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7 OCT 2021 – 15:30 CET

Wi-Fi: Public and Private Networks and Convergence with 5G

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WIRELESS GLOBAL CONGRESS
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Introduction & Welcome

BRUNO TOMÁS

Director of Programs

Wireless Broadband Alliance

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Wi-Fi Powering Innovation Series

Full Program Agenda

September 28th & 29th – WBA Members Only Working Sessions

September 30th – WBA Members Only Working Sessions: Briefing for Asia-based members

WI-FI POWERING INNOVATION SERIES: 06:30 PT; 09:30 ET; 15:30 CET; 23:30 Singapore

Tuesday October 5th	Thursday October 7th	Tuesday October 19th	Thursday October 21st
Wi-Fi Leadership Conference & WBA Industry Awards 2021	**Wi-Fi: Public and Private Networks and Convergence with 5G**	**Wi-Fi: Enabling the Smart Connected Enterprise**	**Innovation for Service Providers, Cities and Venues with Public and Guest Wi-Fi**

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Wi-Fi: Public and Private Networks and Convergence with 5G

OCTOBER 7, 2021

Bruno Tomás

Wireless Broadband Alliance

Kishore Raja

Boingo Wireless

Ahmed Hafez

Deutsche Telekom

Metin Taskin

Airties

Malcolm Smith

Cisco

Dorothy Stanley

Aruba Networks, a Hewlett Packard Enterprise company

Irvind Ghai

onsemi

WBA ROADMAP TECHNICAL PROGRAMS

WBA WORK GROUPS & PROJECTS

5G Work Group

Leading Wi-Fi and 5G RAN Convergence

- **5G & Wi-Fi Convergence in Private 5G Networks**

IoT Work Group

Augmenting Wi-Fi role in IoT

- **Wi-Fi 6/6E for Industrial IoT**
- **Rural Wi-Fi**
- **AR & VR Requirements**

NextGen Work Group

Fast-tracking Wi-Fi deployments for operators

- **Wi-Fi 6E** Trials
- **In-Home** Multi-AP Solutions
- **Wi-Fi Sensing** Deployment Guidelines
- **Trackside Connectivity & Spectrum**

Roaming Work Group

Incubating new business opportunities

- **Roaming Evolution PKI RadSec**
- **In-Flight Connectivity**
- **Profiles & RCOIs Prioritization**
- **OpenRoaming for Private LTE/5G**

Testing & Interop Work Group

Achieving interoperable Wi-Fi services

- **Captive Portal Onboarding Evolution**
- **Wi-Fi IMSI Privacy Protection**
- **Wi-Fi & Devices Identification**

WBA OpenRoamingTM Task Group

Development of standards, federation governance and trials

Policy & Regulatory Affairs Work Group

Industry liaison and advocacy of WBA global programs

Market Work Group

Marketing activities and industry dissemination

Certification Task Group

Addressing interoperability to foster adoption

More Information about WBA projects - https://wballiance.com/what-we-do

WIRELESS GLOBAL CONGRESS
WIRELESS BROADBAND ALLIANCE

Wi-Fi: Public and Private Networks and Convergence with 5G

TODAY'S AGENDA	
15:30pm (CET)	**Introduction & Welcome** Bruno Tomás, Director of Programs, Wireless Broadband Alliance.
15:35pm (CET)	**Convergence: Public & Private Networks Evolve** Kishore Raja, VP Engineering & Strategy, Boingo Wireless.
15:55pm (CET)	**Mobile & Wi-Fi Network Convergence. Challenges & Opportunities.** Ahmed Hafez, VP Network Convergence, Deutsche Telekom.
16:15pm (CET)	**OpenRoaming Paves the Way for 5G Offloading** Metin Taskin, Co-Founder & Chief Technology Officer, Airties.
16:35pm (CET)	**Wi-Fi TSN (WTSN) – From Industrial to Emerging Enterprise Applications** Malcolm Smith, Wireless CTO Advisor, Cisco. Systems.
16:55pm (CET)	**IEEE 802.11 Standards: Wi-Fi 6 and beyond** Dorothy Stanley, IEEE 802.11 WG Chair, Aruba Networks, a Hewlett Packard Enterprise company.
17:15pm (CET)	**Fixed Wireless Access: The Tale of Expanding Connectivity & Coverage** Irvind Ghai, VP Marketing, onsemi.
17:35pm (CET)	**Summary of the WBA work and Close** Bruno Tomás, Director of Programs, Wireless Broadband Alliance.

Convergence: Public & Private Networks Evolve

KISHORE RAJA

VP ENGINEERING

Boingo Wireless

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WBA WIRELESS GLOBAL CONGRESS

CONVERGENCE: PUBLIC & PRIVATE NETWORKS EVOLVE

Kishore Raja, VP, Engineering, Boingo Wireless

OCTOBER 6, 2021

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Chicago, IL

Vivint Smart Home Arena
Salt Lake City, UT

John Wayne Airport
Santa Ana, CA

Salesforce Transit Center
San Francisco, CA

Hollywood Bowl
Los Angeles, CA

Live Nation
Various Locations

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It's A Wireless
World
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Demand Far Beyond Mobile Devices

Digital transformation is everywhere and the demand for connectivity has reached new heights.

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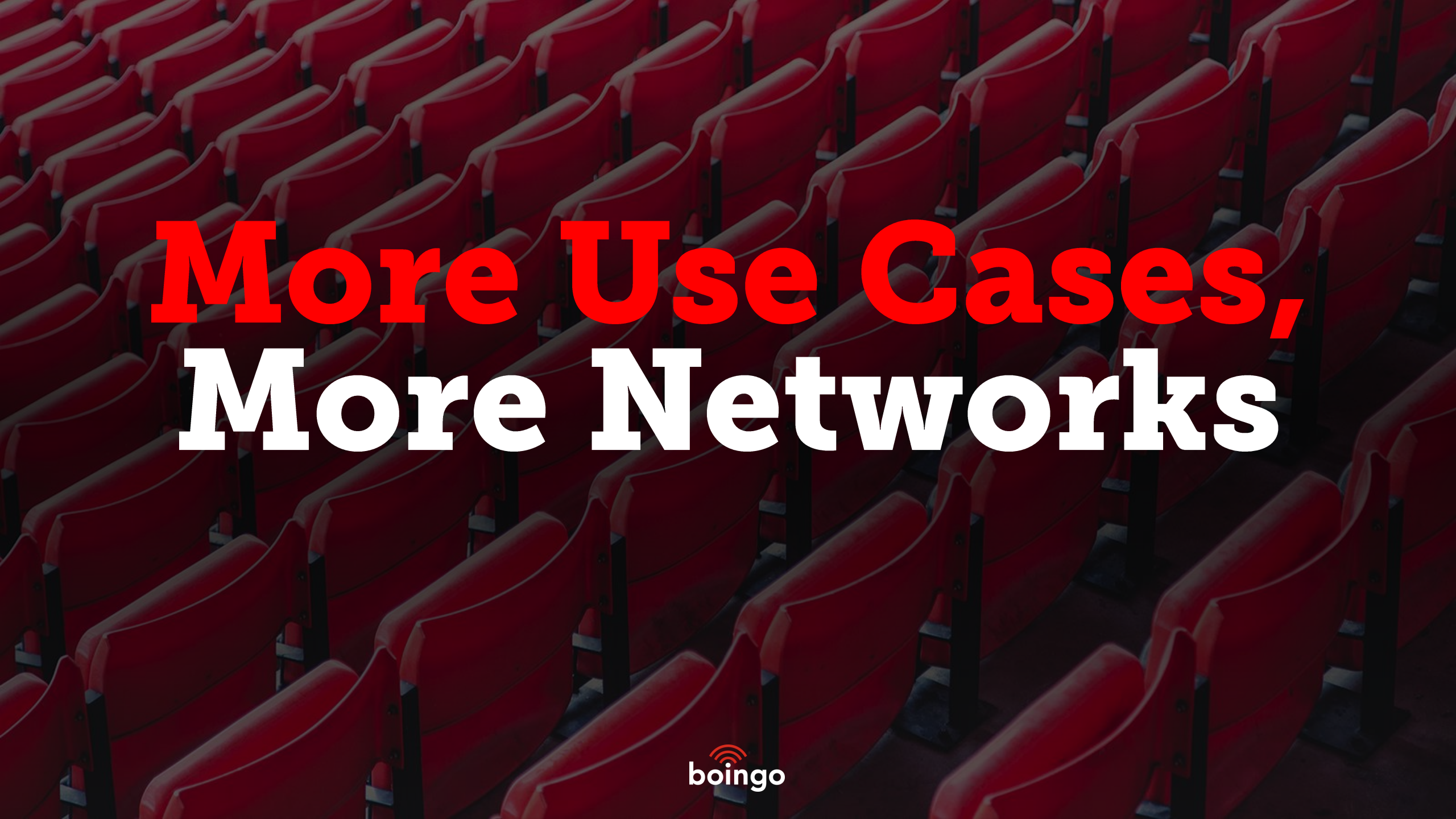
More Use Cases,
More Networks
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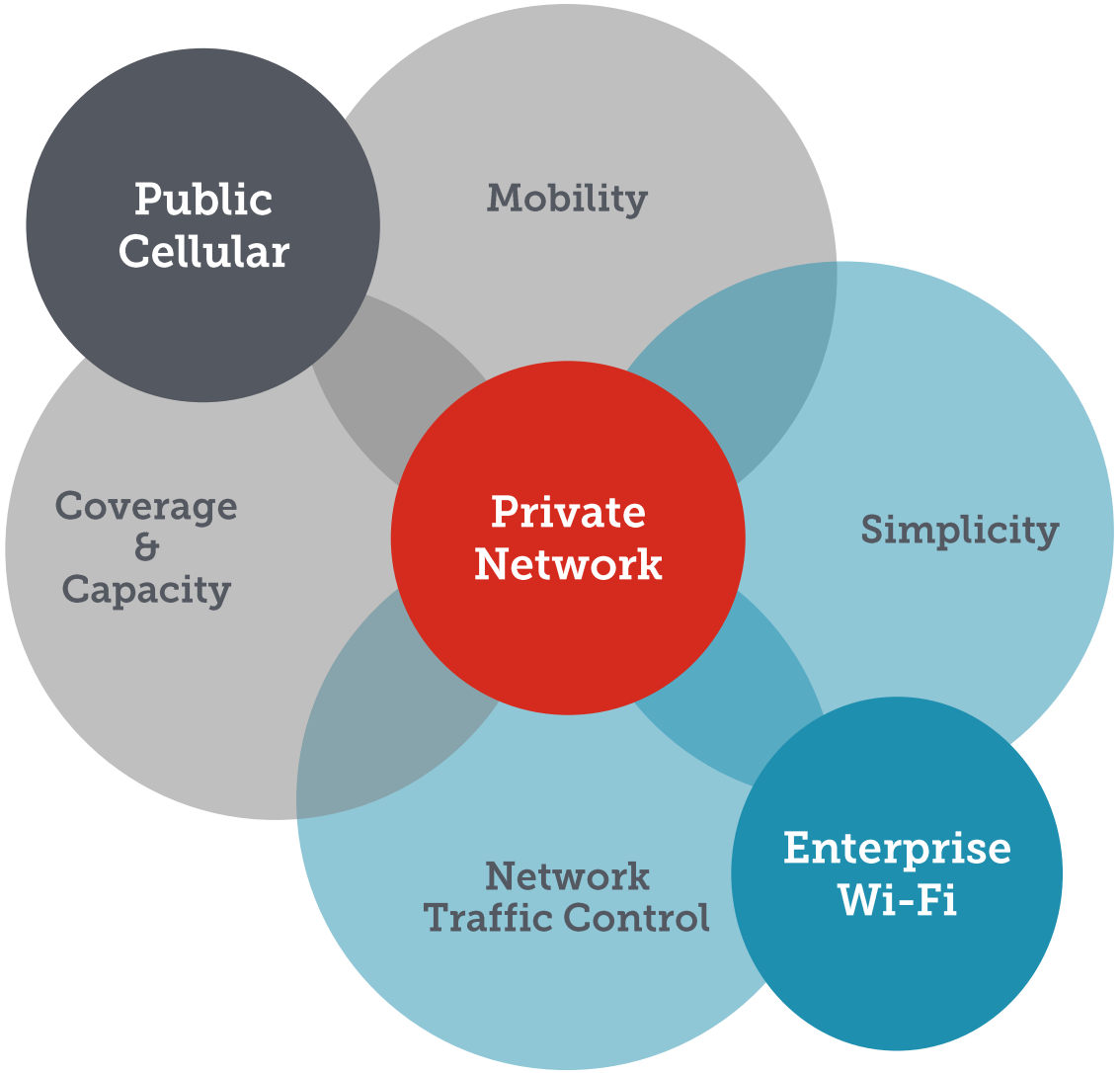
Network Convergence is Key

No one wireless solution can solve all the challenges. **A convergence of multiple technologies and solutions is the answer.**

This approach applies the right technology, spectrum and shared deployment to connect people and things, increasing **operational efficiencies, realizing cost savings and improving the connected experience**.



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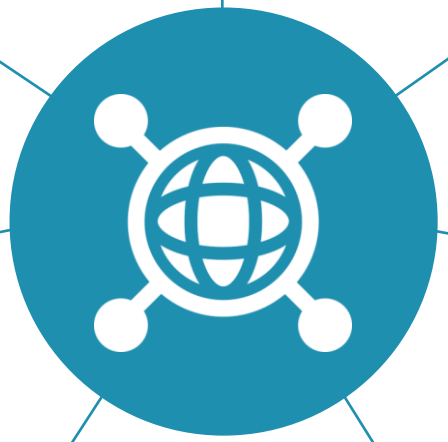
Neutral Host Advantage for Public Networks

A neutral host approach is more important than ever in the 5G era.

Prioritizes venue needs

Reduces costs by sharing resources

Drives revenue opportunities



Focuses on **convergence** for flexible deployments across licensed, unlicensed and shared spectrum

Efficiently manages carriers' densification needs to keep up increasing mobile demands

Helps **maximize carrier participation** on network

Solves demands of **today** and plans for the **future**

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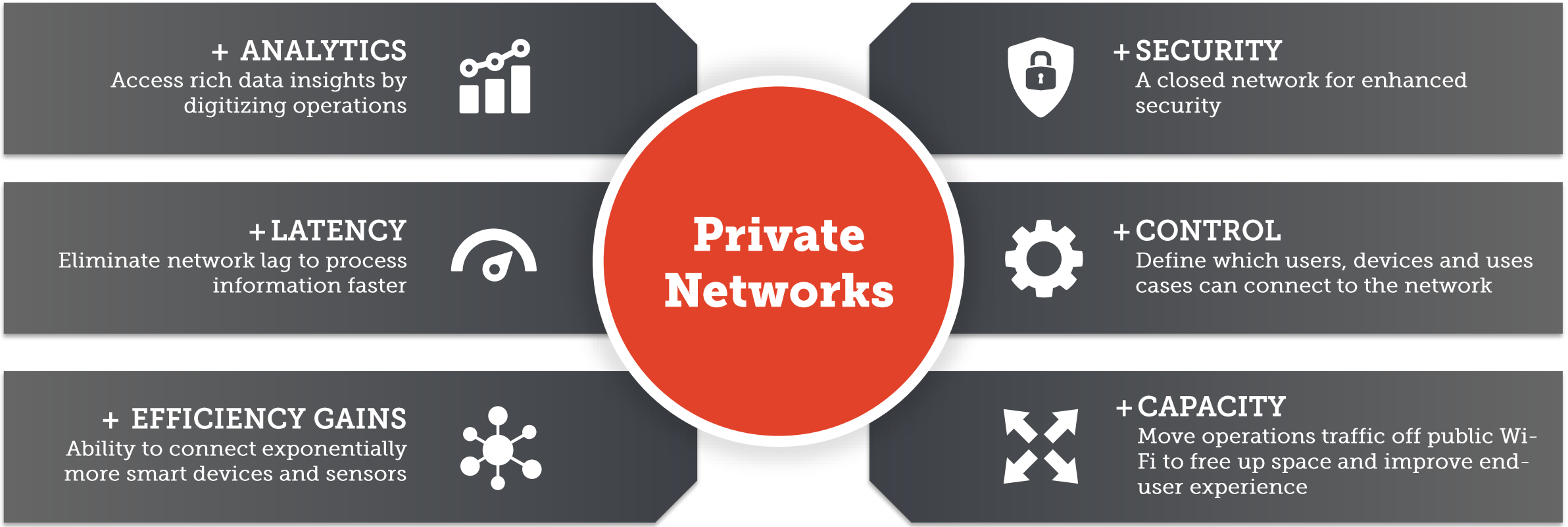
Private Networks & Shared Spectrum

A private wireless network provides dedicated, secure bandwidth to transform operations.



Indoor Use Cases

A private wireless network solves for multiple use cases.

Tenant Services
Dispersed point-of-sale kiosks with self-service payment for food, beverage and retail

Security
Passengers and operations are on separate and isolated networks

Digital Signage
Deploy signage anywhere to drive tenant traffic or critical PAX information

IIoT connectivity
Monitor high traffic facilities for maintenance schedules

Touchless Experience
Biometrics devices for touchless, secure entry and boarding

Dedicated Spectrum
Dedicated spectrum slices for critical operations ensure network availability

MEC
On premise compute and storage capabilities for Airports owned data

Outdoor Use Cases

A private wireless network goes beyond indoor use cases.

Below wing coverage
At gate connectivity for improved operational continuity

Asset tracking
Real-time access to asset location and coordination

Cargo
Continuous sensor connectivity of cargo transportation and storage

Tarmac vehicles
Reliable real-time data on arriving/departing aircraft

Situational Awareness
Real-time high def video with on prem storage and AI via MEC

Security
Passengers and operations are on separate and isolated networks

Ground crew access
Reliable and mobile voice communication for ground crews

Improved efficiencies
Reduce airplane turnaround time

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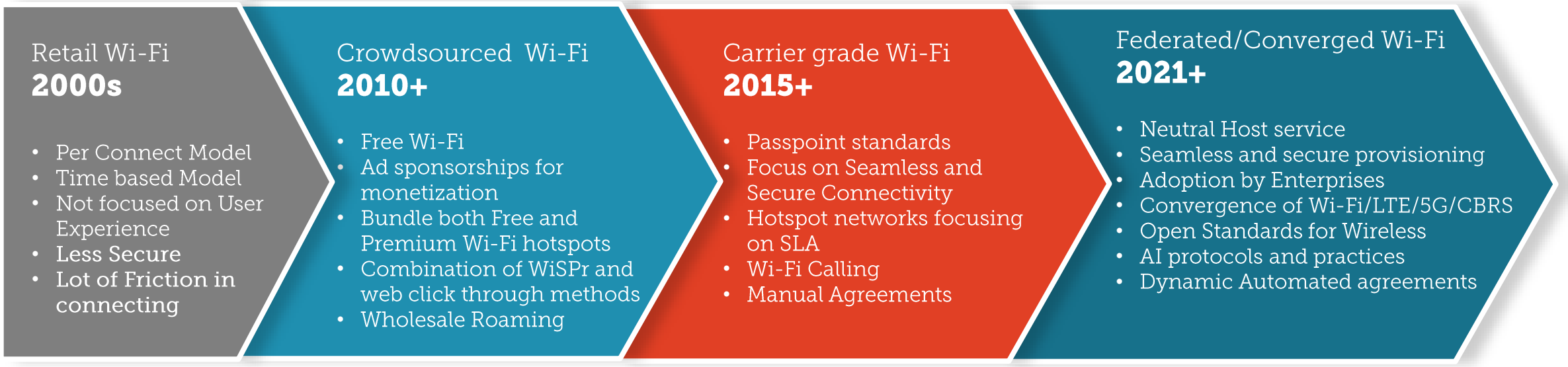
Wi-Fi Continues to Evolve



Realizing the Vision

Convergence across public and private networks create intelligent communities of the future.

HEALTHCARE

- Remote diagnosis and treatment
- Home healthcare for disabled populations
- Support aging in place
- Secure data management

PUBLIC WORKS

- Environmental monitoring
- Smart metering
- Water and waste management
- Weather monitoring stations

TRANSIT HUBS

- Touchless passenger journey
- Advanced security cameras
- Increased connectivity speeds
- Seamless ease-of-use for travelers

MANUFACTURING

- Integrated safety management
- Equipment asset tracking
- Connected utilities
- Logistics and supply chain management

OFFICE BUILDING

- Touchless experience
- Smart building solutions
- BYOD
- Predictive maintenance
- Energy monitoring and savings

PUBLIC SAFETY

- Real-time emergence response
- Drone patrol
- Intelligent cameras
- Traffic management
- Digital signage

OUTDOOR SPACES

- Smart outdoor lights
- Detect overcrowding
- Mobile Wi-Fi hotspots
- Food trucks
- Tenant services

STADIUM

- Touchless experience
- Mobile apps
- Wagers/betting
- In-seat ordering
- AR/VR
- Queueing
- Rideshare

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THANK YOU

Kishore Raja
VP, Engineering
kraja@boingo.com

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Q+A
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Mobile & Wi-Fi Network Convergence Challenges & Opportunities

AHMED HAFEZ

VP NETWORK CONVERGENCVE

Deutsche Telekom

Mobile & Wi-Fi Network Convergence

Challenges & Opportunities

Ahmed Hafez
VP Network Convergence
Deutsche Telekom, May 18, 2021

LIFE IS FOR SHARING.

Content

Context from technical and business perspectives

- 5G and Wi-Fi are complementary in general, but they may serve different requirements
- There is clear demand for convergence among Enterprises

Convergence challenges and Opportunities

- Convergence Challenges
- Does 5G provide a true path towards convergence?

DT AGV (a.k.a. AMR) demo

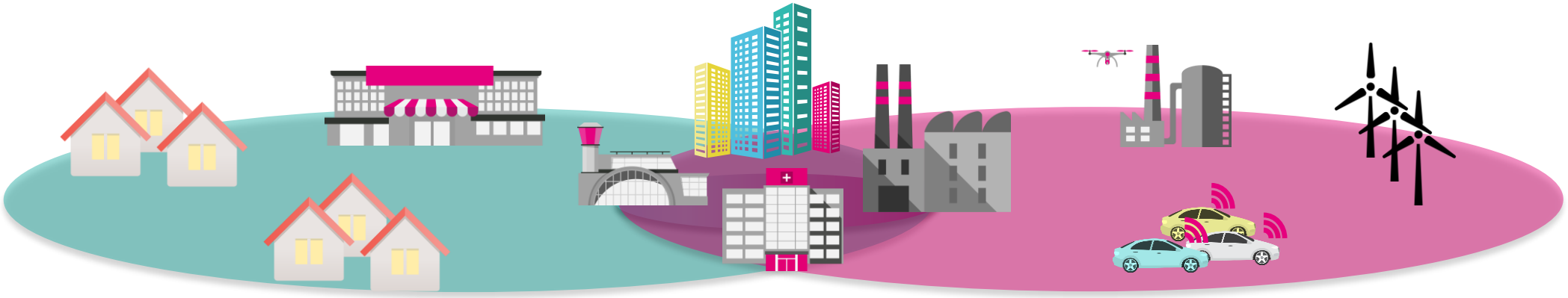
- DT Proof of concept/demo

Context from technical & business perspectives

Wi-Fi and Cellular will remain complementary

Technology capability view

B2C



B2B

Wi-Fi 6

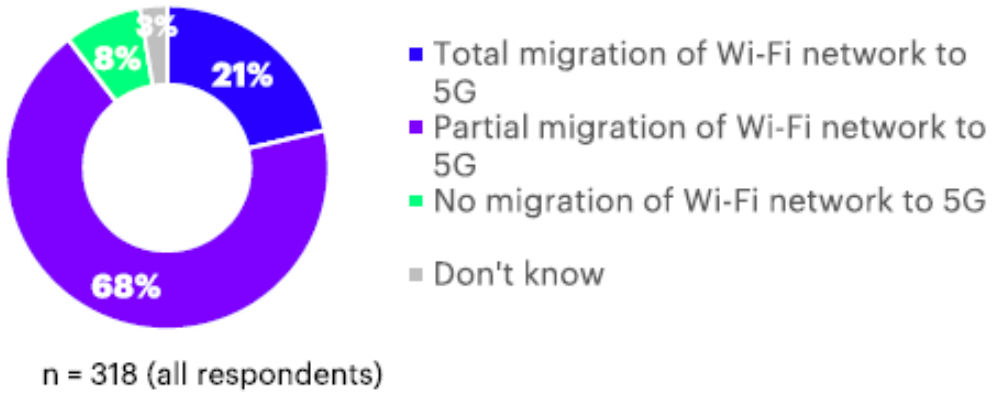
- Cost efficient indoor
- Nomadic use
- Medium device density
- Generic insenstive applications

5G

- Best for outdoor
- Mobility
- High device density
- High-value and mission critical

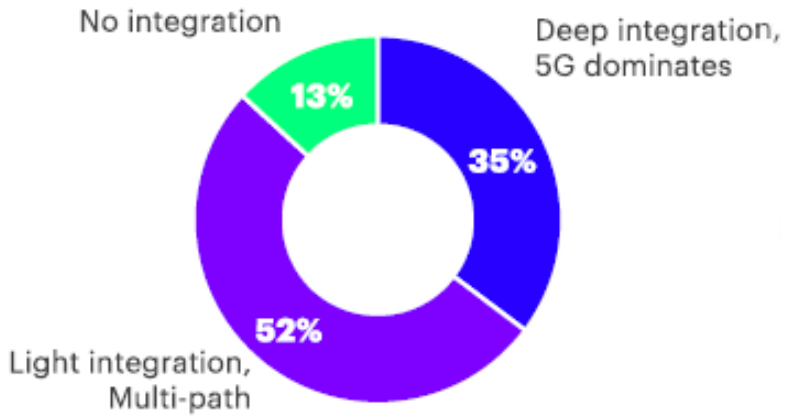
Convergence is top of Enterprise mind and strategy

Plans to migrate from Wi-Fi to 5G within 3 years



n = 318 (all respondents)

Plans to integrate Wi-Fi and 5G



Integration plans driven by business-critical and stationary use cases, while mobile and less critical cases will require less integration.

Source: Accenture study 11/2020: 328 respondents across DE, AT, CZ, PL, HU; companies > 25m € revenues and >100 employees, various branches of industry

Convergence Challenges & Opportunities

Challenges to convergence

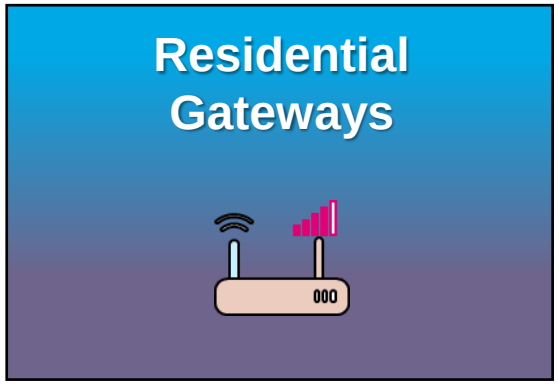
Customer Value Proposition

Balanced Value & Complexity

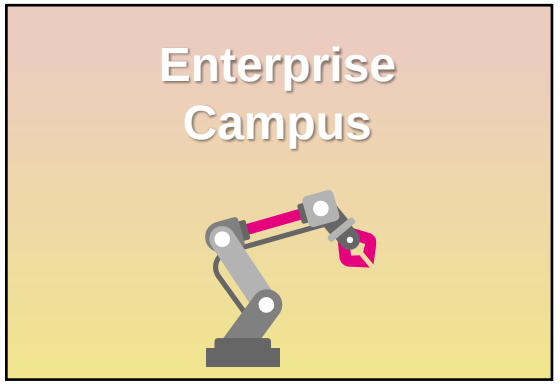
Complete Standardized Solution

What value and use cases are we targeting?

Always best connected



Hybrid Routers

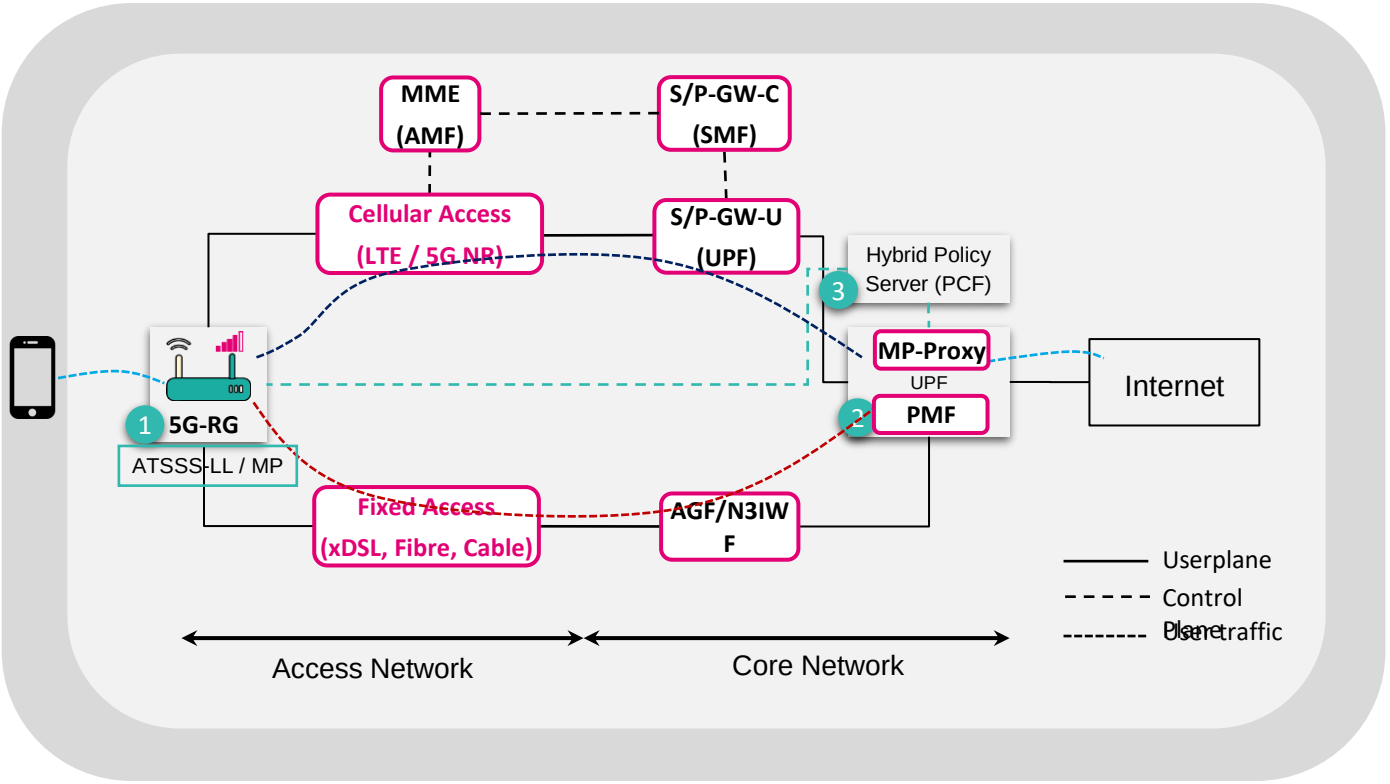


Higher reliability &
higher capacity

First Complete Standardization (3GPP & BBF)

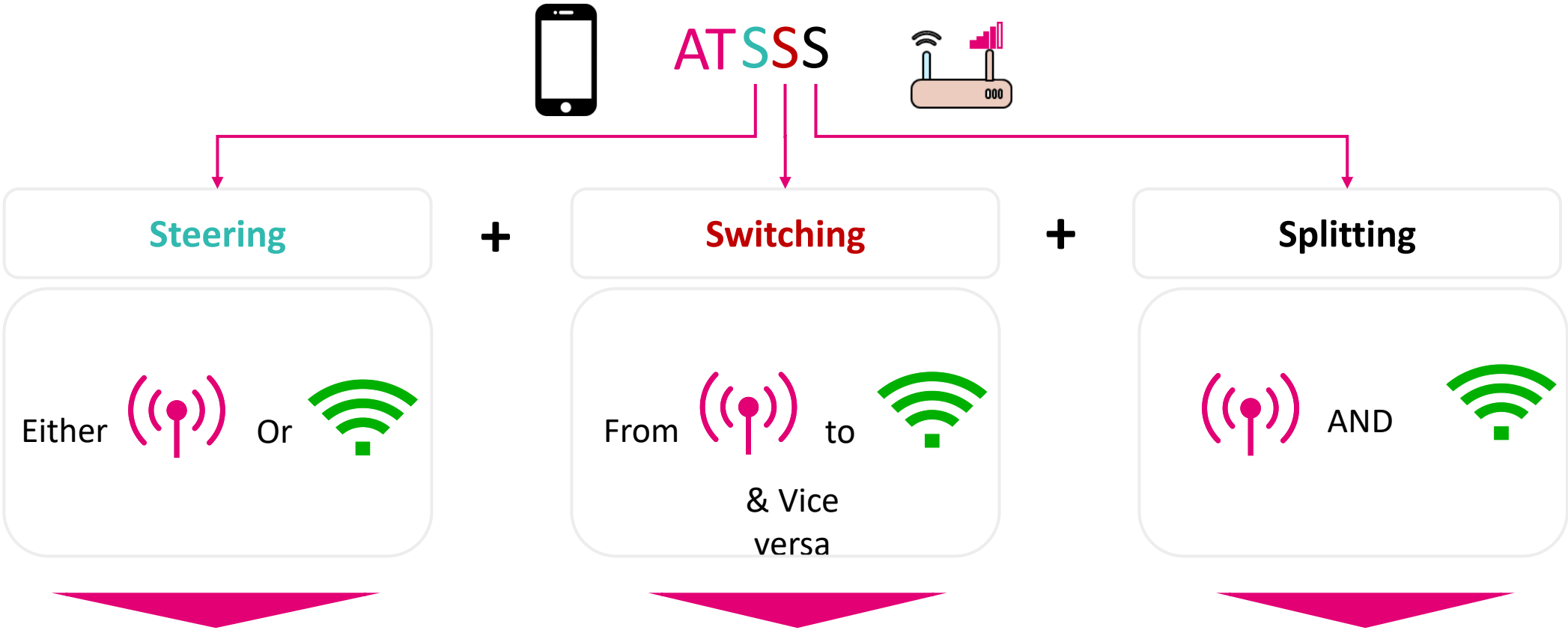
- The 5G came with a strong fulfilled promise of supporting Fixed Network integration as well as true multiaccess capabilities controlled from a unified Core (the 5G Core)

- **ATSSS/MP:** one of the key optional features of 3GPP R16.
  - **ATSSS** is a policy framework that sets the rules and enables connectivity to multiple access network.
  - **Multipath**: is the mechanism that could be used to split the traffic over multiple paths instead of one
- **5G WWC** (Wireless Wireline Convergence Architecture) is the transformation towards a converged Network using the 5GC



What is ATSSS & MP?

ATSSS is a standard defined in Mobile Networks that allows Network Operators and devices to exchange policy and capabilities to enable the intelligent and advance use of 4G/5G and Wi-Fi access in multiple ways as described below



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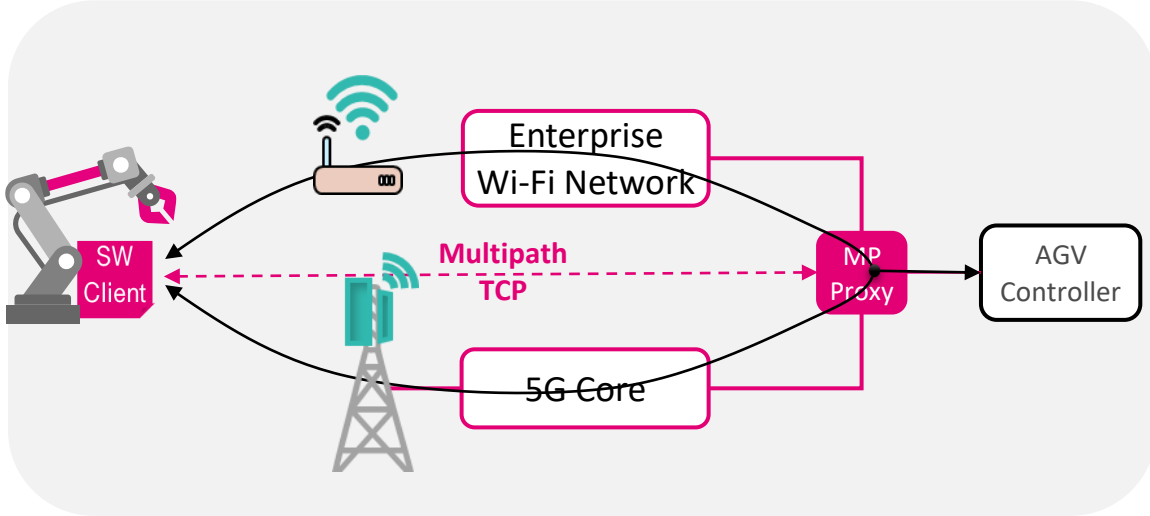
Demo

Light integration - highlight 2020 and outlook 2021

World first PoC (FMC for AGVs)

We have repositioned a **technology pioneered by DT** for smartphones and home Gateways, towards **Campus use cases**.

An **internally developed client** and **proxy**, were installed on the **AGVs** and in front of **AGV-controller** to **enable two parallel paths of communication** between them. This is based on a **pre-standard**. Actual standard come with 5GC in 3GPP R16.



Link to the Demo

Trial Architecture

First trial conducted in Oct-2020 as embedded software

Second trial conducted in Feb-2021 with an external connectivity box

Results

Control signals between AGV & AGV-controller were **maintained** even in case of **physical disconnection** of one access.

Link to trial

Thanks!

OpenRoaming paves the way for 5G Offloading

METIN TASKIN

CO-FOUNDER & CTO

Airties

OpenRoaming paves the way for 5G Offloading

Metin Taskin, Cofounder & CTO of Airties

October 7, 2021

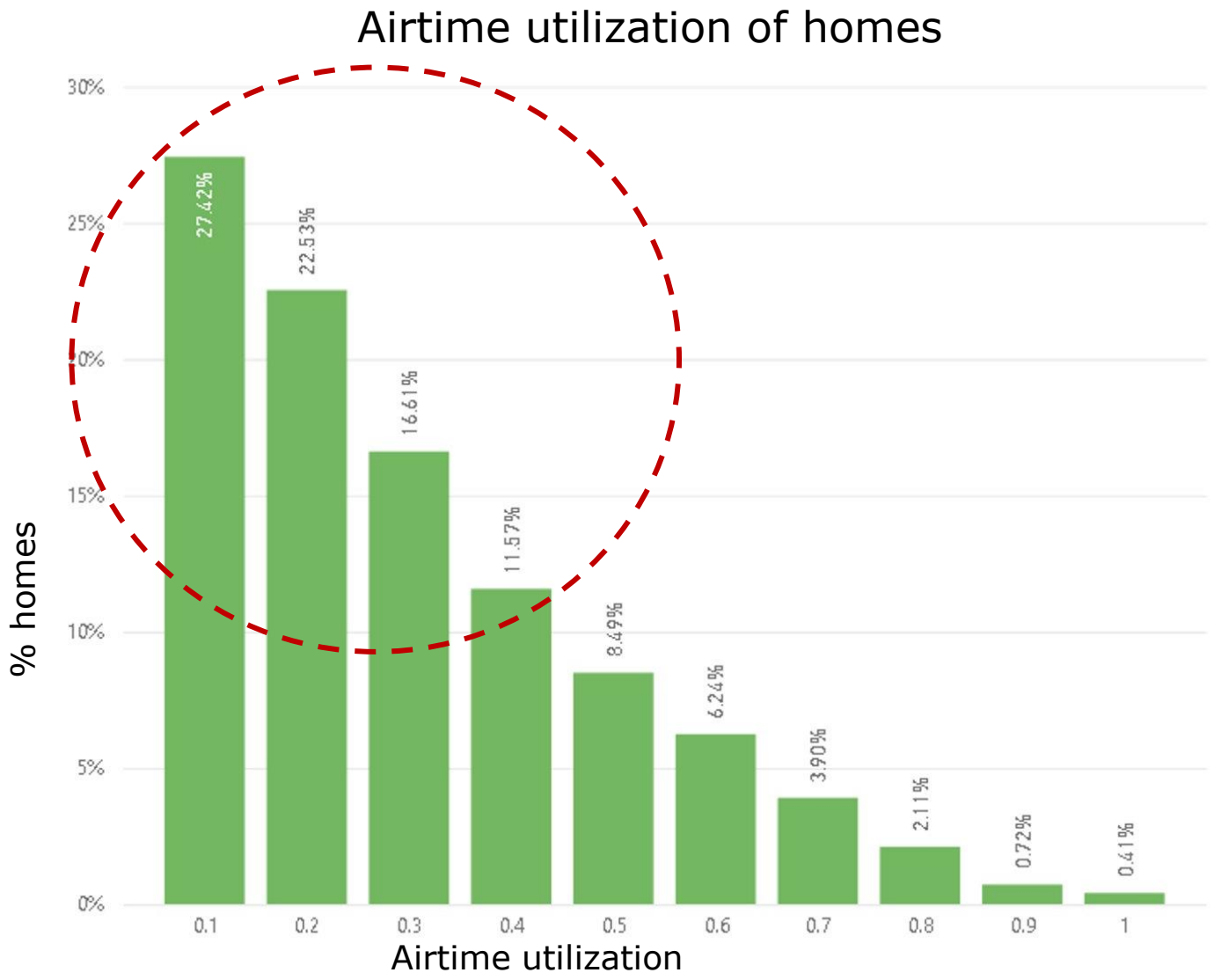
Home Wi-Fi to serve mobile users

Lots of coverage possible from residential Wi-Fi access points

Every home can become a hotspot for mobile devices while continuing to serve the home users

Coverage can be immense as service providers often manage a sizeable percentage of subscribers in the same neighborhood.

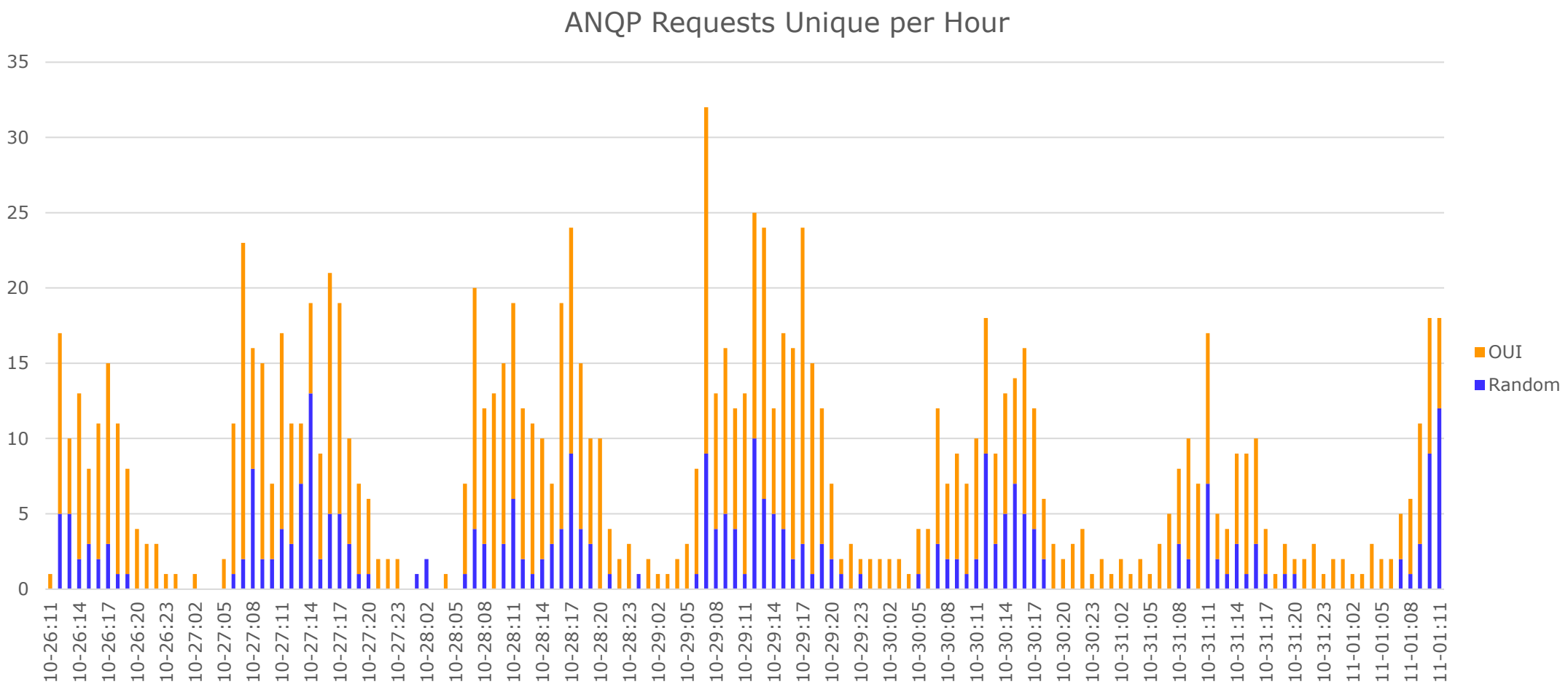
Airtime is not fully utilized



Based on anonymized data from millions of homes in Europe:

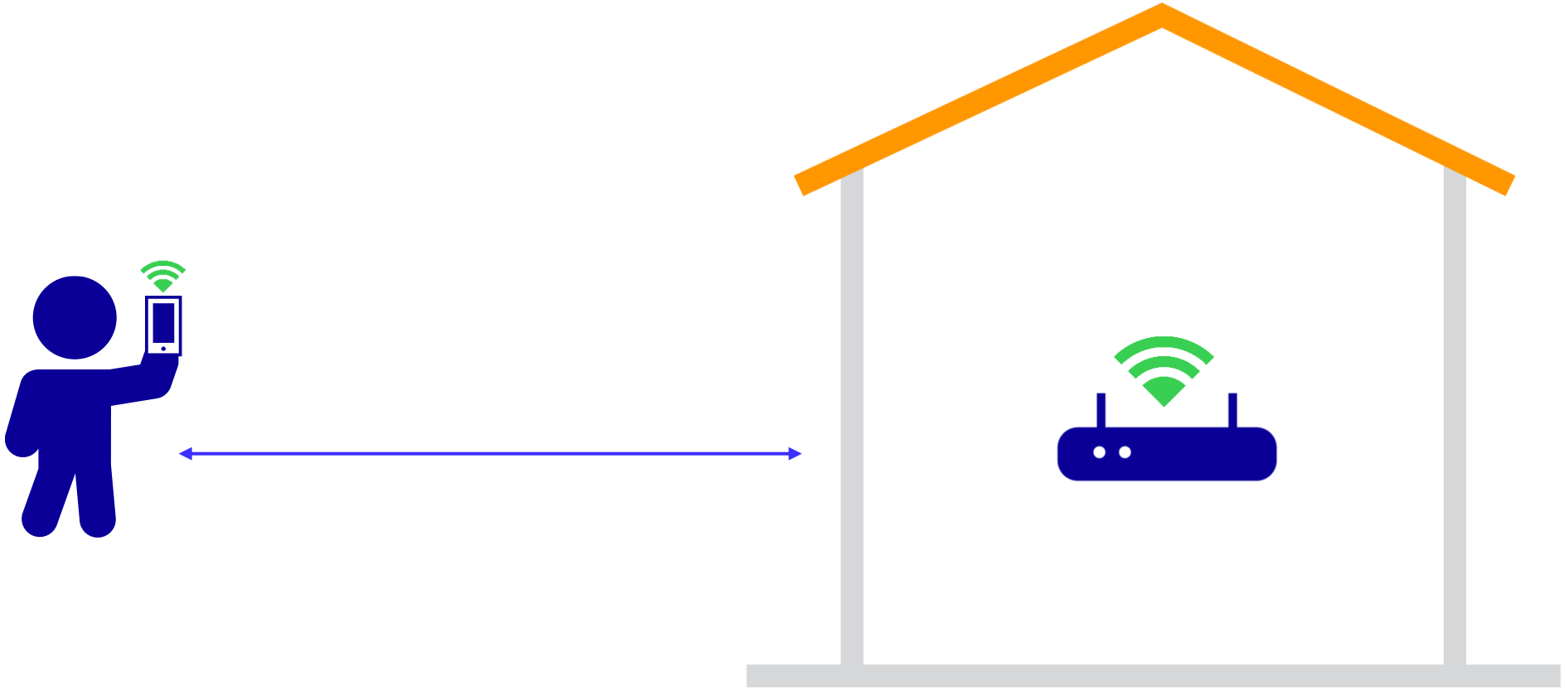
75% of the homes utilize less than 50% of the Airtime at 5GHz

Mobile devices want to connect: ANQP requests in a residential street in Paris

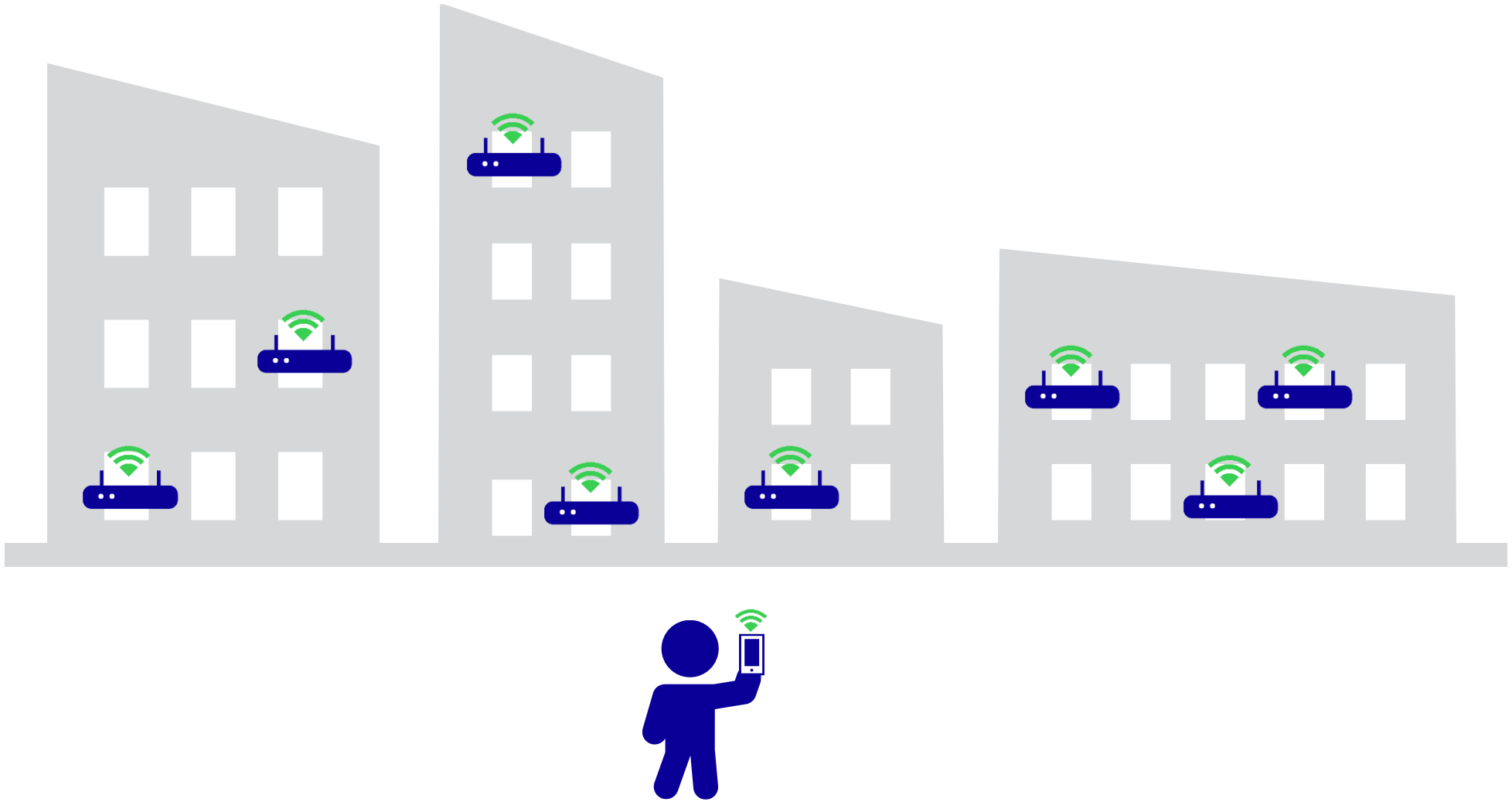


What to look out for?

Hot to connect automatically?



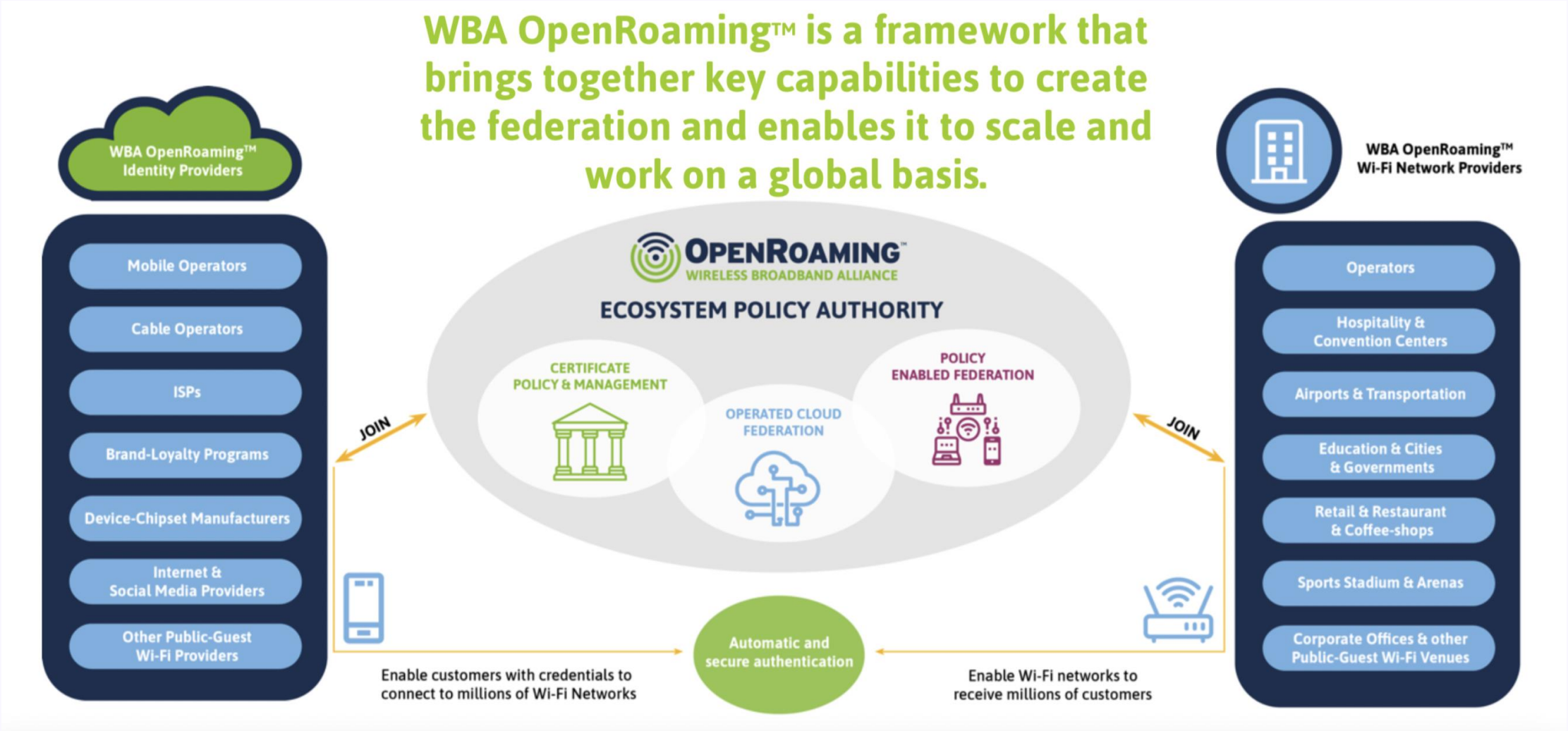
How to know which hotspot to choose from?



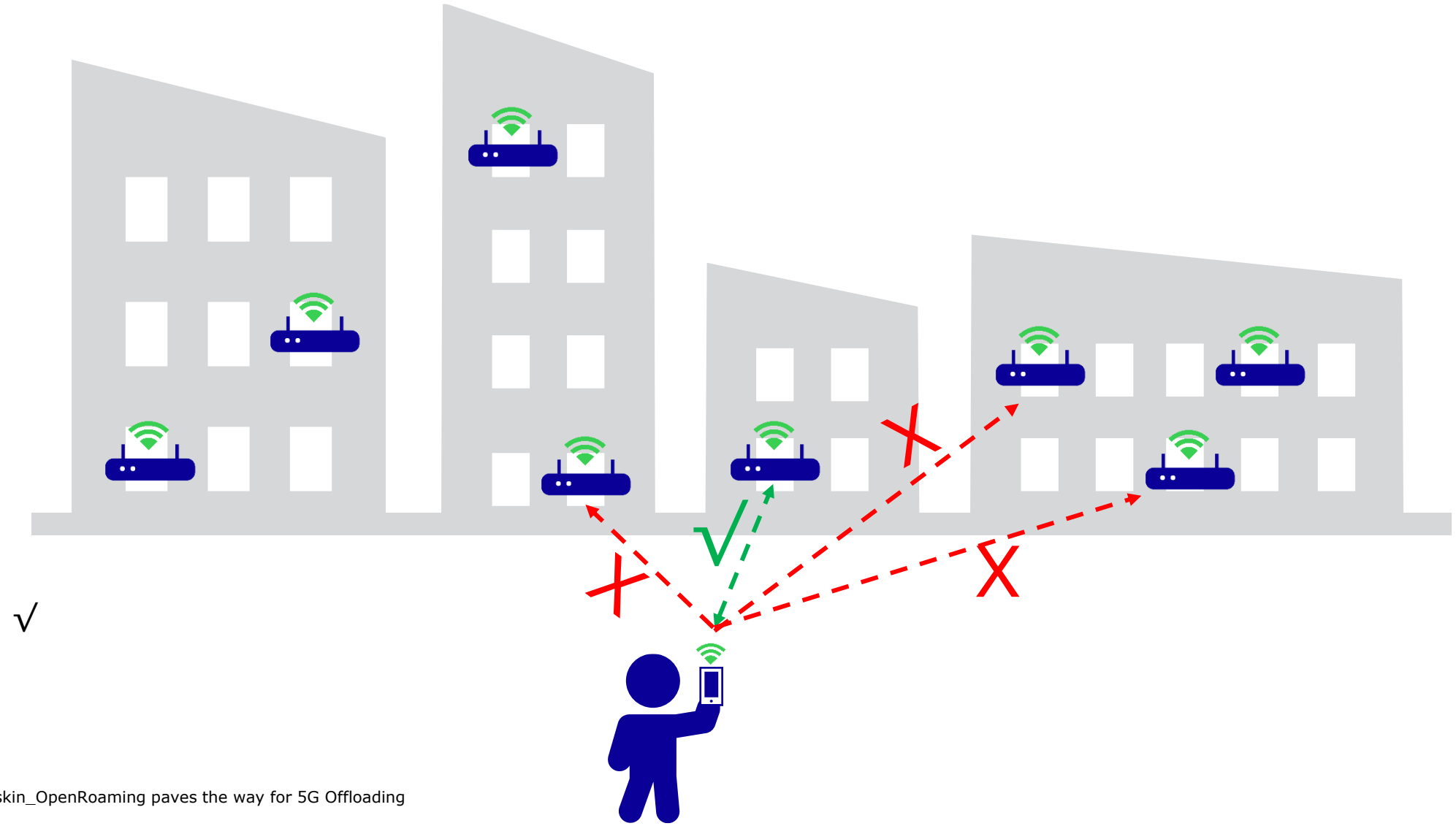
How to make sure that both home and mobile users get good QoE?

There are solutions

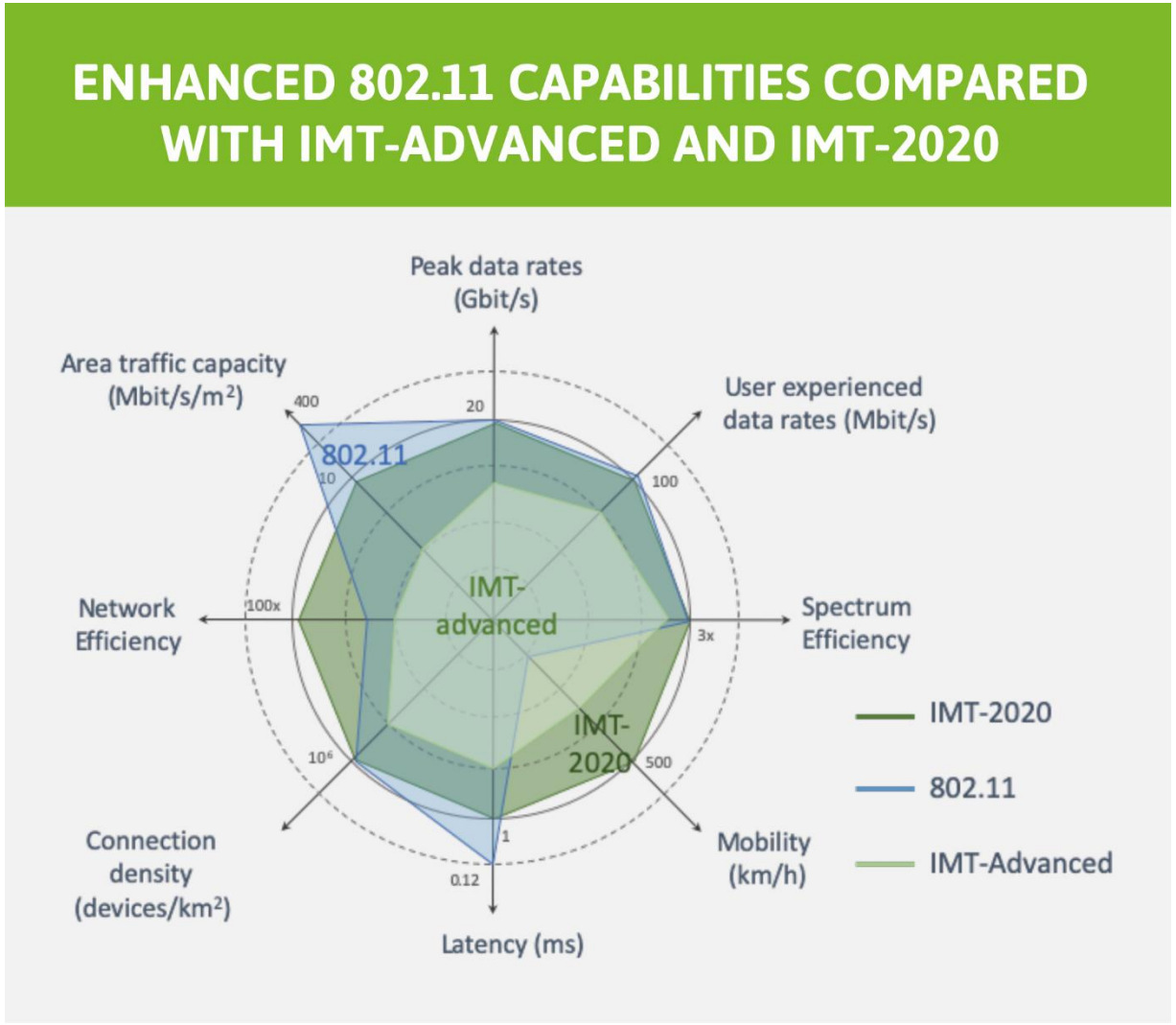
Automatic onboarding: Wi-Fi Passpoint ® for onboarding WBA OpenRoaming™ for roaming



Smart hotspot management to decide which hotspot to serve



Wi-Fi6 for the right QoE: it has very similar capabilities to 5G



- Wi-Fi6 and 5G capabilities are very similar in terms of peak data rate, user experienced data rate, spectrum efficiency, latency
- 5G better supports mobility whereas Wi-Fi has a denser bitrate in small areas
- The addition of 6GHz band allows Wi-Fi far greater bandwidth (unlicensed)
- Upstream and downstream OFDMA and MU-MIMO help control bandwidth and latency at a granular level
- BSS coloring improves frequency re-use

Source: WBA white paper, 5G Networks – The Role of Wi-Fi and Unlicensed Technologies, by Florin Baboescu

Wi-Fi6 installed base is rising rapidly

Average **12.4 Wi-Fi connected devices** per home

10 HOURS

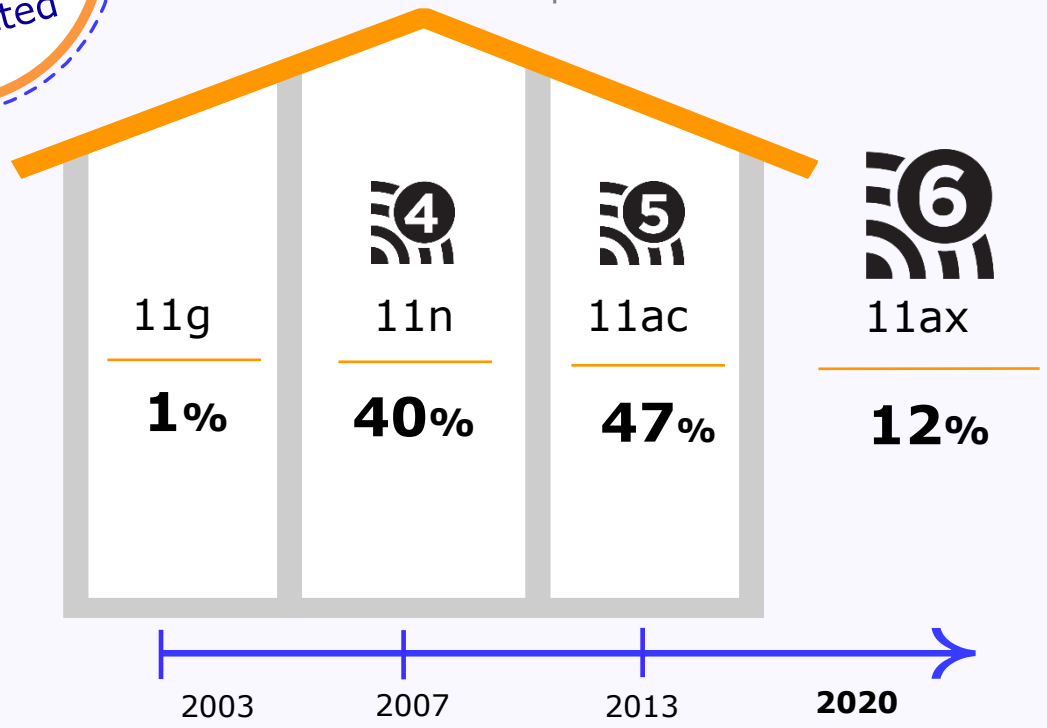
Connection time per day is **10 hours per device**

34%

34% of wireless devices are not dual-band (can only use 2.4GHz)

More than **250 million devices** connected

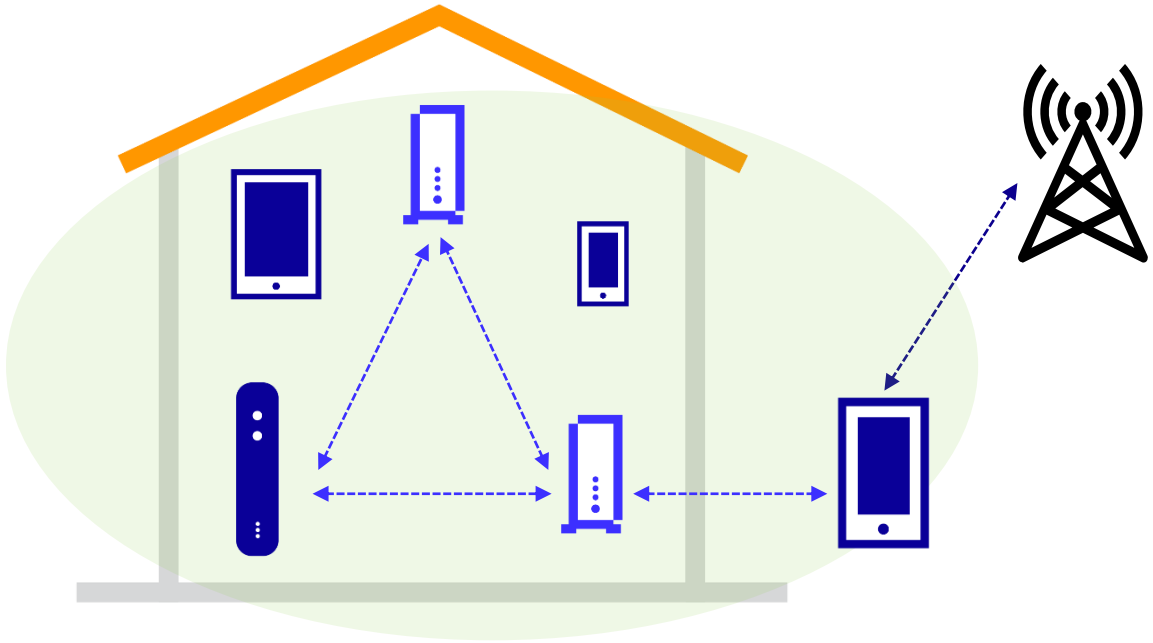
Percentage of client devices per Wi-Fi standard



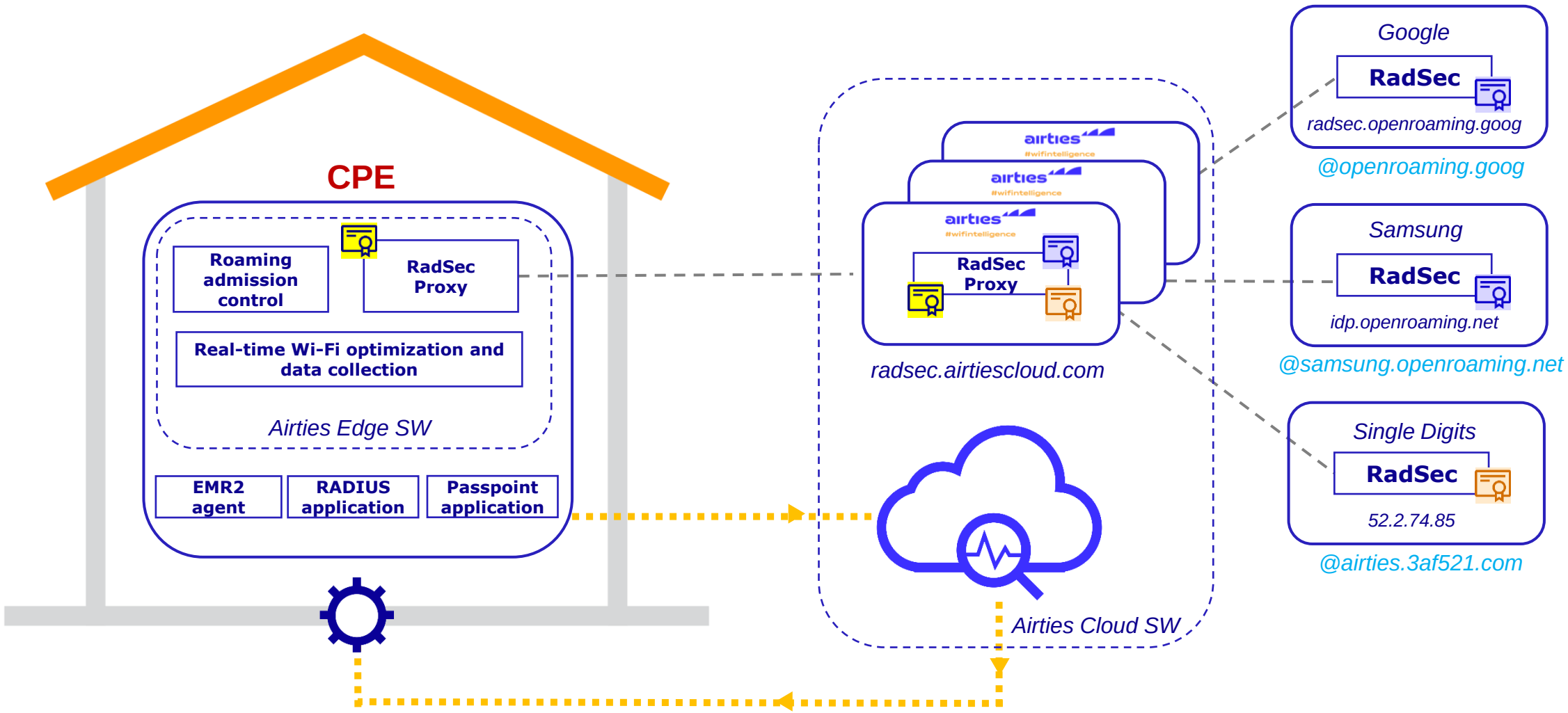
Dec 2020 Airties data - based on actual usage across more than 25 million households worldwide

Airties Smart Wi-Fi supports Wi-Fi Passpoint® and WBA OpenRoaming™

- Airties Smart Wi-Fi allows seamless and secure on-boarding and interoperability for roaming
- Airties makes sure that home user QoE is not adversely affected by hotspot users
- Airties manages hotspots and applies admission control, automatic hotspot enablement
- Airties delivers granular QoS with Wi-Fi6
- Airties measures and reports the user experience of all connected client devices including roaming devices



Airties OpenRoaming™ Solution Architecture



Conclusions

- Home Wi-Fi hotspots can provide significant offload for mobile networks
- Seamless onboarding is addressed by WBA OpenRoaming™ and WFA Passpoint™
- Managed Wi-Fi is necessary to manage the home spots for auto enablement, admission control
- QoE can be achieved through managed Wi-Fi and Wi-Fi 6/6E capabilities
- Converge 5G and Wi-Fi6 which bring the opportunity to deliver uninterrupted QoE

Thank You

www.airties.com

Wi-Fi TSN (WTSN) – from Industrial to Emerging Enterprise Applications

MALCOLM SMITH

WIRELESS CTO ADVISOR

Cisco Systems

WIRELESS BROADBAND ALLIANCE
DRIVING NEXT WIRELESS EXPERIENCE

Wi-Fi TSN (WTSN) – from industrial to emerging Enterprise applications

Malcolm Smith – Wireless CTO Advisor (Cisco Systems Inc.)

Why Wi-Fi TSN (WTSN) ?

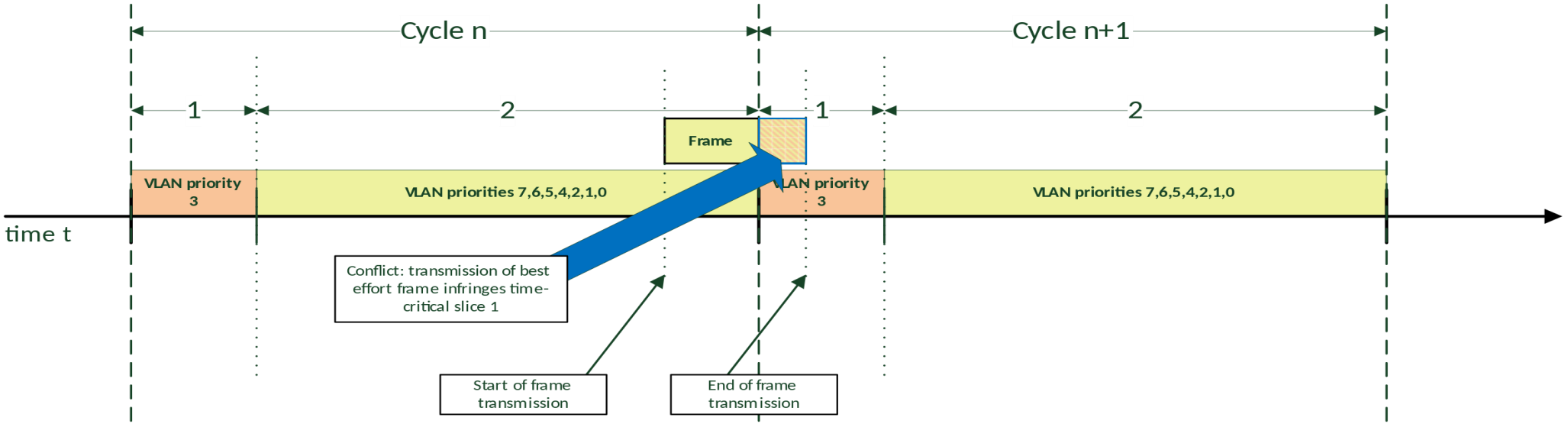
Problem:

Let's recap Wi-Fi6/6E

- Trigger-based uplink access (TB UL-OFDMA)
- AP scheduling can bound *LATENCY*
- Great for *scalable* real-time services such as Voice, Video, Collaboration, etc (e.g. ~10ms)

But what about ultra-low-latency (<1ms) & jitter ?

- Queues *inherently* introduce jitter
- Limited by 802.11 EDCA head-of-line (HOL)



Why Wi-Fi TSN (WTSN) ?

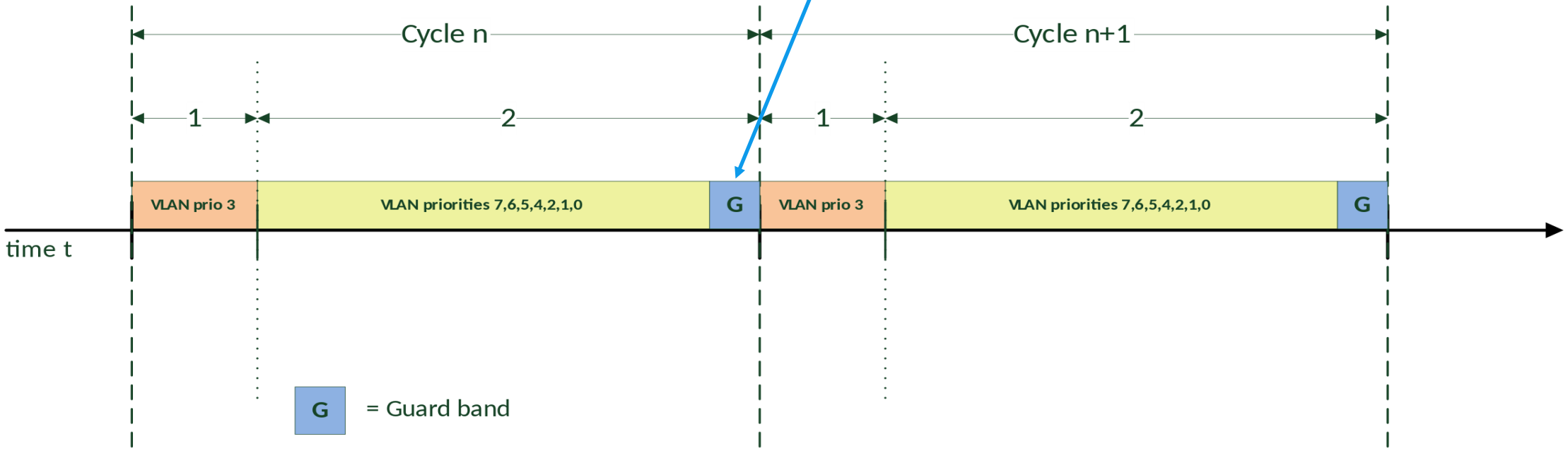
Solution: Wi-Fi Time-sensitive-network (WTSN)

Time-synchronization

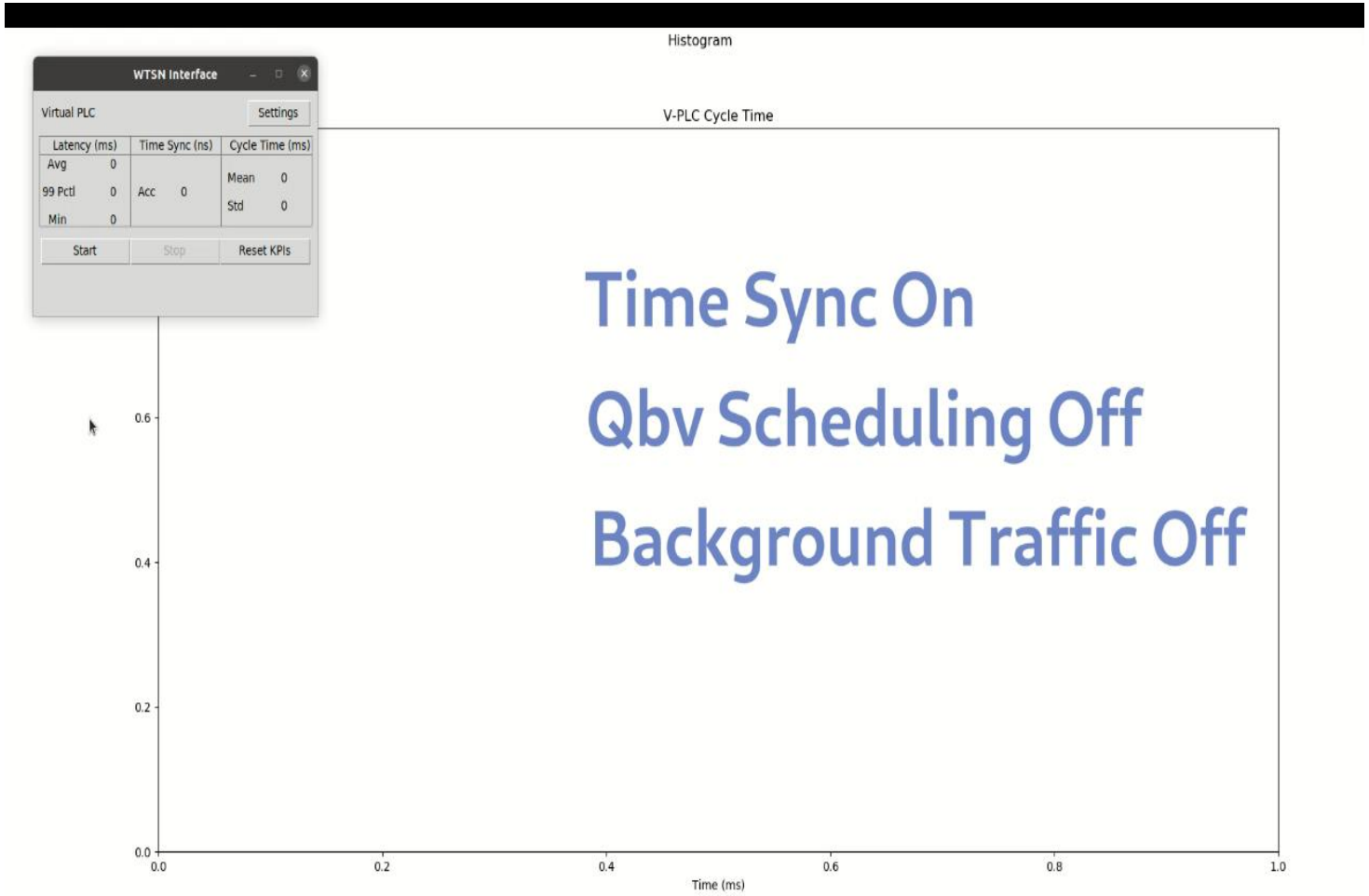
- 802.1AS over 802.11 (FTM) provides common time-reference between network (AP, STA) and applications (e.g. AMR, PLC, etc)

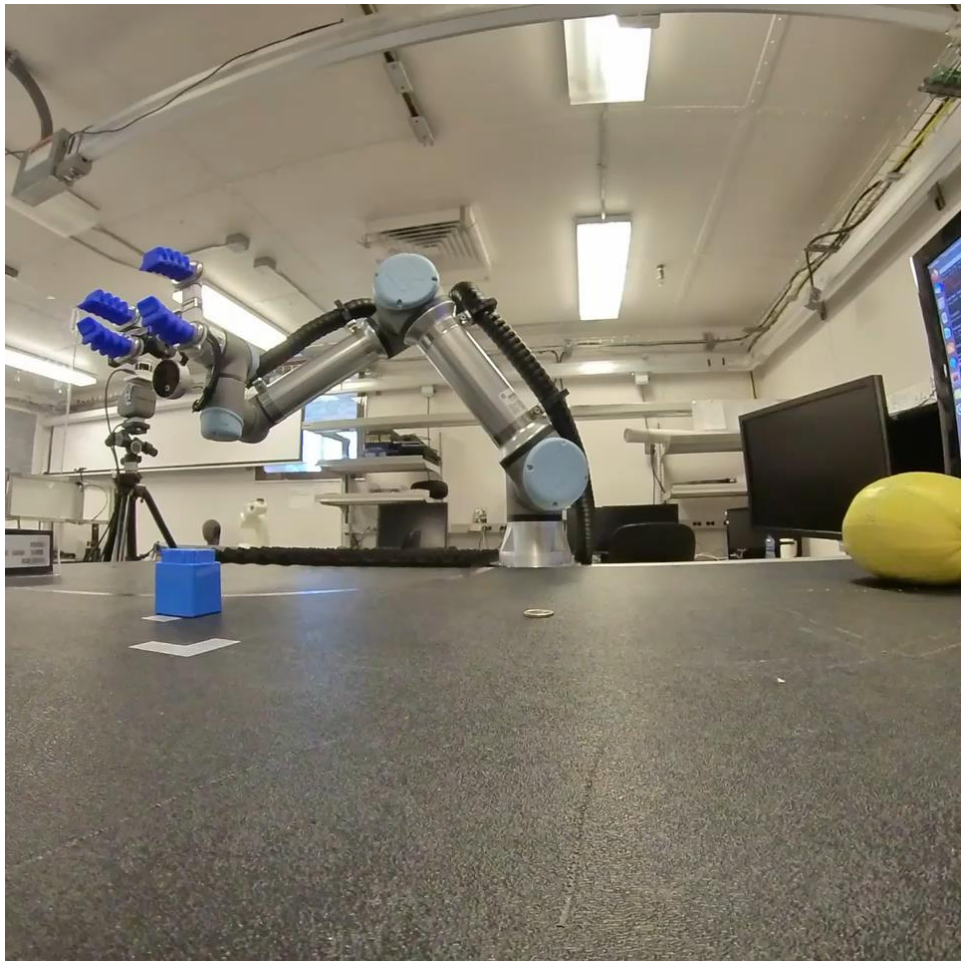
Joint application & network scheduling

- 802.1Qbv (Time-aware-shaping) plus AP scheduling provides time-slots protected with a guard-band (GB)
- Eliminates EDCA HOL blocking
- Enables jitter-free ultra-low-latency (<1ms)



WTSN Affect – Bounded latency





Wi-Fi TSN (WTSN) Industrial use-cases

Typical IIOT WTSN use-cases

- Wireless controls
- AMR/AGVs
- PLCs
- Operational XR
- Video fusion
- …

AR/VR/XR

Technical requirements

- Latency: <1-10ms (99.99…%)
- Virtually no-jitter
- High-reliability

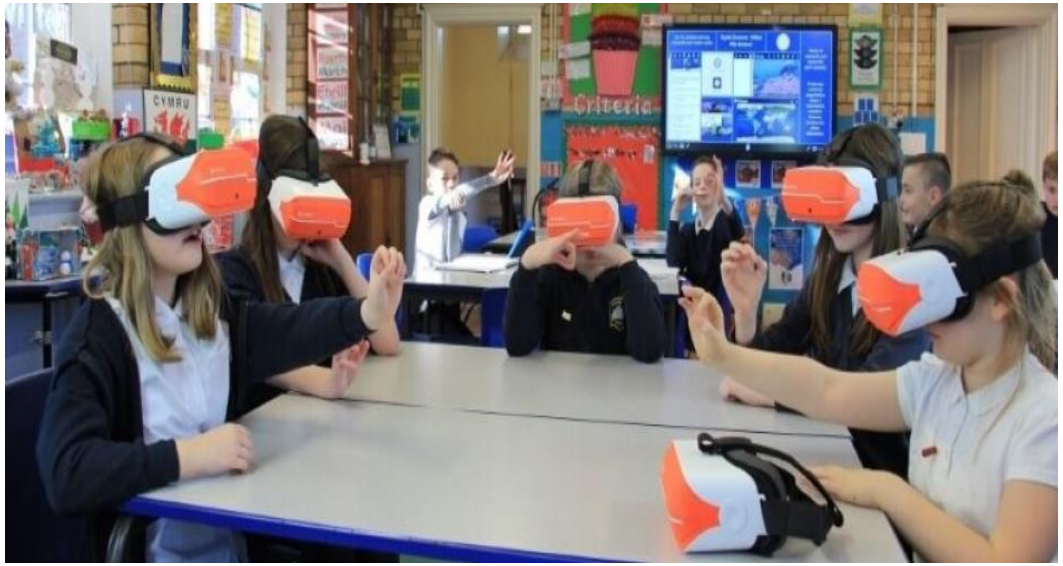
Fail-safe controls

From IIOT to Enterprise

WTSN enables ultra-low latency and jitter-free performance for Industrial IOT include AR/VR/XR applications

Enterprise XR often considered business-critical especially at density e.g. education, conference

WTSN may also be applied to improve Enterprise XR !



Summary

- Wi-Fi TSN (WTSN) enables ultra-low-latency and jitter-free performance
- WiFi6/6E supports WTSN with time-based AP-driven scheduling
- Industrial IOT is the first and most impactful beneficiary of WTSN
- WTSN set to expand into general Enterprise in the form of WTSN for XR

IEEE 802.11 Standards: Wi-Fi 6 and Beyond

DOROTHY STANLEY

IEEE 802.11 WORKING GROUP CHAIR

Aruba Networks, a Hewlett Packard Enterprise company

IEEE 802.11 Standards: Wi-Fi 6 and beyond

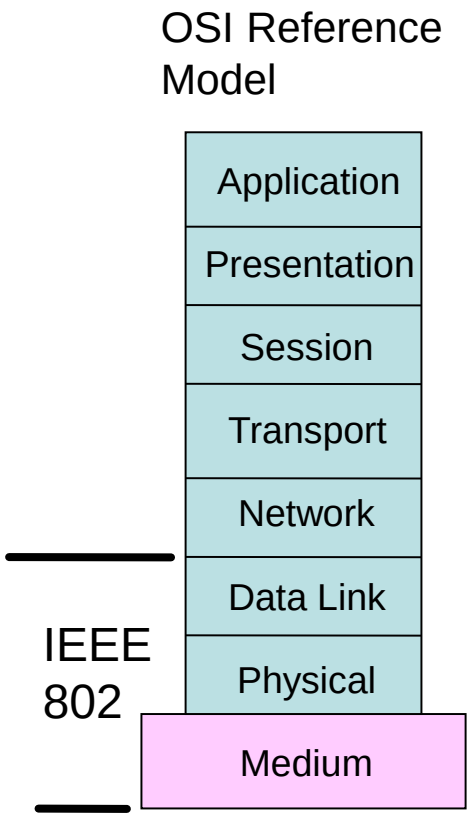
Recently completed standards (4)
Standard support for 5G and WLAN convergence
802.11ah Sub 1GHz and new 802.11 amendments

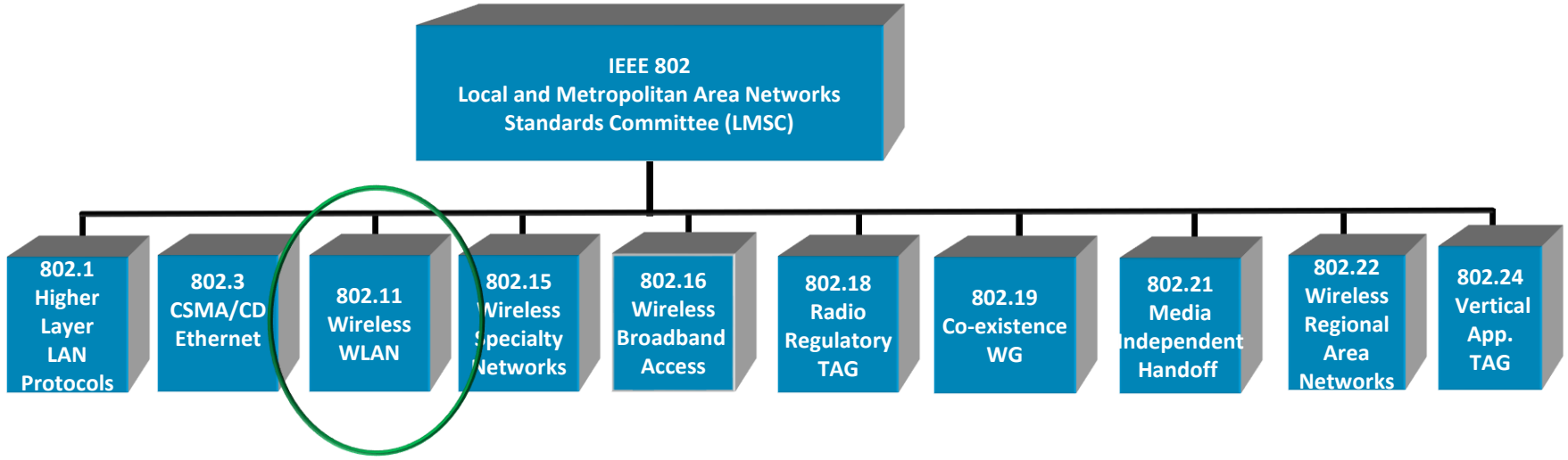
2021-10-07
Presenter: Dorothy Stanley, IEEE 802.11 Working Group Chair

“At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE.” IEEE-SA Standards Board Operation Manual (subclause 5.9.3)

The IEEE 802.11 Wireless LAN Working Group is one of several WGs in the IEEE 802 LAN/MAN Standards Committee

- Focus on **link and physical layers** of the network stack
- Leverage IETF protocols for upper layers





IEEE 802.11 WG Voting Members: 400+

New 802.11 Radio technologies are under development to meet expanding market needs and leverage new technologies. **Completed standards**

IEEE Std 802.11-2020 Revision project, published February, 2021

IEEE Std 802.11ax-2021 – Increased throughput & efficiency in 2.4, 5, 6 GHz bands, published May 2021

IEEE Std 802.11ay-2021 – Support for 20 Gbps in 60 GHz band, published July 2021

802.11az – 2nd generation positioning features

IEEE Std 802.11ba-2021 – Wake up radio. Low power IoT applications, expect publication October 2021

802.11bb – Light Communications

802.11bc – Enhanced Broadcast Service

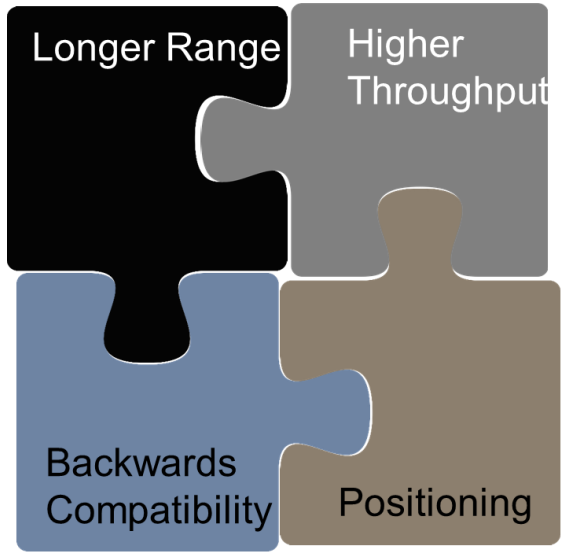
802.11bd – Enhancements for Next Generation V2X

802.11be – Extremely High Throughput

802.11bf – WLAN Sensing

802.11bi – Randomized MAC Addresses

802.11bh – Enhanced Data Privacy



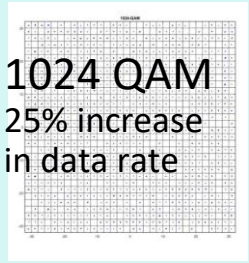
IEEE 802.11 Wi-Fi standard evolution (2.4, 5, 6 GHz)

802.11n (2009) Wi-Fi 4	802.11ac (2013) Wi-Fi 5	802.11ax (2021) Wi-Fi 6 6E	802.11be (est. 2024) Wi-Fi 7
• 2.4GHz and 5GHz supported • Wider channels (40MHz) • Better modulation (64-QAM) • Additional streams (Up to 4) • Backward compatibility with 11a/b/g • Standard supports up to 600Mbps	• 5GHz only • Wider channels (80, 160MHz) • Better modulation (256-QAM) • Additional streams (Up to 8, implemented up to 4) • Backward compatibility with 11a/b/g/n • Standard supports up to 7Gbps	• 2.4GHz, 5GHz and 6GHz supported • Wider channels (80, 160MHz) • Better modulation (1024-QAM) • Additional streams (Up to 8, implemented) • Backward compatibility with 11a/b/g/n/ac • Standard supports up to 9.6Gbps	• 2.4GHz, 5GHz and 6GHz supported • Wider channels (40, 80, 160, 240, 320MHz) • Better modulation (4096-QAM) • Additional streams (Up to 16) • Backward compatibility with 11a/b/g/n/ac/ax • Standard targets throughput minimum of 30Gbps, expect 40Gbps+

(Ratification date) Products available in the market typically ~2 years prior

802.11ax-2021 was approved 2021 Jan, published in 2021 May
Products based on 802.11ax: Wi-Fi 6, 6E

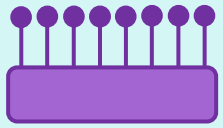
Spectral Efficiency & Area Throughput

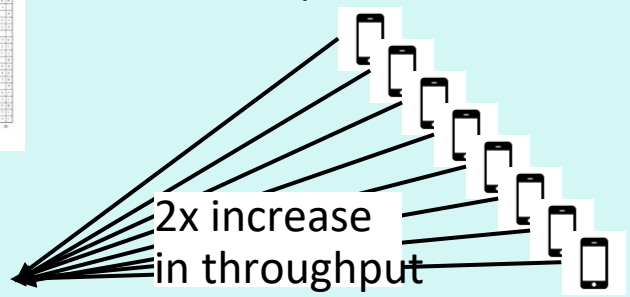


1024 QAM
25% increase
in data rate

DL/UL MU-MIMO
w/ 8 clients

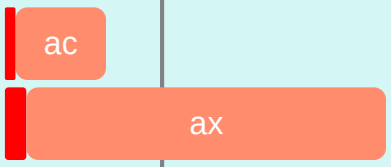
8x8 AP





2x increase
in throughput

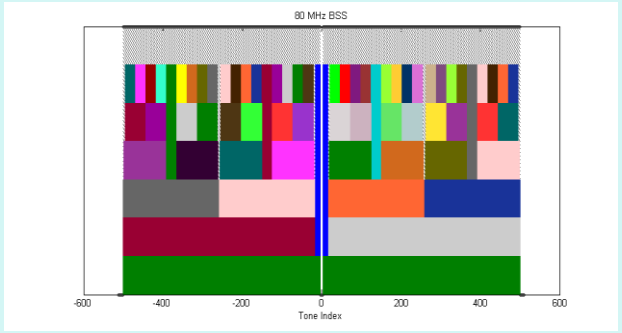
Long OFDM
Symbol



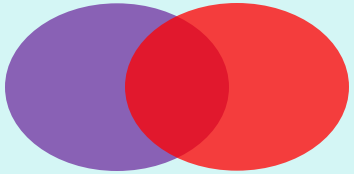
Up to 20%
increase
in data rate

High Density

OFDMA

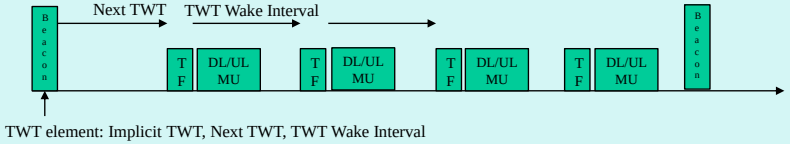


Spatial Reuse



Power Saving

Scheduled sleep and wake times



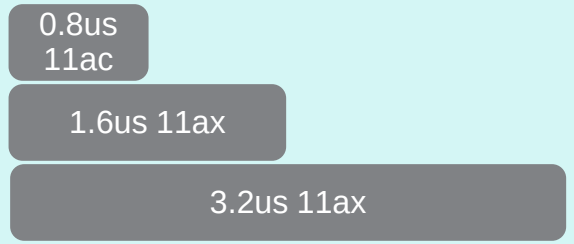
TWT element: Implicit TWT, Next TWT, TWT Wake Interval

20 MHz-only clients

Outdoor / Longer range

Extended range packet structure

Enhanced delay
spread protection-
long guard interval

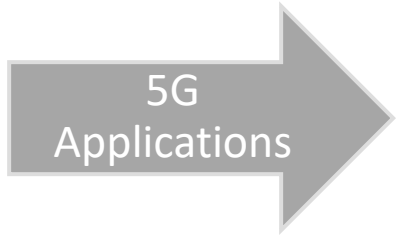


802.11ay-2021 Approved 2021 March, published 2021 July

Defines next generation 60GHz operation to increase throughput, range

20Gbps+ rates are defined
License- Exempt bands above 45Gbps
First chipsets announced

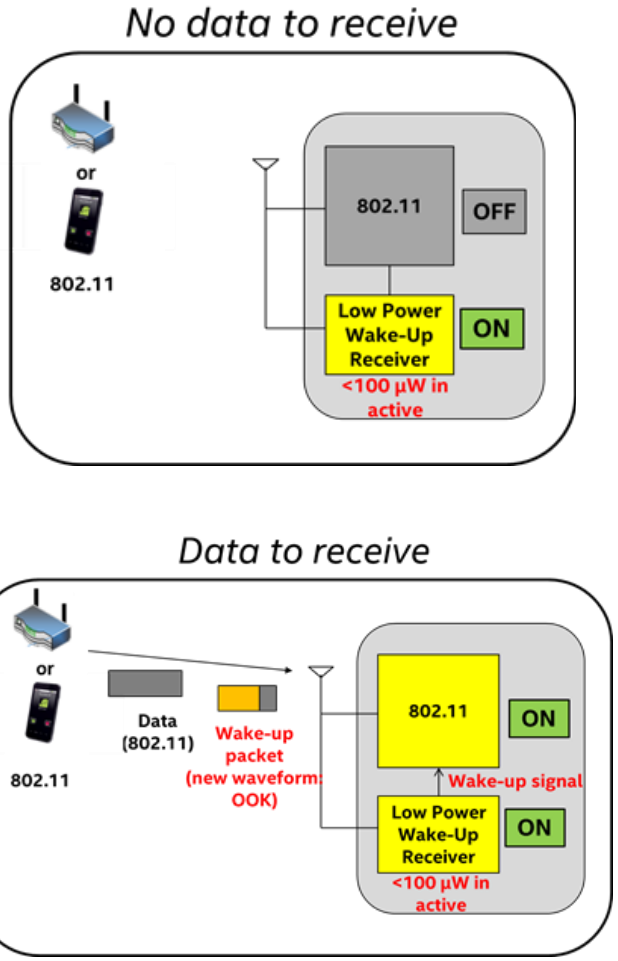
802.11ay Use Cases:
- Ultra-Short Range
- 8K UHD - Smart Home
- AR/VR and wearables
- Data Center Inter Rack connectivity
- Video / Mass-Data distribution
- Mobile Offloading and MBO
- Mobile Fronthauling
- Wireless Backhauling (w. multi-hop)
- Office Docking
- Fixed Wireless Access



5G Use Cases:
- Fixed Wireless Access
- Wireless backhauling (with multi-hop)
- Very High Throughput Short Range

802.11ba Approved 2021 March, publication 2021 October
Introduces a Low-power Wake-up Receiver (LP-WUR)

- Communication Subsystem = Main radio (802.11) + **LP-WUR**
  - **Main radio (802.11): for user data transmission and reception**
    - Main radio is off unless there is something to transmit
    - LP-WUR wakes up the main radio when there is a packet to receive
    - User data is transmitted and received by the main radio
  - **LP-WUR: not for user data; serves as a simple "wake-up" receiver for the main radio**
    - LP-WUR is a simple receiver (doesn't have a transmitter)
    - Active while the main radio is off
    - Target power consumption < 1 mW in the active state
      - Simple modulation scheme such as On-Off-Keying (OOK)
      - Narrow bandwidth (e.g. < 5 MHz)
    - Target transmission range: LP-WUR = Today's 802.11



IEEE 802.11 Standards: Wi-Fi 6 and beyond

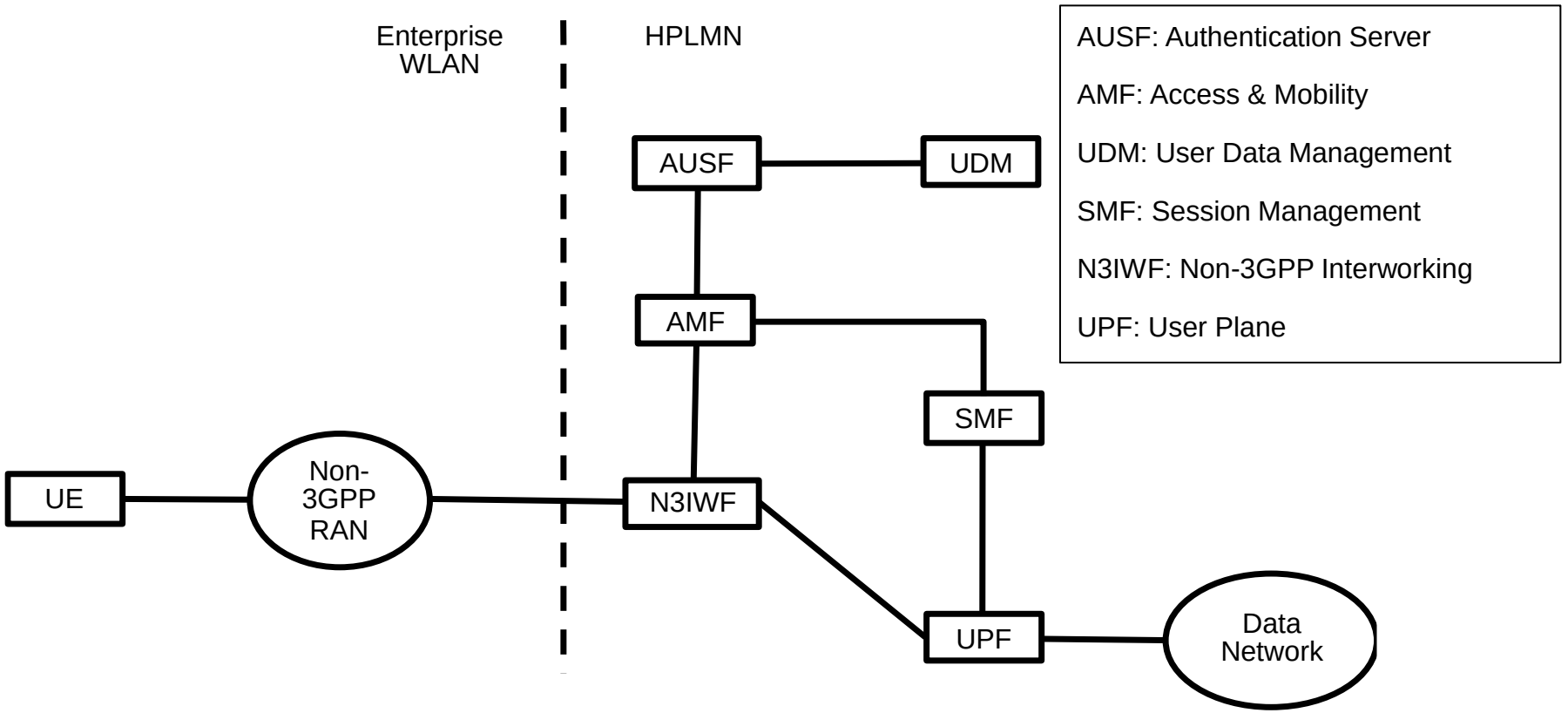
Recently completed standards (4)

Standard support for 5G and WLAN convergence

802.11ah Sub 1GHz and new 802.11 amendments

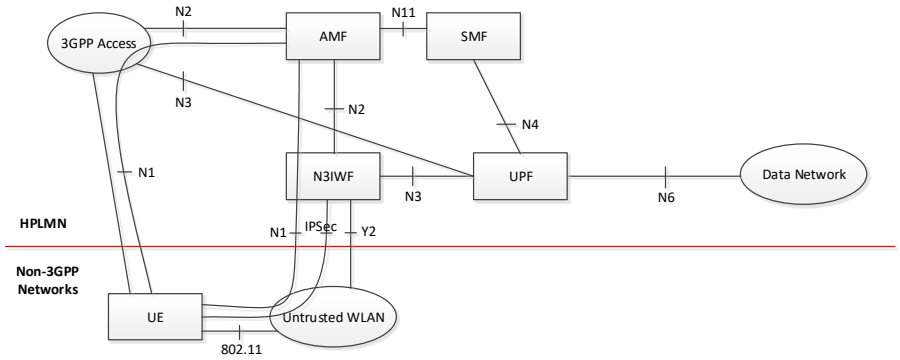
The initial foundations for Wi-Fi in 5G were defined in Rel-15: Technology Agnostic Interface

- *3GPP 5G specifications integrate support for non-3GPP access networks*
- *Wi-Fi discovery and authentication remains out of scope for 3GPP specifications*

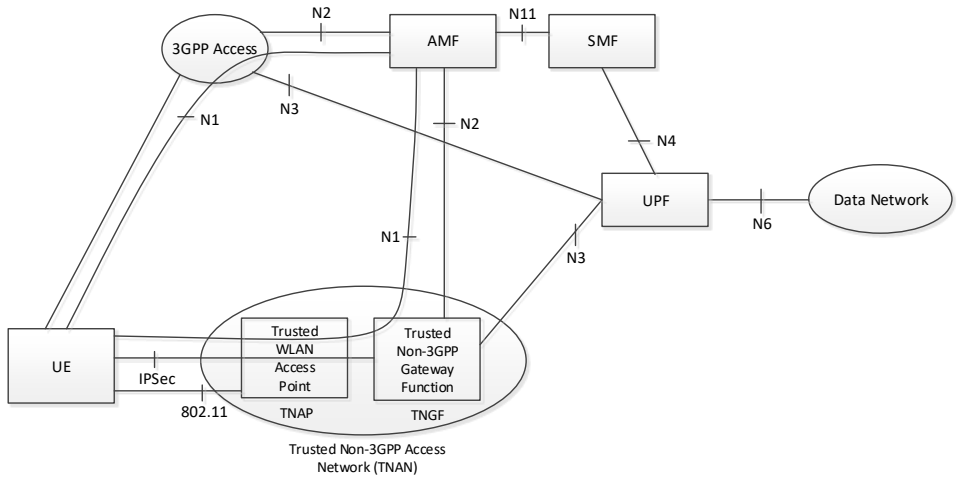


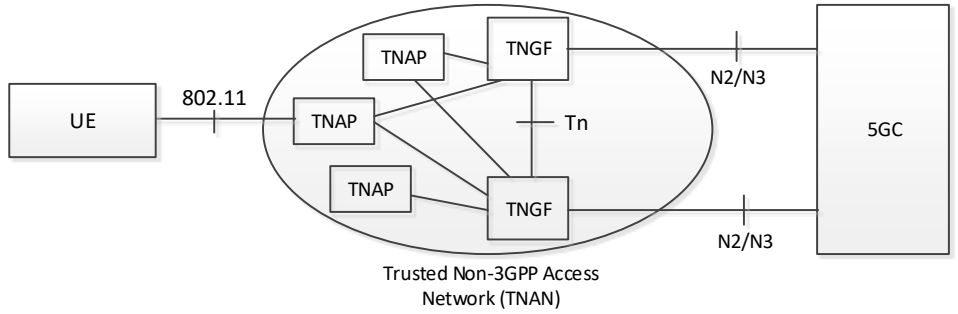
802.11 WLAN is a Peer Radio Access Technology in the 5G System

Untrusted WLAN Access (3GPP Rel-15 onwards)



Trusted WLAN Access (3GPP Rel- 16 onwards)





- 5G System is Access Agnostic: UE devices can register and access 5G services without the need of licensed based access;
- Unified EAP based authentication mechanism for all accesses;
- Unified transport mechanism over WLAN access for both trusted and untrusted use cases;
- Policies based mechanism for access selection and traffic selection, steering and splitting;
- Unified QoS mechanism for both cellular and WLAN access.

IEEE 802.11ax meets the MAC/PHY requirements for 5G IMT-2020 Indoor Hotspot and Dense urban test environments defined by ITU-R

Simulation conforming to the ITU-R evaluation methodology shows that performance of IEEE 802.11ax systems meet or exceed MAC and PHY requirements for the 5G Indoor Hotspot and Dense Urban test environments

	Metric (Indoor Hotspot)	ITU-R Evaluation Method	Minimum Requirement	802.11ax Performance
1	Peak data rate	Analytical	DL/UL : 20/10 Gbps	DL/UL : 20.78 Gbps
2	Peak spectral efficiency	Analytical	DL/UL : 30/15 bits/s/Hz	DL/UL : 58.01 bits/s/Hz
3	User experienced data rate	Analytical for single band and single layer; Simulation for multi-layer	Not applicable for Indoor Hotspot	Not applicable
4	5th percentile user spectral efficiency	Simulation	DL/UL : 0.3/0.21 bits/s/Hz	DL/UL : 0.45/0.52 bits/s/Hz
5	Average spectral efficiency	Simulation	DL/UL : 9/6.75 bits/s/Hz/TRxP	DL/UL : 9.82/13.7 bits/s/Hz/TRxP
6	Area traffic capacity	Analytical	DL : 10 Mbit/s/m^2	Required DL bandwidth = 170 MHz with 3 TRxP/site
7	Mobility	Simulation	UL : 1.5 bits/s/Hz	UL : 9.4 bits/s/Hz
8	Bandwidth	Inspection	100 MHz, scalable	20/40/80/80+80/160 MHz
9	User plane latency	Analytical	DL/UL : 4 ms	DL/UL : 80 us

IEEE 802.11ax in the 6GHz band: WFA Wi-Fi 6E Interoperability certification is now available:

Wi-Fi 6E brings Wi-Fi® into 6 GHz

Features

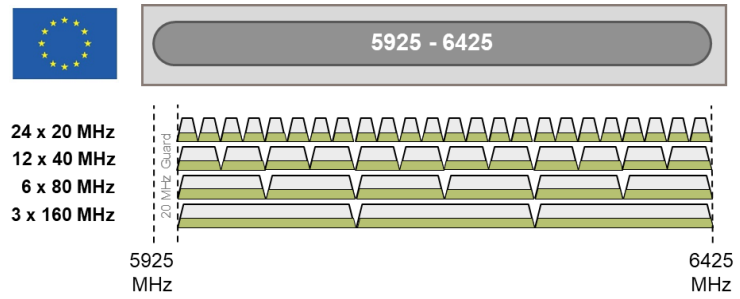
- More, contiguous spectrum (6 GHz)
- Wider channels (80 160 MHz)
- Less interference

Benefits

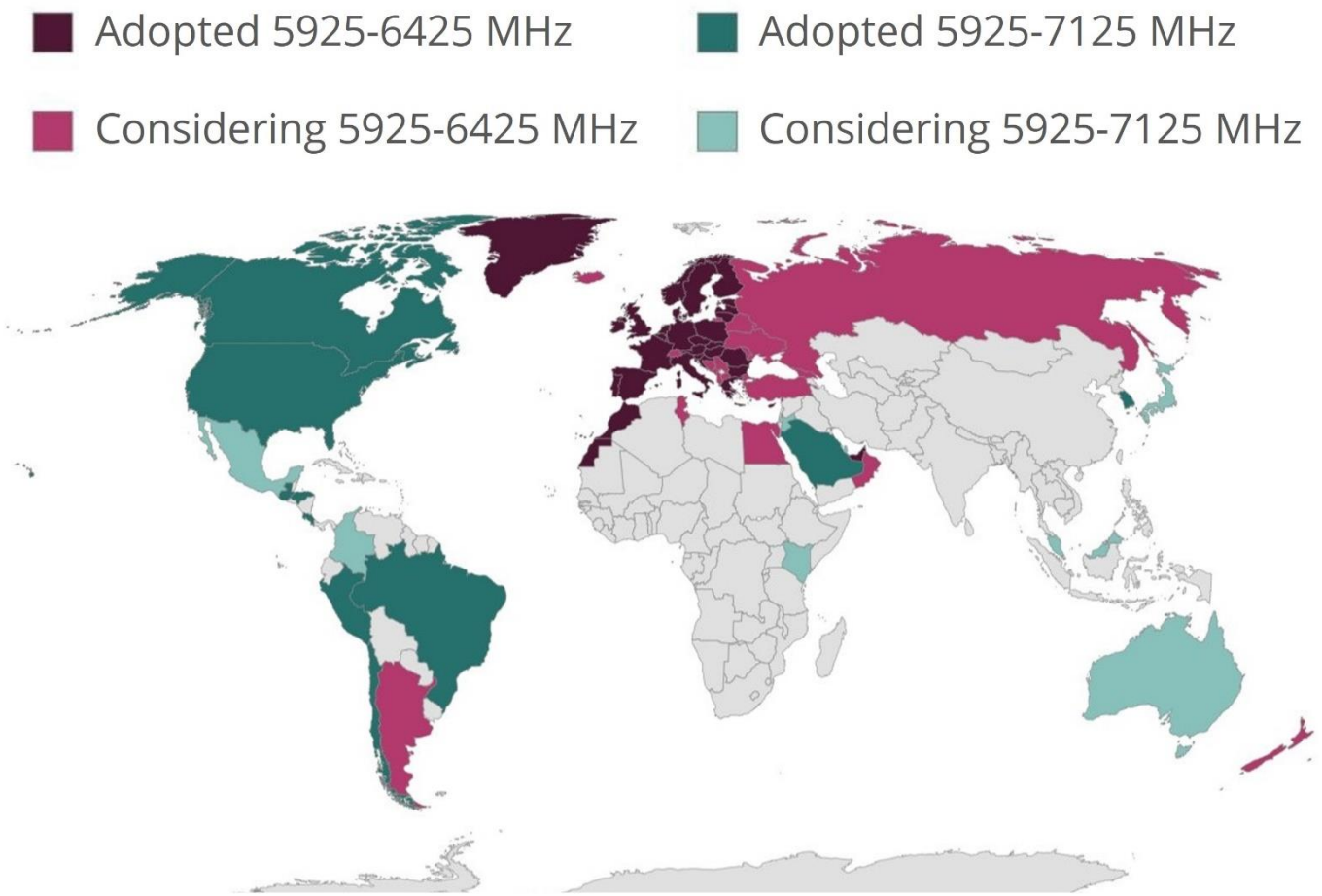
- Gigabit speeds
- Extremely low latency
- High capacity

Certification Announced 2021-01-07

Press release
Paper: Wi-Fi 6E: Wi-Fi® in the 6 GHz band
Wi-Fi 6E Highlights
Wi-Fi 6E Video animation
List of certified devices



Countries enabling Wi-Fi 6E: 6GHz Operation, see https://www.wi-fi.org/countries-enabling-wi-fi-6e (as of 2021-09-29)



Convergence between 5G and Wi-Fi RAN networks span the OSI layers; Focus on QoS

Topics include

- 5G and Wi-Fi convergence architecture (Trusted and Untrusted WLAN)
- ATSSS multi-access functionality
- End-to-end Quality of Service (QoS)
- Policy Interworking and enhancements across 5G and Wi-Fi
- Support for Wi-Fi only devices

See https://mentor.ieee.org/802.11/dcn/21/11-21-0170-00-0000-2021-jan-liaison-from-wba-re-convergence.docx

See https://grouper.ieee.org/groups/802/11/Liaisons/2021-09-28-liaison-response-to-wba-qos-material.pdf

Several relevant QoS management mechanisms are defined in IEEE Std 802.11-2020*

Including:

802.11e EDCA Access Categories: Voice, Video, Best Effort, Background; widely implemented as WFA WMM

Stream Classification Service (initial specification dates to 2009)

Traffic Classification (TCLAS) based on L3 parameters: IPsec Security Parameter Index

Use Multiple TCLAS elements to define SPI, IP Address, Ports

Mirrored Stream Classification Service: Client devices direct the AP QoS marking of downlink IP flows (useful when DSCP markings not present)

QoS Map feature: L2 priority based on L3 DSCP marking in IP headers

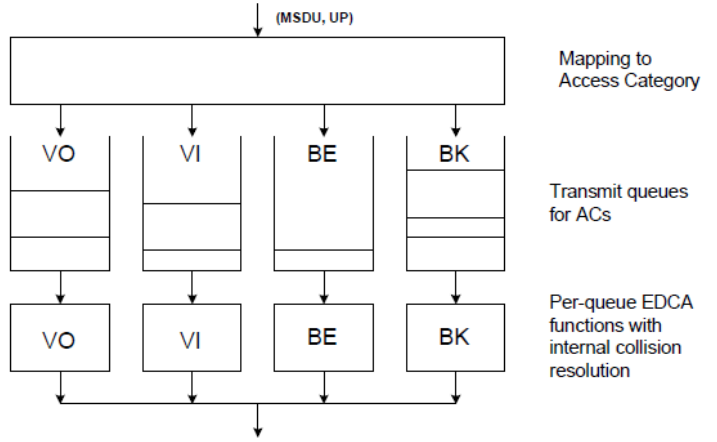


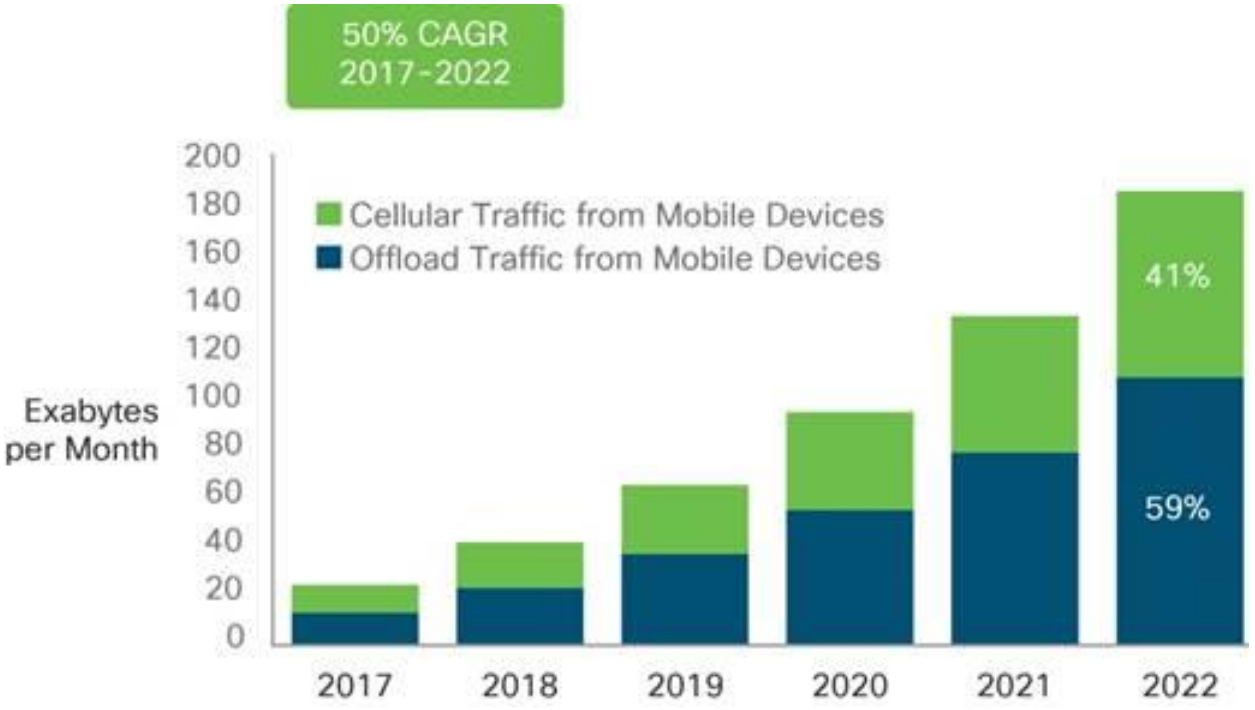
Figure 10-23—Reference implementation model when dot11AlternateEDCAActivated is false or not present

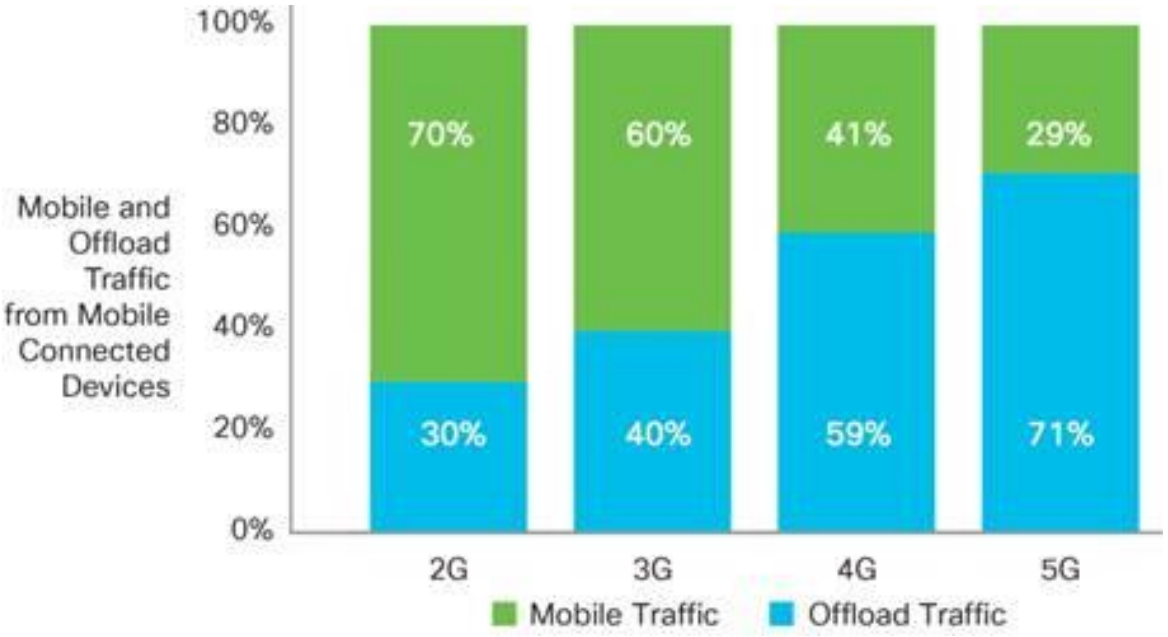
4.3.24.4 Mirrored stream classification service (MSCS)

MSCS enables the establishment of classification using layer 2 and/or layer 3 signaling to classify incoming individually addressed MSDUs into streams. Once classified, individually addressed MSDUs in each stream are assigned to a user priority based on the user priority of MSDUs matching the stream in the reverse direction.

*** Many also have WFA interoperability certification**
Additional mechanisms under development, input welcome

Offload Traffic from Mobile Devices on to Wi-Fi is Significant and Increasing; Wi-Fi Calling use is prevalent and expanding





Source of charts: Cisco VNI 2019

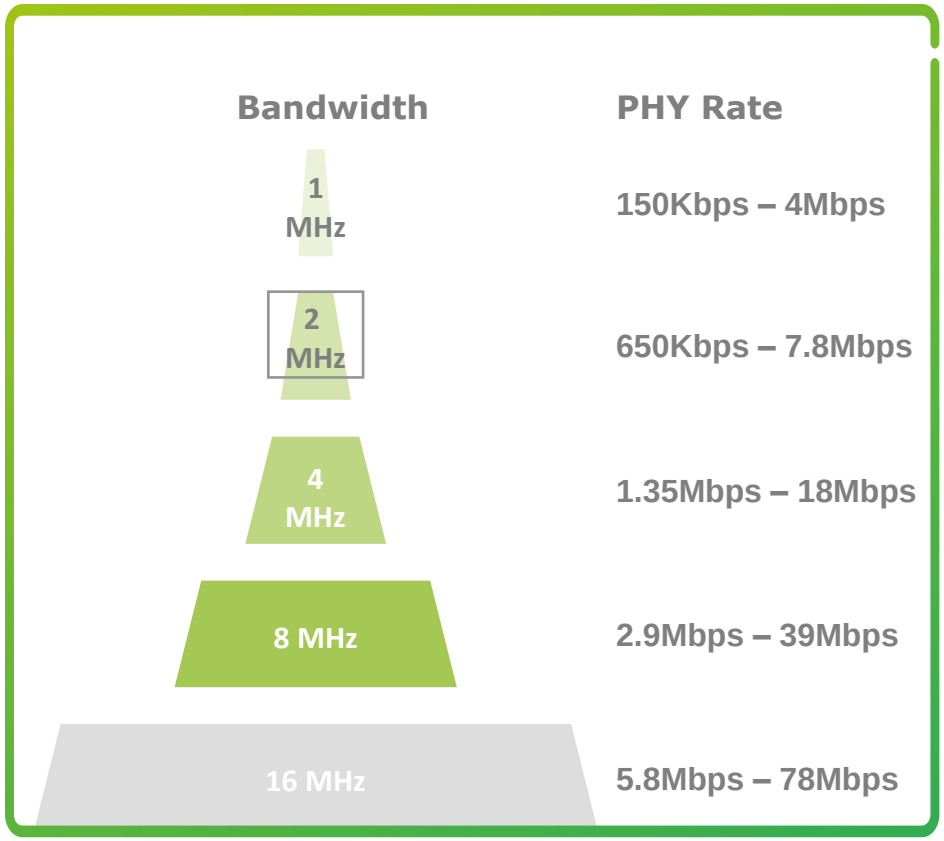
IEEE 802.11 Standards: Wi-Fi 6 and beyond

Recently completed standards (4)

802.11 Standard support for 5G and WLAN convergence

802.11ah Sub 1GHz and new 802.11 amendments

IEEE Std 802.11ah-2016 enables Wi-Fi for M2M and IoT applications



Long range indoor/outdoor connectivity up to 1 km

Robust connections for superior penetration through walls and other obstacles in home and industrial environments

Low power consumption for multi-year battery operation

Bidirectional monitoring and control of IoT client devices enable over the air software updates

Moderate data rates **support IETF TCP/IP, discovery protocols**

WFA is defining the **Wi-Fi Certified HaLow** certification program
Japan: **802.11ah Promotion Council**
New market entrants emerging to develop the technology

802.11ah use cases are broad: Consumer, Industrial, Agricultural

Industrial Automation

Smart robots with local imaging

Agriculture, Horticulture, City farming

Large number of devices supported

See http://www.methods2business.com/applications

Process Automation

Predictive maintenance, logistics, inventory tracking

Healthcare in hospital and home settings

Home and Building automation

Energy and asset management

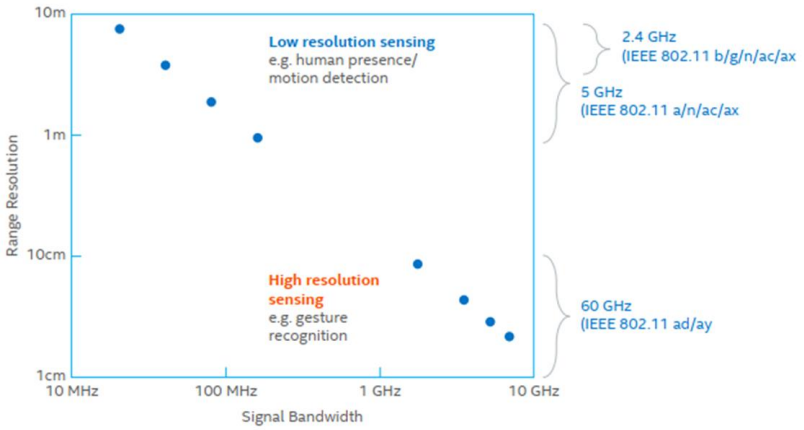
Remote operation/self diagnosis

Whole home coverage for battery operated sensors

Retail: Electronic shelf labels

New 802.11 Radio technologies are under development to meet expanding market needs and leverage new technologies

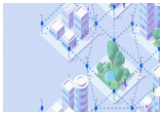
- **802.11az – 2nd generation positioning features**
- **802.11bb – Light Communications**
- **802.11bc – Enhanced Broadcast Service**
- **802.11bd – Enhancements for Next Generation V2X**
- **802.11be – Extremely High Throughput**
- **802.11bf – WLAN Sensing**
- **802.11bh – Randomized MAC Addresses**
- **802.11bi – Enhanced Data Privacy**

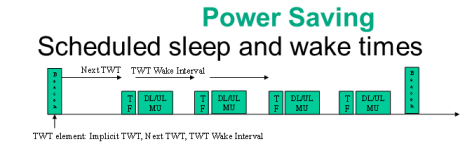


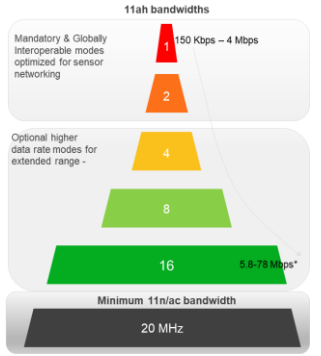
The IEEE 802.11 standard continues to be enhanced to support innovative services and business models

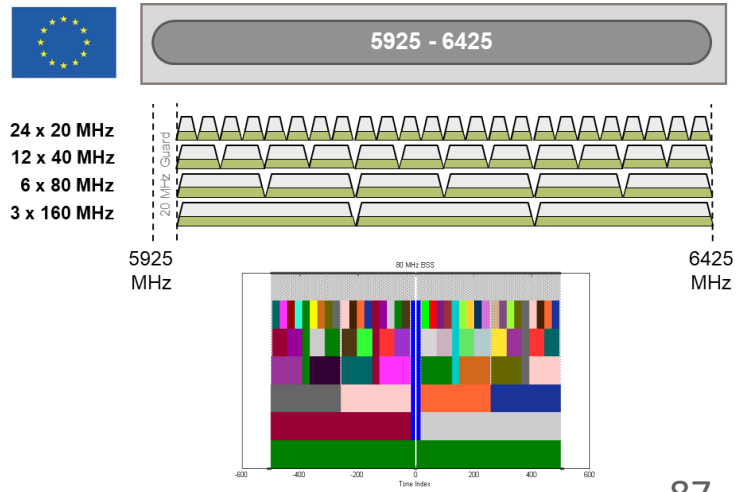
IEEE 802.11 standard development enables

- Support of existing and new services, including 5G services
- Support of existing and new business models
- Enabling significant economic growth and societal development









Thank you!!!

dorothy.stanley@hpe.com dstanley@ieee.org

THANK YOU

QUESTIONS

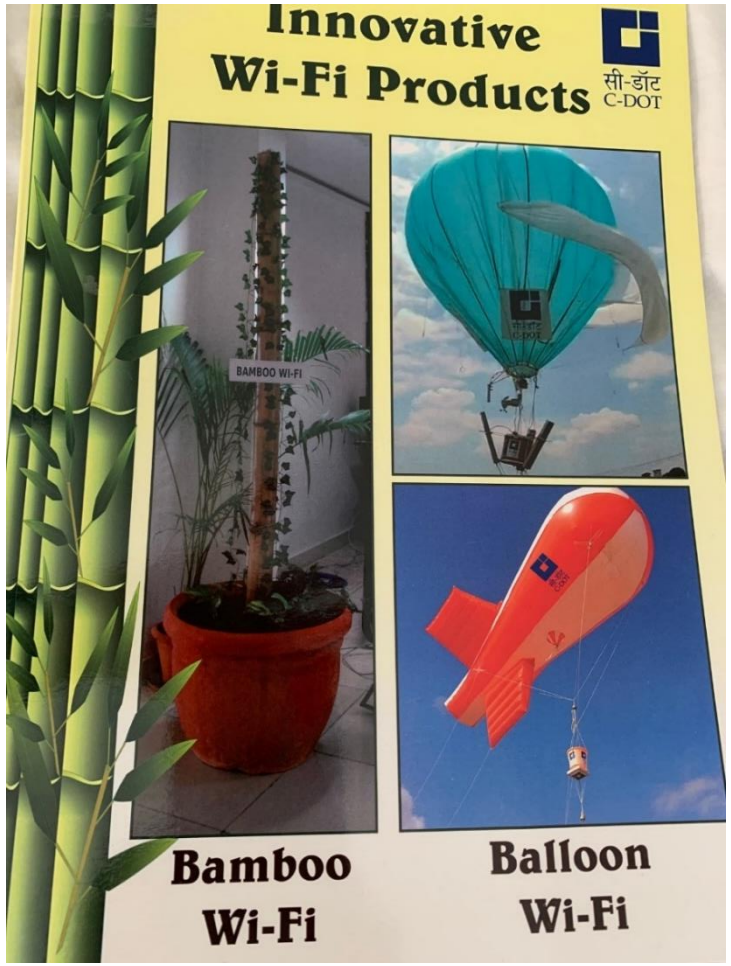
Useful Links

- 802 home page: http://www.ieee802.org/
- 802.11 home page: http://ieee802.org/11/
- Help if you want to contribute: http://www.ieee802.org/11/help.html
- 802.11 document server: https://mentor.ieee.org/802.11/documents
- Wi-Fi Alliance http://www.wi-fi.org/
- Get 802.11 standards:
  - http://standards.ieee.org/about/get/802/802.11.html
  - http://www.techstreet.com/ieee

IEEE 802.11 technology is used globally to provide ICT connectivity

Customized products are developed using IEEE 802.11 systems for *remote connectivity, disaster management, targeting developing countries.*
Example: India Centre for development of Telematics

Hughes Satellite-Enabled *Community Wi-Fi Hotspots* Provide Affordable Internet Access Across Vast Areas of Russia; *1,300 Community Wi-Fi Hotspots enable Internet connectivity for more than 300,000 people*

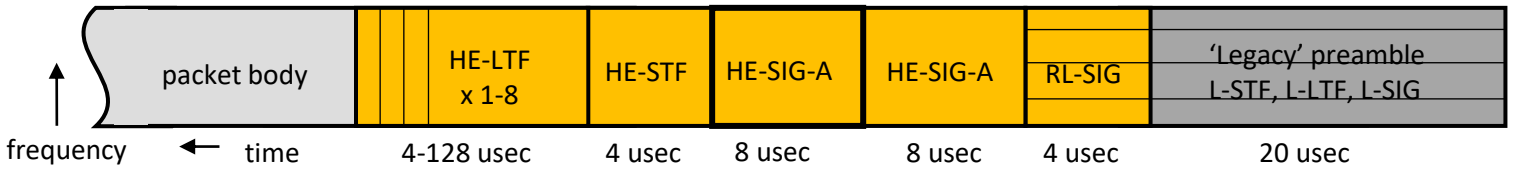


802.11ax features support large client populations, extended range, battery life to meet the needs of IOT Use Cases

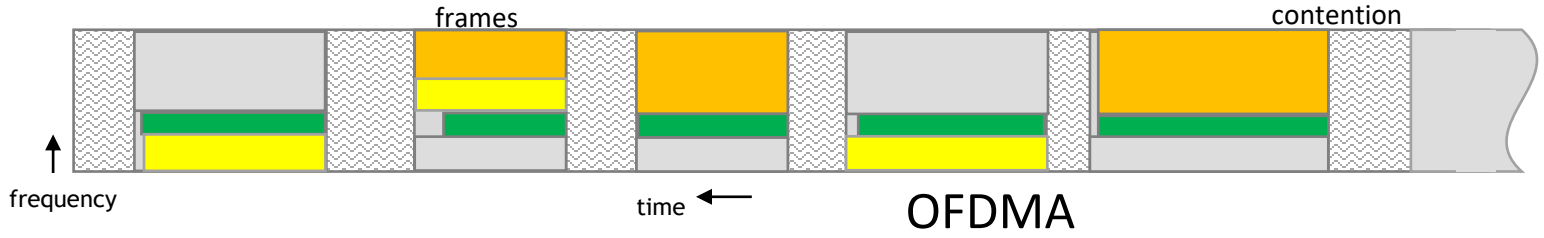
802.11ax features for IoT include:

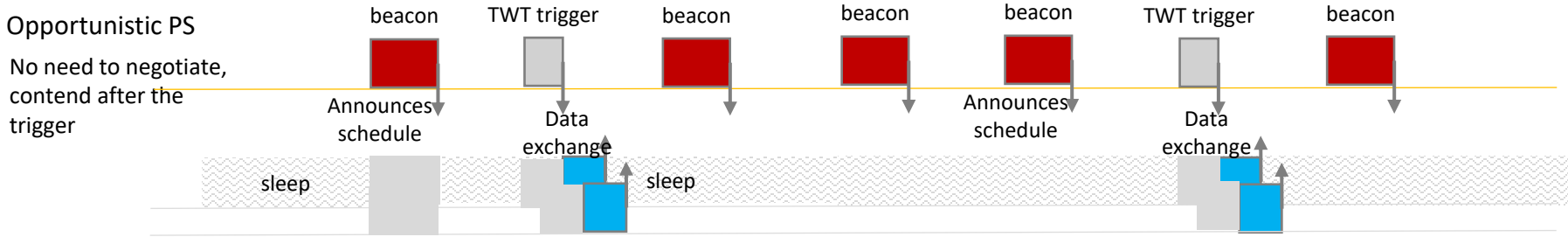
- >1000 devices per AP
- Extended range options
- Low rates with OFDMA
- Power-saving with TWT
- 20 MHz-only operation

Single-user extended-range frame



Always transmitted in 1 spatial stream, at MCS0, MCS1 or MCS2 modulation



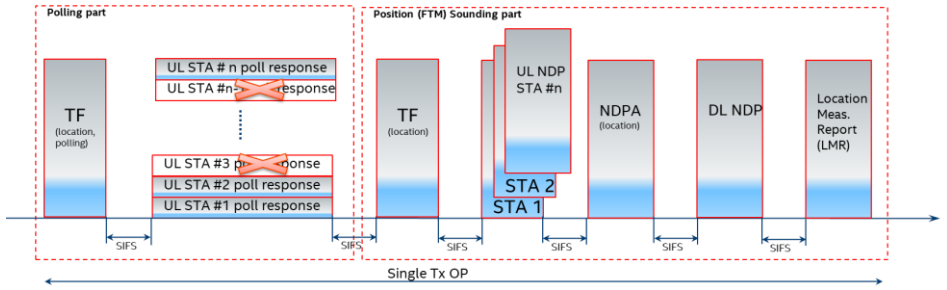


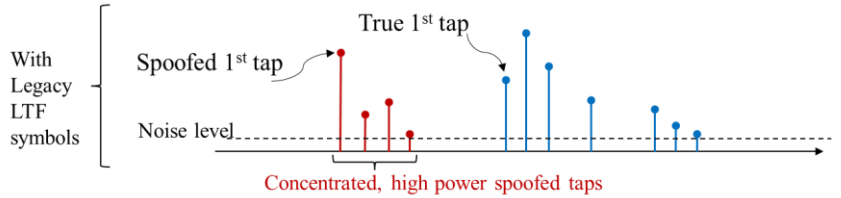
802.11az Next Generation Positioning

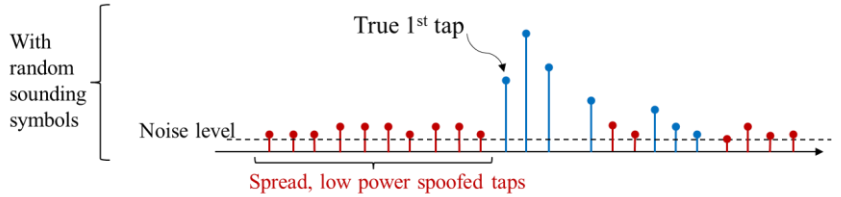
- Next Generation Positioning P802.11az project is the evolutionary roadmap of accurate 802.11 location (FTM) appearing first in previous revisions of the 802.11 standard:
  - Accurate indoor Navigation (sub 1m and into the <0.1m domain).
  - Secured (authenticated and private) positioning – open my car with my smartphone, position aware services (money withdrawal).
  - Open my computer with my phone/watch.
  - Location based link adaptation for home usages (connect to best AP).
  - Navigate in extremely dense environments (stadia/airport scenarios).

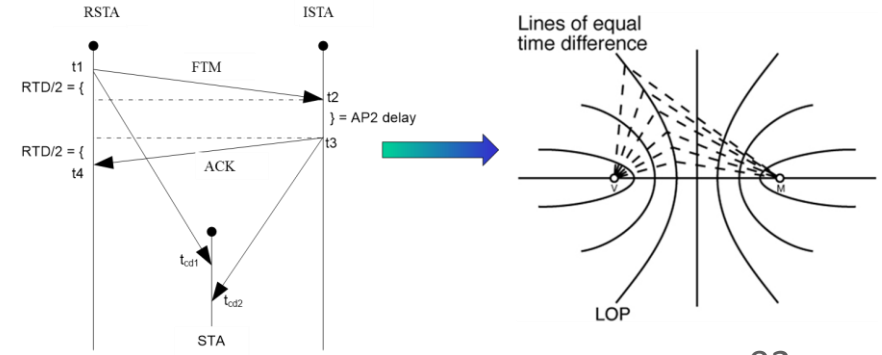
802.11az Key Radio and Positioning Techniques

- Medium efficient operation via dynamic (demand dependent) measurement rate.
- Adaptation to next generation mainstream 802.11ax Trigger Based Operation (MIMO, Trigger Frame, NDP frame)
- Authenticity and privacy and anti-spoofing mechanism via PMF in the unassociated mode and PHY level randomized measurement sequences (HE LTF sequences protection).
- Improved accuracy via MIMO and larger BW available in the <7Ghz band for 11ax.
- MIMO enablement for measurement for improved accuracy especially for NLOS or NNLOS conditions.
- Passive location with fixed overhead independent of number of users









802.11bb Light Communications

- 5Gbps+ rates are defined
- Light Communications (LC)

Use Cases:
- Industrial wireless applications
- Medical environments
- Enterprise
- Home
- Backhaul
- Vehicle to Vehicle Communication
- Underwater Communication
- Gas Pipeline Communication

Key additions :
- Uplink and downlink operations in 380 nm to 5,000 nm band
- Minimum single-link throughput of 10 Mb/s
- Mode supporting at least 5 Gb/s,
- Interoperability among solid state light sources with different modulation bandwidths.

802.11bb usage model 1: Industrial wireless

Pre-Conditions

Devices may experience unstable radio frequency (RF) connection due to Electro-Magnetic Interference (EMI) in factories. LC is deployed to provide reliable wireless connectivity for industrial wireless networks.

Environment

All communications are within a large metal building, industrial or automated work cell. The area of these environments range from tens to thousands of square meters, equipped with industrial robot and other equipment. The environment has high levels of EMI. Lighting level of 150 lux is recommended (1500 lux for dedicated work).

Applications

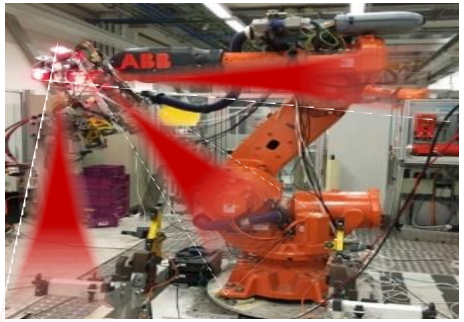
Ultra-high-definition (UHD) video streaming for surveillance or production monitoring (quality control) applications, for video collaboration for team, customer, and supplier meetings. Lightly compressed Video: ~ 1Gbps, delay < 5 ms, $1x10^{-8}$ PER, 99.9% reliability. Fully connected factory—for real-time communications, application execution, and remote access.Distance between LC APs ranges from 2~20 meters.

Traffic Conditions

Both uplink and downlink traffic is using LC.
High levels of OBSS interference between LC access points (APs) expected due to very high density deployment.
Potential non-LC interference from surrounding environments such as artificial-light.
Multiple LC modules are deployed on the robot/equipment and on the ceiling/walls to provide multiple light links for a robust connectivity in case a single line-of-sight (LOS) link is blocked.

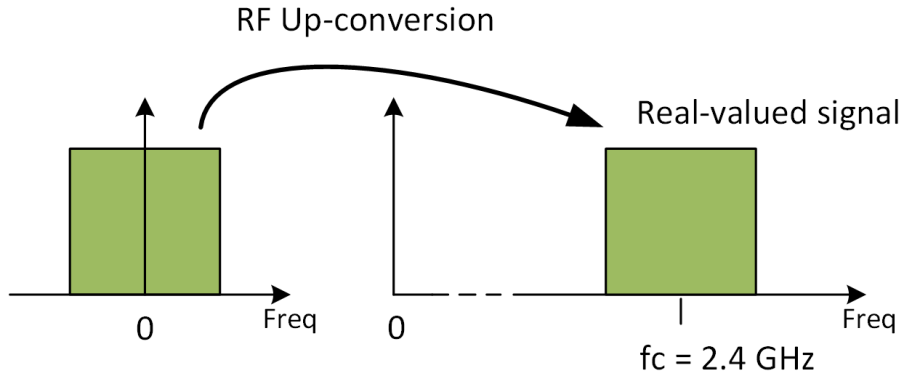
Use Case

An industrial robot is powered on and ready for operation.
Operating instructions are transmitted to the robot via LC.
The robot is working (e.g., movement) according to the instructions and provides real-time feedback information and/or video monitoring data for quality control to control center also via LC. Upon command, the robot finishes the task and is ready for the next one.

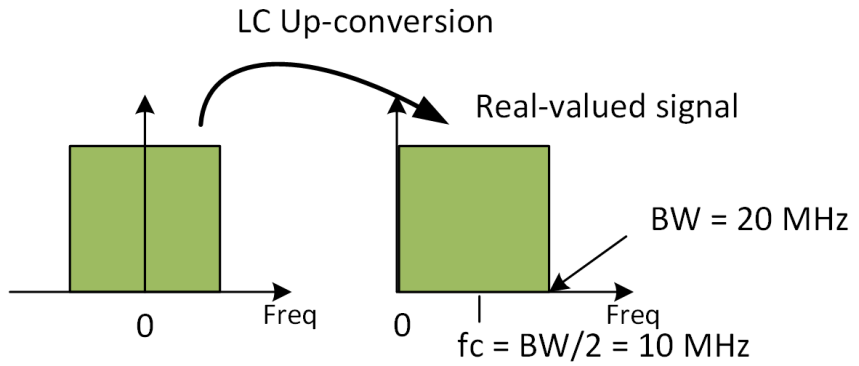


802.11bb uses light spectrum and existing technological capabilities

- RF frontend up-converts baseband signals onto e.g. f_c=2.4 GHz.



- LC frontend up-converts baseband onto low IF e.g. f_c=BW/2 + Δ.
  - Δ is to be agreed depending on signal mask design.



- This way, any complex-valued baseband signal (i.e. any existing IEEE 802.11 PHY) can be used to facilitate LC.

802.11bc is defining Enhanced Broadcast Services

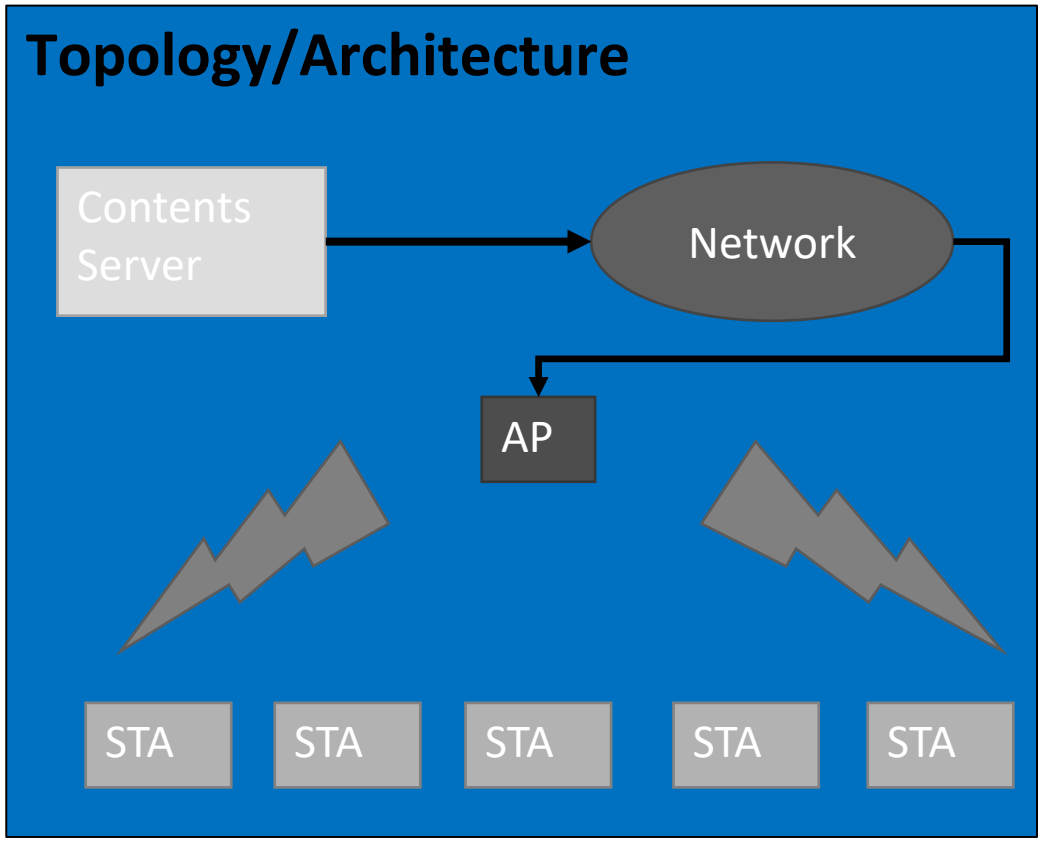
- Enhanced Broadcast Services (eBCS) defines broadcast service enhancements within an 802.11-based network.
- Client end devices broadcast information to an AP, e.g. in an IoT environment, to other STAs so that any of the receiving APs act as an access node to the Internet.

802.11bc Broadcast Downlink use case description

Broadcast Downlink

Provides enhanced Broadcast Services (eBCS) of data (e.g. videos) to a large number of densely located STAs.

These STAs may be associated, or un-associated with the AP or may be low-cost STAs that are receive only.

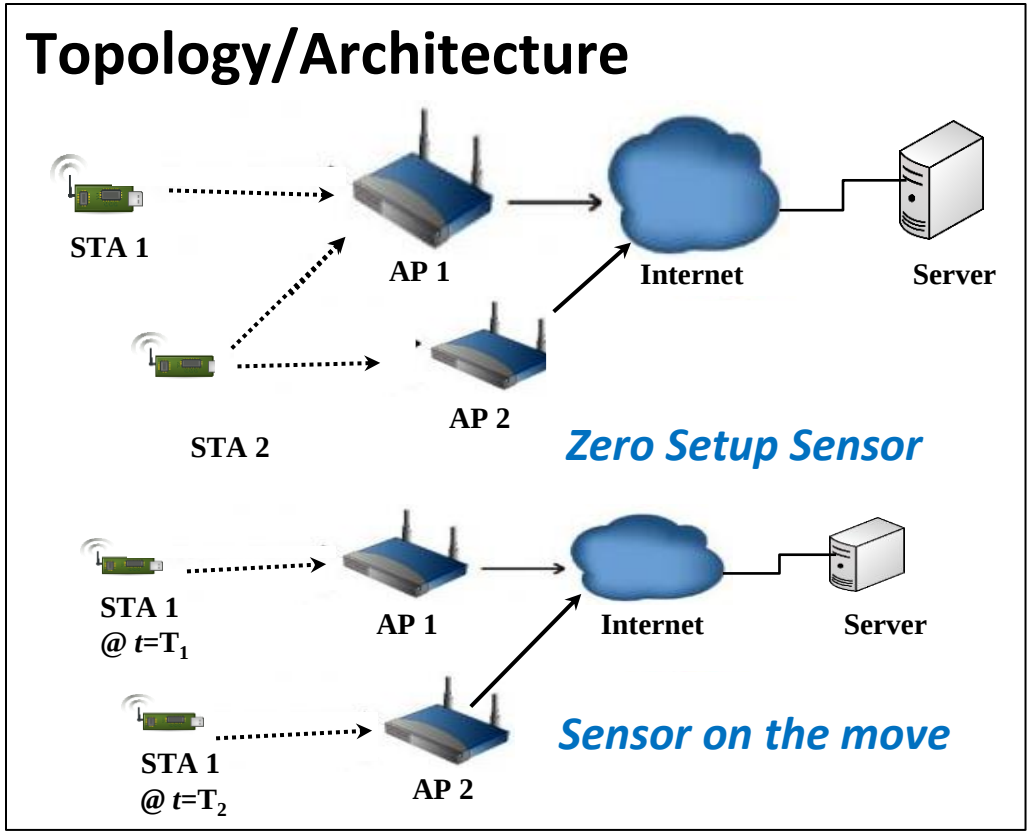


802.11bc Broadcast Uplink use case description

Broadcast Uplink

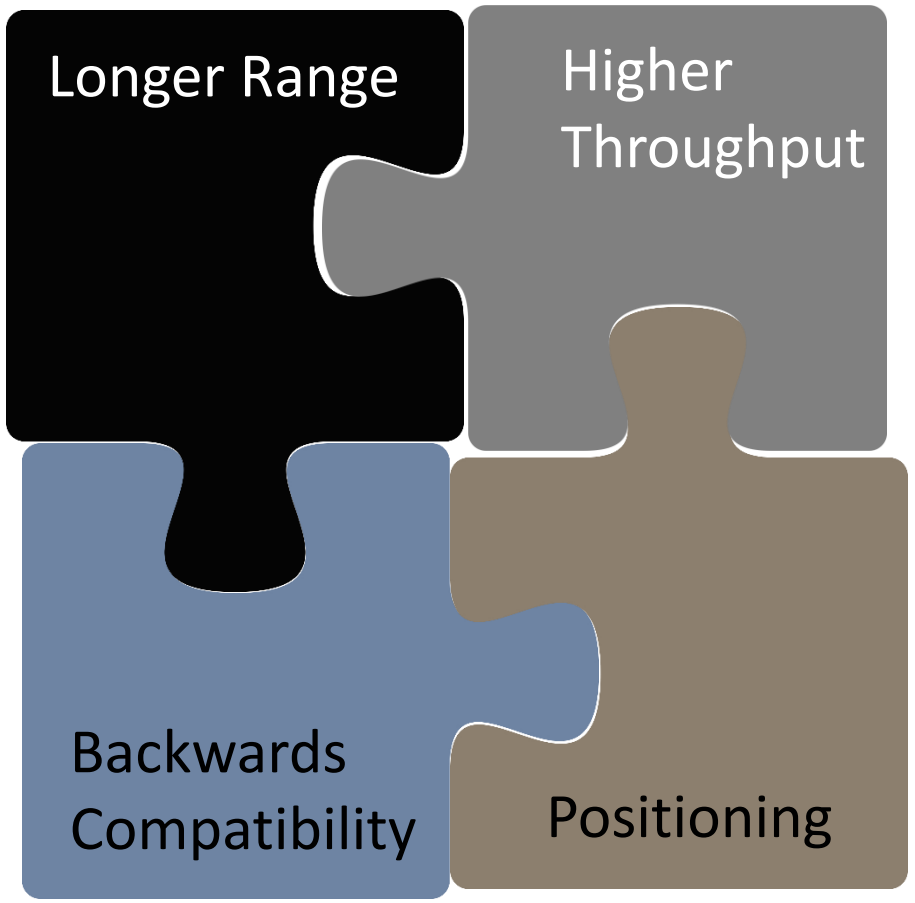
Pre-configured devices (e.g. IoT) automatically connect to the end server through APs with zero setup action required.

Alternatively, low power IoT devices that are in motion, report to their servers through APs without scanning and associating



802.11bd defines an evolution of 802.11p for Vehicle to Anything (V2X)

- 802.11p is largely based on 802.11a.
- 802.11bd defines MAC/PHY enhancements from 802.11n, ac, ax, to provide a backwards compatible next generation V2X protocol.
- **Higher Throughput**
  - OFDM frame design
  - Higher MCS, LDPC coding
  - Packet aggregation
- **Longer Range**
  - Mid-amble design
  - Repeated transmission mechanism
  - More robust channel coding
- **Support for Positioning**
- **Backward Compatibility**
  - Backward compatible frame format design, Version indication



802.11bd: Next Generation V2X Use Cases

5.9 GHz band mainly, and optionally 60 GHz;
Completion in 2022/2023
http://www.ieee802.org/11/Reports/tgbd_update.htm

V2X Use Cases:

- Suport all defined DSRC/802.11p use cases, including Basic safety message (safety, range, backward compatibility, fairness)
- Sensor sharing (throughput)
- Multi-channel operation (safety channel + other channels)
- Infrastructure applications (throughput)
- Vehicular positioning & location (LoS and NLoS positioning accuracy)
- Automated driving assistance (safety, throughput)
- Aerial vehicle IT application (video)
- Train to train (high speed)
- Vehicle to train (high speed, long range)

Key additions :

- Higher throughput (2x) than 802.11p
- Longer range (3dB lower sensitivity level)
- Support for positioning
- Backward compatibility with 11p

The 802.11be Extremely High Throughput amendment builds on 802.11ax, including 6GHz support

Extremely High Throughput (EHT)

Operation in 2.4 GHz, 5 GHz, and 6 GHz bands

Higher throughout – Project goal of at least 30 Gbps; expect 40+Gbps with 320MHz channels, 4096 QAM, 16x16 MU-MIMO

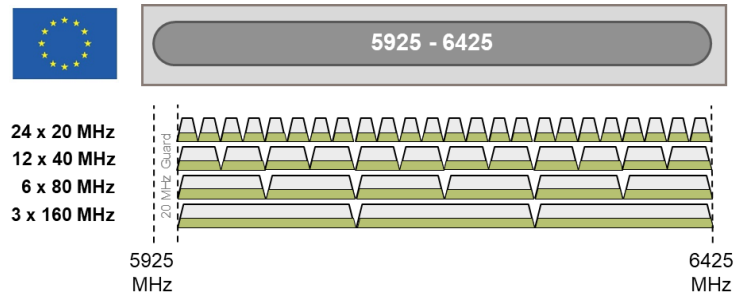
Support for low latency communications

Continued improvements in spectral efficiency

Targeted completion in 2024

Use Cases:

- Home, enterprise, industrial, IoT
- Outdoor
- AR/VR
- 4K and 8K video streaming
- Remote office
- Cloud computing
- Video calling and conferencing

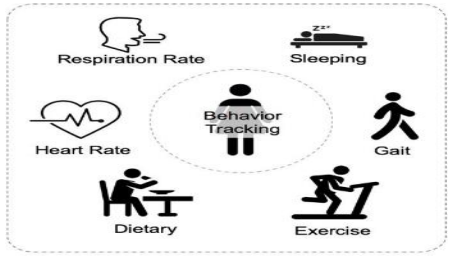


802.11be features under consideration

- 320 MHz bandwidth and more efficient utilization of non-contiguous spectrum
- Multi-band/multi-channel aggregation and operation
- 16 spatial streams and MIMO protocols enhancements
- Multi-AP Coordination (e.g. coordinated and joint transmission)
- Enhanced link adaptation and retransmission protocol (e.g. HARQ)
- Adaptation to regulatory rules specific to 6 GHz spectrum
- Refinements of 802.11ax features

802.11bf WLAN sensing

- **WLAN sensing is the use of received WLAN signals to detect features of an intended target in a given environment.**
  - Measure range, velocity, angular, motion, presence or proximity
  - Detect objects, people, animals: Enables touchless applications
  - Use in room, house, car, enterprise environments
- **Target frequency bands are between 1 GHz and 7.125 GHz (MAC Service interface) and above 45 GHz (MAC/PHY)**
- **Some use cases**



https://www.cse.ust.hk/~qianzh/research/sensing-2.jpg

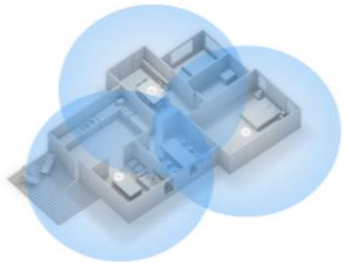
Smart home

https://www.pressebox.com/pressrelease/gb-pronova-gmbh/HoloPro-and-the-magic-of-interactive-control/boxid/129647#

Gesture recognition

http://4.bp.blogspot.com/-_krIAHPdn-8/T02hlSBvOnI/AAAAAAAAA1A/jAufr2N8k4c/s1600/Kinect%2BGames.jpg

Gaming control



https://www.lastampa.it/tecnologia/news/2018/06/27/news/router-google-wifi-internet-senza-fili-in-ogni-angolo-della-casa-1.34027426

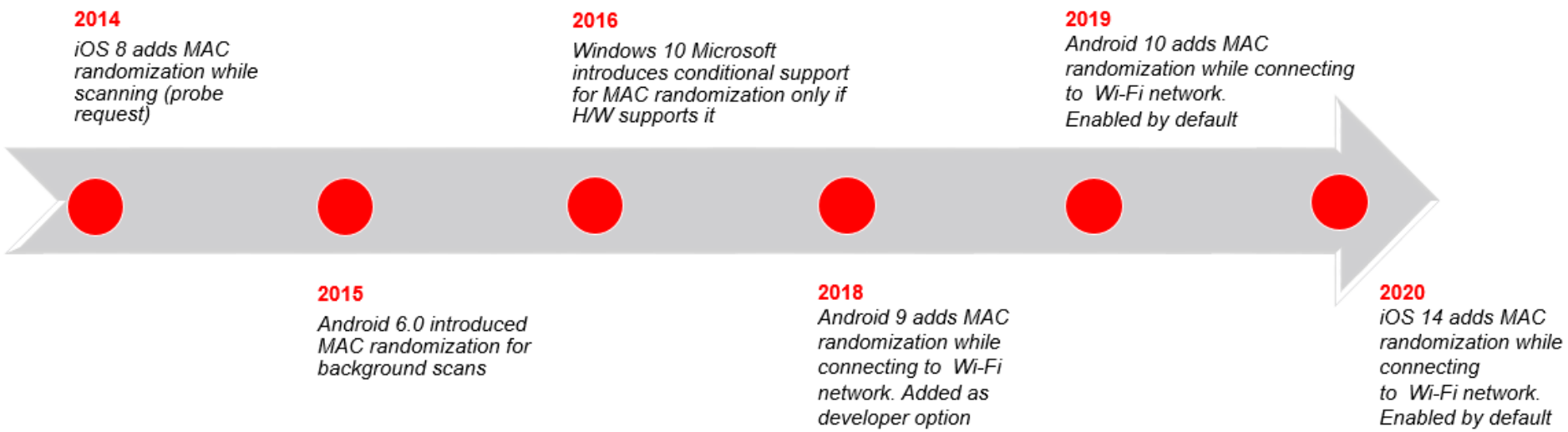
Presence and proximity detection (Home/Enterprise/Vehicle)

- Note: The specification of applications that make use of WLAN sensing measurements is beyond the scope of P802.11bf.

802.11bh Randomized and Changing MAC addresses (RCM)

A MAC address is a physical hardware identifier that is assigned by the hardware manufacturer to a network device (Ethernet, Wireless, and Bluetooth as examples)

To protect user privacy, there is a growing trend to randomize the client device's MAC address, which can otherwise be "snooped" by third-parties and used to track the user's movements and potentially actions.



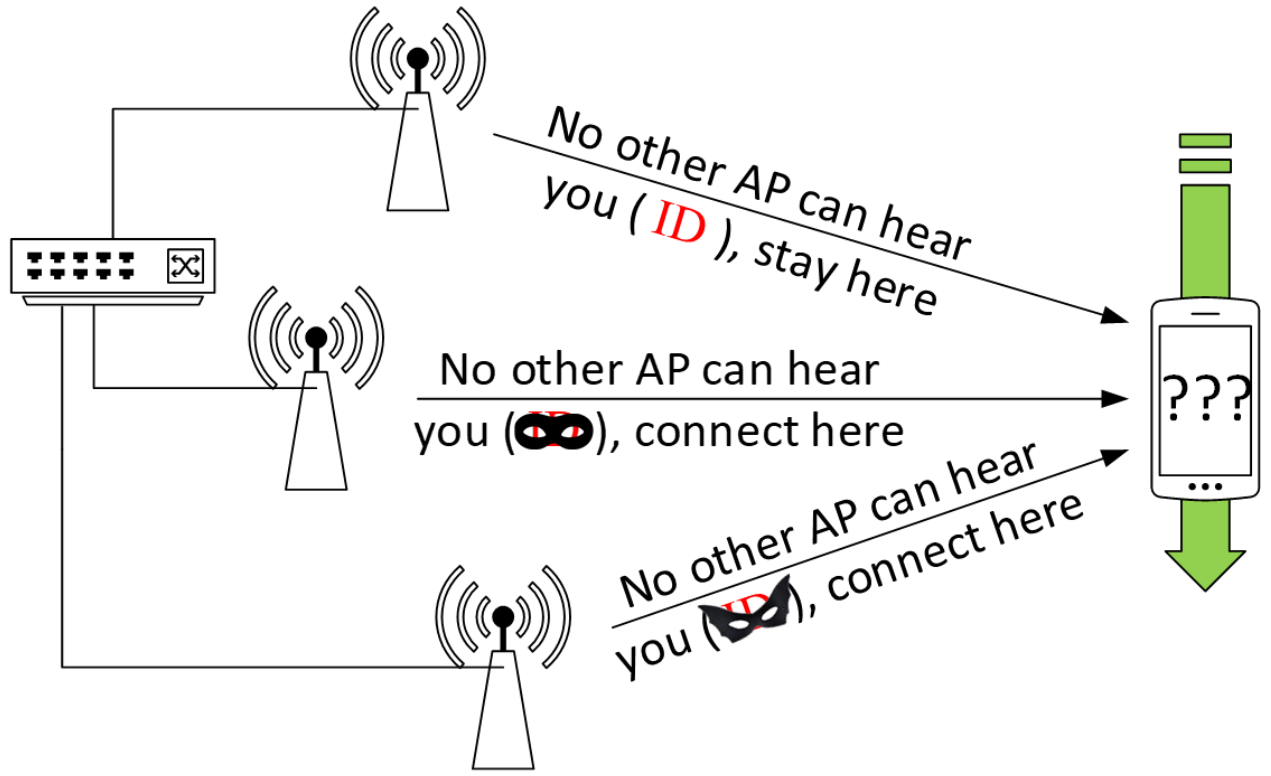
- MAC address randomization can undermine the network's ability to steer the device to the best connection point, or to recognize the device and provide differentiated access in secure environments, pay-for-bandwidth scenarios, etc.

802.11bh Randomized and Changing MAC addresses (RCM)

Client Steering Use Case

Impacted use cases include:

- Steering a client device to the best connection point
- Recognizing the device, to provide personalized home automation
- Access to pay services, or differentiated levels of service
- Customer support and troubleshooting



802.11bi Enhanced Data Privacy

✓ Privacy of Password (WPA3)
Privacy of Password **Identifier**

Defines new mechanisms to improve user privacy

- Today, IEEE Std 802.11aq-2018 defines MAC address randomization and specific requirements to prevent device tracking using passive observation of PHY, MAC protocol fields.

- To ensure continued growth and support for IEEE Std 802.11, this project is investigating additional enhancements for user privacy solutions applicable to 802.11.

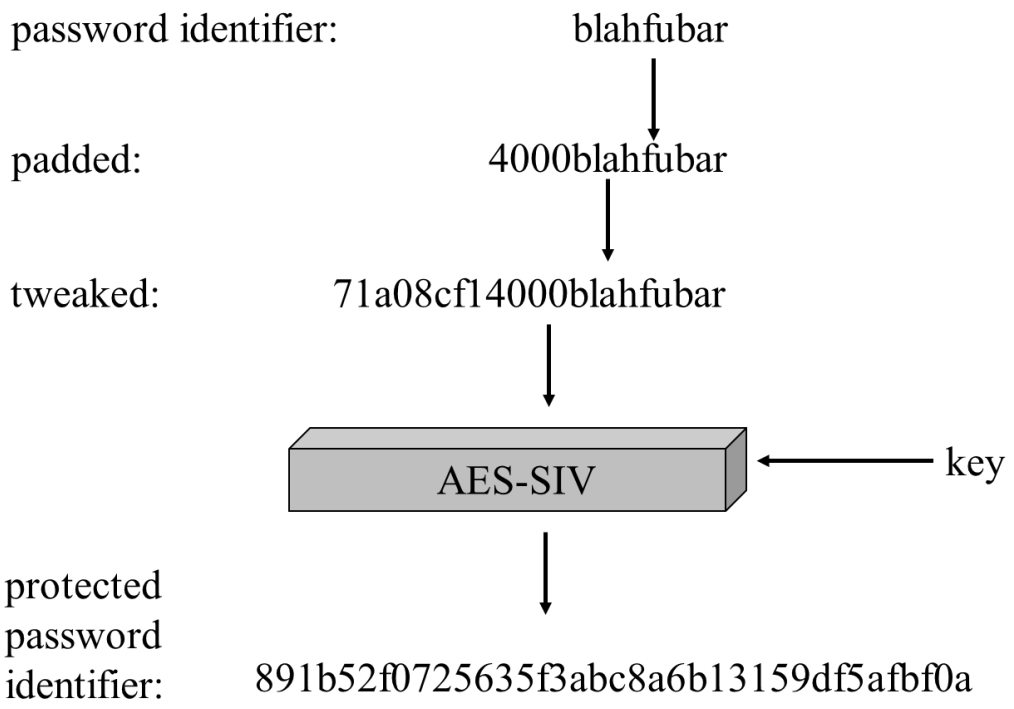


Figure: https://mentor.ieee.org/802.11/dcn/21/11-21-0541-00-00bi-protecting-password-identifiers.pptx

Stream Classification Service (SCS) Overview

- STA advertises Stream Classification Service (SCS) Capability
- Non-AP STA sends a request to specify traffic classes for classification and the priority to assign to matching frames
- AP may accept or reject the traffic class specified by the non-AP STA
- If the service is accepted by the AP,
  - the AP shall process subsequent unicast MSDUs that match the classifier specified in the SCS Descriptor. The processing of matching MSDUs depends upon the access policy assigned to the MSDU:
    - For MSDUs that are not part of a TS, the User Priority subfield of the Intra-Access Priority element is used as the UP of these MSDUs.
    - For MSDUs that are not part of a TS, or MSDUs that are part of a TS that uses EDCA or HEMM as the Access Policy, the Alternate Priority subfield of the Intra-Access Priority element is used to select the EDCA Parameter Set for these MSDUs, if the MIB attribute dot11RobustAVStreamingAlternateEDCAEnabled is true.
    - All matching MSDUs are tagged with their drop eligibility using the value from the Drop Eligibility subfield of the Intra-Access Priority element
- See doc 11-09/0726r0
- Source: 11-09-0725r1

Fixed Wireless Access
The Tale of Expanding Connectivity & Coverage

IRVIND GHAI

VP MARKETING

onsemi

Fixed Wireless Access

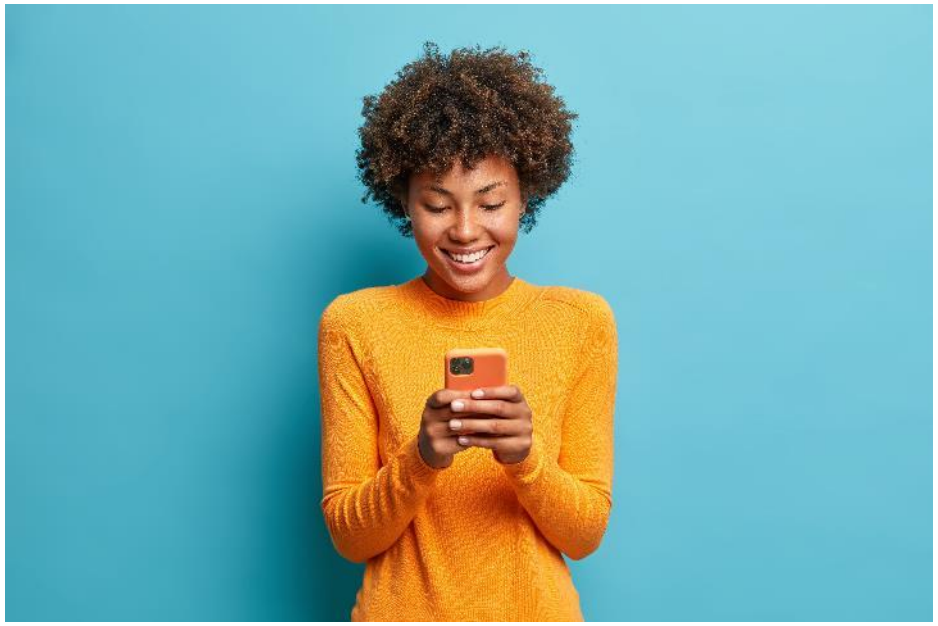
The Tale of Expanding Connectivity & Coverage

October 2021

Agenda

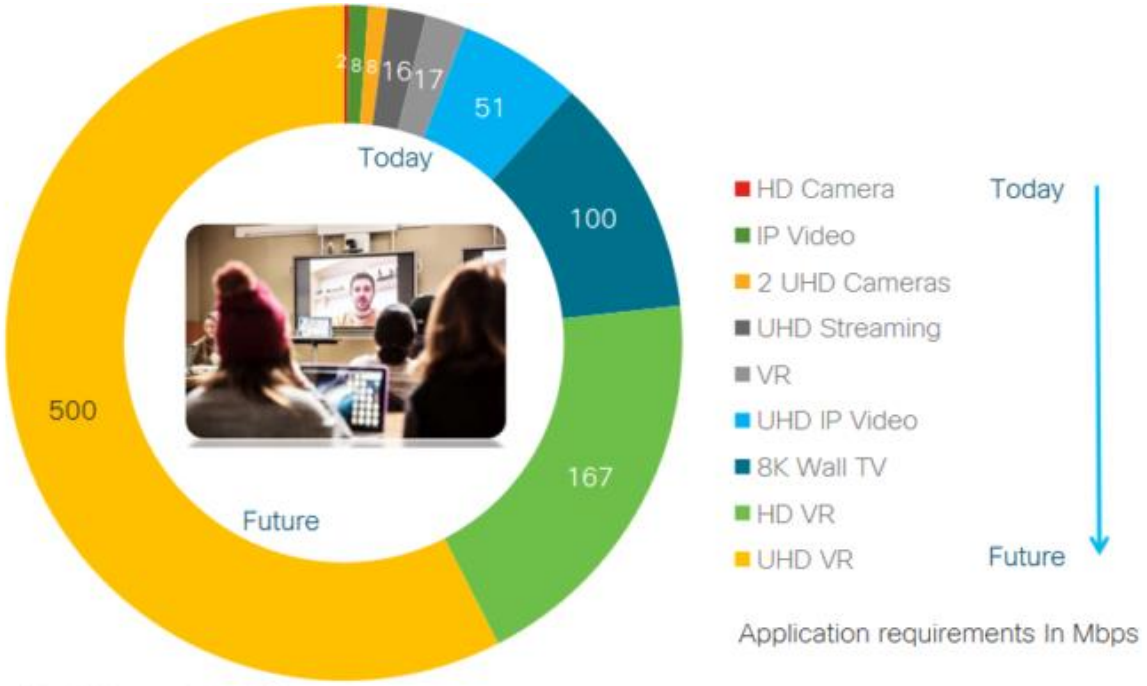
- Broadband Expansion
- Fixed Wireless Access
  - Flavors
  - Benefits
  - 5G & Wi-Fi Options
- Wi-Fi 6/6E
  - FWA Feature Support
  - Solutions
- Wi-Fi 7 Opportunity & Next Steps…

Fixed Wireless Access Meets High-Speed Demand



Significant bandwidth demand for video in future homes

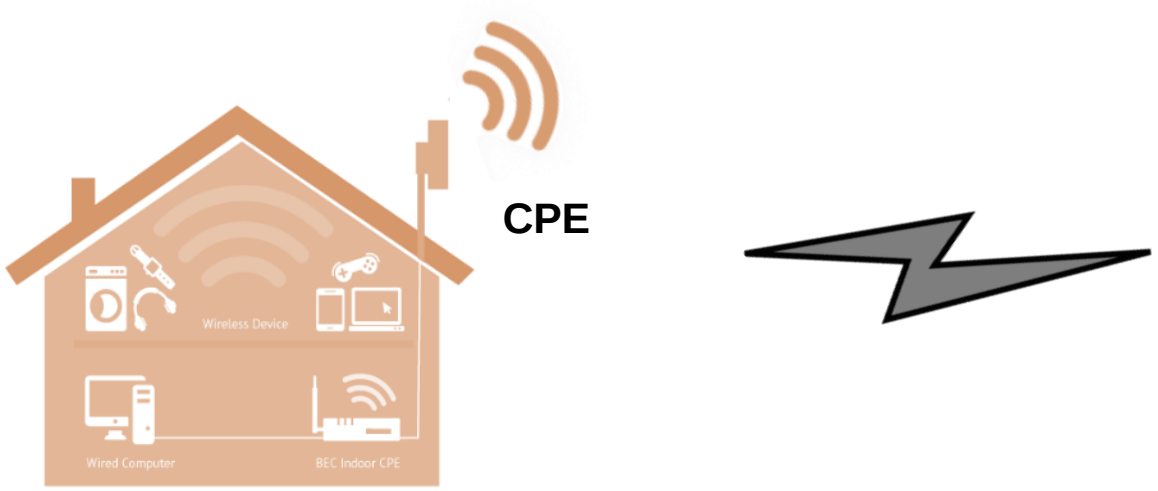
(4K stream requires 30-50Mbps)



What is Fixed Wireless Access?

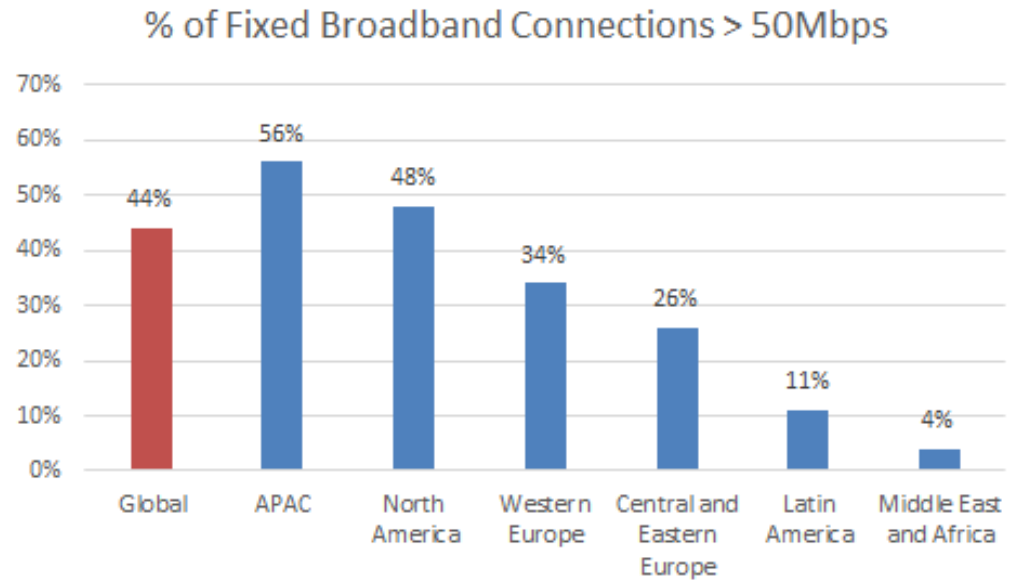
“Fiber-Like” Broadband Access over wireless medium

- **Base Station**: PTP or PTMP or Mesh
- **CPE**: Indoor and Outdoor Units
- **Coverage**: 500m-2km, Speed: 100Mbs to 1Gbps+



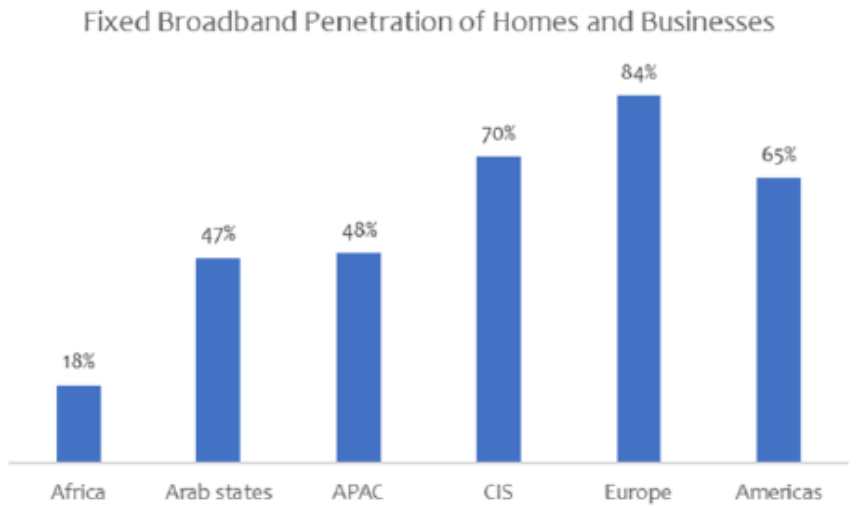
Opportunity: Expand Global Broadband Access

- **Inadequate broadband speed in developed regions**
  - Globally, only 44% of broadband connections are > 50Mbps
  - In US, 37M households are <25Mbps, mostly handicapped by copper



Source: Mobile Experts

- **44% of worldwide households and businesses are unconnected!**
  - ~550M in APAC
  - ~105M in Americas
  - Challenging economics for traditional broadband



Source: ITU

Fixed Wireless Access Benefits

Lower CAPEX

- Leverage mass market wireless technology
- Lower deployment cost
- Amortized over extended coverage

Higher Speed

- Fiber-equivalent
- Gigabit speed per user
- More spectrum becoming available

Fast Deployment

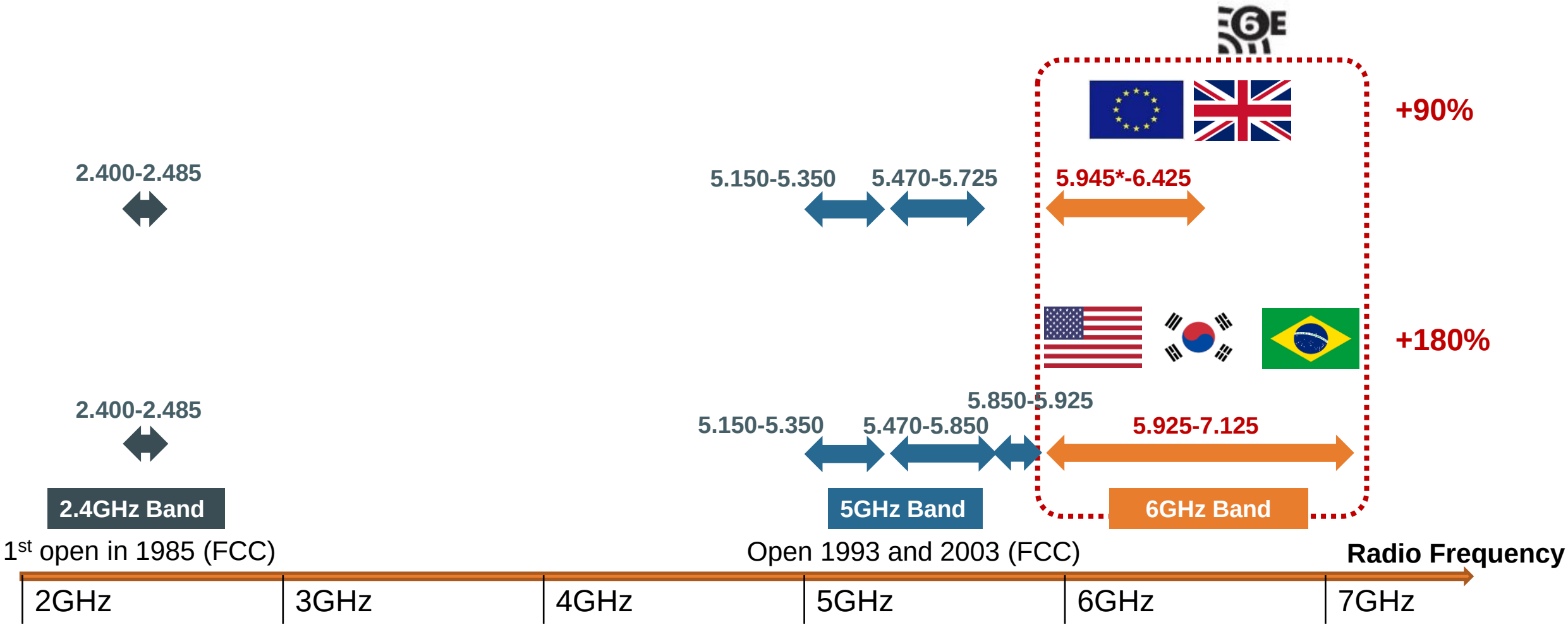
- No need to lay down new cables
- Scalable to different service levels
- Can address both rural and urban needs

5G & Wi-Fi FWA Options

	High-Tier FWA (100's Mbps – 1 Gbps)	Mid-Tier FWA (50 – 100 Mbps)	Low-Tier FWA (10's Mbps)
802.11-based	802.11-based 60 GHz	802.11-based Sub-6GHz	
	802.11-based millimeter wave		
3GPP-based	5G Fixed Wireless millimeter wave	5G Fixed Wireless Sub-6GHz	
			LTE Fixed Wireless Sub-6GHz

Source: Mobile Experts

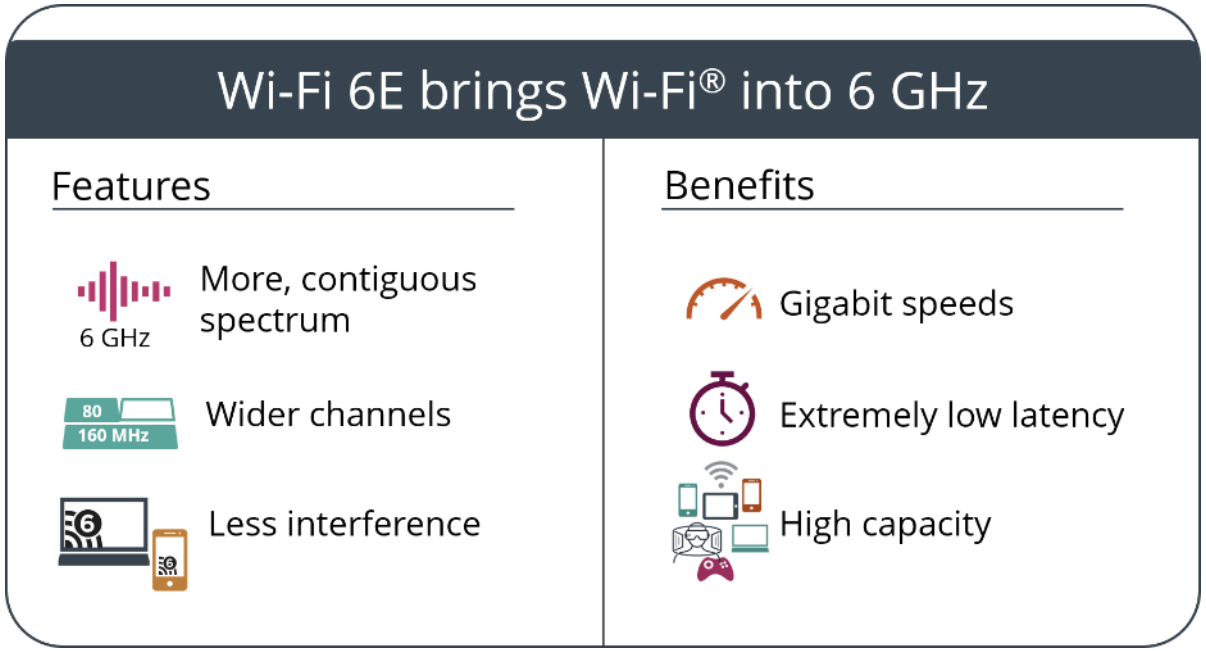
Wi-Fi 6E Inflection



Wi-Fi 6E Certification Program Started

* 5925MHz in the UK

Wi-Fi 6E Benefits

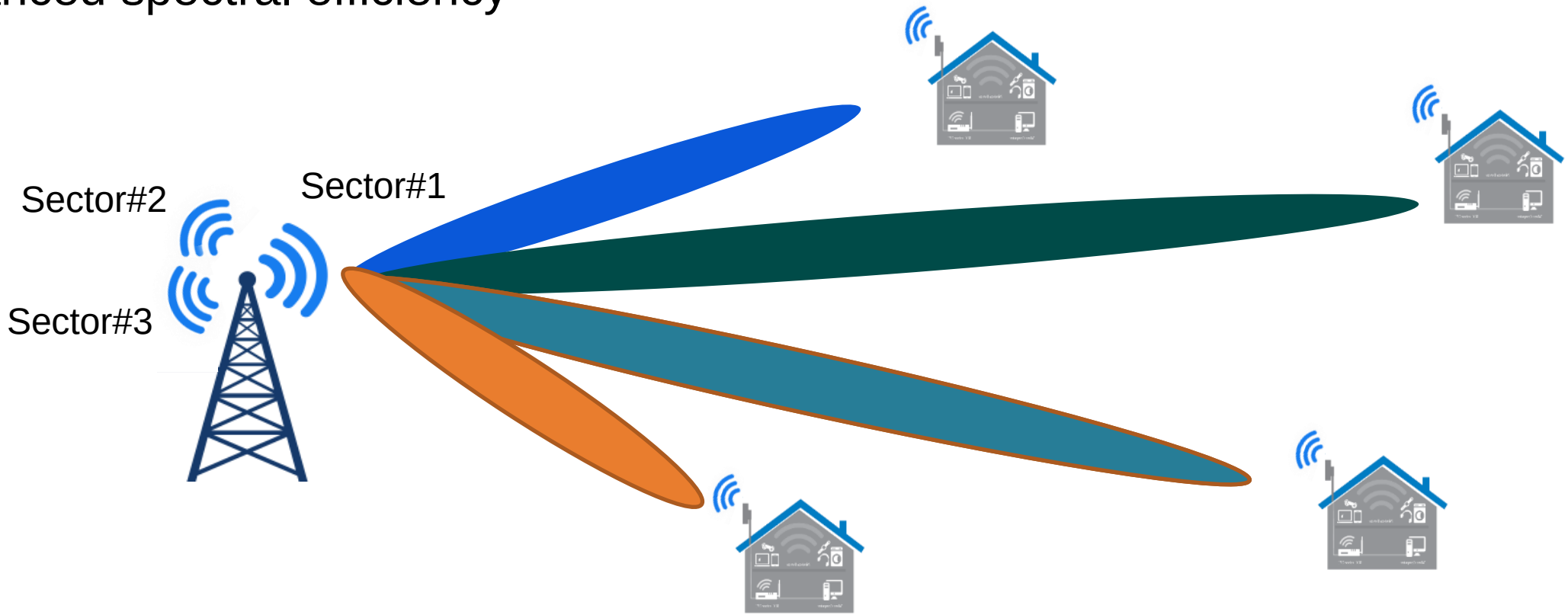


* Wi-Fi Alliance

- Capacity & Speed – Data Intensive Transfers
  - 6GHz Spectrum
  - More 160MHz channels
  - MU-MIMO
- Congestion & Latency – Time Sensitive Apps
  - OFDMA
  - Scheduling & less channel contention
  - 6GHz helps reduce management clutter
  - 6GHz will avoid legacy clients
- Range & Power – Maximize Battery
  - Target Wait Time (TWT)
  - 6GHz low power Wi-Fi (VLP)

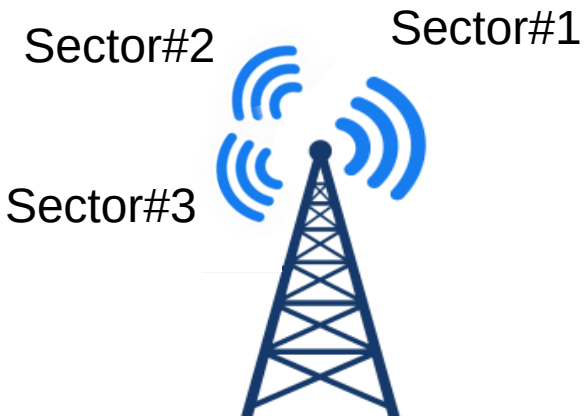
MU-MIMO Bi-Directional Enables Spectral Re-Use

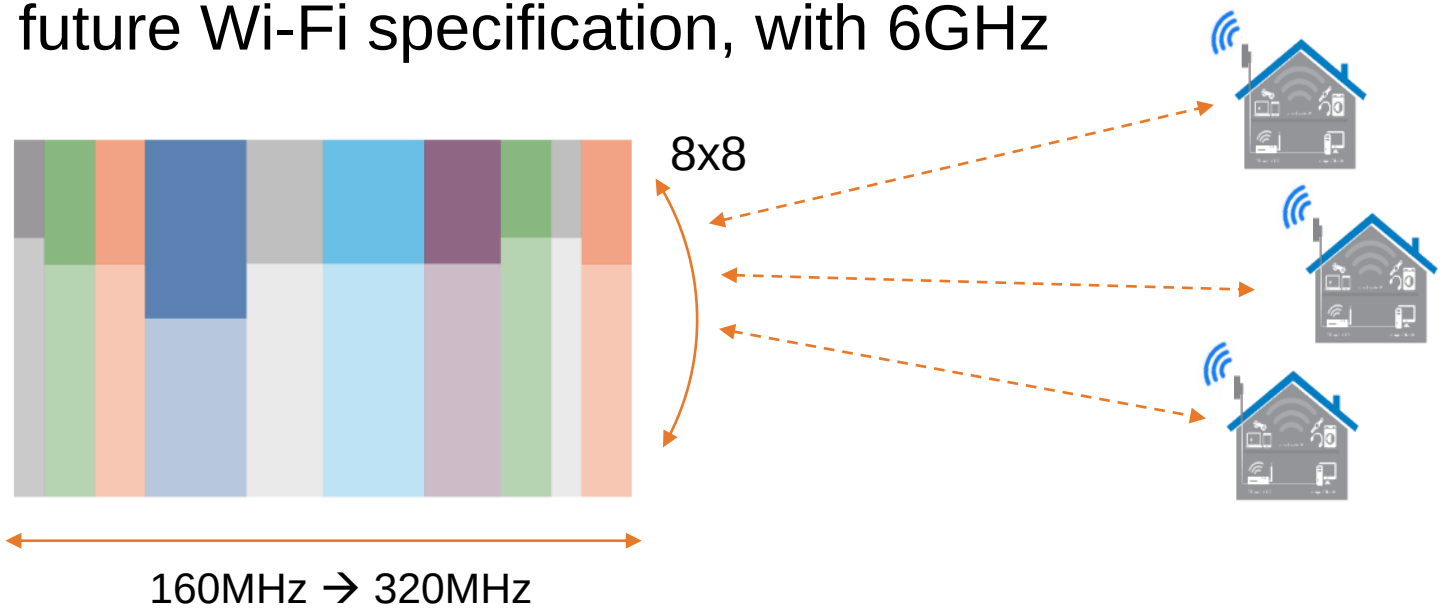
- Highest capacity per site for Point-to-Multi-Point system
- Beamforming directed to multiple CPEs simultaneously within a sector
- Enhanced spectral efficiency



160MHz and 8x8 Provide 10Gbps Capacity per Sector

- Increased overall capacity of FWA network
- Enables high-speed spatial streams to multiple CPEs with MU-MIMO
- 160MHz and 8x8 delivers ~10Gbps capacity – available today
- Scalable to higher capacity in future Wi-Fi specification, with 6GHz spectrum

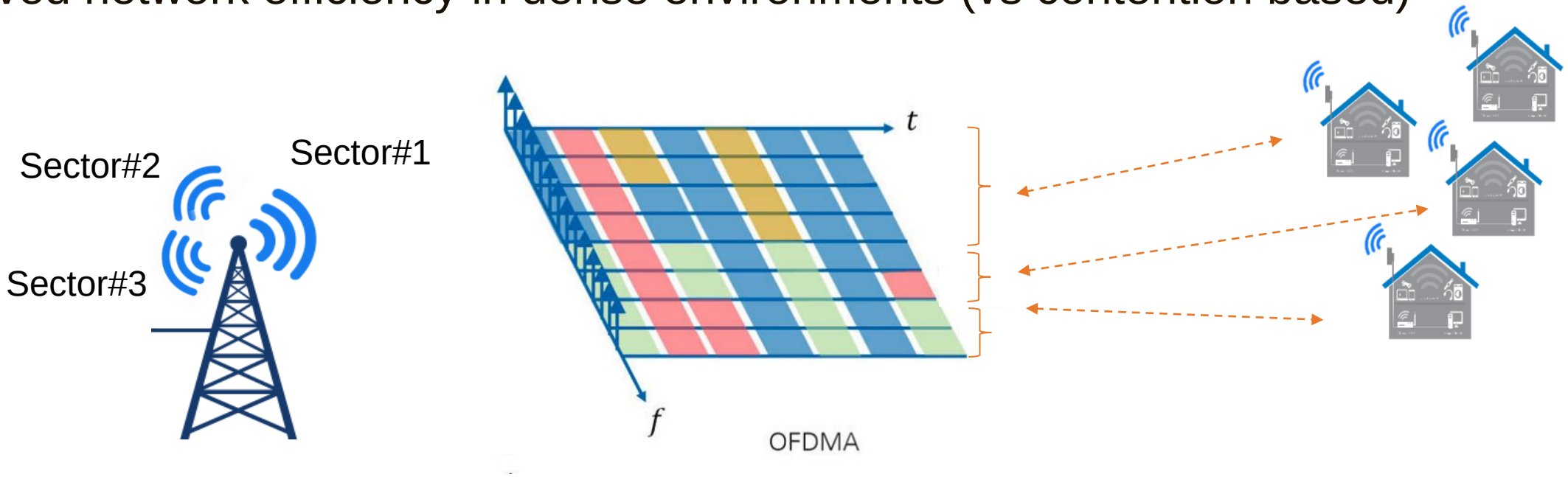




OFDMA

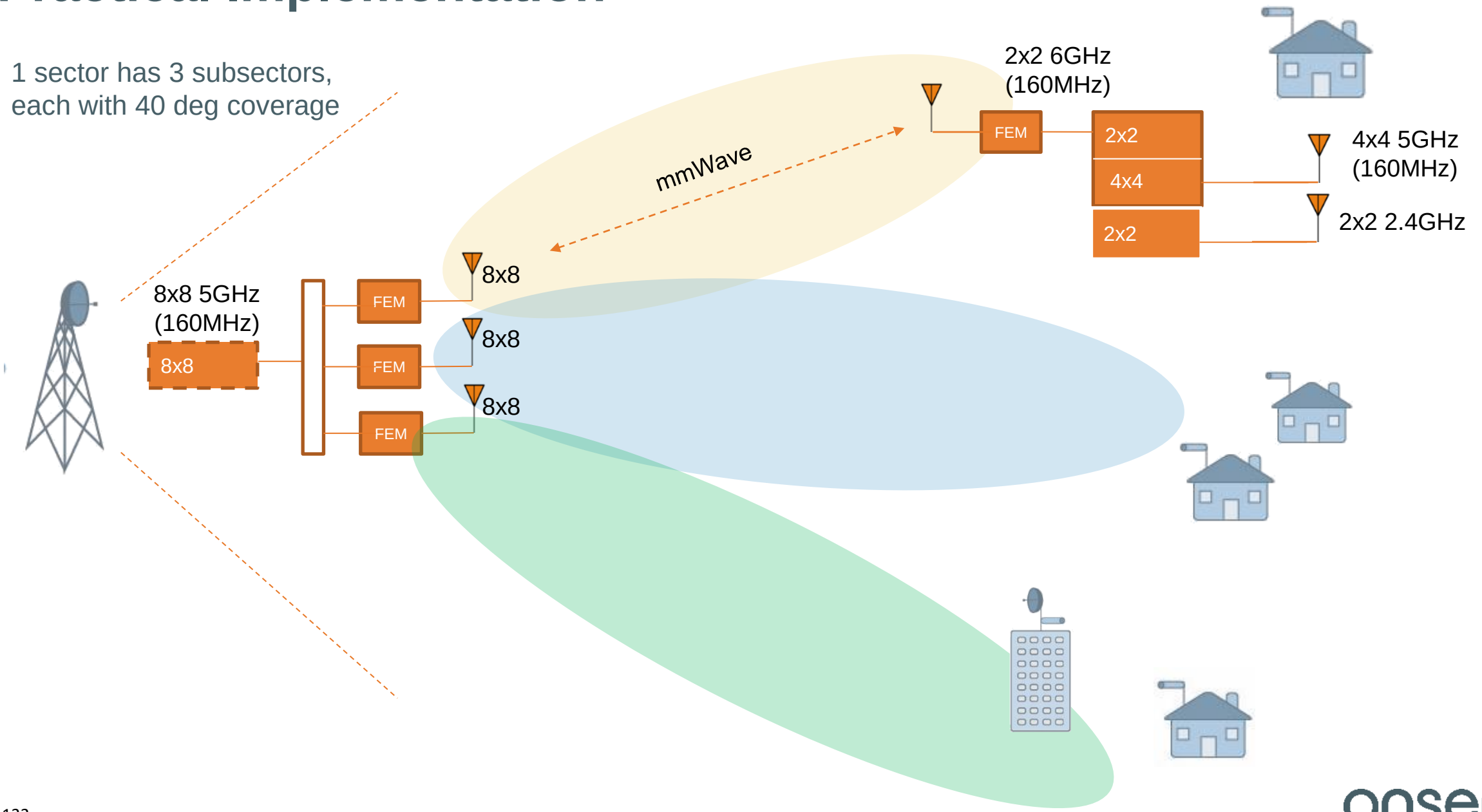
Efficient Multi-User Access in Dense Deployment

- Subcarriers (Resource Units) allocated to different User/CPEs
- Uplink resource scheduling within a sector
- Low-latency + noise filtering
- Improved network efficiency in dense environments (vs contention based)



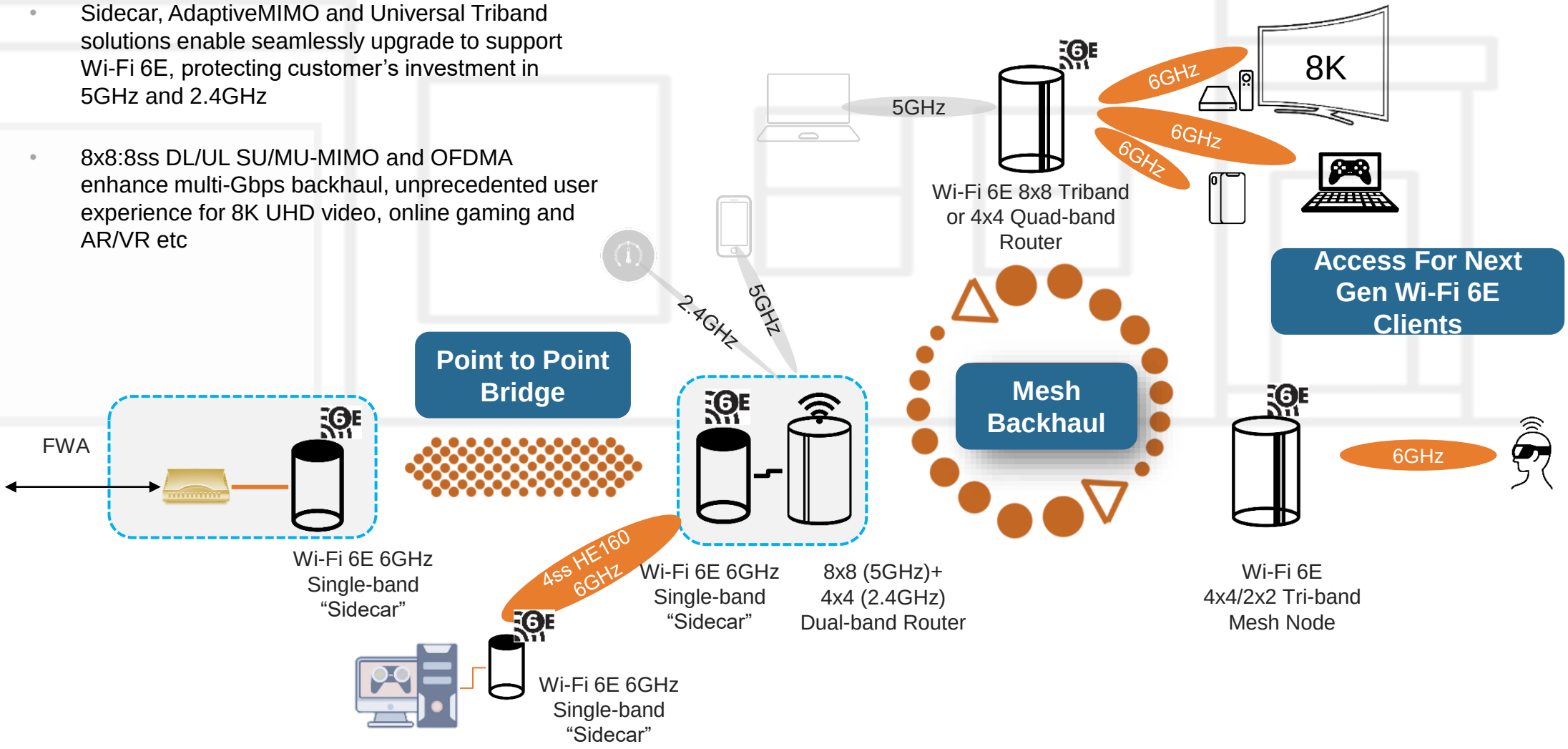
Practical Implementation

1 sector has 3 subsectors,
each with 40 deg coverage



Wi-Fi 6/E Solutions Differentiate Smart Home Networks

- Sidecar, AdaptiveMIMO and Universal Triband solutions enable seamlessly upgrade to support Wi-Fi 6E, protecting customer's investment in 5GHz and 2.4GHz
- 8x8:8ss DL/UL SU/MU-MIMO and OFDMA enhance multi-Gbps backhaul, unprecedented user experience for 8K UHD video, online gaming and AR/VR etc



Advantage of Wi-Fi 6/6E Based Fixed Wireless

Wi-Fi Technology Advancements

- MU-MIMO, OFDMA, 160MHz, 8x8, and beyond…

Unlicensed Spectrum

- 5GHz + new 6GHz for NLOS, can also extend to mmWave

Economy of Scale

- Low CAPEX, Leverage high-volume chipsets

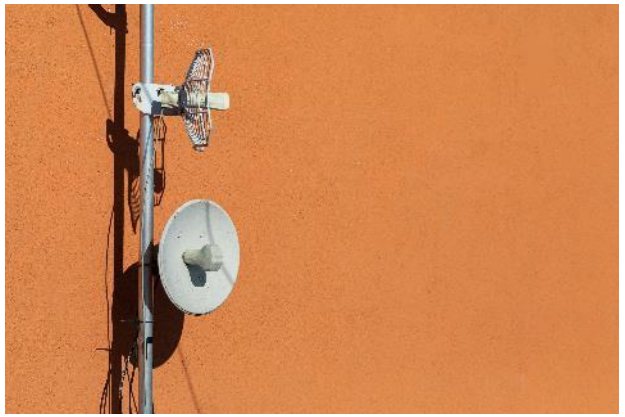
Time to Market

- Scalable to multiple service tiers

Software Platform Re-use

- Product category per market segmentation (speed, coverage, etc)

WISPs
Mobile Operators
Fixed-line Operators
Internet companies



Opportunity & Next Steps

FWA Ramp Underway

- High capacity and efficiency network
- Scalability
- Time to market

Wi-Fi 7: Continued Innovation

- Throughput continues to increase
- TSN efforts underway
- Wi-Fi 7 further addresses:
  - Deterministic enhancements
  - Multi link replication

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Summary of WBA Work and Close

BRUNO TOMÁS

Director of Programs

Wireless Broadband Alliance

WBA WI-FI 6 & 6E PROGRAM

Fast-tracking Wi-Fi 6 & 6E leveraging Carrier-Grade capabilities

Deliver industry guidelines and end-to-end live trials with multiple ecosystem players

Latest Projects

I. Enhanced 802.11ax - Overview, Use Cases, Features, 5G Context

II. Wi-Fi 6 Deployment Guidelines & Scenarios

Current Work

Wi-Fi 6 & 6E Trials: Real-world end-to-end testing of key features and new services to raise confidence and adoption in the technology

Deployment Scenarios	Use Cases
Enterprise - Industrial 4.0	High-density connectivity / latency
Transportation hub	Improved roaming behavior
Residential/MDU	Multi stream live video monitoring (facilities / campus)
Smart Cities/Rural	Real time energy monitoring
Transportation hub	IoT sensor networks
Public Venues	Ultra-reliable low latency communications / critical sensors
University Campus	Augmented reality for trouble shooting
Stadium	Gaming / Health devices > improved latency for key target
Entertainment	Virtual classroom/venue - UHD video intercampus
Public Wi-Fi	

HIGH-DENSITY SHOPPING MALLS

WBA 5G PROGRAM

Identifying main convergence and coexistence use cases for 5G & Wi-Fi

Developing white papers, guidelines, requirements and test plans.

Latest Projects

1. **5G Networks –** The Role of Wi-Fi and Unlicensed Technologies
2. **Network Slicing for 5G –** Wi-Fi Capabilities
3. **Unlicensed Integration with 5G Networks** - assessing the approaches on how to integrate Wi-Fi and 5G

Current Work

End game: Highlight use cases and gaps which need to be addressed to realize convergence between 5G and Wi-Fi

Next Steps

5G & Wi-Fi RAN Convergence for Private Networks

ATSSS, ANDSP
Proof of concept for new policy mechanisms

Multi-Access Edge Computing
Define a set of services and use cases for Wi-Fi and ensure that the MEC APIs are suitable

Multi-path Technologies
Explore new technologies MP-TCP/QUIC and trial the aggregation schemes

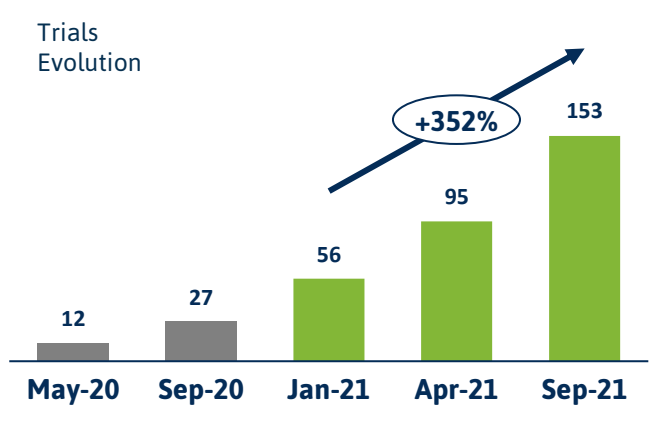
Fixed Wireless Access Address possibilities of providing services for specific use cases

OPENROAMING PROGRESS STATUS

Achievements

1. Impactful OpenRoaming deployments

2. Momentum around global trials and deployments



Global coverage

In Progress

1. Truly holistic OpenRoaming standard, key industry players engaging

airties, Cisco, Cambium Networks, Extreme, EZELINK One World One WiFi, COMMSCOPE, HUAWEI, galgus, JUNIPER driven by Mist AI, LANCOM Systems

11 Vendor OEM Implementing

SAMSUNG, Google, intel, DELL, Viasat, eduroam

Identity Provider massification with key players virtually covering all the market (smartphones, tablets)

2. Accelerating adoption of Federation assets (e.g. API, DB)

Fostering standards compliance acting the Policy Authority to make sure the foundational components of the federation are used globally

OPENROAMING

API

OR Access Network Provider

OR Ecosystem Broker

OpenRoaming leading the Public-Guest Wi-Fi > Focusing on evolving horizontally and vertically

CALL TO ACTION

One Global Wi-Fi Network

VISION: Provide Automatic & Secure Wi-Fi Everywhere to Everyone

MISSION: Create an open framework for all types of players to develop their Wi-Fi services and business

OPENROAMING™
WIRELESS BROADBAND ALLIANCE

STEP 1 Sign up for WBA OpenRoaming™ *(Inclusive for WBA Members)*

STEP 2 Adopt the WBA OpenRoaming™ framework and standards

STEP 3 Choose the interconnect model and technologies

STEP 4 Select your business model and partners that are members of WBA OpenRoaming™

STEP 5 Configure your network and/or customer devices

STEP 6 You are now part of the WBA OpenRoaming™ brand and are **ready** to **ROAM!** Congratulations!

Calling all innovators

Service providers, venues, enterprises, developers and advertisers... yes, we're talking to you. Wi-Fi is now officially open for innovators to grow their businesses by creating the next generation of business models and services for a single, global Wi-Fi network.

https://wballiance.com/openroaming/join

Wi-Fi Powering Innovation Series

Tuesday October 5th

WBA Leadership Conference & WBA Industry Awards

This autumn's premier Wi-Fi event kicks off with a celebration of all things Wi-Fi and the exciting developments we can look forward to in 2022. The WBA Industry Awards will highlight the innovation and excellence from the best in the Wi-Fi Industry. We'll also be looking at strategic impacts of Wi-Fi on the global economy in 2022 and beyond; new innovations in technology and business models for Wi-Fi up to 2025; and featuring the highlights of the 2022 WBA Annual Industry Report, including trends and drivers on Wi-Fi

Thursday October 7th

Wi-Fi: Public and Private Networks and Convergence with 5G

What does the future hold for public and private networks, and what role will 5G convergence play? In this session, hear the latest on Wi-Fi 6, including ongoing use cases, case studies and a deep dive on operational benefits. We'll also be looking at the opportunities and developing use cases for Wi-Fi 6E and taking a snapshot of the rollout of the 6 GHz spectrum, emerging technologies such as Wi-Fi 802.11bf and beyond; and much more!

Tuesday October 19th

Wi-Fi: Enabling the Smart Connected Enterprise

When it comes to enterprises looking to get 'smart' and offer outstanding connectivity for employees and consumers, the role of Wi-Fi can't be understated. Hear how companies can secure their IoT infrastructure with Wi-Fi; how smart Wi-Fi can support customers and operations for verticals such as retail, transportation, healthcare, and the carpeted enterprise; the impacts that the 'bring your own device'(BYOD) era can have on security, privacy, and data integrity; and how Wi-Fi is creating emerging opportunities for Industry 4.0 in the 5G era.

Thursday October 21st

Innovation for Service Providers, Cities and Venues with Public and Guest Wi-Fi

How can Wi-Fi address the emerging needs of enterprise to innovate and adapt in a post-COVID-19 world? This session will explore the latest on emerging opportunities for Industry 4.0 and IoT deployments in the discuss the game changers for the connected retailer and automotive industry; and examine how train operator are stepping up to offer outstanding Wi-Fi connectivity for passengers leading up to 2030.

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THANKS FOR ATTENDING

Next Time:

19 October 2021

Wi-Fi: Enabling the Smart Connected Enterprise

REGISTER NOW

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