

Technology Developments for Deployment of LTE in Unlicensed Bands

Telecommunications Regulatory Affairs Advisory Committee
8 December 2016

Background (1)

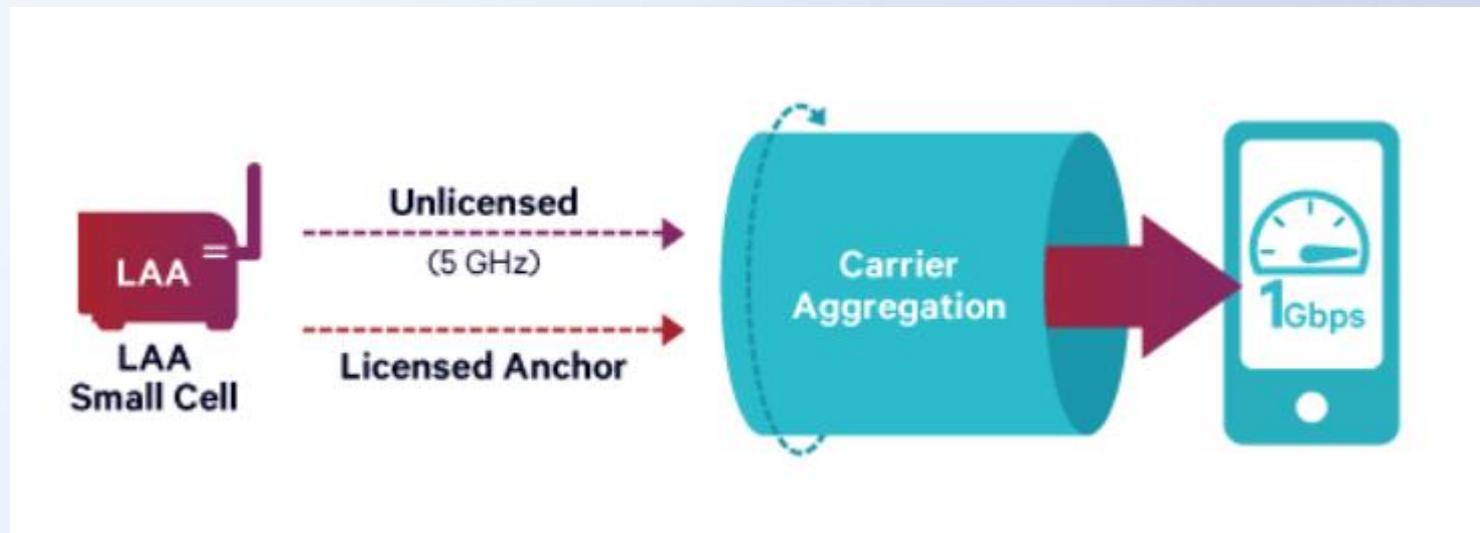
- With rapid growth of mobile data usage and demand for higher mobile speeds around the globe, new technologies have emerged in the market that make use of spectrum in the unlicensed bands:
 - supplementary to the licensed bands used by mobile network operators (MNOs)
 - employing carrier aggregation technology
 - coexistence with devices and applications using other wireless technologies (e.g. Wi-Fi) in the unlicensed bandsthereby boosting performance of mobile networks that end-users will experience, especially in indoor environment

Background (2)

- Some emerging technologies that use spectrum in unlicensed bands:
 - (1) **Licensed Assisted Access (LAA)**
 - (2) **LTE in Unlicensed Spectrum (LTE-U)**
 - (3) **LTE-WLAN Interworking**
 - LTE-WLAN Aggregation (LWA)
 - LTE Wi-Fi radio level integration with IPsec tunnel (LWIP)
- Frequency bands of unlicensed spectrum
 - 5 GHz band (for all LTE on unlicensed bands applications)
 - 2.4 GHz band (for LTE-WLAN interworking)
- Likely deployment scenarios
 - Short-distance low-power transmission
 - Small cells (e.g. femtocells and picocells)

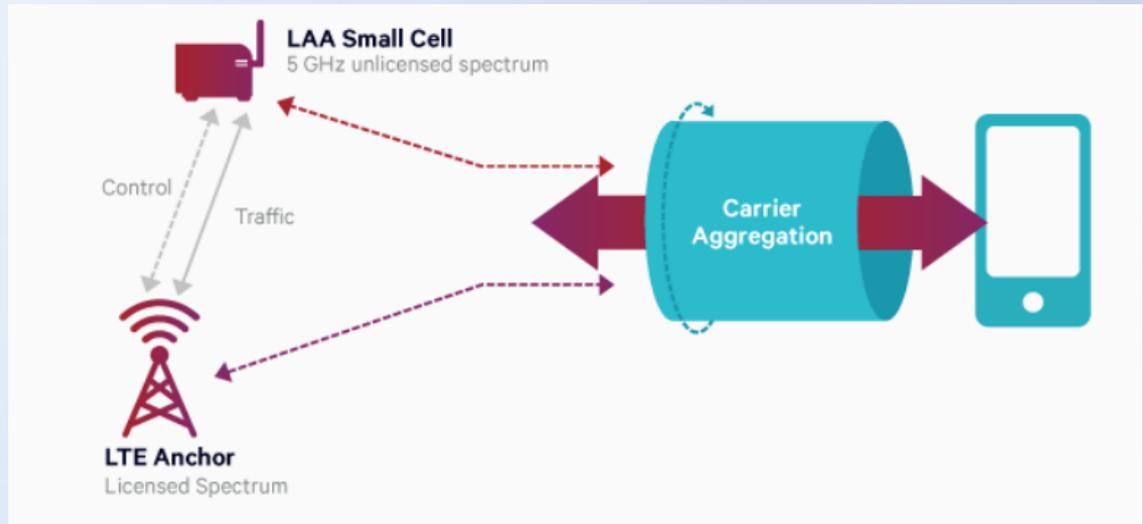
Licensed Assisted Access (LAA) (1)

- Adopted by the standardisation body 3GPP for 4G LTE technology in Release 13 specification (3GPP Rel. 13)
- Employ carrier aggregation in downlink transmission to combine LTE in unlicensed spectrum (in 5 GHz band) with LTE in the licensed band
- Licensed band is required as anchor for signaling and quality of service (QoS) purpose
- Support Listen-Before-Talk (LBT) feature for coexistence with Wi-Fi



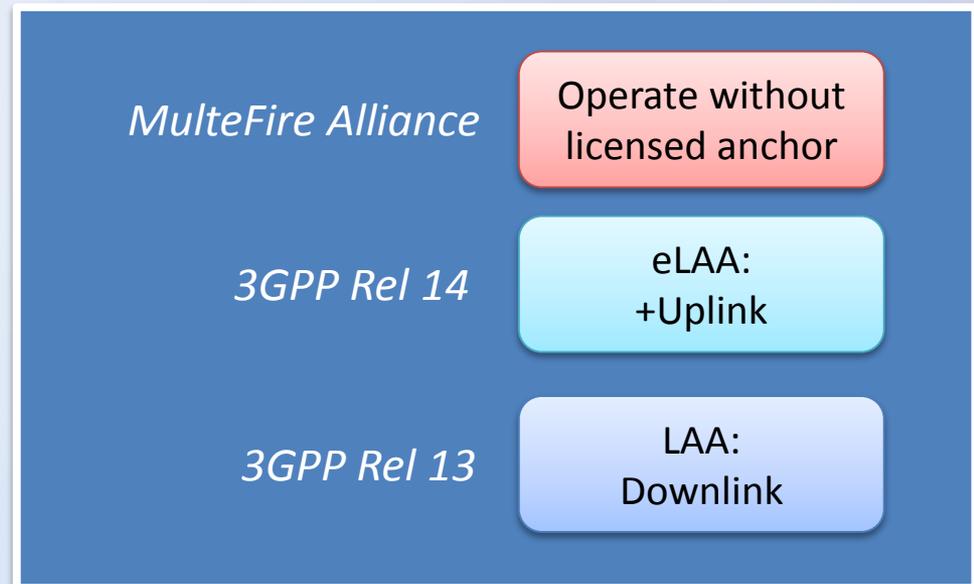
LAA (2)

- Enhanced LAA (eLAA) is proposed as a new Rel. 14 work item
- Support carrier aggregation in both uplink and downlink
- Support “Dual connectivity” for spectrum aggregation between macro and small cells



LAA (3)

- Further development of LTE in unlicensed band is foreseen (e.g. “MulteFire” Technology)
- Design based on 3GPP LAA and eLAA
- Adopt LBT and support uplink and downlink transmission without the need to anchor on licensed spectrum

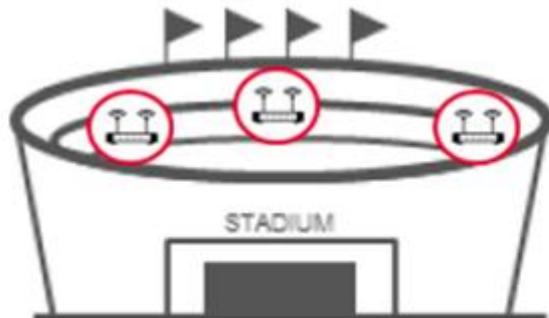


LTE in Unlicensed Spectrum (LTE-U)

- Defined by LTE-U Forum in 2014
- Similar to LAA, LTE-U works in the 5 GHz unlicensed band and supports carrier aggregation in downlink only
- Support Carrier-Sensing Adaptive Transmission (CSAT) feature for coexistence with Wi-Fi
- Previously studied in 3GPP Rel. 12 but no standardisation in 3GPP afterwards

LTE-WLAN Aggregation (LWA) (1)

- Alternative solution to LTE-U or LAA
- Enable link aggregation of LTE and wireless LAN (WLAN) (e.g. Wi-Fi) to increase throughput
- Standardised in 3GPP Rel. 13
- Can be deployed in LTE and WLAN co-located areas or non-co-located areas



Co-located

Integrated LTE/WLAN small-cells

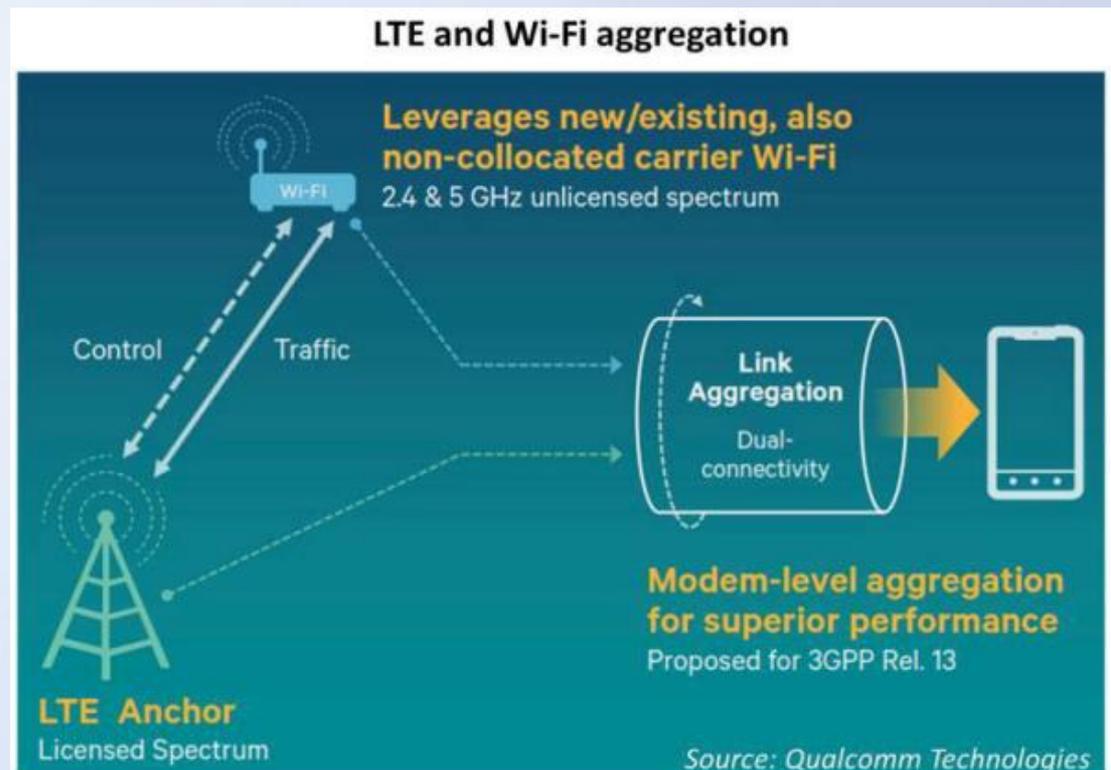


Non-co-located

MNO partnering with WLAN operator

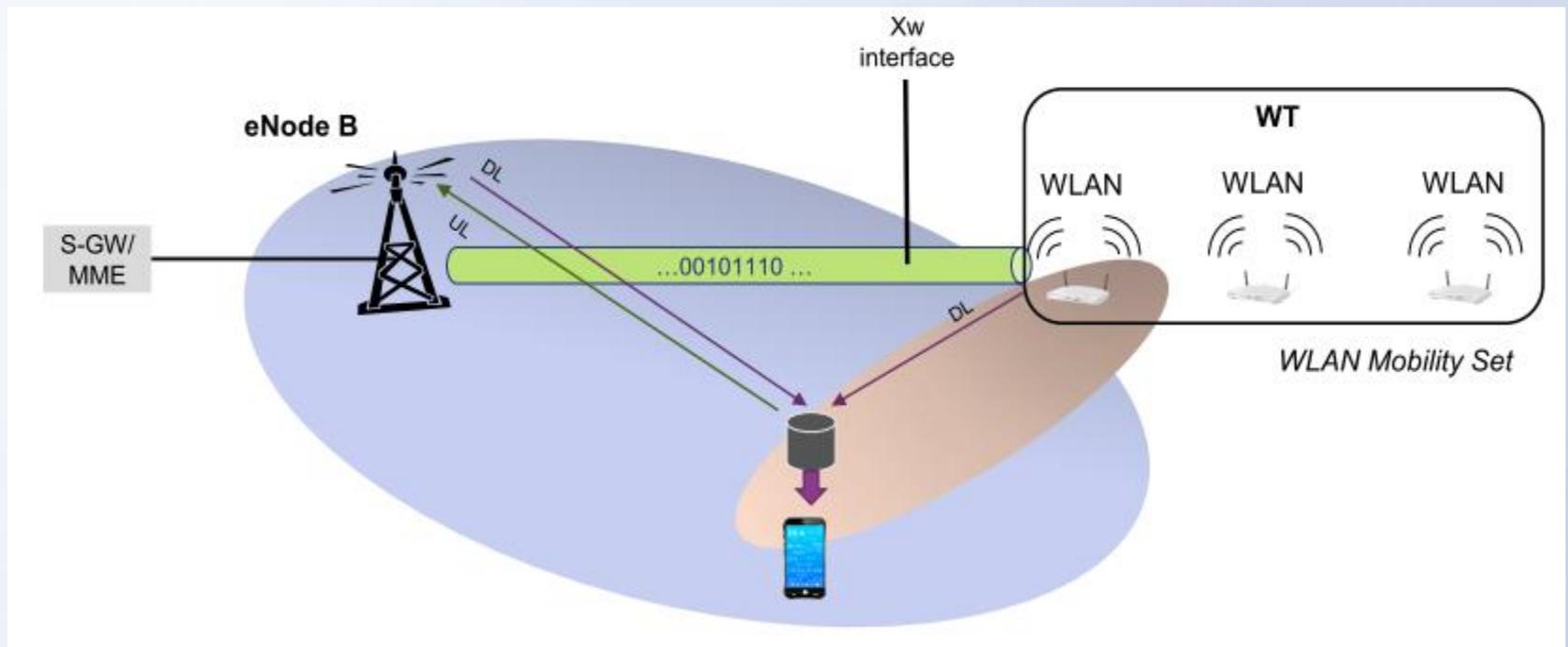
LWA (2)

- LWA uses Wi-Fi but not LTE in either 2.4 GHz or 5 GHz band for unlicensed access
- LWA requires some minor modification to existing Wi-Fi networks (either software upgrade or new Wi-Fi access point) and in devices (update of Operating System)



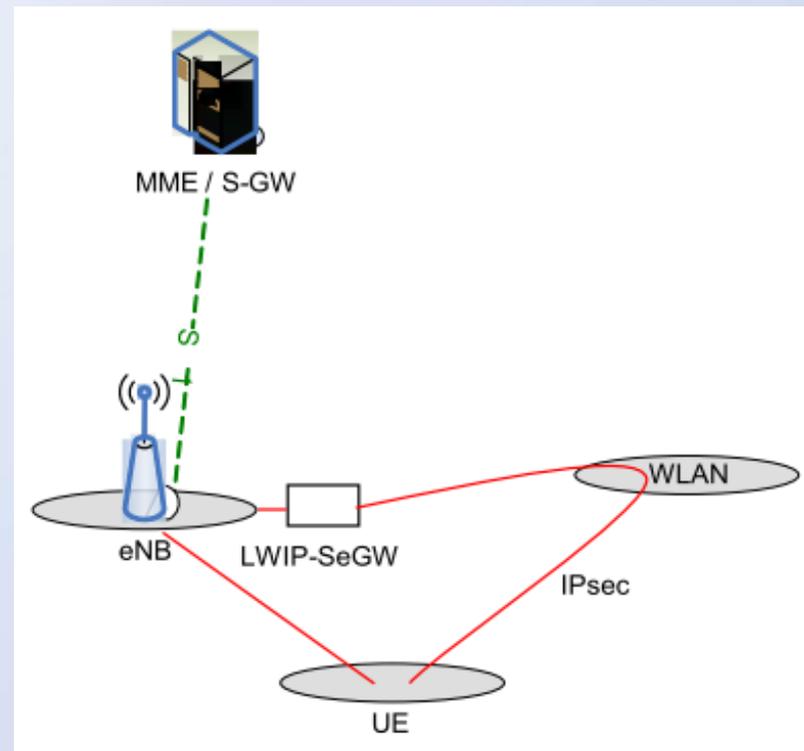
LWA (3)

- Definition of standardised Xw interface to connect between master cell (LTE eNB) and secondary cell (WT)
- Support only downlink WLAN traffic



LTE Wi-Fi radio level integration with IPsec tunnel (LWIP)

- Another WLAN interworking technology (similar to LWA) standardised in 3GPP Rel. 13
- User Equipment (UE) uses IPsec tunnel for connection between UE and eNB via WLAN and a new network node LWIP-SeGW
- No need for standardised network interface and hence no need for modification to Wi-Fi networks
- Support both uplink and downlink WLAN traffic



Technical Solutions to Achieve Coexistence between LTE and Wi-Fi

- 1. Channel Selection:** used to select a clean channel to avoid interference with nearby nodes based on continuous channel measurements
- 2. Time-domain coexistence techniques:** used when there is no clean channel available
 - CSAT
 - LBT

Trials and Equipment Readiness

- Trials and tests on LAA / LTE-U systems were conducted in Europe and USA in 2016
- Network equipment supporting LTE in unlicensed spectrum is expected to be ready around mid 2017
- New high-end mobile handsets are expected to support LTE operation in unlicensed bands at a later time

Way Forward

- OFCA and the industry should continue to monitor the latest developments of LTE in unlicensed bands
- Further study on technical coexistence of LTE and other wireless technologies in the same unlicensed bands may be needed
- MNOs may submit their proposals about the use of unlicensed bands for LTE to OFCA
- OFCA is minded to examine whether and how the current regulatory regime should be updated to facilitate the deployment of such new technologies

Thank you