LAA and Wi-Fi Coexistence work – A case study on cooperation

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Outline

• Background
• Integration of LTE and WLAN
• Licensed Assisted Access (LAA)
• Summary
Growing Traffic Demand

Broadband Applications
Ultra HD (4K, 8K...)

Mobile Data Traffic
Increase 1000-fold from 2010 to 2020

Mega Connections
Over 50 billion in 2020

Spectrum Efficiency Requirement
10-fold in 2020

Source: ARIB, Nokia, Qualcomm; ITRI IEK

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Opportunistic use of unlicensed spectrum is becoming an important complement for operators to meet the growing traffic demand

- **LTE Related SI/WI**
  - Rel-12 LTE/WLAN Interworking
  - Rel-13: LTE-WLAN Radio Level Integration
  - Rel-13: LTE-WLAN Radio Level Integration support Legacy WLAN
  - Rel-13: Licensed-Assisted Access using LTE

Co-located  |  Non-Co-located
---|---
Licensed Carriers | Unlicensed Carriers
Micro/Pico | Micro/Pico/RRH
Rel-12 LTE/WLAN Interworking

**Solution 1**

- **ANDSF Server**
  - (1) ANDSF policies including RAN/WLAN parameters
  - (2) RAN threshold/values

**Solution 2**

- **UE**
- **eNB/RNC**
- **WLAN AP**
  - 1. Parameters
  - 2. Steer traffic to/from WLAN according to RAN rule and ANDSF

*Source: 3GPP TR 37.834

**RAN provides “RAN assistance information” for ANDSF rules**

**RAN2 defines “RAN rules” and “RAN thresholds”**

*Source: 3GPP TR 37.834

The RAN provides (through dedicated and/or broadcast signalling) thresholds which are used in the rules.
3GPP/WLAN Interworking Evolution

Source: Intel

RAN Assisted  →  RAN controlled

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Rel-13: LTE-WLAN Radio Level Integration

LTE+WLAN Aggregation

New C-/U-Plane Interface
[eNB] – Xw-C – [WT]
[eNB] – Xw-U – [WT]

Reference Interworking Enhancement Architecture

Source: R2-154997 36.300 Running Draft CR

WT: WLAN Termination

Source Qualcomm R2-151655

MME / S-GW

S1

S1

WT

eNB

Xw

Xw

S6a

S1-MME

S1-U

S1-MME

S1-U

S1-MME

S1-U

S1-MME

S1-U

Internet

SGi

PGW

SGW

HSS

MME

SGW

SGW

ePDG/ TWAG

Reference Interworking Enhancement Architecture

Source Qualcomm R2-151655
Rel-13: LTE-WLAN Radio Level Integration support Legacy WLAN

• **Scope**
  • Solution shall support legacy WLAN deployments without any need for modifications to the deployed WLAN nodes.

• **Architecture:**
  • Based on IPsec tunneling above PDCP protocol layer between eNB and UE over WLAN.

*Detail WI scope in RP-151615*
Is it Enough?

- Improvement for WiFi under mobile or roaming scenarios are required.
- Companies see benefits for operators to utilize unlicensed spectrum with a unified network
  - may offer potential operational cost saving, improved spectral efficiency and better user experience (*)

*Refer to RWS 140029
Unlicensed Spectrum

- Band Availability
  - Large amount of unlicensed spectrum available in 5GHz band

- Regulatory
  - Listen-Before-Talk (LBT) and maximum transmission duration etc.

*See detail regulatory requirement in 3GPP TR 36.889

5 GHz Spectrum

Taiwan
- 100 MHz
- 100 MHz
- 130 MHz
- 75 MHz
- 125 MHz
- 125 MHz

China
- 100 MHz
- 100 MHz
- 255 MHz

EU
- 100 MHz
- 100 MHz
- 100 MHz
- 255 MHz

JP
- 100 MHz
- 100 MHz
- 100 MHz
- 255 MHz

Korea
- 100 MHz
- 100 MHz
- 180 MHz
- 100 MHz

US
- 100 MHz
- 100 MHz
- 255 MHz
- 100 MHz

*See detail regulatory requirement in 3GPP TR 36.889

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Licensed-Assisted Access using LTE

• Benefit
  • LTE licensed spectrum for performance + LTE unlicensed spectrum for data rate boost
  • Reduce latency and smoother transition

• Facing issue
  • Friendly
  • Fair

Source: Huawei
LAA Design Target

- 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
Rel-13 LAA Status

- To be Friendly and Fair coexistence
  - Category 4 LBT mechanism is recommended as the baseline
    - Modified based on ETSI Option B consider LBT and back-off window (*)
    - Status update and joint meeting with IEEE

- Rel-13 focus on unlicensed band as supplemental DL
  - Performance study: Coexistence evaluation results for LAA with only DL transmissions
    - DL-only LAA coexisting with DL+UL Wi-Fi
    - Performance metrics include UPT, delay, 5\textsuperscript{th}, 50\textsuperscript{th} and 95\textsuperscript{th} percentile and mean values, and low, medium and high loads etc.

(*)See detail in 3GPP TR 36.889 – 7.2.1.6
Wireless Simulator Evolution (WiSE)

- ITRI developed 4G/5G System Level Simulator
  - Support standard 3GPP eNB/Cell deployments with 1000+ UEs under different mobility scenarios (such as Rural / Urban / Indoor etc.)
  - Calibrated system level simulation results

Cell coverage and large-scale SINR [dB] (2500, 2500)

![Graph showing UE Throughput CDF results from various sources]
Observations from LAA Evaluation Results

- Evaluation results of an LAA network operating a category 4 DL LBT scheme showed that it can operate without impacting Wi-Fi more than an equivalent Wi-Fi network (*).
- LAA can coexist with WiFi and outperform it in terms of spectral efficiency.

Source: ITRI (R1-154369, R1-155555)

*See detail in 3GPP TR 36.889 – 8.3.1
Summary

- LTE + Unlicensed can increase spectral efficiency
  - Improve Coverage
  - Reduce Latency
  - Enhance Peak Data Rate
- LAA and WiFi Coexistence
  - Toward being friendly and fair in unlicensed band
  - Evaluation results showed that LAA can operate without impacting Wi-Fi more than an equivalent Wi-Fi network.
Thank You!!