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3GPP & unlicensed spectrum

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Outline

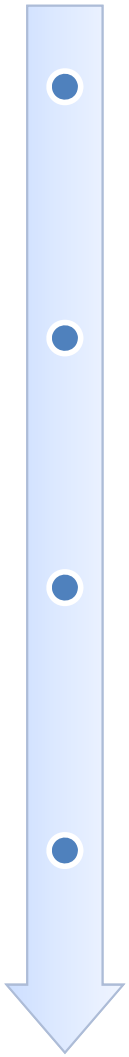
- Introduction
- LTE/Wi-Fi interworking
- LTE over unlicensed
- Cooperation with IEEE

Introduction

- Licensed spectrum remains 3GPP operators' top priority to deliver advanced services and user experience
- Opportunistic use of unlicensed spectrum is becoming an important complement for operators to meet the growing traffic demand
- Moving forward 3GPP operators will have two options to offload traffic to unlicensed spectrum:
  1. Wi-Fi (via LTE/Wi-Fi interworking)
  2. LTE over unlicensed
- It will then be up to each individual operator to choose which approach to use, which will depend on a number of factors

LTE/Wi-Fi interworking

Brief history of LTE/Wi-Fi interworking



Rel-8 (Dec. '08)

- Mobility with IP address preservation of all traffic from 3GPP access to Wi-Fi access (and policing through ISMP)

Rel-10 (Jun. '11)

- Mobility with IP address preservation for selected IP flows (IFOM)
- Simultaneous IP connectivity to 3GPP and Wi-Fi access networks (MAPCON)

Rel-11 (Jun. '13)

- Improved definition of IP flows for enhanced traffic steering (DIDA)
- Transparent IP connectivity via trusted Wi-Fi using GPRS Tunneling Protocol (SaMOG)
- IP connectivity via Broadband Access, such as DSL line

Rel-12 (Mar. '15)

- Multiple IP connectivity via Trusted WLAN using GTP (eSaMOG)
- Prioritization of different 3GPP access networks with respect to Wi-Fi (WORM)
- APN selection based on the type of traffic (IARP)
- Enhanced Wi-Fi network selection policies (integration with HotSpot 2.0)
- Offload based on ANDSF and RAN based policies and UE measured quality of 3GPP and Wi-Fi radio access

System-level

Radio-level

LTE/Wi-Fi interworking

- Framework being developed since the first release of LTE, Rel-8
  - With tighter and tighter forms of interworking added in subsequent releases
  - See previous slide for a brief history of the LTE/Wi-Fi interworking capabilities developed by 3GPP
- New proposals for even tighter radio-level interworking are currently being evaluated for Rel-13, including:
  - LTE/Wi-Fi aggregation
  - Enhanced network controlled mobility, via enhanced UE measurement reporting and network steering capabilities
  - Interface between LTE eNBs and Wi-Fi APs

LTE over unlicensed

LTE over unlicensed

- The discussion was kicked off by a workshop in Jun. 2014, which established the initial priorities (RWS-140029):
  - 5 GHz band
  - Global solution that can work across regions
  - Licensed-Assisted Access operation
    - Aggregation of a primary cell, operating in licensed spectrum to deliver critical information and guaranteed Quality of Service, with a secondary cell, operating in unlicensed spectrum to opportunistically boost data rate
    - The secondary cell operating in unlicensed spectrum can be configured either as downlink-only cell or contain both uplink and downlink
  - Fair coexistence between LTE and Wi-Fi as well as between LTE operators

Licensed-Assisted Access (LAA)

- The feature is targeting completion in Rel-13, which is scheduled to freeze in Mar. 2016
- The Study Item (SI) was approved by RAN in Sep. 2014 and is scheduled to complete in Jun. 2015
  - Main SI goal: study the LTE enhancements needed to operate in unlicensed spectrum and to ensure fair coexistence with Wi-Fi
- The detailed SI description is available in RP-141817

LAA SI: feasibility study

- Started in RAN1 in Q4-14, with initial discussions on:
  - Regulatory requirements
  - Deployment scenarios
  - Design targets & functionalities
  - Coexistence evaluation & methodology

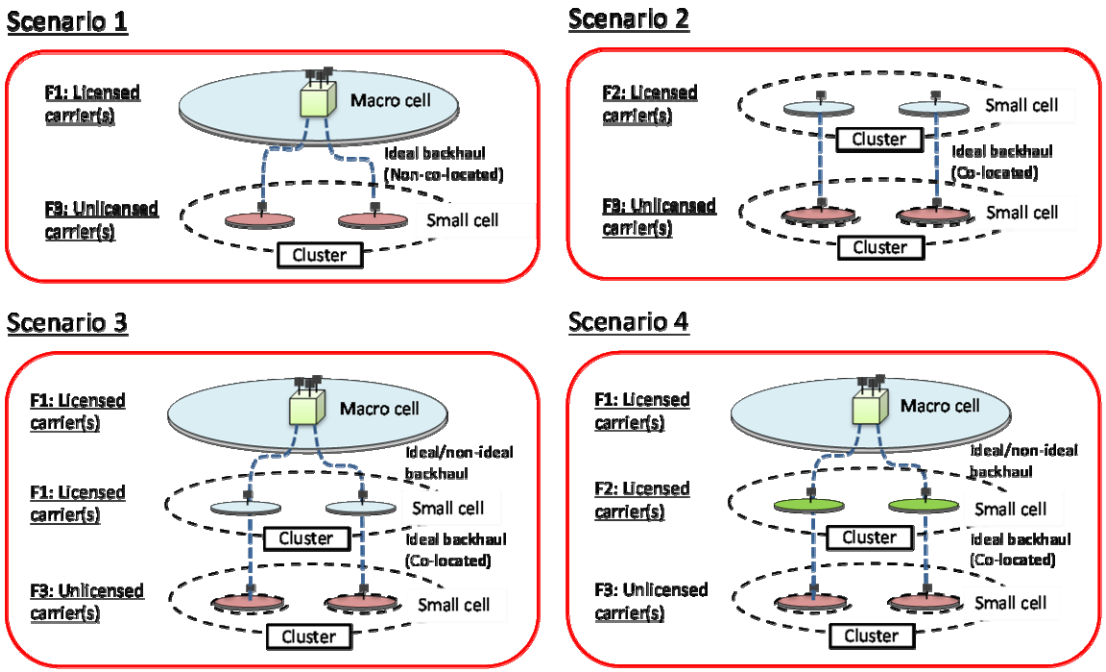
- The Latest version of the TR is available in R1-145483
  - **Still in draft state** (hence not published yet by 3GPP)!

LAA SI: regulatory aspects

- Produced an overview of the regulatory requirements for unlicensed operation in 5 GHz
  - See R1-145483, Sec. 4

- Different regional requirements emerged, in terms of power levels, channel sensing etc.

LAA SI: deployment scenarios



- Scenario 1: Carrier Aggregation (CA) between licensed macro cell (F1) and unlicensed small cell (F3)
- Scenario 2: CA between licensed small cell (F2) and unlicensed small cell (F3) without macro cell coverage
- Scenario 3: Licensed macro and small cell (F1), with CA between licensed small cell (F1) and unlicensed small cell (F3)
- Scenario 4: Licensed macro cell (F1), licensed small cell (F2) and unlicensed small cell (F3)
  - CA between licensed small cell (F2) and unlicensed small cell (F3); If there is ideal backhaul between macro and small cell, there can be CA between macro cell (F1), licensed small cell (F2) and unlicensed small cell (F3); If dual connectivity is enabled, there can be dual connectivity between macro cell and small cell.

Note: Scenario 2 and Scenario 4 will be used in the coexistence study as indoor and outdoor evaluation scenario, respectively.

LAA SI: design targets & functionalities

- Agreed design targets:
  - Single global solution allowing compliance with any regional regulatory requirements
  - Effective and fair coexistence with Wi-Fi
  - Effective and fair coexistence among LAA networks deployed by different operators

- Based on the above targets, it was agreed that at least the following functionalities are required for LAA:
  1. *Listen-before-talk* (Clear channel assessment)
  2. Discontinuous transmission on a carrier with limited maximum transmission duration
  3. *Dynamic Frequency Selection* for radar avoidance in certain bands/regions
  4. Carrier selection
  5. *Transmit Power Control*

Note: not all functionalities may have a spec impact; not all functionalities would be mandatory for all LAA eNBs/UEs

- On **fair** coexistence with Wi-Fi
  - Initial qualitative definition provided in the SI description:
    - *[…] LAA should not impact Wi-Fi services (data, video and voice services) more than an additional Wi-Fi network on the same carrier; these metrics could include throughput, latency, jitter etc. […]*
  - Exact metrics to be defined in the coexistence study

LAA SI: coexistence evaluation

- Established the initial evaluation scenarios and methodology
  - More details on the initial assumptions for the evaluation methodology can be found in R1-145483, Sec 8
- Initial coexistence results expected to be discussed in H1-15

Cooperation with IEEE

Cooperation with IEEE

- In general we welcome further cooperation with IEEE
- The Chairman of the IEEE 802 coexistence group recently gave RAN an interesting presentation on the lessons learned when dealing with unlicensed spectrum operations, RP-141747
- With this presentation we wanted to give you an early indication of where the LAA work is going (the work has just started)
  - We will be happy to come back and present the results of the coexistence analysis, once the feasibility study is completed
- Any feedback from IEEE 802 is welcome and will be taken into account in the regular 3GPP process
  - Lot of interested companies are members of both SDOs and can also contribute directly to 3GPP
- For instance, if IEEE had a standardized requirement on Wi-Fi to Wi-Fi coexistence performance that every Wi-Fi device has to meet, this could complement 3GPP coexistence evaluations
  - If so, a pointer to the corresponding IEEE specification(s) would be highly appreciated
  - This should include the case of uncoordinated networks

Thanks!