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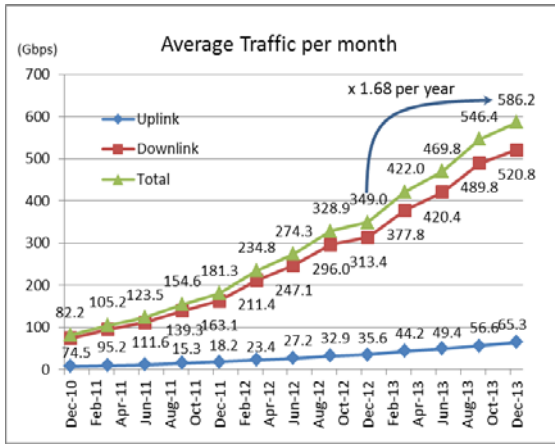
Consideration of LTE in Unlicensed Spectrum RWS-140028

The need for more spectrum

- This Contribution examines some key scenarios and possible technical solutions for use of unlicensed/shared spectrum by LTE-based systems will be reviewed. The main pros and cons of the different options and possible implications for the scope of a RAN study item will be considered



Growing Traffic: 1.6-fold per year

Ref: MIC of Japan, "Mobile communication traffic in Japan," Data base of ICT statistics, Dec. 2013.

- Access to more spectrum is needed to support future mobile data traffic
  - Radio technology improvements alone are not enough to meet growing demand
  - Note imbalance between UL/DL traffic demand
- Unlicensed spectrum can help
- Available technologies may be inadequate

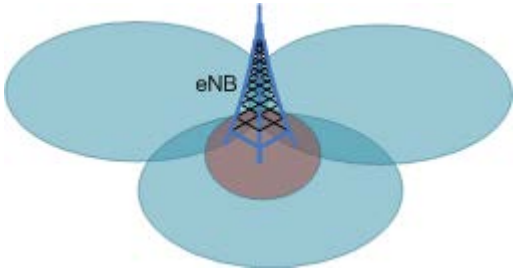
Consider developing LTE-A in unlicensed spectrum

Alternative technologies for use in unlicensed spectrum

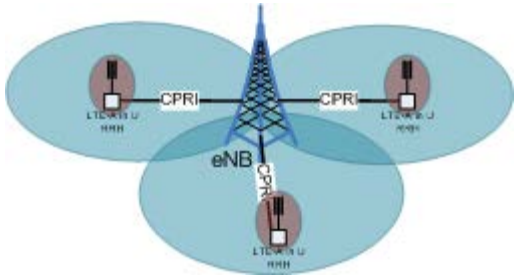
	LTE-A	WiFi
Peak data rate	Very Good	Good
Spectrum efficiency	Very Good	Good
Adjacent channel emissions	Very Good	Poor
Mobility support	Very Good	Poor
Cost of access point	t.b.d.	Good
Cost of mobile transceiver	t.b.d.	Good
Battery life	Very Good	Good

Key scenarios for LTE-A in unlicensed spectrum

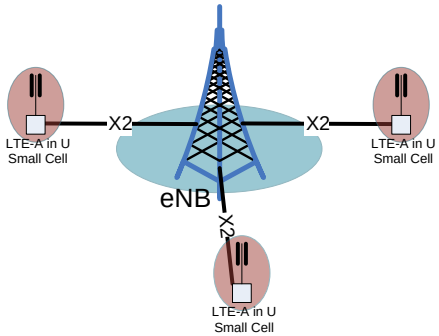
- The need for more capacity is paramount
  - However the different deployment scenarios should be studied to maximise operator deployment flexibility whilst adding new capacity for the users at minimum cost
  - Some possibilities of the types of scenarios that could be considered are:



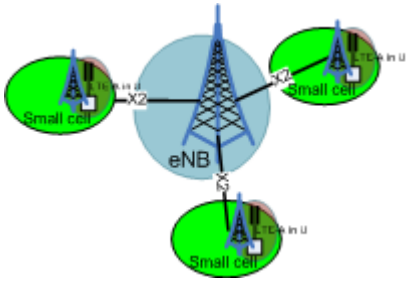
Scenario 1: Carrier Aggregation with the addition of LTE-A in unlicensed spectrum at the same cell site as the eNB



Scenario 2: Carrier Aggregation with the addition of LTE-A in unlicensed spectrum via RRHs connected to the eNB



Scenario 3: Small cells using LTE-A in unlicensed spectrum



Scenario 4: LTE-A Small cells with the additional multiple LTE-A in unlicensed spectrum

Systems which might share unlicensed spectrum with LTE-A

- WLAN (WiFi)
  - 2.4 – 2.484 GHz (already congested)
  - 5.15 – 5.725 GHz (currently more lightly loaded)
- Radar
  - E.g. 5.25 – 5.35 and 5.47 – 5.725 GHz
  - Due the fact that 5 GHz WLANs utilize the frequency band primarily dedicated to meteorological and military radars, there is a Dynamic Frequency Selection (DFS) function which is described in harmonized standard EN 301 893.
  - However up to only 1/3 of tested WLAN fulfilled required administrative requirements [1]
- TV
  - TV White space (e.g. 470-850 MHz in UK)
- ISM (Industrial Scientific and Medical)
  - 2.4 - 2.5 GHz
  - 5.725 – 5.875 GHz

[1] ec.europa.eu/enterprise/sectors/**rtte**/files/**5th-rtte**ms-**report**_en.pdf

- Conditions for co-existence include:
  - Power output
  - Power control
  - Dynamic frequency selection
  - “Politeness”
  - RF emission requirements

Possible technical solutions for sharing of unlicensed spectrum by LTE-A

- LTE-A and WLAN interworking
  - LTE-A in licensed spectrum
  - WiFi used in unlicensed spectrum
- Carrier aggregation/dual connectivity between LTE-A and WLAN
  - Pcell in licensed spectrum
  - WiFi phy-layer used in unlicensed spectrum (possibly downlink only)
- Carrier aggregation between LTE-A and LTE-A in unlicensed spectrum
  - Pcell in licensed spectrum
  - Scell in unlicensed spectrum (possibly downlink only)
- Dual connectivity between LTE-A and LTE-A in unlicensed spectrum
  - Pcell in licensed spectrum
  - SeNB using unlicensed spectrum (both UL and DL)
- Stand-alone LTE-A in unlicensed spectrum

Comparison of solutions

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Solution	Advantages	Disadvantages
LTE-A and WLAN interworking	Rel-12 baseline	Lower battery life
Carrier aggregation between LTE-A and WLAN(1)	QoS	
Carrier aggregation between LTE-A and LTE-A in unlicensed spectrum(1)	Spectrum efficiency, data rate, QoS	Standardisation effort, implementation cost
Dual connectivity between LTE-A and LTE-A in unlicensed spectrum	Spectrum efficiency, data rate, QoS, more flexible deployment	Standardisation effort, implementation cost
Stand-alone LTE-A in unlicensed spectrum(2)	Spectrum efficiency, data rate, QoS, LTE coverage not required	Standardisation effort, implementation cost, licensed spectrum unused

(1) “DL only” could significantly reduce hardware costs
(2) Other solutions would also need to be supported

Additional considerations for future studies of LTE-A in unlicensed spectrum

- For WiFi, capacity is addressed by increasing the density of access points, so increasing capacity becomes an issue of cost (per AP) rather than spectrum efficiency
- Conditions for co-existence including: Listen-before-talk, Duty cycle of transmission and channel selection
- Performance evaluation of LTE-A in unlicensed as compared to gains from tighter integration of WLAN and LTE-A
- Identification and evaluation of performance improvements vs. a suitable Rel-12 (or Rel-13) baseline
- Implementation costs of evaluated solutions vs. costs for equipment supporting both LTE and WLAN
- Architecture options for different network deployments

Conclusions

- The need for more traffic capacity is paramount
- Need to take care of meeting the requirements of the different deployment scenarios
- Study should identify good technical solutions for LTE-A in unlicensed spectrum that give real benefits over tighter integration with WLAN