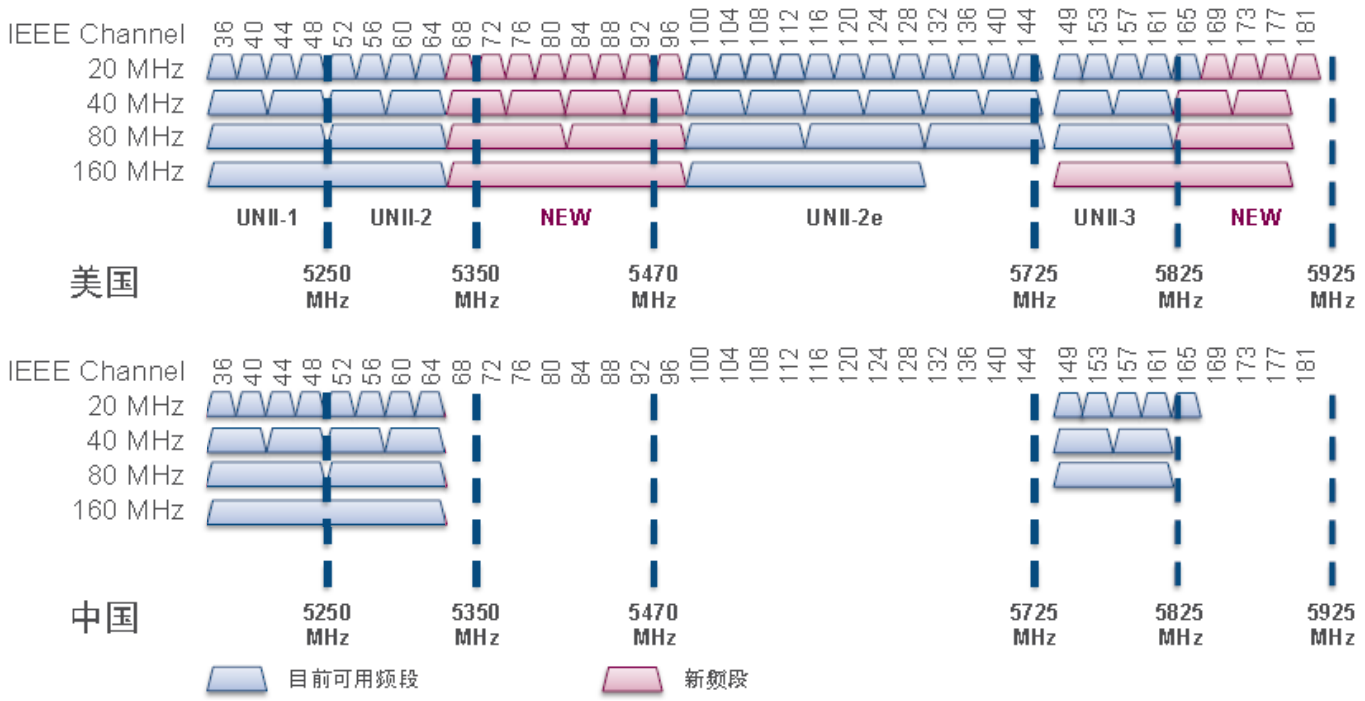
VHT Wave 2：2016 Released

- **MU-MIMO DL**: Assist AP relieve the Down Link inter BSS interference to improve service capable clients account
- **Rx-4SS**: Able to support 4Rx space streams to improve 802.11ac product's receive volume
- **Extended Channel**: Extend ：Channel 64, 100, 140, 149, 165. to be able to use for Wi-Fi 802.11ac
- **160MHz Channel**: Able to support 160MHz Band，the 802.11ac product throughput capability reach to 3Gbps. Currently, there are 2 authorized 160MHz band in U.S.A region and one 160MHz band in mainland China
- **RTS with Bandwidth Signaling**: Add RTS manage scheme, assist to solve 80MHz and 160MHz communication process collision risk



Wi-Fi CERTIFIED ac Available frequency band

CHINA/U.S.A Available 802.11ac Frequency Band



Wi-Fi CERTIFIED Programs for carrier Networks

Wi-Fi Vantage

Mobility

Steering and transition mechanisms for seamless user experience:

- Accessing networks
- Inter-network roaming
- Transitioning to and from Wi-Fi to cellular networks

Technologies:

Wi-Fi Agile Multiband
Wi-Fi Optimized Connectivity

Manageability

Better network intelligence and:

- Resource allocation
- Provisioning
- Authentication
- Intra-network roaming

Technologies:

Wi-Fi Agile Multiband
Wi-Fi Optimized Connectivity
Passpoint

Performance

High level performance in dense environments:

- MU-MIMO
- Higher data rates
- Dual-band capability

Technologies:

Wi-Fi CERTIFIED ac

CAICT WLAN Standards Contributions

2005

The first Wi-Fi Alliance authorized laboratory in China
Participate in the development of 802.11abg CWG standards

2006

Complete the Wi-Fi Alliance 802.11abg CWG standard
The Global first authorized CWG ATL by Wi-Fi Alliance and CTIA

2009

Established YDC_079-2009 Standards. Becoming the first WLAN Chinese network test laboratory. Completed YD/T 1977, YD/T1978, YD/T 1484 Standard. Specification Chana WLAN OTA detection.

2011

Participate in the development of China’ s National Standard Wireless Local Area Network Test Specification

2012

promote Wi-Fi Alliance 802.11n CWG Standard. Research the Wi-Fi test mode standardization
Participate in the promotion of Wi-Fi RF and protocol conformance standards.
Participate in the promotion of Public Wireless Local Area Network System Standard

2013

Continue Wi-Fi Alliance 802.11n CWG Standard promotion work
Continue Wi-Fi RF and protocol conformance standards promotion work
Follow SmartGrid、60GHz、VHT、Passpoint and other Wi-Fi Alliance standardization work

CAICT Wi-Fi Certification Capabilities

CAICT Have the vast majority of Wi-Fi Alliance announced certification test

2005

1st Wi-Fi Alliance ATL in China

2006

1st Global Wi-Fi Alliance CWG ATL

2012

1st Wi-Fi Miracast Qualified ATL in China

2014

1st Wi-Fi TDLS Qualified ATL in China

2015

1st Wi-Fi Aware Qualified ATL in China

2017

1st Wi-Fi Location Qualified ATL in China

Trainer Information

Trainer: FENG ZHIFANG

E-mail: fengzhifang@caict.ac.cn

Department: CTTL-Terminals

Address: No.52 Huayuanbei Road,
Haidian District, Beijing, China, 100191

Thank You !

中国信息通信研究院 http://www.caict.ac.cn