

 MARAVEDIS 20 YEARS

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**The Road to Wi-Fi 7**  
**June 13, 2023**

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## Speakers:

- \* Adlane Fellah, Senior Analyst at Maravedis
- \* Dorothy Stanley group chairwoman for the IEEE 802.11 standardization work group
- \* Gavin Newman, Director, and Engineering Architect, Kyrio

## 2023 Select Topics

- \* **Unlocking WiFi potential with OpenRoaming**
- \* **The Road to WiFi 7**
- \* TIP OpenWiFi: An update from 2022
- \* Why Matter matters to WiFi
- \* WiFi Quality of Experience
- \* Why is WiFi still seen as unsafe?
- \* Prospects for Halow?
- \* Home WiFi trends
- \* Managed WiFi Services
- \* Cloud-native services for WiFi
- \* 5G and WiFi Convergence, myth or reality?
- \* What is the WiFi industry doing about sustainability?
- \* What happened to community WiFi?
- \* What is Deterministic WiFi?
- \* Network Automation for WiFi
- \* Open AFC and 6GHz update
- \* Open RAN, what lessons for WiFi?
- \* The MDU Managed WiFi opportunity
- \* Supply chain issues, where are we?
- \* Fiber Deployments Driving WiFi
- \* WiFi and the Metaverse(s)
- \* WiFi in the BRICS
- \* Impact of private 5G on WiFi
- \* Marketplace for WiFi services
- \* Monetizing WiFi sensing
- \* Wi-Fi Testing
- \* A view of IEEE Roadmap
- \* WiFi opportunity among wireless ISPs

**or select your own topic....**



## Wi-Fi and Private 5G/LTE



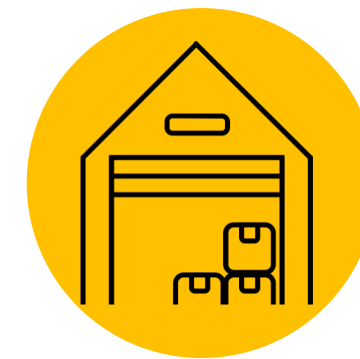
**HOSPITALITY**



**ENTERPRISE CAMPUS**



**MDUs**



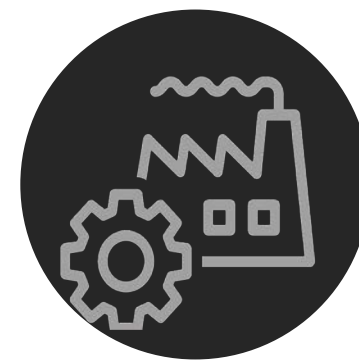
**WAREHOUSES**



**HEALTHCARE**



**EDUCATION**



**MANUFACTURING**



**SMART CITIES**



➤ MARAVEDIS 20 YEARS



# Connectivity Requirements for Smart Warehouses

A chance to win a \$200 Amazon Gift Card

Take the Survey ➤





## Multi-Dwelling Units



## Student Housing



## Senior Living





➤ MARAVEDIS 20 YEARS



Member of  
**NAAA**  
NATIONAL APARTMENT ASSOCIATION

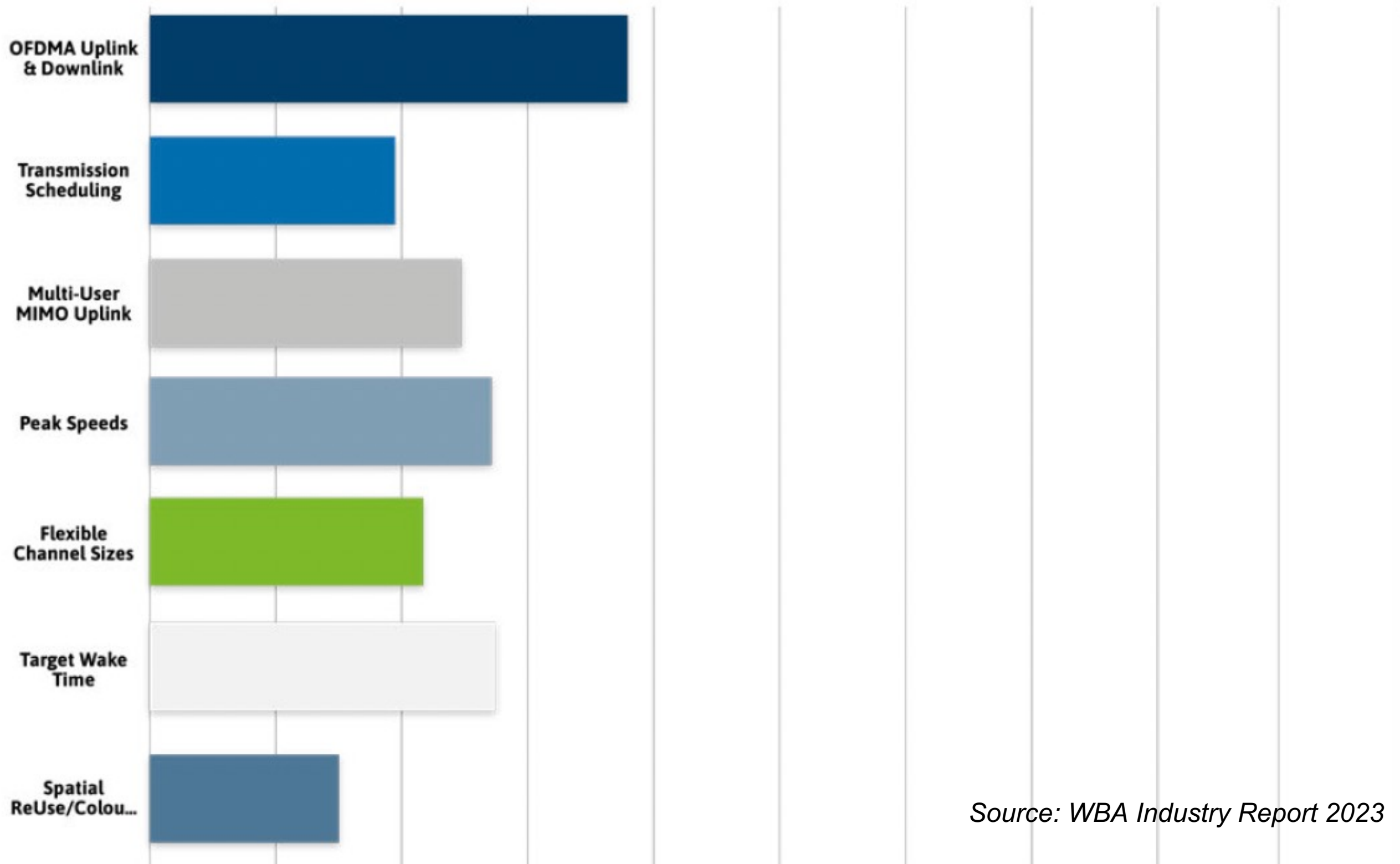
# Managed Wi-Fi for Multi-Dwelling Units

A Chance to Win a \$200 Amazon Gift Card

Take our Survey ➤



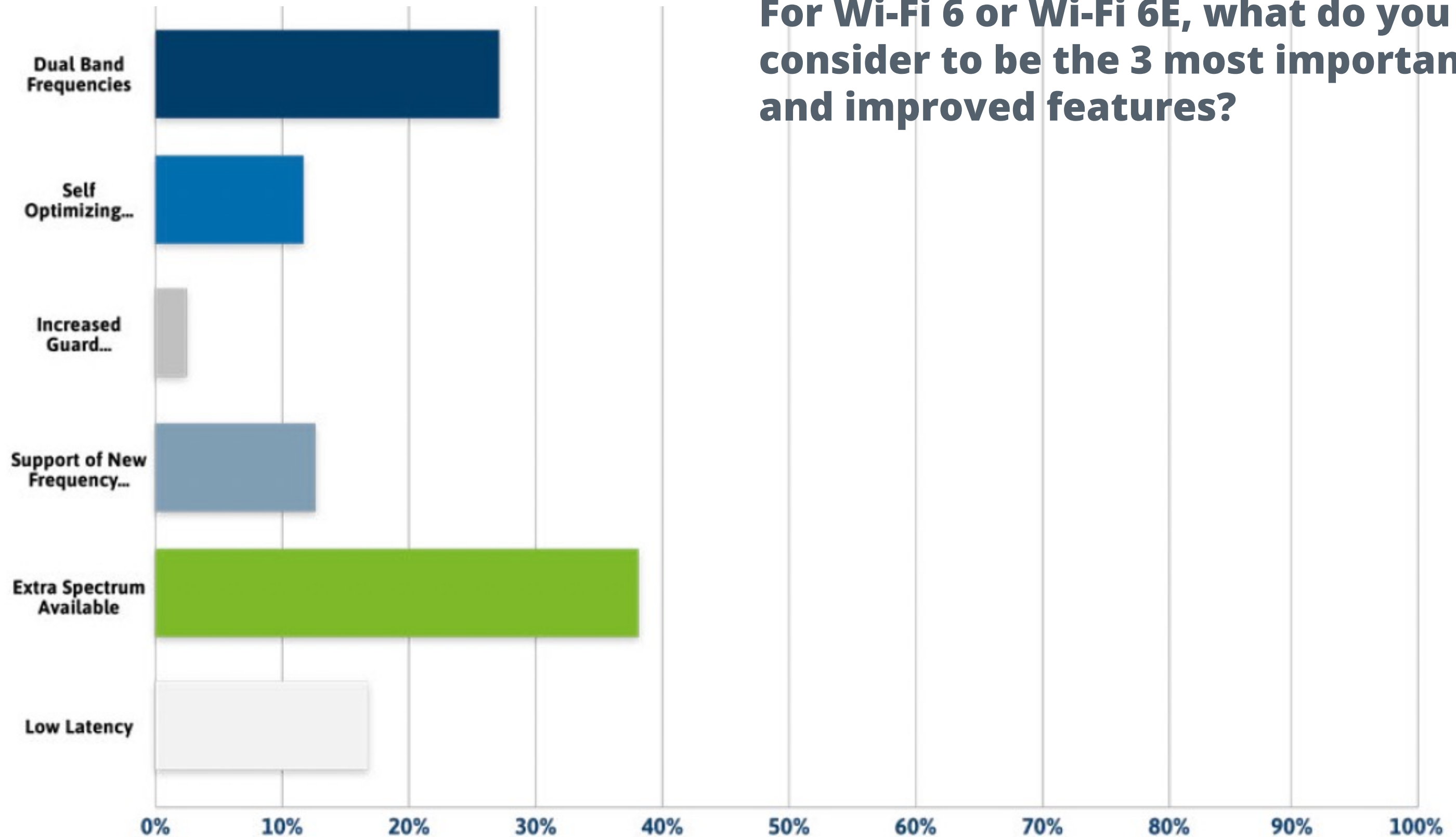
## For Wi-Fi 6 or Wi-Fi 6E, what do you consider to be the 3 most important new and improved features?



Source: WBA Industry Report 2023

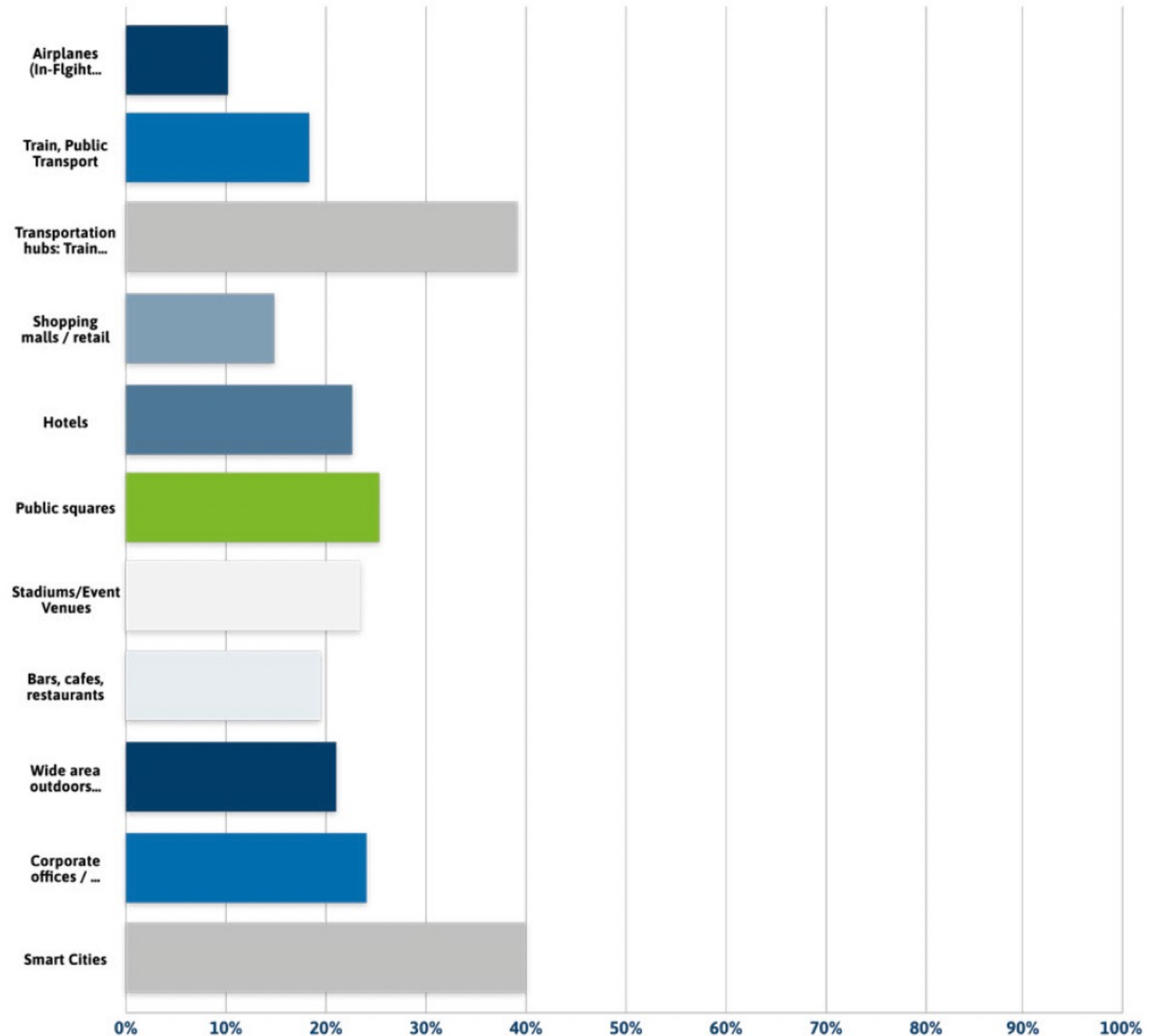


**For Wi-Fi 6 or Wi-Fi 6E, what do you consider to be the 3 most important new and improved features?**





***Please select TOP 3 areas where you expect to see the greatest growth in terms of traffic in the next 12 months.***







## ADLANE FELLAH SENIOR ANALYST & FOUNDER

Mr. Fellah is a veteran industry analyst and influencer with 22 years experience in the telecom sector. He authored various landmark reports on Wi-Fi, 5G and technology trends in various industries including residential, retail and industry 4.0.

He is regularly asked to speak at leading wireless and marketing events and to contribute to various influential portals and magazines such as *RCR Wireless*, *Rethink Wireless*, *The Mobile Network*, *Telecom Reseller* to name a few.

He is a Certified Wireless Network Administrator (CWNA) and Certified Wireless Technology Specialist (CWTS). He also regularly serves as judge for the Glomo Awards (GSMA), Fierce, Glotel, WBA Awards and WiFi Now Awards.



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## MARKETING GROWTH STRATEGY



- Market analysis
- Market sizing and forecasting
- Competitive Intelligence
- Regulatory Trends
- Custom Research
- Online Surveys

- Business Models
- Go to market strategies
- Due diligence
- Partner strategy

- Content marketing for thought leadership and lead generation:
- Webinars
  - White papers
  - Custom reports
  - Case studies
  - Blogs





## CARRIER

- Wi-Fi Offloading
- Wi-Fi Roaming
- OpenRoaming Federation
- Wi-Fi Strategies
- Wi-Fi Hotspot Tracking
- Managed Wi-Fi Services



## ENTERPRISE

- Managed Wi-Fi Trends for SMBs, Hospitality, Retail, In-flight, etc
- Industrial Wi-Fi
- Open Wi-Fi
- Deterministic Wi-Fi (TSN)
- Integration of unlicensed into public & private 5G



## HOME

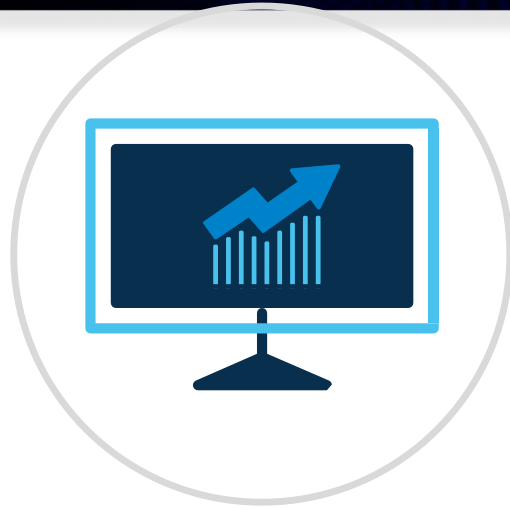
- Smart Home Wi-Fi Trends
- Monitoring and Optimization
- Mesh Networks
- Managed Services for MDUs
- Matter for the Smart Home

EDGE/AI-ML/TELCO CLOUD/CLOUD NATIVE SERVICES

WI-FI MONETIZATION STRATEGIES

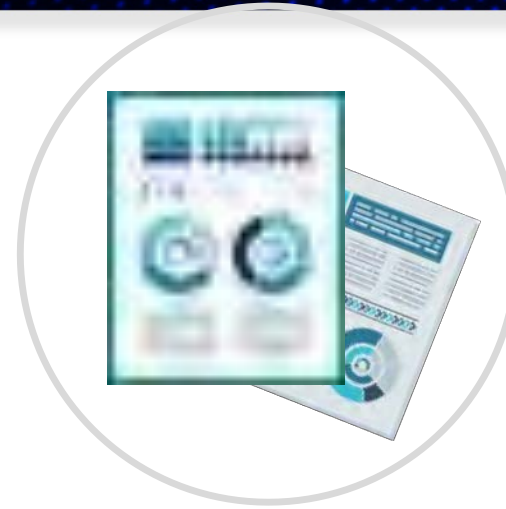
CONVERGENCE: CORE INTERWORKING/SPECTRUM SHARING/6GHz





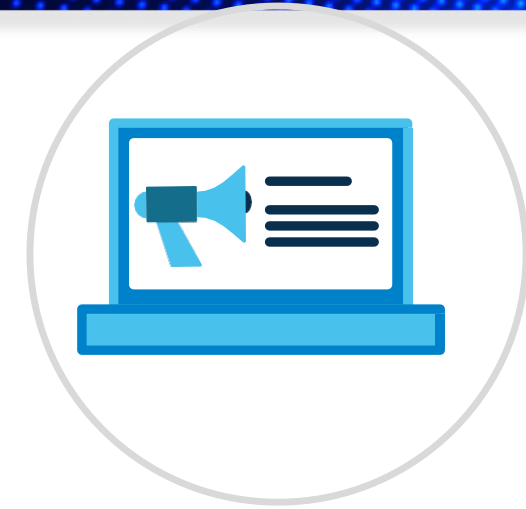
## Lead Generation Webinars

We generate high-quality leads by organizing flawless webinars. We take care of all logistics, promotion, and coordinate content preparation.



## White Papers

Demonstrate thought leadership and expertise by producing in-depth white papers on a particular topic of relevance to your audience.



## Curated Blogs

We produce relevant, strategic, and trusted blogs to support your content marketing strategy.



## Custom Research

We have more than 20 years of experience producing in-depth market reports, case studies, and research briefs for the wireless industry.



## Online Surveys

We conduct telephone interviews and online surveys to extract market trends and generate primary research findings.



## Business Introductions

We provide business introductions among our many contacts and friends in the industry



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# IEEE 802.11: Standards Roadmap

**IEEE 802.11 standard evolution & amendments**  
**New work areas**  
**Recently completed amendments**

**2023 June**

**Presenter: Dorothy Stanley, IEEE 802.11 Working Group Chair**

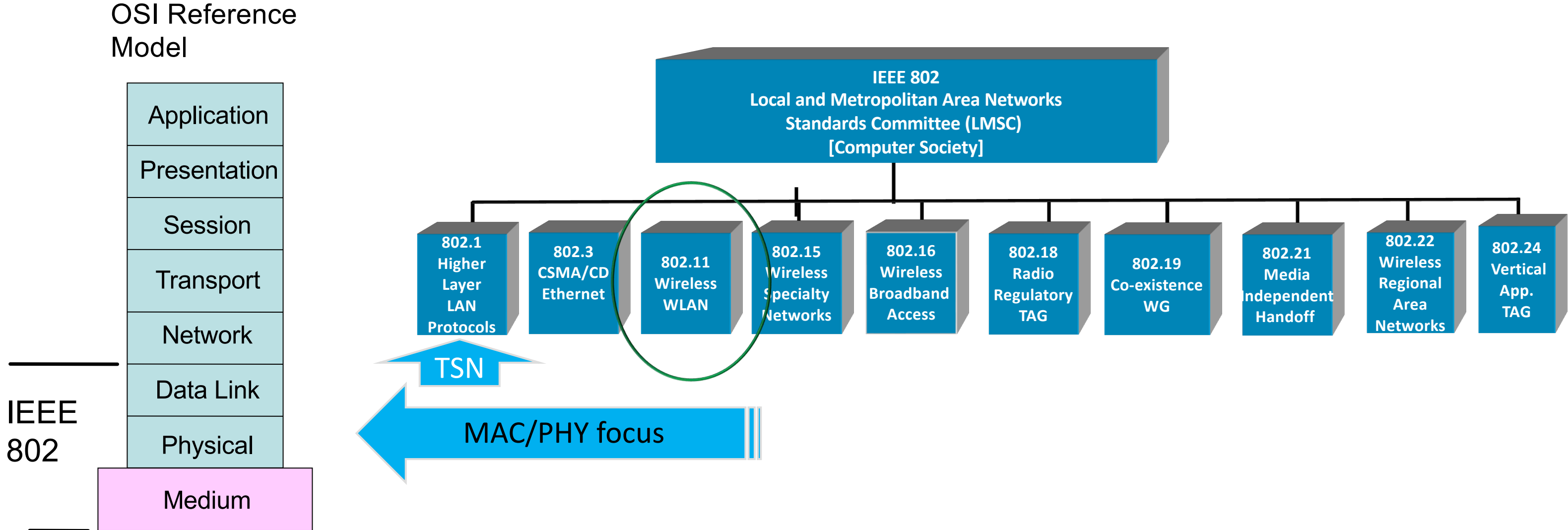
“At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE.” IEEE-SA Standards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



[Maravedis Webinar](#)

# IEEE 802 LAN/MAN Standards Committee standard development covers both Wireless & Wired Media

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





# IEEE 802.11 Wi-Fi standard MAC/PHY evolution

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
<ul style="list-style-type: none"><li>• 2.4GHz and 5GHz supported</li><li>• Wider channels (40MHz)</li><li>• Better modulation (64-QAM)</li><li>• Additional streams (Up to 4)</li><li>• Backward compatibility with 11a/b/g</li><li>• Standard supports up to 600Mbps</li></ul>	<ul style="list-style-type: none"><li>• 5GHz only</li><li>• Wider channels (80, 160MHz)</li><li>• Better modulation (256-QAM)</li><li>• Additional streams (Up to 8, implemented up to 4)</li><li>• Backward compatibility with 11a/b/g/n</li><li>• Standard supports up to 7Gbps</li></ul>	<ul style="list-style-type: none"><li>• <b>2.4GHz, 5GHz and 6GHz supported</b></li><li>• Wider channels (80, 160MHz)</li><li>• Better modulation (1024-QAM)</li><li>• Additional streams (Up to 8, implemented)</li><li>• Backward compatibility with 11a/b/g/n/ac</li><li>• Standard supports up to 9.6Gbps</li></ul>	<ul style="list-style-type: none"><li>• <b>2.4GHz, 5GHz and 6GHz supported</b></li><li>• Wider channels (40, 80, 160, 240, <b>320MHz</b>)</li><li>• Better modulation (<b>4096-QAM</b>)</li><li>• Backward compatibility with 11a/b/g/n/ac/ax</li><li>• Standard targets throughput minimum of 30Gbps, expect 40Gbps+</li></ul>

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

# UHR SG: Ultra High Reliability Study Group was approved in July 2022 to define scope and purpose of next MAC/PHY project

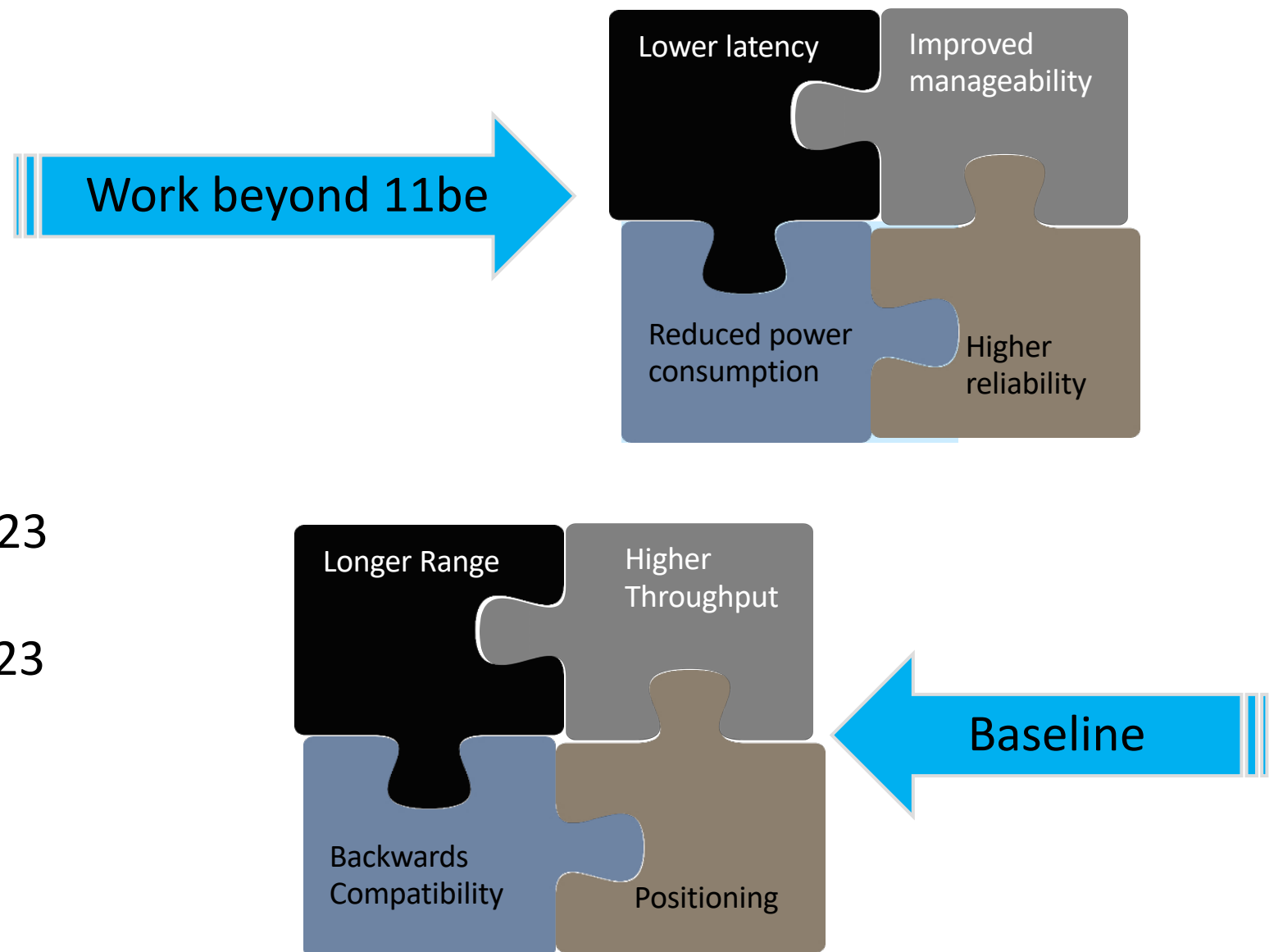
The Study Group will investigate technology to

improve reliability of WLAN connectivity,  
reduce latencies,  
increase manageability,  
increase throughput including at different SNR levels, and  
reduce device level power consumption

➔ Project Authorization Request approved in WG11 in March 2023

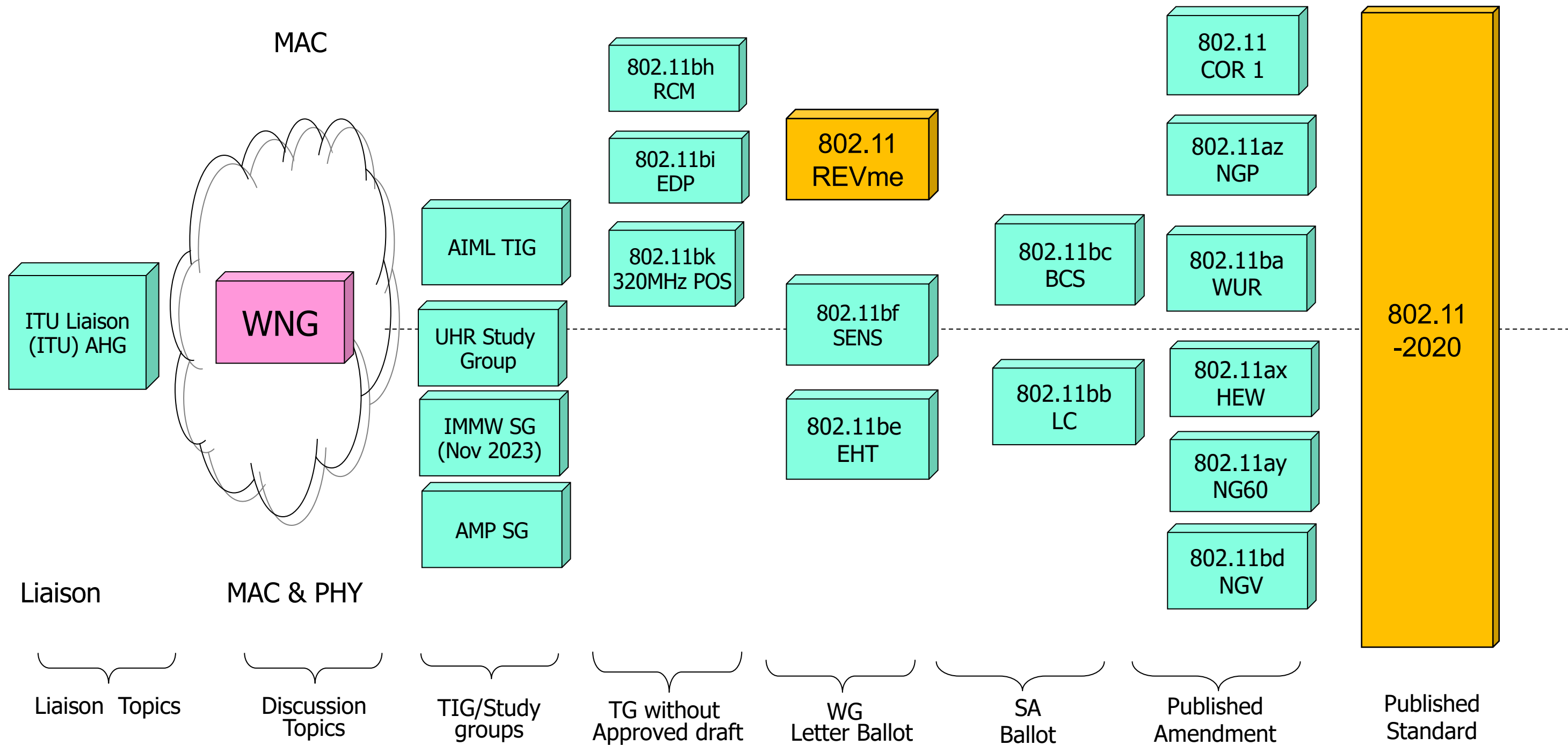
➔ The Task Group (for P802.11bn) to start work in November 2023

➔ March 2023: Also approved a Study Group to investigate Integrated Millimeter Wave, to begin in November 2023





# IEEE 802.11 Standards Pipeline/Roadmap



# Completed: Meet expanding market needs and leverage new technologies



802.11az – 2<sup>nd</sup> generation positioning features (Published 2023)

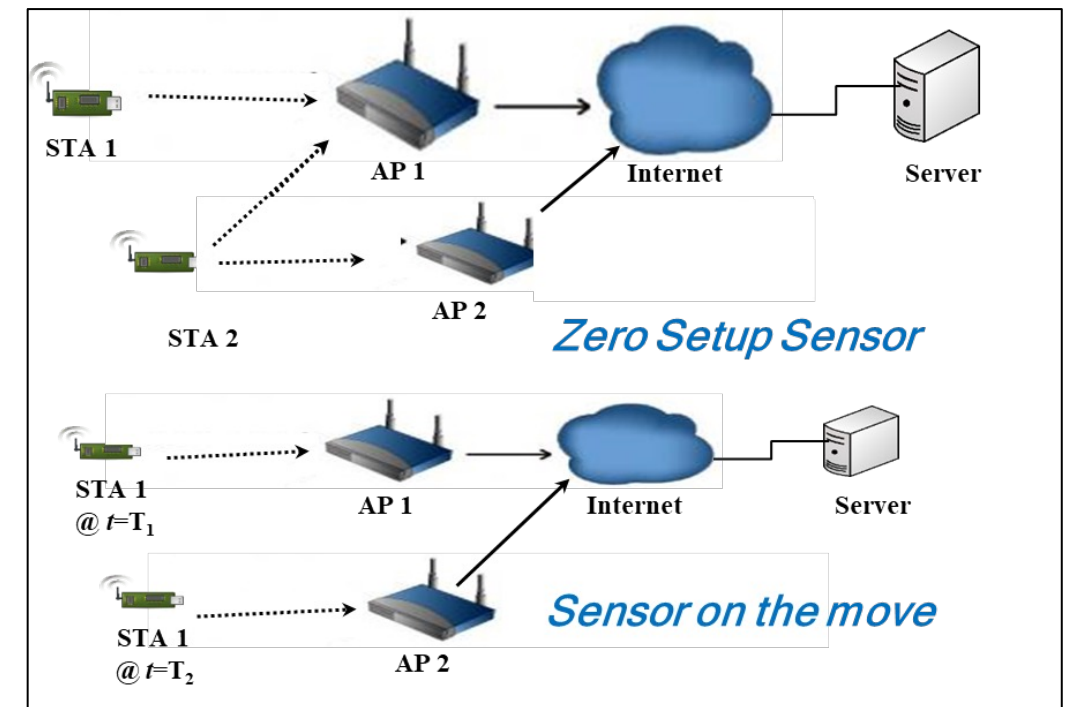
802.11bb – Light Communications (summer 2023 publication)

802.11bc – Enhanced Broadcast Service (summer 2023 publication)

802.11bd – Enhancements for Next Generation V2X (Published 2023)

See IEEE Webinar re: 802.11bb, 802.11bc

See Wi-Fi Now tutorial on 802.11az





# Completed: 802.11bd Next Generation V2X Use Cases

5.9 GHz band mainly, and optionally 60 GHz; Completion in 2022, published 2023

[http://www.ieee802.org/11/Reports/tgbd\\_update.htm](http://www.ieee802.org/11/Reports/tgbd_update.htm)

## V2X Use Cases:

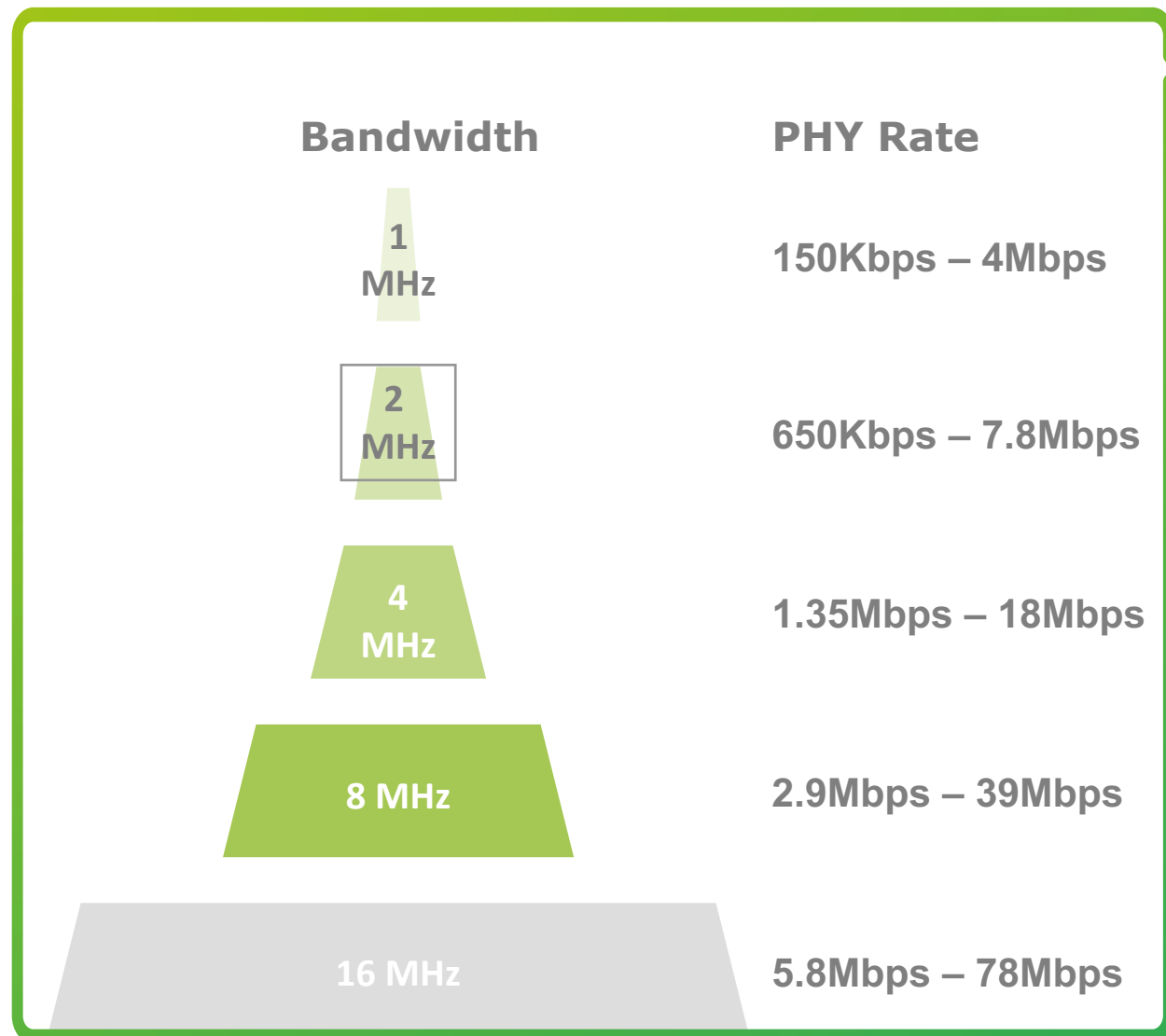
- Support all defined DSRC/802.11p use cases, including Basic safety message (safety, range, backward compatibility, fairness)
- Sensor sharing (throughput)
- Multi-channel operation (safety channel + other channels)
- Infrastructure applications (throughput)
- Vehicular positioning & location (LoS and 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 :

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

Slide 21

## Completed: IEEE Std 802.11ah-2016 enables Wi-Fi for M2M and IoT applications with products now coming to market



**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 **Wi-Fi Certified HaLow** certification program

Japan: **802.11ah Promotion Council**

**New market entrants** emerged to develop the technology



# In progress: New 802.11 Radio technologies are under development to meet expanding market needs and leverage new technologies

802.11be – Extremely High Throughput in 2.4, 5 and 6 GHz bands, aka Wi-Fi 7

802.11bf – WLAN Sensing

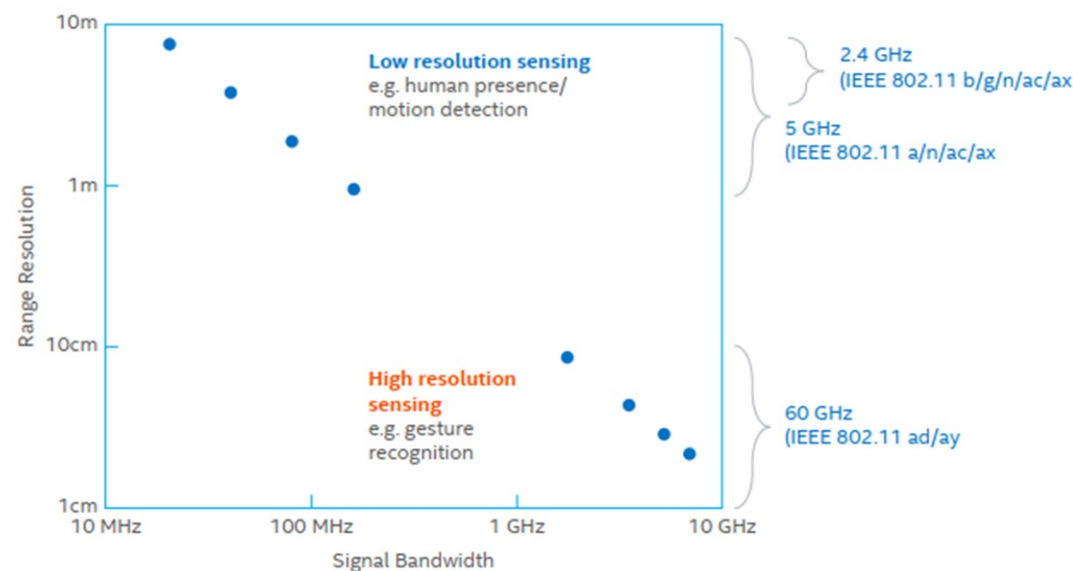
802.11bh – Randomized MAC Addresses

802.11bi – Enhanced Data Privacy

P802.11bk – 320 MHz Ranging

802.11be (est. 2024)  
Wi-Fi 7

- **2.4GHz, 5GHz and 6GHz supported**
- Wider channels (40, 80, 160, 240, **320MHz**)
- Better modulation (**4096-QAM**)
- Backward compatibility with 11a/b/g/n/ac/ax
- Standard targets throughput minimum of 30Gbps, expect 40Gbps+



# AIML TIG: Investigate WLAN support of Artificial Intelligence/ Machine Learning

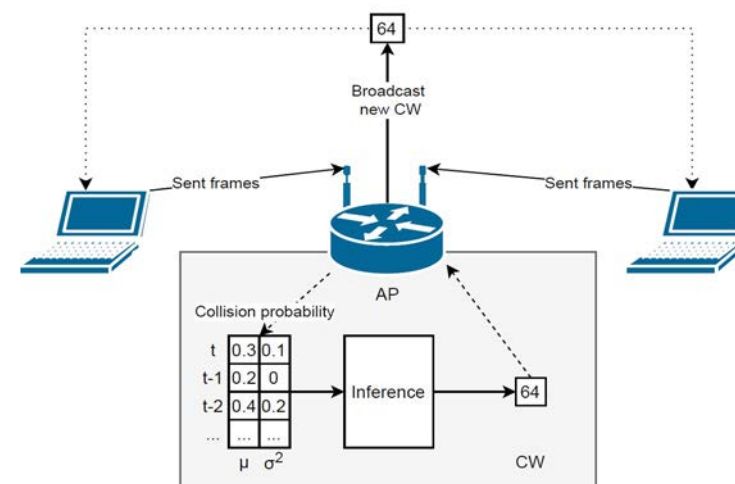
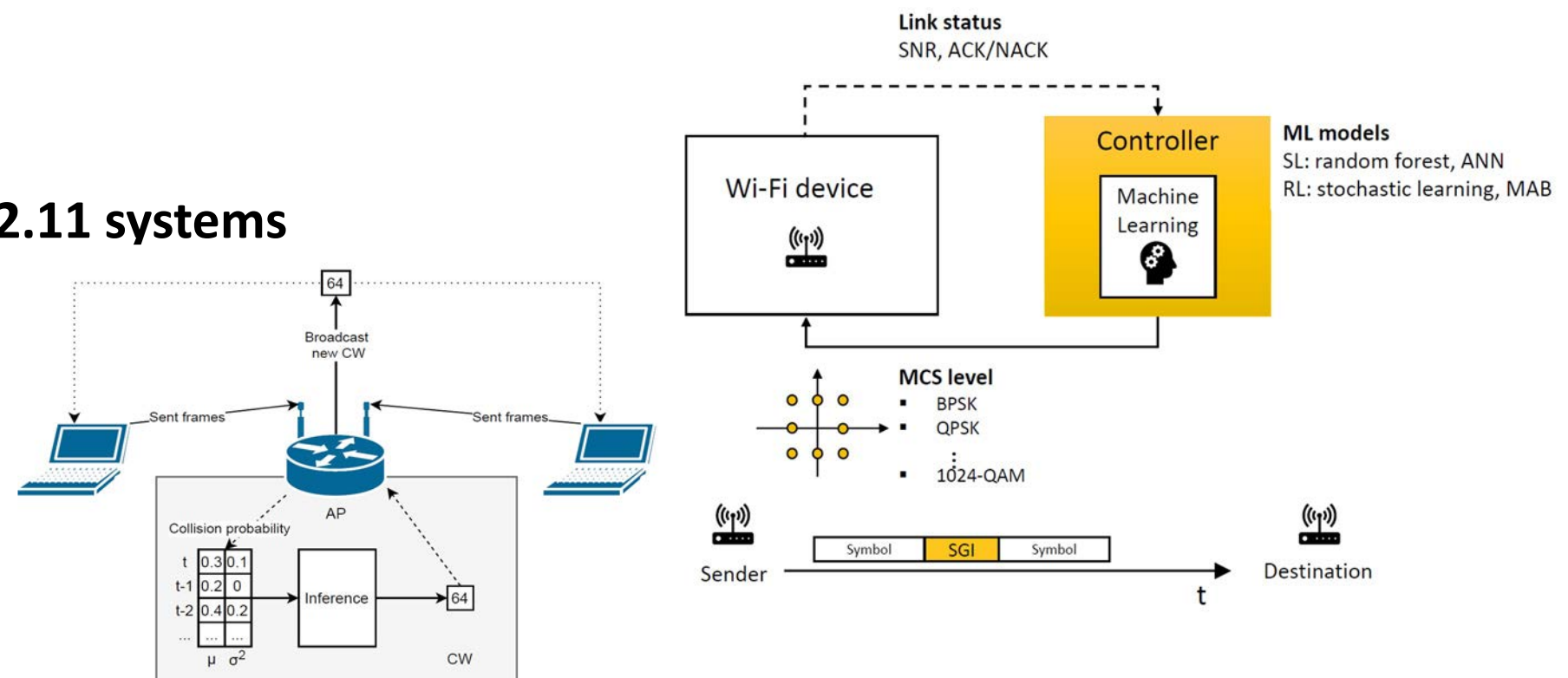
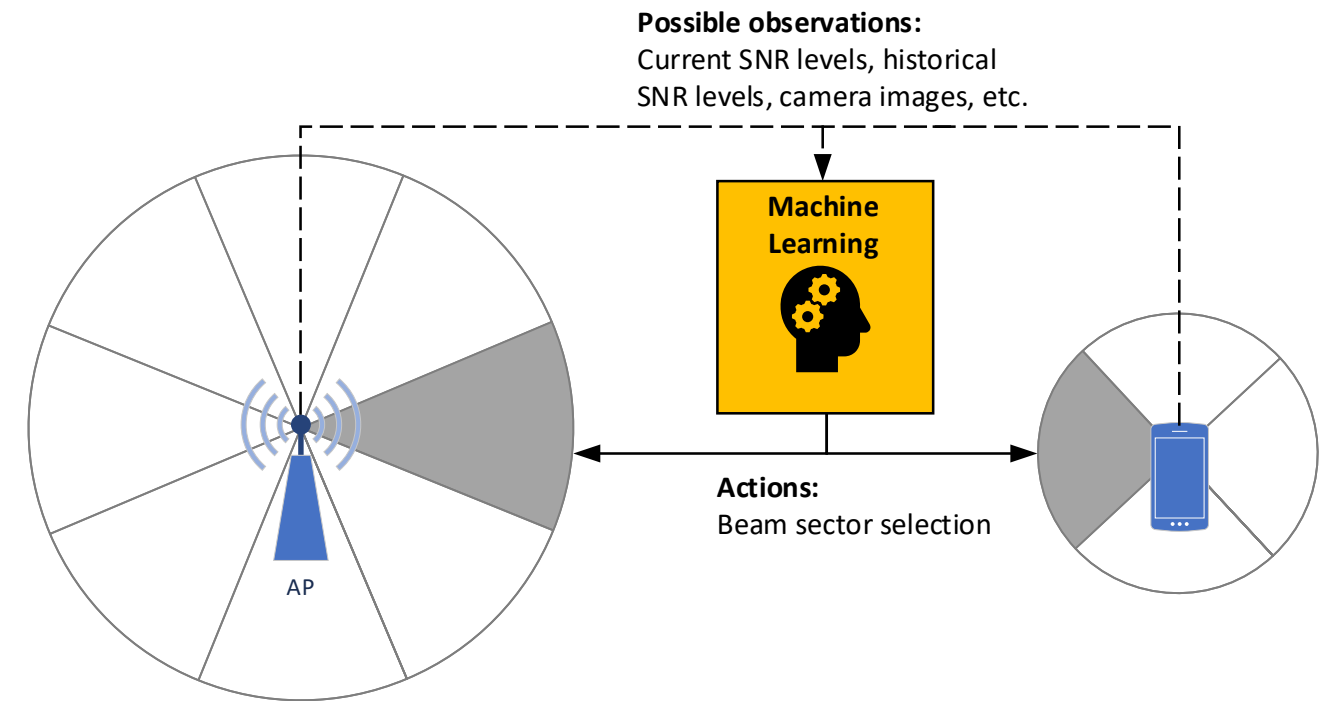
Use of AIML for 802.11 applications is an active area of work in the research community. See [Applying ML to 802.11: Current Research and Emerging Use Cases](#)

Current applications focus on performance improvement parameter selection for channel access control and link adaptation, multi-user parameters, contention window sizes, channel usage, improved BSS transition

Work underway:

Describe use cases for AI/ML applicability in 802.11 systems

Investigate the technical feasibility of features enabling support of AI/ML.





# AMP TIG/Study Group: Investigate WLAN support of Ambient Power

Research into ambient power (energy harvesting) and prototype development has been ongoing using 802.11 based devices

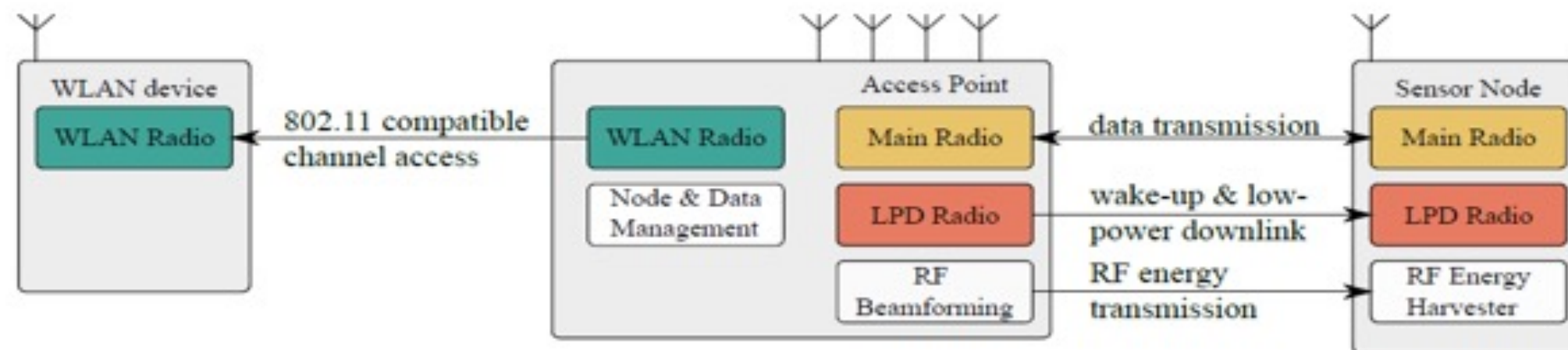
## Optimizing M2M Energy Efficiency in IEEE 802.11ah, IEEE GLOBECOM 2015

“the battery dependency of an 802.11ah sensor is significantly lowered by energy harvesting provided that the sensor size and energy harvesting efficiency are sufficient for the utilized ambient energy source.”



## Low-Power Downlink for the Internet of Things using IEEE 802.11-compliant Wake-Up Receivers, IEEE INFOCOM 2021

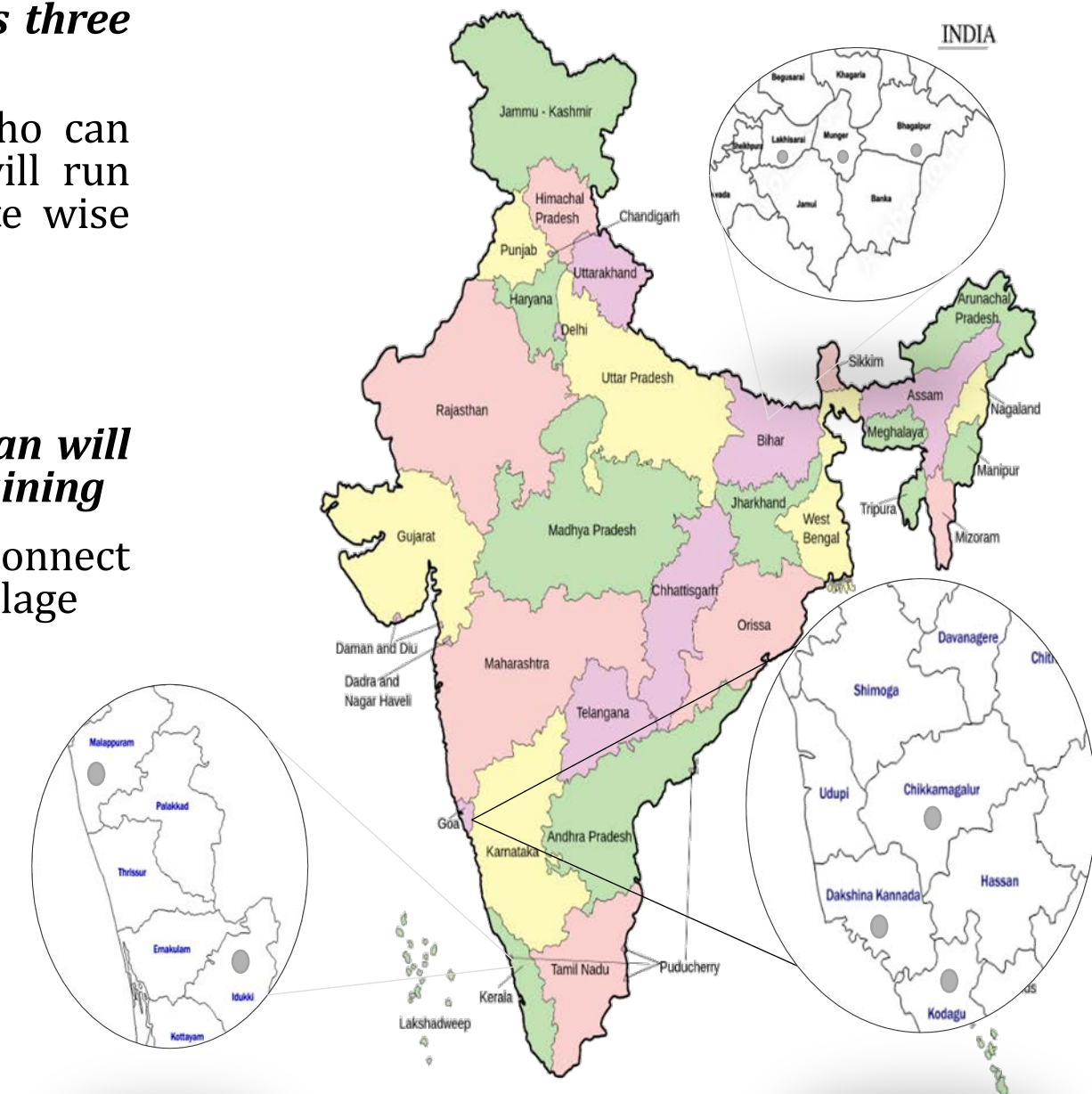
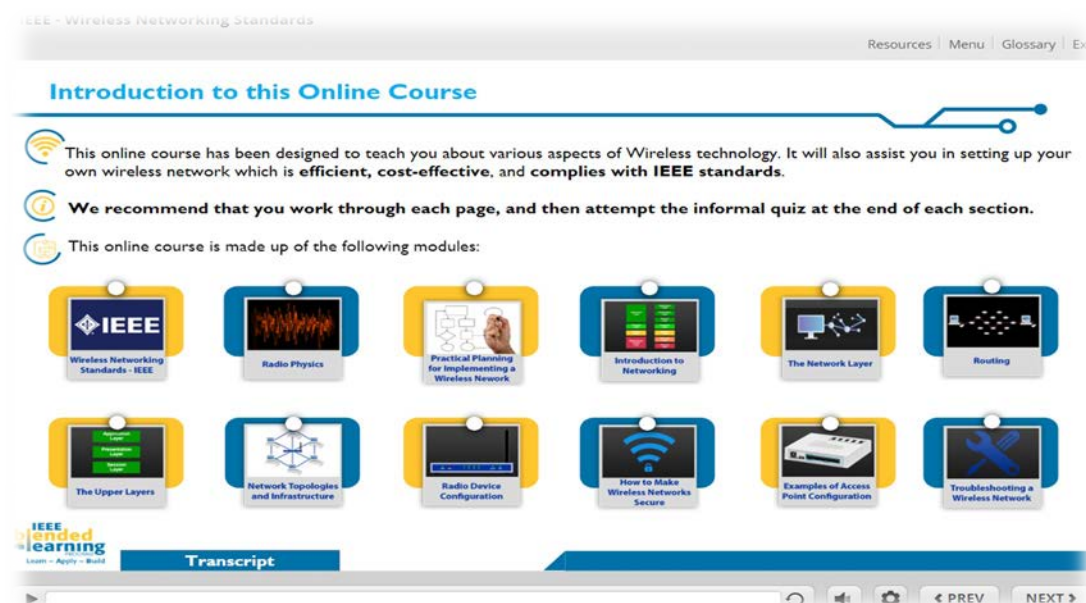
Use Cases include Smart Home, Logistics/Warehouse/Inventory, Industrial Wireless Sensor Networks



See <https://mentor.ieee.org/802.11/dcn/23/11-23-0436-00-0amp-technical-report-on-support-of-amp-iot-devices-in-wlan.docx>

# IEEE 802.11 based products are an essential component for connecting the unconnected: IEEE & ISOC Initiative for Building Wireless Community Networks (BWCN)

- **Use cases: Hotspot access, Community Wi-Fi using satellite, optical for backhaul**
- **Installation of the internet in 200 villages and Installation of 100 digital class across three states (Karnataka, Kerala and Bihar)**
  - Internet: will be provided to schools in the villages through service provider who can provide last mile connectivity Digital classroom : 65-inch touch screen which will run through Android and Windows, prefilled with global level syllabus and later state wise syllabus is installed in partnership with state government
- **BWCN course will be translated to 5 languages to benefit more people**
- **250 VLEs / VLTs (Village Level Technicians / Entrepreneurs) and 500+ junior technician will be trained extensively and the BWCN course, BLP platform will be used to deliver the training**
  - Entrepreneurs are trained to deploy, repair, troubleshoot internet so that they can reconnect internet service with the help of service provider after any disaster situation in the village





## Wi-Fi evolution needs 1200 MHz of global harmonized 6GHz spectrum to support next generation use cases

- Future connectivity and economic value increase will depend on Wi-Fi 6E and Wi-Fi 7
- 6 GHz band is uniquely suited (no alternative) to support growing Wi-Fi spectrum needs
- Next use cases: immersive AR/VR/XR for training, industrial, telehealth, automation, 3-D video, also, critically, dense deployments
- Standard Power Devices with AFC is the most efficient and practical solution to deliver connectivity to underserved areas while coexisting with existing fixed services in the band.

- See <https://www.wi-fi.org/countries-enabling-wi-fi-in-6-ghz-wi-fi-6e>



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

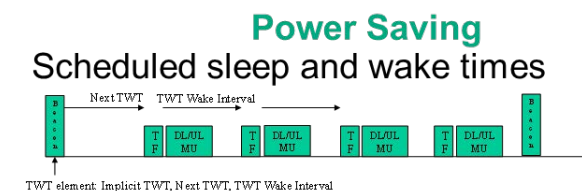
## IEEE 802.11 standard development

Defines Wi-Fi operation in sub 1GHz, 2.4, 5 and 6 GHz spectrum bands

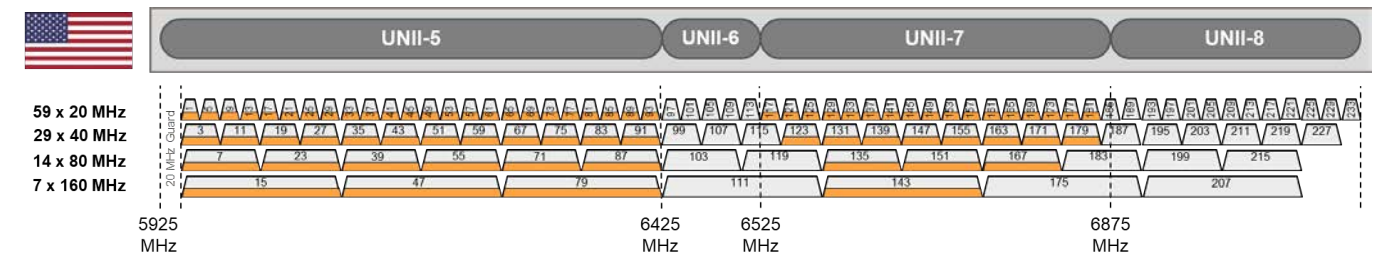
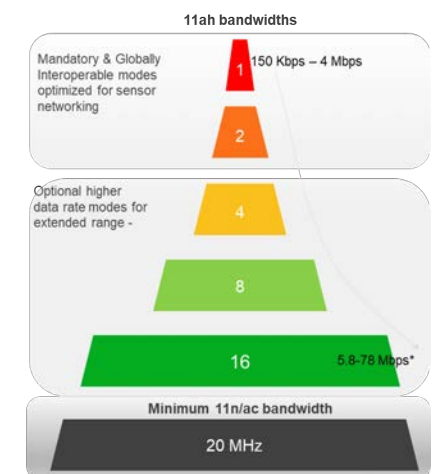
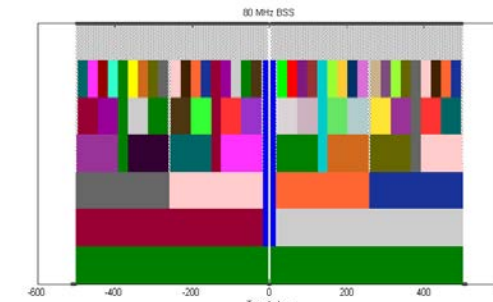
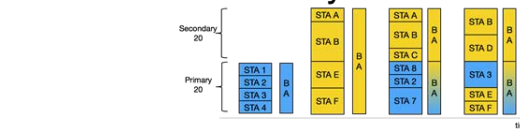
Supports existing and new innovative services, business models, including 5G

Delivers significant economic value

Enables economic growth and societal development



### 20 MHz-only clients





**THANK YOU**

**QUESTIONS**

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# 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>





# Trust Experience. Trust Kyrio.

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The Road to Wi-Fi 7

12<sup>th</sup> June 2023

 [kyrio.com](https://kyrio.com)

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# Agenda

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- 1 Change is Coming
- 2 The Advantages of Wi-Fi 7
- 3 Wi-Fi 7 Testing Challenges

- 4 Early Test Strategies
- 5 The Benefits of an Independent Lab
- 6 Reach Out

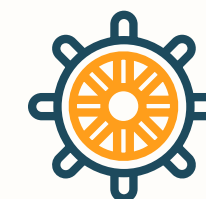


# Change is Coming – Wi-Fi 6 to Wi-Fi 7



## Wi-Fi 6 has only just become the norm !!

	Max PHY Mbps	Radio Freq
Wi-Fi 4 (n) 2008	72 to 600	2.4/5
Wi-Fi 5 (ac) 2014	433 to 6,9335	
Wi-Fi 6 (6/6E) 2019/20	574 to 9,608	2.4/5/6
Wi-Fi 7 (be) 2024 est	1376 to 46,120	2.4/5/6



## Wi-Fi 7 Headline Takeouts

- EHT PHY – Extremely High Throughput, 4k QAM, Other +
- EDCA - Common QoS Improvements
- Enhanced OFDMA - Latency gains – Multi RUs
- Efficient Spectrum Usage with MLO Concurrent Band Aggregation
- Channel Sounding Optimisation - Improvements
- Advanced PHY methods – Spectrum Efficiency, HARQ
- Advanced Multi AP coordination

# The Advantages & Benefits of Wi-Fi 7

## Wi-Fi 7 Advantages



Wi-Fi 7's: focus is on Throughputs and User Experience

6GHz 320MHz Channel Bonding 100% +

4k QAM throughputs – 20% increase

MLO – many permutations to increase speed

Spatial Streams 8 to 16 – TX/RX 100% lift

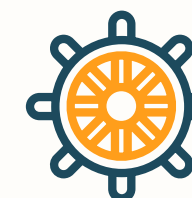
Greatly improved Latency

Anticipated further range of TX / RX, and more TXOps

AP Co ordination - extending the range and wider support

Greater concurrent TX/RX support

## Wi-Fi 7 Benefits in “Combined” action



Greatly Improved Concurrent and individual User throughputs,  
“Max PHYs” move from 9.6Gbps to 46Gbps

*We will discover the compound real world numbers in the Kyrio labs soon enough*

Latency improvements for RTA's inc Gaming / VR / AR / OTT  
4/8K content, Time Sensitive Networking

Concurrent User benefits to meet the higher demands and user volumes in the premise

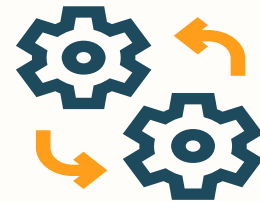
Considerably more TX/RX flexibility to maximise the Wi-Fi environment

Better support for IOT short frame transmission impacts

Better Power usage / Battery Life for devices

# Wi-Fi 7 Testing Challenges

## Risk of Change



Draft 4 May 23

Final Amendment May 24 >>> Sept to Dec 24

Diminishing of change risk

## Test Equipment Availability

Right now, the market is maturing

Many are in Dev, some have launched

Early Adopters are already in market

Test Devices – “Pro-Sumers” & \$\$

Kyrio see Wi-Fi 7 as the same as AC and AX,

Kyrio procures the latest and most suitable Test equipment as soon as its ready, including assisting the suppliers in their Dev’ pre launch

The landscape is changing fast !



# Early Wi-Fi 7 Test Strategies

## Opportunities



Review New features in Wi-Fi 7 vs Wi-Fi 6 and Test capabilities

Build flexible platform that's backwards compatible in the relevant feature areas

Leverage new platform to expose customer impacting issues in legacy technologies as an additional service.

Integrate bigger more customer focused "Compound Testing" capability, to replicate what's really happening in end user homes with Wi-Fi 6 and 7 and Hybrid

## Test Strategic Objectives



Focusing on the Wi-Fi 7 Changes

Market Feedback on Customer Focus – Priorities for delivery

The Important Big Hitters, inc Latency, MLO, 5G interop

Seamless Connectivity between 5G and Wi-Fi 7 will be critical to validate

Creation of a Wi-Fi 7 Relevant Test Strategy / Design

The Implementation of the Wi-Fi 7 Test Methodology and the Environments, inc phasing

Testing in 2 elements – a) Technical and b) User Experience

Creating "Proof of Reality" for the Customer

Seize the "Opportunities" that change brings with Wi-Fi 7

# The Benefits of an Independent Lab

## Leadership



You expect CableLabs and Kyrio to be at the cutting edge

With the Wi-Fi 7 changes, Kyrio seek to be at the front of Test Leadership for Wi-Fi 7

Suitable areas we develop with Wi-Fi 7 we will backport to the Wi-Fi 6 test portfolio too

## Independence



Resources and capacity to support clients from Manufacturing, Service Providers and Importers

One size will NOT fit all, tailored Test Campaigns to suit the customer

We will seek to Expose the Truth of how the technology works with your products and testing

Every customer is confidential, and they always have been. Neutrality is critical and so is trust in Kyrio

## Best Practices and Capability



“Learn Once, Per-fect Many”

Kyrio’s Centre of Excellence

Kyrio’s strong Product Development mindset

WI-FI 7 Investments wont be cheap

Economies of Scale

An Efficient Budget Usage / Control

Flexible Capabilities tailored to Customer requests from the ever deepening pool of experience

# Reach Out

## We should really talk



Today's Message is clear.

Change is coming

It's going to impact Wi-Fi today and tomorrow

It's going to open new opportunities

It's going to force change within all our businesses

How will it impact you ?

Where can Kyrio help you ?

### CONTACT US

858 Coal Creek Circle | Louisville, CO 80027  
(303) 661-9100 | [info@kyrio.com](mailto:info@kyrio.com)





## **Appendix – If needed**

# Wi-Fi 7 Adoption Thoughts – Timelines

## The Market



Domestic Broadband speeds won't support the max Wi-Fi 7 max capability for a while

CATV is under threat from IP, as adoption of IPTV ramps up and OTT services prevail in greater scale

The need for significant Real Time data flow support is growing fast from every device in the premise

2.4 congestion is growing much worse, and so will 5GHz soon enough in denser conurbations – MDUs

Will Corporates' be lead adopters ?

## The Economics



Worldwide Economic Slowdown will weaken immediate take up “surge”

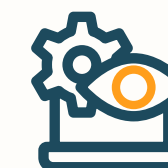
MSO ARPU revenues are under pressure so NPD budgets tight, sweating their Wi-Fi 6 estate more

Early Adopters are still here though

AP and STA costs and availability questions / evolve and ease

Wi-Fi 6 still being adopted and often Early to Maturing phase in its product life cycle in some markets

## Outlook



Power users will be the early adopters, especially if MSO's tier their Wi-Fi 7 as a premium low volume product, for a period

Mass take up will be driven by IPTV / VR and high concurrent demand within the premise, as every end user demands their own “Fast Access” to the 1GBps BB service

True benefits of EHTs will only materialize with >1- 10G BB service to the premise, which in some ISPs is a premium standard product already and NPD elsewhere

The Role of Corporates could well be the game changer