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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

<table>
<thead>
<tr>
<th>Release</th>
<th>Date</th>
<th>Features</th>
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<tbody>
<tr>
<td>Rel-8</td>
<td>Dec. '08</td>
<td>• Mobility with IP address preservation of all traffic from 3GPP access to Wi-Fi access (and policing through ISMP)</td>
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<td>Rel-10</td>
<td>Jun. '11</td>
<td>• Mobility with IP address preservation for selected IP flows (IFOM)</td>
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<td>• Simultaneous IP connectivity to 3GPP and Wi-Fi access networks (MAPCON)</td>
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<td>Rel-11</td>
<td>Jun. '13</td>
<td>• Improved definition of IP flows for enhanced traffic steering (DIDA)</td>
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<td>• Transparent IP connectivity via trusted Wi-Fi using GPRS Tunneling Protocol (SaMOG)</td>
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<td>• IP connectivity via Broadband Access, such as DSL line</td>
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<td>Rel-12</td>
<td>Mar. '15</td>
<td>• Multiple IP connectivity via Trusted WLAN using GTP (eSaMOG)</td>
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<td>• Prioritization of different 3GPP access networks with respect to Wi-Fi (WORM)</td>
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<td>• APN selection based on the type of traffic (IARP)</td>
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<td>• Enhanced Wi-Fi network selection policies (integration with HotSpot 2.0)</td>
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<td>• Offload based on ANDSF and RAN based policies and UE measured quality of 3GPP and Wi-Fi radio access</td>
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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!