3GPP workshop on LTE in unlicensed spectrum
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LTE in Unlicensed Spectrum: European Regulation and Co-existence Considerations

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Motivations for use of LTE on unlicensed band

- The motivation to look at LTE on unlicensed band is to have additional capacity at 5 GHz band
- Instead of WLAN integration single LTE network is well integrated to the existing operator network, thus solving all authentication , O&M and QoS issues
- The spectrum efficiency and range with LTE technology is also better than WLAN's due to more advanced radio features
- WLAN co-existence issues are addressed later in this presentation

Lots of unlicensed spectrum available @5GHz

Same core network with licensed band LTE

Robust performance with licensed band anchoring

Longer range and higher efficiency than WLAN

Co-existence with WLAN is not a problem

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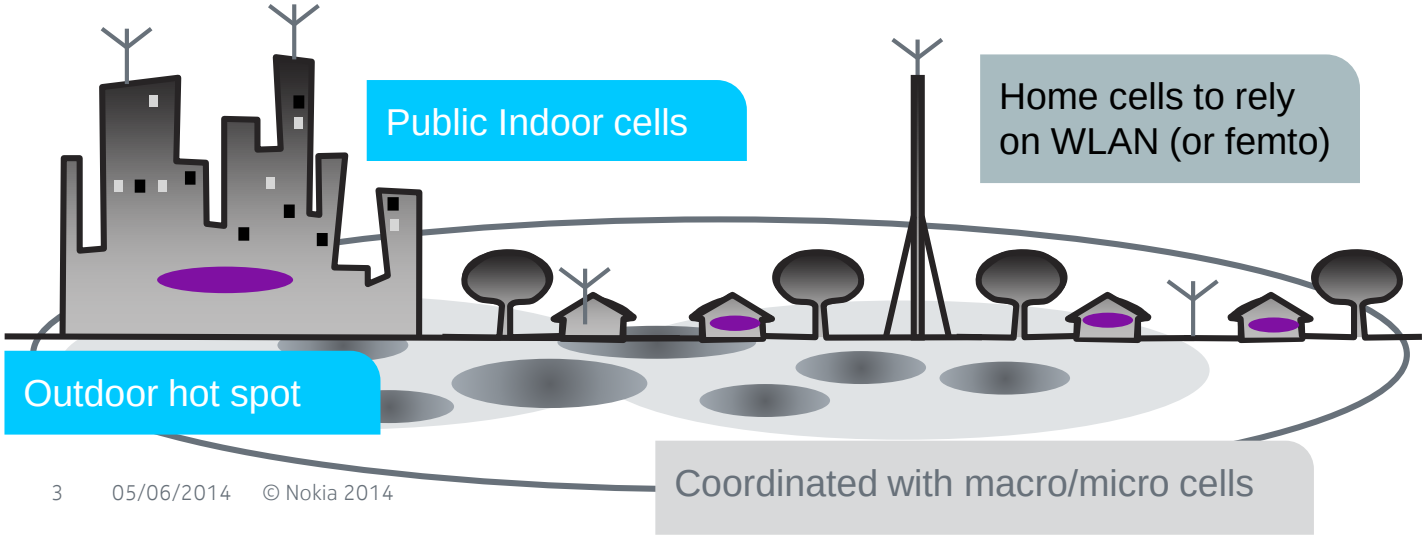
Motivations for Licensed-Assisted Access (LAA)?

- Use cases are outdoor and indoor public small cells
- Focus on public /corporate environment
- 5 GHz frequency band in focus, widely available globally
- Home solution to rely on WLAN → Licensed-Assisted Access always intended to be used together with licensed band operations



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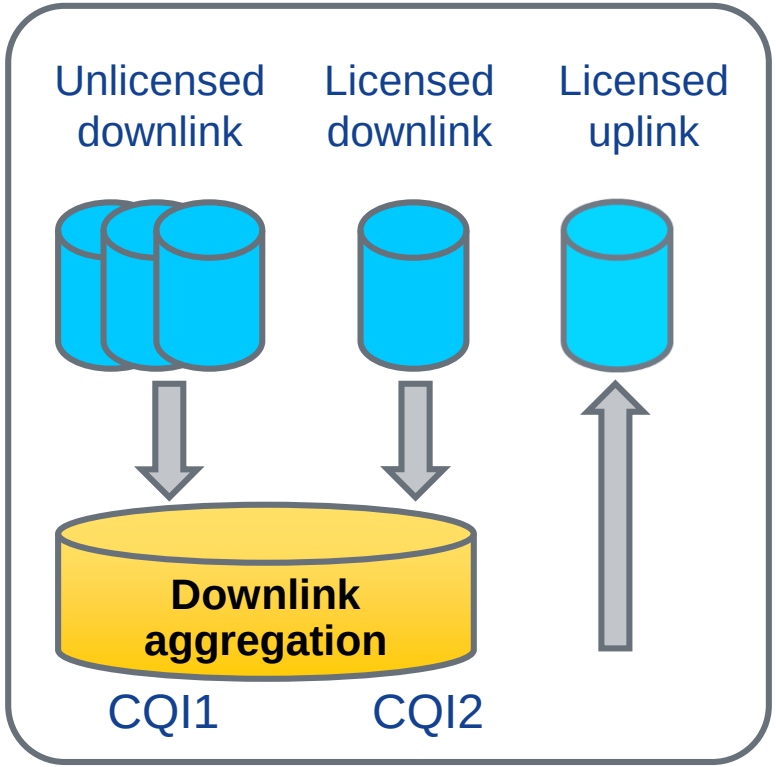
Licensed-Assisted Access (LAA) combines Licensed and Unlicensed Bands



- LAA on unlicensed band is always combined with licensed band LTE
  - Licenced band may use either FDD or TDD
  - LAA either TDD or SDL
- LAA increases especially downlink bandwidth
  - Typical traffic today is asymmetric with 8:1 data volume ratio between downlink and uplink. Also uplink can utilize unlicensed band, but this requires more modifications
- Licensed band LTE provides reliable connection for mobility, signaling, voice and data
- Unlicensed band LTE boosts data rates with good enough signal– ”Opportunistic use”
- eNodeB decides how to split data transmission between licensed and unlicensed bands on 1 ms basis

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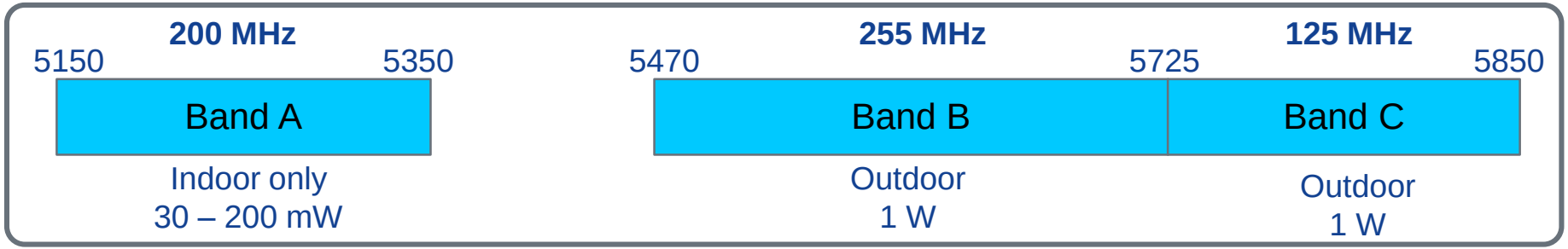
5 GHz Band Rules in Europe

Frequency (GHz)	Transmissionpower (mW/dBm)	Use	DFS	TPC
5,15-5,25	30/13	Indoor		
5,15-5,25	60/14	Indoor		OK
5,15-5,25	200/23	Indoor	OK	OK
5,25-5,35	200/23	Indoor	OK	OK
5,470-5,725	1000/30	Indoor/Outdoor	OK	OK

- Investigate what additional capacity LTE-U at 5 GHz band could offer
- “Band A”: 5150 MHz to 5350 MHz (Ref: EN 301 893)
- “Band B”: 5470 MHz to 5725 MHz (Ref: EN 301 893)
- “Band C”: 5725 MHz to 5875 MHz (Ref: EN 302 502) (Broadband Fixed Wireless Access according to the ECC recommendation)
- Up to 1 W power to the antenna allowed on Band B and C
- Dynamic Frequency Selection (DFS) and Transmit Power Control (TPC) required. DFS is needed to avoid interfering with radars



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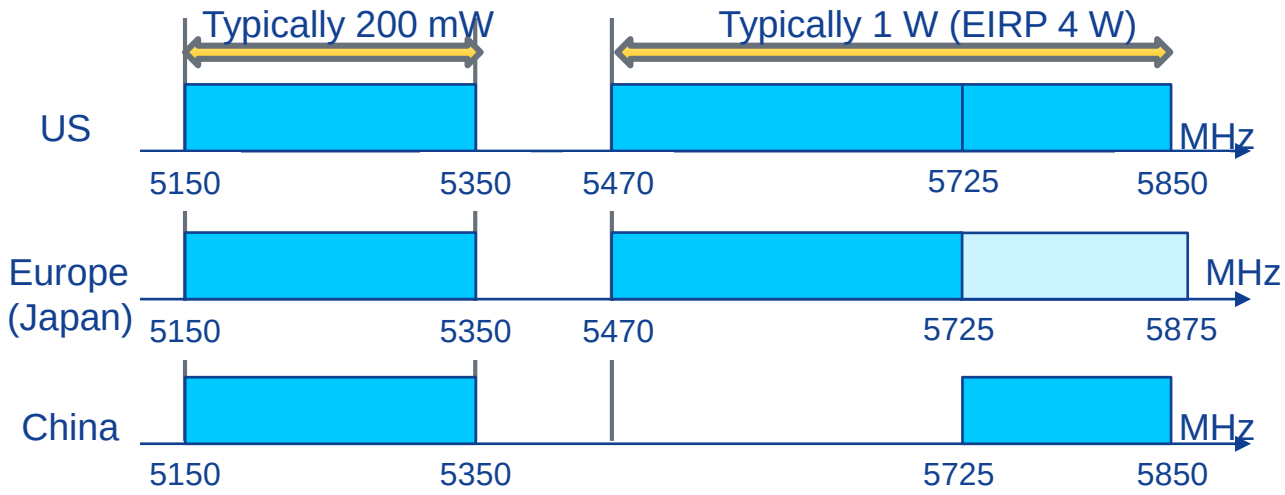
5 GHz Band Globally

- All major markets have 300+ MHz spectrum available at 5 GHz
- 5725 – 5875 MHz in Europe seems to have good alignment with other regions for outdoor deployments. Currently indicated for Broadband Fixed Wireless Access use in the regulation.



= 580 MHz

= 455/605 MHz

= 325 MHz

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Operator Spectrum Needs

- Calculations for spectrum needs e.g. in future and for WRC-15 purposes have been done assuming different use cases where both LTE and WLAN been considered as access technologies.

- There should be no difference in spectrum need regardless if an operator is using WLAN to offload traffic from LTE to WLAN or uses LAA to offload the licensed band LTE operation

- LAA is just one additional access technology for RLAN/WLAN/Wi-Fi use case scenarios → No impact on mobile broadband needs and related spectrum need calculations

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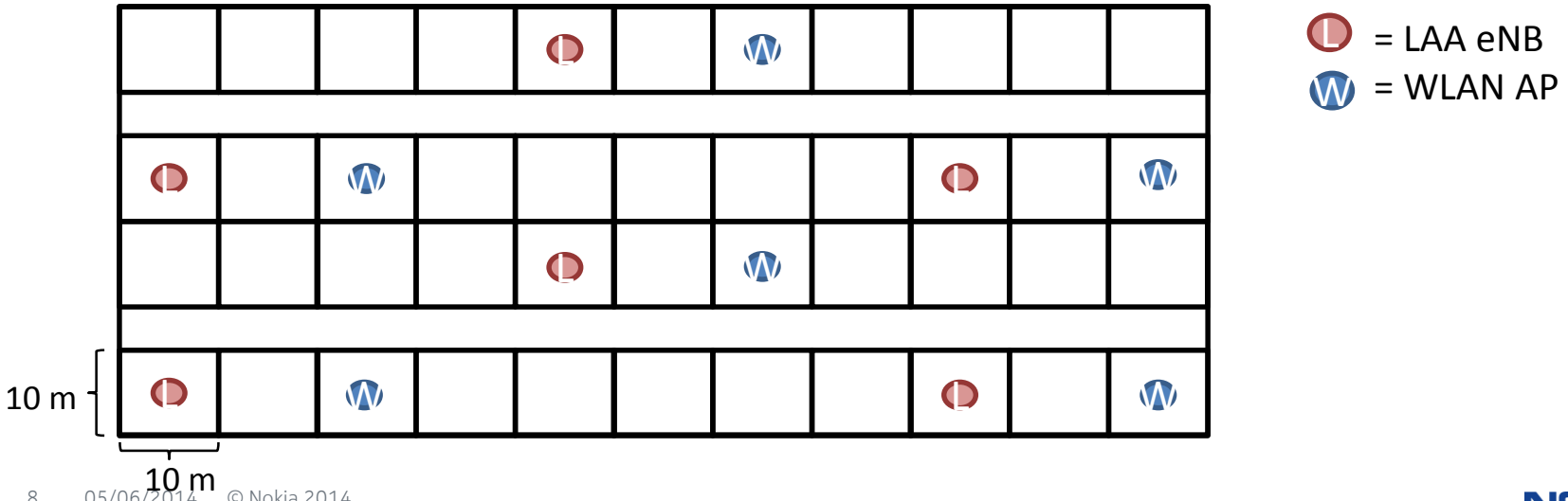
LAA – WLAN Co-existence Simulations in Office Scenario

- One building with 44 rooms and two corridors
- 6 eNB positions, 6 AP positions
  - 1 eNB/AP per 917 m2
- Indoor COST 231 propagation model used
  - Only indoor wall loss considered



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Simulation Cases

- LTE/LAA; 6 eNBs with 20 MHz SDL BW
- WLAN; 6 APs with 20 MHz BW
- WLAN + WLAN; 12 APs
  - Two WLAN networks on the same channel
    - LAA eNBs replaced with WLAN APs of another operator network
    - Users are only connected to their own WLAN network
- LAA + LAA; 12 eNBs
  - Two LAA networks on the same channel
    - WLAN APs replaced with LAA eNBs of another operator network
    - Users are only connected to their own LTE/LAA network

General Simulation assumptions

Parameter	Value
Simulation time	70 s
User creation	Poisson distributed
User placement	Spatially random
User mobility	Static
Simulation scenario	Office
Propagation model	Indoor COST 231
Indoor wall attenuation	5 dB
Slow fading (shadowing)	Off
Traffic model	Simple file download (FTP), 2 MB file size
Traffic transport protocol	UDP
Max segment size	1500 B
Offered load per cell	40 Mbps

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Simulations for two LAA Networks and two WLAN networks for 20 MHz channel

Target offered load [Mbps]	Single LAA NW on a separate channel		LAA + LAA (co-channel)	
	Realized offered load [Mbps]	Served load [Mbps]	Realized offered load [Mbps]	Served load [Mbps]
40	38.44	30.12	38.8	18.77

Target offered load [Mbps]	Single WLAN NW on a separate channel		WLAN+WLAN (co-channel)	
	Realized offered load [Mbps]	Served load [Mbps]	Realized offered load [Mbps]	Served load [Mbps]
40	41.18	17.68	41.15	8.70

- 50%

- LAA is robust even if two separate LAA networks (2 operators) are deployed on the fully overlapping channel.
- Naturally even better performance when fully overlapping channel is avoided

Note: LAA numbers do not include licensed band capacity

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LAA - WLAN co-existence using Listen-Before-Talk and Fairness Algorithm

Target offered load [Mbps]	LAA Served load [Mbps] LBT + fairness algorithm in LAA	WLAN Served load [Mbps] LBT + fairness algorithm in LAA	WLAN+WLAN Served load [Mbps]
40	10,74	9,67	8,7

Good co-existence achieved and
LTE-U+ WLAN served load over 20 Mbps
compared to WLAN - WLAN of 8,7 Mbps per AP

- These results show LAA - WLAN co-existence using Listen-Before-Talk (LBT) and fairness algorithm in LAA.
- LAA can co-exist well with WLAN (with similar co-existence performance as with other WLAN network

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thank you

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