Questions about LAA deployment scenarios

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Abstract	This document discusses realistic unlicensed LTE deployment scenarios and their requirements for license-assisted access, proposing some questions for 3GPP.
Purpose	For review by the IEEE 802.19 WG and incorporation into comments into IEEE 802 input to 3GPP LAA workshop of 29 August 2015.

LAA deployment scenarios

per 3GPP TR 36.889 V1.0.1 (2015-06): *Study on Licensed-Assisted Access to Unlicensed Spectrum* (Release 13)

- *Unlicensed spectrum can never replace the need for more licensed spectrum due to its inability to be used in macro cells providing wide-area coverage and its general inability to provide highly robust quality-of-service due to the uncontrolled interference. Therefore, unlicensed spectrum is better used as "Licensed-Assisted Access" integrated into LTE, where it is considered as a secondary component carrier in a carrier aggregation scenario.*

LAA deployment scenarios

per 3GPP TR 36.889 V1.0.1 (2015-06): *Study on Licensed-Assisted Access to Unlicensed Spectrum* (Release 13)

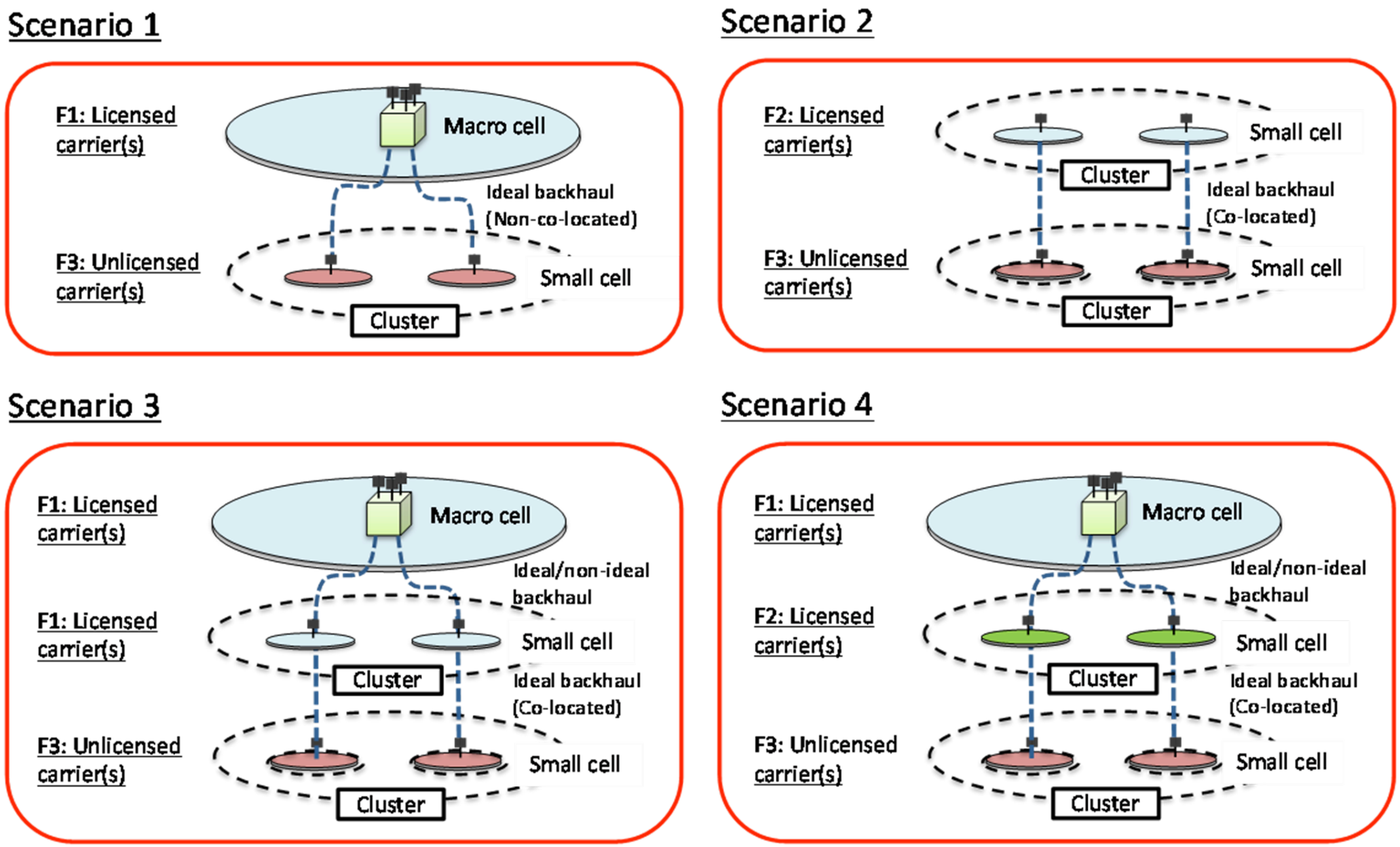


Figure 6-1: LAA deployment scenarios

“Ideal Backhaul”

- Scenario 1 presumes Licensed band in macrocell, not microcells
  - Is a solution that requires a licensed microcell at each unlicensed microcell really practical?
- In Scenario 1, Unlicensed Small Cell is connected to network by “Ideal Backhaul”
- “Ideal Backhaul” is really “fronthaul”
  - Carrier Aggregation takes place in the MAC
  - downlink and uplink resource scheduling is done is at a unified MAC
    - PHY I/Q channels distributed to “remote radio heads” via (e.g.) CPRI
    - ~hundreds of Mbit/s per 20 MHz channel, per antenna
    - with synchronization provided
    - for a number of unlicensed microcells within a large licensed macrocell, it’s an expensive proposition

CPRI Line Bit Rate Options and User-Plane Transport Capacity

Line bit rate	Line Coding	Transport Capacity (#WCDMA AxC)	Transport Capacity (# 20 MHz LTE AxC)
614.4 Mbit/s	8B/10B	4	--
1228.8 Mbit/s	8B/10B	8	1
2457.6 Mbit/s	8B/10B	16	2
3072.0 Mbit/s	8B/10B	20	2
4915.2 Mbit/s	8B/10B	32	4
6144.0 Mbit/s	8B/10B	40	5
8110.08 Mbit/s	64B/66B	64	8
9830.4 Mbit/s	8B/10B	64	8
10137.6 Mbit/s	64B/66B	80	10
12165.12 Mbit/s	64B/66B	96	12

Each 20MHz LTE AxC stream requires ~1Gbps!

liaison-CPRI_Tdoc_1124_presentation-0315.pdf (802.1 contribution, 2015-03)

Ideal Backhaul

per 36.932 V12.1.0 (2013-03): *Scenarios and requirements for small cell enhancements for E-UTRA and E-UTRAN* (Release 12)

Table 6.1-1: Categorization of non-ideal backhaul

Backhaul Technology	Latency (One way)	Throughput	Priority (1 is the highest)
Fiber Access 1	10-30ms	10M-10Gbps	1
Fiber Access 2	5-10ms	100-1000Mbps	2
Fiber Access 3	2-5ms	50M-10Gbps	1
DSL Access	15-60ms	10-100 Mbps	1
Cable	25-35ms	10-100 Mbps	2
Wireless Backhaul	5-35ms	10Mbps – 100Mbps typical, maybe up to Gbps range	1

Table 6.1-2: Categorization of ideal backhaul

Backhaul Technology	Latency (One way)	Throughput	Priority (1 is the highest)
Fiber Access 4 (NOTE 1)	less than 2.5 us (NOTE2)	Up to 10Gbps	1

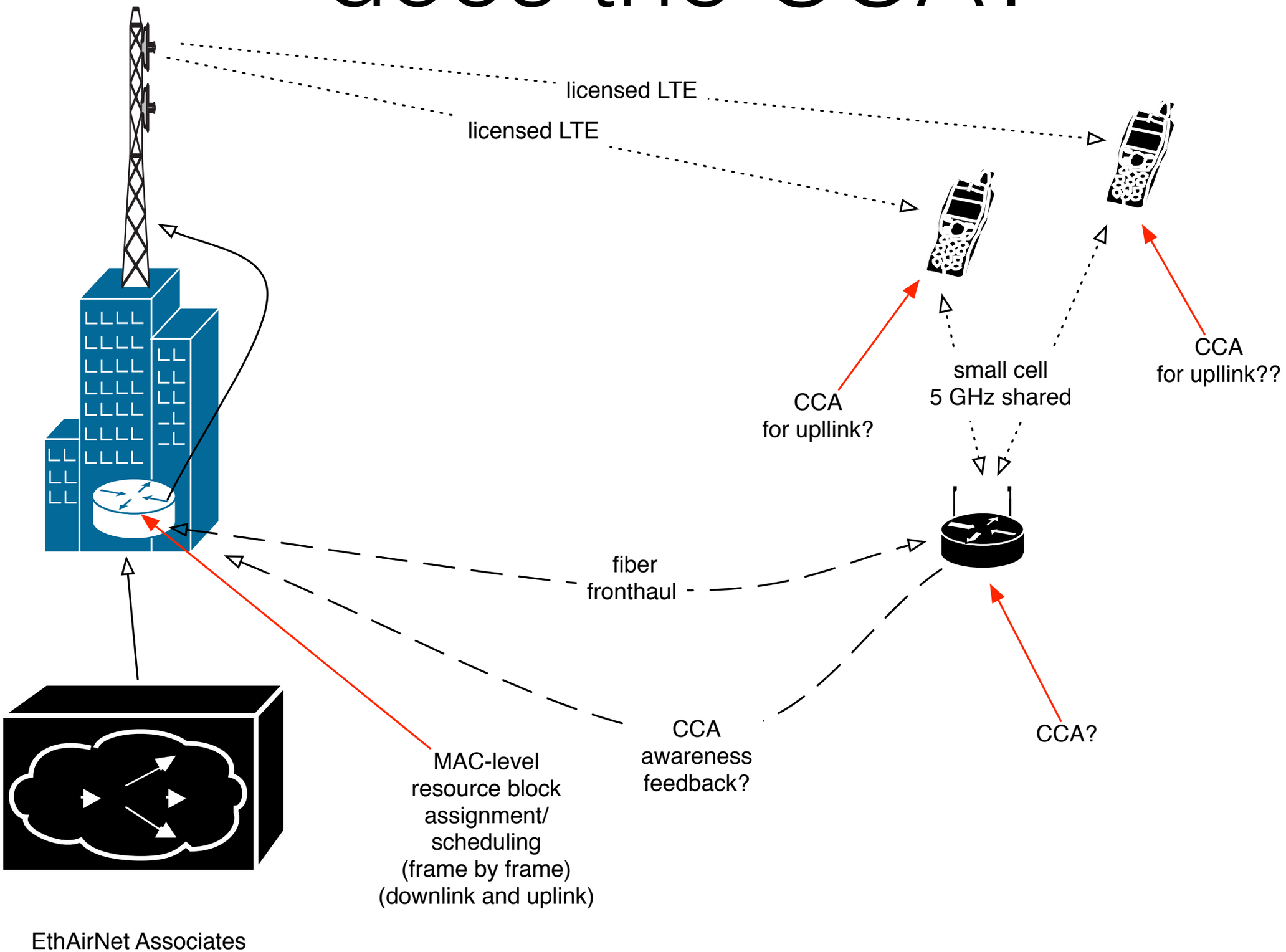
NOTE 1: This can be applied between the eNB and the remote radio head.

NOTE 2: propagation delay in the fiber/cable is not included.

Listen Before Talk

- *The listen-before-talk (LBT) procedure is defined as a mechanism by which an equipment applies a clear channel assessment (CCA) check before using the channel.*
- Which is “the equipment” doing the CCA?

Which “equipment” does the CCA?



How does the timing work?

- Scheduling (downlink and uplink) done at a centralized MAC
- Devices do local CCA and defer transmission until opportunity arises.
  - This invalidates the resource scheduling, unless all CCA information is sent to the central MAC to be considered in scheduling.
- Can the system meet the latency requirement?
- Mobile uplink encounters extra delay, since CCA data needs to be sent over the air (licensed)
  - LAA currently structured as downlink-only; is it feasible to expand to include uplink?

Alternate deployment model

- Instead of carrier aggregation based on a common MAC, traffic flows could be divided above the MAC and sent separately to licensed and unlicensed radio networks.
  - as might be done with 802.11
    - devices maintain local buffers and transmit in available slots, not following a master schedule
    - eliminates “ideal backhaul” requirement
- In this case, unlicensed access could operate independently from licensed access.
  - Is there a need to maintain “license-assisted access,” restricted to use by licensed carriers?
  - Why not standardize standalone unlicensed LTE?

Summary

- LAA, using carrier aggregation with licensed-exempt microcells remote from a central MAC, is complex.
  - LBT exacerbates challenging requirements.
- Alternative, not based on carrier aggregation, is more practical.
  - Could be standardized as standalone unlicensed LTE.
  - Need to better understand the justification for tying unlicensed LTE to licensed operation.

Proposed Slides

- Slides on this topic should be prepared for IEEE 802 input to 3GPP LAA workshop of 29 August 2015.

- Proposal planned for a future revision of this contribution.