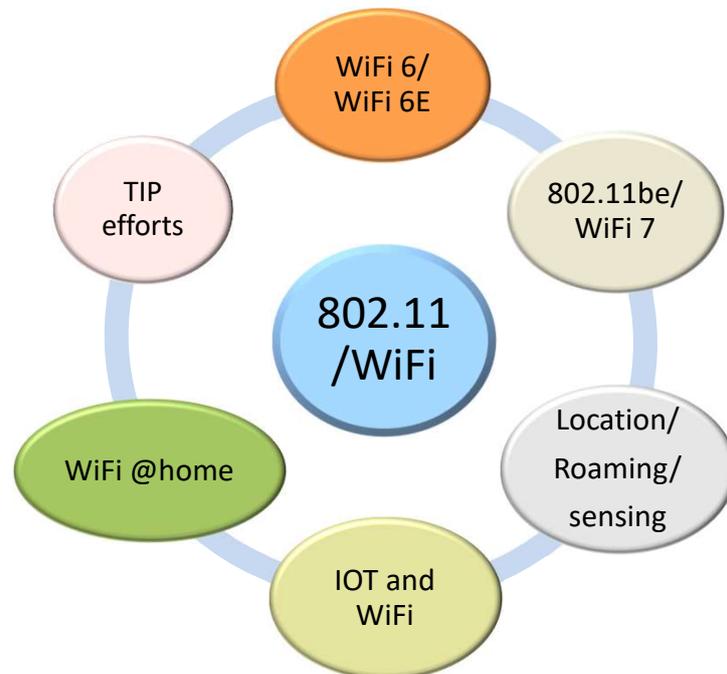


# 802.11/Wi-Fi – state of the union

Dr. Srikanth Subramanian, CKO, Nanocell Networks

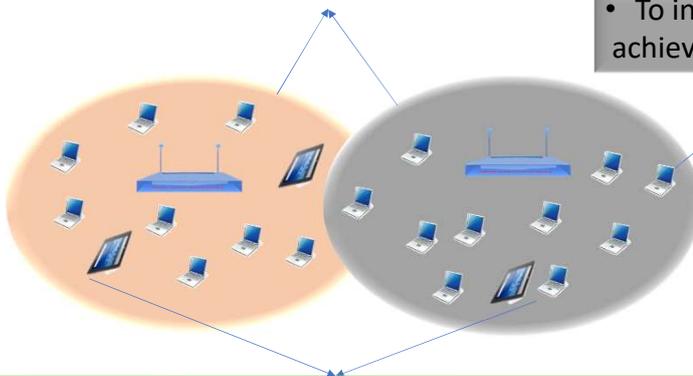
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## 802.11ax /WiFi 6 – has it achieved its objective?

- Majority of deployments will evolve towards high density scenarios in the near future..



- To increase the real world throughput achieved by users.

PAR aims for 4 times higher average throughput at MAC in a dense Wi-Fi environment than previous generation..5-10 times likely

- To improve power efficiency for the battery powered devices.

- Amendment to 802.11 for operations in between 1 to 7 GHz frequency bands.

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## 802.11ax/WiFi 6 in real-life?

No demonstrable improvement in high-density performance or in other metrics in a consistent manner

Scheduler to optimize OFDMA/MU-MIMO performance yet to be seen in practice !! ; spatial reuse features have not taken off

IOT related improvements like TWT have not seen widespread adoption and usage

Client products do not have any big increase in performance to claim !!

Chip shortages, branding, EOL for WiFi 5 products have all helped in propelling sales

Are there any lessons for the future?

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## Can we expect something better in 11ax products?

Some players in the industry have tried a lot without too much success in a neutral environment

Clients are very powerful in WiFi with respect to radio access; they do not want to be told what to do !!.. In 2.4 and 5 GHz, we have legacy which will be with us for a long time

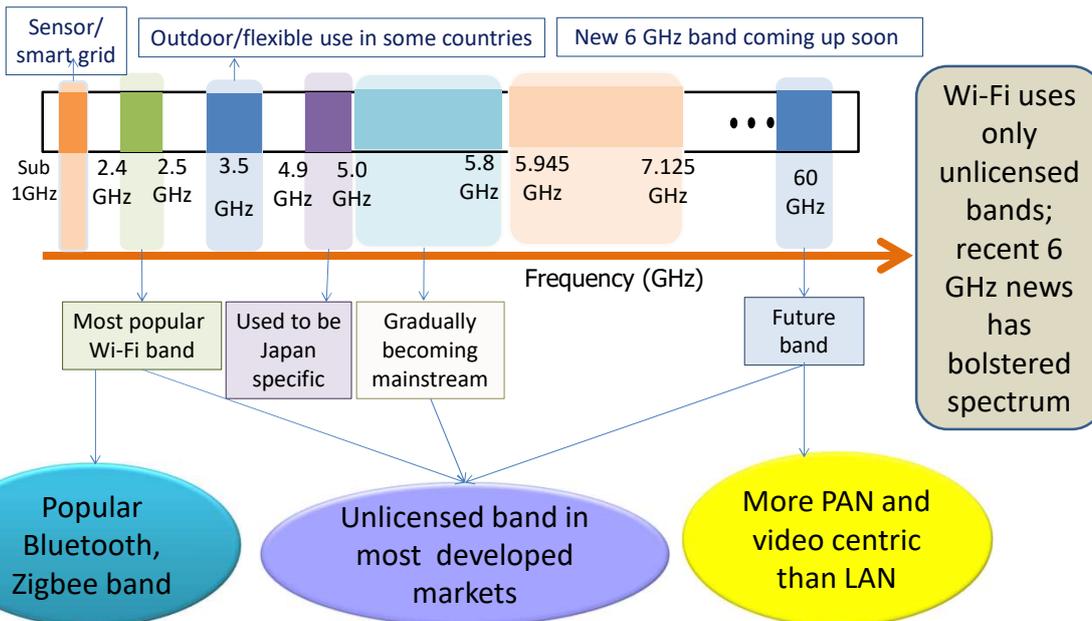


Comparing with cellular is not appropriate for a variety of reasons; WiFi's appeals lies in simplicity, cost, worldwide adoption of bands etc

Industry's focus and attention has also moved on to other things !!

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## Wi-Fi Spectrum



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## Is 6E a savior for 11ax?

All 6E will support WiFi 6



Will not having legacy help with using new features in 11ax?

Is scheduled access going to be dominant in 6 GHz ? ; no enforcement at this time

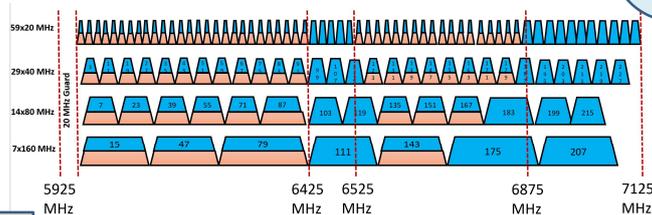
Wide bandwidth channel usage, clean spectrum, adoption of the latest security practices are likely to be the main advantages of WiFi 6E

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## Benefits of 6E

Better usage of OFDMA/MU-MIMO; no need to worry about legacy while scheduling

More spectrum; more higher bandwidth channels; less congestion..



Clean move to all the latest security practices; WPA3/OWE etc

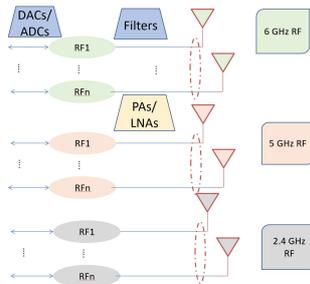
Better practices in scanning for networks, multiple BSS support etc

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## Challenges for 6E

Client adoption will take time due to various considerations; Will infra take the lead?

RF complexity, cost, power consumption can be pretty high



Global harmonization with spectrum and rules can be a challenge for operation; AFC/LPI etc. ...

Enterprise might need more than just an AP replacement to incorporate 6 GHz

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## What's new in WiFi 7

Rate.. Rate.. Rate .. Will be the main marketing theme for 802.11be .. A few other objectives might also become important

Better use of multiple band support in products; many data guzzling devices will support multiple bands/radios

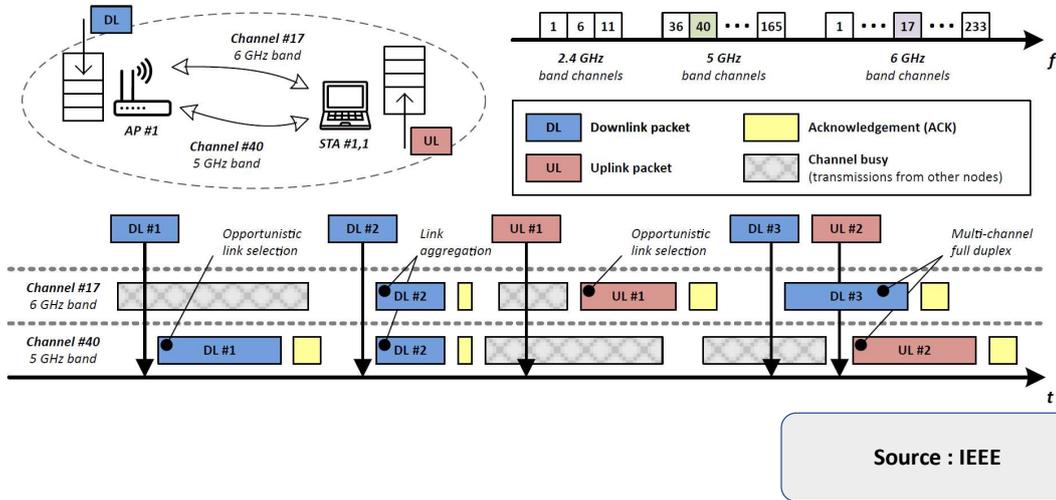


Multi-link has the potential to be an interesting feature; can help with load balancing/aggregation/solving latency matters

Flexible bandwidth usage through MRU/preamble puncturing; multiple AP coordination to leverage large bandwidth possibilities and spatial reuse opportunities are also features that we could see in some products

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## Sample multi-link exchange



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## WiFi 7 challenges

WiFi 6/6E/7 are all sort of bunched together creating a challenge for consumers on what to invest in ?

Will we get the multi-link optimizations right and not have a OFDMA/MU-MIMO like experience?

802.11be  
/  
EHT/  
WiFi 7

Lots of product differentiation likely due to the many features introduced; optimization challenges are going to be interesting in the field with a variety of devices

Hope WiFi 7 does not ask all devices to support all radio features and make it very costly for WiFi to be incorporated

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## Short-range location/position

Wide-area GPS/equivalent services have made a big impact on many associated applications

Indoor navigation for both personal and industrial use cases could be the next big thing

Proximity services, finding objects, keyless entry and many such things are also on the radar for both personal and commercial use cases could be a big business opportunity

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## Candidate technologies



WiFi APs present everywhere..smartphones/laptops/tablets/.. All have WiFi..most of the focus is on high-speed data transfer.. Power hungry

UWB based on 802.15.4

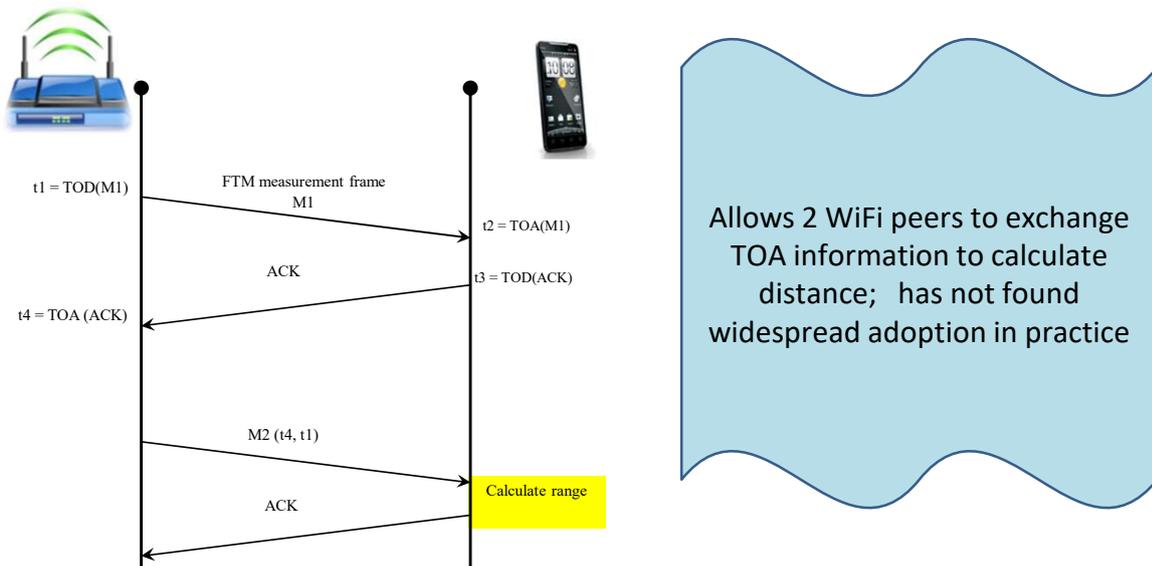
Specialized technology for precision location/positioning



Strong presence in phones/laptops/watches..etc. ..  
Power efficient..IOT friendly technology

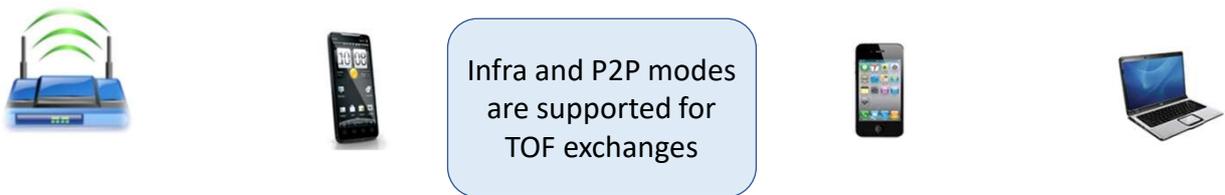
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## 802.11 fine timing measurement



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## 802.11az next generation positioning



Secure exchanges for timing estimation; both MAC and PHY methods proposed; unassociated clients can also use feature; security/privacy important

11ax trigger frames can be used to engage with multiple STAs in one go for measurement, MIMO support, detailed reports,...

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## Challenges

Interoperability of 11az features at L2 level most likely be taken care by WFA?. Which segment will demand this certification?

Will applications be developed to harness the information from the link layers?. - will they work across platforms?..WiFi P2P is still clunky !!

WiFi sensing/WiFi Aware are related things which could use location information !!

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September 2019

doc.: IEEE 802.11-19/1416r0

## Wi-Fi Sensing: Examples of Applications

Gesture recognition (new form of UI):



PC



Automotive



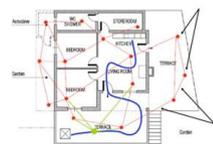
Phone/Tablet

Presence detection:



Wake on approach, walk away lock

Room sensing and presence detection:



Augmenting APs/relays with sensing capabilities



Home security

Target (e.g., people) counting and activity detection:



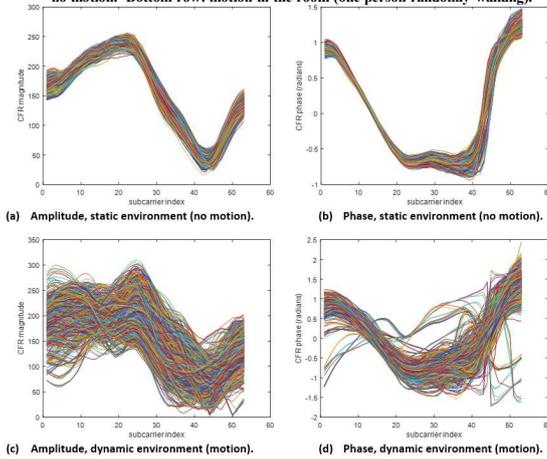
Smart meeting rooms

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## Using Wi-Fi for Sensing

Figures show the amplitude and phase of channel estimates obtained with multiple PPDU's over time (~3 minutes). Each curve corresponds to one PPDU. Top row: no motion. Bottom row: motion in the room (one person randomly walking).

- Technical principle behind Wi-Fi sensing is to track channel estimates obtained when decoding Wi-Fi packets over time, and to detect/classify changes that indicate an event of interest.
- Detection of some features require machine learning, but many can be achieved without it.

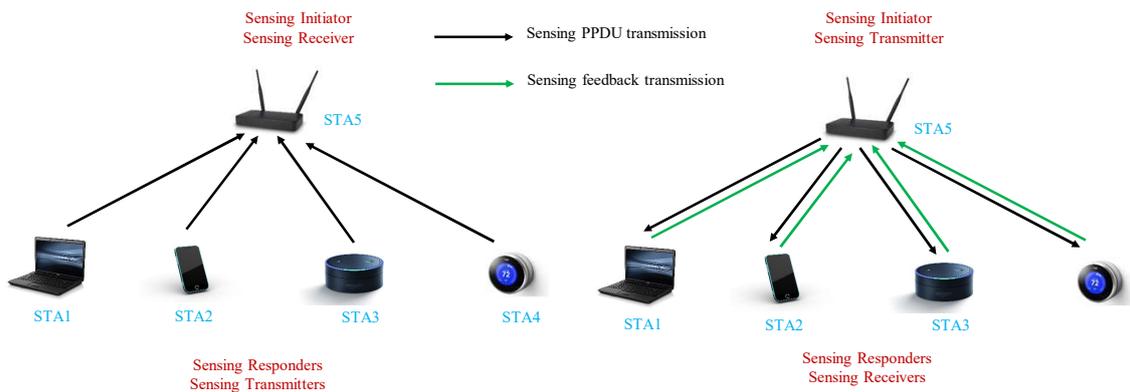


Submission

Slide 19

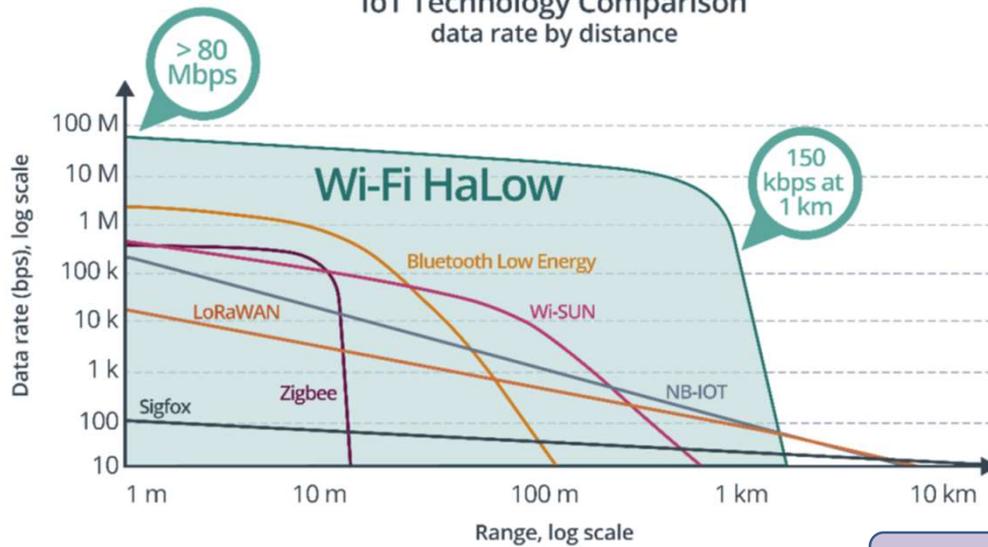
Claudio da Silva, Intel

## WLAN sensing roles



## IOT and WiFi - HaLow

IoT Technology Comparison  
data rate by distance



Source : WFA

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## Matter – Connectivity standards alliance initiative

### Common application layer + data model

Interoperability, simplified setup & control

### IP-based

Convergence layer across all compatible networks

### Secure

AES-128-CCM encryption with 128-bit AES-CBC

### Open-source development approach

Based on market-proven technologies

### Common protocol across device and mobile

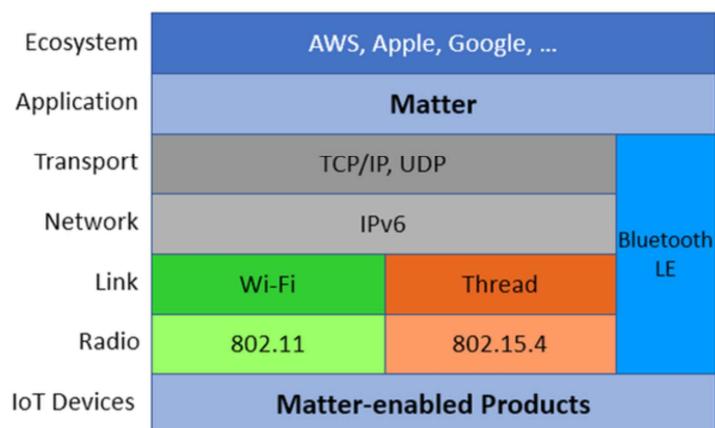
Extendible to cloud

### Common data model

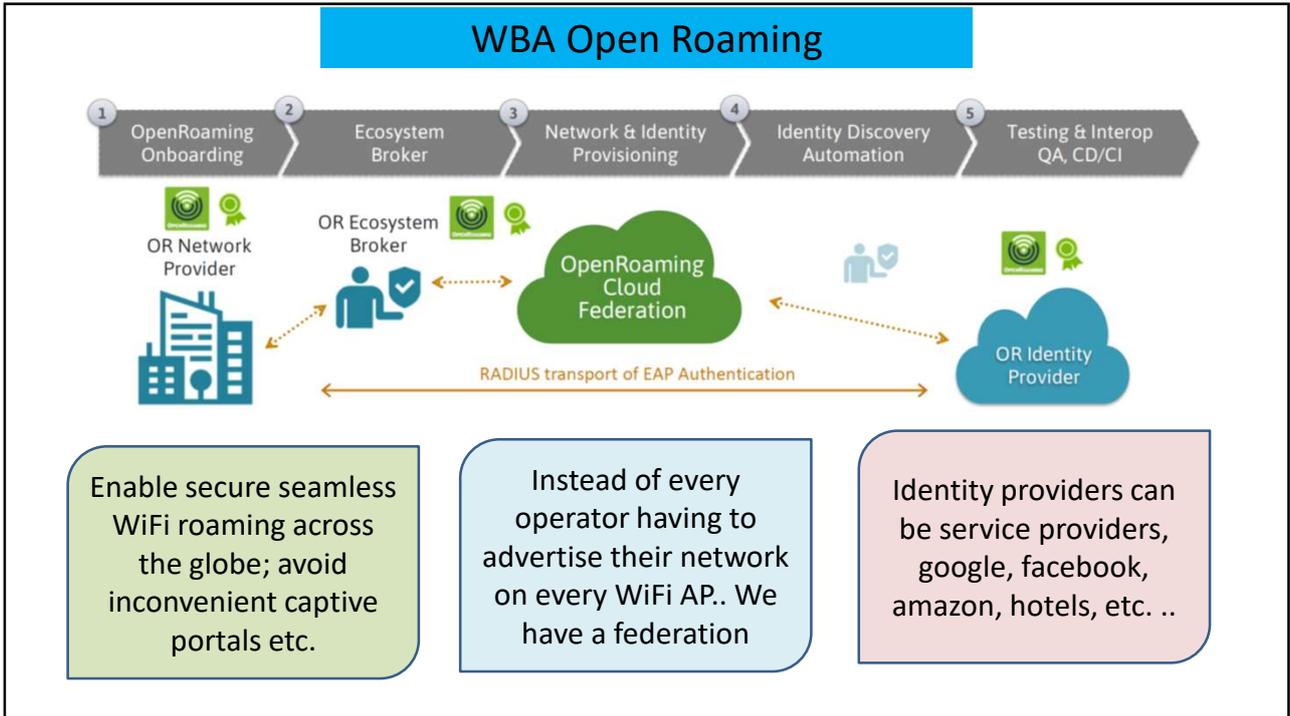
Core operational functions, multiple device types

### Low overhead

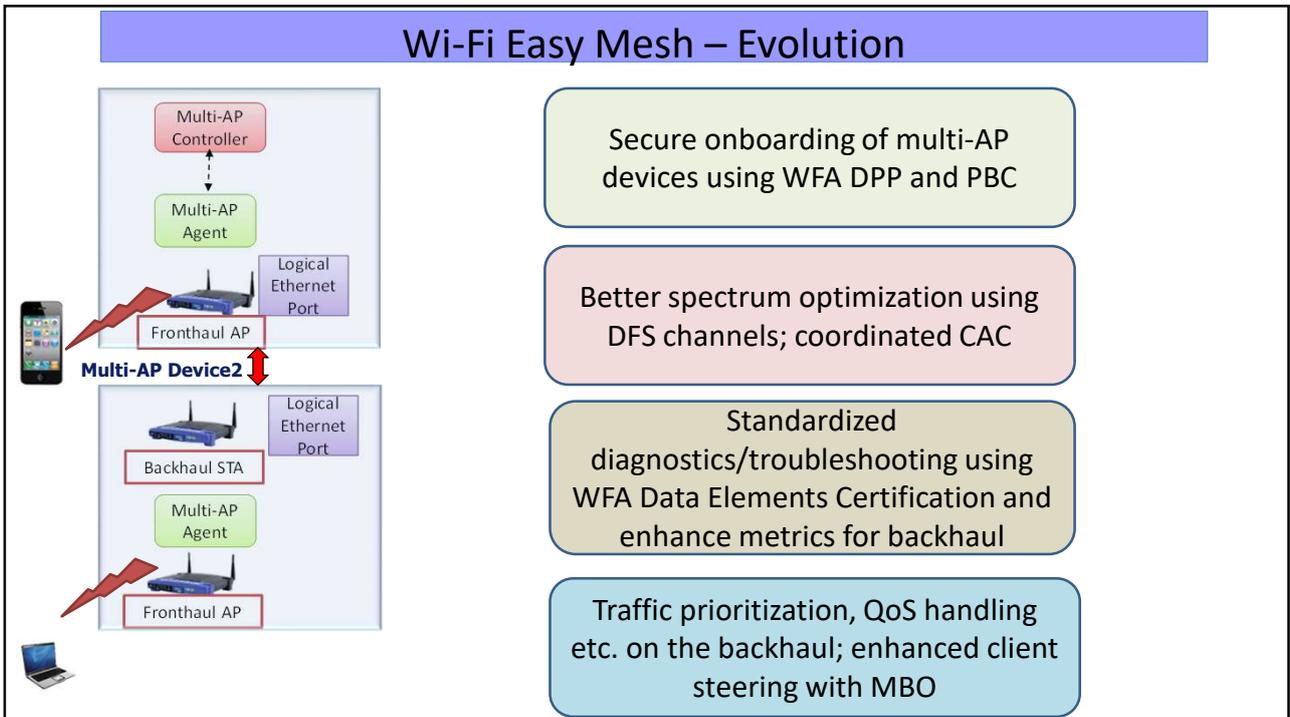
MCU-class compute, <128KB RAM, <1MB Flash



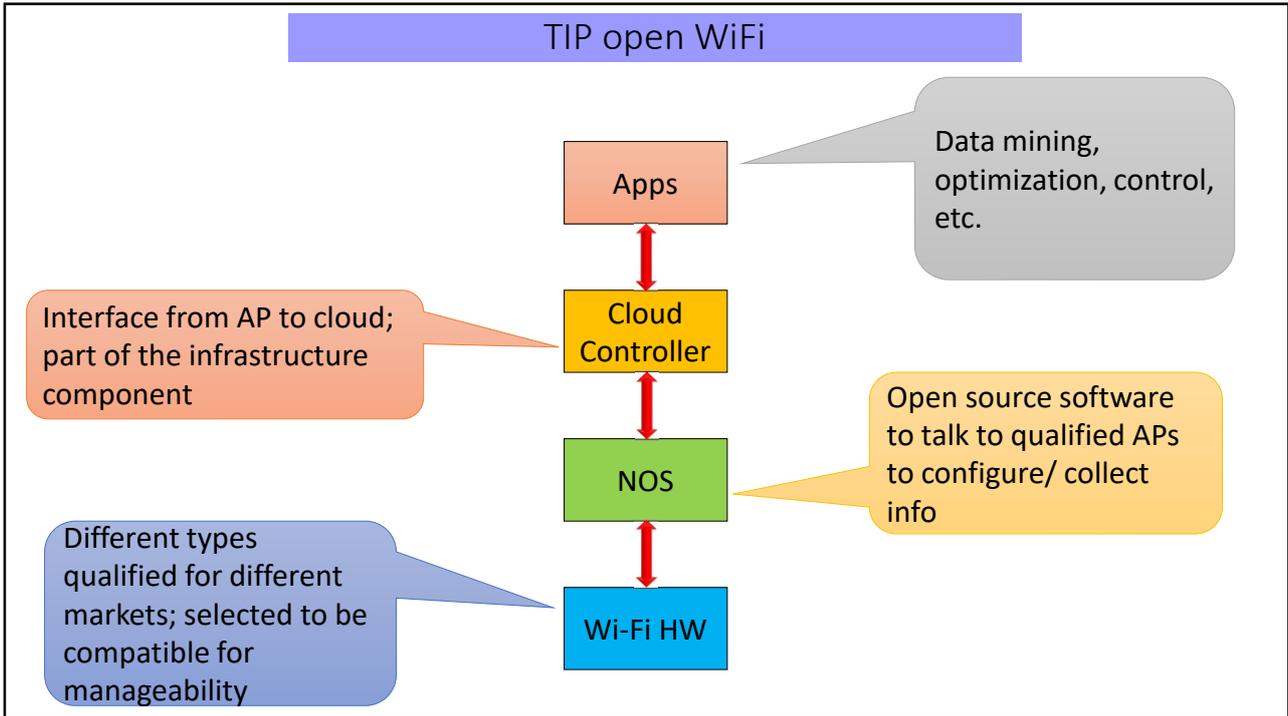
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**Will 5G kill Wi-Fi?**

- Wi-Fi carries lot more data than cellular..more and more devices in home and office incorporating Wi-Fi for connectivity at home/office etc .
- No dependence on carrier/operator/SIM cards
- Good interoperability across the board
- Cost structures are good for many consumers across the world
- Continuous evolution in data rates and other metrics help
- Interaction with carrier networks are getting stronger

**New 6 GHz band makes WiFi even more stronger for a variety of new applications**

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