3GPP TSG-RAN Meeting #88bis **R1-1705459**
Spokane, USA, 3rd-7th April 2017

Source: **Cohere Technologies**

Title: **SS Block Composition, SS Burst Set Composition and SS Time Index Indication**

Agenda item: **8.1.1.1.2**

Document for: **Discussion**

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1. Introduction

In the last 3GPP RAN 1 meetings, initial access and namely Synchronization Sequences (SS) and Physical Broadcast Channel (PBCH) transmission as an SS block and burst were discussed. In the last 3GPP #88 meeting, the following agreements were done with regards to SS burst composition and with regards to the indication of SS Time [1].

Agreements:

- For set of possible SS block time locations, further evaluation till next meeting by considering at least the following:
  - Whether or not a SS block comprises of consecutive symbols and whether or not SS&PBCH in the same or different slots
  - Number of symbols per SS block
  - Whether or not to map across slot boundary(ies)
  - Whether or not to skip symbol(s) within a slot or a slot set
  - Contents of an SS block (note: the contents of an SS block may be further discussed during this meeting)
  - How SS blocks are arranged within a burst set, & the # of SS blocks per burst/burst set

Agreement:

- The maximum number of SS-blocks, L, within SS burst set may be carrier frequency dependent
  - For frequency range category #A (e.g., 0 ~ 6 GHz), the number (L) is TBD within $L \leq [16]$
  - For frequency range category #B (e.g., 6 ~ 60GHz), the number is TBD within $L \leq [128]$
  - FFS: L for additional frequency range category
- The position(s) of actual transmitted SS-blocks can be informed for helping CONNECTED/IDLE mode measurement, for helping CONNECTED mode UE to receive DL data/control in unused SS-blocks and potentially for helping IDLE mode UE to receive DL data/control in unused SS-blocks
  - FFS whether this information is available only in CONNECTED mode or in both modes
  - FFS how to signal the position(s)

2. Discussion

As it can be seen in the agreements above, the general frame of the SS bust set is decided and specific values of parameters related to SS burst set have to be specified. Proposals on the open items follow.

An SS block should be comprised by consecutive symbols. The reason is that PSS and SSS sequences are going to serve as demodulation reference signals, as it has been proposed in [2]. Consecutive symbols of an SS block should be in the same slot. With the flexibility provided in the new numerology, e.g. mini slot, it is therefore preferable to have the consecutive symbols of an SS block located in the same slot.

Proposal 1: An SS block should be comprised by consecutive symbols in the same slot.

The number of symbols in time domain per SS block should be 3 or 4; 1 symbol for PSS, 1 symbol for SSS and 1 or 2 symbols for PBCH. It is estimated that 1 or maximum 2 consecutive symbols are sufficient for PBCH and this should be the number of symbols, so as channel estimation with the aid of PSS and SSS is performed at acceptable levels. In LTE, a total number of 264 or 240 symbols, depending on the number of antenna ports, 2 or 4, is used for PBCH transmission. In the case of NR, for all different parameter sets, the total number of OFDM symbols corresponding to 1 symbol in time domain is 300; i.e., for the parameter set #W, hence for subcarrier spacing equal to 15 kHz, the transmission bandwidth for an SS block is equal to 5 MHz, accounting for 300 subcarriers [1]. In LTE, the number of bits plus CRC is equal to 40 bits and this number of bits fits into 240 or 264 OFDM symbols. In NR, the number of bits including CRC is going to be in the range of 40 to 100 bits, then, it can be readily understood, that this number of information bits can fit into 300 or 600 OFDM symbols, hence 1 or 2 (consecutive) in time domain symbols.

Proposal 2: The number of symbols in time domain of an SS block should be 3 or 4 - depending on the PBCH content and size.

For the reasons explained above, it is suggested that mapping across slot boundaries should be avoided and symbols should not be skipped. Therefore, the content of an SS block should be the one discussed above: PSS, SSS and PBCH. In order to have at least the same performance in terms of latency for cell ID acquisition and for system information acquisition, it is suggested that the default SS burst set periodicity is set to 10 ms.

Proposal 3: The default SS burst set periodicity is set to 10 ms.

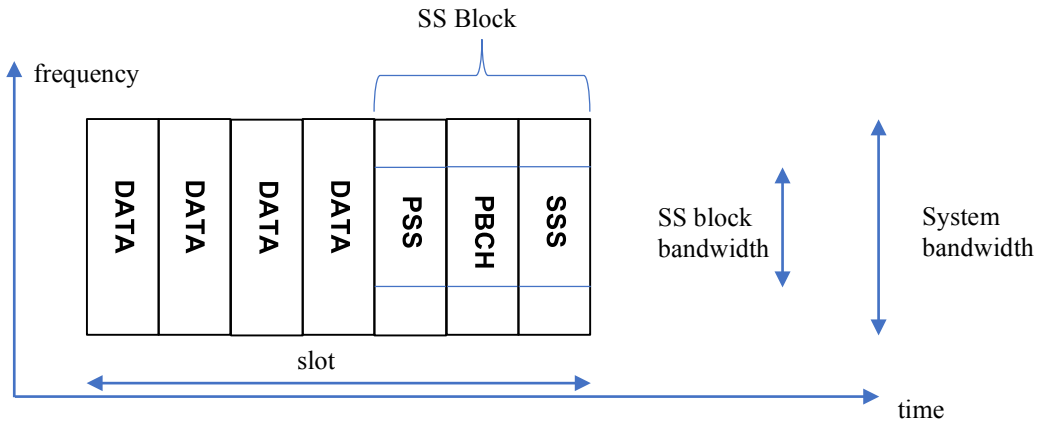

Figure 1: SS block configuration. In this example, PSS is placed before PBCH and SSS. An alternative configuration with SSS before PBCH can be imagined. Alternatively, the SS block can occupy any 3 or 4 symbols of the slot.

The amount of SS blocks in the SS burst and in the SS burst set should be defined by the default SS burst set periodicity and the number of beams in the cell or sector. The starting point should be that any user in the system should "see" the same SS burst set periodicity. The goal is that the UE is attempting to synchronize in the system without the need to blindly detect the number of repeated SS blocks within 1 SS burst and the number of SS bursts within 1 SS burst set. As mentioned above, a single (1) series of 3 or 4 symbols corresponds to a single (1) SS block. Within a cellular network or different networks, sectors or cells with different numbers of beams in the sector are anticipated. In this case, the number of SS blocks within 1 SS burst is equal to the number of beams in the sector. Hence, in case of a sector supporting 8 or 16 beams, then the number of SS blocks within 1 SS burst is 8 and 16 respectively. For the default configuration, 1 SS burst set is consisted of a single (1) SS burst.

Proposal 4: The default number of SS blocks within one (1) SS burst should be equal to the number of beams transmitted by the TRP. The default number of SS bursts within 1 SS burst set is equal to 1.

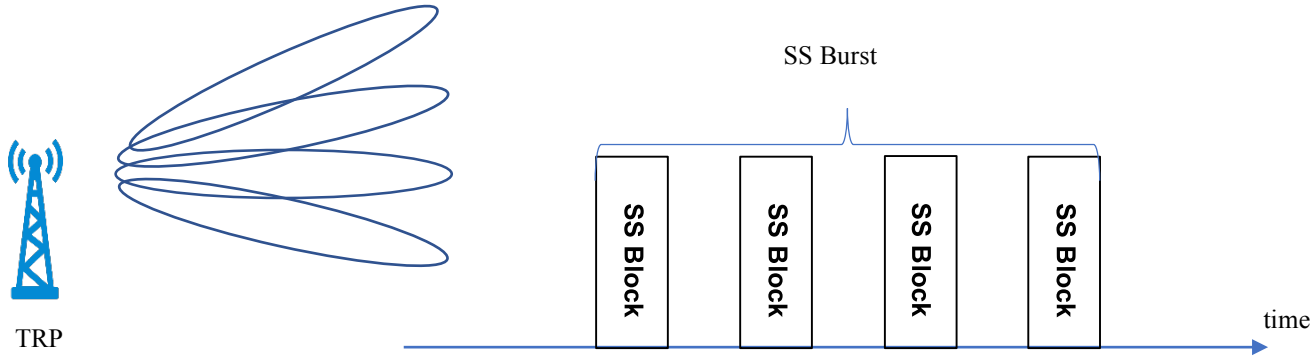

Figure 2: Example of SS burst configuration. In this example, the SS burst is consisted from 4 SS blocks and the number of beams transmitted from the TRP is equal to 4.

As it is discussed during the 3GPP RAN1 #88 meeting and as captured in [1], the network should support indication of SS burst set periodicity and information to derive measurement timing/duration (e.g. time window for NR-SS detection) for connected and idle mode UEs. Candidate periodicity values are 5, 10, 20, 40, 80 and 160 ms.

Hence, connected UEs, or UEs idle in a system and having been connected in the past in the sector can try to detect PSS every 5 ms. UEs in idle mode without having been previously connected to the sector may attempt to listen to PSS every 5ms.

Upon PSS detection, UEs can get an indication of additional SS burst set periodicity by listening to PBCH, if the number of available bits in PBCH can bear this information. In case, the indication of additional SS burst set periodicity cannot be supported by PBCH, then, this information should be carried in System Information (SI). Alternatively, and for the sake of reduced overhead, indication of additional to default SS burst set periodicity can be done with the aid of the physical cell ID.

The physical cell ID can be used to indicate the number of antenna ports, 1 or 2, for the transmission of NR-PBCH, if the number of antenna ports for NR-PBCH is not set to be equal to the number of antenna ports used for NR-SSS.

Proposal 5: SS burst set configuration different than the default one is indicated to UEs via NR-PBCH or System Information.

3. Conclusion

A few open points with regards to the SS Burst Set composition is addressed in this contribution. The following proposals are made:

Proposal 1: An SS block should be comprised by consecutive symbols in the same slot.

Proposal 2: The number of symbols in time domain of an SS block should be 3 or 4 - depending on the PBCH content and size.

Proposal 3: The default SS burst set periodicity is set to 10 ms.

Proposal 4: The default number of SS blocks within one (1) SS burst should be equal to the number of beams transmitted by the TRP. The default number of SS bursts within 1 SS burst set is equal to 1.

Proposal 5: SS burst set configuration different than the default one is indicated to UEs via NR-PBCH or System Information.

4. References

[1]. RAN1 #88 Meeting, February 2017, Chairman's notes

[2]. R1-1702375, "NR SS Burst Composition and SS Time Index Indication," Cohere Technologies, RAN1#88, February 2017.