FEATURE GUIDE

Ruckus LTE AP Feature Guide Release SC 02.03.00.0022

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About this Document

Purpose

The document provides information on new features added to Ruckus LTE AP SC Release 2.3 and previous releases.

Intended Audience

The document is intended for end-users to install and use Ruckus LTE AP.

Abbreviations

The following table describes the abbreviations used in the document.

Abbreviation	Description
ACS	Auto-Configuration Server (TR-069 server)
AP	Access Point
CA	Carrier Aggregation or Certificate Authority (part of a PKI)
CBRS	Citizen Broadband Radio Service
CMP	Certificate Management Protocol
CRL	Certificate Revocation List
DB	Database
DHCP	Dynamic Host Configuration Protocol
DL	Downlink
DNS	Domain Name System
EFS	Encrypted File System
EPC	Evolved Packet Core
FCC	Federal Communications Commission
FQDN	Fully Qualified Domain Name
GPS	Global Positioning System
GUI	Graphic User Interface
HO	Handover
HTTPS	HyperText Transport Protocol Secure
LLDP	Link Layer Discovery Protocol
KPI	Key Performance Indicator
MAC	Media Access Control
MME	Mobility Management Entity

Abbreviation	Description
MQTT	Message Queuing Telemetry Transport
MSL	Message Service Layer
NL	Network Listen (to macrocell)
NTP	Network Time Protocol
OCSP	Online Certificate Status Protocol
PKI	Public key Infrastructure
PTP	Precision Timing Protocol
RF	Radio Frequency
RRC	Radio Resource Control
SAS	Spectrum Access System
SCTP	Stream Control Transmission Protocol
SFS	Secure File System
TLS	Transport Layer Security
URL	Uniform Resource Locator

Ruckus LTE AP Overview

High Level Design

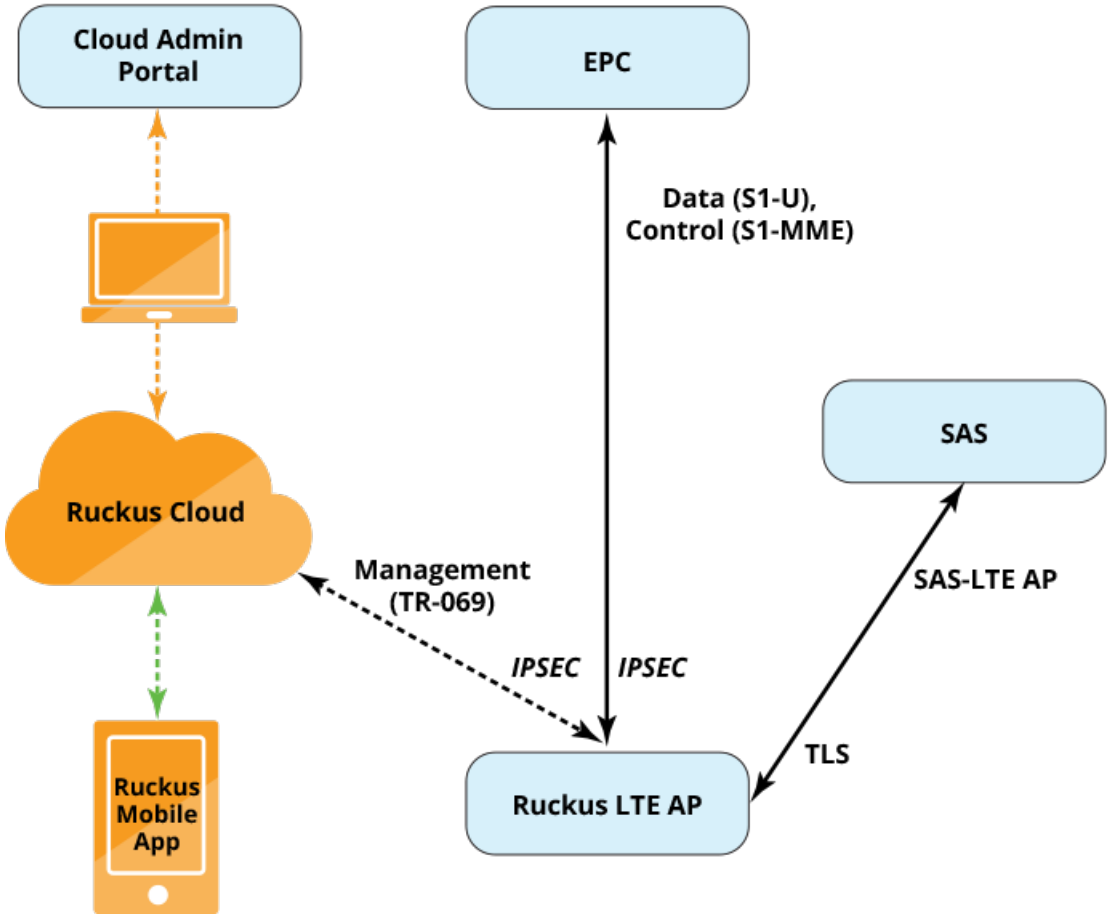
Ruckus offers LTE service via Access Point also known as Ruckus LTE AP. These are TD-LTE devices that operate in Band 48 - CBRS Band. LTE APs ship with default configuration to communicate with Ruckus Cloud as soon as these are powered up and have internet connectivity.

Ruckus Cloud is a web portal (as well as a Mobile App) which can be used to design and configure a complete LTE network which includes LTE AP configuration for GPS location, PTP timing, EPC details, SAS information, and any other details.

LTE AP obtains the above firmware updates (if available) when it powers up and connects with Ruckus Cloud.

The following figure shows connectivity of the management, control, and data interfaces between Ruckus LTE AP and other network elements.

FIGURE 1 Ruckus OpenG Solution

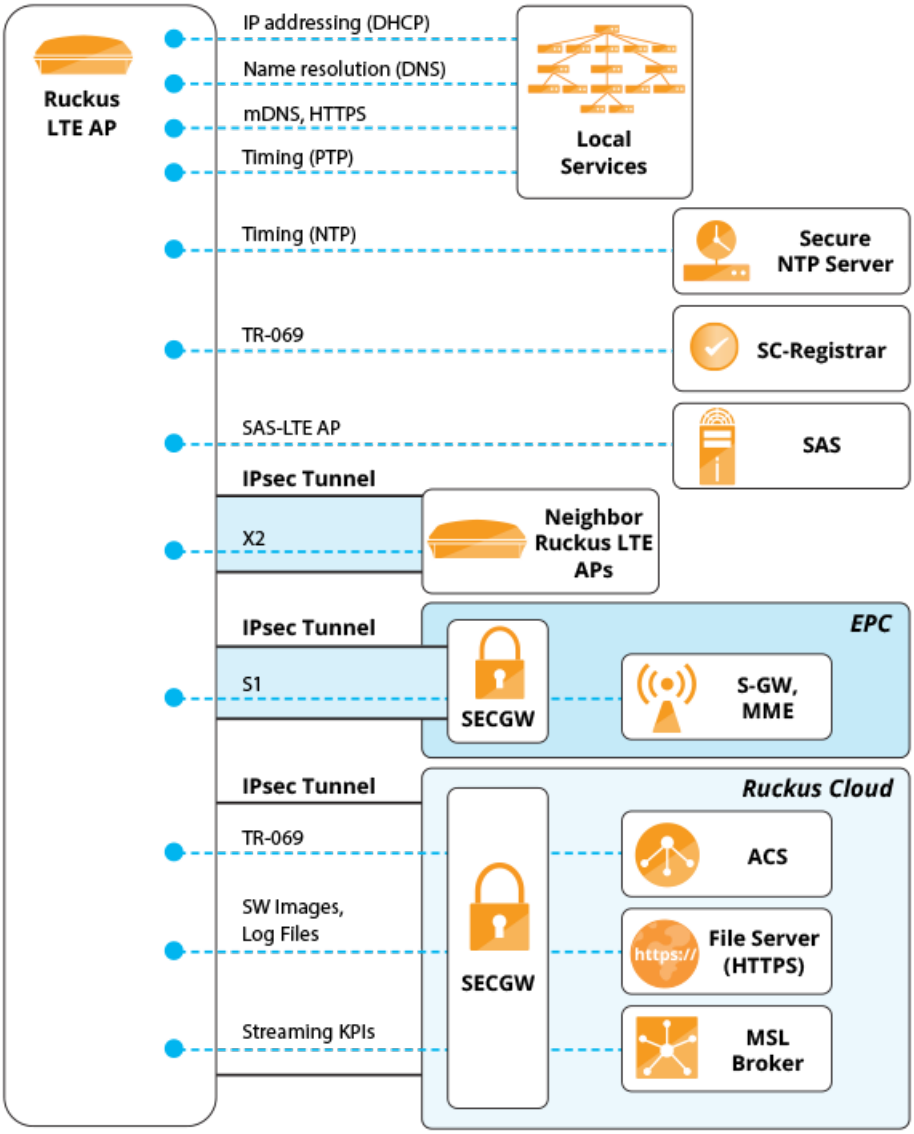


Each Ruckus LTE AP has a separate management as well as control/data interface for traffic. For secure communications, it is highly recommended that both interfaces be configured to communicate via security gateways over IPsec.

Ruckus LTE AP Interfaces

Following figure illustrates the interfaces of Ruckus LTE AP.

FIGURE 2 Ruckus LTE AP Interfaces



Following interfaces are represented in the figure.

- **Local Services:** There are for local services.
  - DHCP server, which allocates a local IPv4 address.

    NOTE
    All LTE APs within a venue should be L3-reachable and can be on the same VLAN.

  - DNS for name resolution.
  - NTP for initial synchronization of the LTE APs date/time function.

    NOTE
    NTP is required for checking the validity interval on SecGW server certificates.

  - PTP: PTP interface is outside the IPsec tunnel, so it is possible for an attacker to try to disrupt this interface. The worst damage an attacker could achieve is a DoS attack, resulting in poor UX (the unit transfers to its OCXO for timing and then shuts down its LTE radio after expiry of the hold-up time).
- **IPsec Tunnels:** There are three or more IPsec tunnels. The outer source IP address of the datagrams transmitted by LTE APs is the locally allocated IPv4 address.

  NOTE
  If an LTE AP is behind a NAT firewall, its outer source IP will be the public IP address of the network in case a packet leaves NAT environment.

  - **IPsec tunnel to Ruckus Cloud:** The inner IP [source] address used by LTE AP for transmitting datagrams is allocated by the IKE function of the IPsec server. The outer destination address of the datagram transmitted by LTE AP is the public IP address of the IPsec server. Inside this tunnel, the following three separate data streams are present:
    - TR-069 towards the ACS for configuration and notifications.
    - HTTP towards the File Server for SW image download and LTE AP log file upload.
    - MSL towards the MSL Broker for streaming KPIs.
  - **IPsec tunnel to EPC:** IPsec tunnel to EPC transports the S1 interface. The inner IP [source] address used by LTE AP for transmitting datagrams is allocated by IKE function of EPC's SecGW.
  - **IPsec tunnel to neighbor LTE APs:** Zero or more IPsec tunnels to neighbor LTE APs (in the same venue), transporting the X2 interface. The inner IP [source] address used by LTE AP for transmitting datagrams is the one allocated by IKE function of the EPC's SecGW.
    - X2 interfaces uses tunnel mode. LTE APs outer IP address of the X2 tunnel is local address and is routable within the LAN.
    - LTE APs discover their neighbors' inner IP address via the S1AP interface.

Factory Defaults

All units when shipped include a base image that allows Ruckus LTE AP to:

- Communicate with sc-rgistrar.rucksuwireless.com that implements i-HeMS functionality and TR-069 protocol. LTE AP will receive its s-SecGW and s-HeMS FQDNs from the SC Registrar. LTE AP shall be capable of mutually authenticating with the SC Registrar.
- Includes two X.509v3 client certificates (primary and backup) issued by Ruckus CA as its manufactured identity. These client certificates are referred to as the manufacturing certificate(s). The manufacturing certificate shall contain LTE AP's serial number and URL of the OCSP server that can supply revocation information.
- Includes the root CA certificate of all the trusted CA and Ruckus CA Root certificates in its read-only secure file system. The certificates are used for validating various server certificates used in the Aztec solution. LTE AP uses the root CA certificate to validate the IPsec server certificate.

When LTE APs connect to the Cloud ACS, LTE APs request to download the primary firmware image (LTE radio firmware) and to reboot while setting the new image as primary.

The Reset button on LTE AP must be long pressed for at least 6 secs to cause a factory reset. Factory reset clears (removes) all the LTE AP's configuration and causes LTE AP to reboot and sets its factory image as primary.

NOTE

- The time duration of 6 secs is the same value as used on Wi-Fi APs.
- The factory image does not include radio functionality.

Feature Overview

Feature introduced in SC 2.3

- Support for Venue profiles

For more information, refer Feature introduced in SC 2.3 on page 13.

Features introduced in SC 2.2

- Carrier Aggregation
- FQDN Support for MME

For more information, refer Features introduced in SC 2.2 on page 15.

Features introduced in SC 2.1

- Alarm Enhancements
- Software Download on Low Bandwidth
- Auto-EARFCN
- LLDP PoE based Power Negotiation
- IPv6 inside IPv4
- IPv4 opt 124/125 and Vendor Extensions

For more information, refer Features introduced in SC 2.1 on page 17.

Features introduced in SC 2.0.2

- GPB Enhancements for GPBS
- LED EPC Changes
- 64 UEs Support
- Q7.7 Integration
- Ruckus Q410 LTE Access Point

For more information, refer Features Introduced in SC 2.0.2 on page 19.

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- Ruckus LTE AP LED Display
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For more information, refer Features Introduced in SC 2.0.1 on page 21.

Feature introduced in SC 2.3

Support for Venue Profiles

With Release 2.3, support for Venue profiles on LTE AP management is available.

Features introduced in SC 2.2

Carrier Aggregation

Carrier Aggregation (CA) is an LTE Advanced feature that provides an increased bandwidth and throughput to an LTE CA-capable UE in downlink (DL) mode only. The feature is enabled on CA-capable UE (CAT 6 onwards).

In a CA cell, Carrier-1 is termed as primary serving cell (PCell) and carrier-2 is termed as secondary serving cell (SCell). In CA-SDL configuration, LTE AP aggregates only SCell-DL along with PCell-DL and uses it for DL transmission to a CA-capable UE.

LTE AP has a single S1 and X2 interface in CA-SDL case and PCell is responsible for controlling data delivery over SI and X2 interface, i.e. there is no interface existing between SCell and EPC or SCell and neighbor AP. LTE AP has same UL/DL TDD configuration for both PCell and SCell.

In current scope, the following bandwidth combinations are supported.

- For CA-SDL configuration,
  - 20+20 MHz
- For non-CA cells,
  - 20 MHz
  - 10 MHz

Unless two or more than two 20 MHz channels are available, PCell alone will be set up.

FQDN support for MME

Ruckus LTE AP accepts Mobility Management Entity (MME) information in the Fully Qualified Domain Name (FQDN) format.

Features introduced in SC 2.1

Alarm Enhancements

In Ruckus LTE Release SC 2.1, RRC SCTP Association Failure alarm is raised in case of Admin State Down. The alarm gets cleared when LTE_ENB_SOM brings up Admin State of LTE Stack after LTE_ENB_SOM admin state is set to "true".

Software Download on Low Bandwidth

Release SC 2.1 supports low bandwidth connection for downloading the software package. LTE AP estimates download speed and in case of low internet speed, AP retries firmware download to accommodate low speed.

Auto-EARFCN

Release SC 2.1 supports Auto-EARFCN feature that enables Ruckus LTE AP to auto-detect inter-frequency carriers (NL Scan based), add inter-frequency neighbors and transmit SIB 5 depending on Spectrum Inquiry.

Once neighbor disappears, frequency will be deleted after a given timer.

LLDP Based PoE Power Negotiation

Ruckus AP switches are capable of negotiating power using Link Layer Discovery Protocol (LLDP). LLDP is a layer 2 network discovery protocol that enables a station to advertise its capabilities to, and to discover, other LLDP-enabled stations in the same 802 LAN segments. Ruckus LTE AP informs its capabilities and negotiates power requirements with a switch using LLDP messages. Based on power requirements for operation, LTE AP is classified under Class 4 Power class.

If the power negotiation results in Power class less than 4, LTE AP raises an alarm indicating power negotiation failure.

IPv6 inside IPv4

Release SC 2.1 supports IPv4 address/FQDN for EPC SecGW. EPC SecGW allocates IP address to the tunnel established by LTE AP that can either be IPv4 or IPv6 address. LTE AP accepts either IPv4 or IPv6 address allocations for the inner tunnel IP for EPC interface.

IPv4 opt 124/125 and Vendor Extensions

In Release SC 2.1, LTE AP sends the vendor class option 60 to IPv4-based DHCP server in the enterprise. It sends "ARRIS" as the vendor class.

64 UEs Support

Release SC 2.1 supports 64 RRCs connected UEs simultaneously. Data transfer can be done on 64 UEs at the same time.

Features Introduced in SC 2.0.2

GPB Enhancements for GPBS

In Release SC 2.0.2, enhancements have been made to identify LTE APs that can see GPS satellites and report related KPIs.

LTE APs can update GPB files through rksCLI instead of modifying RPM keys.

LED-EPC Changes

In Release SC 2.0.2, EPC LED on Access Point (AP) is set to OFF when S1 is terminated when disabling AP via Cloud.

QC 7.7 Integration

QualComm 7.7 version is integrated with Release SC 2.0.2.

Ruckus Q410 LTE Access Point

Q410 is an indoor small cell supporting B48 LTE band (CBRS 3.55 - 3.7 GHz) with Network Listen features. Q410 improves mobile coverage and capacity inside buildings. Q410 utilizes shared spectrum on CBRS band and enables venues to deploy an LTE network with the simplicity of Wi-Fi.
Q410 contain the WGR7640 GPS receiver from Qualcomm for synchronization and timing purposes.

Alarms and Events

With release SC 2.0.2, LTE AP sends the total number of UEs in use to Cloud. Cloud displays these numbers on its user interface.

Features Introduced in SC 2.0.1

RSC LED Display

RSC LED display facilitates easy troubleshooting and provides an indication of the RSC phase to connect back to Ruckus Cloud. RSC LED also displays additional state of SYNC LED to indicate the status of GPS signal for being a potential PTP Master.

The following table lists RSC LED behavior.

TABLE 1 RSC LED Behavior

LED Label	LED Color/Behavior
PWR	**Off:** RSC is not powered. **Red:** Boot up in process. LED shall remain red if RSC does not successfully boot and begin operation. **Slow-flashing green:** RSC does not have a routable IP address (IP address has not been allocated from a DHCP server nor manually assigned). **Green:** RSC is up.
EMS	**Off:** RSC is not being managed by an EMS*. **Slow-flashing green:** RSC is unable to communicate with the EMS' SecGW. **Green:** RSC is being managed by the EMS.

TABLE 1 RSC LED Behavior (continued)

LED Label	LED Color/Behavior
EPC	**Off:** RSC has not been configured with EPC connectivity information. **Slow-flashing green:** RSC is unable to connect with the EPC. **Green:** RSC is connected to the EPC.
SYNC	**Off:** When a potential PTP Master (which turned SOLID AMBER) has not been able to achieve GPS lock. Or when an RSC configured as a PTP Slave is not able to synchronize to a PTP Master, whose IP address has been configured (unicast) or discover and synchronize with a PTP Master (multicast). **Slow-flashing Green:** Not sync'd and the RSC is not receiving a GPS signal, a macrocell signal (NL) or a PTP signal (only in case of Holdover). **Solid AMBER:** For a RSC, configured with GNSS sync source (potential PTP Master), when it is able to see at least 2 GPS Satellites but GPS lock still not acquired. For a RSC configured with PTP as sync source and with unicast address of the PTP Master (so acts as a PTP Slave) but which has not yet acquired sync. This LED is used only for the Manual Assisted PTP Master Selection. For automatic PTP Master selection, fast-flashing green is used for SYNC LED to indicate sync acquiring state. **Green:** Sync'd.
LTE	**Off:** LTE transmitter is disabled. **Amber:** One or more LTE carriers are up, no UEs are attached. **Green:** One or more LTE carriers are up, one or more UEs are attached.

*EMS refers to Ruckus Cloud.

Cloud Controller Discovery

When Ruckus LTE AP is powered up for the first time and LTE AP serial number is added on Ruckus Cloud, AP tries to discover SCR to obtain Ruckus Cloud configuration. After contact with Ruckus Cloud, AP obtains new Firmware images and configuration.

Zero Touch Configuration

Ruckus LTE AP supports zero touch configuration where you can discover and deploy new LTE AP units without user intervention when new units are presented in a valid configuration.

Firmware Download

TR-069 provides two RPCs to download firmware, Download and ScheduleDownload. However, both of these RPCs require the CPE to download and install new firmware, which works effectively for installations having a single RSC. But for venues which have deployed multiple RSCs, ACS is required to request every RSC in a venue to download the new firmware version but not to re-boot RSC. Once ACS has confirmed that all RSCs in a venue have downloaded the new firmware, ACS can then issue a Reboot command towards each RSC to ensure that all RSCs in a given venue are always operating on the same firmware version.

When RSC contacts ACS, RSC should report the firmware versions currently residing in its flash storage. As a result, ACS will not have to schedule a firmware download in cases where RSC already has the requisite firmware images. This optimization is helpful to reduce the RSC's unavailability subsequent to a reboot or factory reset.

NOTE
The optimization helps in time reduction as RSC will not download firmware that it already has.

Alarms and Events

LTE AP supports reporting of alarms and events towards Ruckus Cloud for fault/event triggered on LTE AP.

Logging

Ruckus LTE APs send events to ACS via TR-069 asynchronous notifications. A Log Shipper installed on the ACS product forwards all these events to the Logging Subsystem. Kibana can be used to query Elastic Search (the "E" in ELK) for stored events.

KPI Streaming

Ruckus LTE AP streams in near real-time KPI statistics to Ruckus Cloud. Counters are streamed by LTE AP once every15 minutes towards Ruckus Cloud.

Ruckus Cloud provides the following graphs/analytics from underlying counters generated by LTE AP.

- LTE AP Traffic Volume
- LTE AP throughput
- RRC, ERAB Success Rate
- Drop Call Rate
- Handover Success Rate
- Cell Availability
- SAS Availability
- Timing Sync performance

Online Configuration

You can perform the following configuration changes without requiring a reboot:

- RF Channel
- Transmit Output Power
- AP Name
- Coordinates
- Timing Source
- VLAN for management and PTP
- PLMN-ID

The following configuration changes will require a reboot:

- RF Bandwidth
- VLAN for EPC

RucKPI

RucKPI is a GUI interface for viewing visual display of KPI/statistics from all RSCs across a venue. RucKPI GUI works on Jasper server running on an independent server. It runs as an MQTT subscriber and will subscribe for KPIs being streamed from RSC (acting as MQTT publisher). Once the KPIs from RSCs are captured via RucKPI, it populates the KPIs in postgres database configured on the same server.

For installing RucKPI, perform the following steps:

1. Install jasper server
2. Import postgres setting
3. Configure DB
4. Start data collection scripts

The RucKPI visualization GUI is accessed through a web URL.

The URL for accessing KPI visualization GUI is **http://<serverip>:8080/jasperserver**.

For example: `http://172.19.61.42:8080/jasperserve`.

For more information regarding RucKPI, refer KPI Visualization Tool User Manual available at https://jira-wiki.ruckuswireless.com/display/aztec/RucKPI.

TDD Configuration

Ruckus LTE AP supports TDD and FDD duplex mode. A TDD configuration for a LTE-TDD deployment is a combination of a UL/DL configuration and an associated SSF configuration. In TDD system, a single frequency is shared in time domain between Uplink (UL) and Downlink (DL).

TDD duplex mode needs to switch transmission from DL to UL and UL to DL, so special subframe is required for switching the transmission from DL to UL. LTE AP can support UL-DL configuration 0-6 and special subframe configuration 0-8. For LTE AP, default configuration is 1 and SSF-4.

TABLE 2 Expected TDD throughput results in ideal conditions

Configuration #	DL Throughput (Mbps)	UL Throughput (Mbps)
1	135	19

10 MHz and 20 MHz Bandwidths

Ruckus LTE AP supports 10 MHz and 20 MHz bandwidth configuration. By default, bandwidth configuration is 20 MHz.

LTE AP will use 10 MHz or 20 MHz depending on the bandwidth allocated by SAS.

NOTE
LTE AP supports bandwidth switch from 10 MHz to 20 MHz and vice versa (AP reboot is required).

Inter-Frequency and Intra-Frequency Handovers based on X2 and S1

Ruckus LTE AP supports inter-frequency and intra-frequency handovers based on X2 and S1 interface. In inter-frequency handover, handover occurs over other LTE nodes having different frequencies. In intra-frequency handover, UE gets handover from one LTE AP to other LTE AP having same EARFCN after meeting the handover criteria.

The feature connects mode mobility within LTE to handle the mobility of an RRC_CONNECTED user, including X2 handover and S1 handover.

The following are the handover-related functions for LTE AP behaviors, including handling of failed procedures from both source and target LTE AP standpoints:

- Measurement, including measurement events and measurement gap
- Target cell selection
- X2 or S1 selection
- X2 handover including the following stages
  - Handover preparation
  - Handover execution
  - Handover completion
- S1 handover including the following stages
  - Handover preparation
  - Handover execution
  - Handover completion
- Data forwarding

X2 is the interface between two LTE APs, serving AP and target AP. When X2 interface is present then handover is completed without Evolved Packet Core (EPC) involvement. The release of the resources at source AP is triggered by target AP.

Band 48 Support

LTE AP supporting Band 48 can operate within the entire CBRS frequency range (3550-3700) using bandwidth of 10 MHz or 20 MHz. As per FCC definition, the frequency range is divided into the following categories:

Type of Tier	Allowed Frequency Range (MHz)
Incumbent	3550-3700
PAL	3550-3650
GAA	3550-3700

In Band 48, DL/UL frequency range is 55240-56739.

ChannelFly

LTE supports ChannelFly which assists LTE AP to change frequency triggered via LTE AP itself or SAS to minimize interference due to network traffic.

ChannelFly is a useful LTE SON feature which enables LTE AP operation with minimal interruption. During ChannelFly, ongoing calls handover occurs to neighboring cells.

SAS TS v1.1

Ruckus LTE AP is SAS TS V1.1 compliant including signaling protocol and procedures for the SAS-LTE AP interface. SAS-LTE AP protocol is based on HTTPS protocol that provides transport level assurance that a message has been received by the intended recipient. During TLS exchange, mutual authentication is performed. LTE AP/Domain proxy initiating the TLS connection authenticates SAS, and SAS authenticates LTE AP/Domain proxy. An LTE AP or Domain Proxy which is unable to successfully authenticate a SAS aborts the TLS connection establishment procedure. During TLS message exchange, LTE AP/Domain Proxy provides its client certificate to SAS. A SAS which is unable to successfully authenticate an LTE AP or Domain Proxy aborts the TLS connection establishment procedure. After successful authentication, LTE AP/Domain Proxy and SAS negotiates a cipher suite to use for encrypting all communications between the two entities.

The feature tests the interoperatability of LTE AP with multiple SAS vendors such as Federated Wireless, Sony, and Google.

DHCP-based IPv4 Allocation

Ruckus LTE AP supports IP allocation for LTE AP units using DHCP server. DHCP server is used to retrieve IP address related information including IP address, IP subnet, default router's IP address, DNS server IP address(es), and local domain name.

VLAN Configuration

Ruckus LTE AP supports use of 0 to 3 VLANs inclusive.

> **NOTE**
> When more than 1 VLAN is configured on an LTE AP, the LTE AP supports the use of multiple IP addresses (one per VLAN).

The following VLAN configurations are supported.

- Configuration #0: No VLANs are used (this is an 802.1D network); therefore all interfaces use untagged frames or priority-tagged frames.
- VLAN Configuration #1: A single VLAN is used; therefore all LTE AP internal services use the same VLAN ID. The following requirements apply:
  - This VLAN is the native VLAN (i.e., untagged VLAN).
  - The default (i.e., factory state) VLAN ID is set to 1.
  - This configuration is LTE AP's default configuration, which is established during boot up if LTE AP is in factory state.
- VLAN Configuration #2: Two VLANs are used as follows:
  - VLAN ID #1: The management VLAN (untagged VLAN) includes DHCP, DNS, mDNS, HTTP/HTTPS, NTP, OCSP, TR-096 traffic, the IPsec connection to the management cloud's EPC (in Aztec-v1.1, this is a test configuration), and X2 IPsec connections.
  - VLAN ID #2: PTP traffic.
- VLAN Configuration #3: Two VLANs are used as follows:
  - VLAN ID #1: The management VLAN (untagged VLAN) includes DHCP, DNS, mDNS, HTTP/HTTPS, NTP, OCSP, and TR-096 traffic.

  - VLAN ID #2: IPsec connection to MNO's EPC, X2 IPsec connections and PTP traffic.
- VLAN Configuration #4: Three VLANs are used as follows:
  - VLAN ID #1: The management VLAN (untagged VLAN) includes DHCP, DNS, mDNS, HTTP/HTTPS, NTP, OCSP, and TR-096 traffic.
  - VLAN ID #2: IPsec connection to MNO's EPC and X2 IPsec connections.
  - VLAN ID #3: PTP traffic.

IP Security

LTE AP uses IP Security (IPSec) connection with Ruckus Cloud and EPC SecGW. LTE AP always requests for SecGW certificate and sends its certificate if requested by SecGW (Ruckus Cloud and EPC SecGW should always request for LTE AP certificate). LTE AP and SAS authenticate each other not only using the peer entity certificate and their associated cert-chain integrity and validity but also using additional entity certificate parameters.

TrustZone

TrustZone provides Trusted Execution environment for Ruckus LTE AP. Any LTE AP operation which requires trusted operation, takes place inside TrustZone.

TrustZone image is installed in LTE AP during factory provisioning and cannot be changed over-the-wire once LTE AP leaves the factory.

Secure X2

Ruckus LTE AP supports enterprise local X2 traffic routing over IPsec tunnels within the enterprise itself. LTE AP uses certificate-based mutual authentication and IP Security when connecting to another LTE AP over the X2 interface.

Multi-PKI Security

LTE AP provides multi-PKI support and supports CMPv2 procedures for enrollment to CBRS PKI and EPC SecGW

Following are the key principles for Multi-PKI architecture supported by LTE AP.

- Use of a single public-private key pair across all PKIs; this key-pair is generated and HW fused during manufacturing - generated per LTE AP serial number.
- Establishment of out-of-band trust relationship with CBRS PKI and NHN-Core PKI based on the Ruckus CA/RA issued manufacturing certificate to LTE AP.
- Use of manufacturing certificate and associated trust chain anchored in Ruckus PKI Root for CMPv2 based enrollment to CBRS PKI and NHN-Core PKI CA/RA.
- Use of certificates issued by CBRS PKI and NHN-Core PKI for mutual authentication during secure connection establishment with SAS server and NHN-Core SecGW, respectively.
- Use of Ruckus CA/RA issued certificate for mutual authentication during IPSec connection to Ruckus Cloud SecGW.
- Support of re-keying due to certificate revocation or security policy triggered through ACS.
- Use of OCSP for certificate validity verification and revocation status checking.

Secure NTP

NTP client running in an LTE AP supports NTPv4 and the Autokey protocol. As part of the Autokey exchange, client and server generate different keys needed for integrity protection of NTP's server time sync updates. This enables Ruckus LTE AP to perform time sync in a trusted manner.

> **NOTE**
> It is recommended to use NTP server and client source code from Http://www.ntp.org which supports secure NTP with Autokey.

PTP

Ruckus LTE AP can provide timing sync via PTP and can work in one of the following roles:

- PTP Master
- PTP Slave

When GPS is connected to an LTE AP, LTE AP can perform PTP Master role and can be connected to up to 32 slaves. If multiple masters are available in a cluster, the best master is selected using Best Master Clock Algorithm (BMCA).

LTE AP that does not have GPS connectivity can be configured into PTP slave mode, which communicates with PTP Master via Announce, Sync, and Delay_Resp messages.

GPS/AGPS

Ruckus LTE AP supports GPS/AGPS synchronization management with GNSS as the primary sync source. LTE AP synchronizes its clock/time to GPS.

Bonjour Support

Release SC 2.0.1 provides Bonjour support, which is used for local discovery of LTE AP whenever LTE AP is disconnected from cloud. Bonjour support is used to broadcast mDNS packets and TXT packets and as soon as the bonjour packets get broadcast, LTE AP details such as Timing Status, MAC Address, Serial No. are received. So, bonjour support is used for local discovery of LTE AP in an enterprise when it is disconnected from cloud.

Download/Upload Diagnostic-related DM Parameters Support

Upload/Download Diagnostic feature provides support for checking the statistics of uploading/downloading file/data on/from the server.

For example: On uploading a file on the server, you can check whether complete file has been uploaded, at what time data transfer started, at what time the transfer is completed.

When the diagnostic starts, some parameters must be supplied (like diagnostic state, URL etc.). On completion of the test, results for the diagnostic are populated displaying statistics of the test.

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