

LTE-U Forum:

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LTE-U CSAT Procedure TS V1.0 (2015-10)

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Foreword

This Technical Specification has been produced within the LTE-U Forum.

This document has been developed in order to improve the description of the CSAT procedures for LTE-U. Specifically:

- Improve LTE-U solution performance
- Enhance coexistence functionality by specifying CSAT parameter ranges
- More closely align with 3GPP Rel-13 LAA
- Enable support for 3GPP Rel-13 LAA migration without additional UE modifications
- Allow for good coexistence between Rel13 LAA devices and pre-Rel13 LTE-U devices

Summary of Changes:

- Define supported operating modes for LTE-U SCells
- Define LTE-U Discovery Signal and transmission
- Define MIB and SIB1 transmissions
- Define CSAT operating parameters, including minimum and maximum transmit durations
- Define carrier aggregation activation and deactivation procedure and timings
- Define CQI report/request procedures

1 Scope

The present document describes the LTE-U SCell CSAT procedures for LTE-U capable eNBs and UEs. With this specification, a single eNB shall be able to both serve LTE-U UEs and Rel-13 LAA UEs on the same unlicensed SCell using the same common signals and channels.

The objectives of the LTE-U CSAT procedure are:

- Closer alignment to 3GPP Rel-13 LAA specifications
- Improved LTE-U performance by more efficient use of medium with lower overhead of ramp-up/down subframes
- Alignment with existing 3GPP Carrier Aggregation procedures.
- More responsive to bursty traffic due to low-latency activation of the SCell for a UE

This specification defines the operating parameters for LTE-U CSAT eNBs and UEs.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- [1] “Co-existence test spec, v1.3”, LTE-U Forum
- [2] 3GPP TS 36.300, Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (Release 12)
- [3] 3GPP TS 36.331, Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification (Release 12)
- [4] 3GPP TS 36.306, Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio access capabilities (Release 12)
- [5] 3GPP TS 36.211, Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (Release 12)

3 Abbreviations

ANR	Automatic Neighbour Relations
CA	Carrier Aggregation
CGI	Cell Global Identifier
CRS	Cell-specific Reference Signal
CSAT	Carrier Sense Adaptive Transmission
DCI	Downlink Control Information
DMTC	Discovery Signal Measurement Timing Configuration
DRS	Discovery Reference Signal
eNB	evolved Node B
EPDCCH	Enhanced Physical Downlink Control Channel
LAA	Licensed-Assisted Access
LDS	LTE-U Discovery Signal
MIB	Master Information Broadcast
PCI	Physical Cell Identifier
PDCCH	Physical Downlink Control Channel
PDSCH	Physical Downlink Shared Channel
PLMNID	Public Land Mobile Network Identity
RRC	Radio Resource Control
SI	System Information

SIB	System Information Broadcast
SCell	Secondary Cell (in this document: specifically a LTE-U Secondary Cell)
UE	User Equipment

4 Background

For the LTE-U CSAT procedure, the following definition of SCell states will be used.

- SCell ON-state: SCell is transmitting according to 3GPP LTE Rel-10 or later releases specification or SCell is transmitting LTE-U Discovery Signal (LDS)
- SCell OFF-state: SCell ceases all transmissions, including sync signal, SI signals, CRS, and etc.

5 LTE-U CSAT

5.1 LTE-U CSAT Procedure Overview

In order to provide good co-existence for other nodes operating on the same unlicensed channel, the LTE-U small cell performs ON/OFF transmissions based on the CSAT procedure described in this document. At a high level:

- LTE-U UE shall detect the presence of DL subframe on SCell (SCell ON-state) while SCell in unlicensed spectrum is activated.
- LTE-U Discovery Signal (LDS) is periodically broadcast by the LTE-U eNB according to the DMTC configuration in order to provide UEs the opportunity to perform SCell measurements. UEs are not required to be activated for an LTE-U SCell in order to demodulate and perform measurements based on the LDS.
- Short CSAT ON durations (20 ms or less) shall be used in order to provide frequent channel access opportunities for other users of the channel.

LTE-U CSAT is based on 3GPP Rel-12 and earlier specifications with the following attributes for SCells in unlicensed spectrum:

- Frame Structure type 1 (FDD) shall only be used
- Only Self scheduling shall be used, i.e., no cross carrier scheduling
- CRS based Transmission Modes 2, 3 & 4 shall only be used
- Only PDCCH shall be used as a transport for DCI, i.e., no EPDCCH
- User data shall be transmitted in full subframes only. A partial subframe may be transmitted at the beginning of SCell ON-state.
- SCell transmissions shall stop after the transmission of a full subframe, i.e. the SCell transmission shall not stop before the end of a full subframe.
- Connected mode DRX shall be supported
- SCell inter- & intra-frequency measurements follow 3GPP
- SCell Activation/Deactivation follows existing 3GPP Rel-10 CA procedures

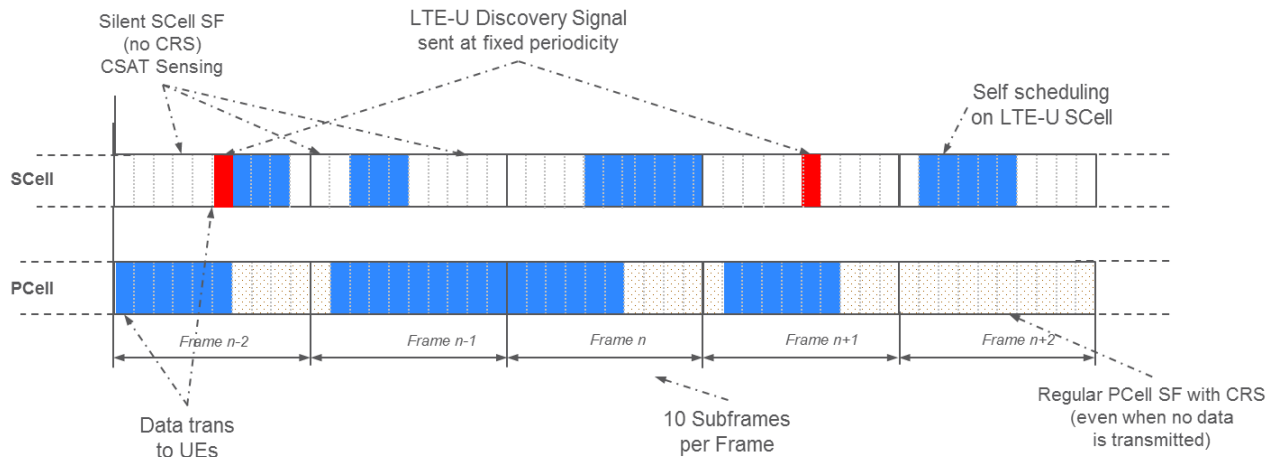


Figure 1: Illustration of LTE-U CSAT

The following functionality is added with respect to 3GPP Rel-10:

1. Short SCell transmission bursts
2. UE capability to perform blind LTE waveform detection
3. Transmission of LDS subframe
4. DMTC RRC Signalling for LDS
5. Ability to skip the transmission of MIB/SIB1

5.2 MIB and SIB Broadcasts on LTE-U SCell

MIB/SIB1 shall be transmitted on SCell when the MIB/SIB1 transmission period coincides with a SCell transmission (SCell ON-state). UE may assume that the MIB is transmitted at least once every 160ms.

MIB/SIB1 transmission on SCell is to allow the detection of transmissions from eNBs belonging to other PLMNs.

LTE-U UE shall have the ability for inter-frequency ANR for the LTE-U bands that UE supports using existing 3GPP CGI request/reporting procedures. Inter-frequency ANR functionality in non-LTE-U bands remains subject to the capability for inter-frequency ANR.

ANR procedure for LTE-U bands is shown below as an example.

- The LTE-U eNB requests UEs to perform measurements for a given frequency;
- The UEs attempt to detect LTE transmissions on the requested frequency;
- The UEs report any detected LTE transmissions including the PCI;
- The eNB request the UEs to report the CGI (i.e. PLMNID) of the previously detected LTE PCI transmission;
- The UEs report the CGI to the eNB via the CGI Report.

5.3 LTE-U Discovery Signal (LDS)

LDS allows UEs to obtain and keep SCell time and frequency alignment as well as performing SCell tracking and measurements. The LDS is transmitted on the SCell regardless of the presence of UEs configured or activated for the SCell. UE is not required to be activated for an LTE-U SCell in order to demodulate and perform measurements based on the LDS.

The LDS is constructed and transmitted as described below:

- The LDS is defined as an instance of subframe#5 with CRS/PSS/SSS and PDCCH/PDSCH (for SIB1 transmission).
- UE may assume that the LDS is transmitted at a fixed time periodicity with a fixed offset signalled in the configured DMTC as per 3GPP Rel-12 DRS RRC configuration [3]. LDS uses the RRC signalling defined for 3GPP Rel-12 DRS [3]. Rel-12 DRS RRC configuration allows periodicities of 40ms, 80ms or 160ms.

The UE is not expected to perform inter-frequency measurements outside a configured measurement gap.

The UE is not expected to perform intra-frequency measurements outside the configured DMTC window.

5.3.1 LDS comparison with Rel-12 DRS

With respect to the 3GPP Rel-12 definition of the DRS, the LDS is an instance of a regular subframe#5 and as such it has the following characteristics which differ from the DRS:

1. The LDS is transmitted from all CRS ports
2. The LDS is only transmitted at subframe#5 occasions
3. The LDS does not contain CSI-RS
4. The LDS includes PDCCH and PDSCH for SIB1 transmission
5. The LDS subframe may include unicast PDCCH and PDSCH

6 Secondary Cell Procedures

The SCell configuration and activation procedure follows 3GPP Rel-10 specifications and capabilities. While SCell is activated, UE shall expect SCell ON-state and OFF-state from eNB, i.e. UE activation may span multiple SCell ON-state and OFF-state cycles.

UE shall attempt to monitor the DL subframes on a subframe basis at least from the 8th subframe after the subframe including the activation MAC CE CMD.

In order to ensure good channel co-existence with delay sensitive transmissions from other nodes the maximum SCell ON-state duration shall not be greater than 20 ms. The minimum SCell ON-state duration shall not be less than 4 ms as long as there is data in users' buffer. Note that MIB and LDS only transmissions can be 1 ms.

The minimum SCell OFF-state duration is 1ms. The maximum SCell OFF-state duration is defined by the LDS periodicity.

If the UE is requested to report the SCell CQI (via aperiodic request), while the UE is unable to perform reliable channel measurements, for example when UE determines that SCell is OFF-state during measurements or while activation actions are still in progress, the UE shall report CQI=0.

Only aperiodic CQI requests shall be used.

Deactivation MAC CE commands are sent independently of the LTE-U SCell ON-state or OFF-state. UE shall not be required to monitor DL subframes (except LDS) after receiving the deactivation MAC CE command from the eNB.
