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(54) Title: NR V2X SIDELINK SYNCHRONIZATION SIGNAL BLOCK

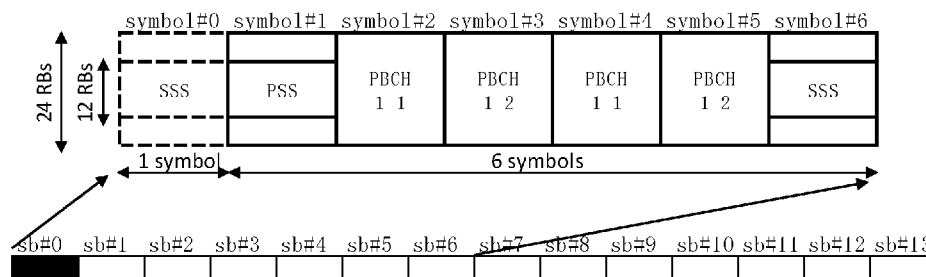


FIG. 5

(57) **Abstract:** For NR V2X side link synchronization signal block (SL-SSB), AGC issue and the performance should be considered. As one example, SL-SSB can be composed by 1 PSS, 4 PBCH symbols and 1 SSS in order. In addition, one more SSS can be placed in the front of SSB for AGC tuning. This additional SSS (e. g., zero or one or multiple symbols) can be (pre) configured or specified according to the SSB numerology and periodicity. 4 symbols of PBCH are formed by repetition of 2 symbols of PBCH so that they can be decoded separately or combined for decoding with joint or independent channel estimation. Moreover, the total 7 symbols of SSB (including 1 symbol of SSS for AGC tuning) can be placed in the beginning of half-subframe so that the additional SSS used for AGC tuning can utilize the longer normal CP for AGC tuning with relatively more time and/or samples for any subcarrier spacing case. Further, there can be only one SL-SSB within a half-subframe.



NR V2X SIDELINK SYNCHRONIZATION SIGNAL BLOCK

FIELD OF INVENTION

This disclosure relates generally to wireless communications, and, more particularly, to methods and apparatus for the synchronization signal block of V2X sidelink communications.

BACKGROUND OF THE INVENTION

In 5G new radio, V2X sidelink(SL) communication may be supported by the unicast, groupcast and broadcast communications. However, there are several issues to be addressed, e.g., how to synchronize between each other and obtain the timing information.

SUMMARY OF THE INVENTION

This disclosure relates generally to wireless communications, and, more particularly, to methods and apparatus for the synchronization signal block of V2X sidelink communications.

For NR V2X sidelink synchronization signal block (S-SSB), AGC issue and the performance should be considered. As one example, S-SSB can be composed of 1 PSS, 4 PBCH symbols and 1 SSS in order. In addition, one more SSS can be placed in the front of SSB for AGC tuning. This additional SSS (e.g., zero or one or multiple symbols) can be (pre)configured or specified according to the S-SSB numerology and periodicity. Alternatively, the other symbols may also be used for AGC tuning such as CSI-RS and PSS. 4 symbols of PBCH are formed by repetition of 2 symbols of PBCH so that they can be decoded separately or combined for decoding with joint or independent channel estimation. Moreover, the total 7 symbols of SSB (including 1 symbol of SSS for AGC tuning) can be placed in the beginning of half-subframe so that the additional SSS used for AGC tuning can utilize the longer normal CP for AGC tuning with relatively more time and/or samples for any subcarrier spacing case. Further, there can be only one SSB within a half-subframe.

For S-SSB transmission time resource indicated by (pre)configured syncOffsetIndicator, it can be carried by PBCH DMRS sequence generated by the corresponding initial value or sequence index. Alternatively, it can also be indicated by the corresponding SSS sequence. Accordingly, depending on the SL-SSB transmission period, the UE can know the LSB bits of the timing derived from the detected syncOffsetIndicator in SL-SSB. And the remaining bits of the timing information (e.g., n MSB bits) can be carried in PBCH payload.

For synchronization based on GNSS, the slot timing can be derived as:

- $DFN = \text{Floor}(0.1 * 0.001 * (T_{\text{current}} - T_{\text{ref}} - \text{offsetDFN})) \bmod 1024;$
- $\text{SubframeNumber} = \text{Floor}(0.001 * (T_{\text{current}} - T_{\text{ref}} - \text{offsetDFN})) \bmod 10;$
- $\text{slotNumber} = \text{Floor}(0.001 * (T_{\text{current}} - T_{\text{ref}} - \text{OffsetDFN}) * 2^u) \bmod 2^u,$

where $u=0,1,2,3$ corresponding to the usage or (pre-)configuration of 15, 30, 60, 120kHz SCS for SL-SSB respectively, $T_{\text{current}}(\text{us})$ is the current UTC time that obtained from GNSS, $T_{\text{ref}}(\text{us})$ is the reference UTC time 00:00:00 on Gregorian calendar date 1 January, 1900 (midnight between Thursday, December 31, 1899 and Friday, January 1, 1900), $\text{OffsetDFN}(\text{us or ms})$ is the value offsetDFN if configured.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention can be more fully understood by reading the subsequent detailed description and examples

with references made to the accompanying drawings, wherein:

FIG. 1 shows an example of SL-SSB composition.

FIG. 2 shows another example of SL-SSB composition with PBCH repetition.

FIG. 3 illustrates the time location of the additional symbol for AGC tuning associated with SL-SSB.

5 FIG. 4 illustrates the symbol candidates of the additional symbol for AGC tuning.

FIG. 5 shows an example of the symbol mapping of the AGC tuning symbol associated with SL-SSB within a slot.

FIG. 6 shows an example of SSB with GP symbols for beam-switching.

10 FIG. 7 shows an exemplary block diagram of a UE (a.k.a device) according to an embodiment of the disclosure.

DETAILED DESCRIPTION

Certain terms are used throughout the description and following claims to refer to particular components. As one skilled in the art will appreciate, manufacturers may refer to a component by different names. This document does not intend to distinguish between components that differ in name but not function. In the following description and in the claims, the terms "include" and "comprise" are used in an open-ended fashion, and thus should be interpreted to mean "include, but not limited to ...". Also, the term "couple" is intended to mean either an indirect or direct electrical connection. Accordingly, if one device is coupled to another device, that connection may be through a direct electrical connection, or through an indirect electrical connection via other devices and connections. The making and using of the embodiments of the disclosure are discussed in detail below. It should be appreciated, however, that the embodiments can be embodied in a wide variety of specific contexts. The specific embodiments discussed are merely illustrative, and do not limit the scope of the disclosure. Some variations of the embodiments are described. Throughout the various views and illustrative embodiments, like reference numbers are used to designate like elements.

25 The following description is of the best-contemplated mode of carrying out the invention. This description is made for the purpose of illustrating the general principles of the invention and should not be taken in a limiting sense. Note that the 3GPP specifications described herein are used to teach the spirit of the invention, and the invention is not limited thereto.

30 FIG. 1 shows an example of SL-SSB composition. One S-SSB with 24 RBs by 4 symbols is composed of 1 PSS symbol, 2 PBCH symbols and SSS symbol in order.

PSS and SSS are generated with length-127 m-sequence located in the central 127 subcarriers of the 24 resource blocks (RB, 1RB=12 subcarriers). PSS and SSS can be used to carry sidelink synchronization ID (SLSS ID) which is used to identify the sync source type and priority. For example, the UEs synced to eNB and gNB can be assigned with different set of sequences for PSS/SSS generation corresponding to the different SLSS ID. Upon the detection of SLSS ID of the directly synced UE, the other UEs synced to the synced UEs (a.k.a indirectly synced UE) can know the sync source of the synced UE (or original sync source) for proper synchronization prioritization if needed. The unused resource in the frequency domain in PSS/SSS symbols can be set as zero power.

40 PBCH symbol will be transmitted over 24 RBs including PBCH-DMRS. The frequency domain precoder cycling can be supported with e.g., 6 RBs per precoding group (PRG) and up to 4 PRGs for exploring the

frequency diversity gain. Alternatively, the time domain precoder cycling can be supported independently or jointly with frequency domain precoder cycling. 1 port pre-coder cycling and/or SFBC transmission can be supported for PBCH transmission.

PBCH-DMRS can be used to carry the additional information such as time resource information for the indirectly synced UE to derive the timing and transmit SLSS. For example, there are two sets of time resources for SLSS transmission corresponding to the different time instance. Such time resources are also preconfigured for UE so that the indirectly synced UE can derive the part of the timing based on the detection of time resource indicator (e.g., syncOffsetIndicator) which can be carried in PBCH-DMRS (and/or PSS/SSS). Such time resource indicator (e.g., indicator 1 for time resource 1 and indicator 2 for time resource 2) can be used as the initialization value for PBCH-DMRS sequence generation. PBCH-DMRS RE mapping can have the fixed location or have the frequency cyclic shift based on a function of the SLSS ID.

For example, the UE assumes the reference-signal sequence $r(m)$ for PBCH is defined by

$$r(m) = \frac{1}{\sqrt{2}}(1 - 2 \cdot c(2m)) + j \frac{1}{\sqrt{2}}(1 - 2 \cdot c(2m+1))$$

where $c(n)$ is given by clause 5.2.1 in 3GPP TS 38.211. The scrambling sequence generator can be initialized at the start of PBCH occasion with c_{init} based on a function of the time resource indicator (and/or in/out-coverage indicator). For example,

$$c_{init} = (TimeResourceId + 1) * 2^{22} + (InCoverageIndicator + 1) * 2^{18} + (SLID + 1).$$

PSS, SSS and PBCH symbols can have the same total power. And the transmission power per RE for PBCH-DMRS can be same as PSS/SSS and/or PBCH-Data.

FIG. 2 shows another example of SL-SSB composition with PBCH repetition. The main difference than SL-SSB composition shown in FIG. 1 is the repetition of PBCH symbols. That is, PBCH channel with two (or more) PBCH symbols in FIG. 1 can be repeated once (or multiple times) with total 4 (or more) symbols for PBCH transmission. So the UE can decode these two (or more) PBCH channels independently or soft combined for improving the performance and coverage. Moreover, the channel estimation for PBCH can be done jointly across 4 symbols for the better performance.

Alternatively, the PBCH symbols can also be repeated symbol by symbol with one or multiple times, e.g., PBCH 1-1, PBCH 1-1, PBCH 1-2 and PBCH 1-2 for one more repetition on each symbol.

FIG. 3 illustrates the time location of the additional symbol(s) for AGC tuning associated with SL-SSB. Considering the channel variation and interference/loading dramatic change, the AGC may have to be retuned for SL-SSB reception each time, especially if the time interval between two consecutive SL-SSBs are too large to have any correlation. In this case, one (or multiple) AGC symbol may be needed to be added in the front of SL-SSB for the proper reception of PSS. As shown in FIG. 3, one (or more) SSS symbol added in the front of SL-SSB is used for AGC tuning before PSS reception. Such SSS symbol can be a repetition of the SSS symbol in SL-SSB (the last symbol of the SL-SSB). Alternatively, such SSS symbol for AGC tuning can be complementary to the SSS in SL-SSB with a SSS sequence number derived from the SSS sequence in SSS of SL-SSB. Besides, SSS for AGC tuning can also help to improve the SSS detection performance. On the other hand, such SSS for AGC tuning can be also considered as the part of SL-SSB. The number of SSS for AGC tuning can be pre-defined or (pre-)configured. The number of SSS for AGC tuning can be dependent on the

SL-SSB numerology and/or SL-SSB periodicity, e.g., more symbols are used with the large subcarrier spacing and/or large SL-SSB periodicity whereas less (or zero) symbols are used for the small subcarrier and/or small SL-SSB periodicity. For example, for 30 kHz SL-SSB, 1 symbol of SSS is (pre)configured or defined for AGC tuning whereas 2 symbols of SSS may be used with 60 kHz SL-SSB.

FIG. 4 illustrates the symbol candidates of the additional symbol for AGC tuning. Within each half-subframe (0.5ms), the first symbol will have a longer normal CP. Such longer normal CP can spare more time for AGC tuning. Thus, these can be used as the candidate location for AGC symbols.

FIG. 5 shows an example of the symbol mapping of the AGC tuning symbol associated with SL-SSB within a slot. The symbol(s) for AGC tuning followed by SL-SSB can be placed in the first symbol of a half-frame to gain more time for AGC tuning. In this case, the SSB location will be relative to the boundary of the half-subframe. Alternatively, SSB location can be any location within a slot.

FIG. 6 shows an example of SSB with GP symbols for beam-switching. The GP (Guard Period) symbol can be placed before and/or after each SL-SSB (including AGC symbol). Especially in case of SL-SSB burst with multiple-beam transmission, at least one GP symbol is needed between two consecutive SL-SSBs within SL-SSB burst for potential analog beam switching at UE.

In case of transmission for a SSB burst composing of multiple SSBs at one time, it can be (pre)configured and/or defined that the multiple SSBs are transmitted with the same analog beams or not. Alternatively, SSB index number can be same if the analog beams are same. The SSB index can be carried in PBCH-DMRS during the sequence generation with the different initialization value.

For PBCH payload information, the slot information may be needed in addition to the (D2D) System Frame Number (DFN) and the subframe number. Such slot information may also depend on the subcarrier spacing to be used for SL-SSB transmission. In case of synchronization to GNSS, UE transmitting SL-SSB has to derive the slot information according to the received GNSS information.

For synchronization based on GNSS, the slot timing can be derived as:

- $DFN = \text{Floor}(0.1 * 0.001 * (T_{\text{current}} - T_{\text{ref}} - \text{offsetDFN})) \bmod 1024$;
- $\text{SubframeNumber} = \text{Floor}(0.001 * (T_{\text{current}} - T_{\text{ref}} - \text{offsetDFN})) \bmod 10$;
- $\text{SlotNumber} = \text{Floor}(0.001 * (T_{\text{current}} - T_{\text{ref}} - \text{OffsetDFN}) * 2^u) \bmod 2^u$,

where

- $u=0,1,2,3$ corresponding to the usage or (pre-)configuration of 15, 30, 60, 120kHz SCS for SL-SSB respectively,

• $T_{\text{current}}(us)$ is the current UTC time that obtained from GNSS, $T_{\text{ref}}(us)$ Is the reference UTC time 00:00:00 on Gregorian calendar date 1 January, 1900 (midnight between Thursday, December 31, 1899 and Friday, January 1, 1900),

- $\text{OffsetDFN}(us \text{ or } ms)$ is the value offsetDFN if configured.

Fig. 7 shows an exemplary block diagram of a UE 800 according to an embodiment of the disclosure. The UE 800 can be configured to implement various embodiments of the disclosure described herein. The UE 800 can include a processor 810, a memory 820, and a radio frequency (RF) module 830 that are coupled together as shown in Fig. 7. In different examples, the UE 800 can be a mobile phone, a tablet computer, a desktop computer, a vehicle carried device, and the like.

The processor 810 can be configured to perform various functions described above with reference to Figs. 1-6. The processor 810 can include signal processing circuitry to process received or to be transmitted data according to communication protocols specified in, for example, LTE and NR standards. Additionally, the processor 810 may execute program instructions, for example, stored in the memory 820, to perform functions related with different communication protocols. The processor 810 can be implemented with suitable hardware, software, or a combination thereof. For example, the processor 810 can be implemented with application specific integrated circuits (ASIC), field programmable gate arrays (FPGA), and the like, that includes circuitry. The circuitry can be configured to perform various functions of the processor 810.

In one example, the memory 820 can store program instructions that, when executed by the processor 810, cause the processor 810 to perform various functions as described herein. The memory 820 can include a read only memory (ROM), a random access memory (RAM), a flash memory, a solid state memory, a hard disk drive, and the like.

The RF module 830 can be configured to receive a digital signal from the processor 810 and accordingly transmit a signal to a base station in a wireless communication network via an antenna 840. In addition, the RF module 830 can be configured to receive a wireless signal from a base station and accordingly generate a digital signal which is provided to the processor 810. The RF module 830 can include digital to analog/analog to digital converters (DAC/ADC), frequency down/up converters, filters, and amplifiers for reception and transmission operations. For example, the RF module 830 can include converter circuits, filter circuits, amplification circuits, and the like, for processing signals on different carriers or bandwidth parts.

The UE 800 can optionally include other components, such as input and output devices, additional CPU or signal processing circuitry, and the like. Accordingly, the UE 800 may be capable of performing other additional functions, such as executing application programs, and processing alternative communication protocols.

The processes and functions described herein can be implemented as a computer program which, when executed by one or more processors, can cause the one or more processors to perform the respective processes and functions. The computer program may be stored or distributed on a suitable medium, such as an optical storage medium or a solid-state medium supplied together with, or as part of, other hardware. The computer program may also be distributed in other forms, such as via the Internet or other wired or wireless telecommunication systems. For example, the computer program can be obtained and loaded into an apparatus, including obtaining the computer program through physical medium or distributed system, including, for example, from a server connected to the Internet.

The computer program may be accessible from a computer-readable medium providing program instructions for use by or in connection with a computer or any instruction execution system. A computer readable medium may include any apparatus that stores, communicates, propagates, or transports the computer program for use by or in connection with an instruction execution system, apparatus, or device. The computer-readable medium can be magnetic, optical, electronic, electromagnetic, infrared, or semiconductor system (or apparatus or device) or a propagation medium. The computer-readable medium may include a computer-readable non-transitory storage medium such as a semiconductor or solid state memory, magnetic tape, a removable computer diskette, a random access memory (RAM), a read-only memory (ROM), a magnetic disk and an optical disk, and the like. The computer-readable non-transitory storage medium can include all types

of computer readable medium, including magnetic storage medium, optical storage medium, flash medium and solid state storage medium.

While aspects of the present disclosure have been described in conjunction with the specific embodiments thereof that are proposed as examples, alternatives, modifications, and variations to the examples may be made.

5 Accordingly, embodiments as set forth herein are intended to be illustrative and not limiting. There are changes that may be made without departing from the scope of the claims set forth below.

CLAIMS

1. A method, comprising:

receiving a configuration or pre-configuration for V2X sidelink synchronization signal block;

performing time/frequency synchronization; and/or

5 performing time synchronization based on GNSS.

2. The method of claim 1, wherein a configuration or pre-configuration for V2X sidelink synchronization signal block is SSB composition including PSS/SSS, PBCH and/or the additional front-loaded symbol(s) for AGC tuning.

3. The method of claim 1, wherein performing time/frequency synchronization including
10 reception/transmission of PSS/SSS and PBCH.

4. The method of claim 2, wherein the front-loaded SSS symbol can be used as the AGC symbol.

5. The method of claim 2, wherein the AGC symbol can be located in the first symbol of half-subframe for more AGC-tuning time due to longer normal CP.

6. The method of claim 2, wherein at least one GP symbol may be (pre)configured or reserved in
15 between two SSB transmissions in a SSB burst for beam switching.

7. The method of claim 1, wherein performing time synchronization based on GNSS can be deriving the slotNumber information based on the (pre-)configuration of subcarrier spacing to be used for SL-SSB.

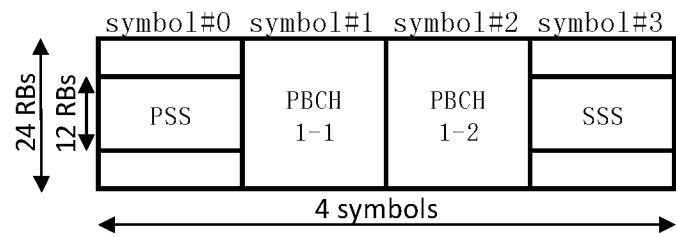


FIG. 1

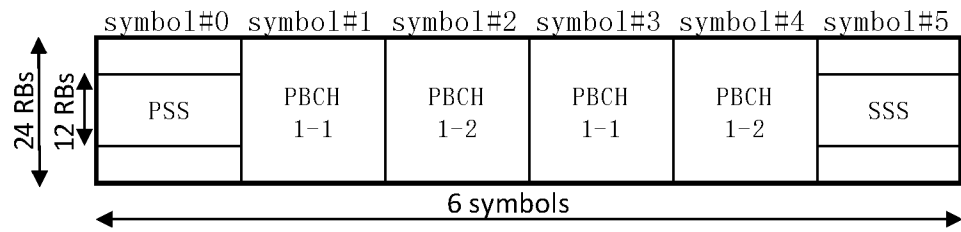


FIG. 2

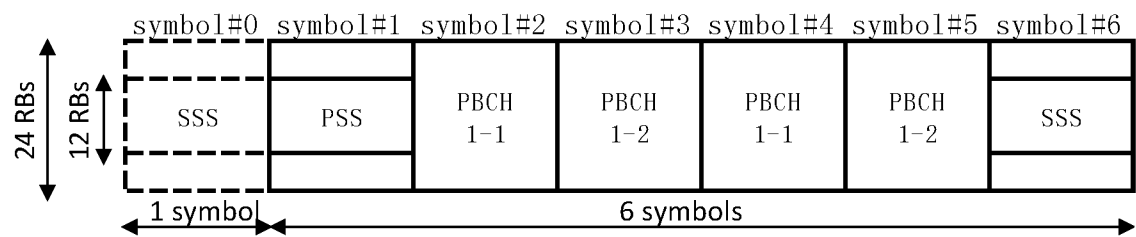


FIG. 3

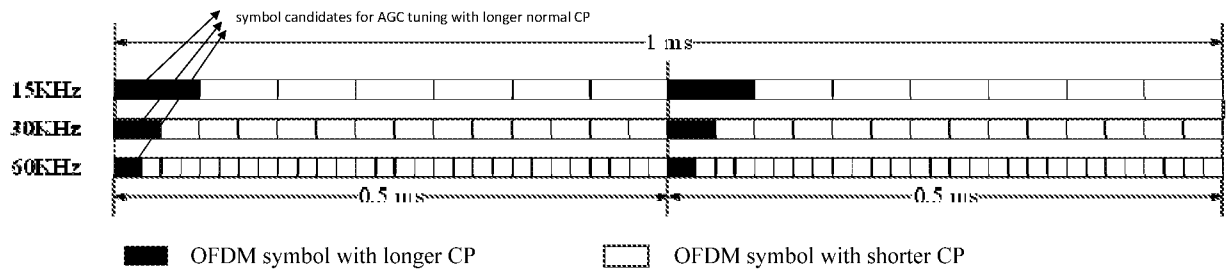


FIG. 4

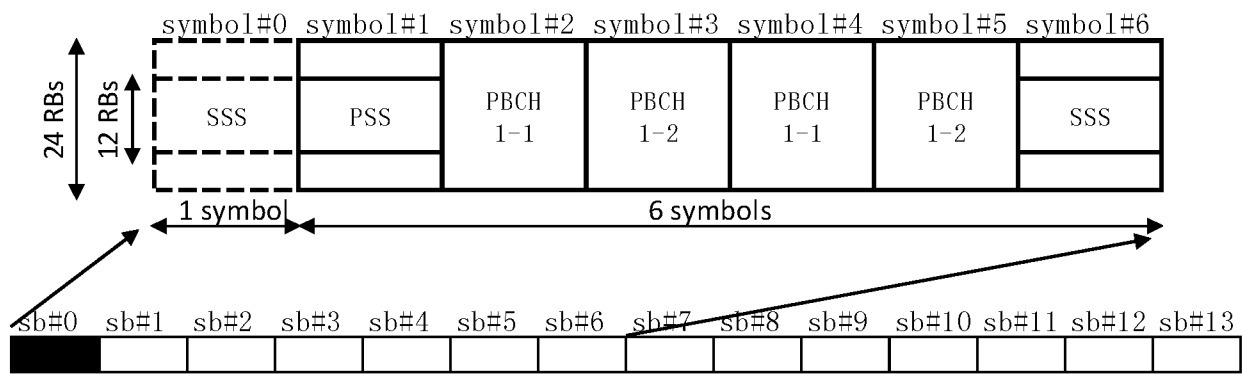


FIG. 5

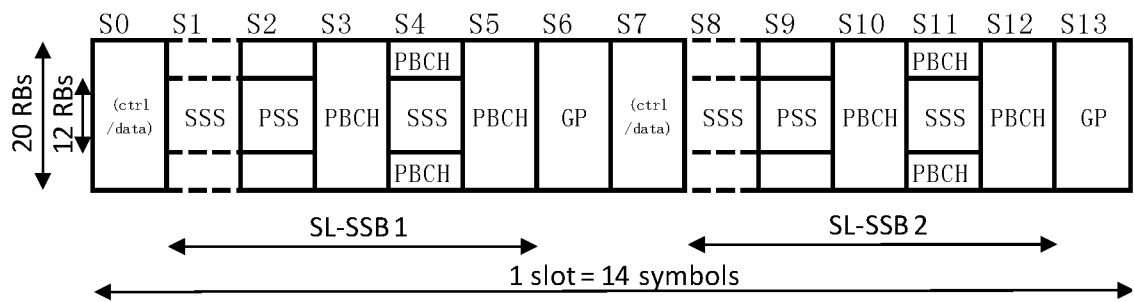


FIG. 6

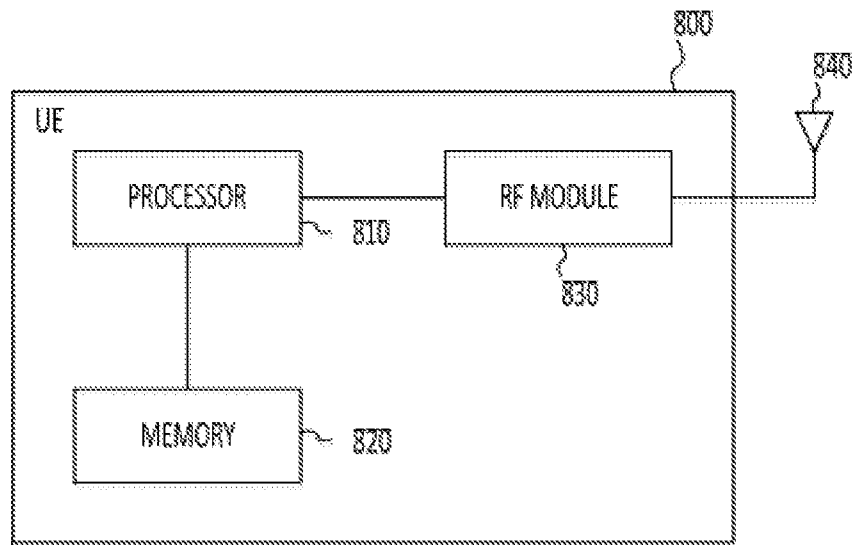


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/071224

A. CLASSIFICATION OF SUBJECT MATTER

H04W 56/00(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W; H04Q7/-; H04M; H04L; H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT, CNABS, CNKI, VEN, USTXT, WOTXT, EPTXT, 3GPP: V2X, sidelink, side link, synchronization, signal, block, SSB, PSS, SSS, PBCH, AGC, GP, GNSS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CATT, . "Offline summary on AI 7.2.4.1.3 Synchronization mechanism" <i>RI-1814147</i> , 19 November 2018 (2018-11-19), parts 2 and 9	1-3, 5-7
X	OPPO, . "Discussion of synchronization mechanism for NR-V2X" <i>RI-1812812</i> , 03 November 2018 (2018-11-03), parts 1 and 2	1-3, 5-7
X	Samsung, . "Discussion on Synchronization Mechanisms for NR V2X" <i>RI-1812986</i> , 02 November 2018 (2018-11-02), part 2	1-3, 5-7
X	CN 109155728 A (XIAO BEIJING XIAOMI MOBILE SOFTWARE CO LTD) 04 January 2019 (2019-01-04) description, paragraphs [0182] - [0398] and figures 1-28	1-3, 7
X	CN 109076478 A (XIAO BEIJING XIAOMI MOBILE SOFTWARE CO LTD) 21 December 2018 (2018-12-21) description, paragraphs [0161] - [0368] and figures 1-23	1-3, 7



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

23 September 2019

Date of mailing of the international search report

29 September 2019

Name and mailing address of the ISA/CN

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Facsimile No. (86-10)62019451

Telephone No. 86-(010)-62412035

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/071224

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 109121214 A (SMSU BEIJING SAMSUNG COMMUNICATION TECHNOLOGY ET AL.) 01 January 2019 (2019-01-01) the whole document	1-7

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2019/071224

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN	109155728	A	04 January 2019	None	
CN	109076478	A	21 December 2018	None	
CN	109121214	A	01 January 2019	None	