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Introducing the 6 GHz Band & Wi-Fi 6E

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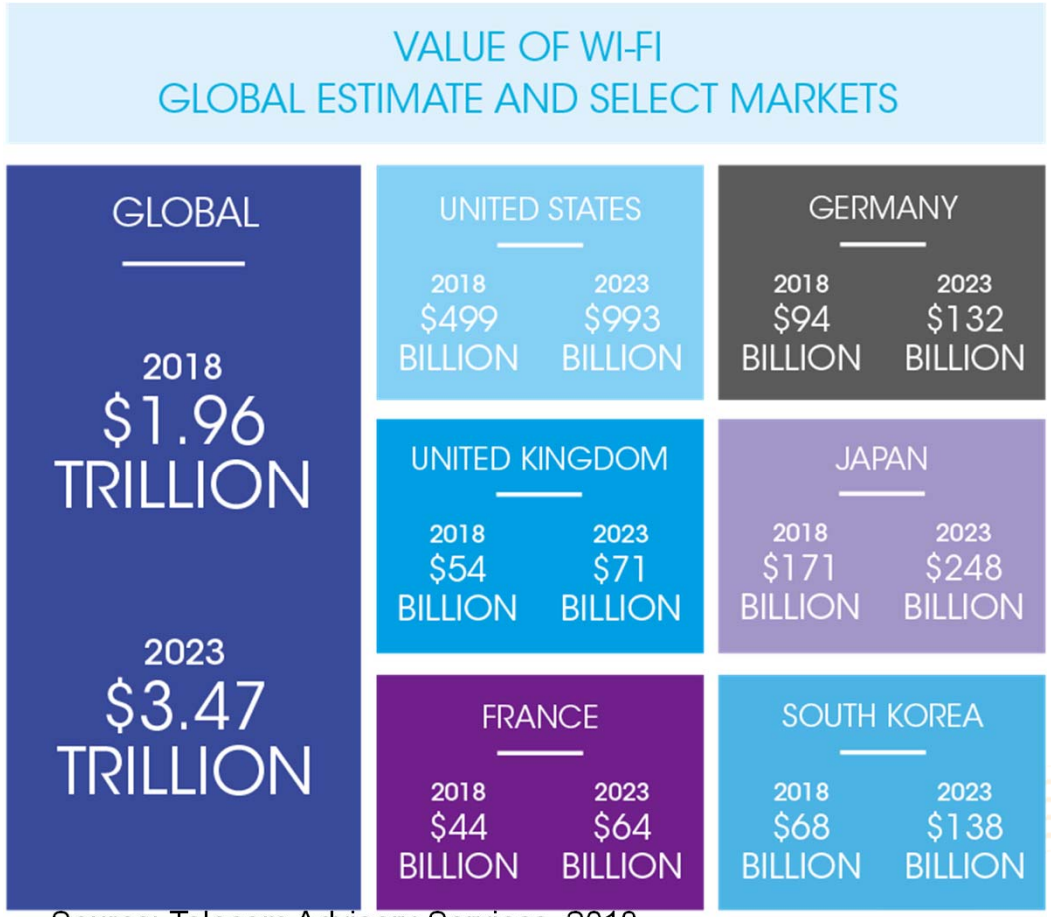
a Hewlett Packard Enterprise company

Wi-Fi is Key to Economic Growth

- As reliable broadband connectivity becomes more important than ever, high performance Wi-Fi is a vital driver of economic growth.

- In the wake of the COVID-19 pandemic, citizens, businesses and governments are relying on Wi-Fi to remain connected with colleagues, teachers, healthcare professionals and other vital services.

- In-home Wi-Fi is helping limit the economic and societal damage caused by the pandemic.



Source: Telecom Advisory Services, 2018

Wi-Fi 6 and 4G / 5G Are Complementary

- Without the ability to offload traffic to Wi-Fi, 4G/5G networks would be more expensive. Mobile operators would need to invest more in network densification, deploying many more small cells in dense urban areas to offer high-speed throughput.
- Many “core” 4G/5G use cases depend on Wi-Fi for value creation. These include:
  - Consumer & enterprise fixed wireless access (FWA)
  - Mobile AR/VR for consumer & enterprise
  - Mobile gigabit hotspot
  - Smart home
  - 4K movie casting from smartphones to smart TVs
  - Home health monitoring devices & wearables

Wi-Fi Depends on a Contention Based Protocol

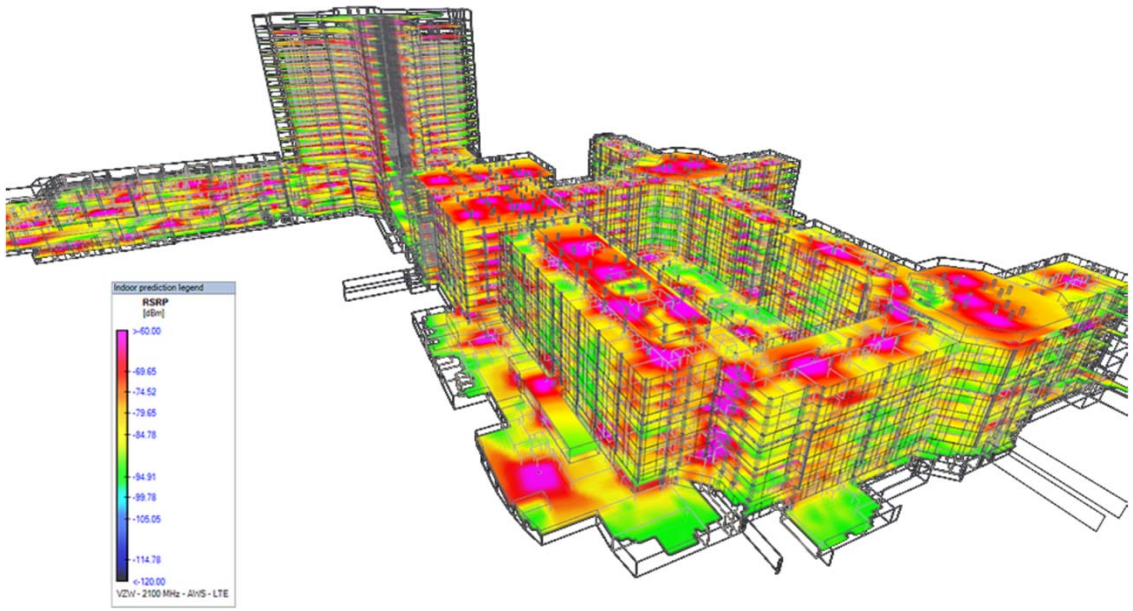
- RLANs are inherently self-coordinating
  - They integrate dynamic spectrum access techniques in the frequency and time domain to maximize utilization in license-exempt bands with no prior coordination between device owners

- The primary techniques employed by Wi-Fi are:
  - Cell silencing via backward-compatible reservation signal (preamble)
  - Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) for random channel access

- It can be shown that at least 7 channels are required for such a system to be acceptably non-blocking in real world conditions

Self-Coordination Requires Multiple Channels

Licensed Spectrum = Hand Coordinated



Operator networks are precision engineered to achieve exacting C/(I+N) targets with Reuse={1,3} networks by a single operator and costly high quality radio components

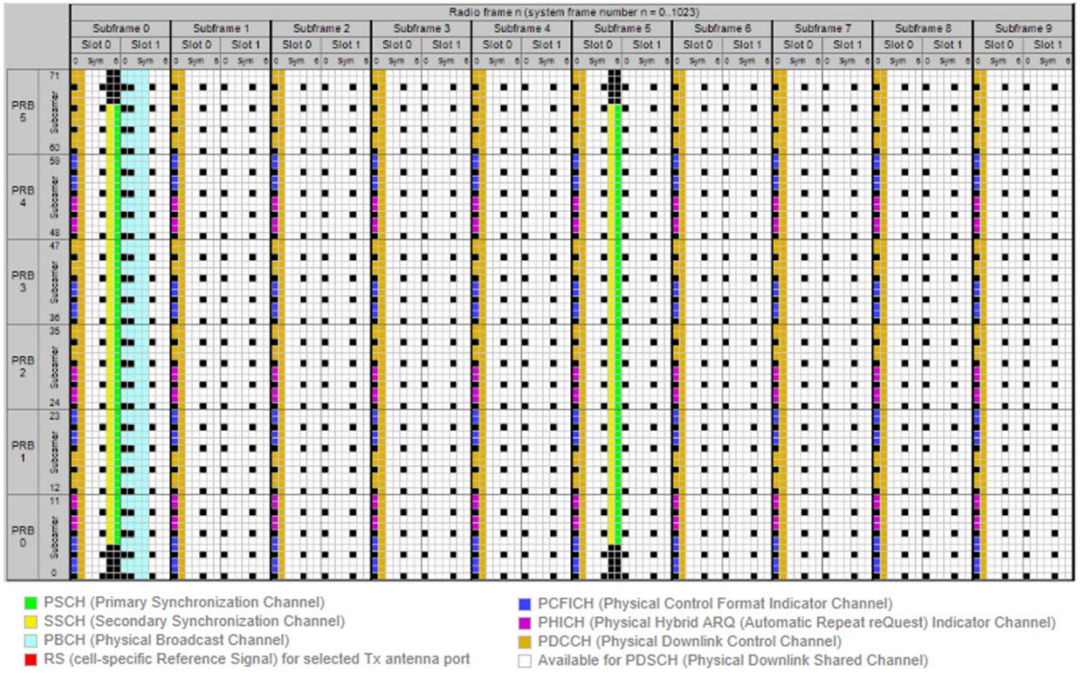
License-Exempt Spectrum = Self Coordinated

Wi-Fi uses combination of Energy Detect (ED) and/or Preamble Detect (PD) with Reuse={3-25} networks using C/N operation and consumer grade components

Sources: DAS Everywhere Brochure showing IBWave model; Aruba Networks Next-Generation Residence Halls VRD

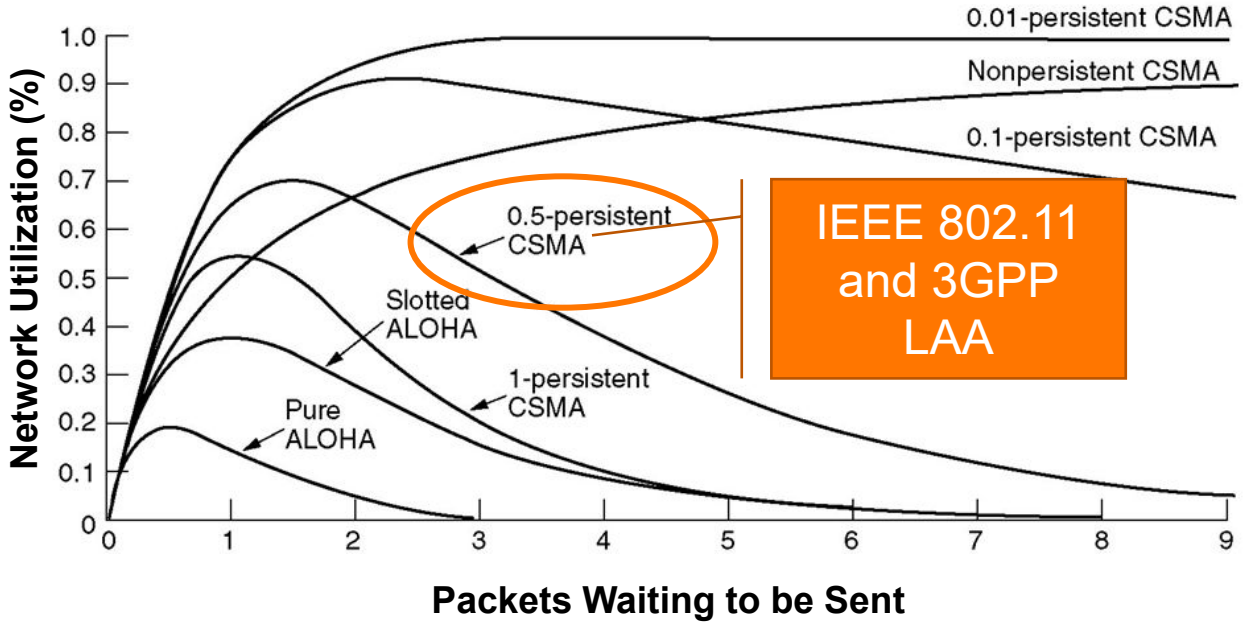
Self-Coordination Is Critical to Low Cost Devices

Licensed Spectrum = Scheduled Access



Fully scheduled radio systems require dedicated spectrum under control of a single operator

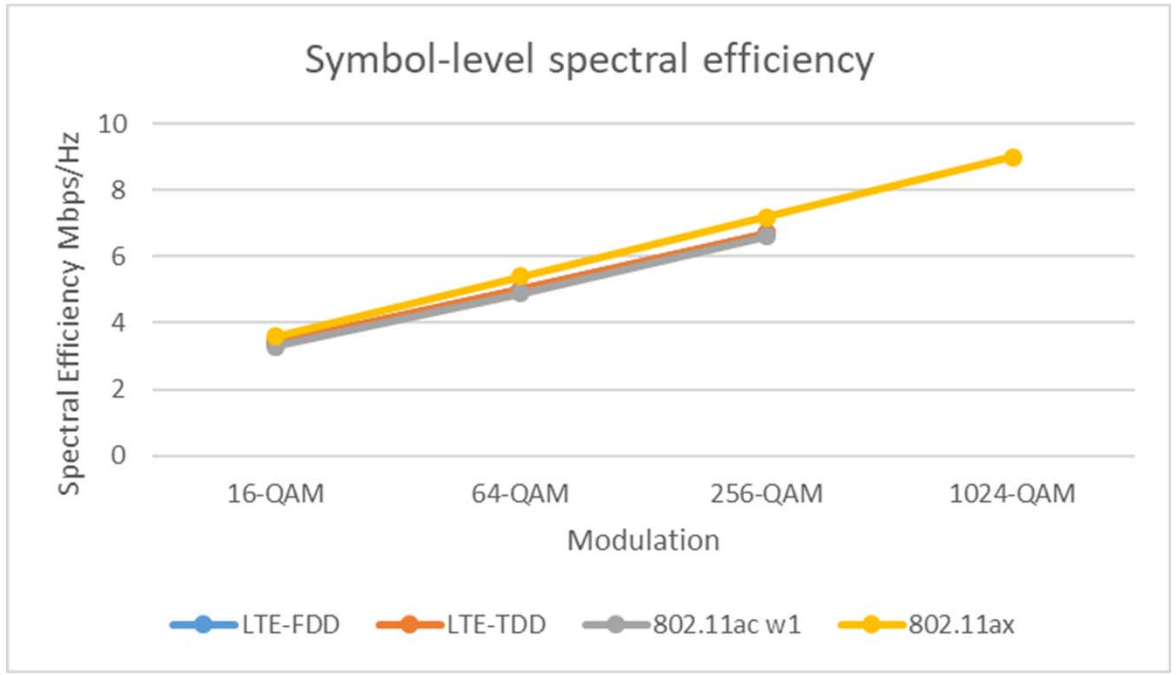
License-Exempt Spectrum = Random Access

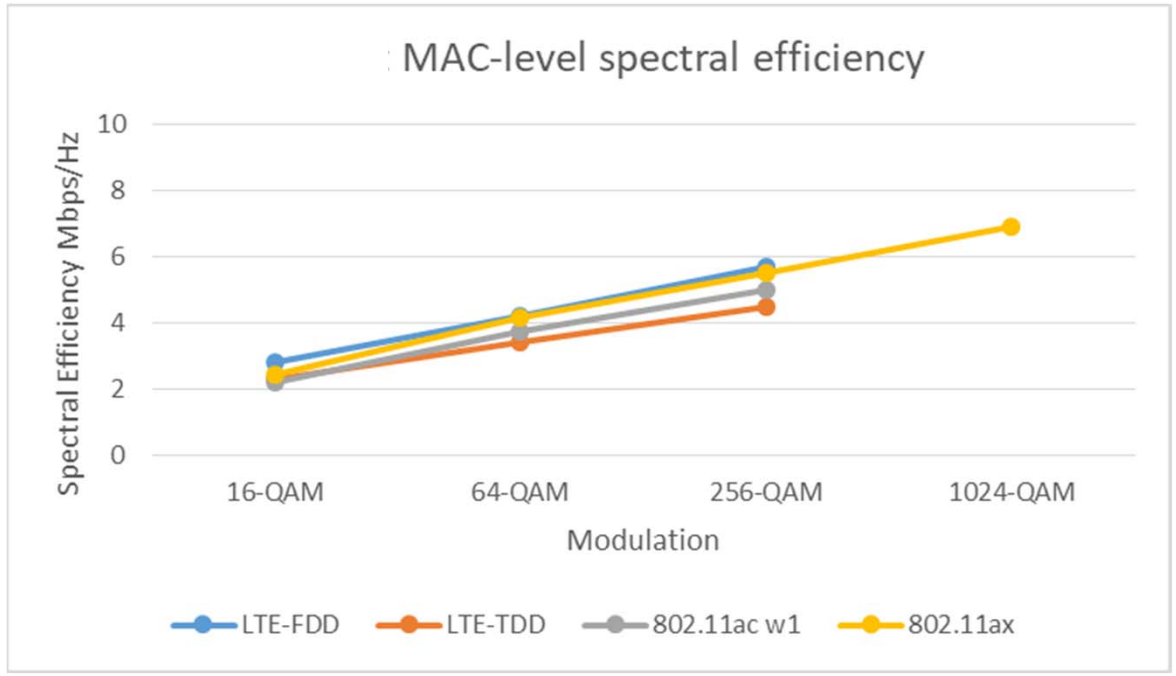


RLANs use **listen-before-talk methods** and statistical channel access to achieve **uncoordinated random access** with high channel utilization levels

Source: Computer Networks, 5th Edition, Andrew Tanenbaum & David Wetherall, 2011

Wi-Fi & 3GPP Technologies Achieve Similar Spectral Efficiency





- Wi-Fi and LTE are both OFDM
- When normalized at the symbol level, they have nearly identical performance
- Wi-Fi 6 delivers bidirectional OFDMA

- At the MAC layer, Wi-Fi and LTE deliver very similar efficiency after accounting for layer-2 overheads
- Wi-Fi 6 delivers additional efficiency gains

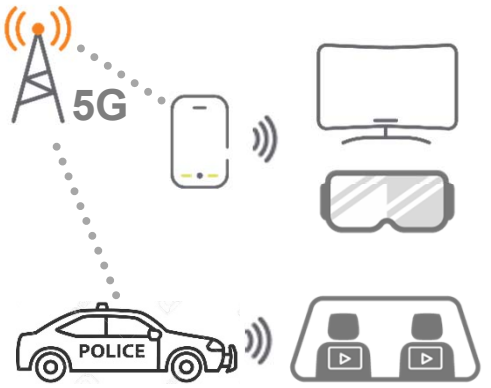
Source: Aruba Networks Research

Device Classes in 6 GHz

Low Power Indoor (LPI) AP
- Fixed indoor only
- Up to 63X lower energy
- No antenna connectors
- No weatherproofing
- Wired power

Standard Power (SP) AP
- Fixed indoor / outdoor
- Controlled by AFC database
- Automated geolocation
- Pointing angle restriction

Very Low Power (VLP) AP
- Mobile indoor / outdoor
- 160X lower energy



~2 Gbps throughput with sub-ms latency at 3m

Subordinate Indoor Device
- Same rules as LPI AP, ***plus***:
- Under AP control
- No direct Internet connection

Mobile Client
- Indoor / outdoor
- 4X less power than connected AP

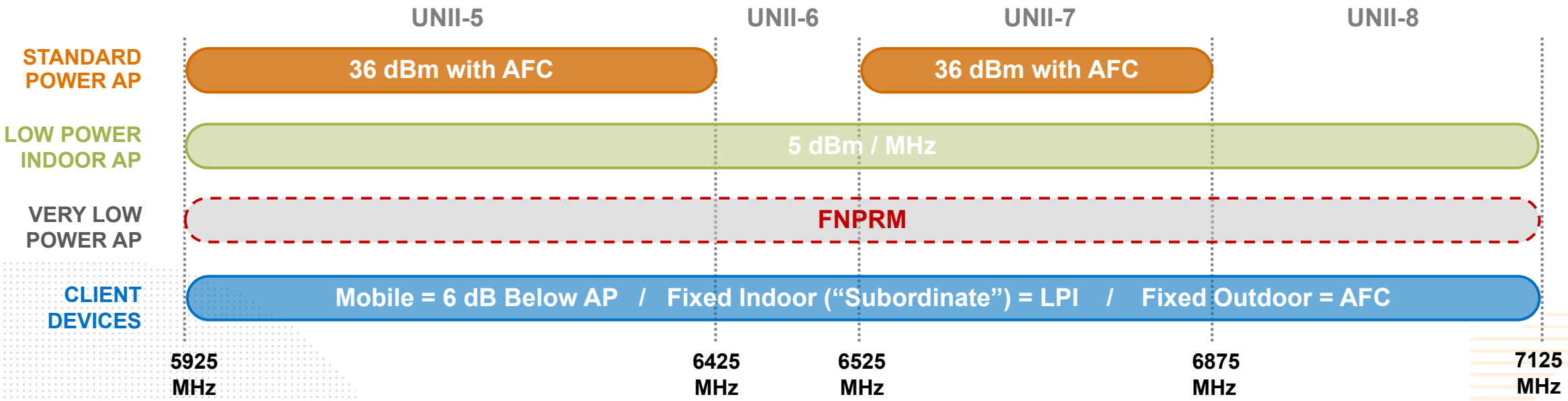
Fixed Outdoor Device
- Same rules as SP AP, ***plus***:
- Attached to structure

Initial 6 GHz Rules in United States

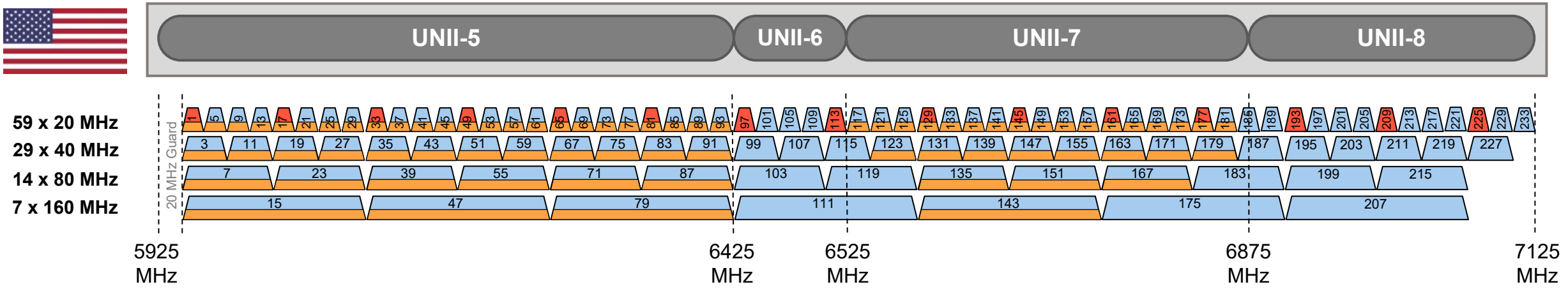
– Indoor low power across the entire band without AFC @ 5 dBm/MHz; Prohibition on connectors

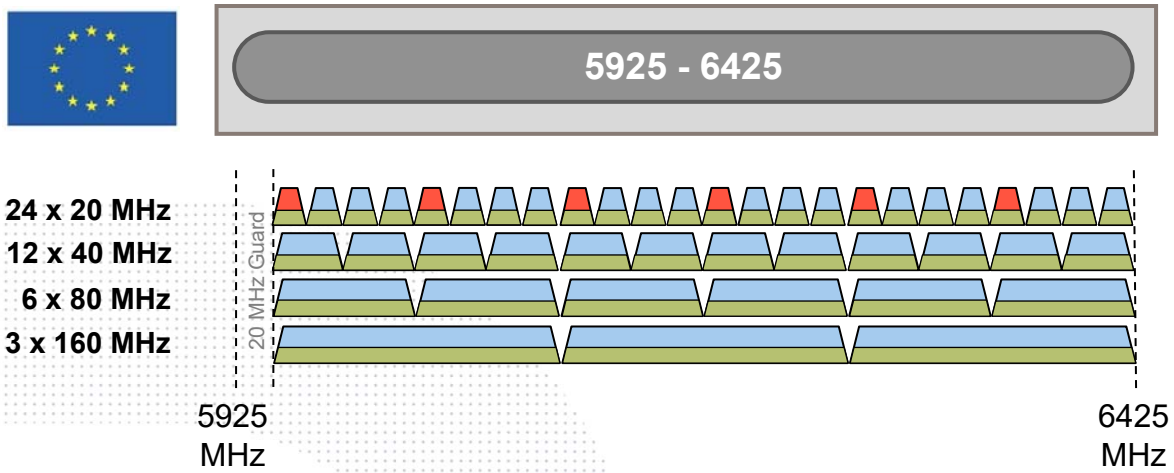
– Automated Frequency Coordination (AFC) required in UNII-5/7 for “full” power indoor and all outdoor APs

– FNPRM on “Very Low Power” class for portable APs and short-range applications



6 GHz Channels in United States & Europe/CEPT





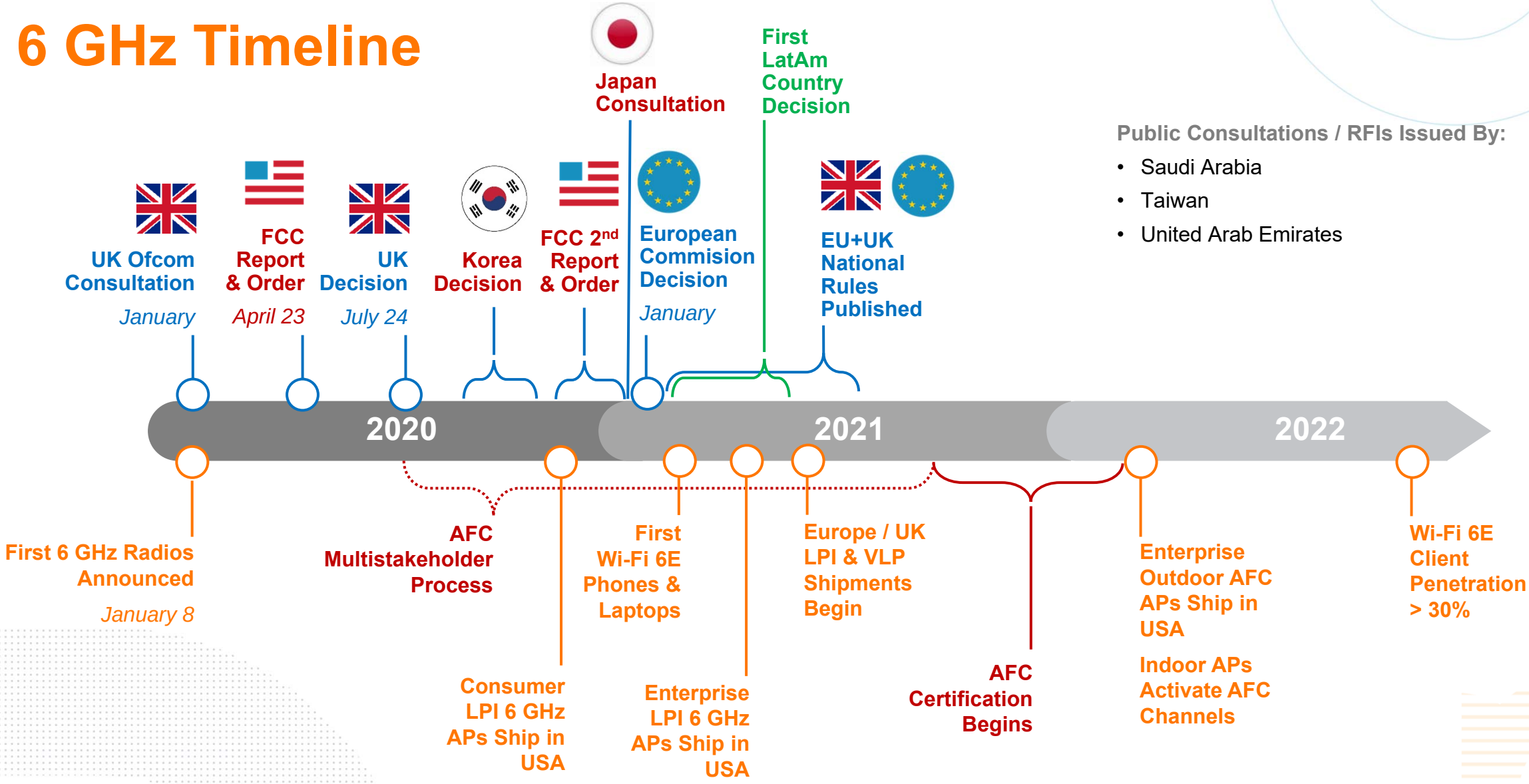
= Low Power Indoor (LPI) Only

= LPI & Automatic Frequency Coordination (AFC)

= LPI & Very Lower Power (VLP)

= Preferred Scanning Channels (PSC)

6 GHz Timeline

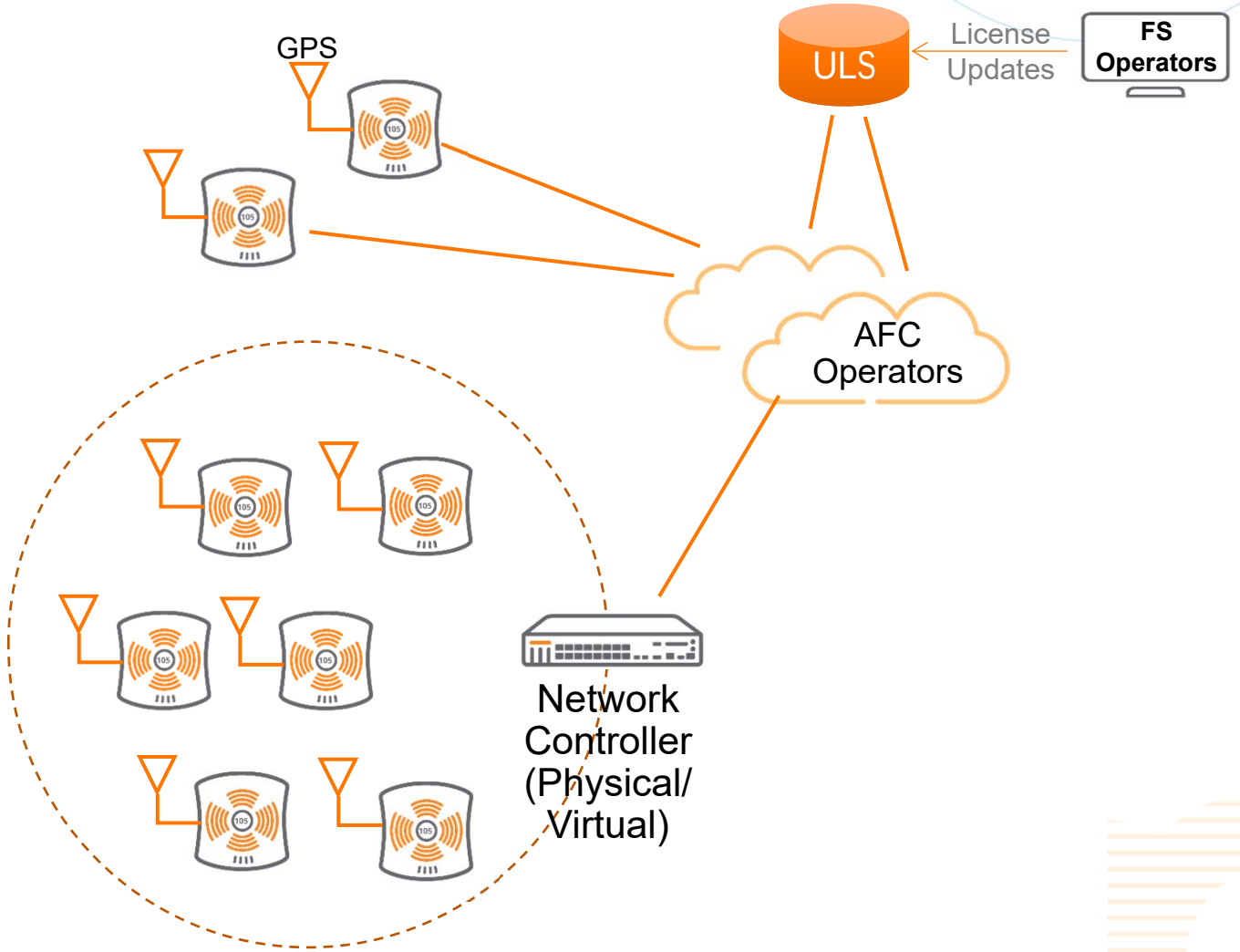


Public Consultations / RFIs Issued By:

- Saudi Arabia
- Taiwan
- United Arab Emirates

How an AFC Deployment Works

- Constellation of APs under local or remote management and control
- AFC access points must be capable of determining their geolocation
- AFC access points must request a list of available channels from AFC Operator every 24 hours
- Channel availability requests include AP geolocation (with uncertainty estimate), FCCID and AP serial number
- AP or network controller chooses operating channel(s) and configures APs until its control



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Thank you

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