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(54) **SYSTEMS AND METHODS TO ADJUST A SOUNDING REFERENCE SIGNAL TIMING OFFSET**

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H04W 12/45	(2021.01)
H04W 74/0808	(2024.01)
H04W 88/06	(2009.01)
H04W 28/02	(2009.01)
H04W 74/0833	(2024.01)

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CPC ***H04W 56/0005*** (2013.01); ***H04W 12/45*** (2021.01); ***H04W 56/0035*** (2013.01); ***H04W 56/005*** (2013.01); ***H04W 74/0825*** (2013.01); ***H04W 88/06*** (2013.01); *H04W 28/0294* (2013.01); *H04W 74/0858* (2013.01)

(58) **Field of Classification Search**

CPC H04W 4/50–60; H04W 88/00–06; H04W 8/18–245

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

10,716,019	B1 *	7/2020	Velusamy	H04W 24/06
2014/0274168	A1 *	9/2014	Xia	H04W 68/005 455/458
2015/0079986	A1 *	3/2015	Nayak	H04W 52/0229 455/435.2
2018/0288732	A1 *	10/2018	Balasubramaniam	H04W 76/19
2020/0128391	A1 *	4/2020	Yun	H04W 68/005
2020/0259683	A1 *	8/2020	Manolakos	G01S 13/878
2020/0374833	A1 *	11/2020	Guo	H04W 68/02

(Continued)

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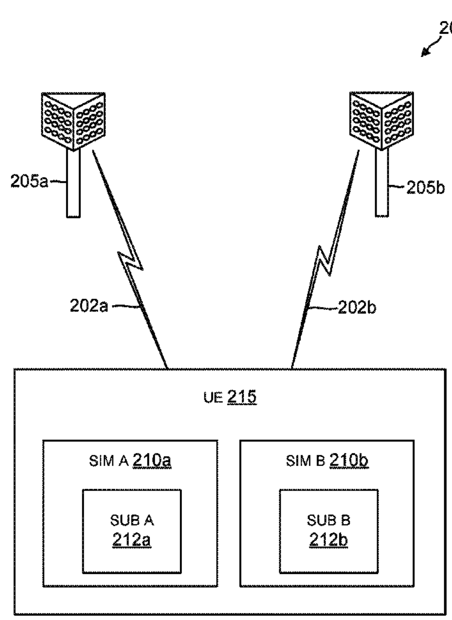
(57) **ABSTRACT**

A method of wireless communication performed by a user equipment (UE) includes: operating in a Dual SIM Dual Standby (DSDS) mode in which a first subscriber identity module (SIM) is designated as a default data subscription (DDS); transmitting a sounding reference signal (SRS) from a communication port of the UE, wherein the SRS has a timing offset assigned by a network associated with the first SIM; receiving paging messages from a network associated with a second SIM; determining an offset adjustment to avoid a collision between the SRS and the paging messages; sending a request to the network associated with the first SIM to adjust the timing offset according to the offset adjustment; and receiving an offset change configuration from the network associated with the first SIM.

21 Claims, 8 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2021/0127256	A1*	4/2021	Li	H04W 60/005
2022/0117018	A1*	4/2022	Gu	H04W 8/183
2022/0303088	A1*	9/2022	Sun	H04L 5/0048

* cited by examiner

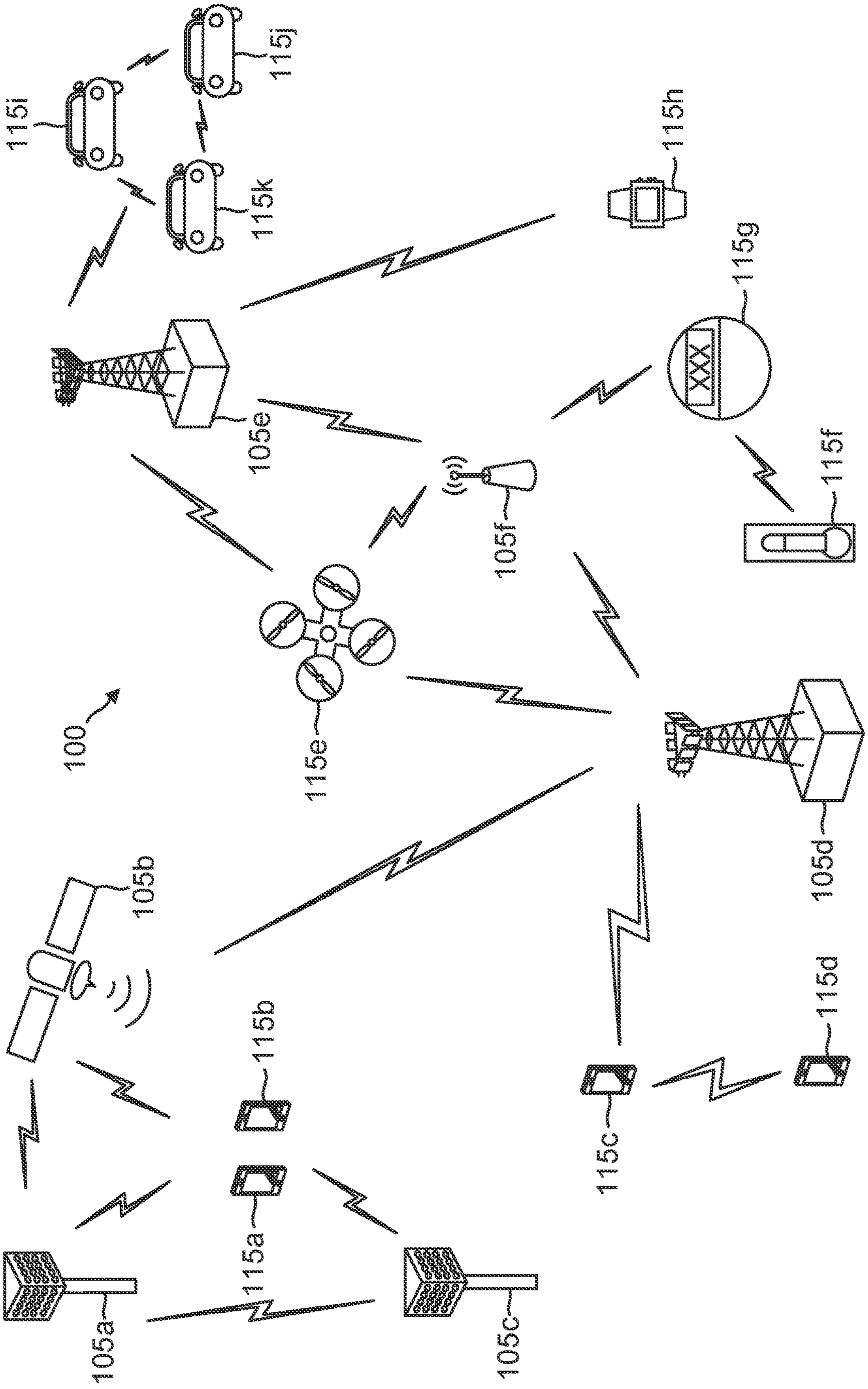

100
105a
105b
105c
105d
105e
105f
115a
115b
115c
115d
115e
115f
115g
115h
115i
115j
115k
XXX

FIG. 1

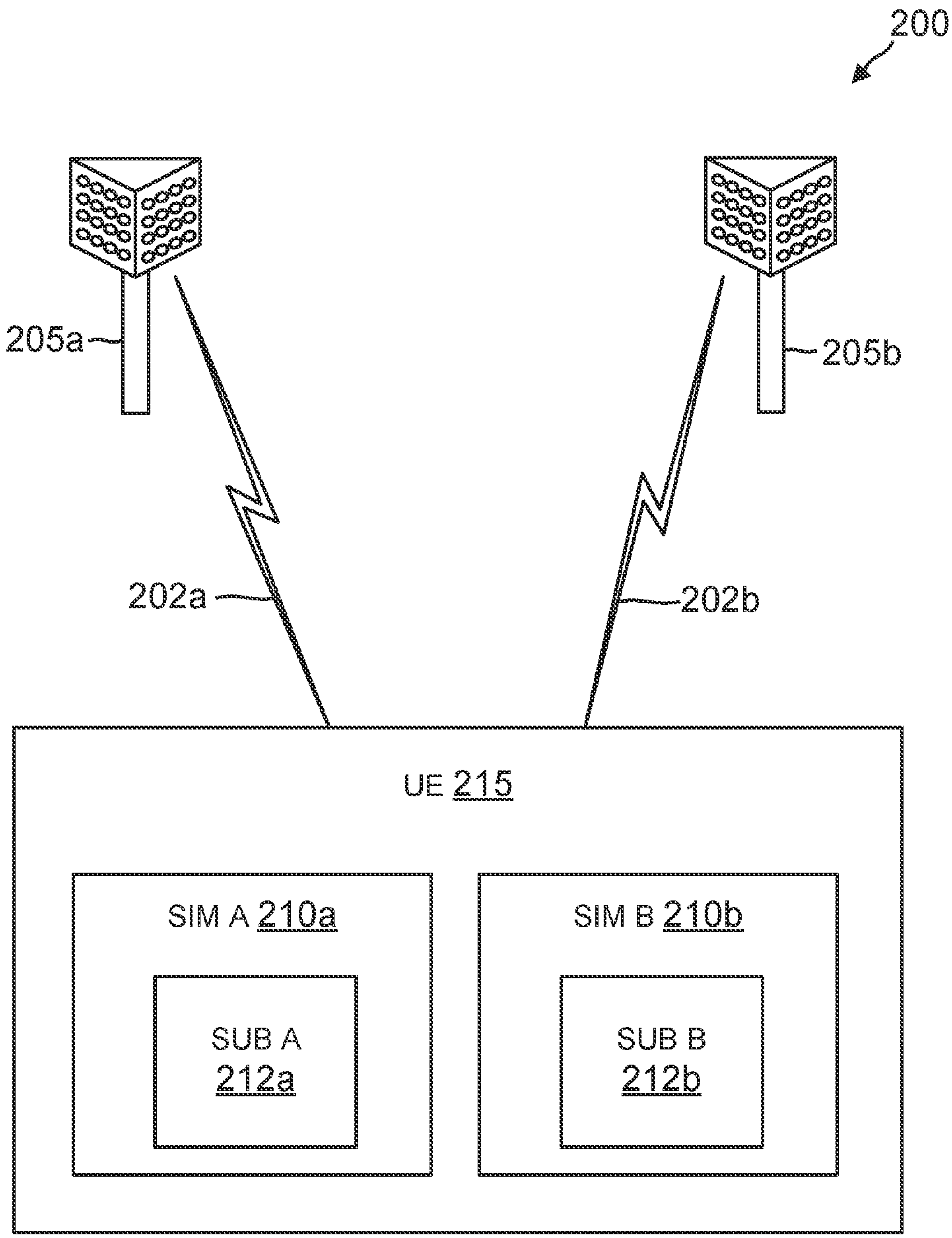

200
205a
205b
202a
202b
UE 215
SIM A 210a
SIM B 210b
SUB A
212a
SUB B
212b

FIG. 2

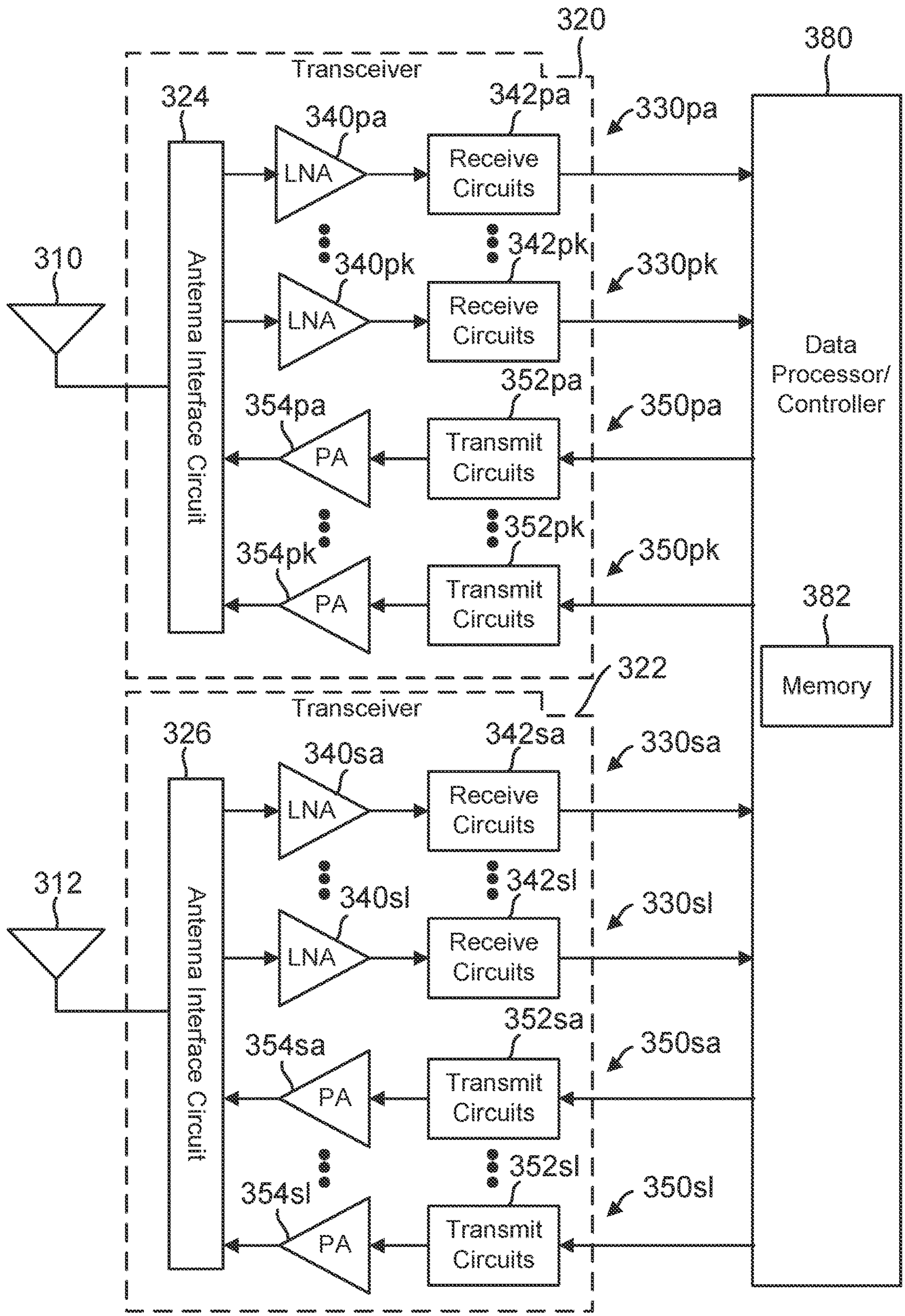

320
380
Transceiver
324
342pa
330pa
340pa
LNA
Receive Circuits
342pk
340pk
330pk
310
LNA
Receive Circuits
Antenna Interface Circuit
Data Processor/ Controller
352pa
354pa
350pa
PA
Transmit Circuits
352pk
354pk
350pk
PA
Transmit Circuits
382
Memory
322
Transceiver
326
342sa
330sa
340sa
LNA
Receive Circuits
342sl
340sl
330sl
312
LNA
Receive Circuits
Antenna Interface Circuit
352sa
354sa
350sa
PA
Transmit Circuits
352sl
354sl
350sl
PA
Transmit Circuits

FIG. 3

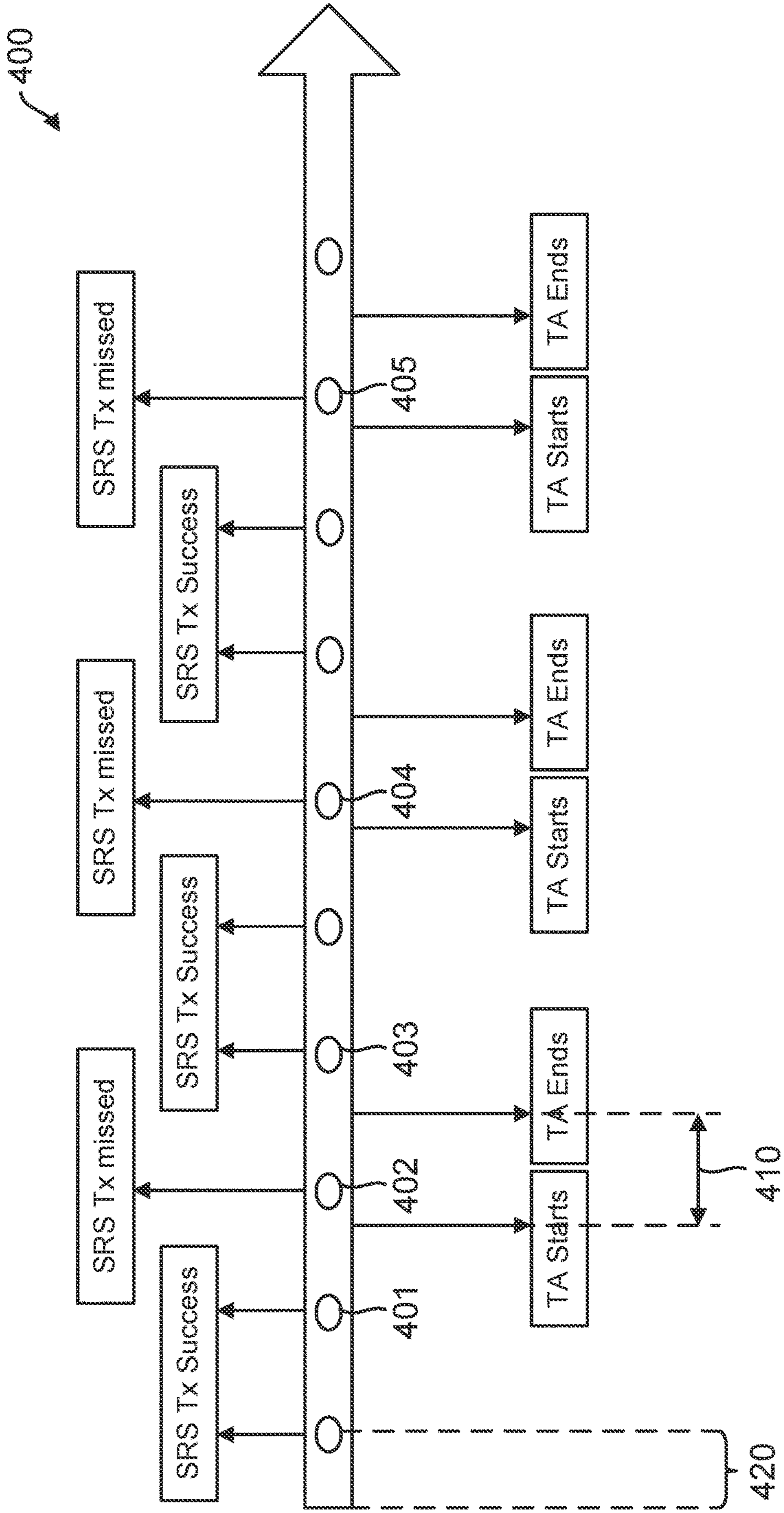

400
SRS Tx Success
SRS Tx missed
SRS Tx Success
SRS Tx Success
SRS Tx missed
SRS Tx Success
SRS Tx Success
SRS Tx missed
401
402
403
404
405
TA Starts
TA Ends
TA Starts
TA Ends
TA Starts
TA Ends
410
420

FIG. 4

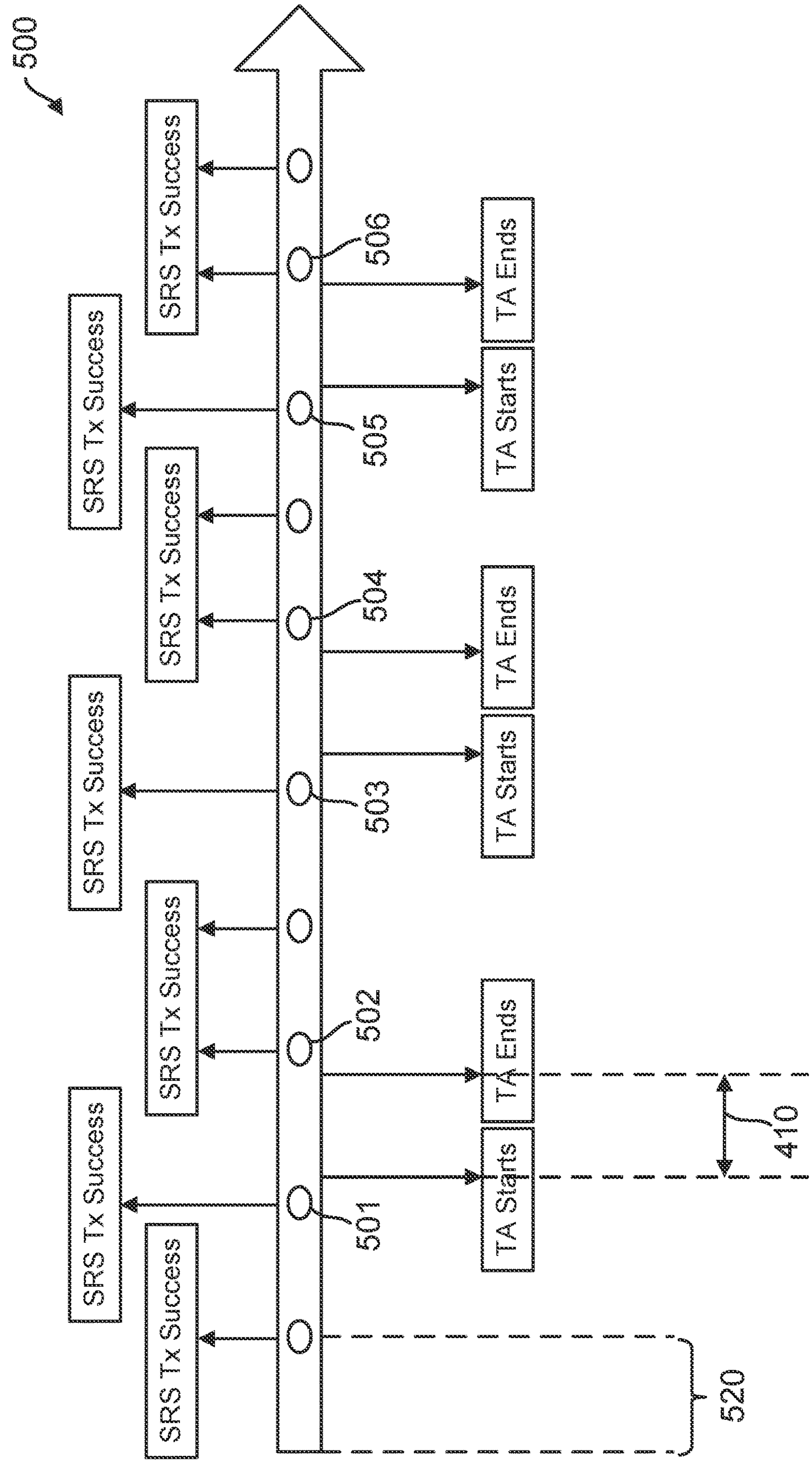

500
SRS Tx Success
SRS Tx Success
SRS Tx Success
SRS Tx Success
SRS Tx Success
SRS Tx Success
SRS Tx Success
SRS Tx Success
SRS Tx Success
506
505
504
503
502
501
TA Ends
TA Starts
TA Ends
TA Starts
TA Ends
TA Starts
410
520

FIG. 5

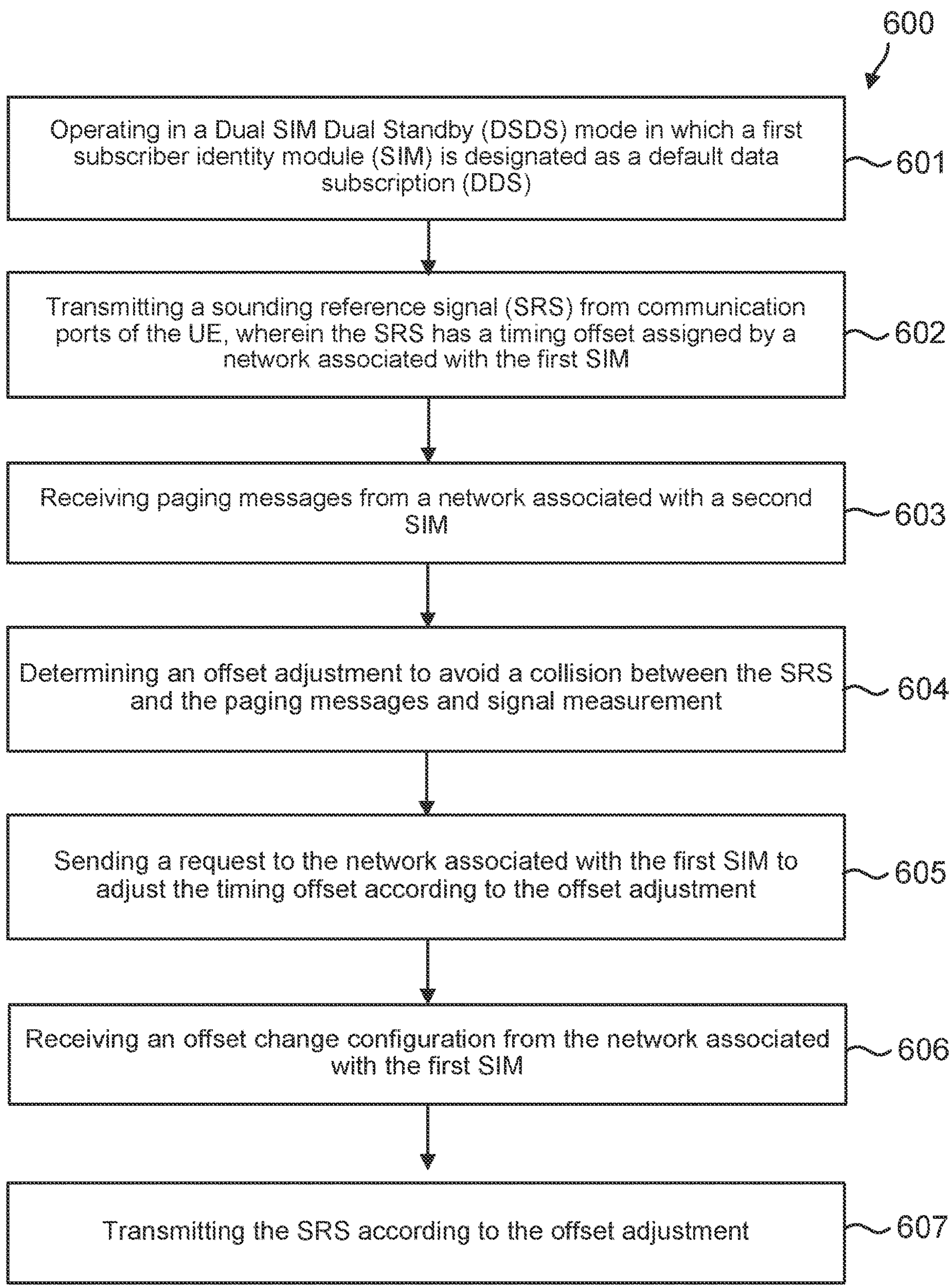

600
Operating in a Dual SIM Dual Standby (DSDS) mode in which a first subscriber identity module (SIM) is designated as a default data subscription (DDS)
601
Transmitting a sounding reference signal (SRS) from communication ports of the UE, wherein the SRS has a timing offset assigned by a network associated with the first SIM
602
Receiving paging messages from a network associated with a second SIM
603
Determining an offset adjustment to avoid a collision between the SRS and the paging messages and signal measurement
604
Sending a request to the network associated with the first SIM to adjust the timing offset according to the offset adjustment
605
Receiving an offset change configuration from the network associated with the first SIM
606
Transmitting the SRS according to the offset adjustment
607

FIG. 6

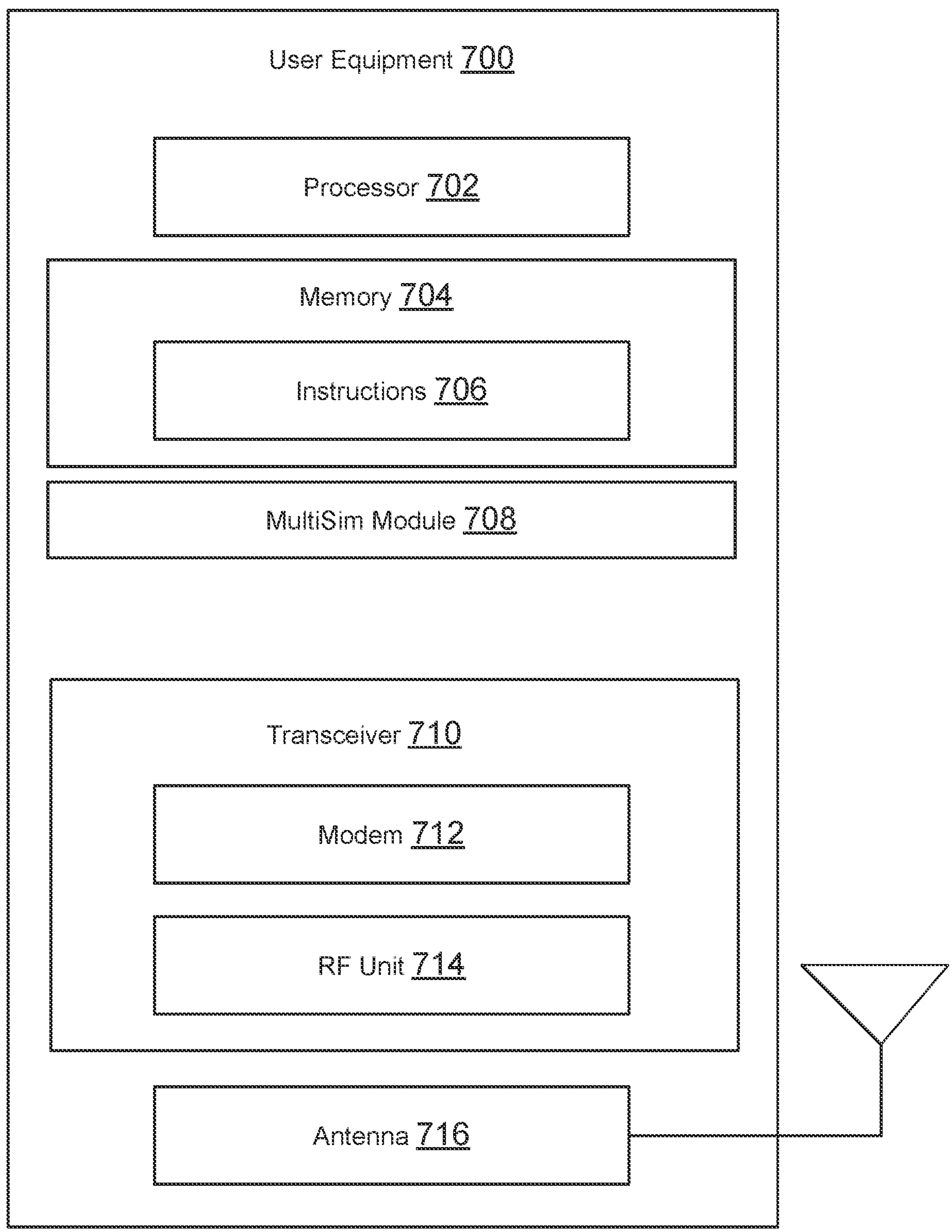

User Equipment 700
Processor 702
Memory 704
Instructions 706
MultiSim Module 708
Transceiver 710
Modem 712
RF Unit 714
Antenna 716

FIG. 7

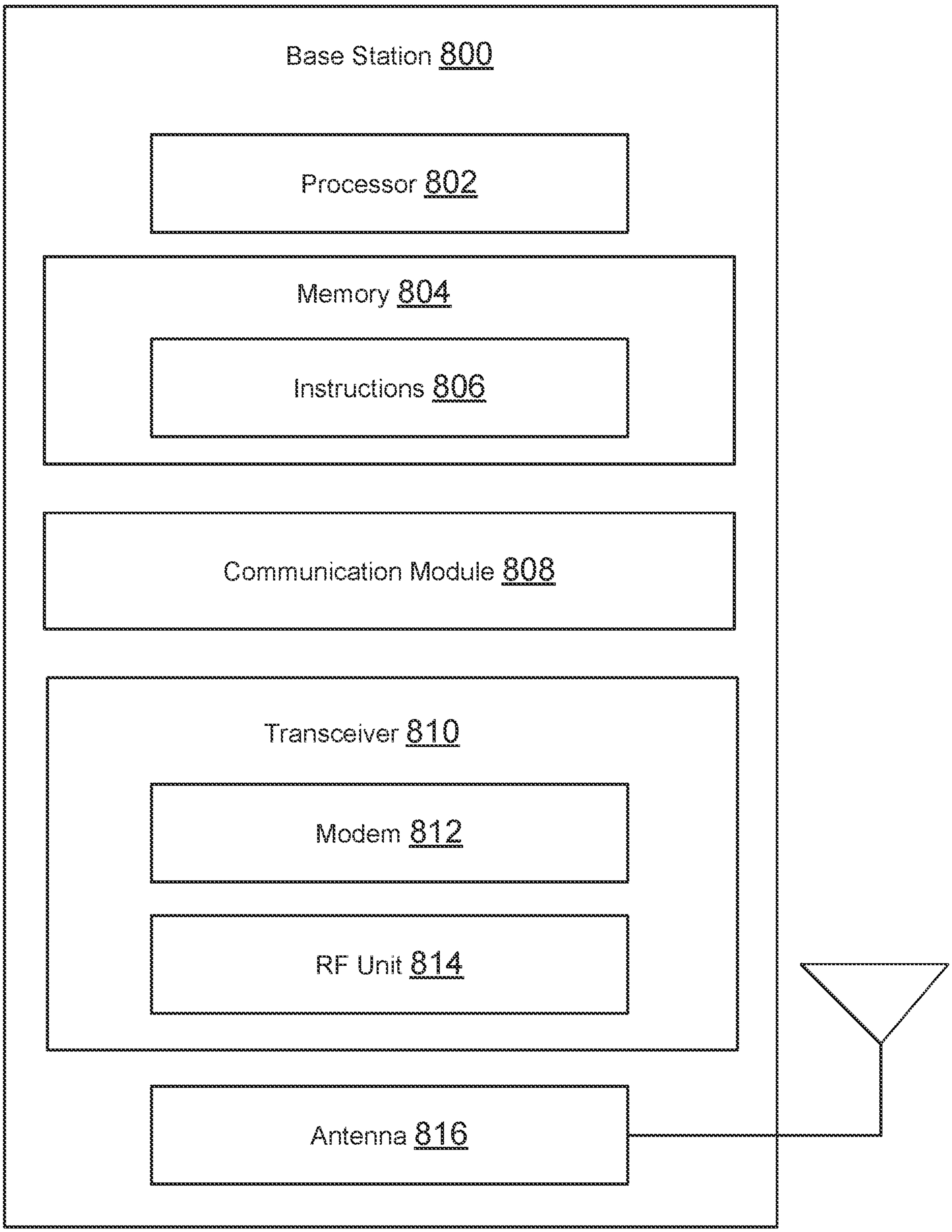

Base Station 800
Processor 802
Memory 804
Instructions 806
Communication Module 808
Transceiver 810
Modem 812
RF Unit 814
Antenna 816

FIG. 8

SYSTEMS AND METHODS TO ADJUST A SOUNDING REFERENCE SIGNAL TIMING OFFSET

TECHNICAL FIELD

This application relates to wireless communication systems, and more particularly adjusting a sounding reference signal timing offset in multi-subscriber identity module (MultiSim) devices.

INTRODUCTION

Wireless communications systems are widely deployed to provide various types of communication content such as voice, video, packet data, messaging, broadcast, and so on. These systems may be capable of supporting communication with multiple users by sharing the available system resources (e.g., time, frequency, and power). A wireless multiple-access communications system may include a number of base stations (BSs), each simultaneously supporting communications for multiple communication devices, which may be otherwise known as user equipment (UE).

To meet the growing demands for expanded mobile broadband connectivity, wireless communication technologies are advancing from the long term evolution (LTE) technology to a next generation new radio (NR) technology, which may be referred to as 5^{th} Generation (5G). For example, NR is designed to provide a lower latency, a higher bandwidth or a higher throughput, and a higher reliability than LTE. NR is designed to operate over a wide array of spectrum bands, for example, from low-frequency bands below about 1 gigahertz (GHz) and mid-frequency bands from about 1 GHz to about 6 GHz, to high-frequency bands such as millimeter wave (mmWave) bands. NR is also designed to operate across different spectrum types, from licensed spectrum to unlicensed and shared spectrum. Furthermore, as wireless communication becomes cheaper and more reliable, expectations among consumers change. Some UE manufacturers are responding to consumer preferences by including multiple subscriber identity modules (SIMS) within UEs.

However, including multiple SIMS within a device may lead to scenarios in which activities by one SIM may interfere with or preclude activities by the other SIM. There is a need in the art for techniques to manage use of multiple subscriptions in multi-SIM devices.

BRIEF SUMMARY OF SOME EXAMPLES

The following summarizes some aspects of the present disclosure to provide a basic understanding of the discussed technology. This summary is not an extensive overview of all contemplated features of the disclosure and is intended neither to identify key or critical elements of all aspects of the disclosure nor to delineate the scope of any or all aspects of the disclosure. Its sole purpose is to present some concepts of one or more aspects of the disclosure in summary form as a prelude to the more detailed description that is presented later.

In one aspect of the disclosure, a method of wireless communication performed by a user equipment (UE) includes: operating in a Dual SIM Dual Standby (DSDS) mode in which a first subscriber identity module (SIM) is designated as a default data subscription (DDS); transmitting a sounding reference signal (SRS) from a communication port of the UE, wherein the SRS has a timing offset assigned by a network associated with the first SIM; receiving paging messages from a network associated with a second SIM; determining an offset adjustment to avoid a collision between the SRS and the paging messages; sending a request to the network associated with the first SIM to adjust the timing offset according to the offset adjustment; and receiving an offset change configuration from the network associated with the first SIM.

In an additional aspect of the disclosure, a user equipment (UE) includes: a first subscriber identity module (SIM) and a second SIM; means for operating the first SIM in an active-mode and operating the second SIM in an idle mode; means for generating a request to reconfigure a timing offset of a sounding reference signal (SRS) associated with the first SIM, including calculating a number of slots for adjusting the timing offset to avoid collision with paging decode and signal measurement associated with the second SIM; means for receiving configuration information from a network serving the first SIM, the configuration information adjusting the timing offset in accordance with the request; and means for transmitting the SRS according to the configuration information.

In an additional aspect of the disclosure, a non-transitory computer-readable medium having program code recorded thereon for wireless communication by a UE, the program code includes: for an active-mode subscriber identity module (SIM) of the UE; code for performing a radio frequency (RF) tune away to accommodate decoding paging signals and received signal measurement for an idle-mode SIM of the UE, wherein the RF tune away collides with an SRS occurrence; code for generating a request for adjustment of the timing offset to avoid collision of the RF tune away and the SRS occurrence; code for transmitting the request for adjustment to a network serving the active-mode SIM; and code for adjusting the timing offset in response to receipt of configuration information from the network serving the active-mode SIM.

In an additional aspect of the disclosure, a UE includes a first subscriber identity module (SIM) associated with a first service provider subscription and a second SIM associated with a second service provider subscription; a modem configured to interface with a base station; and a processor configured to interface with the modem and to access the first SIM and the second SIM, wherein the modem is further configured to: operate in a Dual SIM Dual Standby (DSDS) mode in which the first SIM is in an active-mode and the second SIM is in an idle mode; transmitting a sounding reference signal (SRS) from a communication port of the UE, wherein the SRS has a timing offset assigned by a network associated with the first SIM; performing signal measurement with respect to a signal received from a network associated with a second SIM; determining an offset adjustment to avoid a collision between the SRS and the signal measurement; sending a request to the network associated with the first SIM to adjust the timing offset according to the offset adjustment; and receiving an offset change configuration from the network associated with the first SIM.

Other aspects, features, and embodiments will become apparent to those of ordinary skill in the art, upon reviewing the following description of specific, exemplary aspects in conjunction with the accompanying figures. While features may be discussed relative to certain aspects and figures below, all aspects can include one or more of the advantageous features discussed herein. In other words, while one or more aspects may be discussed as having certain advantageous features, one or more of such features may also be used in accordance with the various aspects discussed herein. In similar fashion, while exemplary aspects may be discussed below as device, system, or method aspects it should be understood that such exemplary aspects can be implemented in various devices, systems, and methods.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a wireless communication network according to some aspects of the present disclosure.

FIG. **2** illustrates a communication scenario utilizing multiple subscriptions according to some aspects of the present disclosure.

FIG. **3** is a block diagram of a hardware architecture of a UE, such as the UEs of FIGS. **1-2**, according to some aspects of the present disclosure.

FIGS. **4-5** are example timelines for transmitting and receiving in a multi-SIM device, according to some aspects of the disclosure.

FIG. **6** is a diagram of an example method for adjusting a timing offset of a sounding reference signal (SRS), according to some aspects of the present disclosure.

FIG. **7** illustrates a block diagram of a user equipment (UE) according to some aspects of the present disclosure.

FIG. **8** illustrates a block diagram of a base station (BS) according to some aspects of the present disclosure.

DETAILED DESCRIPTION

The detailed description set forth below, in connection with the appended drawings, is intended as a description of various configurations and is not intended to represent the only configurations in which the concepts described herein may be practiced. The detailed description includes specific details for the purpose of providing a thorough understanding of the various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. In some aspects, well-known structures and components are shown in block diagram form in order to avoid obscuring such concepts.

This disclosure relates generally to wireless communications systems, also referred to as wireless communications networks. In various aspects, the techniques and apparatus may be used for wireless communication networks such as code division multiple access (CDMA) networks, time division multiple access (TDMA) networks, frequency division multiple access (FDMA) networks, orthogonal FDMA (OFDMA) networks, single-carrier FDMA (SC-FDMA) networks, LTE networks, Global System for Mobile Communications (GSM) networks, 5^{th} Generation (5G) or new radio (NR) networks, as well as other communications networks. As described herein, the terms "networks" and "systems" may be used interchangeably.

An OFDMA network may implement a radio technology such as evolved UTRA (E-UTRA), Institute of Electrical and Electronics Engineers (IEEE) 802.11, IEEE 802.16, IEEE 802.20, flash-OFDM and the like. UTRA, E-UTRA, and GSM are part of universal mobile telecommunication system (UMTS). In particular, long term evolution (LTE) is a release of UMTS that uses E-UTRA. UTRA, E-UTRA, GSM, UMTS and LTE are described in documents provided from an organization named "3rd Generation Partnership Project" (3GPP), and cdma2000 is described in documents from an organization named "3rd Generation Partnership Project 2" (3GPP2). These various radio technologies and standards are known or are being developed. For example, the 3rd Generation Partnership Project (3GPP) is a collaboration between groups of telecommunications associations that aims to define a globally applicable third generation (3G) mobile phone specification. 3GPP long term evolution (LTE) is a 3GPP project which was aimed at improving the UMTS mobile phone standard. The 3GPP may define specifications for the next generation of mobile networks, mobile systems, and mobile devices. The present disclosure is concerned with the evolution of wireless technologies from LTE, 4G, 5G, NR, and beyond with shared access to wireless spectrum between networks using a collection of new and different radio access technologies or radio air interfaces.

In particular, 5G networks contemplate diverse deployments, diverse spectrum, and diverse services and devices that may be implemented using an OFDM-based unified, air interface. To achieve these goals, further enhancements to LTE and LTE-A are considered in addition to development of the new radio technology for 5G NR networks. The 5G NR will be capable of scaling to provide coverage (1) to a massive Internet of things (IoTs) with a ULtra-high density (e.g., ~1M nodes/km^2), ultra-low complexity (e.g., ~10s of bits/sec), ultra-low energy (e.g., —10+ years of battery life), and deep coverage with the capability to reach challenging locations; (2) including control with strong security to safeguard sensitive personal, financial, or classified information, ultra-high reliability (e.g., ~99.9999% reliability), ultra-low latency (e.g., ~1 ms), and users with wide ranges of mobility or lack thereof; and (3) with enhanced mobile broadband including extreme high capacity (e.g., ~10 Tbps/km^2), extreme data rates (e.g., multi-Gbps rate, 100+ Mbps user experienced rates), and deep awareness with advanced discovery and optimizations.

A 5G NR system may be implemented to use optimized OFDM-based waveforms with scalable numerology and transmission time interval (TTI); having a common, flexible framework to efficiently multiplex services and features with a dynamic, low-latency time division duplex (TDD)/frequency division duplex (FDD) design; and with advanced wireless technologies, such as massive multiple input, multiple output (MIMO), robust millimeter wave (mmWave) transmissions, advanced channel coding, and device-centric mobility. Scalability of the numerology in 5G NR, with scaling of subcarrier spacing, may efficiently address operating diverse services across diverse spectrum and diverse deployments. For example, in various outdoor and macro coverage deployments of less than 3 GHz FDD/TDD implementations, subcarrier spacing may occur with 15 kHz, for example over 5, 10, 20 MHz, and the like bandwidth (BW). For other various outdoor and small cell coverage deployments of TDD greater than 3 GHz, subcarrier spacing may occur with 30 kHz over 80/100 MHz BW. For other various indoor wideband implementations, using a TDD over the unlicensed portion of the 5 GHz band, the subcarrier spacing may occur with 60 kHz over a 160 MHz BW. Finally, for various deployments transmitting with mmWave components at a TDD of 28 GHz, subcarrier spacing may occur with 120 kHz over a 500 MHz BW. In certain aspects, frequency bands for 5G NR are separated into two different frequency ranges, a frequency range one (FR1) and a frequency range two (FR2). FR1 bands include frequency bands at 7 GHz or lower (e.g., between about 410 MHz to about 7125 MHz). FR2 bands include frequency bands in mmWave ranges between about 24.25 GHz and about 52.6 GHz. The mmWave bands may have a shorter range, but a higher bandwidth than the FR1 bands. Additionally, 5G NR may support different sets of subcarrier spacing for different frequency ranges.

The scalable numerology of the 5G NR facilitates scalable TTI for diverse latency and quality of service (QoS) requirements. For example, shorter TTI may be used for low latency and high reliability, while longer TTI may be used for higher spectral efficiency. The efficient multiplexing of long and short TTIs to allow transmissions to start on symbol boundaries. 5G NR also contemplates a self-contained integrated subframe design with UL/downlink scheduling information, data, and acknowledgement in the same subframe. The self-contained integrated subframe supports communications in unlicensed or contention-based shared spectrum, adaptive UL/downlink that may be flexibly configured on a per-cell basis to dynamically switch between UL and downlink to meet the current traffic needs.

Various other aspects and features of the disclosure are further described below. It should be apparent that the teachings herein may be embodied in a wide variety of forms and that any specific structure, function, or both being disclosed herein is merely representative and not limiting. Based on the teachings herein one of an ordinary level of skill in the art should appreciate that an aspect disclosed herein may be implemented independently of any other aspects and that two or more of these aspects may be combined in various ways. For example, an apparatus may be implemented or a method may be practiced using any number of the aspects set forth herein. In addition, such an apparatus may be implemented or such a method may be practiced using other structure, functionality, or structure and functionality in addition to or other than one or more of the aspects set forth herein. For example, a method may be implemented as part of a system, device, apparatus, and/or as instructions stored on a computer readable medium for execution on a processor or computer. Furthermore, an aspect may comprise at least one element of a claim.

In certain aspects, a wireless communication device or UE is a multiple SIM (MultiSim) device capable of utilizing multiple subscriptions for communication with one or more networks. For instance, the UE may include two SIMS, a first SIM for a first subscription and a second SIM for a second subscription. In some instances, the first and second subscriptions may be provided by the same operator. For example, the first subscription and the second subscription may correspond to different user accounts and/or services on the same operator network. In other instances, the first and second subscriptions may be provided by different operators. In any case, in certain scenarios, the UE may communicate using the first subscription and/or the second subscription. In some instances, the UE may operate in a dual-SIM dual-standby (DSDS) mode, where both subscriptions can be on standby (in an idle mode) waiting to begin communications. However, when a communication or network connection is established on one SIM (e.g., the first subscription), the other SIM (e.g., the second subscription) is no longer active. That is, one SIM may be active at a given time. The DSDS mode may be suitable for UEs that are equipped with a single transceiver and/or radio frequency (RF) chain which can either be utilized by the first subscription or the second subscription. In other instances, the UE may operate in a dual-SIM dual-active (DSDA) mode, where the UE may simultaneously connect to the same network or different networks via the first SIM and the second SIM. To operate in the DSDA mode, the UE may have separate transceiver and/or RF chains or resources for the first SIM and the second SIM. In the present disclosure, an operation or communication performed via a SIM may refer to an operation or communication performed for a wireless service subscription associated with the SIM (where the subscription information for the wireless service is stored).

For a multi-SIM device, one of the SIMS/subscriptions carries the internet data traffic, and it is referred to as the default data subscription (DDS) The other subscription—nDDS—is mainly used for voice and short message service (SMS). The user chooses which subscription is the DDS, and the user may change the DDS through a user interface (UI) of the UE.

For a multi-SIM device in DSDS mode, there may be periodic sharing of the UE's radio frequency (RF) resources between the two subscriptions for signal transmission on one subscription and decoding pages and performing measurements in idle mode on the other subscription. Such periodic sharing may result in undesirable loss of downlink throughput in some instances, as described below.

Sounding reference signal (SRS) periodicity can vary from 10 ms to 160 ms as configured by the network in some examples. If the periodicity of SRS is 80 ms, until the time another SRS occasion falls, the network may not be able to assess the condition of the UE receive ports for another 80 ms. Due to sharing of the RF resources to the other subscription, SRS transmission from a first subscription (e.g., the DDS) may be suspended while the RF resources tune away for page decode and measurement for the other subscription (e.g., the nDDS). If the SRS occasion falls during the tune away duration, there may be no transmission of SRS for a given receive (RX) port from the UE side. The network may then penalize the DDS in terms of downlink (DL) modulation and coding scheme (MCS) and resource blocks (RBs) for not receiving the SRS at the expected occasion resulting in the throughput degradation.

In fact, some network operators are aggressive in penalizing the UE due to SRS suspension. One operator in particular takes around 200 ms to recover to the same MCS which was prior to the opening of the tune away gap corresponding to a missing SRS. If the periodicity of the page decode on the nDDS is as low as 320 ms, then for more than 75% of the time, the DDS may be served with lesser MCS and RBs, resulting in DL throughput degradation of about ~30% when compared to a single SIM device.

In some implementations, a UE may detect that an SRS occasion of a first subscription is in collision with a periodic gap associated with page decode and measurement of a second subscription. Or put another way, the UE may detect that the SRS occasion falls within a tune away time corresponding to page decode and measurement. The UE may then indicate to the network to change an offset of the SRS occasion.

Continuing with the example, the network may receive the indication from the UE and then change the SRS offset in a subsequent radio resource control (RRC) configuration message. The new SRS offset timing may be selected so that the SRS occasion does not fall inside the tune away period of the second subscription. In one example, the UE may send the SRS timing offset change indication in a media access control (MAC) control element (CE). While this example refers to an RRC configuration message and a MAC CE indication, the scope of implementations may include any appropriate message or element to implement an SRS timing offset adjustment.

Furthermore, various implementations the UE may calculate a change in the timing offset based on a location of the SRS occasion within the tune away duration. In one example, the SRS occasion may be postponed or pre-poned as appropriate and according to a numerology used by the DDS.

Various implementations may include advantages. For instance, implementations providing for SRS offset timing adjustment may experience greater DL throughput to the DDS compared to a multi-SIM device that is unable to request an SRS offset timing adjustment. The greater DL throughput may lead to more efficient operation of the DDS as well as greater user satisfaction.

FIG. **1** illustrates a wireless communication network **100** according to some aspects of the present disclosure. The network **100** may be a 5G network. The network **100** includes a number of base stations (BSs) **105** (individually labeled as **105***a*, **105***b*, **105***c*, **105***d*, **105***e*, and **105***f*) and other network entities. ABS **105** may be a station that communicates with UEs **115** (individually labeled as **115***a*, **115***b*, **115***c*, **115***d*, **115***e*, **115***f*, **115***g*, **115***h*, and **115***k*) and may also be referred to as an evolved node B (eNB), a next generation eNB (gNB), an access point, and the like. Each BS **105** may provide communication coverage for a particular geographic area. In 3GPP, the term "cell" can refer to this particular geographic coverage area of a BS **105** and/or a BS subsystem serving the coverage area, depending on the context in which the term is used.

ABS **105** may provide communication coverage for a macro cell or a small cell, such as a pico cell or a femto cell, and/or other types of cell. A macro cell generally covers a relatively large geographic area (e.g., several kilometers in radius) and may allow unrestricted access by UEs with service subscriptions with the network provider. A small cell, such as a pico cell, would generally cover a relatively smaller geographic area and may allow unrestricted access by UEs with service subscriptions with the network provider. A small cell, such as a femto cell, would also generally cover a relatively small geographic area (e.g., a home) and, in addition to unrestricted access, may also provide restricted access by UEs having an association with the femto cell (e.g., UEs in a closed subscriber group (CSG), UEs for users in the home, and the like). A BS for a macro cell may be referred to as a macro BS. A BS for a small cell may be referred to as a small cell BS, a pico BS, a femto BS or a home BS. In the example shown in FIG. **1**, the BSs **105***d* and **105***e* may be regular macro BSs, while the BSs **105***a*-**105***c* may be macro BSs enabled with one of three dimension (3D), full dimension (FD), or massive MIMO. The BSs **105***a*-**105***c* may take advantage of their higher dimension MIMO capabilities to exploit 3D beamforming in both elevation and azimuth beamforming to increase coverage and capacity. The BS **105***f* may be a small cell BS which may be a home node or portable access point. A BS **105** may support one or multiple (e.g., two, three, four, and the like) cells.

The network **100** may support synchronous or asynchronous operation. For synchronous operation, the BSs may have similar frame timing, and transmissions from different BSs may be approximately aligned in time. For asynchronous operation, the BSs may have different frame timing, and transmissions from different BSs may not be aligned in time.

The UEs **115** are dispersed throughout the wireless network **100**, and each UE **115** may be stationary or mobile. A UE **115** may also be referred to as a terminal, a mobile station, a subscriber unit, a station, or the like. A UE **115** may be a cellular phone, a personal digital assistant (PDA), a wireless modem, a wireless communication device, a handheld device, a tablet computer, a laptop computer, a cordless phone, a wireless local loop (WLL) station, or the like. In one aspect, a UE **115** may be a device that includes a Universal Integrated Circuit Card (UICC). In another aspect, a UE may be a device that does not include a UICC. In some aspects, the UEs **115** that do not include UICCs may also be referred to as IoT devices or internet of everything (IoE) devices. The UEs **115***a*-**115***d* are examples of mobile smart phone-type devices accessing network **100**. A UE **115** may also be a machine specifically configured for connected communication, including machine type communication (MTC), enhanced MTC (eMTC), narrowband IoT (NB-IoT) and the like. The UEs **115***e*-**115***h* are examples of various machines configured for communication that access the network **100**. The UEs **115***i*-**115***k* are examples of vehicles equipped with wireless communication devices configured for communication that access the network **100**. A UE **115** may be able to communicate with any type of the BSs, whether macro BS, small cell, or the like. In FIG. **1**, a lightning bolt (e.g., communication links) indicates wireless transmissions between a UE **115** and a serving BS **105**, which is a BS designated to serve the UE **115** on the downlink (DL) and/or uplink (UL), desired transmission between BSs **105**, backhaul transmissions between BSs, or sidelink transmissions between UEs **115**.

In operation, the BSs **105***a*-**105***c* may serve the UEs **115***a* and **115***b* using 3D beamforming and coordinated spatial techniques, such as coordinated multipoint (CoMP) or multi-connectivity. The macro BS **105***d* may perform backhaul communications with the BSs **105***a*-**105***c*, as well as small cell, the BS **105***f*. The macro BS **105***d* may also transmits multicast services which are subscribed to and received by the UEs **115***c* and **115***d*. Such multicast services may include mobile television or stream video, or may include other services for providing community information, such as weather emergencies or alerts, such as Amber alerts or gray alerts.

The BSs **105** may also communicate with a core network. The core network may provide user authentication, access authorization, tracking, Internet Protocol (IP) connectivity, and other access, routing, or mobility functions. At least some of the BSs **105** (e.g., which may be an example of a gNB or an access node controller (ANC)) may interface with the core network through backhaul links (e.g., NG-C, NG-U, etc.) and may perform radio configuration and scheduling for communication with the UEs **115**. In various examples, the BSs **105** may communicate, either directly or indirectly (e.g., through core network), with each other over backhaul links (e.g., X1, X2, etc.), which may be wired or wireless communication links.

The network **100** may also support communications with ultra-reliable and redundant links for devices, such as the UE **115***e*, which may be airborne. Redundant communication links with the UE **115***e* may include links from the macro BSs **105***d* and **105***e*, as well as links from the small cell BS **105***f*. Other machine type devices, such as the UE **115***f* (e.g., a thermometer), the UE **115***g* (e.g., smart meter), and UE **115***h* (e.g., wearable device) may communicate through the network **100** either directly with BSs, such as the small cell BS **105***f*, and the macro BS **105***e*, or in multi-action-size configurations by communicating with another user device which relays its information to the network, such as the UE **115***f* communicating temperature measurement information to the smart meter, the UE **115***g*, which is then reported to the network through the small cell BS **105***f*. The network **100** may also provide additional network efficiency through dynamic, low-latency TDD/FDD communications, such as V2V, V2X, C-V2X communications between a UE **115***i*,

115*j*, or **115***k* and other UEs **115**, and/or vehicle-to-infrastructure (V2I) communications between a UE **115***i*, **115***j*, or **115***k* and a BS **105**.

In some implementations, the network **100** utilizes OFDM-based waveforms for communications. An OFDM-based system may partition the system BW into multiple (K) orthogonal subcarriers, which are also commonly referred to as subcarriers, tones, bins, or the like. Each subcarrier may be modulated with data. In some aspects, the subcarrier spacing between adjacent subcarriers may be fixed, and the total number of subcarriers (K) may be dependent on the system BW. The system BW may also be partitioned into subbands. In other aspects, the subcarrier spacing and/or the duration of TTIs may be scalable.

In some aspects, the BSs **105** can assign or schedule transmission resources (e.g., in the form of time-frequency resource blocks (RB)) for downlink (DL) and uplink (UL) transmissions in the network **100**. DL refers to the transmission direction from a BS **105** to a UE **115**, whereas UL refers to the transmission direction from a UE **115** to a BS **105**. The communication can be in the form of radio frames. A radio frame may be divided into a plurality of subframes or slots, for example, about 10. Each slot may be further divided into mini-slots. In a FDD mode, simultaneous UL and DL transmissions may occur in different frequency bands. For example, each subframe includes a UL subframe in a UL frequency band and a DL subframe in a DL frequency band. In a TDD mode, UL and DL transmissions occur at different time periods using the same frequency band. For example, a subset of the subframes (e.g., DL subframes) in a radio frame may be used for DL transmissions and another subset of the subframes (e.g., UL subframes) in the radio frame may be used for UL transmissions.

The DL subframes and the UL subframes can be further divided into several regions. For example, each DL or UL subframe may have pre-defined regions for transmissions of reference signals, control information, and data. Reference signals are predetermined signals that facilitate the communications between the BSs **105** and the UEs **115**. For example, a reference signal can have a particular pilot pattern or structure, where pilot tones may span across an operational BW or frequency band, each positioned at a pre-defined time and a pre-defined frequency. For example, a BS **105** may transmit cell specific reference signals (CRSs) and/or channel state information—reference signals (CSI-RSs) to enable a UE **115** to estimate a DL channel. Similarly, a UE **115** may transmit sounding reference signals (SRSs) to enable a BS **105** to estimate a UL channel. Control information may include resource assignments and protocol controls. Data may include protocol data and/or operational data. In some aspects, the BSs **105** and the UEs **115** may communicate using self-contained subframes. A self-contained subframe may include a portion for DL communication and a portion for UL communication. A self-contained subframe can be DL-centric or UL-centric. A DL-centric subframe may include a longer duration for DL communication than for UL communication. A UL-centric subframe may include a longer duration for UL communication than for UL communication.

In some aspects, the network **100** may be an NR network deployed over a licensed spectrum. The BSs **105** can transmit synchronization signals (e.g., including a primary synchronization signal (PSS) and a secondary synchronization signal (SSS)) in the network **100** to facilitate synchronization. The BSs **105** can broadcast system information associated with the network **100** (e.g., including a master information block (MIB), remaining system information (RMSI), and other system information (OSI)) to facilitate initial network access. In some aspects, the BSs **105** may broadcast the PSS, the SSS, and/or the MIB in the form of synchronization signal block (SSBs) and may broadcast the RMSI and/or the OSI over a physical downlink shared channel (PDSCH). The MIB may be transmitted over a physical broadcast channel (PBCH).

In some aspects, a UE **115** attempting to access the network **100** may perform an initial cell search by detecting a PSS from a BS **105**. The PSS may enable synchronization of period timing and may indicate a physical layer identity value. The UE **115** may then receive a SSS. The SSS may enable radio frame synchronization, and may provide a cell identity value, which may be combined with the physical layer identity value to identify the cell. The PSS and the SSS may be located in a central portion of a carrier or any suitable frequencies within the carrier.

After receiving the PSS and SSS, the UE **115** may receive a MIB. The MIB may include system information for initial network access and scheduling information for RMSI and/or OSI. After decoding the MIB, the UE **115** may receive RMSI and/or OSI. The RMSI and/or OSI may include radio resource control (RRC) information related to random access channel (RACH) procedures, paging, control resource set (CORESET) for physical downlink control channel (PDCCH) monitoring, physical UL control channel (PUCCH), physical UL shared channel (PUSCH), power control, and SRS.

After obtaining the MIB, the RMSI and/or the OSI, the UE **115** can perform a random access procedure to establish a connection with the BS **105**. In some examples, the random access procedure may be a four-step random access procedure. For example, the UE **115** may transmit a random access preamble and the BS **105** may respond with a random access response. The random access response (RAR) may include a detected random access preamble identifier (ID) corresponding to the random access preamble, timing advance (TA) information, a UL grant, a temporary cell-radio network temporary identifier (C-RNTI), and/or a back-off indicator. Upon receiving the random access response, the UE **115** may transmit a connection request to the BS **105** and the BS **105** may respond with a connection response. The connection response may indicate a contention resolution. In some examples, the random access preamble, the RAR, the connection request, and the connection response can be referred to as message 1 (MSG1), message 2 (MSG2), message 3 (MSG3), and message 4 (MSG4), respectively. In some examples, the random access procedure may be a two-step random access procedure, where the UE **115** may transmit a random access preamble and a connection request in a single transmission and the BS **105** may respond by transmitting a random access response and a connection response in a single transmission.

After establishing a connection, the UE **115** and the BS **105** can enter a normal operation stage, where operational data may be exchanged. For example, the BS **105** may schedule the UE **115** for UL and/or DL communications. The BS **105** may transmit UL and/or DL scheduling grants to the UE **115** via a PDCCH. The scheduling grants may be transmitted in the form of DL control information (DCI). The BS **105** may transmit a DL communication signal (e.g., carrying data) to the UE **115** via a PDSCH according to a DL scheduling grant. The UE **115** may transmit a UL communication signal to the BS **105** via a PUSCH and/or PUCCH according to a UL scheduling grant. The connection may be referred to as an RRC connection. When the UE **115** is actively exchanging data with the BS **105**, the UE **115** is in an RRC connected state.

In an example, after establishing a connection with the BS **105**, the UE **115** may initiate an initial network attachment procedure with the network **100**. The BS **105** may coordinate with various network entities or fifth generation core (5GC) entities, such as an access and mobility function (AMF), a serving gateway (SGW), and/or a packet data network gateway (PGW), to complete the network attachment procedure. For example, the BS **105** may coordinate with the network entities in the 5GC to identify the UE, authenticate the UE, and/or authorize the UE for sending and/or receiving data in the network **100**. In addition, the AMF may assign the UE with a group of tracking areas (TAs). Once the network attach procedure succeeds, a context is established for the UE **115** in the AMF. After a successful attach to the network, the UE **115** can move around the current TA. For tracking area update (TAU), the BS **105** may request the UE **115** to update the network **100** with the UE **115**'s location periodically. Alternatively, the UE **115** may only report the UE **115**'s location to the network **100** when entering a new TA. The TAU allows the network **100** to quickly locate the UE **115** and page the UE **115** upon receiving an incoming data packet or call for the UE **115**.

In some aspects, the BS **105** may communicate with a UE **115** using HARQ techniques to improve communication reliability, for example, to provide a URLLC service. The BS **105** may schedule a UE **115** for a PDSCH communication by transmitting a DL grant in a PDCCH. The BS **105** may transmit a DL data packet to the UE **115** according to the schedule in the PDSCH. The DL data packet may be transmitted in the form of a transport block (TB). If the UE **115** receives the DL data packet successfully, the UE **115** may transmit a HARQ ACK to the BS **105**. Conversely, if the UE **115** fails to receive the DL transmission successfully, the UE **115** may transmit a HARQ NACK to the BS **105**. Upon receiving a HARQ NACK from the UE **115**, the BS **105** may retransmit the DL data packet to the UE **115**. The retransmission may include the same coded version of DL data as the initial transmission. Alternatively, the retransmission may include a different coded version of the DL data than the initial transmission. The UE **115** may apply soft combining to combine the encoded data received from the initial transmission and the retransmission for decoding. The BS **105** and the UE **115** may also apply HARQ for UL communications using substantially similar mechanisms as the DL HARQ.

In some aspects, the network **100** may operate over a system BW or a component carrier (CC) BW. The network **100** may partition the system BW into multiple BWPs (e.g., portions). A BS **105** may dynamically assign a UE **115** to operate over a certain BWP (e.g., a certain portion of the system BW). The assigned BWP may be referred to as the active BWP. The UE **115** may monitor the active BWP for signaling information from the BS **105**. The BS **105** may schedule the UE **115** for UL or DL communications in the active BWP. In some aspects, a BS **105** may assign a pair of BWPs within the CC to a UE **115** for UL and DL communications. For example, the BWP pair may include one BWP for UL communications and one BWP for DL communications.

In some aspects, a UE **115** may be capable of utilizing multiple SIMS and may operate in a DSDS mode and may manage SRS timing offset adjustment, as explained in more detail below.

FIG. **2** illustrates a communication scenario **200** that utilizes multiple subscriptions according to some aspects of the present disclosure. The communication scenario **200** may correspond to a communication scenario among BSs **105** and or UEs **115** in the network **100**. For simplicity, FIG. **2** illustrates two BSs **205** (shown as **205***a* and **205***b*) and one UE **215**, but a greater number of UEs **215** (e.g., the about 3, 4, 3, 6, 7, 8, 9, 10, or more) and/or BSs **205** (e.g., the about 3, 4 or more) may be supported. The BS **205** and the UEs **215** may be similar to the BSs **105** and the UEs **115**, respectively.

In the scenario **200**, the UE **215** is capable of utilizing multiple SIMS (e.g., SIM cards) for communication with one or more networks. For simplicity, FIG. **2** illustrates the UE **215** including two SIMS **210** (shown as SIM A **210***a* and SIM B **210***b*), but the UE **215** may include more than two SIMS (e.g., about 3, 4 or more). In some aspects, each SIM **210** may include integrated circuits and/or memory configured to store information used for accessing a network, for example, to authenticate and identify the UE **215** as a subscriber of the network. Some examples of information stored at the SIM A **210***a* and/or SIM B **210***b* may include, but not limited to, a subscriber identity such as an international mobile subscriber identity (IMSI) and/or information and/or key used to identify and authenticate the UE **215** in a certain provider network. As an example, the UE **215** may subscribe to a first operator and a second operator. That is, the UE **215** may have a first subscription **212***a* (shown as SUB A) with the first operator and a second subscription **212***b* (shown as SUB B) with the second operator. Accordingly, the SIM A **210***a* may store or maintain information for accessing a network of the first operator based on the first subscription **212***a*, and the SIM B **210***b* may store information for accessing a network of the second operator based on the second subscription **212***b*. In some instances, the first operator and the second operator may correspond to the same operator. For example, the first subscription **212***a* and the second subscription **212***b* may correspond to different user accounts and/or services subscribed with the same operator. In other instances, the first operator may be different from the second operator.

In operation, the UE **215** may communicate with a BS **205***a* (operated by the first operator) using the SIM A **210***a* via a radio link **202***a*. Further, the UE **215** may communicate with a BS **205***b* (operated by the second operator) using the SIM B **210***b* via a radio link **202***b*. In some aspects, the UE **215** may use the same radio access technology (e.g., NR or NR-U) for communication with the BS **205***a* and the BS **205***b*. In other aspects, the UE **215** may use one radio access technology (e.g., NR or NR-U) for communication with the BS **205***a* and another radio access technology (e.g., LTE) for communication with the BS **205***b*. Although FIG. **2** illustrates the UE **215** communicates with different BSs **205** using the SIM A **210***a* and the SIM B **210***b*, it should be understood that in other examples the UE **215** may communicate with the same BS. For instance, the UE **215** may communicate with the same BS **205***a* for the first subscription **212***a* via the SIM A **210***a* and for the second subscription **212***b* via the SIM B **210***b*.

In some aspects, the UE **215** may operate in a DSDS mode, where both SIMs **210***a* and **210***b* can be on standby (in an idle mode) waiting to begin communications. When a communication is established on one SIM (e.g., the SIM A **210***a*), the other SIM (e.g., the SIM B **210***b*) is no longer active. That is, one SIM may be active at a given time. For instance, both SIMS **210** may share a single transceiver and/or RF chain at the UE **215** for communications with corresponding network(s).

In some aspects, the radio link **202***a* between the UE **215** and the BS **205***a* and the radio link **202***b* between the UE **215** and the BS **205***b* may be over orthogonal bands such as FR1/FR2 or low band/high band FR1. Of course, any combination of radio links **202** is possible, and the radio links may even take place using different radio access technologies. For instance, radio link **202***a* may carry communications according to 5G protocols, whereas radio link **202***b* may carry communications according to LTE protocols.

Furthermore, UE **215** may manage SRS timing offset adjustments, according to the techniques described below with respect to FIGS. **3-6**.

FIG. **3** illustrates an example hardware architecture for RF chains, which may be implemented within UE **115** (FIG. **1**), UE **215** (FIG. **2**), or UE **700** (FIG. **7**). In this exemplary design, the hardware architecture includes a transceiver **320** coupled to a first antenna **310**, a transceiver **322** coupled to a second antenna **312**, and a data processor/controller **380**. Transceiver **320** includes multiple (K) receivers **330***pa* to **330***pk* and multiple (K) transmitters **350***pa* to **350***pk* to support multiple frequency bands, multiple radio technologies, carrier aggregation, etc. Transceiver **322** includes L receivers **330***sa* to **330***s***1** and L transmitters **350***sa* to **350***s***1** to support multiple frequency bands, multiple radio technologies, carrier aggregation, receive diversity, multiple-input multiple-output (MIMO) transmission from multiple transmit antennas to multiple receive antennas, etc.

In the exemplary design shown in FIG. **3**, each receiver **330** includes an LNA **340** and receive circuits **342**. For data reception, antenna **310** receives signals from base stations and/or other transmitter stations and provides a received RF signal, which may be routed through an antenna interface circuit **324** and presented as an input RF signal to a selected receiver. Antenna interface circuit **324** may include switches, duplexers, transmit filters, receive filters, matching circuits, etc. The description below assumes that receiver **330***pa* is the selected receiver, though the described operations apply equally well to any of the other receivers **330**. Within receiver **330***pa*, an LNA **340***pa* amplifies the input RF signal and provides an output RF signal. Receive circuits **342***pa* downconvert the output RF signal from RF to baseband, amplify and filter the downconverted signal, and provide an analog input signal to data processor **380**. Receive circuits **342***pa* may include mixers, filters, amplifiers, matching circuits, an oscillator, a local oscillator (LO) generator, a phase locked loop (PLL), etc. Each remaining receiver **330** in transceivers **320** and **322** may operate in a similar manner as receiver **330***pa.*

In the exemplary design shown in FIG. **3**, each transmitter **350** includes transmit circuits **352** and a power amplifier (PA) **354**. For data transmission, data processor **380** processes (e.g., encodes and modulates) data to be transmitted and provides an analog output signal to a selected transmitter. The description below assumes that transmitter **350***pa* is the selected transmitter, though the described operations apply equally well to any of the other transmitters **350**. Within transmitter **350***pa*, transmit circuits **352***pa* amplify, filter, and upconvert the analog output signal from baseband to RF and provide a modulated RF signal. Transmit circuits **352***pa* may include amplifiers, filters, mixers, matching circuits, an oscillator, an LO generator, a PLL, etc. A PA **354***pa* receives and amplifies the modulated RF signal and provides a transmit RF signal having the proper output power level. The transmit RF signal may be routed through antenna interface circuit **324** and transmitted via antenna **310**. Each remaining transmitter **350** in transceivers **320** and **322** may operate in a similar manner as transmitter **350***pa.*

FIG. **3** shows an exemplary design of receiver **330** and transmitter **350**. A receiver and a transmitter may also include other circuits not shown in FIG. **3**, such as filters, matching circuits, etc. All or a portion of transceivers **320** and **322** may be implemented on one or more analog (ICs, RF ICs (RFICs), mixed-signal ICs, etc. For example, LNAs **340** and receive circuits **342** within transceivers **320** and **322** may be implemented on multiple IC chips or on the same IC chip. The circuits in transceivers **320** and **322** may also be implemented in other manners.

Data processor/controller **380** may perform various functions for wireless device **110**. For example, data processor **380** may perform processing for data being received via receivers **330** and data being transmitted via transmitters **350**. Controller **380** may control the operation of the various circuits within transceivers **320** and **322**. A memory **382** may store program codes and data for data processor/controller **380**. Data processor/controller **380** may be implemented on one or more application specific integrated circuits (ASICs) and/or other ICs.

Controller **380** may be in communication with one or more SIMS to provide DSDA operation in which one SIM may be transmitting and receiving data, while the other SIM may be in idle mode. The controller **380** may execute software logic that assigns one of the transceivers **320**, **322** to a particular SIM and the other one of the transceivers to the other SIM in a dual SIM implementation. In another example, the controller **380** may assign both transceivers **320**, **322** to both SIMS, thereby allowing both SIMS two employ multi-antenna operations, such as beam forming and the like. In one example implementation, one of the SIMS is active, whereas the other SIM is in idle mode. During an SRS occurrence, the first SIM (e.g., the DDS) may use the transmitting portions of either or both of the transceivers **320**, **322** to transmit an SRS. The network may then use received SRS to estimate the DL channel for the RX ports (e.g., antenna/transceiver pairs) of the UE.

However, the other SIM may periodically receive paging signals from its network. In doing so, the other SIM may use RF resources (e.g., antennas **310**, **312**, interface circuits **324**, **326**, and various filters, mixers, oscillators, and processing circuits not shown) and require those RF resources to be "tuned away" from the SRS and tuned instead toward the paging signals. That "tune away" time represents a duration in which the SRS may not be transmitted. Therefore, in various implementations, the processor **380** executes instructions to provide SRS offset timing adjustment, as described in more detail below with respect to FIGS. **4-5**.

FIG. **4** is an illustration of an example timeline **400**, according to one implementation. The timeline **400** may represent the operation of a UE, such as UE **115** (FIG. **1**), UE **215** (FIG. **2**), or UE **700** (FIG. **7**).

Timeline **400** includes a multitude of SRS occasions, exemplified by the dots **401-405**. SRS transmission **401** is successful, as is SRS transmission **403**. However, SRS occasion **402** falls within a tune away duration **410**. Tune away duration **410** was explained above with respect to FIG. **3** and, in short, it refers to a time in which an idle mode SIM in the multi-SIM device has control of RF hardware in order to perform the page decode and other measurements. Such RF hardware is unavailable to the active-mode SIM during tune away period **410**. Tune away duration **410** is shown as extending from a time when the tune away starts to a time when the tune away ends.

Similarly, SRS occasions **404**, **405** fall within tune away durations in which the active-mode SIM would not be able to transmit an SRS. Nevertheless, SRS occasions **401**, **403** and others not within tune away durations would include transmitted SRS. The network may then use the transmitted SRS to estimate the DL channel for the RX ports of the UE.

The SRS occasions **401-405** are configured by the network to have an offset **420** from a reference slot as well as to have a particular periodicity. For instance, the periodicity of the SRS occasions **401-405** may be anywhere from 10 ms to 160 ms in some networks. The timing offset, measured in slots, may be 32 to 64 slots in some networks, where that number of slots may correspond to different time amounts depending on a numerology used by the active-mode SIM.

FIG. **5** is an illustration of an example timeline **500**, according to one implementation. The timeline **500** may represent the operation of a UE, such as UE **115** (FIG. **1**), UE **215** (FIG. **2**), or UE **700** (FIG. **7**). In fact, the timeline **500** represents an effect of a timing offset adjustment performed by the UE to avoid SRS occasions colliding with tune away durations.

The UE, having recognized the collision illustrated by SRS occasion **402** falling within tune away duration **410**, may request a timing offset adjustment from the network. For instance, the UE may calculate a timing offset adjustment for the request.

An example tune away time seen in the field is 40 ms, though other tune away times are possible. The tune away time represents the time it takes for one subscription to perform the page decode and measurements. The tune away time is not something configured by the network or the UE; instead, the tune away time is usually a function of the software or hardware of the UE, and it is not readily changeable.

In one example, the calculated SRS offset range includes −x to x, so the range size can be up to 2x.

−x: left shift the SRS offset by $32*2*(\mu+1)$ slots

0: No change in offset

x: right shift the SRS offset by $32*2*(\mu+1)$ slots, where μcorresponds to the numerology mentioned in the below Table 1. The values for left-shifting and right-shifting are for example only, and other implementations may use different values.

TABLE 1

μ	Sub Carrier Spacing (kHz)	Cyclic Prefix
0	15	Normal
1	30	Normal
2	60	Normal, Extended
3	120	Normal
4	240	Normal

The calculation of the offset adjustment can be performed by the UE based on the location of the SRS occasion within the tune away duration and based on the particular numerology (μ) used by the network that is serving the active-mode subscription. Assuming that the time of the tune away (the duration) is 40 ms, the UE may split that 40 ms in half. If the missed SRS falls within the first 20 ms, then the UE may request to shift the SRS offset more than 20 ms before. In other words, pre-pone or shift to the left and use a negative value. If the missed SRS falls after the first 20 ms, then the UE may request to shift the SRS offset to right shift the RS offset, in other words postpone the RS offset.

The offset range is measured in slots, and the slots are defined by the numerology, including the subcarrier spacing (15 kHz, 30 kHz, 60 kHz, 120 kHz, or 240 kHz). The slot duration may vary based on numerology. For the example, the subcarrier spacing of 15 kHz gives either a left or right shift of 64 ms, and in case of 30 kHz gives a left or right shift of 32 ms. The scope of embodiments may be adapted for use with any numerology and may be applied to both FR1 and FR2.

The calculation of the offset adjustment may be performed by the UE. The UE may determine a number of slots to request for the offset. The UE may send the offset adjustment request to the network using the MAC CE. The network may then choose to change the timing offset of the SRS or not—it is not mandatory. If the network accepts the change, then it may send the offset adjustment to the UE in a subsequent RRC configuration.

FIG. **5** shows the example timeline **500**, which is subsequent to the UE receiving a RRC configuration from the network to adjust the SRS timing offset. Timeline **500** shows the same periodicity of the SRS as in timeline **400** (FIG. **4**), but with a different offset **520** from a reference or initial slot. As a result, the various SRS occasions, exemplified by the dots **501-506**, do not fall within the tune away durations (e.g., duration **410**). Therefore, each of the SRS occasions corresponds to an SRS transmit success. The network may then receive each of the SRS transmissions and assign an appropriate MCS and number of RBs for the detected condition of the RX ports of the UE.

The timelines **400** and **500** are not drawn to scale, so it is understood that the tune away duration **410**, and a timing offsets **420**, **520** are for illustration only.

FIG. **6** is a flowchart of a method **600** to adjust an SRS timing offset to avoid a collision between SRS and paging and measurement in a multi-SIM system, according to some aspects of the present disclosure. The method **600** may be performed by UE, such as UE **115** (FIG. **1**), UE **215** (FIG. **2**), or UE **700** (FIG. **7**). As illustrated, the method **600** includes a number of enumerated actions, but aspects of the method **600** may include additional actions before, after, and in between the enumerated actions. In some aspects, one or more of the enumerated actions may be omitted or performed in a different order.

At action **601**, the UE operates in a DSDS mode in which a first SIM is designated as the DDS, and in which a second SIM is the nDDS. Further in this example, the DDS is in active-mode, whereas the nDDS is in idle mode. The first SIM and the second SIM may be serviced by a same network or different networks.

At action **602**, the UE transmits an SRS from communication ports of the UE. Examples of communication ports include those shown in FIG. **3**, such as the transceiver/antenna pair **310**/**320** and the transceiver/antenna pair **312**/**322**. The UE transmits the SRS from those communication ports, and the SRS is received by the network associated with the first SIM through one or more base stations.

The SRS has a timing offset assigned by the network. Example timing offsets are shown in FIGS. **4** and **5** (items **420**, **520**).

At action **603**, the UE receives a paging message or paging messages from a network that is associated with the second SIM. The paging messages may be received during a tune away time, such as the tune away time **410** illustrated in FIGS. **4** and **5**. Action **603** may also include the UE performing various measurements, such as for reference signal received power (RSRP), received signal strength indicator (RSSI), signal and interference to noise ratio (SINR), and the like. The tune away time is a time during which shared RF circuitry is unavailable to the first SIM while it is being used by the second SIM for page decode and measurement.

At action **604**, the UE determines an offset adjustment to avoid a collision between the SRS and the paging messages and signal measurement. For instance, if the UE determines that an occurrence of the SRS falls within a first-in-time half of a tune away period of radio frequency (RF) hardware shared by the first SIM and the second SIM, then the UE may then determine to pre-pone the SRS. Similarly, if the UE determines that an occurrence of the SRS falls within a second-in-time half of the tuna way period, then the UE may determine to postpone the SRS.

An example of calculating an SRS timing adjustment is given above with respect to FIG. **5**. For instance, the UE may apply a function to left-shift or right-shift the timing offset by a particular number of slots dependent upon a numerology used by the first SIM. As noted above, slot duration made differ from numerology to numerology, so the offset as measured in milliseconds may differ depending on the particular numerology.

At action **605**, the UE sends a request to the network associated with the first SIM. The request may indicate to the network to adjust the timing offset according to the offset adjustment that was calculated at action **604**. In some examples, the request may be included in a MAC CE message, perhaps using a reserved field or any other appropriate field. The scope of implementations is not limited to MAC CE only, as any appropriate signaling, such as DCI, may be used in other examples.

At action **606**, the UE receives an offset change configuration from the network that is associated with the first SIM. For instance, the network may configure the timing offset using RRC or other appropriate signaling. In this example, the network may determine whether to accept or ignore the request from the UE. In the example of method **600**, the network has determined to accept the request from the network and has generated and transmitted a RRC configuration to the UE, where the RRC configuration incorporates the offset adjustment.

At action **607**, the UE transmits the SRS according to the offset adjustment. In other words, the UE receives the RRC from the network, parses the RRC to process the information in the RRC, the information including the timing adjustment. The UE then implements that timing adjustment and may continue using the new timing offset until it is reconfigured by yet another subsequent RRC.

In the example of method **600**, action **602** may be similar to the SRS transmissions of FIG. **4**, where some SRS occasions may be blocked by a tune away duration. Furthermore, the action **607** may be similar to the SRS transmissions of FIG. **5**, where the SRS occasions are not blocked by tune away durations.

The action **601**-**607** may be repeated as often as appropriate. For instance, as the UE moves from one base station to another base station, configurations may be changed, including a timing of paging reception and a timing of SRS. Accordingly, the UE may adjust the SRS timing offset as described above to avoid or at least reduce a number of SRS occasions that are blocked by a tune away duration.

Various embodiments may provide advantages over prior systems. For instance, embodiments that can avoid or reduce a number of blocked SRS occasions may also avoid or reduce the artificial throttling, via MCS and RB configuration, performed by some networks that assume an increased block error rate when SRS occasions are blocked. As a result, those systems may increase throughput, thereby increasing data per battery charge efficiency and data per time efficiency. Furthermore, such systems may also increase user satisfaction by having faster download times.

FIG. **7** is a block diagram of an exemplary UE **700** according to some aspects of the present disclosure. The UE **700** may be a UE **115** or UE **215** as discussed above in FIGS. **1**-**2** and may conform to the hardware architecture described above with respect to FIG. **3**. As shown, the UE **700** may include a processor **702**, a memory **704**, a MultiSim module **708**, a transceiver **710** including a modem subsystem **712** and a radio frequency (RF) unit **714**, and one or more antennas **716**. These elements may be coupled with one another. The term "coupled" may refer to directly or indirectly coupled or connected to one or more intervening elements. For instance, these elements may be in direct or indirect communication with each other, for example via one or more buses.

The processor **702** may include a central processing unit (CPU), a digital signal processor (DSP), an application specific integrated circuit (ASIC), a controller, a field programmable gate array (FPGA) device, another hardware device, a firmware device, or any combination thereof configured to perform the operations described herein. The processor **702** may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

The memory **704** may include a cache memory (e.g., a cache memory of the processor **702**), random access memory (RAM), magnetoresistive RAM (MRAM), read-only memory (ROM), programmable read-only memory (PROM), erasable programmable read only memory (EPROM), electrically erasable programmable read only memory (EEPROM), flash memory, solid state memory device, hard disk drives, other forms of volatile and non-volatile memory, or a combination of different types of memory. In an aspect, the memory **704** includes a non-transitory computer-readable medium. The memory **704** may store, or have recorded thereon, instructions **706**. The instructions **706** may include instructions that, when executed by the processor **702**, cause the processor **702** to perform the operations described herein with reference to a UE **115**, **215** in connection with aspects of the present disclosure, for example, aspects of FIGS. **1**-**6**. Instructions **706** may also be referred to as code, which may include any type of computer-readable statements.

The MultiSim module **708** may be implemented via hardware, software, or combinations thereof. For example, the MultiSim module **708** may be implemented as a processor, circuit, and/or instructions **706** stored in the memory **704** and executed by the processor **702**.

In some aspects, the MultiSim module **708** may include multiple SIMS or SIM cards (e.g., 2, 3, 4, or more) similar to the SIMS **210**. Each SIM may be configured to store information used for accessing a network, for example, to authenticate and identify the UE **700** as a subscriber of the network. Some examples of information stored on a SIM may include, but not limited to, a subscriber identity such as an international mobile subscriber identity (IMSI) and/or information and/or key used to identify and authenticate the UE **700** in a certain provider network. In some aspects, the UE **700** may have a first subscription on a first SIM of the multiple SIMS and a second subscription on a second SIM of the multiple SIMS. The first subscription may identify the UE **700** by a first subscriber identity, and the second subscription may identify the UE **700** by a second subscriber identity.

In some embodiments, the functionality described above with respect to FIG. **6** may be included as logic within Multi-SIM module **708**. Other embodiments, the functionality may be included in another component, such as in computer readable code within instructions **706** in memory **704**.

As shown, the transceiver **710** may include the modem subsystem **712** and the RF unit **714**. The transceiver **710** can be configured to communicate bi-directionally with other devices, such as the BSs **105** and **500**. The modem subsystem **712** may be configured to modulate and/or encode the data from the memory **704** and the MultiSim module **708** according to a modulation and coding scheme (MCS), e.g., a low-density parity check (LDPC) coding scheme, a turbo coding scheme, a convolutional coding scheme, a digital beamforming scheme, etc. The RF unit **714** may be configured to process (e.g., perform analog to digital conversion or digital to analog conversion, etc.) modulated/encoded data (e.g., PUSCH data, PUCCH UCI, MSG1, MSG3, etc.) or of transmissions originating from another source such as a UE **115**, a BS **105**, or an anchor. The RF unit **714** may be further configured to perform analog beamforming in conjunction with digital beamforming. Although shown as integrated together in transceiver **710**, the modem subsystem **712** and the RF unit **714** may be separate devices that are coupled together at the UE **700** to enable the UE **700** to communicate with other devices.

The RF unit **714** may provide the modulated and/or processed data, e.g. data packets (or, more generally, data messages that may contain one or more data packets and other information), to the antennas **716** for transmission to one or more other devices. The antennas **716** may further receive data messages transmitted from other devices. The antennas **716** may provide the received data messages for processing and/or demodulation at the transceiver **710**. The transceiver **710** may provide the demodulated and decoded data (e.g., RRC configurations, MIB, PDSCH data and/or PDCCH DCIs, etc.) to the MultiSim module **708** for processing. The antennas **716** may include multiple antennas of similar or different designs in order to sustain multiple transmission links.

In an aspect, the UE **700** can include multiple transceivers **710** implementing different RATs (e.g., NR and LTE). In an aspect, the UE **700** can include a single transceiver **710** implementing multiple RATs (e.g., NR and LTE). In an aspect, the transceiver **710** can include various components, where different combinations of components can implement different RATs.

FIG. **8** is a block diagram of an exemplary BS **800** according to some aspects of the present disclosure. The BS **800** may be a BS **105** or a BS **205** as discussed in FIGS. **1** and **2**. As shown, the BS **800** may include a processor **802**, a memory **804**, a communication module **808**, a transceiver **810** including a modem subsystem **812** and a RF unit **814**, and one or more antennas **816**. These elements may be coupled with one another. The term "coupled" may refer to directly or indirectly coupled or connected to one or more intervening elements. For instance, these elements may be in direct or indirect communication with each other, for example via one or more buses.

The processor **802** may have various features as a specific-type processor. For example, these may include a CPU, a DSP, an ASIC, a controller, a FPGA device, another hardware device, a firmware device, or any combination thereof configured to perform the operations described herein. The processor **802** may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

The memory **804** may include a cache memory (e.g., a cache memory of the processor **802**), RAM, MRAM, ROM, PROM, EPROM, EEPROM, flash memory, a solid state memory device, one or more hard disk drives, memristor-based arrays, other forms of volatile and non-volatile memory, or a combination of different types of memory. In some aspects, the memory **804** may include a non-transitory computer-readable medium. The memory **804** may store instructions **806**. The instructions **806** may include instructions that, when executed by the processor **802**, cause the processor **802** to perform operations described herein, for example, aspects of FIGS. **1** and **2**. Instructions **806** may also be referred to as program code. The program code may be for causing a wireless communication device to perform these operations, for example by causing one or more processors (such as processor **802**) to control or command the wireless communication device to do so. The terms "instructions" and "code" should be interpreted broadly to include any type of computer-readable statement(s). For example, the terms "instructions" and "code" may refer to one or more programs, routines, sub-routines, functions, procedures, etc. "Instructions" and "code" may include a single computer-readable statement or many computer-readable statements.

The communication module **808** may be implemented via hardware, software, or combinations thereof. For example, the communication module **808** may be implemented as a processor, circuit, and/or instructions **806** stored in the memory **804** and executed by the processor **802**. In some examples, the communication module **808** can be integrated within the modem subsystem **812**. For example, the communication module **808** can be implemented by a combination of software components (e.g., executed by a DSP or a general processor) and hardware components (e.g., logic gates and circuitry) within the modem subsystem **812**. The communication module **808** may communicate with one or more components of BS **800** to implement various aspects of the present disclosure, for example, aspects of FIGS. **1** and **2**.

As shown, the transceiver **810** may include the modem subsystem **812** and the RF unit **814**. The transceiver **810** can be configured to communicate bi-directionally with other devices, such as the UEs **115**, **215** and/or BS **800** and/or another core network element. The modem subsystem **812** may be configured to modulate and/or encode data according to a MCS, e.g., a LDPC coding scheme, a turbo coding scheme, a convolutional coding scheme, a digital beamforming scheme, etc. The RF unit **814** may be configured to process (e.g., perform analog to digital conversion or digital to analog conversion, etc.) modulated/encoded data (e.g., RRC configurations, MIB, PDSCH data and/or PDCCH DCIs, etc.) from the modem subsystem **812** (on outbound transmissions) or of transmissions originating from another source such as a UE **115**, **215**, and/or UE **700**. The RF unit **814** may be further configured to perform analog beamforming in conjunction with the digital beamforming. Although shown as integrated together in transceiver **810**, the modem subsystem **812** and/or the RF unit **814** may be separate devices that are coupled together at the BS **800** to enable the BS **800** to communicate with other devices.

The RF unit **814** may provide the modulated and/or processed data, e.g. data packets (or, more generally, data messages that may contain one or more data packets and other information), to the antennas **816** for transmission to one or more other devices. The antennas **816** may further receive data messages transmitted from other devices and provide the received data messages for processing and/or demodulation at the transceiver **810**. The transceiver **810** may provide the demodulated and decoded data (e.g., PUSCH data, PUCCH UCI, MSG1, MSG3, etc.) to the communication module **808** for processing. The antennas **816** may include multiple antennas of similar or different designs in order to sustain multiple transmission links.

In an aspect, the BS **800** can include multiple transceivers **810** implementing different RATs (e.g., NR and LTE). In an aspect, the BS **800** can include a single transceiver **810** implementing multiple RATs (e.g., NR and LTE). In an aspect, the transceiver **810** can include various components, where different combinations of components can implement different RATs.

Further aspects of the present disclosure include the following clauses:

1. A method of wireless communication performed by a user equipment (UE), the method comprising:
   operating in a Dual SIM Dual Standby (DSDS) mode in which a first subscriber identity module (SIM) is designated as a default data subscription (DDS);
   transmitting a sounding reference signal (SRS) from a communication port of the UE, wherein the SRS has a timing offset assigned by a network associated with the first SIM;
   receiving paging messages from a network associated with a second SIM;
   determining an offset adjustment to avoid a collision between the SRS and the paging messages;
   sending a request to the network associated with the first SIM to adjust the timing offset according to the offset adjustment; and
   receiving an offset change configuration from the network associated with the first SIM.
2. The method of clause 1, wherein determining the offset adjustment further includes calculating the offset adjustment to further avoid a collision between the SRS and measurement for an item selected from a list consisting of: reference signal received power (RSRP), received signal strength indicator (RSSI), and signal and interference to noise ratio (SINR).
3. The method of clauses 1-2, wherein the network associated with the first SIM and the network associated with the second SIM are a same network.
4. The method of clauses 1-2, wherein the network associated with the first SIM and the network associated with the second SIM are different networks.
5. The method of clauses 1-4, wherein sending the request to the network associated with the first SIM comprises:
   transmitting a media access control (MAC) control element (CE) from the UE to the network associated with the first SIM, the MAC CE including an indication of the offset adjustment.
6. The method of clauses 1-5, further comprising:
   subsequent to receiving the offset change configuration, transmitting the SRS according to the offset adjustment.
7. The method of clauses 1-6, wherein receiving the offset change configuration includes receiving a radio resource control (RRC) message reconfiguring the timing offset assigned by the network associated with the first SIM.
8. The method of clauses 1-7, wherein determining the offset adjustment comprises:
   determining that an occurrence of the SRS falls within a first-in-time half of a tune away period of radio frequency (RF) hardware shared by the first SIM and the second SIM; and
   in response to determining that the occurrence of the SRS falls within the first-in-time half, determining to pre-pone the SRS.
9. The method of clauses 1-7, wherein determining the offset adjustment comprises:
   determining that an occurrence of the SRS falls within a second-in-time half of a tune away period of radio frequency (RF) hardware shared by the first SIM and the second SIM; and
   in response to determining that the occurrence of the SRS falls within the second-in-time half, determining to postpone the SRS.
10. The method of clauses 1-9, wherein determining the offset adjustment includes applying a function dependent upon a numerology applied by the first SIM.
11. A non-transitory computer-readable medium having program code recorded thereon for wireless communication by a user equipment (UE), the program code comprising:
    code for transmitting a sounding reference signal (SRS) with a periodicity and a timing offset for an active-mode subscriber identity module (SIM) of the UE;
    code for performing a radio frequency (RF) tune away to accommodate decoding paging signals and received signal measurement for an idle-mode SIM of the UE, wherein the RF tune away collides with an SRS occurrence;
    code for generating a request for adjustment of the timing offset to avoid collision of the RF tune away and the SRS occurrence;
    code for transmitting the request for adjustment to a network serving the active-mode SIM; and
    code for adjusting the timing offset in response to receipt of configuration information from the network serving the active-mode SIM.
12. The non-transitory computer-readable medium of clause 11, wherein the received signal measurement includes an item selected from a list consisting of: reference signal received power (RSRP), received signal strength indicator (RSSI), and signal and interference to noise ratio (SINR).
13. The non-transitory computer-readable medium of clauses 11-12, wherein transmitting the request for adjustment comprises:
    transmitting a media access control (MAC) control element (CE) from the UE to the network serving the active-mode SIM, the MAC CE including an indication of a timing offset adjustment.
14. The non-transitory computer-readable medium of clauses 11-13, further comprising code for receiving a radio resource control (RRC) message with the configuration information.
15. The non-transitory computer-readable medium of clauses 11-14, wherein the code for generating the request comprises:
    code for determining that an occurrence of the SRS falls within a first-in-time half of a duration of the RF tune away; and

code for, in response to determining that the occurrence of the SRS falls within the first-in-time half, determining to pre-pone the SRS.

16. The non-transitory computer-readable medium of clauses 11-14, wherein the code for generating the request comprises:

code for determining that an occurrence of the SRS falls within a second-in-time half of a duration of the RF tune away; and

code for, in response to determining that the occurrence of the SRS falls within the second-in-time half, determining to postpone the SRS.

17. The non-transitory computer-readable medium of clauses 11-16, wherein the code for generating the request includes code for applying a function dependent upon a numerology applied by the active-mode SIM to calculate either a left-shift or a right-shift of a particular number of slots for the timing offset.

18. A user equipment (UE) comprising:

a first subscriber identity module (SIM) and a second SIM;

means for operating the first SIM in an active-mode and operating the second SIM in an idle mode;

means for generating a request to reconfigure a timing offset of a sounding reference signal (SRS) associated with the first SIM, including calculating a number of slots for adjusting the timing offset to avoid collision with paging decode and signal measurement associated with the second SIM;

means for receiving configuration information from a network serving the first SIM, the configuration information adjusting the timing offset in accordance with the request; and

means for transmitting the SRS according to the configuration information.

19. The UE of clause 18, wherein the network serving the first SIM is a same network serving the second SIM.

20. The UE of clauses 18-19, wherein the network serving the first SIM is different from a network serving the second SIM.

21. The UE of clauses 18-20, wherein the signal measurement comprises at least one item selected from a list consisting of: reference signal received power (RSRP), received signal strength indicator (RSSI), and signal and interference to noise ratio (SINR).

22. The UE of clauses 18-21, wherein the means for generating the request comprises:

means for determining that an occurrence of the SRS falls within a first-in-time half of a tune away period of radio frequency (RF) hardware shared by the first SIM and the second SIM; and

means for determining to pre-pone the SRS in response to determining that the occurrence of the SRS falls within the first-in-time half.

23. The UE of clauses 18-21, wherein the means for generating the request comprises:

means for determining that an occurrence of the SRS falls within a second-in-time half of a tune away period of radio frequency (RF) hardware shared by the first SIM and the second SIM; and

means for determining to postpone the SRS in response to determining that the occurrence of the SRS falls within the second-in-time half.

24. A user equipment (UE) comprising:

a first subscriber identity module (SIM) associated with a first service provider subscription and a second SIM associated with a second service provider subscription;

a modem configured to interface with a base station; and

a processor configured to interface with the modem and to access the first SIM and the second SIM, wherein the modem is further configured to:

operate in a Dual SIM Dual Standby (DSDS) mode in which the first SIM is in an active-mode and the second SIM is in an idle mode;

transmitting a sounding reference signal (SRS) from a communication port of the UE, wherein the SRS has a timing offset assigned by a network associated with the first SIM;

performing signal measurement with respect to a signal received from a network associated with a second SIM;

determining an offset adjustment to avoid a collision between the SRS and the signal measurement;

sending a request to the network associated with the first SIM to adjust the timing offset according to the offset adjustment; and

receiving an offset change configuration from the network associated with the first SIM.

25. The UE of clause 24, wherein the processor is further configured to determine the offset adjustment to avoid colliding the SRS with page decode associated with the second SIM.

26. The UE of clauses 24-25, wherein the processor is configured to determine the offset adjustment, including:

determining that an occurrence of the SRS falls within a first-in-time half of a tune away period of radio frequency (RF) hardware shared by the first SIM and the second SIM; and

in response to determining that the occurrence of the SRS falls within the first-in-time half, determining to pre-pone the SRS.

27. The UE of clauses 24-25, wherein the processor is configured to determine the offset adjustment, including:

determining that an occurrence of the SRS falls within a second-in-time half of a tune away period of radio frequency (RF) hardware shared by the first SIM and the second SIM; and

in response to determining that the occurrence of the SRS falls within the second-in-time half, determining to postpone the SRS.

The various illustrative blocks and modules described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a DSP, an ASIC, an FPGA or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices (e.g., a combination of a DSP and a microprocessor, multiple microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration).

The functions described herein may be implemented in hardware, software executed by a processor, firmware, or any combination thereof. If implemented in software executed by a processor, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Other examples and implementations are within the scope of the disclosure and appended claims. For example, due to the nature of software, functions described above can be implemented using software executed by a processor, hardware, firmware, hardwiring, or combinations of any of these. Features implementing functions may also be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations. Also, as used herein, including in the claims, "or" as used in a list of items (for example, a list of items prefaced by a phrase such as "at least one of" or "one or more of") indicates an inclusive list such that, for example, a list of [at least one of A, B, or C] means A or B or C or AB or AC or BC or ABC (i.e., A and B and C).

As those of some skill in this art will by now appreciate and depending on the particular application at hand, many modifications, substitutions and variations can be made in and to the materials, apparatus, configurations and methods of use of the devices of the present disclosure without departing from the spirit and scope thereof. In light of this, the scope of the present disclosure should not be limited to that of the particular aspects illustrated and described herein, as they are merely by way of some examples thereof, but rather, should be fully commensurate with that of the claims appended hereafter and their functional equivalents.

What is claimed is:

1. A method of wireless communication performed by a user equipment (UE), the method comprising:

operating in a Dual SIM Dual Standby (DSDS) mode in which a first subscriber identity module (SIM) is designated as a default data subscription (DDS);

transmitting, while operating in the DSDS mode, a sounding reference signal (SRS) from a communication port of the UE, wherein the SRS has a timing offset assigned by a network associated with the first SIM;

receiving, while operating in the DSDS mode, paging messages from a network associated with a second SIM;

determining an offset adjustment to avoid a collision between the SRS and the paging messages, wherein determining the offset adjustment comprises determining that an occurrence of the SRS falls within a tune away period of radio frequency (RF) hardware shared by the first SIM and the second SIM;

sending, while operating in the DSDS mode, a request to the network associated with the first SIM to adjust the timing offset according to the offset adjustment to avoid the collision between the SRS and the paging messages; and

receiving, in response to the request to adjust the timing offset, an offset change configuration from the network associated with the first SIM.

2. The method of claim **1**, wherein determining the offset adjustment further includes calculating the offset adjustment to further avoid a collision between the SRS and measurement for an item selected from a list consisting of: reference signal received power (RSRP), received signal strength indicator (RSSI), and signal and interference to noise ratio (SINR).

3. The method of claim **1**, wherein the network associated with the first SIM and the network associated with the second SIM are a same network.

4. The method of claim **1**, wherein the network associated with the first SIM and the network associated with the second SIM are different networks.

5. The method of claim **1**, wherein sending the request to the network associated with the first SIM comprises:

transmitting a media access control (MAC) control element (CE) from the UE to the network associated with the first SIM, the MAC CE including an indication of the offset adjustment.

6. The method of claim **1**, further comprising:

subsequent to receiving the offset change configuration, transmitting the SRS according to the offset adjustment.

7. The method of claim **1**, wherein receiving the offset change configuration includes receiving a radio resource control (RRC) message reconfiguring the timing offset assigned by the network associated with the first SIM.

8. The method of claim **1**, wherein determining the offset adjustment further comprises:

determining that an occurrence of the SRS falls within a first-in-time half of the tune away period of the RF hardware shared by the first SIM and the second SIM; and

in response to determining that the occurrence of the SRS falls within the first-in-time half, determining to prepone the SRS.

9. The method of claim **1**, wherein determining the offset adjustment further comprises:

determining that an occurrence of the SRS falls within a second-in-time half of the tune away period of the RF hardware shared by the first SIM and the second SIM; and

in response to determining that the occurrence of the SRS falls within the second-in-time half, determining to postpone the SRS.

10. The method of claim **1**, wherein determining the offset adjustment further includes applying a function dependent upon a numerology applied by the first SIM.

11. A user equipment (UE) comprising:

a first subscriber identity module (SIM) associated with a first service provider subscription and a second SIM associated with a second service provider subscription;

a modem configured to interface with a base station;

one or more memories; and

one or more processors configured to interface with the modem and to access the first SIM and the second SIM, wherein the one or more processors are coupled to the one or more memories, the one or more memories storing instructions executable by the one or more processors, individually or in any combination, to cause the UE to:

operate in a Dual SIM Dual Standby (DSDS) mode in which the first SIM is in an active-mode and the second SIM is in an idle mode;

transmit, while operating in the DSDS mode, a sounding reference signal (SRS) from a communication port of the UE, wherein the SRS has a timing offset assigned by a network associated with the first SIM;

perform, while operating in the DSDS mode, signal measurement with respect to a signal received from a network associated with the second SIM;

determine an offset adjustment to avoid a collision between the SRS and the signal measurement, wherein determining the offset adjustment comprises determining that an occurrence of the SRS falls within a tune away period of radio frequency (RF) hardware shared by the first SIM and the second SIM;

send, while operating in the DSDS mode, a request to the network associated with the first SIM to adjust the timing offset according to the offset adjustment to avoid the collision between the SRS and the signal measurement; and

receive, in response to the request to adjust the timing offset, an offset change configuration from the network associated with the first SIM.

12. The UE of claim **11**, wherein the one or more memories store instructions that are executable by the one or more processors, individually or in any combination, to cause the UE to determine the offset adjustment to avoid colliding the SRS with a page decode associated with the second SIM.

13. The UE of claim **11**, wherein the one or more memories store instructions that are executable by the one or more processors, individually or in any combination, to cause the UE to determine the offset adjustment, including:

determining that an occurrence of the SRS falls within a first-in-time half of the tune away period of the RF hardware shared by the first SIM and the second SIM; and

in response to determining that the occurrence of the SRS falls within the first-in-time half, determining to prepone the SRS.

14. The UE of claim **11**, wherein the one or more memories store instructions that are executable by the one or more processors, individually or in any combination, to cause the UE to determine the offset adjustment, including:

determining that an occurrence of the SRS falls within a second-in-time half of the tune away period of the RF hardware shared by the first SIM and the second SIM; and

in response to determining that the occurrence of the SRS falls within the second-in-time half, determining to postpone the SRS.

15. The UE of claim **11**, wherein the signal measurement includes at least one of: a reference signal received power (RSRP), a received signal strength indicator (RSSI), or a signal and interference to noise ratio (SINR).

16. The UE of claim **11**, wherein the network associated with the first SIM and the network associated with the second SIM are a same network.

17. The UE of claim **11**, wherein the network associated with the first SIM and the network associated with the second SIM are different networks.

18. The UE of claim **11**, wherein one or more memories store instructions that are executable by the one or more processors, individually or in any combination, to cause the UE the modem is further configured to send the request to the network associated with the first SIM, including:

transmitting a media access control (MAC) control element (CE) to the network associated with the first SIM, the MAC CE including an indication of the offset adjustment.

19. The UE of claim **11**, wherein the one or more memories store instructions that are executable by the one or more processors, individually or in any combination, to cause the UE to:

transmit, subsequent to receiving the offset change configuration, the SRS according to the offset adjustment.

20. The UE of claim **11**, wherein the one or more memories store instructions that are executable by the one or more processors, individually or in any combination, to cause the UE to receive the offset change configuration, including:

receiving a radio resource control (RRC) message reconfiguring the timing offset assigned by the network associated with the first SIM.

21. The UE of claim **11**, wherein the one or more memories store instructions that are executable by the one or more processors, individually or in any combination, to cause the UE to determine the offset adjustment, including:

applying a function dependent upon a numerology applied by the first SIM.

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