US 20110159801A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2011/0159801 A1

(43) Pub. Date: Jun. 30, 2011

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(54) **DISTRIBUTED SIMULTANEOUS TRANSMIT AND RELAY SYSTEM**

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(21) Appl. No.: **12/889,994**

(22) Filed: **Sep. 24, 2010**

Related U.S. Application Data

(60) Provisional application No. 61/291,787, filed on Dec. 31, 2009.

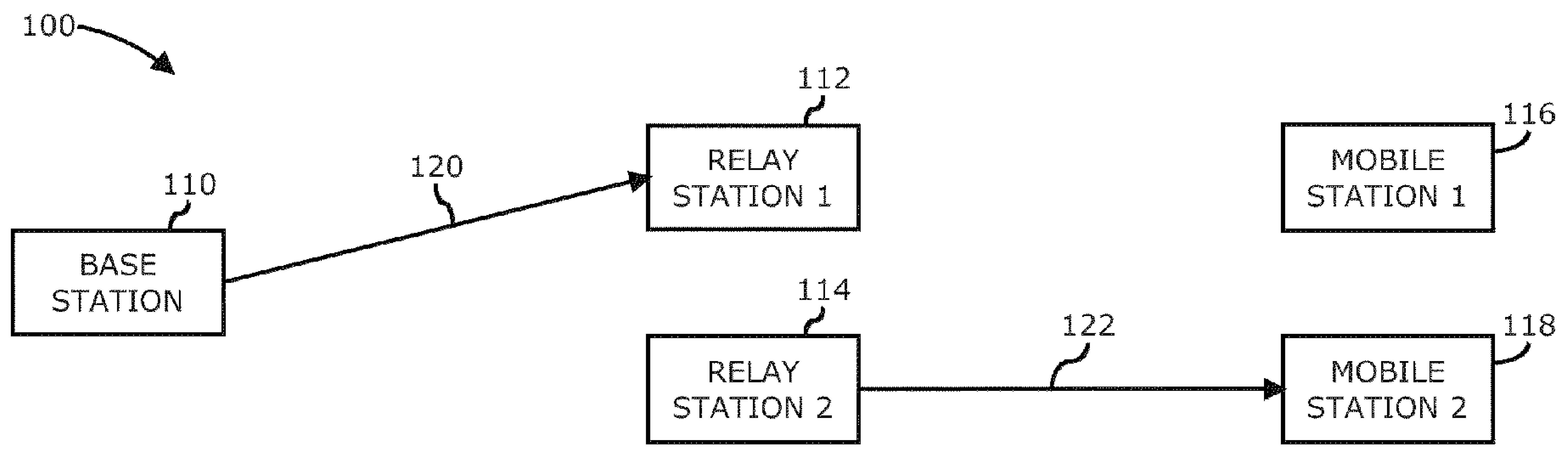
Publication Classification

(51) **Int. Cl.**
H04B 7/14 (2006.01)

(52) **U.S. Cl.** **455/7**

(57) **ABSTRACT**

Briefly, in accordance with one or more embodiments, a distributed simultaneous transmit and receive system implements relaying without incurring the additional overhead associated with relaying and without requiring additional isolation techniques to isolate the transmit and receive circuits of the relay stations. During a first transmission resource, a base station transmits to a first relay station while a second relay station transmits to one or more mobile stations associated with the second relay station. During a second transmission resource, the base station transmits to the second relay station while the first relay station transmits to one or more mobile stations associated with the first relay station.



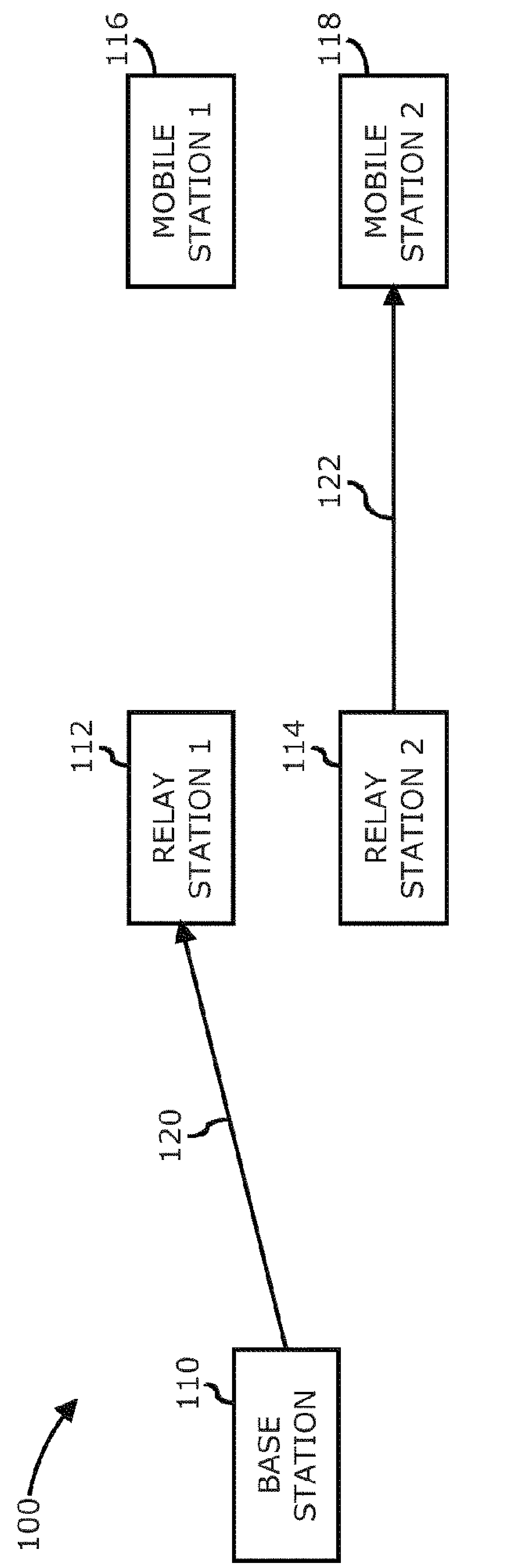

100
BASE STATION
110
RELAY STATION 1
112
RELAY STATION 2
114
MOBILE STATION 1
116
MOBILE STATION 2
118
120
122

FIG. 1A

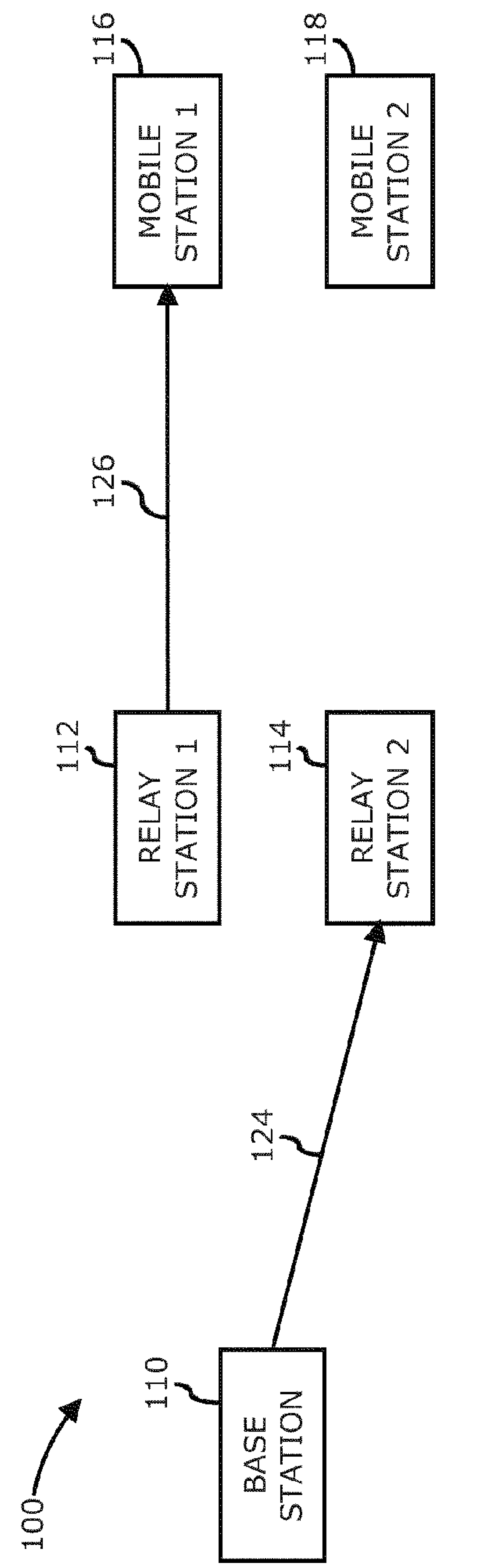

100
BASE STATION
110
RELAY STATION 1
112
RELAY STATION 2
114
MOBILE STATION 1
116
MOBILE STATION 2
118
124
126

FIG. 1B

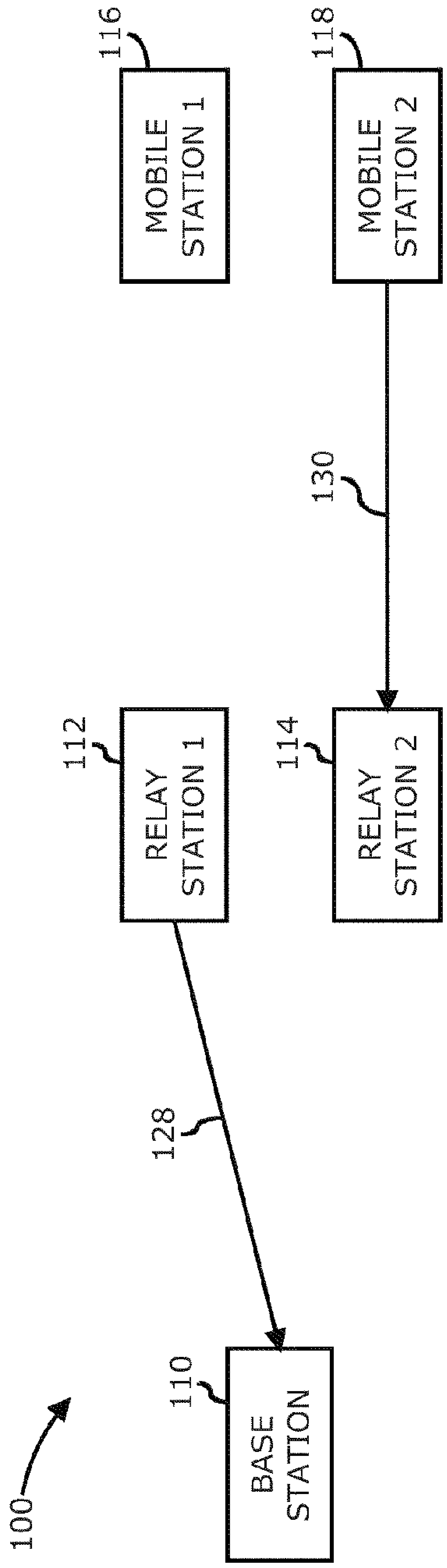

100
BASE STATION
110
128
RELAY STATION 1
112
RELAY STATION 2
114
130
MOBILE STATION 1
116
MOBILE STATION 2
118

FIG. 1C

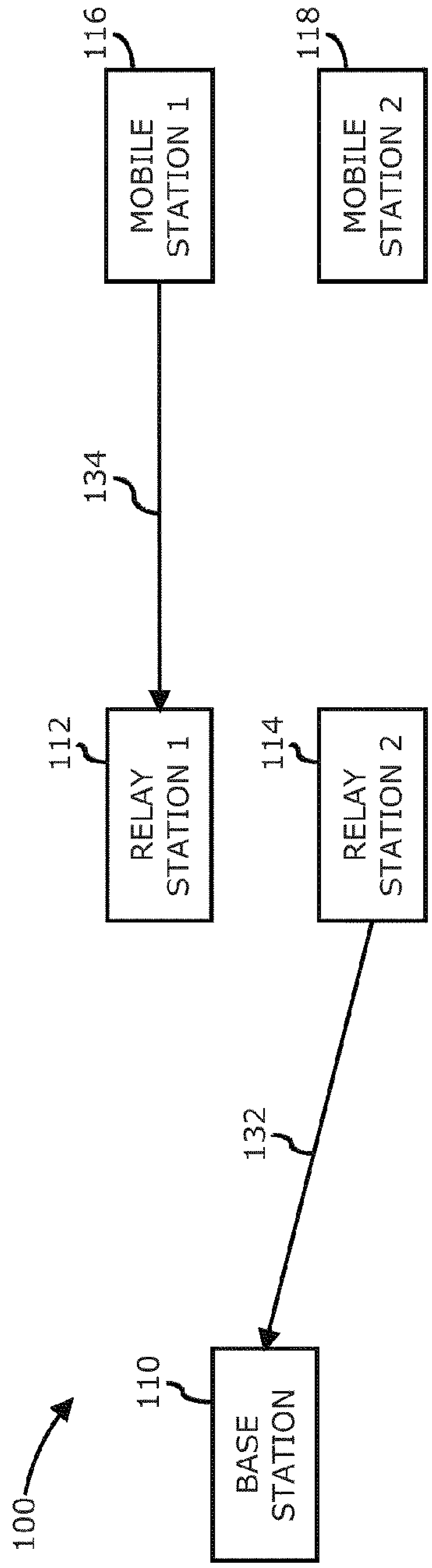

100
BASE STATION
110
132
RELAY STATION 1
112
RELAY STATION 2
114
134
MOBILE STATION 1
116
MOBILE STATION 2
118

FIG. 1D

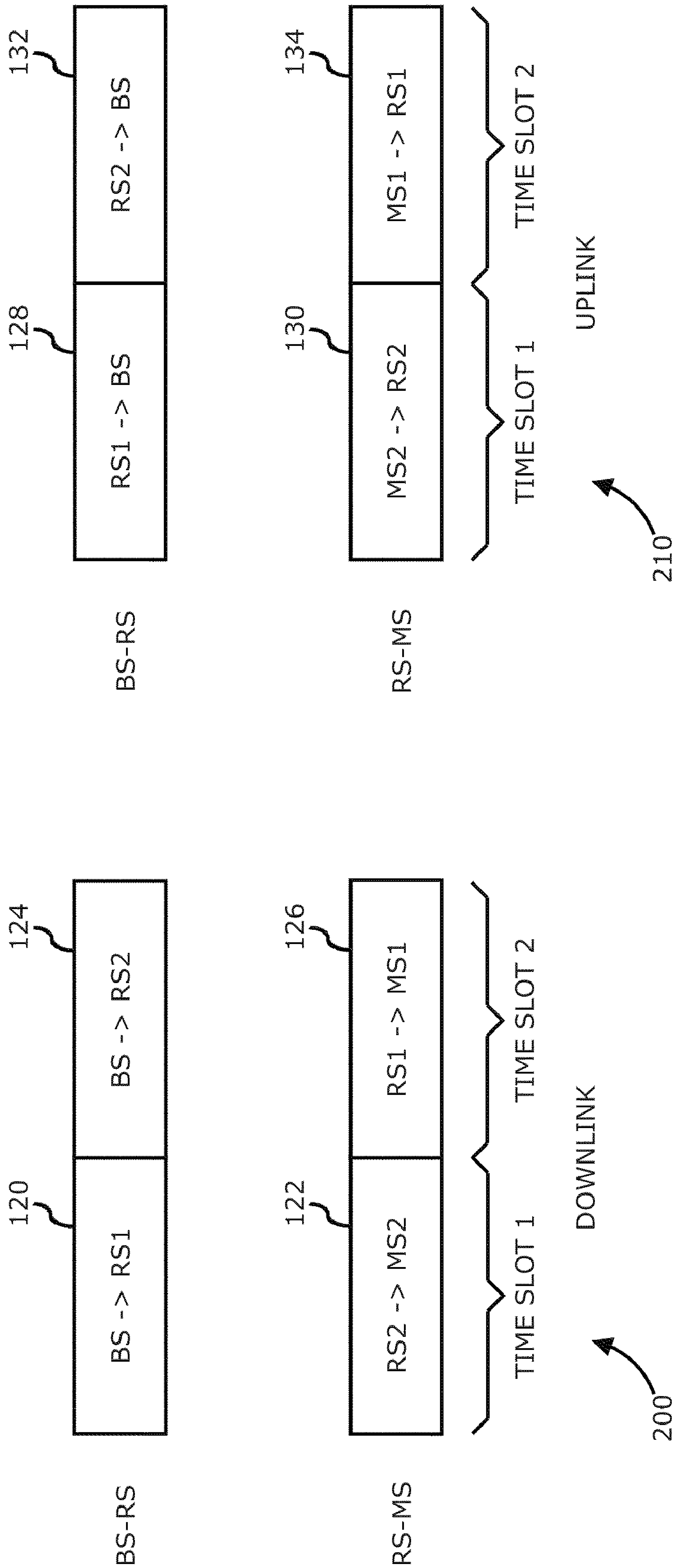

BS-RS
RS-MS
BS -> RS1
BS -> RS2
RS2 -> MS2
RS1 -> MS1
120
124
122
126
TIME SLOT 1
TIME SLOT 2
DOWNLINK
200
RS1 -> BS
RS2 -> BS
MS2 -> RS2
MS1 -> RS1
128
132
130
134
UPLINK
210

FIG. 2

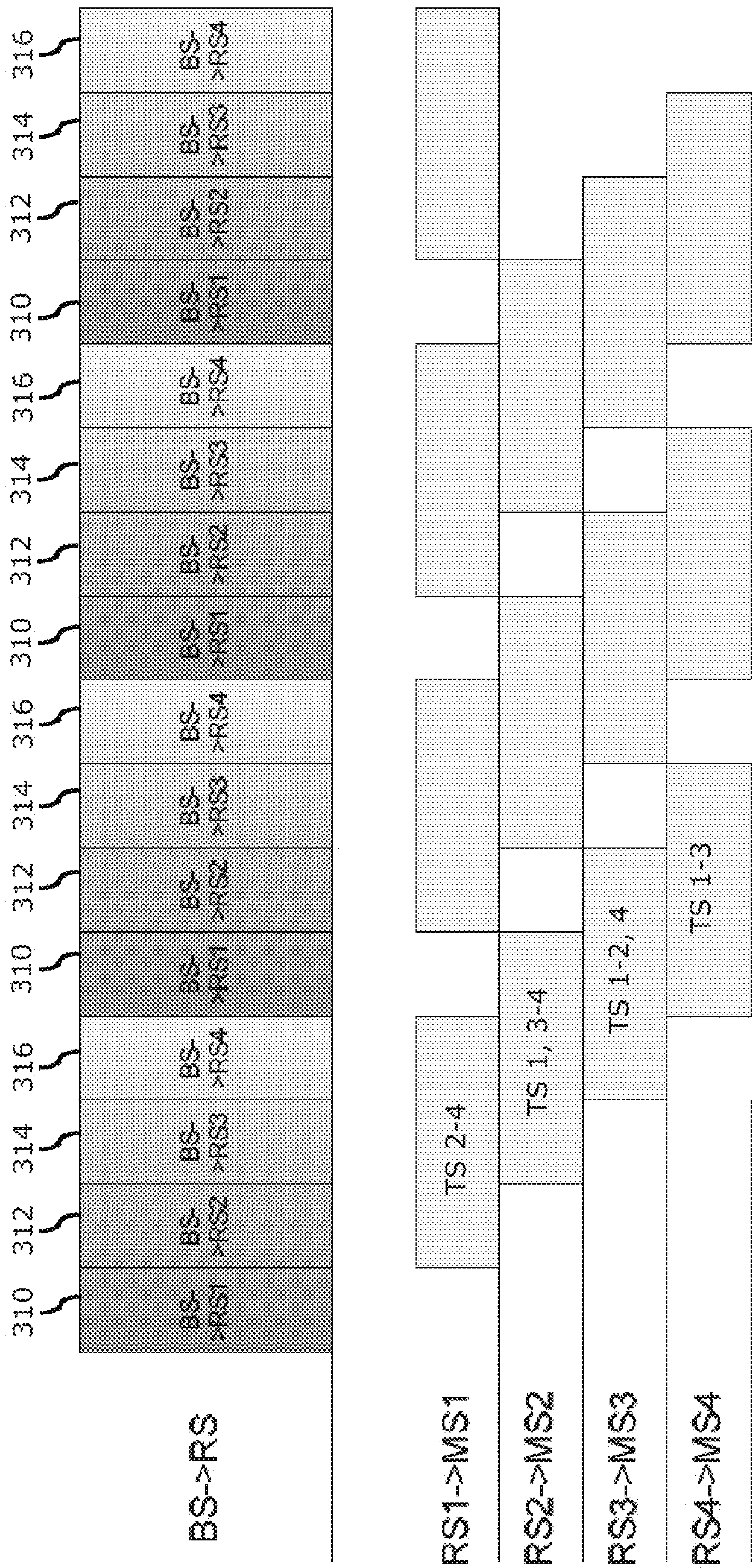

BS->RS
RS1->MS1
RS2->MS2
RS3->MS3
RS4->MS4
310
312
314
316
BS->RS1
BS->RS2
BS->RS3
BS->RS4
TS 2-4
TS 1, 3-4
TS 1-2, 4
TS 1-3

FIG. 3

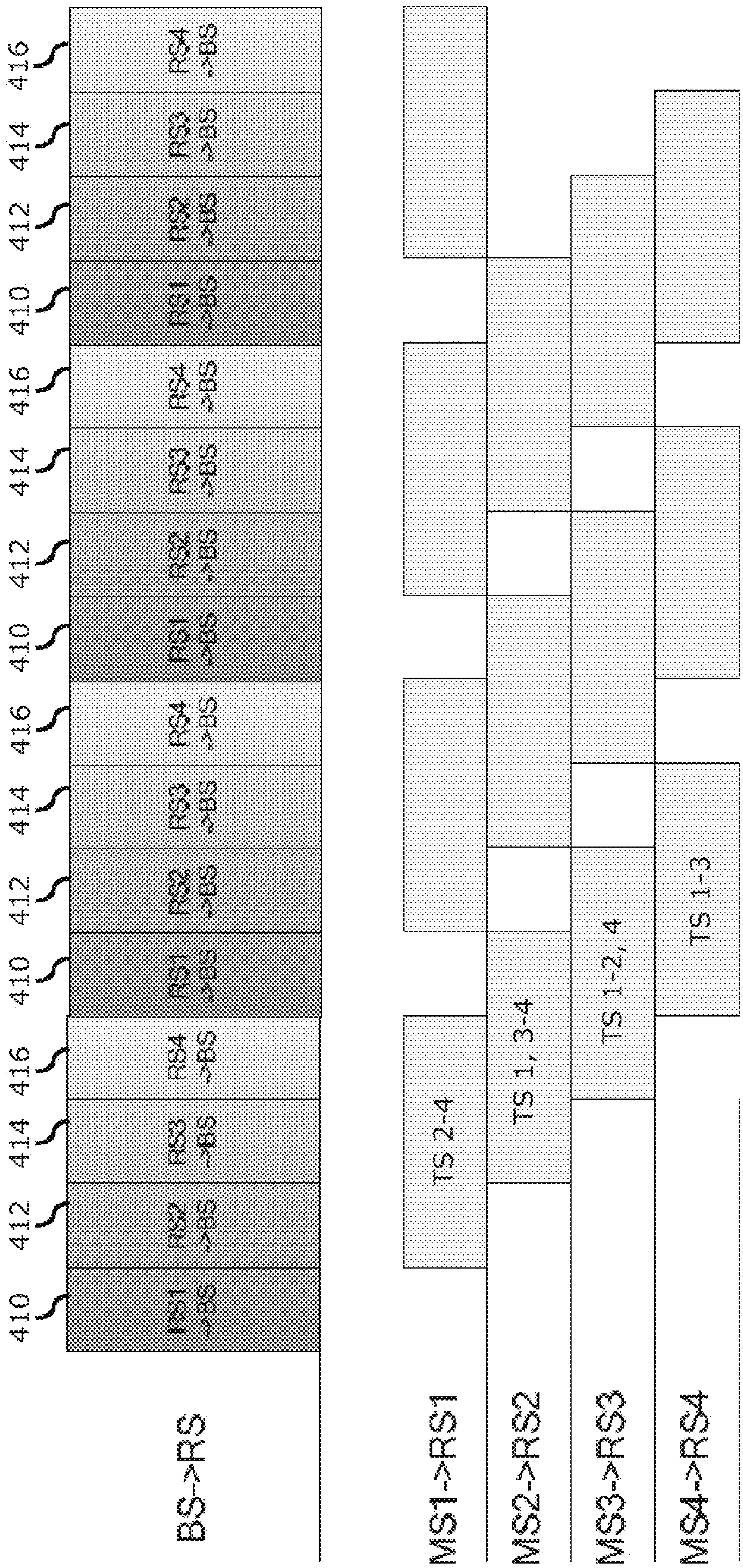

BS->RS
MS1->RS1
MS2->RS2
MS3->RS3
MS4->RS4
410
412
414
416
RS1 ->BS
RS2 ->BS
RS3 ->BS
RS4 ->BS
TS 2-4
TS 1, 3-4
TS 1-2, 4
TS 1-3

FIG. 4

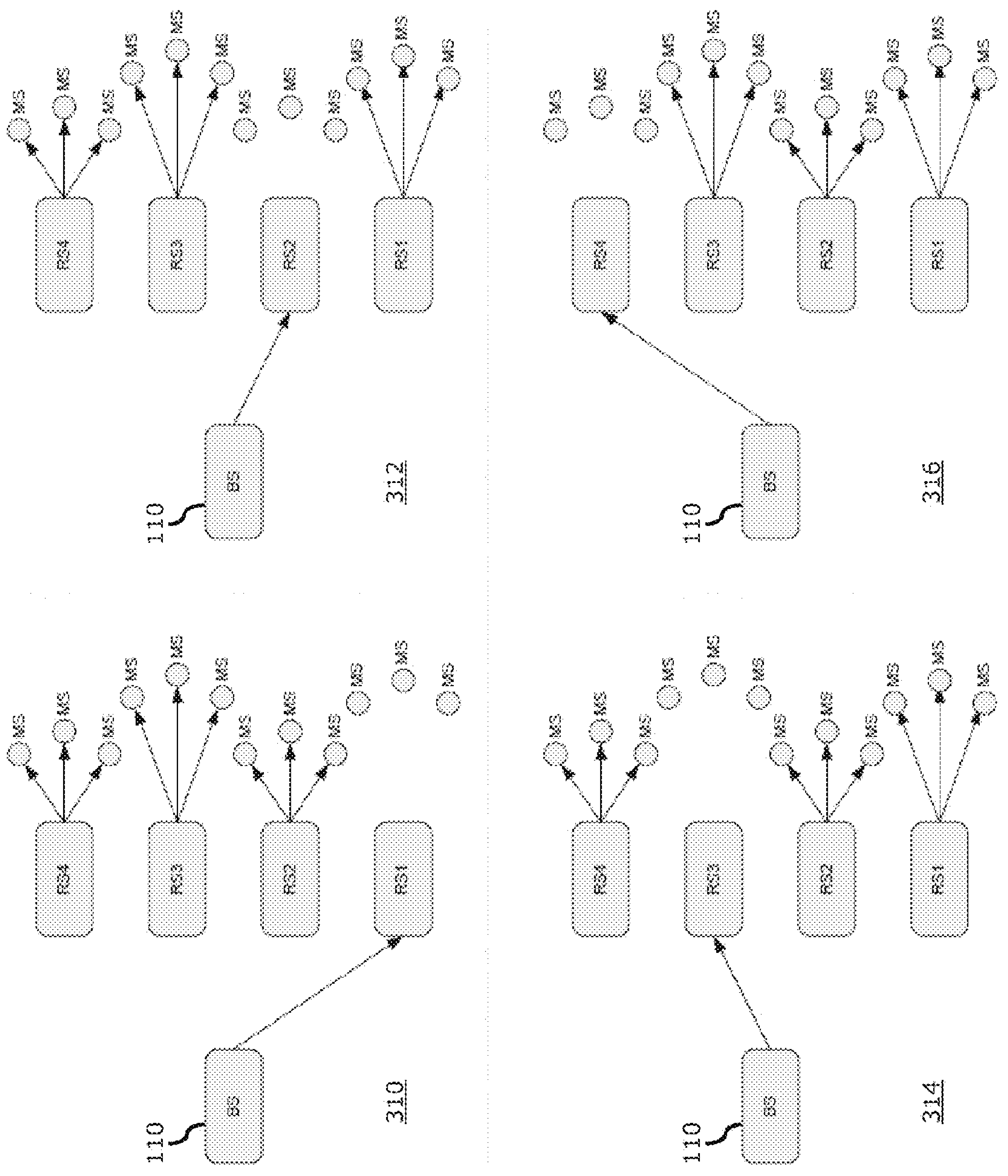


FIG. 5

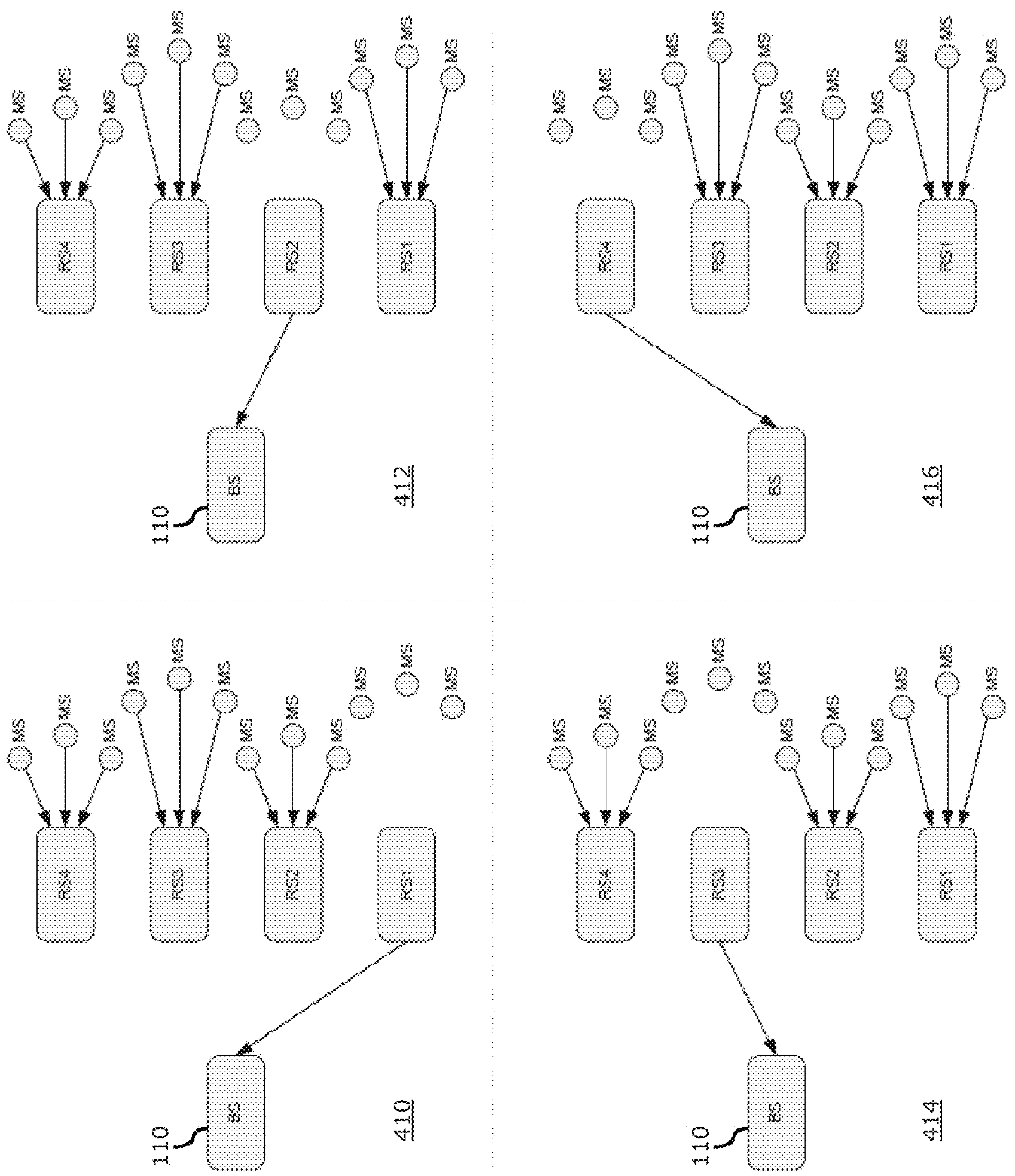


FIG. 6

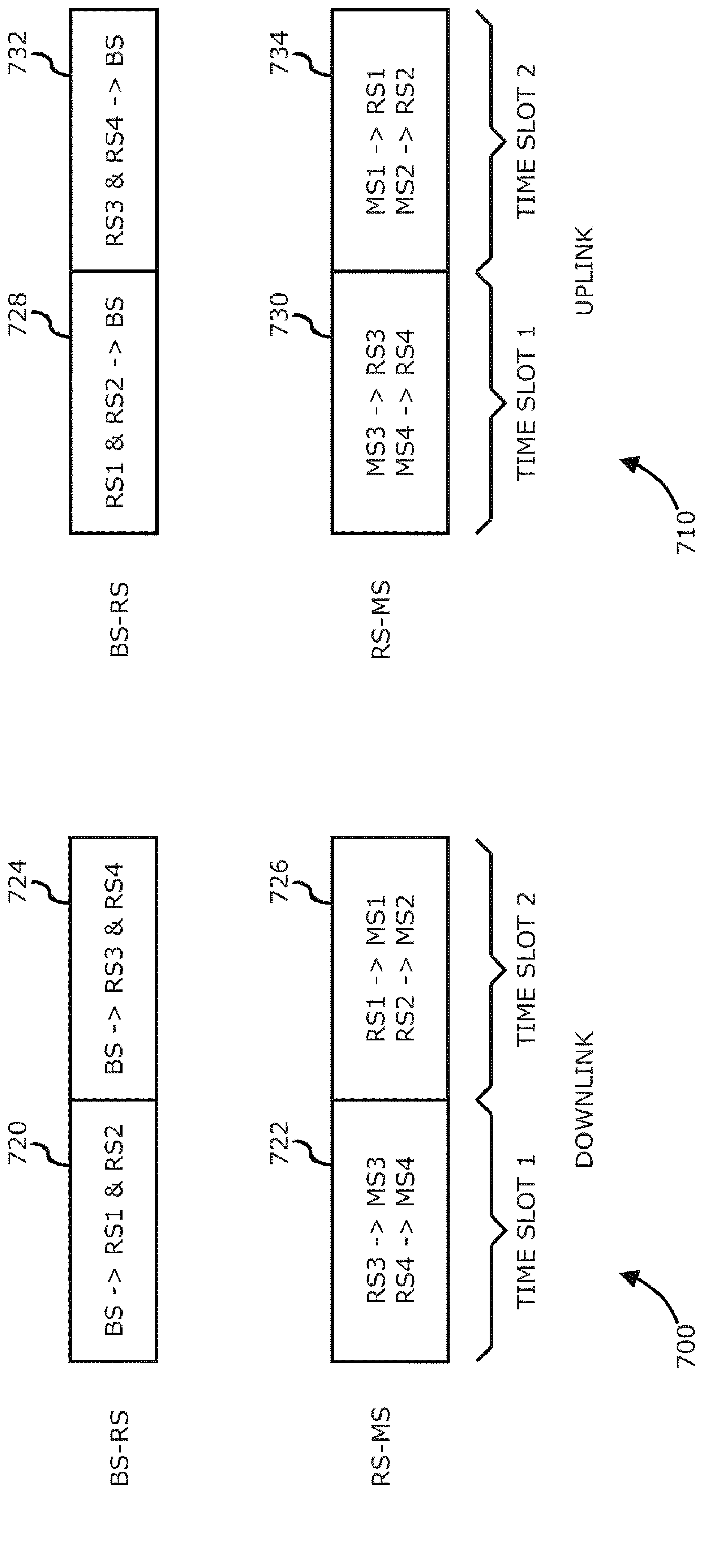

BS-RS
RS-MS
BS -> RS1 & RS2
BS -> RS3 & RS4
RS3 -> MS3
RS4 -> MS4
RS1 -> MS1
RS2 -> MS2
720
724
722
726
TIME SLOT 1
TIME SLOT 2
DOWNLINK
700
BS-RS
RS-MS
RS1 & RS2 -> BS
RS3 & RS4 -> BS
MS3 -> RS3
MS4 -> RS4
MS1 -> RS1
MS2 -> RS2
728
732
730
734
TIME SLOT 1
TIME SLOT 2
UPLINK
710

FIG. 7

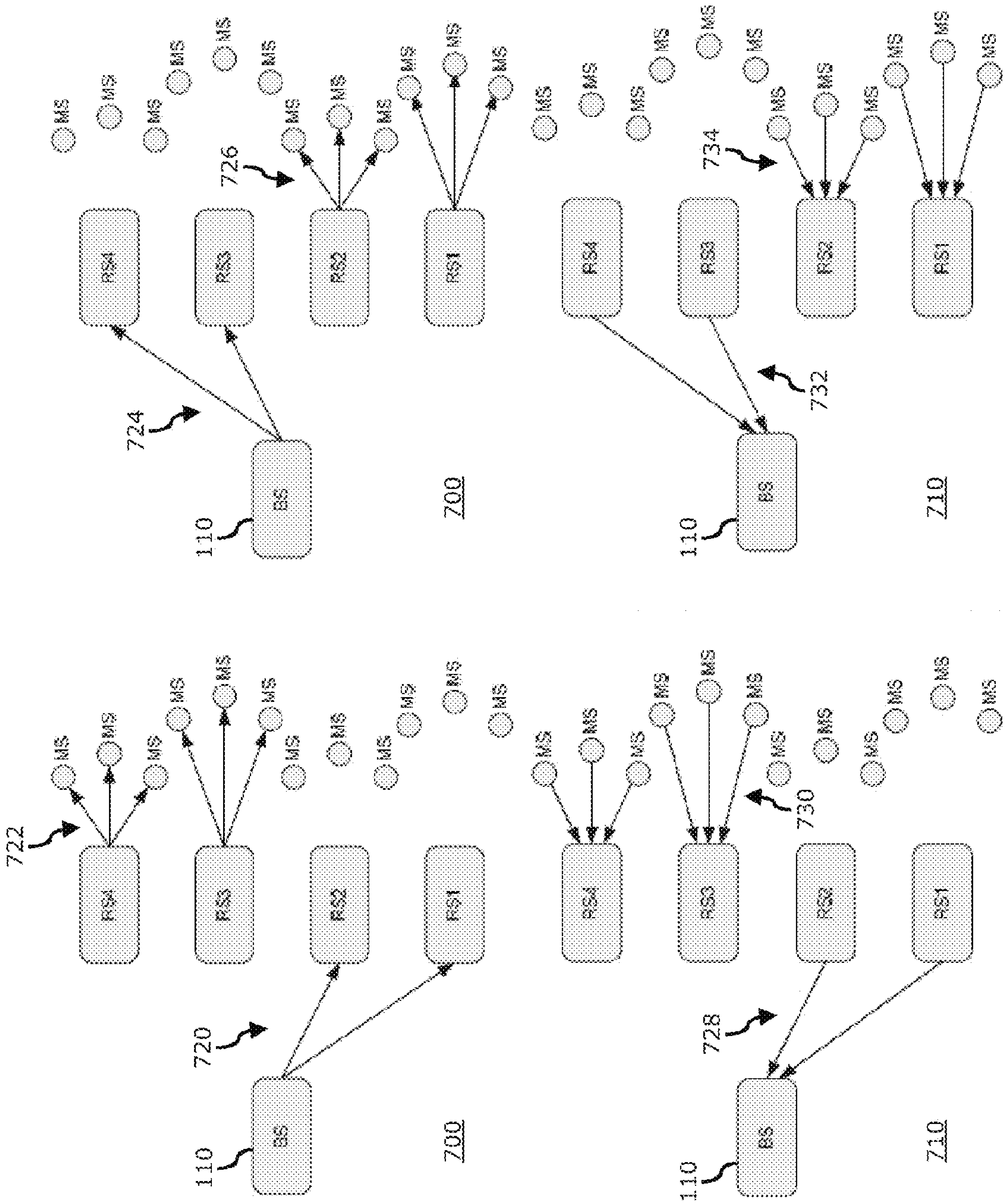


FIG. 8

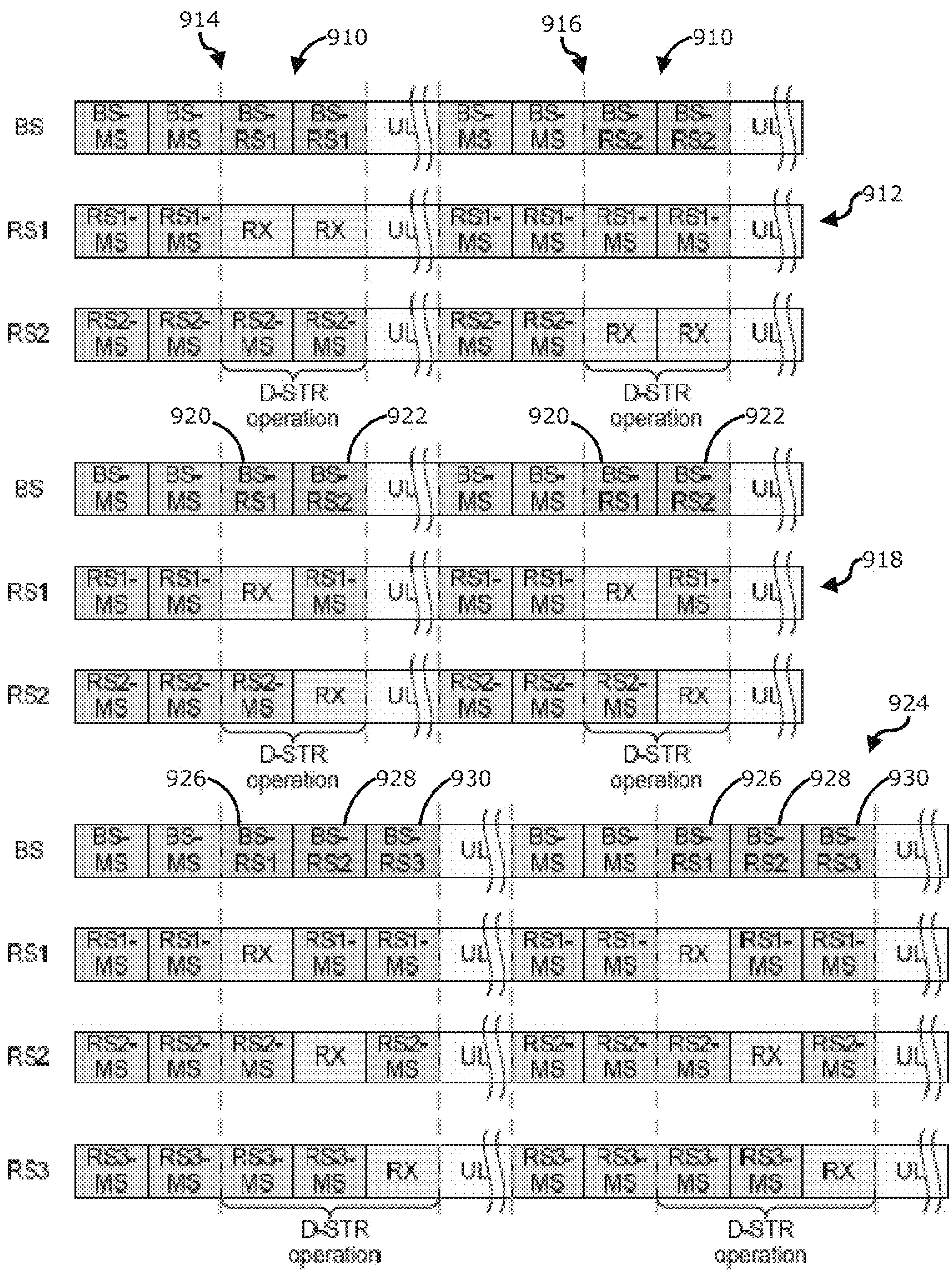

914
910
916
910
BS
BS-MS
BS-MS
BS-RS1
BS-RS1
UL
BS-MS
BS-MS
BS-RS2
BS-RS2
UL
RS1
RS1-MS
RS1-MS
RX
RX
UL
RS1-MS
RS1-MS
RS1-MS
RS1-MS
UL
912
RS2
RS2-MS
RS2-MS
RS2-MS
RS2-MS
UL
RS2-MS
RS2-MS
RX
RX
UL
D-STR operation
D-STR operation
920
922
920
922
BS
BS-MS
BS-MS
BS-RS1
BS-RS2
UL
BS-MS
BS-MS
BS-RS1
BS-RS2
UL
RS1
RS1-MS
RS1-MS
RX
RS1-MS
UL
RS1-MS
RS1-MS
RX
RS1-MS
UL
918
RS2
RS2-MS
RS2-MS
RS2-MS
RX
UL
RS2-MS
RS2-MS
RS2-MS
RX
UL
D-STR operation
D-STR operation
924
926
928
930
926
928
930
BS
BS-MS
BS-MS
BS-RS1
BS-RS2
BS-RS3
UL
BS-MS
BS-MS
BS-RS1
BS-RS2
BS-RS3
UL
RS1
RS1-MS
RS1-MS
RX
RS1-MS
RS1-MS
UL
RS1-MS
RS1-MS
RX
RS1-MS
RS1-MS
UL
RS2
RS2-MS
RS2-MS
RS2-MS
RX
RS2-MS
UL
RS2-MS
RS2-MS
RS2-MS
RX
RS2-MS
UL
RS3
RS3-MS
RS3-MS
RS3-MS
RS3-MS
RX
UL
RS3-MS
RS3-MS
RS3-MS
RS3-MS
RX
UL
D-STR operation
D-STR operation

FIG. 9

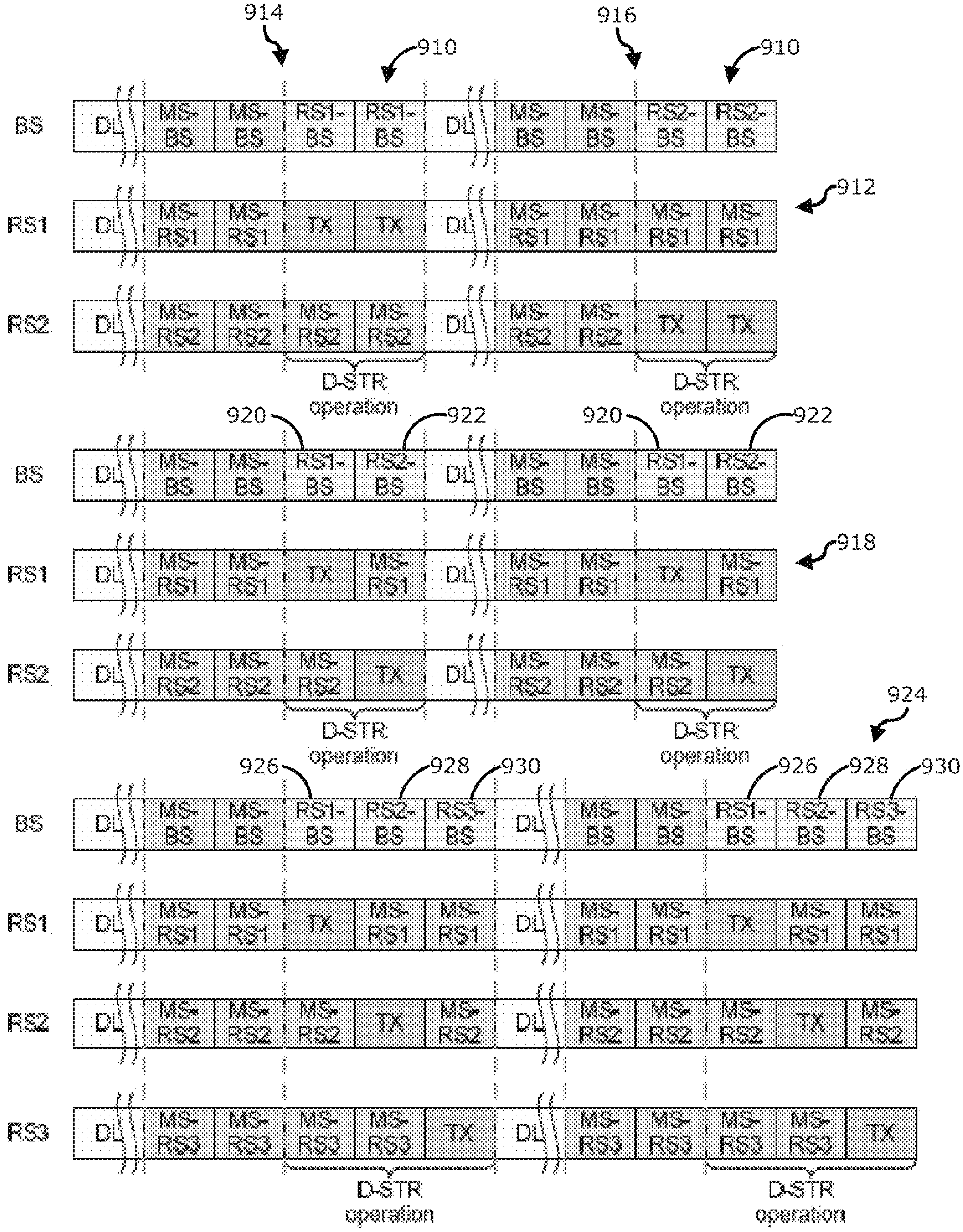

914
910
916
910
BS
DL
MS-BS
MS-BS
RS1-BS
RS1-BS
DL
MS-BS
MS-BS
RS2-BS
RS2-BS
RS1
MS-RS1
TX
912
RS2
MS-RS2
D-STR operation
920
922
RS2-BS
918
924
926
928
930
RS3-BS
RS3
MS-RS3

FIG. 10

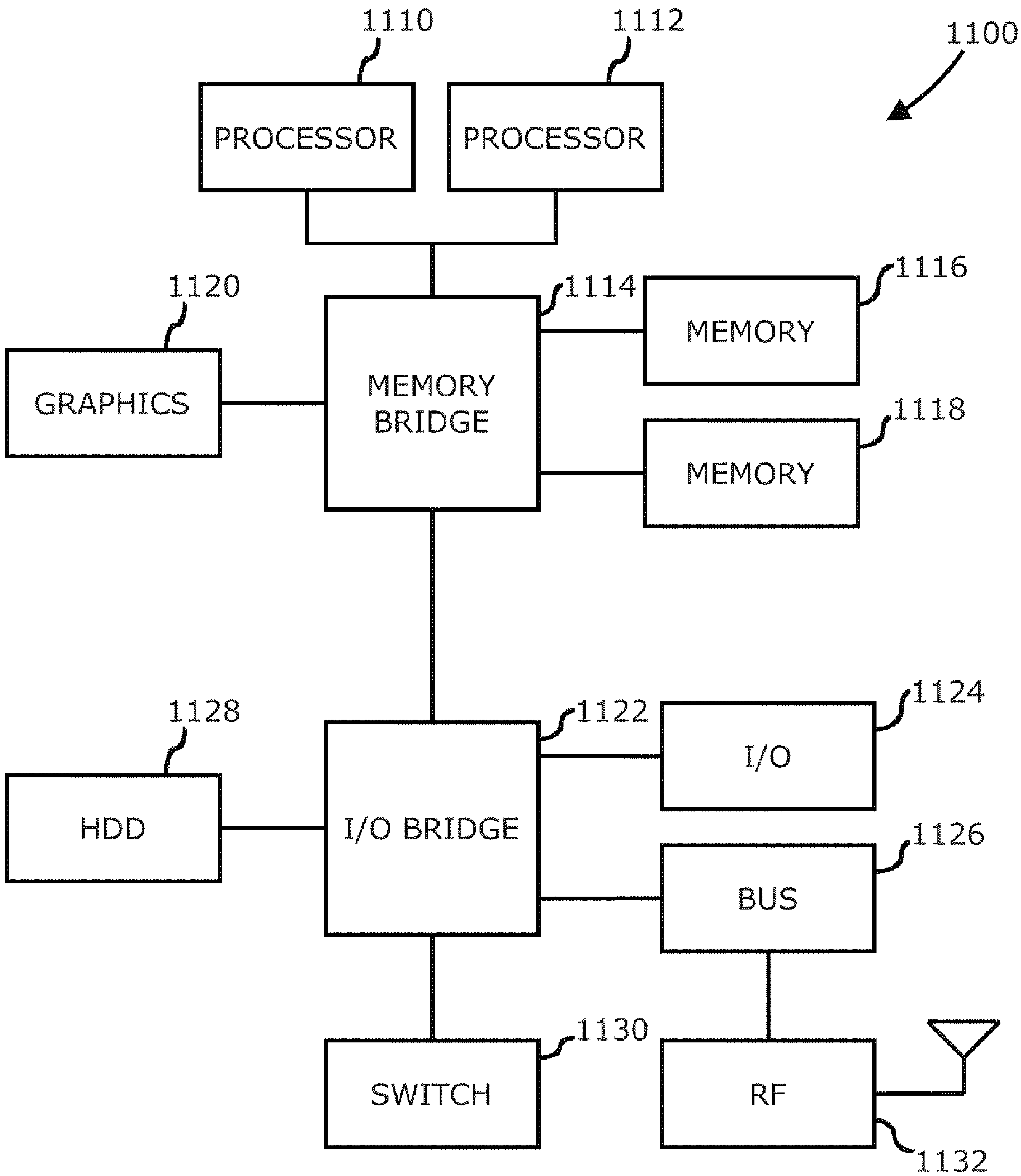

1100
1110
1112
PROCESSOR
PROCESSOR
1120
GRAPHICS
1114
MEMORY BRIDGE
1116
MEMORY
1118
MEMORY
1128
HDD
1122
I/O BRIDGE
1124
I/O
1126
BUS
1130
SWITCH
RF
1132

FIG. 11

DISTRIBUTED SIMULTANEOUS TRANSMIT AND RELAY SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. Provisional Application No. 61/291,787 (Attorney Docket No. P33337Z) filed Dec. 31, 2009. Said Application No. 61/291,787 is hereby incorporated herein in its entirety.

BACKGROUND

[0002] Relaying of a data burst in wireless cellular networks with conventional decode and forward relay station involves additional overhead in the form of base station (BS) to relay station (RS) data transmissions. Using a relay station consumes additional time and/or frequency resources that otherwise could be used to deliver data to the mobile station (MS). To overcome this problem, one approach is to utilize a specially designed relay station having simultaneous transmit and receive (STR) operation capability. Such STR relay stations are capable of receiving data from the base station while simultaneously transmitting the data to the mobile stations, and vice versa, in the same time-frequency resource. Therefore, an STR relay station does not incur additional base station to relay station overhead. However, STR relay stations may have a substantial drawback in that they require a very high degree of mutual insulation of the antennas between the Relay link (base station to relay station) and the Access link (relay station to mobile station) to avoid strong interference from the transmission signal of one link onto the receive circuits of the other link. Thus, STR relay stations typically require additional interference cancellers at both links, which complicates the relay station design and leads to higher equipment cost.

DESCRIPTION OF THE DRAWING FIGURES

[0003] Claimed subject matter is particularly pointed out and distinctly claimed in the concluding portion of the specification. However, such subject matter may be understood by reference to the following detailed description when read with the accompanying drawings in which:

[0004] FIGS. **1**A, **1**B, **1**C, and **1**D are block diagrams of a distributed simultaneous transmit and receive relay system in accordance with one or more embodiments;

[0005] FIG. **2** is a diagram of distributed simultaneous transmit and receive operations wherein two relays per sector are deployed in accordance with one or more embodiments;

[0006] FIG. **3** is a diagram of a simultaneous transmit and receive operation in the downlink wherein an arbitrary number of relays per sector is deployed in accordance with one or more embodiments;

[0007] FIG. **4** is a diagram of a simultaneous transmit and receive operation in the uplink wherein an arbitrary number of relays per sector is deployed in accordance with one or more embodiments;

[0008] FIG. **5** is a block diagram of distributed simultaneous transmit and receive system showing downlink transmissions corresponding to different time instances in accordance with one or more embodiments;

[0009] FIG. **6** is a block diagram of distributed simultaneous transmit and receive system showing uplink transmissions corresponding to different time instances in accordance with one or more embodiments;

[0010] FIG. **7** is a block diagram of distributed simultaneous transmit and receive operations in the downlink and the uplink wherein four relays per sector are deployed using multiuser multiple-input and multiple output (MU-MIMO) on the relay links in accordance with one or more embodiments;

[0011] FIG. **8** is a block diagram of a distributed simultaneous transmit and receive system using multiuser multiple-input and multiple output (MU-MIMO) on the relay links in accordance with one or more embodiments;

[0012] FIG. **9** is a diagram showing example embodiments simultaneous transmit and receive operation in downlink frames in accordance with one or more embodiments;

[0013] FIG. **10** is a diagram showing example embodiments simultaneous transmit and receive operation in uplink frames in accordance with one or more embodiments; and

[0014] FIG. **11** is a block diagram of an information handling system capable of implementing distributed simultaneous transmit and receive operations in accordance with one or more embodiments.

[0015] It will be appreciated that for simplicity and/or clarity of illustration, elements illustrated in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity. Further, if considered appropriate, reference numerals have been repeated among the figures to indicate corresponding and/or analogous elements.

DETAILED DESCRIPTION

[0016] In the following detailed description, numerous specific details are set forth to provide a thorough understanding of claimed subject matter. However, it will be understood by those skilled in the art that claimed subject matter may be practiced without these specific details. In other instances, well-known methods, procedures, components and/or circuits have not been described in detail.

[0017] In the following description and/or claims, the terms coupled and/or connected, along with their derivatives, may be used. In particular embodiments, connected may be used to indicate that two or more elements are in direct physical and/or electrical contact with each other. Coupled may mean that two or more elements are in direct physical and/or electrical contact. However, coupled may also mean that two or more elements may not be in direct contact with each other, but yet may still cooperate and/or interact with each other. For example, "coupled" may mean that two or more elements do not contact each other but are indirectly joined together via another element or intermediate elements. Finally, the terms "on," "overlying," and "over" may be used in the following description and claims. "On," "overlying," and "over" may be used to indicate that two or more elements are in direct physical contact with each other. However, "over" may also mean that two or more elements are not in direct contact with each other. For example, "over" may mean that one element is above another element but not contact each other and may have another element or elements in between the two elements. Furthermore, the term "and/or" may mean "and", it may mean "or", it may mean "exclusive- or", it may mean "one", it may mean "some, but not all", it may mean "neither", and/or it may mean "both", although the scope of claimed subject matter is not limited in this respect. In the following description and/or claims, the terms "comprise" and "include," along with their derivatives, may be used and are intended as synonyms for each other.

[0018] Referring now to FIGS. 1A, 1B, 1C, and 1D, block diagrams of a distributed simultaneous transmit and receive relay system in accordance with one or more embodiments will be discussed. As shown, a distributed simultaneous transmit and receive (D-STR) system 100 may comprise a base station (BS) 110 to communicate with one or more mobile stations such as a first mobile station (MS1) 116 and a second mobile station (MS2) 118. In one or more embodiments, distributed simultaneous transmit and receive system 100 may be operated in compliance with an Institute of Electrical and Electronics Engineers (IEEE) standard such as the IEEE 802.16m Task Group m (TGm) standard to implement a Worldwide Interoperability of Microwave Access (WiMAX) protocol or the like, or alternatively in compliance with a Long Term Evolution (LTE) standard such as the Third Generation Partnership Project (3GPP) Long Term Evolution-Advanced (LTE-Advanced) standard or the like, or any subsequent versions of such standards, and the scope of the claimed subject matter is not limited in this respect. In one or more embodiments, two or more relay stations such as a first relay station (RS1) 112 and a second relay station (RS2) 114 may be deployed between base station 110 and the mobile stations 116 and 118 to retransmit the signals between the broadcasting elements in order to enhance the signal strength and extend the operable range of communication between the base station and the mobile stations. In general, in accordance with one or more embodiments, two or more relay stations are utilized in order to implement simultaneous transmitting and receiving of the signals between the base station and the mobile stations. For example, as shown in FIG. 1A, in a first time slot for downlink transmission, base station 120 transmits to relay station (RS1) 112 via transmission 120, and relay station (RS2) 114 transmits to relay mobile station (MS2) 118 via transmission 122. As shown in FIG. 1B, in a next time slot for downlink transmission, base station 110 transmits to the relay station (RS2) 114 via transmission 124, and relay station (RS1) 112 transmits to mobile station (MS1) 116 via transmission 126. Likewise, as shown in FIG. 1C, in a first time slot for uplink transmission, relay station (RS1) 112 transmits to base station 110 via transmission 128, and mobile station (MS2) 118 transmits to relay stations (RS2) 114 via transmission 130. As shown in FIG. 1D, in a next time slot for uplink transmission, relay station (RS2) 114 transmits to base station 110 via transmission 132, and mobile station (MS1) 116 transmits to relay station (RS1) 112 via transmission 134. In general, in the distributed simultaneous transmit and receive (D-STR) system 100 shown in FIG. 1A-1D, at least two relay stations are deployed to implement simultaneous transmitting and receiving of signals wherein a first relay station is receiving while a second relay station is transmitting, and then alternatively the first relay stations is transmitting while the second relay station is receiving. In a more generalized embodiment of D-STR system 100, one or more relay stations are receiving while one or more other relay stations are transmitting, and then alternatively one more relay stations are transmitting while one or more other relay stations are receiving. An example D-STR system 100 wherein two relays per a given sector are deployed is shown in and described with respect to FIG. 2, below, and more generalized embodiments are shown in and described subsequently, below.

[0019] Referring now to FIG. 2, a diagram of distributed simultaneous transmit and receive operations wherein two relays per sector are deployed in accordance with one or more embodiments will be discussed. The basic principles of operation of a two relay embodiment of distributed simultaneous transmit and receive (D-STR) operation are shown in FIG. 2 with respect to the D-STR system 100 of FIGS. 1A-1D. As shown in FIG. 2, a simple example of data transmission protocol in accordance with the proposed scheme for deployment with two relays per sector is illustrated. However, it should be known that although FIG. 2 merely describes an example of two relays per sector, the D-STR concept discussed herein may be extrapolated to any number of relays per sector, and the scope of the claimed subject matter is not limited in this respect. For the downlink (DL) 200, in the first time slot (TIME SLOT 1) the base station BS 110 sends the data to the first relay station RS1 112 via transmission 120, and in the same time slot the second relay station RS2 114 sends the data, previously obtained from the base station in an earlier time slot (not shown), to mobile station MS2 associated with relay station RS2 114 via transmission 122. In the second time slot (TIME SLOT 2) for the downlink 200, base station BS 110 sends the data to the second relay station RS2 114 via transmission 124, and the first relay station RS1 112 sends the data, received in the first time slot from base station BS 120, to mobile station MS1 116 associated with the first relay station RS1 112 via transmission 126. For the Uplink (UL) 210, the operation is similar to that of the downlink (DL) 200 via transmissions 128, 130, 132, and 134. In such an arrangement, the two relay stations, RS1 112 and RS2 114, together may be viewed as distributed relay system having the simultaneous transmit and receive (STR) capability of distributed simultaneous transmit and receive (D-STR) system 100. In this D-STR system 100, the insulation between the access and the relay links may be achieved with better performance versus typical STR relays due to substantial distance between the simultaneously and alternating operating transmitters and receivers of the two relays RS1 112 and RS 114, however, the scope of the claimed subject matter is not limited in this respect. Although FIGS. 1A-1D and FIG. 2 illustrate the D-STR system 100 for the case of two relays, a D-STR system having an arbitrary number of relays, for example 4 relays, is shown in and described with respect to FIG. 3 through FIG. 6, below.

[0020] Referring now to FIG. 3, a diagram of a simultaneous transmit and receive operation in the downlink wherein an arbitrary number of relays per sector is deployed in accordance with one or more embodiments will be discussed. As shown in FIG. 3, for a deployment of more than two relays per sector generalized transmission protocol may be extrapolated to implement distributed simultaneous transmit and receive (D-STR) with multiple relays, with four relays and four mobile stations in the example shown. In this protocol, the transmission time may be divided into the number of time slots equal to the number of the relay stations. Each of the relay stations may receive data from base station BS 110 in one slot, for example in the time slot corresponding to the relay station's number. When not receiving data from the base station 110, a given relay stations sends the data received from the base station 110 to its served mobile station or stations in all other time slots. Since the spectral efficiency of the relay links is typically much higher than the access links, a good load balance for relay stations may be achieved in such an arrangement. Additionally, to enhance overall system performance, the base station BS 110 may apply beamforming when transmitting to a given relay station in order to avoid interference on the transmissions between the other relay stations and their respective relay stations. For example, in the time slot **1** (**310**), the base station **110** may steer its beam onto relay station RS**1** to deliver data to RS**1** at a high speed and at the same time reduce the interference onto the mobile stations served by all other relay stations RS**2**, RS**3**, and RS**4**. In other time slots, such as time slot **2** (**312**), time slot **3** (**314**), and time slot **4** (**316**), the base station **110** may steer its beam onto the other relay stations, respectively. Thus, relay station RS**1** may receive data from the base station **110** in time slot **1** (**310**) and may transmit to its mobile station MS**1** in time slots **2**-**4** (**312**, **314**, and **316**). Relay station RS**2** may receive data from the base station **110** in time slot **2** (**312**) and may transmit to its mobile station MS**2** in time slots **1** and **3**-**4** (**310**, **314**, and **316**). Relay station RS**3** may receive data from the base station **110** in time slot **3** (**314**) and may transmit to mobile station MS**3** in time slots **1**-**2** and **4** (**310**, **312**, and **316**). Relay station RS**4** may receive data from the base station **110** in time slot **4** (**316**) and may transmit to mobile station MS**4** in time slots **1**-**3** (**310**, **312**, and **316**). Although in the example shown in FIG. **3** each relay station serves one mobile station, in other embodiments a relay station may serve two or more mobile stations, and the scope of the claimed subject matter is not limited in this respect.

[0021] Referring now to FIG. **4**, a diagram of a simultaneous transmit and receive operation in the uplink wherein an arbitrary number of relays per sector is deployed in accordance with one or more embodiments will be discussed. While FIG. **3** illustrates the downlink, FIG. **4** illustrates how D-STR system **100** operates in the uplink and symmetrically with respect to the downlink. As shown in FIG. **4**, each relay station may collect data from one or more mobile stations associated with the corresponding relay station during all time slots except for one time slot which, for example, is the time slip corresponding to the number of the relay station. During the time slot corresponding to the respective relay station number, the relay station sends the data collected from its mobile stations to the base station BS **110**. For example, relay station RS**1** receives data from base station **110** in time slot **1** (**410**), and receives data from mobile station MS**1** in time slots **2**-**4** (**412**, **414**, and **416**). Relay station RS**2** receives data from base station **110** in time slot **2** (**412**), and receives data from mobile station MS**2** in time slots **1** and **3**-**4** (**410**, **414**, and **416**). Relay station RS**3** receives data from base station **110** in time slot **3** (**414**), and receives data from mobile station MS**3** in time slots **1**-**2** and **4** (**410**, **412**, and **416**). Relay station RS **4** receives data from base station **110** in time slot **4** (**416**), and receives data from mobile station MS**4** in time slot **1**-**3** (**410**, **412**, and **414**). Although in the example shown in FIG. **5** each relay station serves one mobile station, in other embodiments a relay station may serve two or more mobile stations, and the scope of the claimed subject matter is not limited in this respect.

[0022] Referring now to FIG. **5** and FIG. **6**, a block diagram of distributed simultaneous transmit and receive system showing downlink transmissions (FIG. **5**) and uplink transmissions (FIG. **6**) corresponding to different time instances in accordance with one or more embodiments will be discussed. FIG. **5** and FIG. **6** show the transmission diagrams for the operation of the distributed simultaneous transmit and receive (D-STR) system in an example of deployment with four relays per sector for downlink as shown in FIG. **3**, and for the uplink as shown in FIG. **4**, respectively. Considering the downlink as shown in FIG. **5**, in the first time slot (**310**), the base station **110** sends the data to relay station RS**1**, and all other relay stations send data to their respective associated base stations. In the second time slot (**312**) the base station **110** sends the data to relay station RS**2**, and all other relay stations send data to their respective associated with mobile stations. The D-STR system operates similarly for the third time slot (**314**) and the fourth timeslot (**316**). In the uplink as shown in FIG. **6**, the operation is symmetrical with respect to the downlink for time slots **410**, **412**, **414**, and **416**. Although an example of a D-STR system **100** is shown in FIG. **3**, FIG. **4**, FIG. **5**, and FIG. **6** illustrating a four relay system, it should be noted that D-STR system **100** ma be generalized to any number of relays, and the scope of the claimed subject matter is not limited in this respect.

[0023] Referring now to FIG. **7** and FIG. **8**, a block diagrams of distributed simultaneous transmit and receive operations in the downlink and the uplink wherein four relays per sector are deployed using multiuser multiple-input and multiple output (MU-MIMO) on the relay links in accordance with one or more embodiments will be discussed. Extrapolating the distributed simultaneous transmit and receive (D-STR) system **100** to multiple antenna systems, the aggregate spectral efficiency of the D-STR system **100** with relays may be further improved via utilization of a multiple-input and multiple-output (MIMO) capable base station **110**. As shown in FIG. **7**, to organize distributed simultaneous transmit and receive (STR) and/or quasi-STR operation of the relay stations in a MIMO deployment, the relay stations may be organized into several groups, with at least one group having two or more relay stations. In such an arrangement, the D-STR system **100** described herein, above, may be applied between each group of relay stations. The aggregate spectral efficiency in a given cell may be enhanced by delivering the data to several relays members of a given group in parallel, that is simultaneously, by using different spatial multiplexing (SM) schemes. For example, for the deployment with four relay stations per sector with a MIMO capable base station BS **110**, the relay stations may be split into two groups, wherein the first group comprises relay stations RS**1** and RS**2**, and the second group comprises relay station RS**3** and RS**4**. The data transmission may be organized as shown in FIG. **7** and in FIG. **8**. For example, for the downlink **700**, in time slot **1** base station **110** transmits to relay stations RS**1** and RS**2** via transmission **720**, and relay stations RS**3** and RS**4** transmit to respective mobile stations MS**3** and MS**4** via transmission **720**. In time slot **2** base station **110** transmits to relay stations RS**3** and RS**4** via transmission **724**, and relay stations RS**1** and RS**2** transmit to respective mobile stations MS**1** and MS**2** via transmission **726**. Likewise, for the uplink **710**, in time slot **1** base station **110** receives data from relay stations RS**1** and RS**2** via transmission **728**, and relay stations RS**3** and RS**4** receive data from respective mobile stations MS**3** and MS**4** via transmission **730**. In time slot **2** base station **110** receives data from relay stations RS**3** and RS**4** via transmission **732**, and relay stations RS**1** and RS**2** receive data from respective mobile stations MS**1** and MS**2** via transmission **734**. It should be noted that base station **110** may implement MIMO communication between multiple relay stations in respective groups, the relay stations themselves may also implement MIMO communication between multiple mobile stations served by the respective relay stations, and the scope of the claimed subject matter is not limited in this respect. Furthermore, although FIG. **7** and FIG. **8** illustrate an example of two groups of two relay stations per group of relay stations, it should be noted that any arbitrary number of groups may be utilized, and a given group of relay stations may have any arbitrary number of relay stations in the group, and the scope of the claimed subject matter is not limited in these respects.

[0024] Referring now to FIG. **9** and FIG. **10**, a diagrams showing example embodiments of simultaneous transmit and receive operation in downlink frames (FIG. **9**) and uplink frames (FIG. **10**) in accordance with one or more embodiments will be discussed. As an example, FIG. **9** and FIG. **10** show the implementation of the distributed simultaneous transmit and receive (D-STR) system in a frame structure in accordance with an Institute of Electrical and Electronics Engineers (IEEE) standard such as the IEEE 802.16m frame structure. As shown in FIG. **9** and FIG. **10**, the frame structure of the IEEE 802.16m standard is based on subframes comprising several subframes in the downlink (DL) part of the frame (FIG. **9**) and several subframes in the uplink (UL) part of the frame (FIG. **10**). Data transmissions in the IEEE 802.16m standard are aligned to subframe time boundaries. In downlink and uplink parts of the frame, the last several subframes may be utilized to create a D-STR Relay Zone, wherein base station BS **100** communicates with the relay stations and wherein the D-STR operation may be implemented. The rest of the subframes comprise the DL and UL Access Zones where communications between the base station **110** and the mobile stations and between the relay stations and mobile stations are implemented.

[0025] In the D-STR Relay Zone **910**, several embodiments of implementing D-STR technique may be implemented. In a first embodiment, under a frame-wise approach **912**, in the downlink D-STR Relay Zone **910** (FIG. **9**), in a first frame **914** relay station RS**1** receives data from the base station **100**, and relay station RS**2** transmits data to its mobile stations. In the D-STR Relay Zone **910** of another frame **916**, the relay stations do the opposite wherein relay station RS**1** distributes data to its mobile stations, and relay station RS**2** receives data from the base station **110**. In the Uplink as shown in FIG. **10**, the frame-wise approach **912** operation is similar to the downlink frame-wise approach operation with transmissions occurring in the reverse direction. Implementing such a frame-wise approach **912** in the frame structure defined in the IEEE 802.16m standard involves allowing a given relay station to serve its mobile stations in the D-STR Relay Zone **910** with RS-MS transmission in the downlink and MS-RS transmission in the uplink. In such an arrangement, configuration messages and/or information elements are modified accordingly to accommodate D-STR operation.

[0026] In another embodiment, D-STR is implemented via a subframe-wise approach **918**. Under a subframe-wise approach the relay stations alternate their roles within the same frame from one subframe to another subframe. For example, with reference to FIG. **9**, in the downlink in the first subframe **920** of D-STR Relay Zone **910**, relay station RS**1** receives data from base station **110**, and relay station RS**2** transmits data to its mobile stations. In the second subframe **922** of D-STR Relay Zone **910**, relay station RS**1** distributes the data to its mobile stations, and relay station RS**2** receives data from the base station **110**. Operation of the subframe-wise approach **918** in the uplink is similar as shown in FIG. **10** with transmissions occurring in the reverse direction.

[0027] The subframe-wise approach for three D-STR relays is shown at **924**. The three or more relay approach may involve three or more corresponding subframes of the frame. Since the entire D-STR cycle completes within the same frame, the subframe-wise approach has less latency of data transmissions to the mobile stations associated with corresponding relay stations. However, since this approach requires more frequent transition of the relay between the transmit (TX) and receive (RX) states, implementing a subframe-wise approach may involve introduction of additional receive-transmit gaps on the base station to relay station links. In case of zero-length gaps, the subframe-wise approach may be implemented in the IEEE 802.16m or Third Generation Partnership Project (3GPP) Long Term Evolution-Advanced (LTE-Advanced) standards, however the scope of the claimed subject matter is not limited in these respects.

[0028] Although the examples shown and described herein illustrate various approaches to single-hop relaying to implement a distributed simultaneous transmit and receive (D-STR) system **100**, in one or more embodiments the D-STR system **100** may be extrapolated to provide multi-hop relaying operation with an arbitrary number of hops and which may be implemented in compliance with future revisions or versions of one or more IEEE 802.16 standards or Third Generation Partnership Project (3GPP) Long Term Evolution-Advanced (LTE-Advanced) standard or the like, and the scope of the claimed subject matter is not limited in this respect. An example of an information handling system capable of implementing distributed simultaneous transmit and receive (D-STR) operation in a D-STR system **100** is shown in and described with respect to FIG. **11**, below.

[0029] Referring now to FIG. **11**, a block diagram of an information handling system capable of implementing distributed simultaneous transmit and receive operations in accordance with one or more embodiments will be discussed. Information handling system **1100** of FIG. **11** may tangibly embody one or more of any of the network elements of distributed simultaneous transmit and receive (D-STR) system **100** as shown in and described with respect to FIGS. **1A-1D** and the other various alternative embodiments discussed herein. For example, information handling system **1100** may represent the hardware of base station **110**, relay stations **112** and **114**, or mobile stations **116** and **118**, with greater or fewer components depending on the hardware specifications of the particular device or network element. Although information handling system **1100** represents one example of several types of computing platforms, information handling system **1100** may include more or fewer elements and/or different arrangements of elements than shown in FIG. **11**, and the scope of the claimed subject matter is not limited in these respects.

[0030] Information handling system **1100** may comprise one or more processors such as processor **1110** and/or processor **1112**, which may comprise one or more processing cores. One or more of processor **1110** and/or processor **1112** may couple to one or more memories **1116** and/or **1118** via memory bridge **1114**, which may be disposed external to processors **1110** and/or **1112**, or alternatively at least partially disposed within one or more of processors **1110** and/or **1112**. Memory **1116** and/or memory **1118** may comprise various types of semiconductor based memory, for example volatile type memory and/or non-volatile type memory. Memory bridge **1114** may couple to a graphics system **1120** to drive a display device (not shown) coupled to information handling system **1100**.

[0031] Information handling system **1100** may further comprise input/output (I/O) bridge **1122** to couple to various types of I/O systems. I/O system **1124** may comprise, for example, a universal serial bus (USB) type system, an IEEE 1394 type system, or the like, to couple one or more peripheral devices to information handling system **1100**. Bus system **1126** may comprise one or more bus systems such as a peripheral component interconnect (PCI) express type bus or the like, to connect one or more peripheral devices to information handling system **1100**. A hard disk drive (HDD) controller system **1128** may couple one or more hard disk drives or the like to information handling system, for example Serial ATA type drives or the like, or alternatively a semiconductor based drive comprising flash memory, phase change, and/or chalcogenide type memory or the like. Switch **1130** may be utilized to couple one or more switched devices to I/O bridge **1122**, for example Gigabit Ethernet type devices or the like. Furthermore, as shown in FIG. **11**, information handling system **1100** may include a radio-frequency (RF) block **1132** comprising RF circuits and devices for wireless communication with other wireless communication devices and/or via wireless networks such as D-STR system **100** of FIG. **1** or the various alternative embodiments discussed herein, for example where information handling system **1100** embodies base station **110**, relay stations **112** and **114** and, or mobile stations **116** and **118**, although the scope of the claimed subject matter is not limited in this respect.

[0032] Although the claimed subject matter has been described with a certain degree of particularity, it should be recognized that elements thereof may be altered by persons skilled in the art without departing from the spirit and/or scope of claimed subject matter. It is believed that the subject matter pertaining to a distributed simultaneous transmit and receive relay system and/or many of its attendant utilities will be understood by the forgoing description, and it will be apparent that various changes may be made in the form, construction and/or arrangement of the components thereof without departing from the scope and/or spirit of the claimed subject matter or without sacrificing all of its material advantages, the form herein before described being merely an explanatory embodiment thereof, and/or further without providing substantial change thereto. It is the intention of the claims to encompass and/or include such changes.

What is claimed is:

1. A method, comprising:

during a first time frame, transmitting to a first relay station while a second relay station transmits to one or more mobile stations associated with the second relay station; and

during a second time frame, transmitting to the second relay station while the first relay station transmits to one or more mobile stations associated with the first relay station.

2. A method as claimed in claim **1**, wherein the first time frame comprises a first subframe of a given frame, and the second time frame comprises a second subframe of the given frame.

3. A method as claimed in claim **1**, wherein at least one or more mobile stations associated with the first relay station and one or more of the mobile stations associated with the second relay stations are the same mobile stations such that one or more mobile stations are associated with both the first relay station and the second relay station.

4. A method as claimed in claim **1**, further comprising:

during the first time frame, transmitting to the first relay station and to a presently associated mobile station while the second relay station transmits to one or more mobile stations associated with the second relay station; and

during the second time frame, transmitting to the second relay station and to a presently associated mobile station while the first relay station transmits to one or more mobile stations associated with the first relay station.

5. A method, comprising:

during a first time frame, receiving data from a first relay station while a second relay station receives data from one or more mobile stations associated with the second relay station; and

during a second time frame, receiving data from the second relay station while the first relay station receives data from one or more mobile stations associated with the first relay station.

6. A method as claimed in claim **5**, wherein the first time frame comprises a first subframe of a given frame, and the second time frame comprises a second subframe of the given frame.

7. A method as claimed in claim **5**, wherein at least one or more mobile stations associated with the first relay station and one or more of the mobile stations associated with the second relay stations are the same mobile stations such that one or more mobile stations are associated with both the first relay station and the second relay station.

8. A method as claimed in claim **5**, further comprising:

during the first time frame, receiving data from the first relay station and from a presently associated mobile station while the second relay station receives data from one or more mobile stations associated with the second relay station; and

during the second time frame, receiving data from the second relay station and from a presently associated mobile station while the first relay station receives data from one or more mobile stations associated with the first relay station.

9. A method, comprising:

during a first time frame, transmitting to a first group of relay stations while a second group of relay stations transmits to one or more mobile stations associated with the second group of relay stations; and

during a second time frame, transmitting to the second group of relay stations while the first group of relay stations transmits to one or more mobile stations associated with the first group of relay stations.

10. A method as claimed in claim **9**, wherein said transmitting to the first group of relay stations or to the second group of relay stations, or combinations thereof, comprises using beamforming or multiple-input and multiple output, or combinations thereof, to provide simultaneous transmission of different data to different respective relay stations in the first group of relay stations or the second group of relay stations.

11. A method as claimed in claim **9**, wherein the first group of relay stations and the second group of relay stations changes between one time frame and another time frame such that membership of the first group of relay stations or membership of the second group of relay stations, or combinations thereof, changes between time frames.

12. A method, comprising:

during a first time frame, receiving data from a first group of relay stations while a second group of relay stations receives data from one or more mobile stations associated with the second group of relay stations; and during a second time frame, receiving data from the second group of relay stations while the first group of relay stations receives data from one or more mobile stations associated with the first group of relay stations.

13. A method as claimed in claim **12**, wherein said receiving data from the first group of relay stations or from the second group of relay stations, or combinations thereof, comprises using beamforming to provide simultaneous reception of different data from different respective relay stations in the first group of relay stations or the second group of relay stations.

14. A method as claimed in claim **12**, wherein said receiving data from the first group of relay stations or said receiving data from the second group of relay stations, or combinations thereof, comprises using multiple-input and multiple output to receive data from the first group of relay stations or to the second group of relay stations.

15. A method as claimed in claim **12**, wherein the first group of relay stations and the second group of relay stations changes between one time frame and another time frame such that membership of the first group of relay stations or membership the second group of relay stations, or combinations thereof, changes between time frames.

16. A method as claimed in claim **12**, wherein at least one or more mobile stations associated with the first group of relay stations and one or more of the mobile stations associated with the second group of relay stations are the same mobile stations such that one or more mobile stations are associated with both the first group of relay stations and the second group of relay stations.

17. An apparatus, comprising

a processor and a memory coupled to the processor; and

a radio-frequency transceiver coupled to the processor, wherein processor is configured via the memory to:

during a first time frame, transmit to a first relay station while a second relay station transmits to one or more mobile stations associated with the second relay station; and

during a second time frame, transmit to the second relay station while the first relay station transmits to one or more mobile stations associated with the first relay station.

18. An apparatus as claimed in claim **17**, wherein the processor is further configured to cause the radio-frequency transceiver to:

during a third time frame, transmit to a third relay station while the first relay station transmits to the one or more mobile stations associated with the first relay station and the second relay station transmits to the one or more mobile stations associated with the second relay station.

19. An apparatus, comprising

a processor and a memory coupled to the processor; and

a radio-frequency transceiver coupled to the processor, wherein processor is configured via the memory to:

during a first time frame, receive data from the first relay station while the second relay station receives data from one or more mobile stations associated with the second relay station; and

during a second time frame, receive data from the second relay station while the first relay station receives data from one or more mobile stations associated with the first relay station.

20. A method, comprising:

during a first time frame, receiving data transmitted from a base station while one or more other relay stations transmit to one or more mobile stations associated with the one or more other relay stations; and

during a second time frame, transmitting the data received from the base station to one or more presently associated mobile stations while the one or more other relay stations receive data transmitted from the base station.

21. A method, comprising:

during a first time frame, receiving data from the one or more presently associated mobile stations while the one or more other relay stations transmit to the base station; and

during a second time frame, transmitting the data received from the one or more presently associated mobile stations to the base station while the one or more other relay stations receive data from the one or more mobile stations associated with the one or more other relay stations.

22. A method, comprising:

during a first time frame, receiving data transmitted from a first relay station while a second relay station receives data transmitted from a base station; and

during a second time frame, not receiving any data transmitted from the first relay station while the first relay station receives data transmitted from the base station and the second relay station transmits data to one or more mobile station associated with the second relay station.

23. A method, comprising:

during a first time frame, transmitting data to the first relay station while the second relay station transmits data to the base station; and

during a second time frame, not transmitting any data to the first relay station while the first relay station transmits data to the base station and the second relay station receives data from the one or more mobile station associated with the second relay station.

24. A method, comprising:

during a first time frame, transmitting data to the first relay station while the second relay station transmits data to the base station; and

during a second time frame, transmitting data to the second relay station while the first relay station transmits data to the base station.

25. A method, comprising:

during a first time frame, receiving data transmitted from a first relay station while a second relay station receives data transmitted from a base station; and

during a second time frame, receiving data transmitted from the second relay station while the first relay station receives data transmitted from the base station.

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