**3GPP TSG RAN WG1 Meeting #100bis-e R1-200xxxx**

**April 20th – April 30th, 2020**

**Agenda item: 7.2.2.1.1**

**Source: Moderator (Qualcomm Incorporated)**

**Title: Email discussion on k\_SSB indication in PBCH for SSB on sync raster and off-sync raster**

**Document for: Discussion and Decision**

# Introduction

For agenda item 7.2.2.1.1 on NR-U initial access signals and channels, after preparation stage email discussion, it was agreed to discuss the following in email discussion.

[100b-e-NR-unlic-NRU-InitSignalChannel-01] Email discussion/approval on k\_SSB indication in PBCH for SSB on sync raster and off-sync raster by 4/22; if necessary, followed by endorsing the corresponding TP by 4/28 – Jing (Qualcomm)

# Discussion on k\_SSB indication

The LSB of k\_SSB in MIB is used for indication of *ssbPositionQCL-Relationship-r16* for Rel.16 NR-U. As a result, need to determine k\_SSB LSB with default interpretations.

During the preparation stage of the email discussion, there are two alternatives collected.

* Alt 1. The assumed value for LSB of k\_SSB is SSB center frequency dependent
	+ If LSB of *ssb-SubcarrierOffset* is used for signalling of *ssbPositionQCL-Relationship-r16*, LSB of k\_SSB is set to ‘0’ for SS/PBCH on a sync raster.
	+ If LSB of *ssb-SubcarrierOffset* is used for signalling of *ssbPositionQCL-Relationship-r16*, for a SS/PBCH not on a sync raster,
		- If the distance between a synchronization raster for NR-U and the center frequency of the SS/PBCH is equal to integer multiple of 30 kHz, LSB of k\_SSB is set to ‘0’.
		- Otherwise, if the distance between a synchronization raster for NR-U and the center frequency of the SS/PBCH is not equal to integer multiple of 30 kHz but equal to integer multiple of 15 kHz, LSB of k\_SSB is set to ‘1’.
	+ Support: LGE
* Alt 2. The LSB of k\_SSB is set to 0, and restrict the center frequency of SSB on both sync raster and non-sync raster to be multiple of 30KHz away from the sync raster SSB
	+ Support: Nokia, NSB, Samsung, Fujitsu, Huawei, HiSilicon, ZTE, Ericsson, NTT DOCOMO, Vivo

Proposal:

* Adopt the Alt 2 text proposals below for 38.211 7.4.3.1 and 38.213 4.1 for k\_SSB indication.
	+ Note: For operation with shared spectrum channel access, k\_SSB of the SSB is an even number, and the corresponding ssbFrequency cannot be (2k+1)\*15 kHz shift from the synchronization raster
	+ Send LS to RAN2 to provide the above information

------------------------------------Alt 1 TP for 38.211, 7.4.3.1----------------------------------

7.4.3.1 Time-frequency structure of an SS/PBCH block

In the time domain, an SS/PBCH block consists of 4 OFDM symbols, numbered in increasing order from 0 to 3 within the SS/PBCH block, where PSS, SSS, and PBCH with associated DM-RS are mapped to symbols as given by Table 7.4.3.1-1.

In the frequency domain, an SS/PBCH block consists of 240 contiguous subcarriers with the subcarriers numbered in increasing order from 0 to 239 within the SS/PBCH block. The quantities  and  represent the frequency and time indices, respectively, within one SS/PBCH block. The UE may assume that the complex-valued symbols corresponding to resource elements denoted as 'Set to 0' in Table 7.4.3.1-1 are set to zero. The quantity  in Table 7.4.3.1-1 is given by $v=N\_{ID}^{cell} mod 4$. The quantity  is the subcarrier offset from subcarrier 0 in common resource block $N\_{CRB}^{SSB}$ to subcarrier 0 of the SS/PBCH block, where $N\_{CRB}^{SSB}$ is obtained from the higher-layer parameter *offsetToPointA* and the 4 least significant bits of  are given by the higher-layer parameter *ssb-SubcarrierOffset* and for SS/PBCH block type A the most significant bit of  is given by $\overbar{a}\_{\overbar{A}+5}$ in the PBCH payload as defined in clause 7.1.1 of [4, TS 38.212]. For operation with shared spectrum channel access, 4 least significant bits of $\overbar{k}\_{SSB}$ are given by the higher-layer parameter *ssb-SubcarrierOffset* and the most significant bit of $\overbar{k}\_{SSB}$ is given by $\overbar{a}\_{\overbar{A}+5}$ in the PBCH payload as defined in clause 7.1.1 of [4, TS 38.212]. If $\overbar{k}\_{SSB}\geq 24$, $k\_{SSB}=\overbar{k}\_{SSB}$; otherwise, $k\_{SSB}$ is given by

 $k\_{SSB}=\left\{\begin{array}{c}2⋅floor\left(\overbar{k}\_{SSB}/2\right) if (D/1000) mod 30=0\\2⋅floor\left(\overbar{k}\_{SSB}/2\right)+1 otherwise\end{array}\right.$

where $D$ is defined by the frequency distance between the lowest subcarrier of the SS/PBCH block and the lowest subcarrier of a SS/PBCH block located at the GSCN of a synchronization raster entry as defined in [X, TS 38.101-1].If *ssb-SubcarrierOffset* is not provided, $k\_{SSB}$ is derived from the frequency difference between the SS/PBCH block and Point A.

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------------------------------------Alt 2 TP for 38.211, 7.4.3.1----------------------------------

7.4.3.1 Time-frequency structure of an SS/PBCH block

In the time domain, an SS/PBCH block consists of 4 OFDM symbols, numbered in increasing order from 0 to 3 within the SS/PBCH block, where PSS, SSS, and PBCH with associated DM-RS are mapped to symbols as given by Table 7.4.3.1-1.

In the frequency domain, an SS/PBCH block consists of 240 contiguous subcarriers with the subcarriers numbered in increasing order from 0 to 239 within the SS/PBCH block. The quantities  and  represent the frequency and time indices, respectively, within one SS/PBCH block. The UE may assume that the complex-valued symbols corresponding to resource elements denoted as 'Set to 0' in Table 7.4.3.1-1 are set to zero. The quantity  in Table 7.4.3.1-1 is given by $v=N\_{ID}^{cell} mod 4$. The quantity  is the subcarrier offset from subcarrier 0 in common resource block $N\_{CRB}^{SSB}$ to subcarrier 0 of the SS/PBCH block, where $N\_{CRB}^{SSB}$ is obtained from the higher-layer parameter *offsetToPointA* and the 4 least significant bits of  are given by the higher-layer parameter *ssb-SubcarrierOffset* and for SS/PBCH block type A the most significant bit of  is given by $\overbar{a}\_{\overbar{A}+5}$ in the PBCH payload as defined in clause 7.1.1 of [4, TS 38.212]. For operation with shared spectrum channel access, 4 least significant bits of $\overbar{k}\_{SSB}$ are given by the higher-layer parameter *ssb-SubcarrierOffset* and the most significant bit of $\overbar{k}\_{SSB}$ is given by $\overbar{a}\_{\overbar{A}+5}$ in the PBCH payload as defined in clause 7.1.1 of [4, TS 38.212]. If $\overbar{k}\_{SSB}\geq 24$, $k\_{SSB}=\overbar{k}\_{SSB}$; otherwise, $k\_{SSB}=2⋅\left⌊\overbar{k}\_{SSB}/2\right⌋$. If *ssb-SubcarrierOffset* is not provided, $k\_{SSB}$ is derived from the frequency difference between the SS/PBCH block and Point A.

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------------------------------------ Alt 2. Text Proposal for 38.213, Section 4.1----------------------------

\*\*\* Unchanged text omitted \*\*\*

$N\_{SSB}^{QCL}$ is either provided by *ssbPositionQCL-Relationship-r16* or, if *ssbPositionQCL-Relationship-r16* is not provided,obtained from a *MIB* provided by a SS/PBCH block according to Table 4-1 with $k\_{SSB}$<24 as defined in clause 7.4.3.1 of [4, 38.211].

\*\*\* Unchanged text omitted \*\*\*

-------------------------------------- End Text Proposal --------------------------------------

Please provide company views below

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, NSB | We think that there is no need to restrict R15 SSB placement for Scell. We prefer that restriction on 30kHz granularity applies only to *ssb-SubcarrierOffset* provided by MIB. This can be formulated asFor operation with shared spectrum channel access, the least significant bit of $k\_{SSB}$, provided by *ssb-SubcarrierOffset,* is set 0. |
| Samsung | Alt 2, but with some clarification. First we agree with Nokia’s comment. Then, we have the following further clarification. The indication of Q should be only applicable to SSB with k\_SSB values in the range 0 to 23, and should not impact the SSB with k\_SSB values in the range 24 to 31 wherein those SSBs use k\_SSB for other purpose instead of determining the subcarrier offset. Genetically setting LSB of k\_SSB as 0 cannot make k\_SSB from {25, 27, 29, 31}, but SSBs with k\_SSB as such value should not be impacted by indication of Q. Hence, the UE procedure for determining the k\_SSB should be, the UE first calculate a value $\overbar{k}\_{SSB}= 16\*\overbar{a}\_{\overbar{A}+5}$+ *ssb-SubcarrierOffset*, if $\overbar{k}\_{SSB}\geq 24$, $k\_{SSB}=\overbar{k}\_{SSB}$; otherwise, $k\_{SSB}=2\*floor(\overbar{k}\_{SSB}/2)$ (i.e., set LSB of k\_SSB as 0). To summarize, our revised proposal TP for Alt 2 is as follow. Alt 2. For operation with shared spectrum channel access, 4 least significant bits of $\overbar{k}\_{SSB}$ are given by the higher-layer parameter *ssb-SubcarrierOffset* and the most significant bit of $\overbar{k}\_{SSB}$ is given by $\overbar{a}\_{\overbar{A}+5}$ in the PBCH payload as defined in clause 7.1.1 of [4, TS 38.212]. If $\overbar{k}\_{SSB}\geq 24$, $k\_{SSB}=\overbar{k}\_{SSB}$; otherwise, $k\_{SSB}=2⋅floor(\overbar{k}\_{SSB}/2)$. |
| LG Electronics | Alt 1, with some modification.Alt 1 takes advantage of supporting ANR functionality with full flexibility, since currently *ssbFrequency* in a measurement configuration provided with *reportCGI* is configured with *ARFCN-ValueNR* having 15 kHz SCS granularity.If we go with Alt 2, we need to restrict *ssbFrequency* in a measurement configuration provided with *reportCGI* to be configured only with 30 kHz SCS granularity, which can lead to additional impact on 38.331 specification.Given that Q is indicated only when k\_SSB is smaller than 24 as Samsung pointed out, we provide modified TP as follows:Alt 1. For operation with shared spectrum channel access, 4 least significant bits of $\overbar{k}\_{SSB}$ are given by the higher-layer parameter *ssb-SubcarrierOffset* and the most significant bit of $\overbar{k}\_{SSB}$ is given by $\overbar{a}\_{\overbar{A}+5}$ in the PBCH payload as defined in clause 7.1.1 of [4, TS 38.212]. If $\overbar{k}\_{SSB}\geq 24$, $k\_{SSB}=\overbar{k}\_{SSB}$; otherwise, $k\_{SSB}$ is given by $k\_{SSB}=\left\{\begin{array}{c}2⋅floor\left(\overbar{k}\_{SSB}/2\right) if (D/1000) mod 30=0\\2⋅floor\left(\overbar{k}\_{SSB}/2\right)+1 otherwise\end{array}\right.$where $D$ is defined by the frequency distance between the lowest subcarrier of the SS/PBCH block and the lowest subcarrier of a SS/PBCH block located at the GSCN of a synchronization raster entry as defined in [X, TS 38.101-1]. |
| Fujitsu | Alt 2, with some modification.Regarding determination of k\_SSB, we share the similar view with SS, and we are OK with the TP provided by SS. We don’t see the necessity of the additional flexibility for an SSB not on a sync raster. Meanwhile, we also don’t see the necessity of changing measurement configuration with *reportCGI* in 38.331 if we adopt Alt 2. Indeed, Alt 2 would restrict position for SSB associated with RMSI but not on a sync raster. gNB should set proper position of SSB associated with RMSI. Following that, for CGI report purpose, gNB could set proper *ssbFrequency*. But that could be left to gNB implementation, not necessary to update 38.331.Additionally, as also pointed out by SS and LG, Q is indicated only when SSB is associated with RMSI (i.e. when$\overbar{k}\_{SSB}$<24), that is, *subCarrierSpacingCommon* and LSB of *ssb-SubcarrierOffset* are used for determining Q by UE only when $\overbar{k}\_{SSB}$<24. It would be better to clarify it. So on top of the TP on determination of k\_SSB, we further provide a TP for determination of Q as follows:------------------------------------ Text Proposal for 38.213, Section 4.1----------------------------\*\*\* Unchanged text omitted \*\*\*$N\_{SSB}^{QCL}$ is either provided by *ssbPositionQCL-Relationship-r16* or, if *ssbPositionQCL-Relationship-r16* is not provided,obtained from a *MIB* provided by a SS/PBCH block according to Table 4-1 when $\overbar{k}\_{SSB}$<24 as defined in clause 7.4.3.1 of [4, 38.211].\*\*\* Unchanged text omitted \*\*\*-------------------------------------- End Text Proposal -------------------------------------- |
| Huawei, HiSilicon | Alt 2.  |
| ZTE | We prefer Alt 2.Compared to Alt 1, Alt 2 has less impact on spec, and only influences the non-sync SSB case that the distance between a sync raster and the center frequency of the SS/PBCH is not equal to integer multiple of 30 kHz but equal to integer multiple of 15 kHz. From our understanding, we could avoid this case by implementation. |
| Ericsson | We agree with Samsung’s TP for Alt-2.This TP has the benefit of not restricting the SSB placement on an SCell (agree with Nokia), as well as not modifying the k\_SSB definition for the case when k >= 24. |
| NTT DOCOMO | We support Alt-2, and Samsung’s TP. |
| vivo | Alt-2 for simplicity.  |
| OPPO | Alt-2 is better. Although we think simply set LSB of Kssb=0 can also work. When k\_SSB is larger than 23, k\_SSB values are used to indicate GSCN of second SSB. If LSB of k\_SSB is set to 0, k\_SSB values from {24, 26, 28, 30} can be used for the purpose of GSCN of second SSB indication. For NR-U, only very fewer sync rasters are allowed for initial access, as defined in TS 38.101-1. That is, about 1/14 GSCN are allowed for sync rasters in NR-U band. If we consider only the allowed GSCN can be indicated using k\_SSB values, the k\_SSB values from {24, 26, 28, 30} are enough for this purpose. |

# References

[1]. R1-2001649, Remaining issues on initial access signals and channles, vivo

[2]. R1-2001702, Remaining issues on the initial access signals for NR-U, ZTE, Sanechips

[3]. R1-2001756, Discussion on the remaining issues of initial access signal/channel, OPPO

[4]. R1-2001932, Remaining issues of initial access signals and channels for NR-U, LG Electronics

[5]. R1-2002028, Initial access signals and channels, Ericsson

[6]. R1-2002114, Initial access signals and channels for NR-U, Samsung

[7]. R1-2002224, Remaining issues on Initial Access Signals and Channels for NR-U, Nokia, Nokia Shanghai Bell

[8]. R1-2002262, Remaining issues on initial access signals/channels, Spreadtrum Communications

[9]. R1-2002575, Maintainance on the initial access signals and channels, Huawei, HiSilicon