

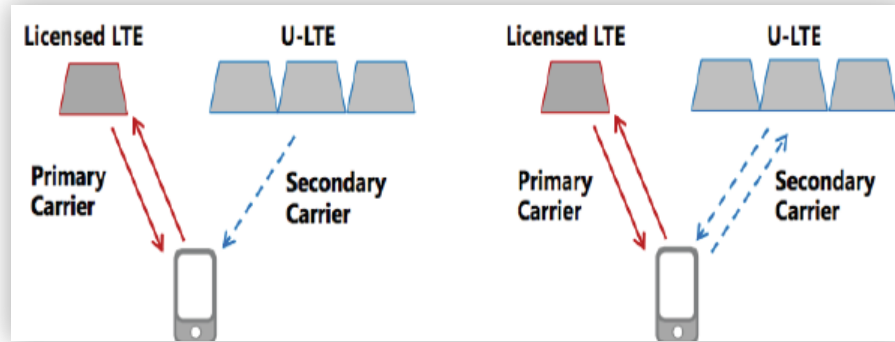
LTE-U/LAA & Wi-Fi

Clint W. Brown

Broadcom Corporation

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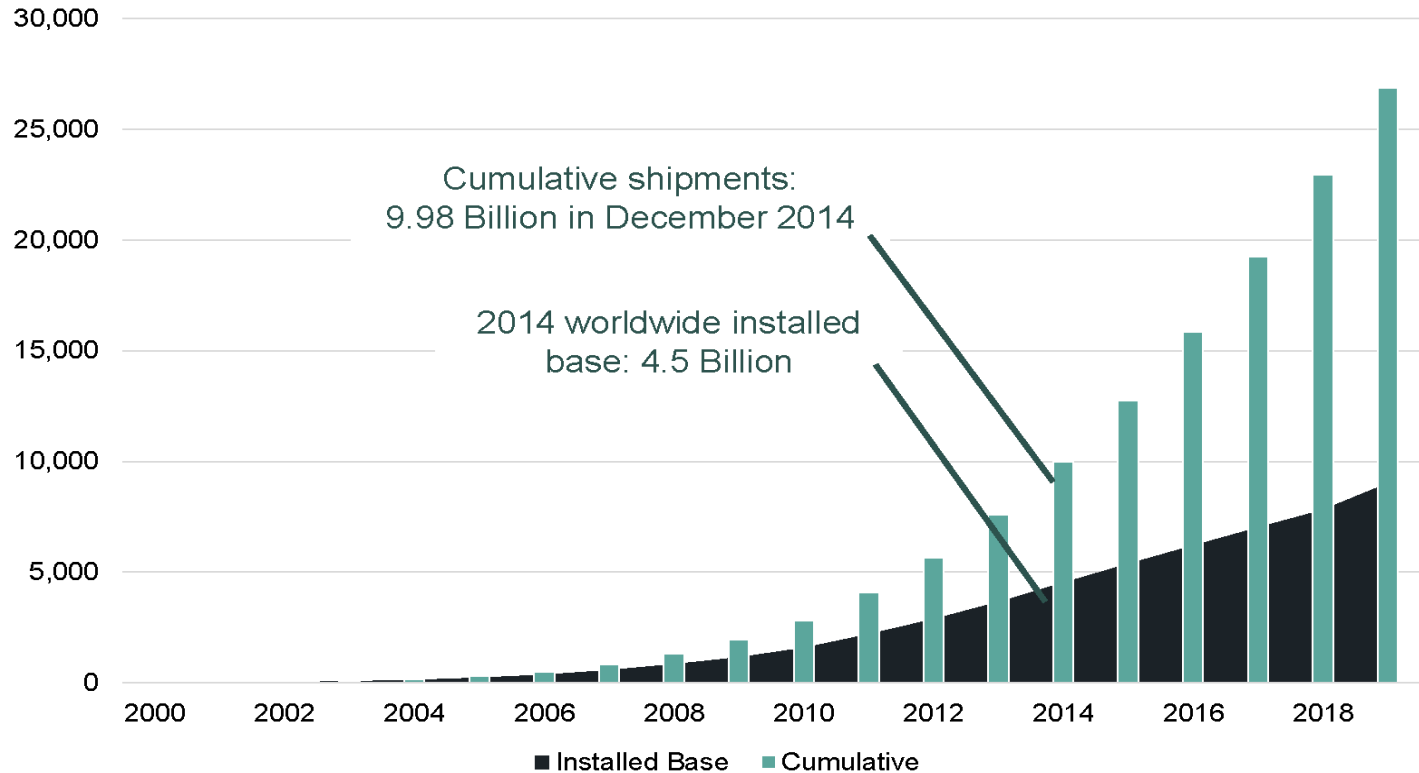
LTE-U & LAA



- LTE-U & LAA are envisioned to complement existing LTE networks with carriers in unlicensed band (5 GHz)
 - LTE-U: Pre standard version
 - LAA: Version currently being standardized in 3GPP
- Initially LTE-U & LAA deployments are expected to be for downlink traffic only on LAA carriers, but later to encompass uplink
- Only best effort data to be serviced by the unlicensed band
 - QoS sensitive applications such as video and voice continue to use licensed band
- Primarily restricted to small-cell usage models

Wi-Fi® Device Shipments 2000-2019

(ABI Research, December 2014)



WI-FI Densification Continues

802.11N

2009

450 Mbps
20/40 MHz

802.11AC

2012

1.75 Gbps
80 MHz

Advanced 802.11AC

2015

3.5 Gbps
160 MHz
MU-MIMO

3x deployment
density

802.11AX

2017

7 Gbps
High efficiency MAC

High density and
efficiency Wi-Fi

But higher Wi-Fi
deployment
density using
wider
transmission
bandwidths
increases channel
congestion -
**mandates polite
behavior from
LTE-U/LAA**

Design Mandate for Robust Coexistence: as Fair as Wi-Fi

- Broadcom suggests standardization of at least a three-pronged approach to healthy coexistence among broadband unlicensed technologies:
- Let other data transmissions and handshake mechanisms complete before transmitting; be adaptive to current occupants
 - Solution: LTE-U/LAA should deliberately wait for a nominally acceptable time before transmissions
 - Possible Technical solution: Initial wait for ~43 microseconds prior to arbitration - similar to Wi-Fi
- Back-off transmissions rapidly when significant interference with other users is detected; be adaptive to congestion
 - Solution: LTE-U/LAA should implement technologies similar to those in Wi-Fi such as “Exponential Back-off” which defer transmissions upon detection of interference
- Detect signals that are far below regulatory requirements to maintain thriving unlicensed ecosystem
 - Solution: Match Wi-Fi mechanisms, which detect other Wi-Fi signals as weak as 1000 times below regulatory requirements
 - Possible Technical solution: LTE-U/LAA could operate at -82 dBm to -92 dBm for preamble or carrier sense detection and at -62 dBm energy detection assuming 20 MHz signal bandwidth

Potential Issues With LTE-U Deployment

- Pre-standard LTE-U being promoted by few companies within LTE-U Forum
- LTE-U Forum technical documentation describes LTE-U using “duty cycle (on/off periods)” for medium sharing
 - Wi-Fi uses idle “off” periods for transmissions
- Potential problems with this approach are:
 - Wide range of implementations to set “duty cycle” parameters are possible
 - Coex mechanisms based on Wi-Fi RSSI values (high detection threshold) – poor coexistence expected
 - Coex mechanisms bases on detecting Wi-Fi signals (“Wi-Fi sniffer” approach) – better coexistence expected
 - LTE-U operators unilaterally regulate duty cycle period and therefore time allocated for Wi-Fi communication
 - LTE-U operators may not have incentive to protect high QoS Wi-Fi traffic since LTE-U high QoS traffic will be transmitted on licensed carriers
 - It will be very difficult to adapt duty cycle on fast changing Wi-Fi traffic
 - Wi-Fi VoIP and Video applications may suffer unacceptable delays and loss in QoS
- Deployment of pre-standard version should be avoided
 - Industry should find consensus and develop solutions in standardization bodies
 - Solution should be global: LTE-U is not
 - Solution should be fair to billions of Wi-Fi devices deployed worldwide