Wi-Fi 6E and 6 GHz Update

11 March 2021

Introduction

Kevin Robinson
Senior Vice President, Marketing

Agenda

	Topic	Presenter	Start Time PST	Length (min)
1	Introduction	Robinson	9.00	5
2	Regulatory Update	Roytblat	9.05	25
3	Wi-Fi 6E update	Sargologos	9.30	25
4	WBA Wi-Fi 6E trials	Rodrigues	9.55	30
5	Closing	Robinson	10.25	5

Regulatory update

Alex Roytblat
Vice President, Worldwide Regulatory Affairs

6 GHz and Wi-Fi 6E Update - Outline

- Regulatory status of 6 GHz
- Regulatory conditions in 6 GHz
- Regulatory certification of 6 GHz devices

Regulatory status of 6 GHz

Policymakers are recognizing

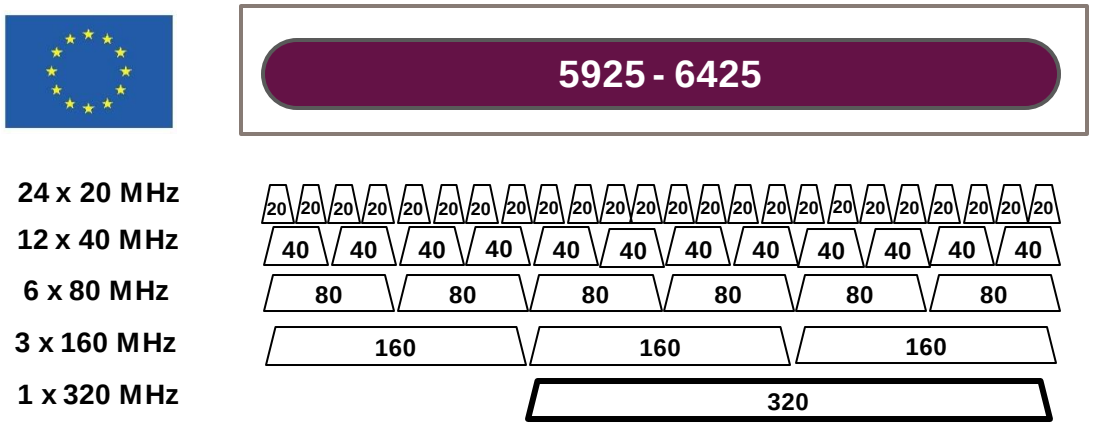
the growing importance of Wi-Fi

to national telecom infrastructure

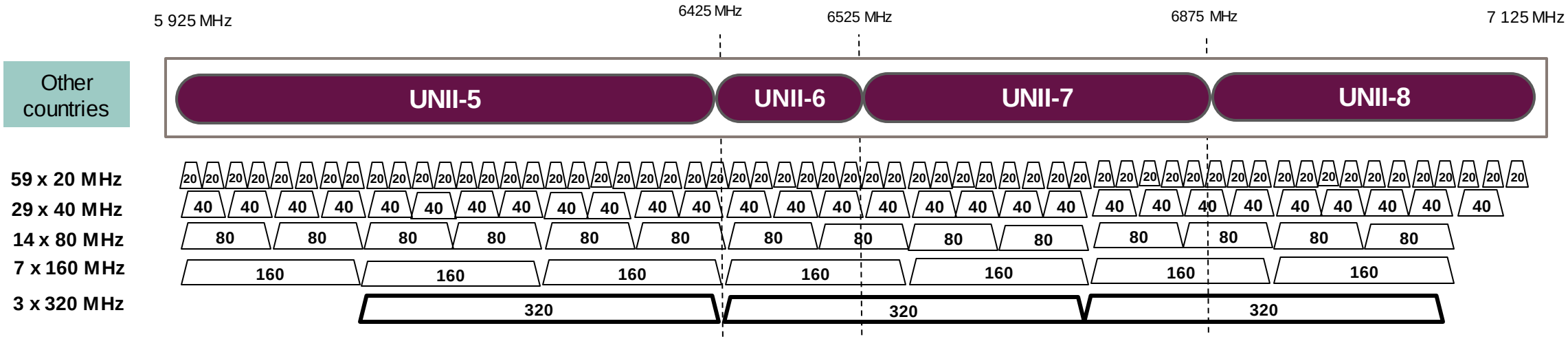
Administrations are opening 6 GHz

for license-exempt access

6 GHz spectrum access approaches



- Dynamic random spectrum access and contention-based protocols require access to **multiple channels** to maintain acceptable performance
- **IEEE 802.11be** designed for Extremely High Throughput: channel bandwidth of up to 320 MHz



Administrations enabling RLANs in 6 GHz

1200 MHz vs. 500 MHz

EMEA

- European Union
- Jordan
- Saudi Arabia
- United Arab Emirates
- United Kingdom

Asia Pacific

- Japan
- South Korea

Americas

- Argentina
- Brazil
- Canada
- Chile
- Colombia
- Costa Rica
- Honduras
- Mexico
- Peru
- United States

Many more expected in 2021

Regulatory condition in 6 GHz

Regulatory framework for protecting 6 GHz incumbents

- **Regulators' objective:** expand utilization of 6 GHz band without disrupting incumbent services
- 6 GHz incumbents largely "harmonized" worldwide
  - Fixed satellite service (FSS) Earth-to-space uplinks
  - Point-to-point fixed service (FS) links
- **Method:** limit RLAN's signal energy at incumbent receivers

Regulatory framework for protecting 6 GHz incumbents

- **Regulators converging on regulatory framework:** based on three regulatory-classifications for 6 GHz RLAN devices:

1. **Very Low Power (VLP) devices**: minimal signal power

2. **Low Power Indoor-only (LPI) devices**: low-power and building structure attenuation

3. **Standard Power devices**:
   - To protect Fixed Service: require automated frequency coordination, RLANs avoid frequency overlap with fixed service; implementation requires open access to FS licensing database
   - To protect FSS (on-orbit receivers): limit transmit power at 30 deg. elevation angle

Technical condition for 6 GHz Very Low Power (VLP) device

	US (proposed)	Europe (adopted)	South Korea (adopted)	Brazil (adopted)
Frequency band	5.925-7.125 GHz	5.945-6.425 GHz	5.925-6.425 GHz	5.925-7.125 GHz
Channel access and occupation rules	contention-based	contention-based	contention-based	contention-based
Maximum AP e.i.r.p.	14 dBm	14 dBm	14 dBm	17 dBm
Maximum AP e.i.r.p. density	-8 dBm/MHz Industry ask: 1 dBm/MHz	1 dBm/MHz 10 dBm/MHz for narrowband	<20 MHz: 1 dBm/MHz <40 MHz: -2 dBm/MHz <80 MHz: -5 dBm/MHz <160 MHz: -8 dBm/MHz	-8 dBm/MHz
OOBE limit	-27 dBm/MHz below 5925 MHz	-45 dBm/MHz (-37 dBm/MHz in 2025) below 5935 MHz	-27 dBm/MHz below 5925 MHz	-27 dBm/MHz below 5925 MHz

Technical condition for 6 GHz Low Power Indoor-only (LPI) device

	US (adopted)	Europe (adopted)	South Korea (adopted)	Brazil (adopted)
Frequency band	5.925-7.125 GHz	5.945-6.425 GHz	5.925-7.125 GHz	5.925-7.125 GHz
Channel access and occupation rules	contention-based	contention-based	contention-based	contention-based
Maximum AP e.i.r.p.	30 dBm	23 dBm		30 dBm
Maximum AP e.i.r.p. density	5 dBm/MHz proposed 8 dBm/MHz	10 dBm/MHz	2 dBm/MHz	5 dBm/MHz
Maximum Client e.i.r.p.	24 dBm/MHz			24 dBm/MHz
Maximum Client e.i.r.p. density	-1 dBm/MHz			-1 dBm/MHz
OOBE limit	-27 dBm/MHz below 5925 MHz	-22 dBm/MHz below 5935 MHz	-27 dBm/MHz below 5925 MHz	-27 dBm/MHz below 5925 MHz

Technical condition for 6 GHz standard power device

	US (adopted)	Europe	South Korea	Brazil
Frequency band	5.925-6.425 GHz 6.525-7.125 GHz	(possible site licensing by national regulators)	TBD	TBD
Channel access and occupation rules	contention-based			
Maximum AP e.i.r.p.	36 dBm			
Maximum AP e.i.r.p. density	23 dBm/MHz			
Maximum Client e.i.r.p.	30 dBm/MHz			
Maximum Client e.i.r.p. density	17 dBm/MHz			
OOBE limit	-27 dBm/MHz below 5925 MHz			
Other constraints	Under AFC control			

Regulatory certification of 6 GHz devices

Regulatory certification of 6 GHz devices

- US certification
  - For LPI FCC OET Knowledge Database
  - For Standard Power – requires FCC approval of AFC system/operator
- European certification
  - 2020 December: approved ECC/DEC/(20)01 "*On the harmonised use of the frequency band 5945-6425 MHz for WAS/RLAN*" – voluntary transposition into national law (up to 2 years)
  - 2020 March: European Commission Radio Spectrum Committee #74--positive opinion
  - 2020 Apr/May: Final EC Decision published in Official Journal of the EU (OJEU)
  - 2020 Q4: Mandatory transposition into national law (within 6 months from publication in OJEU); some countries may proceed faster
- Compliance with ETSI Harmonised Standard EN 303 687

Q&A

Wi-Fi 6E update

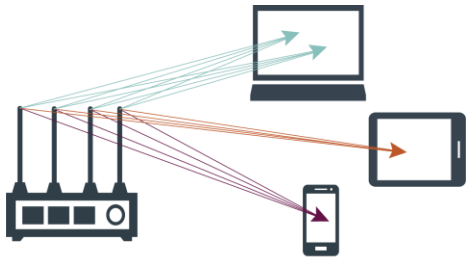
Nick Sargologos, Senior Product Manager

Topics

- Wi-Fi 6E status
- Market impact
- Key benefits
- Products
- Regulatory developments for 6 GHz

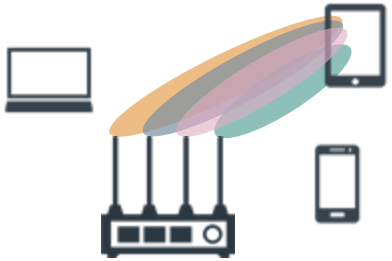
Wi-Fi CERTIFIED 6™ key features

Downlink Multi-User MIMO

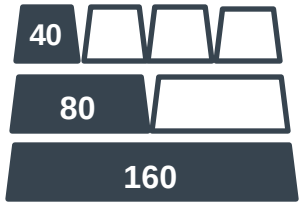


OFDMA

Beamforming



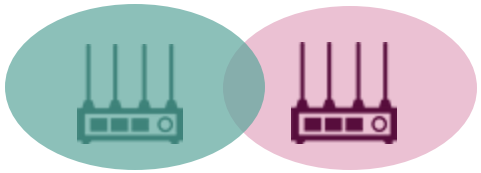
160 MHz Channel Bandwidth



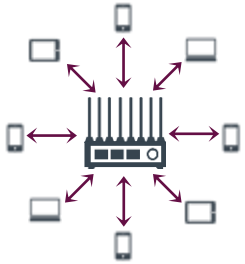
Wi-Fi 6™ CERTIFIED

Target Wake Time

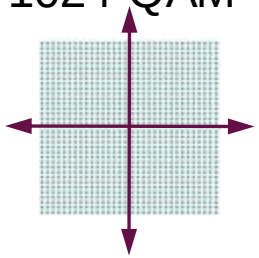
BSS Coloring



8 Spatial Streams



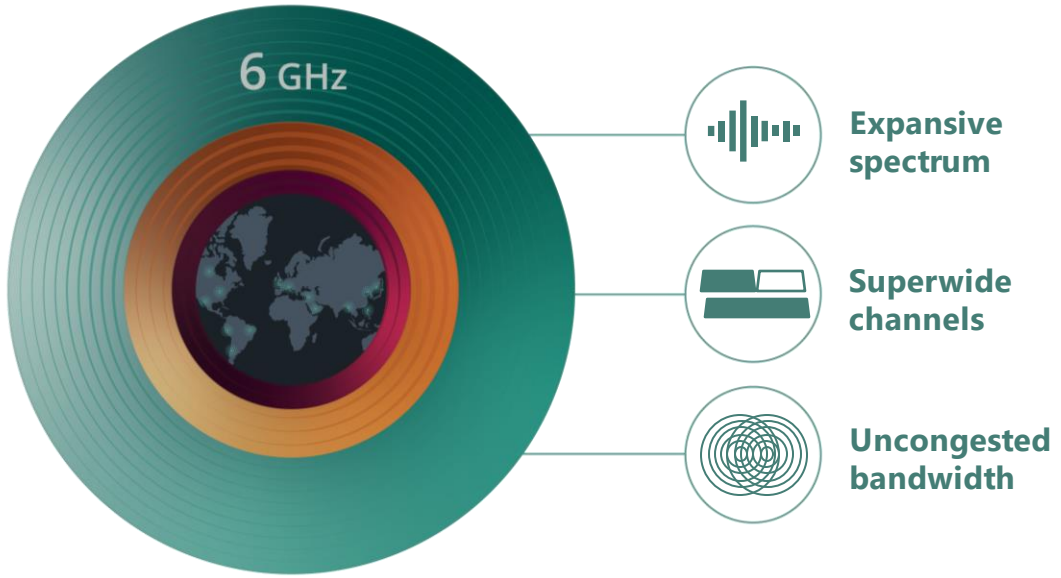
1024-QAM



Wi-Fi 6E extends Wi-Fi CERTIFIED 6™ into 6 GHz

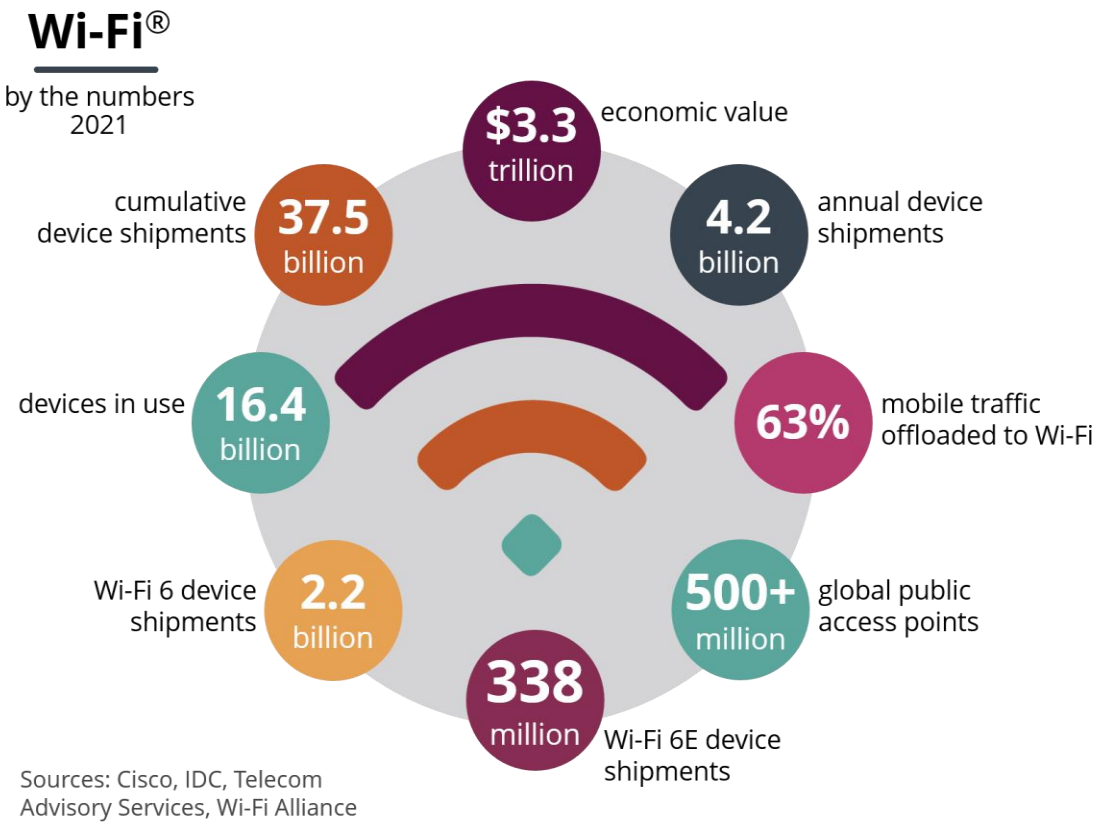
Announced January 2021

- Wi-Fi 6E devices make use of the 6 GHz band
  - Four times more capacity than the 2.5 and 5 GHz bands
  - Seven superwide 160 MHz channels for blazing speeds
  - Lowest latency since Wi-Fi devices in 6 GHz are Wi-Fi 6
- The Wi-Fi CERTIFIED 6 program extends into 6 GHz band to support Wi-Fi 6E devices
  - Wi-Fi 6E is now part of Wi-Fi CERTIFIED 6 certification
- Wi-Fi Alliance® certification drives worldwide interoperability of Wi-Fi 6E devices resulting in a broader ecosystem

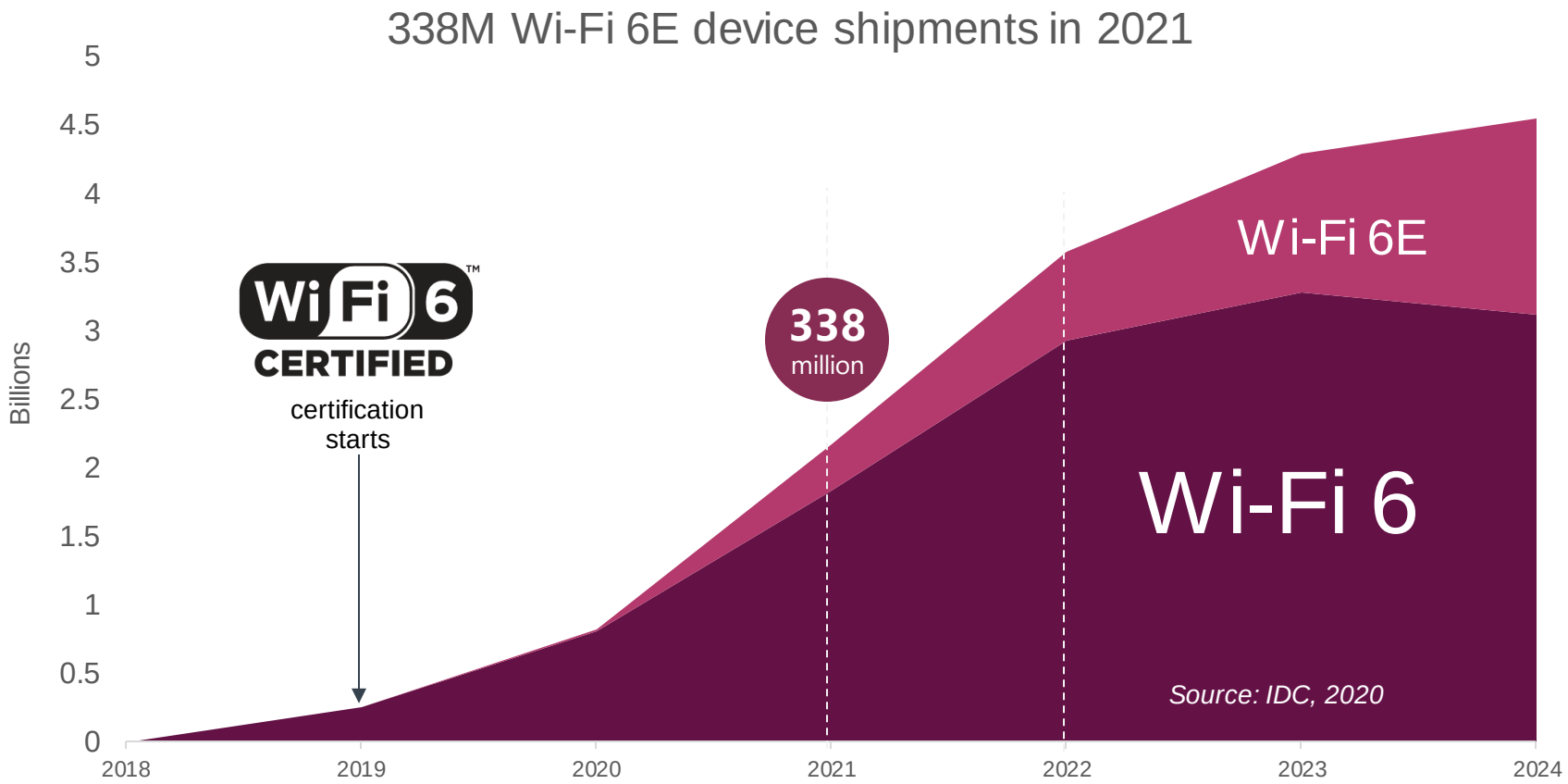


Wi-Fi 6E video

Wi-Fi 6E market impact

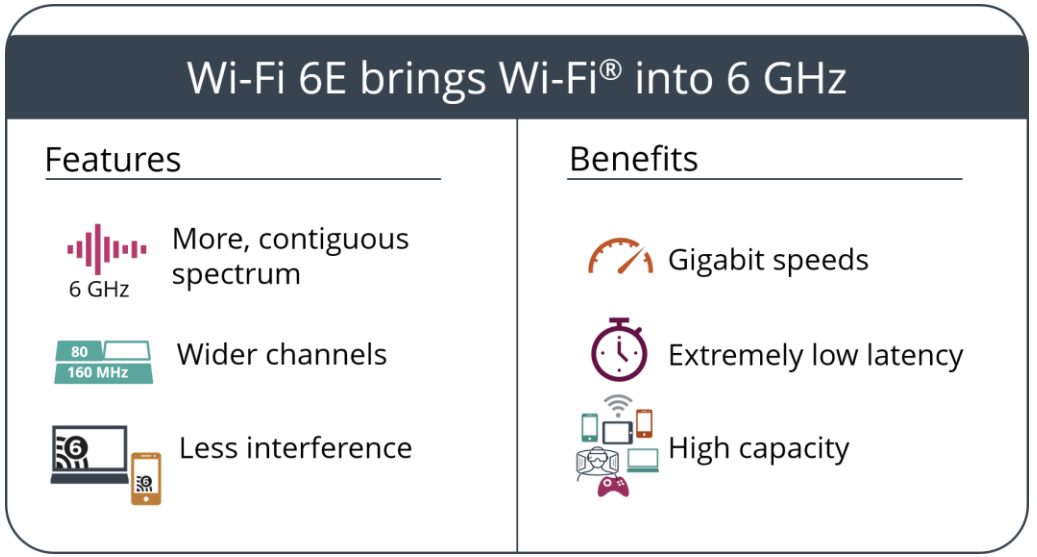


Wi-Fi 6E market impact



Wi-Fi CERTIFIED 6 with Wi-Fi 6E key benefits

- Wi-Fi 6E delivers all the benefits of Wi-Fi CERTIFIED 6, ***plus***
- Provides key performance enabler for Wi-Fi 6: **wider channels**
- Adds 1200 MHz of spectrum, a 3X increase over combined spectrum available in 2.4 and 5 GHz bands
- Offers up to seven superwide 160 MHz channels to support demanding applications that require high throughput and low latency
- Frees Wi-Fi 6E networks from overhead and traffic from legacy devices, enabling a higher baseline performance than the 2.4 GHz and 5 GHz bands



Wi-Fi® capabilities by frequency band

- The key to unlocking the highest performance of Wi-Fi is *wider* channels
- The key to reducing latency is *lower* overhead

	2.4 GHz	5 GHz	6 GHz	Advantages of Wi-Fi 6 in 6 GHz
Wi-Fi standards supported in band	Wi-Fi 6 Wi-Fi 5 Wi-Fi 4 802.11g 802.11b	Wi-Fi 6 Wi-Fi 5 Wi-Fi 4 802.11a	Wi-Fi 6	• Vastly greater spectrum • Reduced congestion & overhead • Lower latency • Enables full performance of Wi-Fi 6
Channel width / number available	20 MHz – 14 40 MHz – 2	20 MHz – 25 (9)* 40 MHz – 12 (4)* 80 MHz – 6 (2)* 160 MHz – 2 (0)*	20 MHz – 59 40 MHz – 29 80 MHz – 14 160 MHz – 7	• Vastly greater number of channels • Significantly more wide channels
AP discovery	In band only	In band only	Both in-band and out of band	• Faster AP discovery

* Number of channels not subject to DFS restrictions in 5 GHz

Wi-Fi 6E interest

- Chipsets now shipping, such as:
  - Broadcom BCM4389
  - Qualcomm Networking Pro 1210 Platform
  - Intel
  - MediaTek
- Seven of twelve Wi-Fi 6 routers announced at CES 2021 are Wi-Fi 6E, including:
  - Linksys AXE8400
  - TP-Link Archer AX206
  - Netgear Nighthawk® Tri-Band WiFi 6E Router
  - Asus ROG Rapture GT-AXE11000
- Smartphones, PCs, and laptops expected in the first quarter of 2021
  - Galaxy S21 Ultra
  - Intel vPro laptop platform
- TVs and VR products expected midyear

Wi-Fi 6E spectrum overview

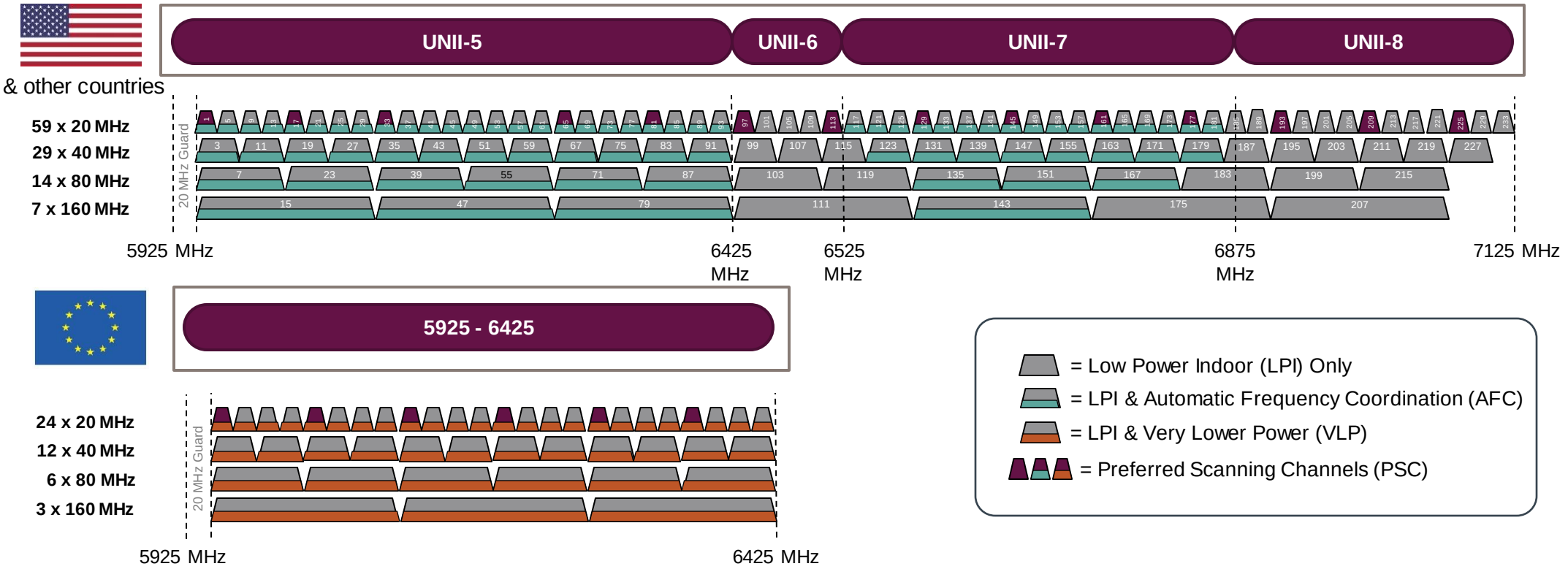
1200 MHz of additional bandwidth

- UNII-5 covering 500 MHz – up to three 160 MHz channels
- UNII-6 covering 100 MHz
- UNII-7 covering 350 MHz
- UNII-8 covering 250 MHz

} up to four 160 MHz channels

6 GHz advantages

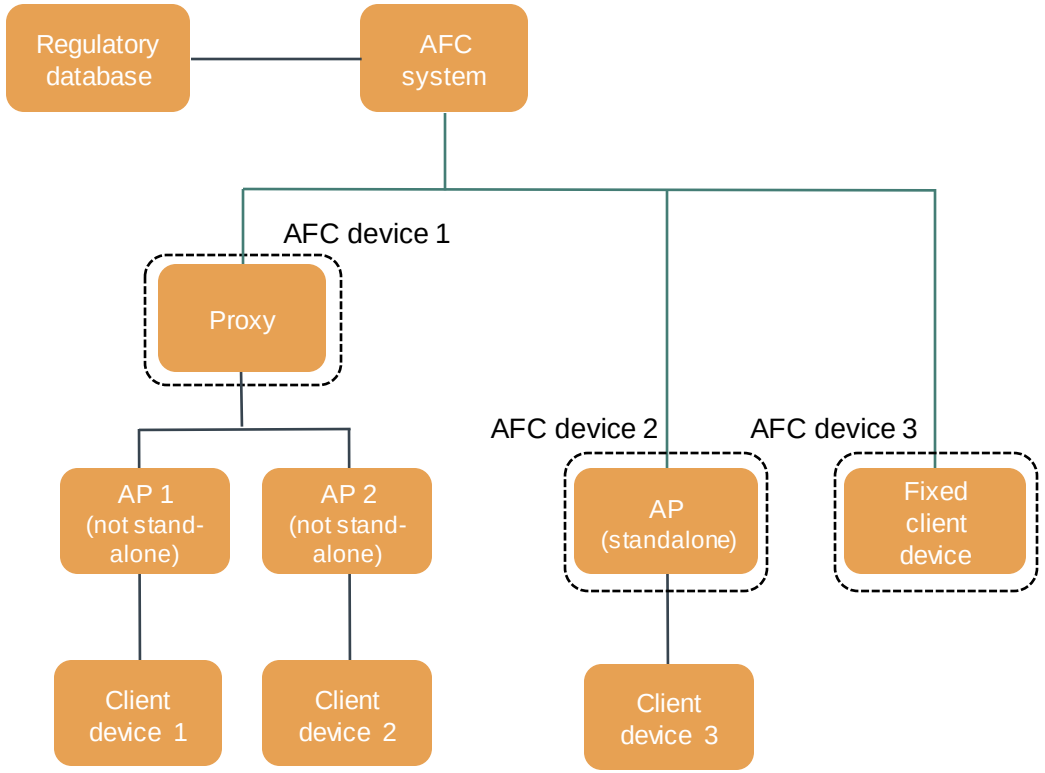
- 2.4 GHz does not allow 160 MHz channels
- 5 GHz only allows two 160 MHz channels
- 6 GHz allows up to seven 160 MHz channels
  - Required to enable maximum Wi-Fi 6 data rate of 9 Gbps



AFC System to AFC Device Interface specification

- March 2021: Wi-Fi Alliance published AFC System to AFC Device Interface Specification V1.0
- Describes method for standard power Wi-Fi 6E devices will communicate with AFC System

AFC System Architecture



Summary

- Wi-Fi 6E is a certification option in the Wi-Fi CERTIFIED 6 program
- Wi-Fi 6E devices extend Wi-Fi operation into 6 GHz
- 6 GHz unlocks the full performance of Wi-Fi 6
- Major OEMs and chip vendors are now shipping new products with Wi-Fi 6E
- Key markets have already opened, or plan to open, Wi-Fi access to 6 GHz
- Wi-Fi Alliance certification will help secure device quality in the 6 GHz band

Q&A

Wi-Fi 6E trial report

Tiago Rodrigues
CEO, Wireless Broadband Alliance

WIRELESS BROADBAND ALLIANCE

DRIVING WI-FI EXPERIENCE

WITH WI-FI 6E & OPENROAMING

11th March 2021

OUR VISION

WIRELESS BROADBAND ALLIANCE

"Seamless and interoperable services experience on Wi-Fi within the global wireless ecosystem"

Seamless, Secure and Interoperable Wi-Fi

Accelerate Next Generation Wi-Fi Networks

Convergence of Wi-Fi & Cellular Networks

Established **in 2003**

120+ MEMBERSHIP **COMMUNITY**

PROJECTS & **PROGRAMS**

2 ANNUAL **EVENTS**

PROMOTION AND **GO-TO-MARKET**

THOUGHT LEADERSHIP & **MARKET RESEARCH**

WIRELESS GLOBAL CONGRESS
WIRELESS BROADBAND ALLIANCE

OPENROAMING™
WIRELESS BROADBAND ALLIANCE

WORLD™ Wi-Fi Day

CARRIER WIRELESS Services Certification

WBA INDUSTRY Awards CELEBRATING ECOSYSTEM EXCELLENCE

CONNECTED CITY Advisory Board

12 Years of collaboration in multiple areas - technical, marketing, events and media

WORK GROUPS & PROJECTS ROADMAP 2021

5G Work Group	IoT Work Group	NextGen Work Group	Roaming Work Group	Testing & Interoperability Work Group
5G & Wi-Fi Convergence in Private 5G Networks	**Wi-Fi 6/6E for Industrial IoT**	**Wi-Fi 6/6E** Trials	**Roaming Evolution** PKI RadSec	**Captive Portal** Onboarding Evolution
	Rural Wi-Fi	**In-Home** Multi-AP Solutions	**In-Flight Connectivity**	**Wi-Fi IMSI Privacy Protection**
	AR & VR Requirements	**Wi-Fi Sensing** Deployment Guidelines	**Profiles & RCOIs Prioritization**	**Wi-Fi Devices Identification**
		Trackside Connectivity & Spectrum	**OpenRoaming for Private LTE/5G**	

WBA OpenRoaming™ Task Group	Policy & Regulatory Affairs Work Group	Market Work Group	WBA Certification Task Group

More Information regarding WBA projects (https://wballiance.com/what-we-do)

WORK GROUPS & PROJECTS ROADMAP 2021

5G Work Group	IoT Work Group	NextGen Work Group	Roaming Work Group	Testing & Interoperability Work Group
5G & Wi-Fi Convergence in Private 5G Networks	Wi-Fi 6/6E for Industrial IoT	Wi-Fi 6/6E Trials	Roaming Evolution PKI RadSec	Captive Portal Onboarding Evolution
	Rural Wi-Fi	In-Home Multi-AP Solutions	In-Flight Connectivity	Wi-Fi IMSI Privacy Protection
	AR & VR Requirements	Wi-Fi Sensing Deployment Guidelines	Profiles & RCOIs Prioritization	Wi-Fi Devices Identification
		Trackside Connectivity & Spectrum	OpenRoaming for Private LTE/5G	

WBA OpenRoaming™ Task Group	Policy & Regulatory Affairs Work Group	Market Work Group	WBA Certification Task Group

More Information regarding WBA projects (https://wballiance.com/what-we-do)

1. Show readiness and create confidence to accelerate adoption
2. Address business and services requirements
3. Expose benefits to decision makers
4. Collaborative effort with multiple players
5. Neutral environment to share learnings and address end-to-end challenges

+70 Organizations Involved in 2020-2021 Trials

75% Carriers, Enterprises, Cities and Government Agencies

25% Technology Providers & Vendors

The Wi-Fi 6 & 6E Program was setup to educate and raise confidence for industry adoption

Phase 1 – Blueprints & Guidelines

I. Enhanced Wi-Fi 6 - Overview, Use Cases, Features, 5G Context

II. Wi-Fi 6 Deployment Guidelines & Scenarios

Phase 2 – Real world end-to-end testing

Deployment Scenarios
Enterprise - Industrial 4.0
Transportation hub
Residential/MDU
Smart Cities/Rural
Transportation hub
Public Venues
University Campus
Stadium
Entertainment
Public Wi-Fi

Use Cases
High-density connectivity / latency
Improved roaming behavior
Multi stream live video monitoring (facilities / campus)
Real time energy monitoring
IoT sensor networks
Ultra-reliable low latency communications / critical sensors
Augmented reality for trouble shooting
Gaming / Health devices > improved latency for key target
Virtual classroom/venue - UHD video intercampus

Wi-Fi 6 AND Wi-Fi 6E GLOBAL TRIALS PROGRAM

+20 Trials across the globe on Wi-Fi 6 and Wi-Fi 6E

Join the trials to accelerate Wi-Fi 6 & Wi-Fi 6E adoption

Not exhaustive list

Coordinated trials execution with reporting across use cases

Entertainment (Stadia)

Transportation

Residential (single and multi units)

Industrial

Smart Villages/ Last mile

Smart Cities (Outdoor)

Wi-Fi 6/6E Trial, focused on the Industry Manufacturing vertical with Mettis Aerospace

This project enabled the use of augmented reality, real-time monitoring, and other applications in an enterprise network environment designed to digitize Mettis' Aerospace production line.

Phase 1 – Completed

- Scoping, survey, installation and testing
- Sustained throughput and reliability test
- Surpassed environment conditions (e.g. fume)
- Mixed 802.11 standard test (Wi-Fi 5 vs Wi-Fi 6)
- Real life production testing
- Network ready for operation addressing use cases

Phase 2 – In progress

- Testing of Wi-Fi 6E (6Ghz spectrum)
- Augmented reality testing
- Temporary licensed granted by Ofcom
- Wi-Fi 6 IoT sensor – Target Wake Time test

End User Equipment

Smartphones *Laptops*

Key Partners

Redditch, Midlands UK

هيئة الاتصالات وتقنية المعلومات
Communications & Information Technology Commission

Wi-Fi 6E & OpenRoaming focusing on global adoption and local economic growth

This project enables regulator to experience added benefits of new generation of Wi-Fi 6E, as well as the adoption on new policies for security and onboarding, improving user experience with OpenRoaming

Phase 1 – In Progress

- Testing of Wi-Fi 6E (6Ghz spectrum)
- Using readily available equipment
- Starting on CITC premises with a lab enablement
- Evolving to a live venue

Phase 2 – June 2021

- Including pre-commercial and commercial equipment
- Advancing policy-making processes
- Enabling OpenRoaming across footprint
- Partnering with local entities

End User Equipment

SAMSUNG — *Smartphones*

intel — *Laptops*

Key Partners

BROADCOM, intel, Extreme

CITC & Riyadh, Saudi Arabia

Wi-Fi 6 E & OpenRoaming deployment in Major International Airport

This project focus on the use of Wi-Fi 6, Wi-Fi 6E and OpenRoaming, combining technologies and services, enabling the evolution to a new paradigm of user experience in dense environments

Phase 1 – In Progress

- Scoping, Survey, Installation and Testing
- Real life production network
- OpenRoaming fully supported across footprint
- Partnership with local and international players

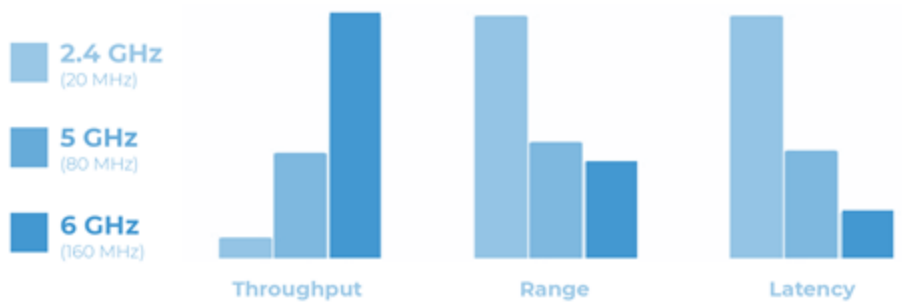
Phase 2 – June 2021

- Testing of Wi-Fi 6E (6Ghz spectrum)
- IoT, AR/VR, Augmented reality testing

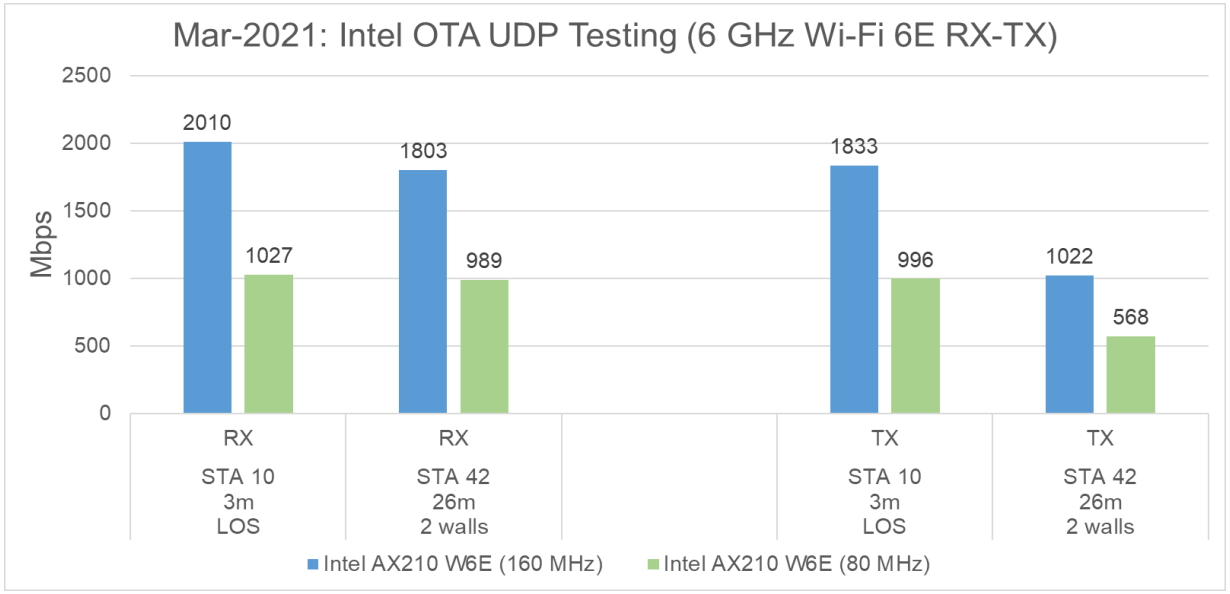
Wi-Fi 6E TESTING FINDINGS

Wi-Fi 6 expansion to be able to use up additional 1200 MHz of spectrum enables reliable access to 160 MHz channels, makes high throughput and low latency easily achievable enabling applications such as AR/VR

Phase 1 – Lab testing



BROADCOM intel



Test configuration:

Platform: 14-inch production notebook PC (11th Gen, Intel® Core i5),
Operating System: Windows 10 (Insider Build)
Wireless Card: Intel® Wi-Fi 6E AX210, Driver: 22.40.0.6
Production Consumer Wi-Fi 6E Router

2 Gbps

Intel® preliminary internal test results. Actual results may vary based on specific hardware selection & testing environment

OPENROAMING
WIRELESS BROADBAND ALLIANCE

- WBA OpenRoaming™ is a **Cloud Roaming Federation service** enabling an automatic and secure Wi-Fi experience globally
- An **industry standard framework for all organizations** in the ecosystem to power new opportunities in the Wi-Fi 6 & 5G era

WBA OpenRoaming™ Dimensions	WBA OpenRoaming™ Components
Cybersecurity Service	• Manages secure public keying infrastructure (PKI) for certificates policy, management and broker services • Supports dynamic & static interconnection technologies
Cloud Federation	• Operates centralized federation policies and global identifiers for Wi-Fi networks & identity providers • WBA unique Wi-Fi network identifier (WBAID) for federation partners • Wireless Roaming Intermediary eXchange (WRIX) standard enables roaming services harmonization and multiple business models
Network Automation	• Manages automated roaming consortium codes and policy provisioning mechanisms • Utilizes Passpoint® technology

OPENROAMING – GLOBAL TRIALS STATUS OVERVIEW

50+ TRIALS

in Development

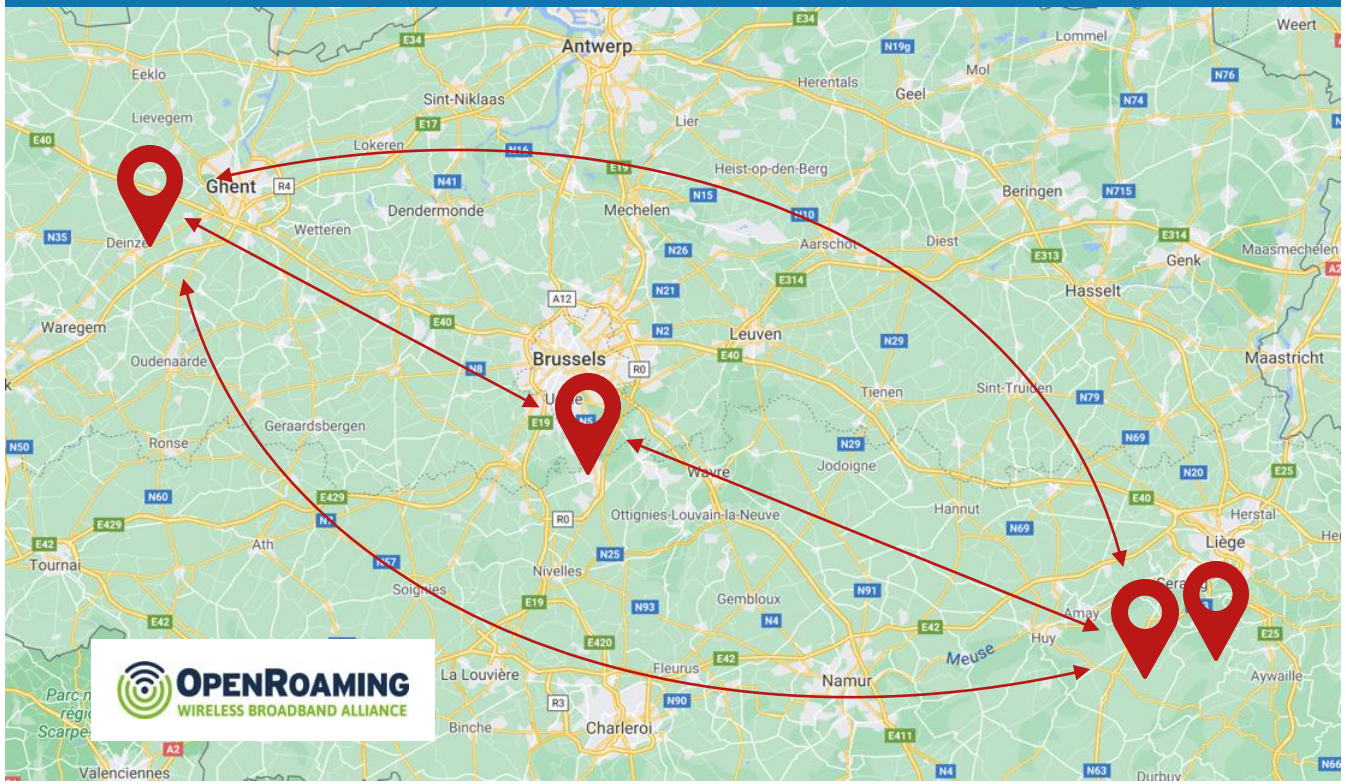
OPENROAMING™
WIRELESS BROADBAND ALLIANCE

Vendors

- BROADCOM
- CISCO
- COMMSCOPE
- Extreme Customer-Driven Networking
- Google
- intel
- Mist A Juniper Company
- SAMSUNG

Not exhaustive list

Provide Seamless and secure roaming across different municipalities, with fast and reliable authentication



1. 4 Belgium municipalities with different mix of vendors OEMs, IT integrators, roaming hubs and end-user devices

2. User onboarding simple and easy:
   - Off the shelf profiles available, from Samsung and Google
   - Onboarding portal possibility for local credentials

3. Guarantee interoperability and roaming between the cities using the same credential

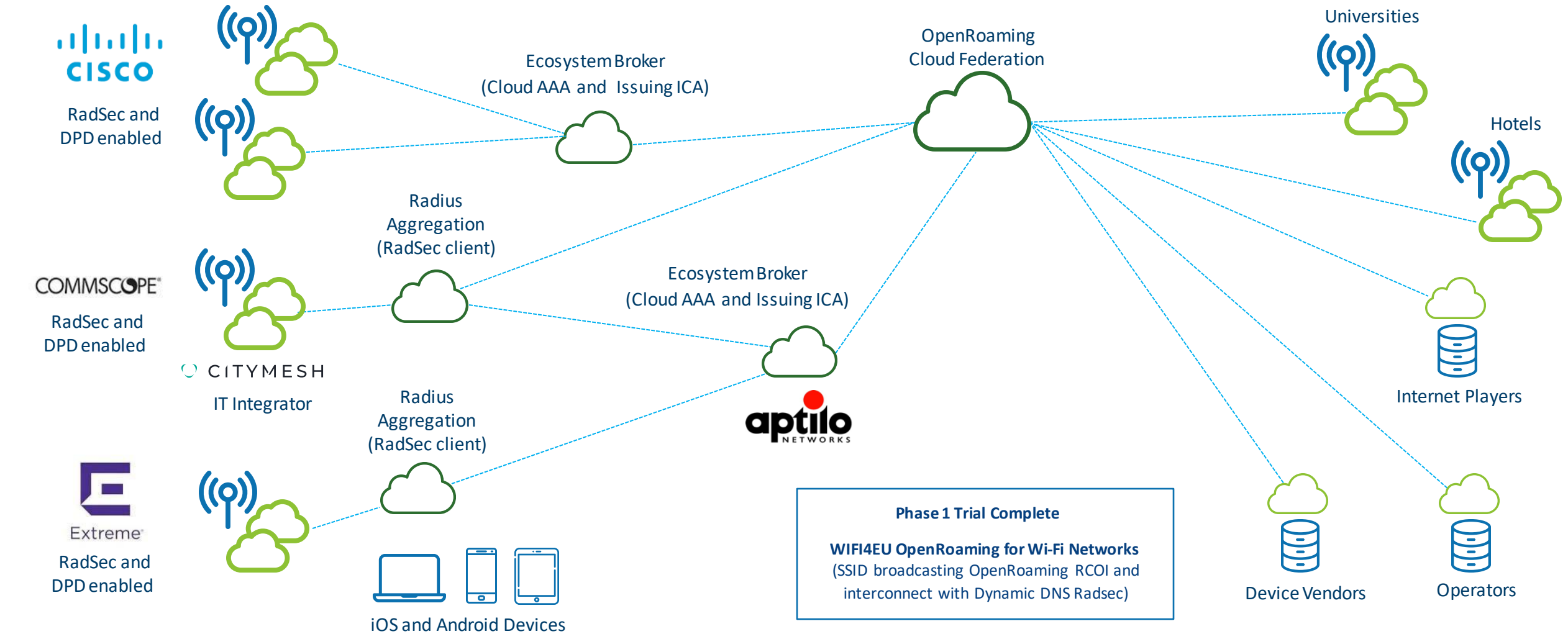
4. System stability, legal framework and interoperability with any other Wi-Fi network

OPENROAMING FOR WIFI4EU MUNICIPALITIES – TRIAL ARCHITECTURE

WIRELESS BROADBAND ALLIANCE

European Municipalities
(SSID broadcasting OpenRoaming RCOI)
WIFI4EU Municipalities: Tervuren, Beveren, ChaudeFontaine and Olne

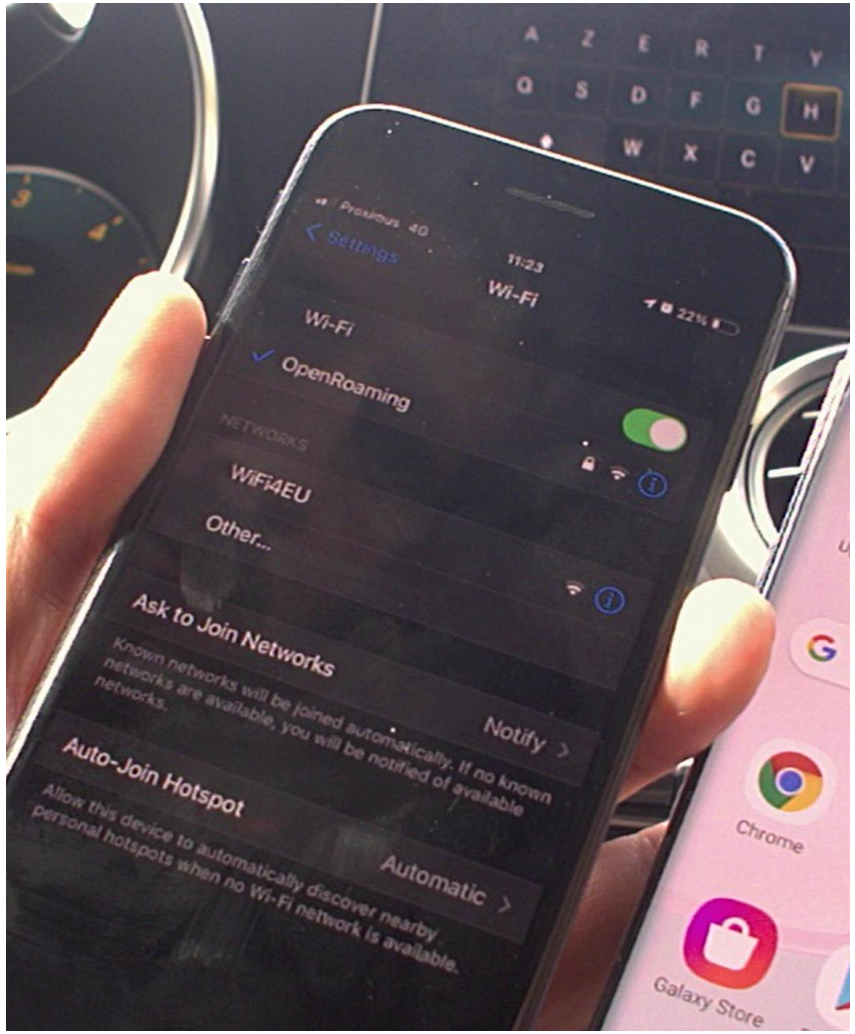
OpenRoaming Connector
Dynamic DNS (DPD)
Radsec Certificate

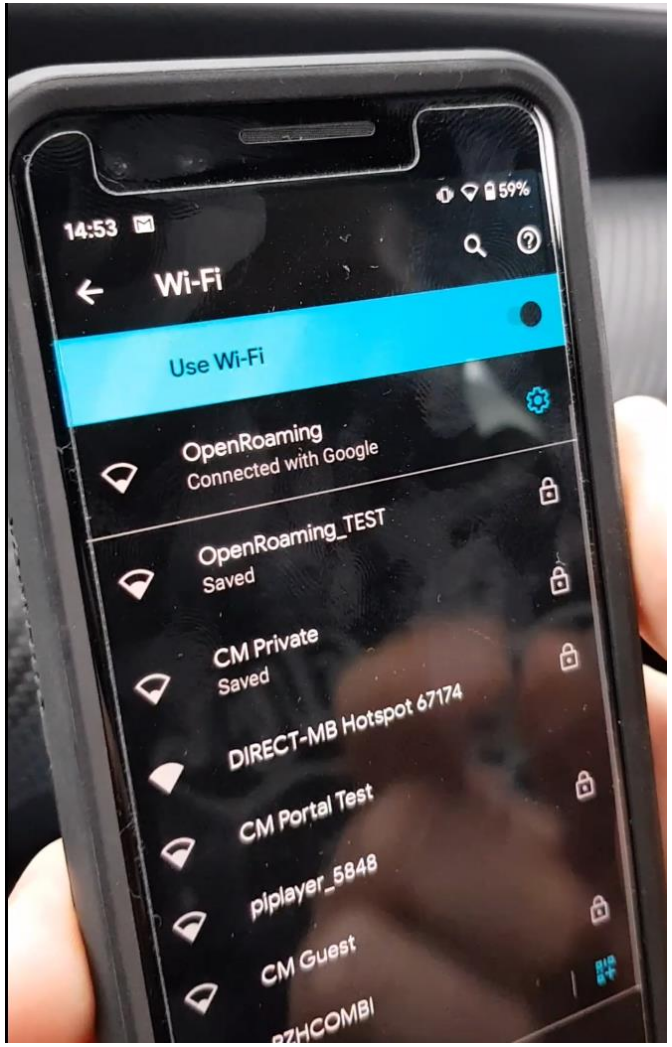


Phase 1 Trial Complete

WIFI4EU OpenRoaming for Wi-Fi Networks
(SSID broadcasting OpenRoaming RCOI and interconnect with Dynamic DNS Radsec)

OPENROAMING FOR WIFI4EU MUNICIPALITIES LIVE





Chaudfontaine, Belgium

Beveren, Belgium

Wi-Fi 6 AND Wi-Fi 6E PROGRAM

OpenRoaming™
WIRELESS BROADBAND ALLIANCE

GET INVOLVED IN OUR TRIALS PROGRAM

FIND OUT MORE @wballiance.com

Wi-Fi 6 AND Wi-Fi 6E PROGRAM

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Q&A

Thank you for attending!