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THE ROLE OF WI-FI IN 5G NETWORKS

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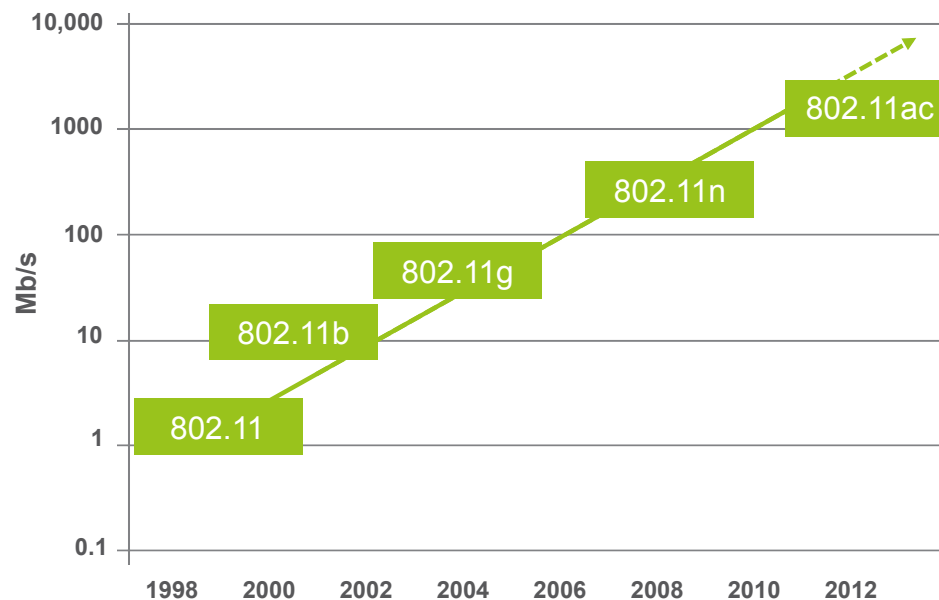


OUTLINE

- › Wi-Fi background and status
- › IEEE 802.11 HEW
- › Wi-Fi and cellular integration
- › Other 802.11 technologies
- › Conclusions



WI-FI TECHNOLOGY EVOLUTION

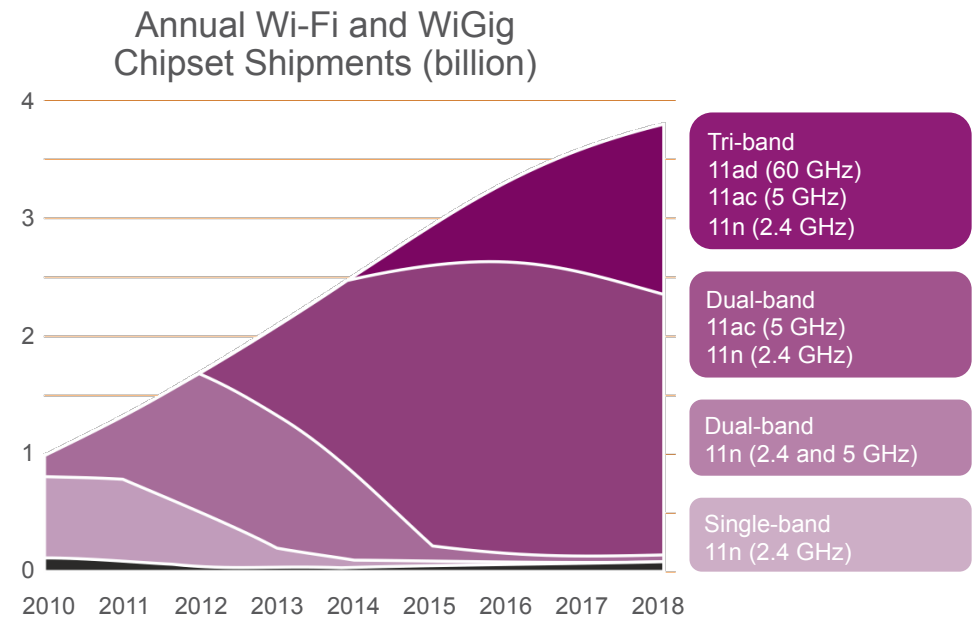


- › Relentless increases in throughput at roughly constant low(!) price
- › 5x throughput every ~3 years
- › Focus has been on data rates for a single link

WI-FI MARKET

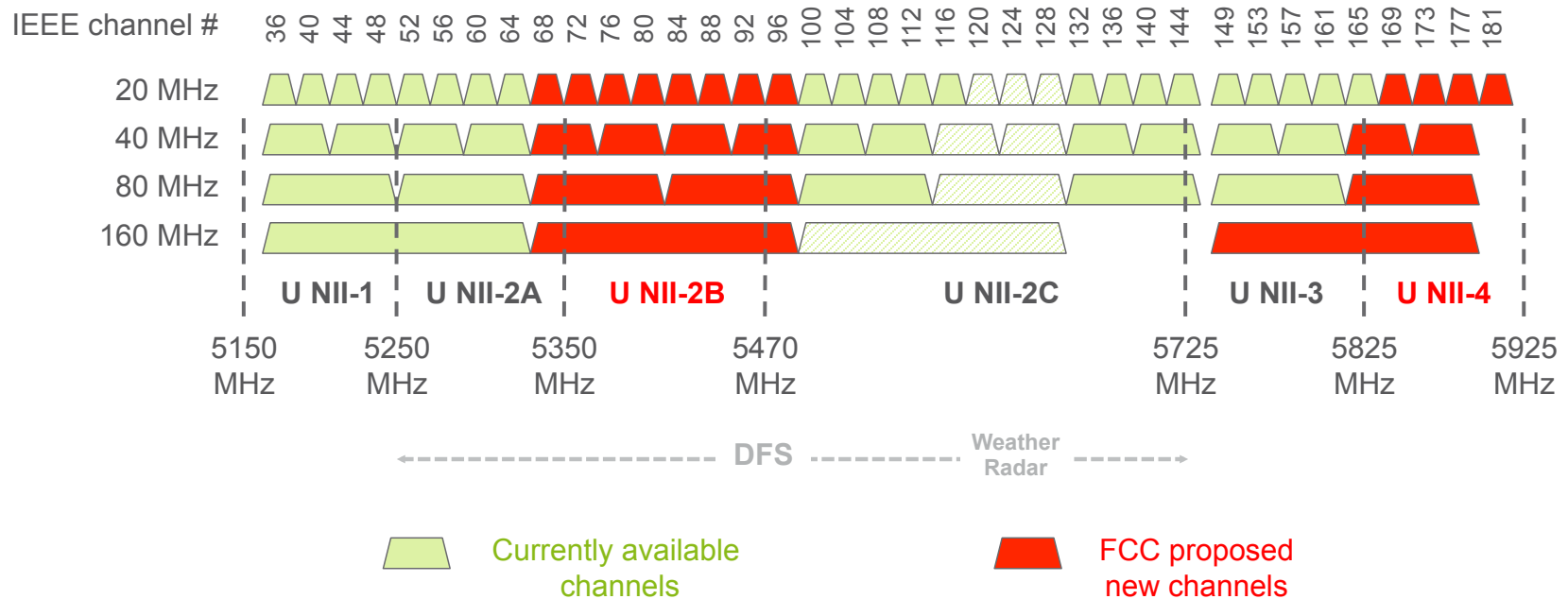


- › 7 billion chipsets shipped cumulative total YE 2013
- › Forecasts call for another 7 billion in 3 years
- › Enterprise Wi-Fi – US\$3B in 2013
- › Carrier Wi-Fi – US\$1.1B in 2013
- › 10.5M hotspots by 2018
- › Recent push into Internet of Things



UNLICENSED SPECTRUM

CURRENTLY 555 MHz AT 5GHz





IEEE 802.11AC

1 GB/S WI-FI AT 5GHZ

Wide channel bandwidth
80 or 160 MHz

- › Increased data rate
- › 1.3 ~ 3.6 Gb/s PHY rate

High-order modulation
256 QAM

- › Increased data rate at short distance

Non-contiguous channelization

- › *Effective use of spectrum*

Additional MIMO Streams

- › 802 standard supports up to 8 streams, 3 and 4 being certified

Multi User MIMO

- › *Network capacity and spectral efficiency with single radio devices*



Certification of
IEEE 802.11ac
happens in
two releases



IEEE HEW HISTORY

HIGH EFFICIENCY WLAN

- › HEW Study Group created in March 2013 to enhance 802.11 PHY and MAC in 2.4 and 5 GHz:
 - Improve spectrum efficiency and area throughput
 - Improve real world performance in indoor and outdoor deployments
- › 802.11ax Task Group approved in March 2014 with scope:
 - At least 4X improvement in average throughput per device over current systems in dense deployment scenario
 - Maintain or improve power efficiency
 - Operate in frequency bands between 1 and 6 GHz
 - Maintain backward compatibility and coexistence
 - Outdoor operation limited to stationary and pedestrian speeds



IEEE 802.11AX

CURRENT STATUS

Many technologies being discussed

- › Dynamic sensitivity control
- › OFDMA
- › UL-MIMO
- › Scheduling
- › In band duplex
- › Hybrid ARQ

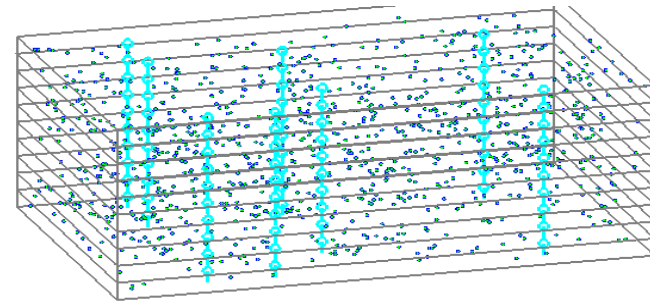
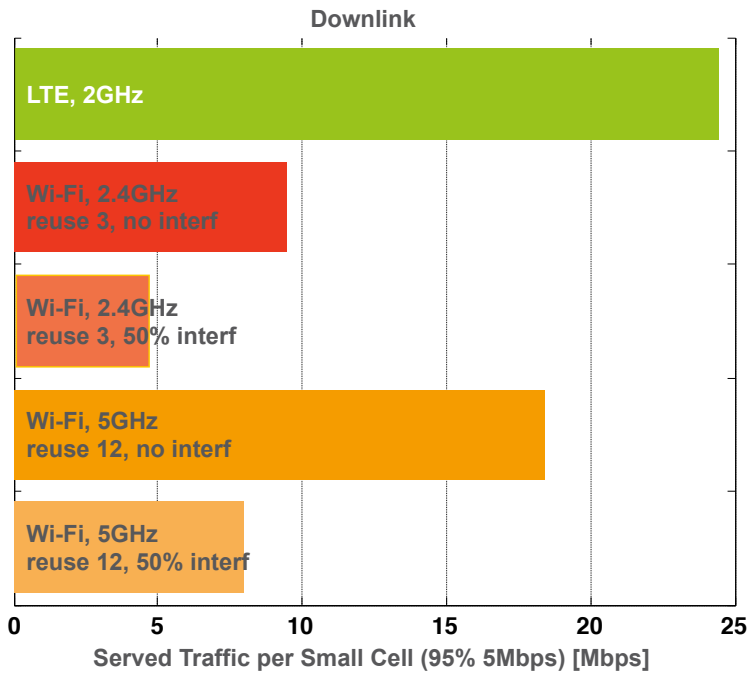
Current work

- › Channel models
- › Simulation scenarios
- › Evaluation methodology

- › Estimate standard complete July 2018
- › Participation from operators, chip vendors, OEMs and universities

THE WI-FI EFFICIENCY CHALLENGE

SIMULATION COMPARISON



LTE

20+20 MHz, 2x2 DL and 1x2 UL MIMO

Wi-Fi

802.11n, multiples of 20 MHz, 2x2 MIMO
CS threshold -85dBm

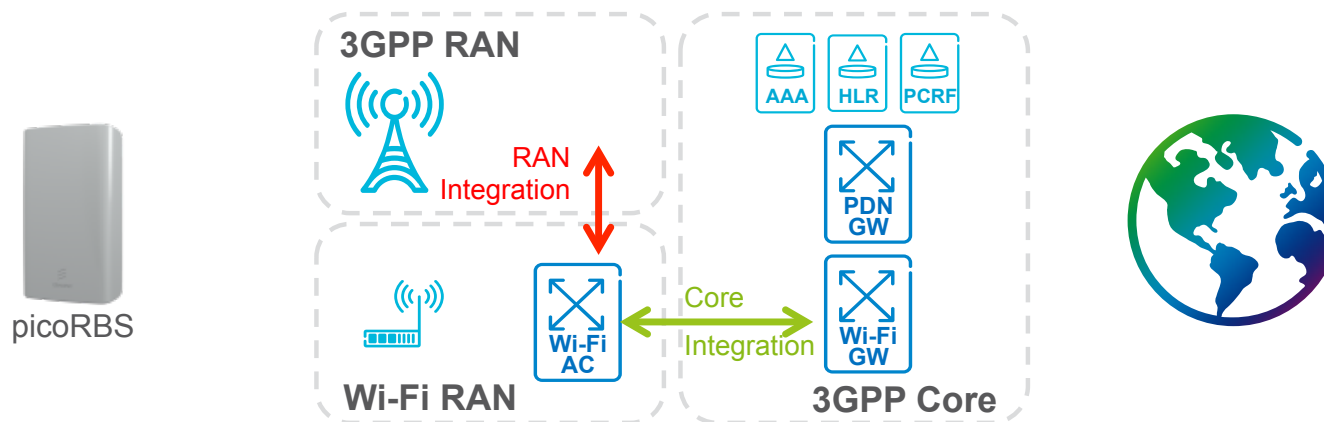
Typical enterprise setting

80x50m, four floors, walls every 10m
250 users per floor, eight APs per floor



WI-FI CELLULAR INTEGRATION

WI-FI BECOMES 'JUST ANOTHER RAT'



RAN Integration for:

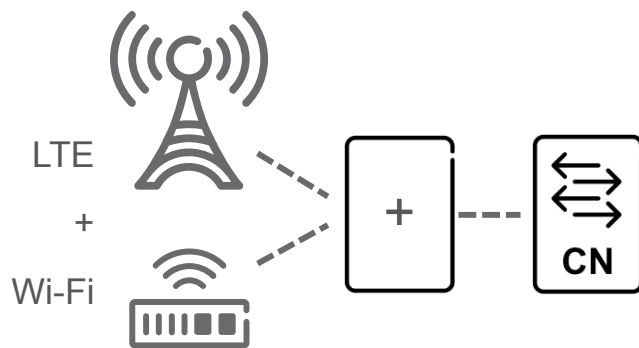
- Steering of users between RANs depending on e.g. signal quality and load
- Improve end user experience and network performance
- Ericsson products, 3GPP RAN2, Wi-Fi Alliance

Core Integration for:

- Authenticating and charging subscriber
- Policy decision and enforcement
- Deep packet inspection, lawful intercept, etc.
- End to end QoS
- Session mobility between RANs
- Ericsson products, 3GPP ANDSF, SaMOG

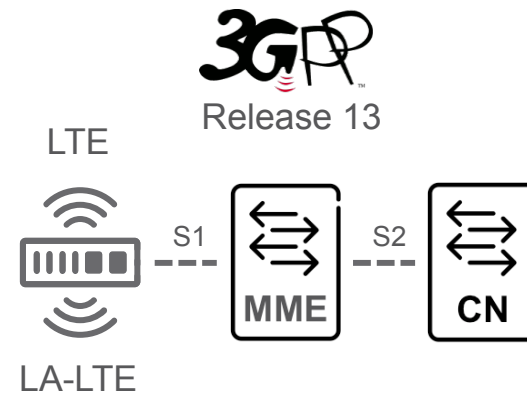


UNLICENSED BAND AGGREGATION



LTE Wi-Fi Aggregation

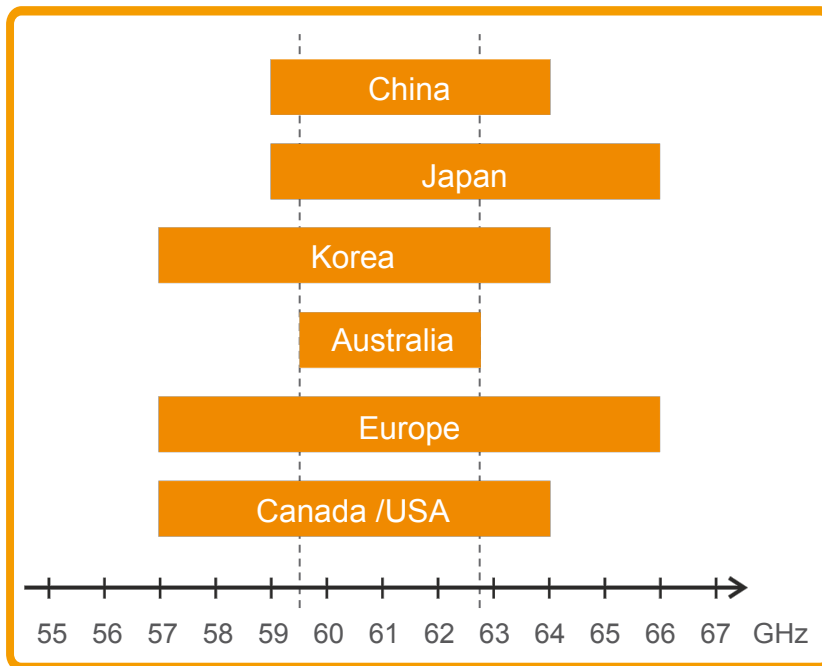
- RAN aggregation
- IP aggregation - MPTCP



LA-LTE

- Spectrum supplement for licensed bands
- Common MAC/PHY + RRM

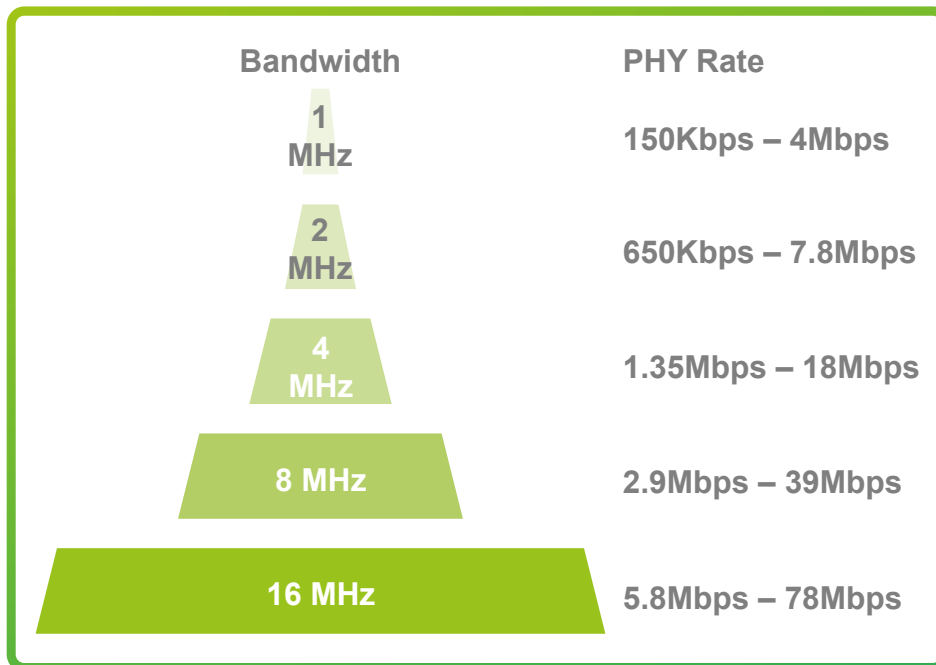
IEEE 802.11AD WIGIG IS NOW WI-FI AT 60GHZ



- › 2.16MHz channel bandwidth
- › Typically 4 channels
- › 385 Mb/s ~ 6756 Mb/s
- › BPSK ~ 64-QAM
- › Line of sight, in room, very high throughput applications
- › e.g. wireless USB, SD card and HD display extension
- › With high gain antennas can be used for P2P wireless backhaul
- › IEEE standard ratified in 2013
- › Wi-Fi Alliance has several certification programs near launch

IEEE 802.11AH

WI-FI FOR M2M AND IoT



- › For license exempt bands below 1 GHz
- › Enhancements for short packets, reduced power, huge # of devices
- › e.g. machine type communications, home automation, wearable devices
- › Extended range connectivity up to 1 km?
- › IEEE Draft 2.0 expected to go for letter ballot in May 2014
target completion March 2016
- › WFA recently started to define certification program

CONCLUSIONS



- › Wi-Fi is a major consumer and enterprise technology to be reckoned with
- › Access to a large and growing amount of unlicensed spectrum
- › Performance and efficiency will continue to improve, e.g. with HEW
- › Ericsson a leader in integrating Wi-Fi and cellular technologies at many levels
- › Wi-Fi will be an element of the evolution of mobile broadband for 5G
- › Other 802.11 technologies may play a role in the MTC elements of 5G

WI-FI WILL CONTINUE TO COMPLEMENT AND BE
SYNERGISTICALLY INTEGRATED WITH CELLULAR TECHNOLOGY
AS WE ADVANCE TO 5G



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