**3GPP TSG-RAN WG2 Meeting #116 electronic R2-21xxxxx**

**Online, Nov. 1st – Nov. 12th, 2021**

**Agenda Item: 8.2.4**

**Source: OPPO**

**Title: [Post115-e][218][R17 DCCA] TRS-based SCell activation (OPPO)**

**Document for: Discussion and decision**

# Introduction

This paper is to trigger the following email discussion TRS based SCell activation after RAN2#115e.

* [Post115-e][218][R17 DCCA] TRS-based SCell activation (OPPO)

 Scope: Discuss RAN2 impacts of TRS-based SCell activation and attempt to draft initial CRs to RRC/MAC to understand the scope.

 Intended outcome: Report + draft CR to MAC/RRC

 Deadline: Long

There are two phases for the email discussion.

* In phase 1: the open issues for TRS based SCell activation will be discussed, including scenarios, RRC configuration, MAC CE design and so on. The deadline of the email discussion phase 1 is: 19th Oct., 2021.
* In phase 2: the RRC CR and MAC CR will discussed. The deadline of the email discussion phase 1 is: 22th Oct, 2021.

**Contact Information**

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# Discussion

## ***Issue 1: Scenario for TRS based SCell activation***

Upon receiving SCell activation command in slot n, the UE shall be capable to transmit valid CSI report and apply actions related to the activation command for the SCell being activated no later than in slot $n+\frac{T\_{HARQ}+T\_{activation\\_time}+T\_{CSI\\_Reporting}}{NR slot length}$[3].

Tactivation\_time is the main contribution to SCell activation delay and the SSB periodicity will impact the Tactivation\_time a lot. The SSB periodicity can be {ms5, ms10, ms20, ms40, ms80, ms160} and usually 20ms is configured for capacity cell and ms160 is configured for coverage cell. The SSB periodicity increased the SCell activation delay. So RAN1 agree to use TRS to replace the SSB for time-frequency synchronisation for SCell activation [3].

Currently, the SCell can be activated via SCell A/D MAC CE or RRC signaling directly while SCell addition. However, RAN1 only consider MAC CE based Scell activation for fast SCell activation [3].

**Q1: Do companies agree that only MAC CE triggered SCell activation will apply TRS based SCell activation, i.e. RRC triggered SCell activation will be excluded in R17?**

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| Company | Agree?(Yes or No) | Comments |
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In R16 DCCA enhancement, the activated SCell state can be in dormancy beaviour or non-dormancy behavior, i.e. the DL active BWP is a dormant BWP or not. For MAC CE based SCell activation, when the SCell is activated from deactivated state, the BWP indicated by *firstActiveDownlinkBWP-Id* will be active BWP. However, if *firstActiveDownlinkBWP-Id* is dormant BWP, it is not clear whether the TRS can be activated or not in this case.

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| **Copy from TS 38.321 g50**1> if an SCell is configured with *sCellState* set to *activated* upon SCell configuration, or an SCell Activation/Deactivation MAC CE is received activating the SCell:2> if the SCell was deactivated prior to receiving this SCell Activation/Deactivation MAC CE; or2> if the SCell is configured with *sCellState* set to *activated* upon SCell configuration:3> if *firstActiveDownlinkBWP-Id* is not set to dormant BWP:===omit some text===3> else (i.e. *firstActiveDownlinkBWP-Id* is set to dormant BWP):4> stop the *bwp-InactivityTimer* of this Serving Cell, if running.3> activate the DL BWP and UL BWP indicated by *firstActiveDownlinkBWP-Id* and *firstActiveUplinkBWP-Id* respectively.===omit some text===== |

**Q2: Do companies agree that only when the following conditons are met, the TRS can be activated for fast SCell activation?**

**(a) The TRS for SCell activation is configured for this SCell;**

**(b) The SCell is activated from deactivated by SCell A/D MAC CE;**

**(c) The BWP indicated by *firstActiveDownlinkBWP-Id* is not dormant BWP;**

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## ***Issue 2: MAC CE design for TRS based SCell activation***

In RAN1#105e, RAN1 reached the following down-selection, i.e. option 1.1 and option 1.2, for MAC CE design. In last RAN2 meeting, three companies [1][2][3] provide following reasons to prefer option 1.1.

* Usually it is an implementation issue to transmit two MAC CEs either jointly in one PDSCH or separately in two PDSCHs. The gNB makes the decision depending on available resources and system efficiency. For Opt 1.2, RAN2 would need to add the restriction that two MAC CEs for triggering the RS need be in one PDSCH.
* the UE which receives the legacy MAC CE needs to check whether the new MAC CE for temporary RS is included or not in the same PDSCH, and then the UE follows the Rel-17 UE behaviour or the legacy UE behaviour accordingly.
* Opt 1.2 still needs to define a new MAC CE.

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| **Agreement**To trigger temporary RS for efficient activation of SCells,the contents of the triggering MAC-CE(s) in a single PDSCH provide at least the following information (explicitly or implicitly):* Whether or not temporary RS is triggered
* FFS detailed Information of temporary RS, e.g.:
	+ Resources used for triggered Temporary RS
	+ Triggering time offset of triggered Temporary RS
	+ QCL source for triggered Temporary RS
* FFS: Detailed signaling structure of the triggering MAC-CE(s) including the down-selection between the following example options and whether the decision should be made in RAN1 or RAN2
	+ Opt. 1.1: One new MAC CE for both SCell activation triggering and corresponding temporary RS triggering
	+ Opt. 1.2: One R15/16 SCell activation MAC CE for SCell activation triggering and one new MAC CE (in the same PDSCH) for corresponding temporary RS triggering
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**Q3: Do companies agree that a new MAC CE is defined to trigger both SCell activation and corresponding temporary RS, i.e. the new MAC CE includes SCell A/D part and TRS activation part?**

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In legacy R15/16 SCell A/D MAC CE, each SCell will map to one bit in MAC CE, the corresponding bit is setting to 1 means to activate the SCell, otherwise, it means deactivated the SCell. In the new MAC CE for both SCell activation/deactivation and TRS activation, it is reasonable to includes all SCell’s corresponding bit for SCell activation as legacy R15/16 SCell A/D MAC CE.

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| Figure 6.1.3.10-1/2: SCell Activation/Deactivation MAC CE of one octet/four octets |

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| 57 | SCell Activation/Deactivation (four octets) |
| 58 | SCell Activation/Deactivation (one octet) |

Two LCIDs are defined for SCell A/D MAC CE for “one octet” and “four octet” respectively. However, it is not clear how to set LCID for new MAC CE for both SCell activation and corresponding TRS activation.

**Option 1:** Define two new LCID for the new MAC CE for “one octet” SCell activation indication and “four octet” SCell activation indication respectively.

**Option 2**: (Implicit) Resue the LCID of SCell A/D MAC CE for new MAC CE, and the UE will decide the MAC CE is leagacy SCell A/D MAC CE or new MAC CE according to whether there is at least one SCell configdured with TRS for SCell activation.

**Option 3**: (Explicit) Resue the LCID of SCell A/D MAC CE for new MAC CE, and network will indicated UE that it is leagacy SCell A/D MAC CE or new MAC CE via RRC signalling.

**Q4: Which option do companies prefer to define LCID to address new MAC CE if yes to Q3?**

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In RAN1#106e, RAN1 agreed that

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| **Agreement** (containing the common part of Alt1 and Alt2 in the next agreement)*To trigger temporary RS,* * *MAC-CE at least provides the following information:*
* *temporary RSs are to be triggered on X out of Y (Y≥X) to-be-activated SCells, respectively, while no temporary RS is to be triggered on the other to-be-activated SCells.*
* *The following information can be provided by RRC for temporary RS for each SCell*
* *The number of RS bursts and the gap length between the RS bursts (Opt 2.3.3)*
* *Triggering offset of temporary RS (Opt 2.3.4)*
* *QCL information (Opt 2.3.5)*

*FFS: the maximum number of temporary RS per cell/per UE**Note: Reusing A-TRS triggering framework is not precluded.** *Information for 0, 1, or more temporary RS can be provided for each configured SCell*

**Agreement*** *For triggering temporary RS, down-select based on the following alternatives, or let RAN2 be aware the status of this discussion*
* *Alt 1: Bitmap approach in MAC-CE*
	+ - *Every Z-bit block in the bitmap corresponds to a SCell, Z>=0*
		- *A Z-bit block indicates the temporary RS [configuration index], and a value zero indicated by the bit block means no RS resource transmitted.*
		- *The to-be-activated SCell is indicated via the C values in the legacy SCell activation/de-activation MAC CE or in the new MAC-CE*
* *Alt 2: Reuse A-TRS triggering framework*
	+ - *A trigger state is indicated by the MAC-CE explicitly*
		- *The association between a trigger state and temporary RS for one or multiple SCells is configured by RRC according Rel-16 A-TRS triggering framework*
			* *~~SCell ID is configured as a part of the temporary RS configuration. Some SCell IDs derived from the trigger state triggered by the new MAC-CE may not refer to to-be-activated SCells that are indicated by the new MAC-CE or the legacy SCell activation/de-activation MAC-CE~~*
		- *FFS: The value zero of the MAC-CE indication means no temporary RS is triggered by the MAC-CE for all to-be-activated SCells*
* *Note: The down-selection targets at a RAN1 consensus on MAC-CE functionality and the list of RRC parameters for this feature. Any MAC-CE signaling design above are reference concept, its final MAC-CE signaling design is up to RAN2.*
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Based on RAN1 agreements in RAN1#106e, there are two alternatives to define the MAC CE for TRS activation part.

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| **Alternatives**  | **Comments**  | **Pros./Cons.** |
| Alt 1: Bitmap approach in MAC-CE | The MAC CE will include temporary RS index for each SCell, i.e. Z bit block. | Pros: No need of pre-confguartion in RRC signaling.Cons: The new MAC CE is needed. |
| Alt 2: Reuse A-TRS triggering framework | The MAC CE will include temporary RS trigger state index for UE, and the temporary RS trigger state index refers to the entry number in list of TRS trigger state configuration. Each state will contains each SCell’s TRS trigger state and which TRS is triggered. | Pros: Reuse A-TRS triggering framework.Cons: * the temporary RS trigger state index will be huge.
* The new MAC CE is needed.
* The RRC needs to configure the list of temporary RS trigger state. The network should ensure to configure all possible case of TRS trigger of each SCell and each TRS in one SCell.
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**Q5: Which Alternative do companies prefer for TRS activation part in the new MAC CE?**

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If Alt1 is chosen, please see the below text for Q6a.

In RAN1#105e, RAN1 agreed that the number of temporary RS bursts and TRS triggering offset are indicated in MAC CE and FFS to which field in MAC CE is used.

In RAN1#106e, RAN1 agreed that Z-bit block in the bitmap corresponds to a SCell indicate temporary configuration index will be indicated in MAC CE.

So how to indicate these information in MAC CE is not clear.

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| **Agreement**For efficient activation of a Scell (in known Scell case), at least the number of temporary RS bursts is indicated by a field in new MAC-CE* The number of temporary RS bursts is RRC configurable.
* FFS: which field in MAC-CE is used and how this field is associated with the number of bursts
* For the purpose of designing temporary RS Scell activation, there is no RAN1 specification impact for the case where the number of indicated temporary RS bursts is smaller than what is expected by the UE

**Agreement***For efficient activation of a Scell (in known Scell case), the triggering offset of temporary RS is indicated by a field in new MAC-CE** *The candidate value(s) of triggering offset(s) is RRC configurable*
* *FFS: which field in MAC-CE is used and how this field is associated with the value of triggering offset*
 |

**Option 1**: The number of temporary RS bursts and TRS triggering offset are configured per temporary RS in RRC signaling and only temporary configuration index is included in MAC CE for TRS activation part. The number of temporary RS bursts and TRS triggering offset are indicated in MAC CE implicitly via temporary configuration index.

**Option 2**: The number of temporary RS bursts and TRS triggering offset are configured per UE in RRC signaling. The number of temporary RS bursts and TRS triggering offset are indicated explicitly alone with temporary configuration index in MAC CE for TRS activation part.

**Q6a: Which option do companies prefer for information included in MAC CE, if Alt1 is chosen?**

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If Alt2 is chosen, only temporary RS trigger state index is included in MAC CE for TRS activation part for all SCells.

**Q6b: Do companies agree only temporary RS trigger state index is included in MAC CE for TRS activation part for all SCells configured with TRS, if Alt2 is chosen?**

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## ***Issue 3: RRC configurations for TRS based SCell activation***

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| **Agreement** (containing the common part of Alt1 and Alt2 in the next agreement)*To trigger temporary RS,* * *MAC-CE at least provides the following information:*
* *temporary RSs are to be triggered on X out of Y (Y≥X) to-be-activated SCells, respectively, while no temporary RS is to be triggered on the other to-be-activated SCells.*
* *The following information can be provided by RRC for temporary RS for each SCell*
* *The number of RS bursts and the gap length between the RS bursts (Opt 2.3.3)*
* *Triggering offset of temporary RS (Opt 2.3.4)*
* *QCL information (Opt 2.3.5)*

*FFS: the maximum number of temporary RS per cell/per UE**Note: Reusing A-TRS triggering framework is not precluded.** *Information for 0, 1, or more temporary RS can be provided for each configured SCell*
 |

Based on RAN1#106e agreements, RAN1 agreed that following parameters are configured for temporary RS in RRC signanling.

* The number of temporary RS bursts;
* gap length between the RS bursts;
* The candidate value(s) of triggering offset(s);
* A list of temporary RS;

Based on Q6a, it is not clear the number of temporary RS bursts and triggering offset are configured per TRS or per SCell.

**Q7: Companies are invited to provided their opinion on whether the following parameters are configured per SCell or Per TRS configuration?**

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| Company | Number of burst(per SCell/per TRS) | gap length (per SCell/per TRS) | triggering offset(per SCell/per TRS) | QCL info(per SCell/per TRS) |
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Currently, trs-Info in NZP-CSI-RS-ResourceSet is configured to indicate TRS configuration in R15. It is not clear how to configure temporary RS for SCell activation.

NZP-CSI-RS-ResourceSet ::= SEQUENCE {

 nzp-CSI-ResourceSetId NZP-CSI-RS-ResourceSetId,

 nzp-CSI-RS-Resources SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS-ResourcesPerSet)) OF NZP-CSI-RS-ResourceId,

 repetition ENUMERATED { on, off } OPTIONAL, -- Need S

 aperiodicTriggeringOffset INTEGER(0..6) OPTIONAL, -- Need S

 trs-Info ENUMERATED {true} OPTIONAL, -- Need R

 ...,

 [[

 aperiodicTriggeringOffset-r16 INTEGER(0..31) OPTIONAL -- Need S

 ]]

}

**Option 1**: Based on extension of NZP-CSI-RS-ResourceSet to configure temporary RS for SCell activiaton, i.e. including the temporary RS related new parameters in NZP-CSI-RS-ResourceSet.

**Option 2**: Define a new IE, .e.g temporaryRS-Config, to configure temporary RS for SCell activiaton.

**Q8: Do companies agree to introduce a new IE, e.g. temporaryRS-Config, to configure tempory RS for SCell activation? And one list of temporaryRS-Config is configed in CSI-MeasConfig IE for one SCell.**

**The temporaryRS-Config IE includes:**

* The number of temporary RS bursts, gap length between the RS bursts, the candidate value(s) of triggering offset(s); QCL information if agree per TRS configuration;
* Temporary RS configuration; FFS based on NZP-CSI-RS-Resource or NZP-CSI-RS-ResourceSet (This FFS is up to RAN1).

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In [2], RAN4 LS indicates 2 RS burst are required for AGC and time/frequency tracking respectively. It is not clear how to configure the 2 TRS burst in RRC signalling.

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| * SCell to be activated is known and belongs to FR1 and if SCell measurement cycle is larger than 160ms,

It is confirmed in [R4-2104067] [R4-2105799] that * + Temporary RS can be used for AGC
		- 1 burst (2-slot with four CSI-RS resources) is required
	+ Temporary RS can be used for time/frequency tracking
		- 1 separate burst (2-slot with four CSI-RS resources) is required in addition to the one burst required for AGC
 |

**Option 1**: One burst for TRS configuration is configured and one indication is configured to indicate whether there is another burst repetition.

**Option 2**: Two separate burst for TRS configuration are configured to indicate two TRS bursts.

**Q9: Which option do companies prefer to configure 2 burst TRS configuration?**

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## ***Issue 4: UE capability for TRS based SCell activation***

TRS for SCell activation is introduced in R17, it is obvious new UE capability should be introduced to indicate whether UE support TRS for SCell activation or not.

Tempoery RS for SCell activation is one kind of TRS. The UE capability for TRS in R15 is defined as below:

CSI-RS-ForTracking ::= SEQUENCE {

 maxBurstLength INTEGER (1..2),

 maxSimultaneousResourceSetsPerCC INTEGER (1..8),

 maxConfiguredResourceSetsPerCC INTEGER (1..64),

 maxConfiguredResourceSetsAllCC INTEGER (1..256)

}

| ***csi-RS-ForTracking***Indicates support of CSI-RS for tracking (i.e. TRS). This capability signalling comprises the following parameters:- *maxBurstLength* indicates the TRS burst length. Value 1 indicates 1 slot and value 2 indicates both of 1 slot and 2 slots. In this release UE is mandated to report value 2;- *maxSimultaneousResourceSetsPerCC* indicates the maximum number of TRS resource sets per CC which the UE can track simultaneously;- *maxConfiguredResourceSetsPerCC* indicates the maximum number of TRS resource sets configured to UE per CC. It is mandated to report at least 8 for FR1 and 16 for FR2;- *maxConfiguredResourceSetsAllCC* indicates the maximum number of TRS resource sets configured to UE across CCs. If the UE includes the field in an FR1 band, it shall set the same value in all FR1 bands. If the UE includes the field in an FR2 band, it shall set the same value in all FR2 bands. The UE supports a total number of resources equal to the maximum of the FR1 and FR2 value, but no more than the FR1 value across all FR1 serving cells and no more than the FR2 value across all FR2 serving cells. The UE is mandated to report at least 16 for FR1 and 32 for FR2.The UE is mandated to report *csi-RS-ForTracking*. | Band | Yes | N/A | N/A |
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Now, it is not clear whether the new introduced temporary RS list for SCell activation will also be restricted by this UE capapbility.

**Q10: Do companies agree that temporary RS for SCell activation is also restricted by UE capability: CSI-RS-ForTracking?**

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**Q11: Do companies agree that new UE capability is introduced to indicate whether UE support temporary RS for SCell activation or not?**

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# Conclusions

Based on the discussion above, we propose:

# Reference

[1] [R2-2107984](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107984.zip) MAC CE for scell activation and temporary RS Nokia, Nokia Shanghai Bell discussion Rel-17 LTE\_NR\_DC\_enh2-Core

[2] [R2-2108450](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108450.zip) On RAN4 LS on Temporary RS for SCell activation Huawei, HiSilicon discussion Rel-17 LTE\_NR\_DC\_enh2-Core

[3] [R2-2107021](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107021.zip) Discussion on TRS activation for fast SCell activation OPPO discussion Rel-17 LTE\_NR\_DC\_enh2-Core