**3GPP TSG RAN WG1 Meeting #102-e R1-20xxxxx**

**E-Meeting, August 17 – 28, 2020**

**Agenda Item: 6.2.3**

**Source: Moderator (Huawei)**

**Title: Feature summary on LTE DL MIMO efficiency enhancement**

**Document for: Discussion and Decision**

# Introduction

Agreements and conclusions in previous meeting for the LTE DL MIMO efficiency enhancements (WI code LTE\_DL\_MIMO\_EE-Core; WID in RP-182901) are summarized in [1].

In this paper, the inputs from companies submitted to RAN1#102-e meeting ([2]-[4]) on remaining issues are summarized.

# Discussion

Issue 1: Terminology of additional SRS and trigger type 2 SRS.

* As explained in [2][3][4], the term used in 36.211 is additional SRS symbol while in 36.213 it’s trigger type 2. But it is not specified that trigger type 2 SRS corresponds to additional SRS, and it should be clarified that trigger type 0 SRS and trigger type 1 SRS correspond to periodic SRS and aperiodic SRS of basic SRS respectively.
* Proposal: Endorse one of the following text proposal

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| Text proposal to 36.213**<Unchanged parts are omitted>****8.2 UE sounding procedure**If the UE is configured with a PUCCH-SCell, the UE shall apply the procedures described in this clause for both primary PUCCH group and secondary PUCCH group unless stated otherwise* When the procedures are applied for the primary PUCCH group, the terms 'secondary cell', 'secondary cells', 'serving cell', and 'serving cells' in this clause refer to secondary cell, secondary cells, serving cell or serving cells belonging to the primary PUCCH group respectively unless stated otherwise.
* When the procedures are applied for secondary PUCCH group, the terms 'secondary cell', 'secondary cells', 'serving cell' and 'serving cells' in this clause refer to secondary cell, secondary cells (not including the PUCCH-SCell), serving cell, serving cells belonging to the secondary PUCCH group respectively unless stated otherwise. The term 'primary cell' in this clause refers to the PUCCH-SCell of the secondary PUCCH group.

A UE shall transmit Sounding Reference Symbol (SRS) on per serving cell SRS resources based on three trigger types: - trigger type 0: higher layer signalling - trigger type 1: triggering of basic sounding reference signals as defined in subclause 5.5.3 of [3], by DCI formats 0/0A/0B/4/4A/4B/1A/6-0A/6-1A for FDD, TDD, and frame structure type 3 and DCI formats 2B/2C/2D/3B for TDD, and frame structure type 3, and DCI format 7-0A/7-0B/7-1E/7-1F/7-1G for TDD if the UE is configured by higher layers for SRS triggering via DCI format 7-0A and has indicated the capability *srs-DCI7-Triggering-FS2*  and the UE is configured for SRS triggering with *srs-DCI7-TriggeringConfig* . * trigger type 2: triggering of additional sounding reference signals as defined in subclause 5.5.3 of [3], by DCI formats 0/4/1A/6-0A/6-1A for FDD and TDD, and DCI formats 2B/2C/2D/3B for TDD, and DCI format 7-0A/7-0B/7-1E/7-1F/7-1G for TDD if the UE is configured by higher layers for SRS triggering via DCI format 7-0A and has indicated the capability *srs-DCI7-Triggering-FS2* and the UE is configured for SRS triggering with *srs-DCI7-TriggeringConfig*.

**<Unchanged parts are omitted>** |

Or

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| Text proposal to 36.211 **---- Unchanged parts are omitted ----**5.5.3 Sounding reference signal Two types of sounding reference signals can be configured:- basic sounding reference signal, supporting periodic or aperiodic transmission- **additional sounding reference signal**, supporting aperiodic transmission onlyBasic SRS corresponds to either SRS trigger type 0 or type 1 in 8.2 of [4]. Additional SRS corresponds to SRS trigger type 2 in 8.2 of [4]. **---- Unchanged parts are omitted ----** |

Or

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| -------------------------- Start of proposed TP1 for TS 36.211 ------------------------------------5.5.1.5 Determining virtual cell identity for sequence generationThe definition of  depends on the type of transmission.Transmissions associated with PUSCH:-  if no value for  is configured by higher layers or if the PUSCH transmission corresponds to a Random Access Response Grant or a retransmission of the same transport block as part of the contention based random access procedure, -  otherwise.Transmissions associated with SPUCCH/PUCCH:-  if no value for  is configured by higher layers, -  otherwise.~~Basic s~~Sounding reference signal~~s~~ transmissions of types 0 and 1 as defined in 8.2 of [4]:- $n\_{ID}^{RS}=n\_{ID}^{SRS}$ if the higher-layer parameters *nSRS-Identity-Legacy* and *nSRS-Identity* both are configured, where $n\_{ID}^{SRS}$ equals the higher-layer parameter *nSRS-Identity*- $n\_{ID}^{RS}=N\_{ID}^{cell}$ otherwise.~~Additional s~~Sounding reference signal~~s~~ transmissions of type 2 as defined in 8.2 of [4]:- $n\_{ID}^{RS}=N\_{ID}^{cell}$ if no value for $n\_{ID}^{SRS}$ is configured by the higher-layer parameter *nSRS-Identity*- $n\_{ID}^{RS}=n\_{ID}^{SRS}$ otherwise.----------------------------------------------- Unchanged text omitted -------------------------------------------5.5.3 Sounding reference signal Three types of sounding reference signals can be configured as defined in 8.2 of [4]: SRS trigger type 0, SRS trigger type 1, and SRS trigger type 2.~~Two types of sounding reference signals can be configured:~~~~- basic sounding reference signal, supporting periodic or aperiodic transmission~~~~- additional sounding reference signal, supporting aperiodic transmission only~~5.5.3.1 Sequence generation5.5.3.1.1 Sequence generation for SRS trigger types 0 and 1 ~~basic SRS~~The sounding reference signal sequence  is defined by clause 5.5.1, where  is the sequence-group number defined in clause 5.5.1.3,  is the base sequence number defined in clause 5.5.1.4, and . The cyclic shift  of the sounding reference signal is given as ,where  is configured separately for periodic and each configuration of aperiodic sounding by the higher-layer parameters *cyclicShift* and *cyclicShift-ap*, respectively, for each UE and  is the number of antenna ports used for sounding reference signal transmission. The parameter  if  , otherwise . The parameter  is given by the higher layer parameter *transmissionCombNum* if configured, otherwise .5.5.3.1.2 Sequence generation for SRS trigger type 2 ~~additional SRS~~The sounding reference signal $r\_{SRS}^{(\tilde{p})}\left(n\right)$ is defined by clause 5.5.3.1.1 with the following exceptions- $n\_{SRS}^{cs}$ is given by the higher-layer parameter *additionalSRS-cyclicShift*- $N\_{ap}$ is given by the higher-layer parameter *additionalSRS-AntennaPort*- $K\_{TC}$ is given by the higher-layer parameter *additionalSRS-transmissionComb*- the function $f\_{gh}$ in clause 5.5.1.3 is given by$$f\_{gh}\left(n\_{s},l\right)=\left\{\begin{matrix}0&if group hopping is disabled\\\left(\sum\_{i=0}^{7}2^{i}c\left(8\left(n\_{s}N\_{symb}^{UL}+l\right)+i\right)\right) mod 30&if group hopping is enabled\end{matrix}\right.$$ where $l$ is the OFDM symbol index within the slot $n\_{s}$ and $N\_{symb}^{UL}$ is the number of OFDM symbols per slot- the function $v$ in clause 5.5.1.4 is given by$$v=\left\{\begin{matrix}c\left(n\_{s}N\_{symb}^{UL}+l\right)&if group hopping is disabled and sequence hopping is enabled\\0&otherwise\end{matrix}\right.$$5.5.3.2 Mapping to physical resources5.5.3.2.1 Mapping to physical resources for SRS trigger types 0 and 1 ~~basic SRS~~The sequence shall be multiplied with the amplitude scaling factor  in order to conform to the transmit power  specified in clause 5.1.3.1 in 3GPP TS 36.213 [4], and mapped in sequence starting with  to resource elements  on antenna port  according to----------------------------------------------- Unchanged text omitted -------------------------------------------5.5.3.2.2 Mapping to physical resources for SRS trigger type 2 ~~additional SRS~~An ~~additional~~ SRS of trigger type 2 spans one or more OFDM symbols in the time domain, where- the starting OFDM symbol $l\_{0}$ within the subframe is given by the higher-layer parameter *additionalSRS-startPos*;- the duration $N$ in number of OFDM symbols, including potential guard symbols, is given by the higher-layer parameter *additionalSRS-duration*;Mapping to physical resources shall be done according to clause 5.5.3.2.1 with the following exceptions:- frequency hopping between OFDM symbols is supported and if a UE is configured by higher layer parameter *additionalSRS-GuardSymbolFH*, a guard symbol is added between every frequency hop;- $n\_{SRS}=\left⌊{l}/{R}\right⌋$ where $l$ is the index of the OFDM symbol number carrying ~~additional~~ SRS of trigger type 2 within the subframe not counting guard symbol(s), and $R\in \left\{1,2,3,4,6,7,8,9,12,13\right\}$ is the repetition factor given by the higher-layer parameter *additionalSRS-RepNum*;- $B\_{SRS}$ is given by the higher-layer parameter *additionalSRS-Bandwidth*;- $b\_{hop}$ is given by the higher-layer parameter *additionalSRS-HoppingBandwidth*;- $N\_{FH}$ is the number of frequency hops for ~~additional~~ SRS of trigger type 2, derived from $N=RN\_{FH}+\left(N\_{FH}-1\right)G\_{FH}$ if antenna switching is not configured for ~~additional~~ SRS of trigger type 2, and from $N=RN\_{AS}N\_{FH}+\left(N\_{AS}-1\right)G\_{AS}+\left(N\_{FH}-1\right)G\_{FH}$ if antenna switching is configured for ~~additional~~ SRS of trigger type 2, where $R$ is the repetition factor given by the higher-layer parameter *additionalSRS-RepNum*, $N\_{AS}$ is the number of antenna switches for ~~additional~~ SRS of trigger type 2 defined in 8.2 of [4], $G\_{AS}\in \left\{0, 1\right\}$ is the guard-symbol configuration for antenna switching given by the higher-layer parameter *additionalSRS-GuardSymbolAS*, $G\_{FH}\in \left\{0, 1\right\}$ is the guard symbol configuration for frequency hopping given by the higher-layer parameter *additionalSRS-GuardSymbolFH*, and $N$ is given by the higher-layer parameter *additionalSRS-duration*;- $n\_{RRC}$ is given by the higher-layer parameter *freqDomainPosition-additionalSRS*;- $N\_{ap}$ is given by the higher-layer parameter *additionalSRS-AntennaPort*;- $n\_{SRS}^{cs}$ is given by the higher-layer parameter *additionalSRS-cyclicShift*;- $K\_{TC}$ is given by the higher-layer parameter *additionalSRS-transmissionCombNum*;- $\overbar{k}\_{TC}$ is given by the higher-layer parameter *additionalSRS-transmissionComb*.------------------------------------------- End of proposed TP 1 ---------------------------------------------------- |

Issue 2: Corrections for power control in 36.213.

* As explained in [3], there are several typos in 36.213 for power control.
* Note from Moderator: there are also errors when referring to higher layer parameters, which can be corrected as well under this issue.
* Proposal: Endorse the following text proposal to TS 36.213

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| Text proposal to 36.213**---- Unchanged parts are omitted ----**5.1.3 Sounding Reference Symbol (SRS)5.1.3.1 UE behaviourThe setting of the UE Transmit power for the SRS transmitted on subframe *i* for serving cell is defined by: for SRS transmission given trigger type 2 or for serving cell with frame structure type 2, and not configured for PUSCH/PUCCH transmission [dBm]otherwise [dBm]where - is the configured UE transmit power defined in [6] in subframe *i* for serving cell .- is semi-statically configured by higher layers for *m=0* and *m=1* for serving cell . For SRS transmission given trigger type 0 then *m=0* and for SRS transmission given trigger type 1 then *m=1*. - is the bandwidth of the SRS transmission in subframe *i* for serving cell expressed in number of resource blocks.- is the current PUSCH power control adjustment state for serving cell , see Subclause 5.1.1.1.- and are parameters as defined in Subclause 5.1.1.1 for subframe , where .- is the higher layer parameter *alpha-SRS* for SRS transmission given trigger type 0, 1, or is the higher layer parameter *alphaSRS-Add* for SRS transmission given trigger type 2, configured by higher layers for serving cell .- is a parameter composed of the sum of a component which is *p0-Nominal-PeriodicSRS,* *p0-Nominal-AperiodicSRS*, or *p0-NominalSRS-Add* provided from higher layers for *m=0,* *1* or *2* respectively, and a component which is *p0-UE-PeriodicSRS,* *p0-UE-AperiodicSRS*, or *p0-UE-SRS-Add* provided by higher layers for *m=0,* *1* or *2* respectively, for serving cell . For SRS transmission given trigger type 0 then *m=0* and for SRS transmission given trigger type 1 then *m=1* and for SRS transmission given trigger type 2 then *m=2*. **---- Unchanged parts are omitted ----** |

# Summary

To be updated.

# References

1. R1-1913596, “RAN1 agreements for DL MIMO efficiency enhancements for LTE”, Huawei, Reno, USA, November 2019.
2. R1-2005817 Corrections on additional SRS symbols Huawei, HiSilicon
3. R1-2006592 Text proposals on additional SRS symbols LG Electronics
4. R1-2006690 Maintenance on additional SRS symbols Ericsson