LTE-WLAN Aggregation (LWA), RAN Controlled LTE-WLAN Interworking (RCLWI), and LTE/WLAN Radio Level Integration with IPsec Tunnel (LWIP) in 3GPP Release 13

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Agenda

- Background
- LWA
- RCLWI
- LWIP
Background

• Growing traffic demand
• Licensed + unlicensed
  – Rel-12: LTE/WLAN Interworking
  – Rel-13: LTE-WLAN Radio Level Integration and Interworking enhancement
  – Rel-13: LTE-WLAN Radio Level Integration support Legacy WLAN
  – Rel-13: Licensed-Assisted Access using LTE
Objective of SI/WI

- LTE-WLAN Aggregation should be transparent to EPC.
- Consider only WLAN nodes deployed and controlled by operators and their partners.
- Solutions for Aggregation should build upon Release-12 LTE Dual Connectivity architecture.
- Improve mobility to/from WLAN while minimizing the core network signalling.
- Improve network control of WLAN offload.
- Improve overall UE throughput by using both cellular and WLAN access.
Dual Connectivity

- Increase UE throughput especially for cell edge UEs
- Mobility robustness enhancement
- Reducing signaling overhead towards the CN due to frequent handover

Source: TS 36.842
Non-collocated LWA Overall Architecture

MME / S-GW

eNB: E-UTRAN NodeB

WT: WLAN Termination

Source: TS 36.300
Establish a UE context at the WT in order to provide WLAN resources to the UE.

1. WT Addition Request
2. WT Addition Request Acknowledge
3. RRCConnectionReconfiguration
4. RRCConnectionReconfigurationComplete
5. UE starts using the new LWA configuration and performs WLAN association
6. WT Association Confirmation
7. WLANConnectionStatusReport
Polled or periodical PDCP Status Reporting

PDCP Control PDU format for PDCCP status report

<table>
<thead>
<tr>
<th>D/C</th>
<th>PDU Type</th>
<th>FMS</th>
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<tbody>
<tr>
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<td>FMS (cont.)</td>
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<td>Bitmap₁ (optional)</td>
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<td>Bitmapₙ (optional)</td>
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- First Missing PDCP SN (FMS)
- Highest successfully Received PDCP SN on WLAN link (HRW)
- Number of Missing PDCP PDUs (NMP)

PDCP Control PDU format for LWA status report

<table>
<thead>
<tr>
<th>D/C</th>
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<th>FMS</th>
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<td>FMS (cont.)</td>
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<td>HRW</td>
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<td>HRW (cont.)</td>
<td>NMP</td>
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<td>NMP (cont.)</td>
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</tbody>
</table>

Oct 1
Oct 2
Oct 3
Oct 4
Oct 5
Measurement

• Measurement report triggering
  – WLAN becomes better than a threshold
  – All WLAN inside WLAN mobility set becomes worse than threshold1 and a WLAN outside WLAN mobility set becomes better than threshold2
  – All WLAN inside WLAN mobility set becomes worse than a threshold

• Measurement information elements
  – MeasObjectToAddModList
  – MeasObjectWLAN
  – MeasResults
  – QuantityConfig
  – ReportConfigInterRAT
  – WLAN-CarrierInfo
  – WLAN-Status
WLAN Connection Status Reporting

- T351 Expiry (WLAN Connection Attempt Timeout)
- WLAN Status Monitoring
  - successfulAssociation,
  - failureWlanRadioLink,
  - failureWlanUnavailable,
  - failureTimeout
UE Capabilities

• wlan-MeasurementReporting-r13
• supportedBandListWLAN
• LWA parameters
  – lwa-r13
  – lwa-SplitBearer-r13
  – lwa-BufferSize-r13
• RCLWI parameters
  – rclwi-r13
37.834 Study on WLAN - 3GPP radio interworking (r12)

Sol. 1

- UE
- eNB/RNC
- WLAN AP

broadcast signalling (and optionally dedicated signalling)

Sol. 2

- UE
- eNB/RNC
- WLAN AP

1. Parameters
2. Steer traffic to/from WLAN according to RAN rule and ANDSF

dedicated and/or broadcast signalling

dedicated traffic steering commands, potentially based also on WLAN measurements

Sol. 3

- UE
- eNB/RNC
- WLAN AP

1. Measurement control
2. Measurement report
3. Steering command
4. UE Ack/Response

Event trigger

Steer traffic to/from WLAN

RRC connection request

ANDSF policies including RAN/WLAN parameters

(1) ANDSF thresholds

(2) RAN thresholds

LTE

WLAN

ANDSF Server

UE

eNB

WLAN AP
RCLWI

- Share the same architecture as LWA but no LWA specific functions
- Measurement and WLAN mobility set
- Steering command
- UE idle mode behavior
steeringCommandWLAN-r13

1. RRCConnectionReconfiguration
2. RRCConnectionReconfigurationComplete
3. UE starts using the new RCLWI configuration and performs WLAN association
4. WLANConnectionStatusReport

Traffic steering from E-UTRAN to WLAN procedure (success case)

Traffic steering from WLAN to E-UTRAN procedure
LTE-WLAN RAN Level Integration supporting legacy WLAN

started: Sep. 15; target: Mar 15; WID: RP-151615

- **Objective of SI/WI**
  - define a RAN based LTE-WLAN aggregation solution at a bearer level which addresses the legacy WLAN deployment scenarios.
    - without need for modifications to the deployed WLAN node
  - Specify RAN and WLAN protocol architecture of LTE-WLAN RAN level integration at the UE and RAN side based on IPsec tunneling above PDCP protocol layer
  - Specify RRC enhancements for establishing the tunnel between eNB and UE, including required signalling of parameters to the UE
  - Initiation of WLAN aggregation and the IPsec tunnel establishment at the UE is triggered by the eNB via RRC.
LWIP Overall Architecture

[Diagram showing the overall architecture of LWIP, including MME/S-GW connections, S1, eNB, LWIP-SeGW, UE, and WLAN.]
LWIP Protocol Architecture

Diagram shows the protocol layers from UE to eNB and from eNB to WLAN, including:
- **PHY**
- **MAC**
- **RLC**
- **PDCP**
- **RRC**
- **NAS**

Key points:
- User plane IP Packets from DRB
- LWIP Tunnel
- User plane IP Packets from MME
- IPsec Tunnel
- LWIP-IPsec Tunnel
- LWIP Tunnel
LWIP Tunnel for data bearer setup procedure

1. RRCConnectionReconfiguration
2. RRCConnectionReconfigurationComplete
3. WLAN Measurements
4. RRCConnectionReconfiguration
5. RRCConnectionReconfigurationComplete
6. WLAN association (if not already associated)
7. WLANConnectionStatusReport (Association Confirmation)
8. RRCConnectionReconfiguration
9. RRCConnectionReconfigurationComplete

LWIP Tunnel between UE and eNB via WLAN

WLAN mobility set

parameters to establish IPSec tunnel
References and affected technical specifications

- **36.300** Overall description; Stage 2
  - CR0809 LTE WLAN Radio Core
  - CR0839 LWIP Tunnel Clarifications

- **36.304** UE procedures in idle mode
  - RAN-assisted WLAN interworking in idle mode

- **36.306** UE Capability
  - CR0336 Total Layer2 buffer size for LWA capable UE
  - CR0337 Introduction LWA and RCLWI UE capabilities

- **36.323** PDCP specification
  - CR0158 LWA PDCP status report

- **36.331** RRC; Protocol specification
  - CR2008 Introduction LWA
  - CR2051 Introduction RCLWI
  - CR2054 LWIP

- **36.360** LWAAP

- **24.302** Access to the EPC via non-3GPP access networks; Stage 3
thank you