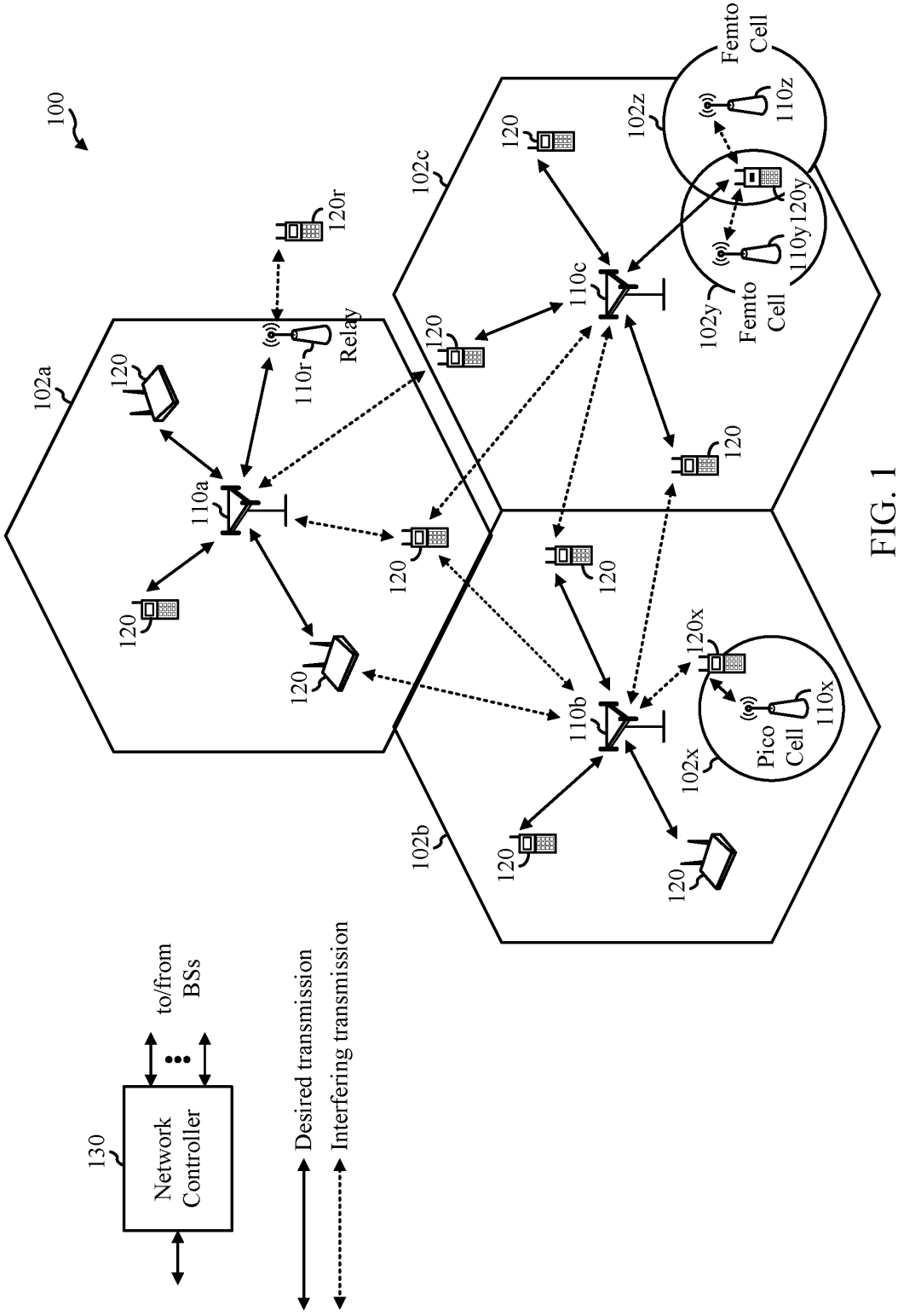
100
102a
102b
102c
102x
102y
102z
110a
110b
110c
110r
110x
110y
110z
120
120r
120x
120y
Relay
Femto Cell
Pico Cell
130
Network Controller
to/from BSs
Desired transmission
Interfering transmission

FIG. 1

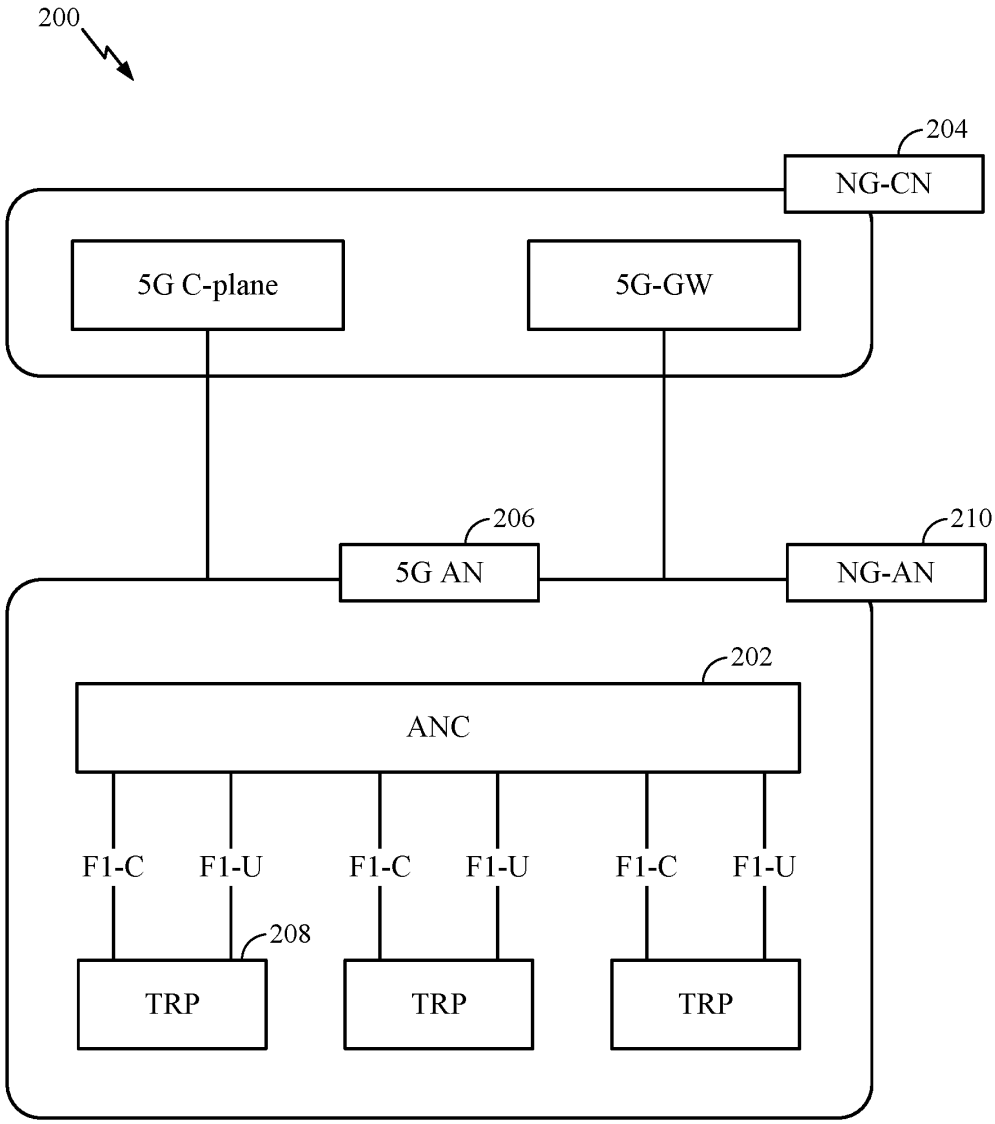
200
204
NG-CN
5G C-plane
5G-GW
206
5G AN
210
NG-AN
202
ANC
F1-C
F1-U
F1-C
F1-U
F1-C
F1-U
208
TRP
TRP
TRP

FIG. 2

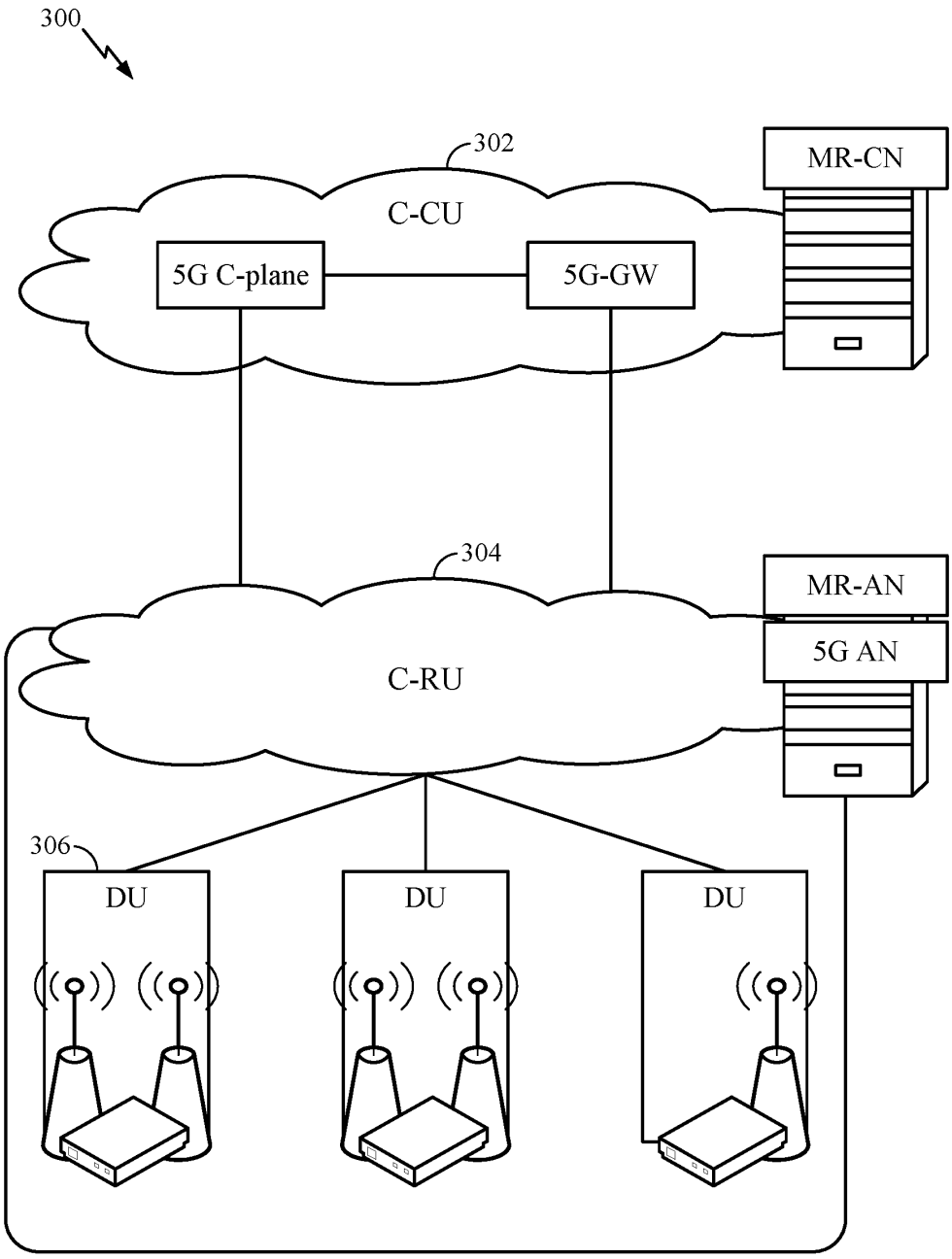

FIG. 3

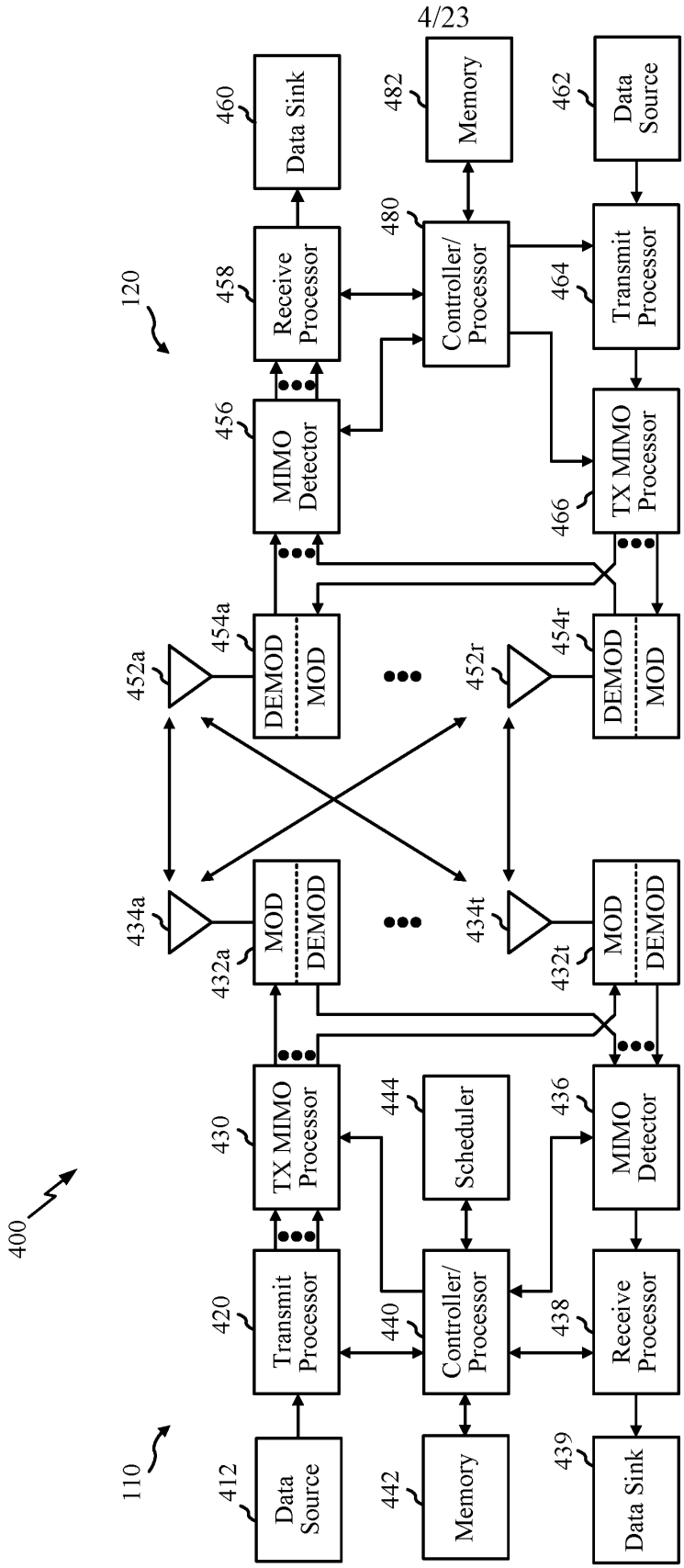
400
110
Data Source
412
Transmit Processor
420
TX MIMO Processor
430
MOD
DEMOD
432a
434a
452a
DEMOD
MOD
454a
MIMO Detector
456
Receive Processor
458
120
Data Sink
460
Data Source
462
Transmit Processor
464
TX MIMO Processor
466
DEMOD
MOD
454r
452r
MOD
DEMOD
432t
434t
MIMO Detector
436
Receive Processor
438
Data Sink
439
Memory
442
Controller/ Processor
440
Scheduler
444
Controller/ Processor
480
Memory
482

FIG. 4

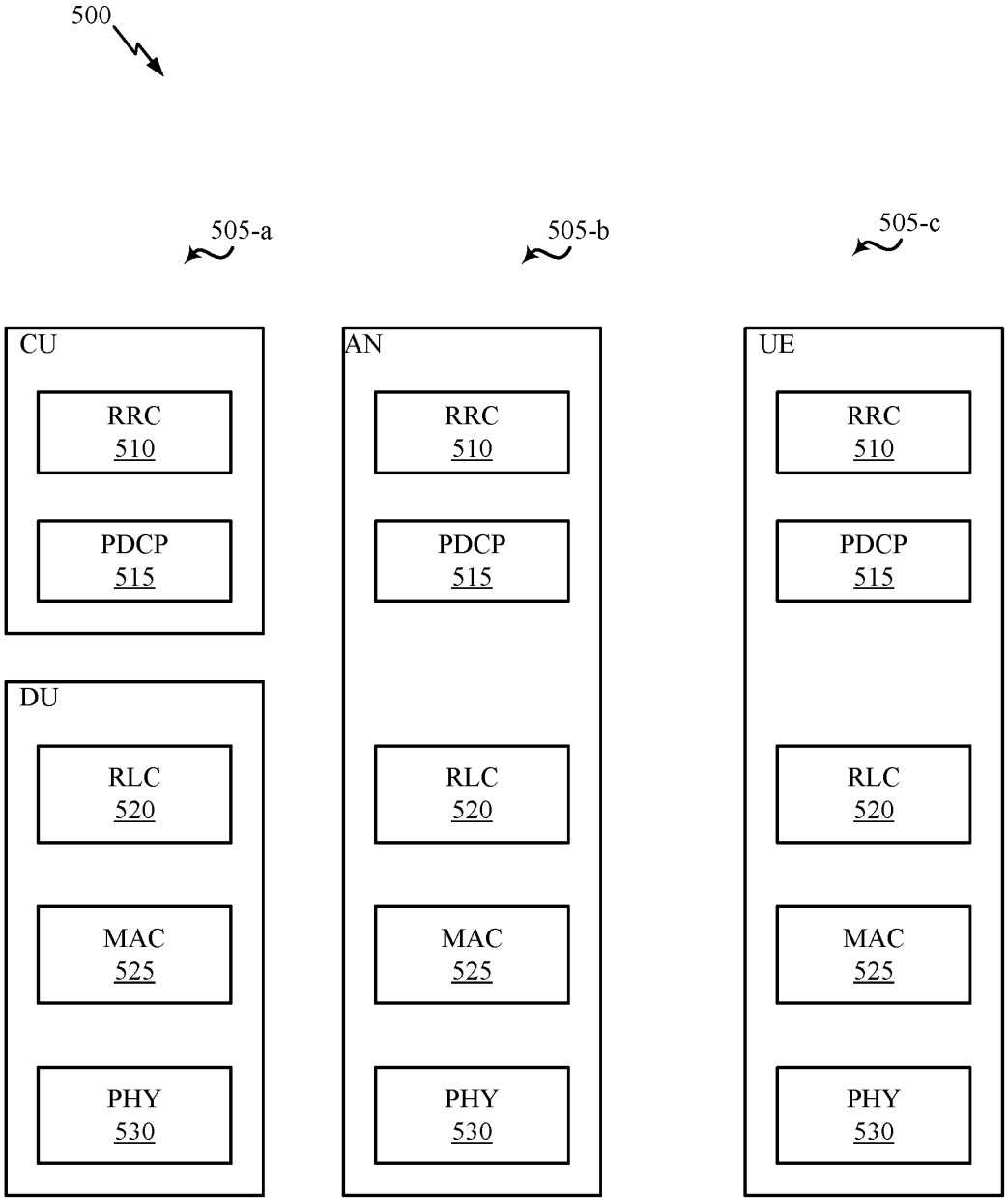
500
505-a
505-b
505-c
CU
RRC
510
PDCP
515
DU
RLC
520
MAC
525
PHY
530
AN
RRC
510
PDCP
515
RLC
520
MAC
525
PHY
530
UE
RRC
510
PDCP
515
RLC
520
MAC
525
PHY
530

FIG. 5

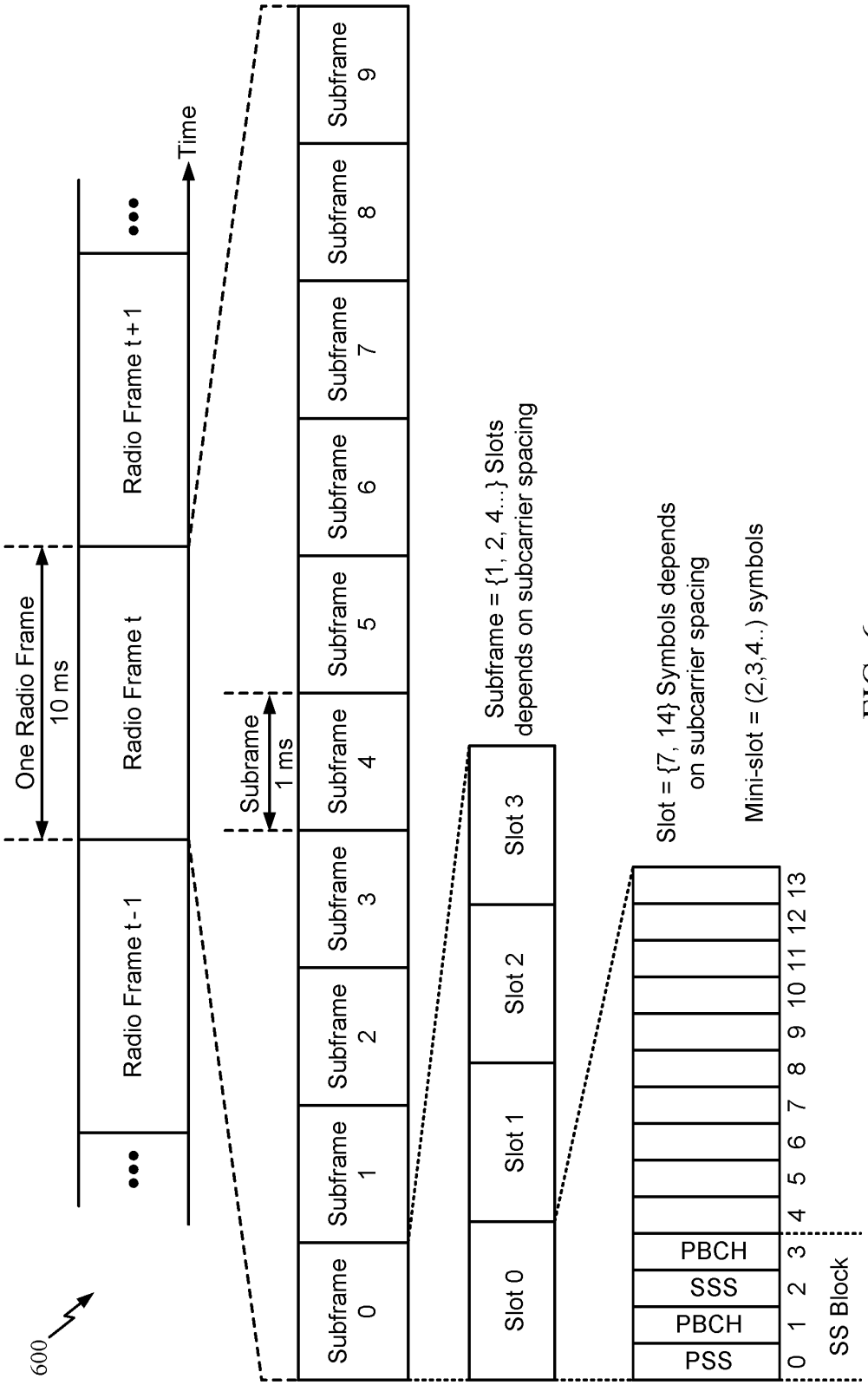
600
Time
One Radio Frame
10 ms
Radio Frame t-1
Radio Frame t
Radio Frame t+1
Subframe 0
Subframe 1
Subframe 2
Subframe 3
Subframe 4
Subframe 5
Subframe 6
Subframe 7
Subframe 8
Subframe 9
Subframe
1 ms
Slot 0
Slot 1
Slot 2
Slot 3
Subframe = {1, 2, 4...} Slots
depends on subcarrier spacing
Slot = {7, 14} Symbols depends
on subcarrier spacing
Mini-slot = (2,3,4..) symbols
PSS
PBCH
SSS
PBCH
SS Block
0 1 2 3 4 5 6 7 8 9 10 11 12 13

FIG. 6

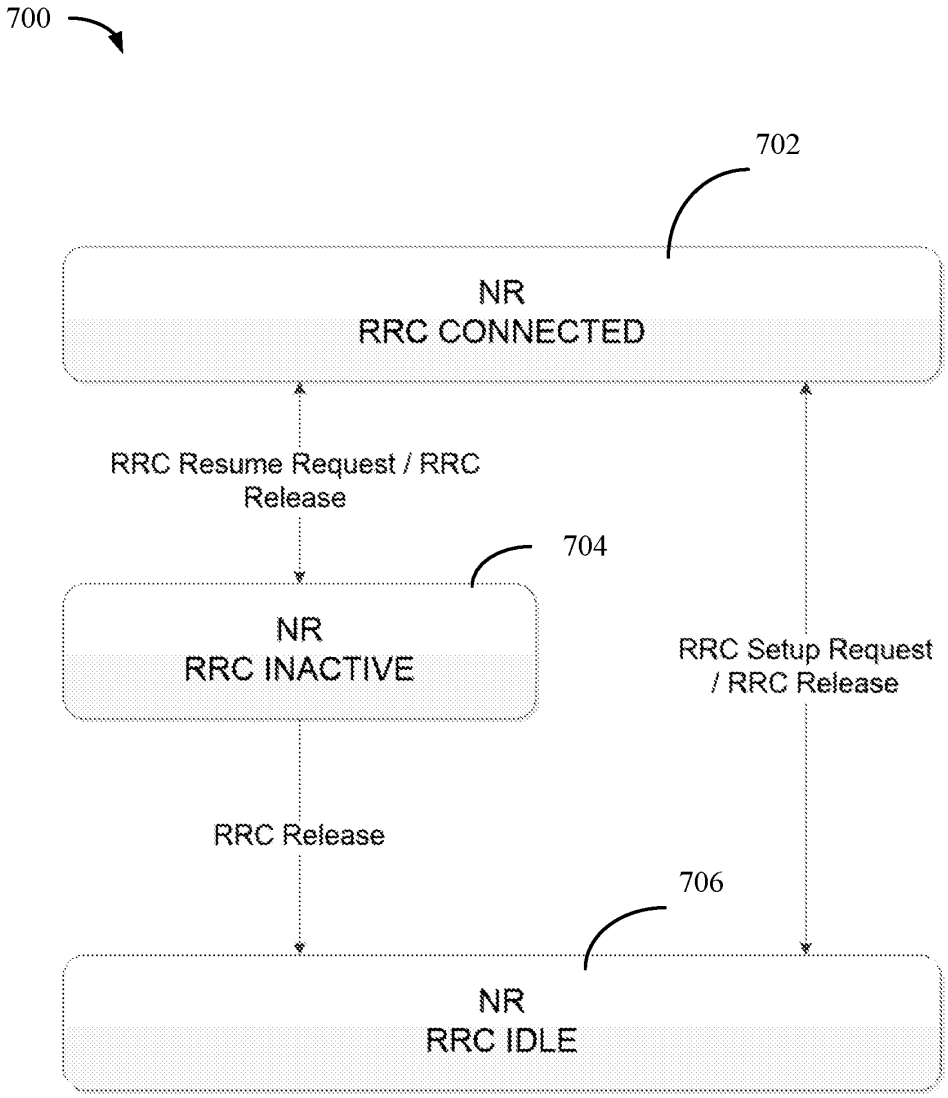
700
702
NR
RRC CONNECTED
RRC Resume Request / RRC
Release
704
NR
RRC INACTIVE
RRC Setup Request
/ RRC Release
RRC Release
706
NR
RRC IDLE

FIG. 7

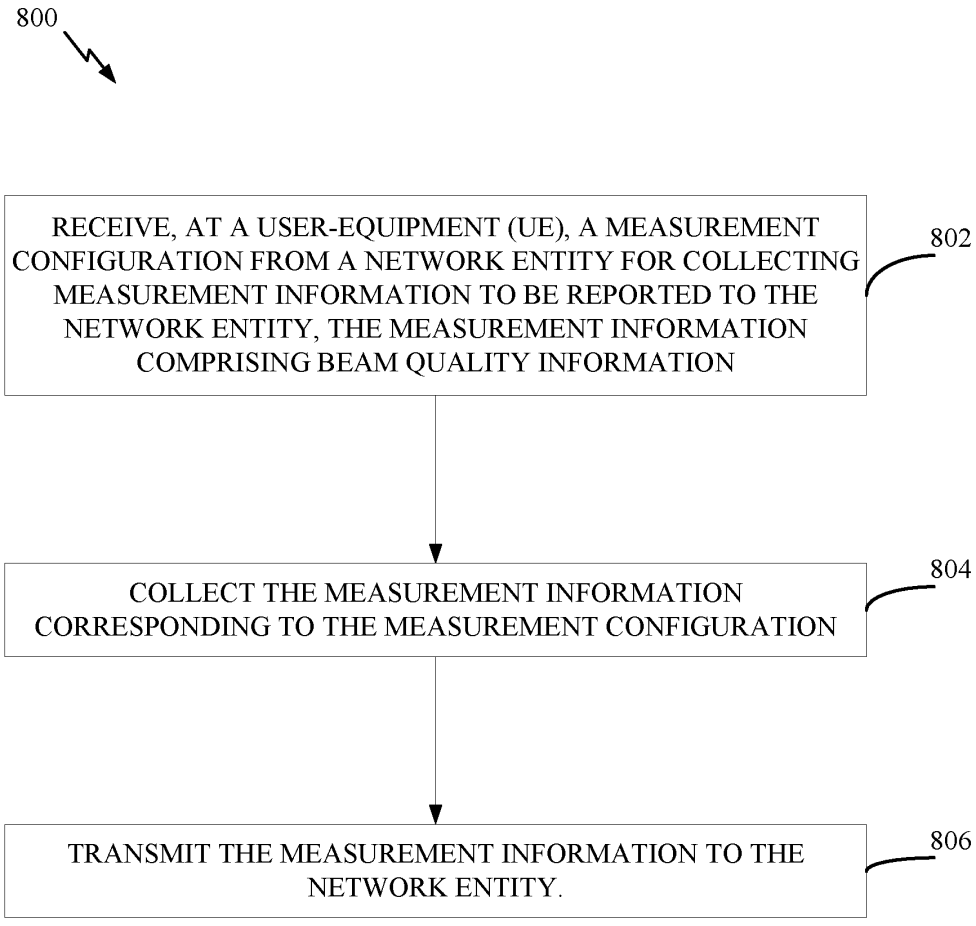
800
RECEIVE, AT A USER-EQUIPMENT (UE), A MEASUREMENT CONFIGURATION FROM A NETWORK ENTITY FOR COLLECTING MEASUREMENT INFORMATION TO BE REPORTED TO THE NETWORK ENTITY, THE MEASUREMENT INFORMATION COMPRISING BEAM QUALITY INFORMATION
802
COLLECT THE MEASUREMENT INFORMATION CORRESPONDING TO THE MEASUREMENT CONFIGURATION
804
TRANSMIT THE MEASUREMENT INFORMATION TO THE NETWORK ENTITY.
806

FIG. 8

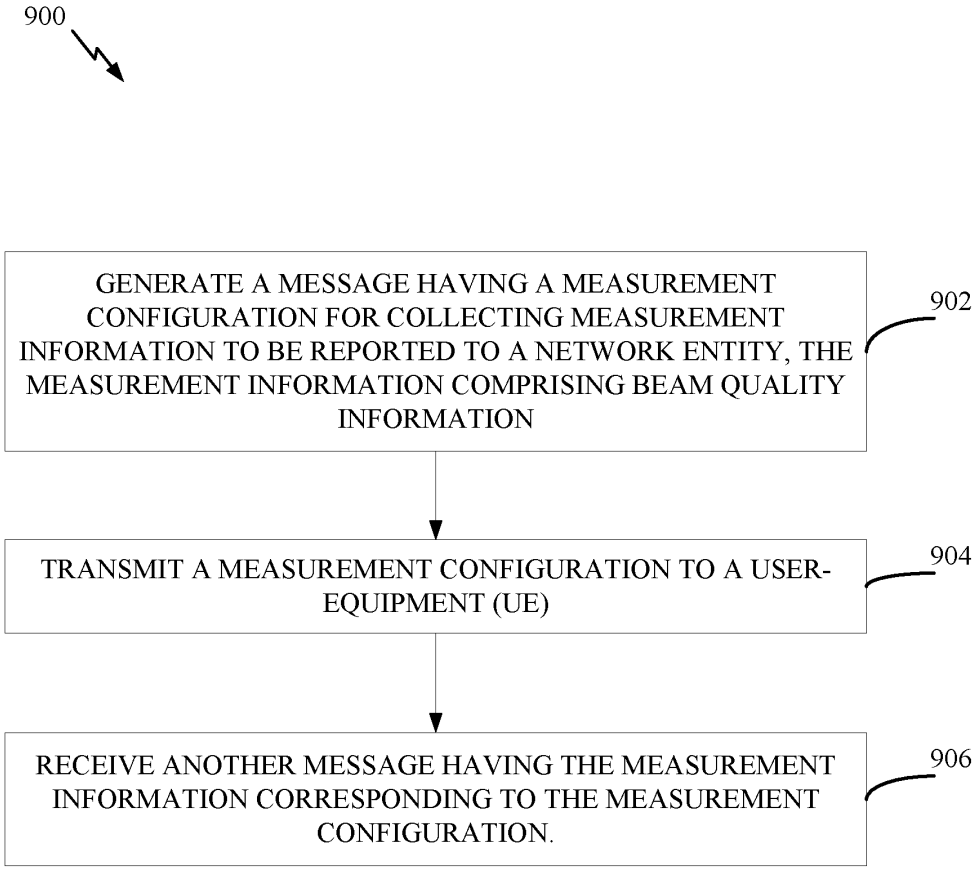
900
GENERATE A MESSAGE HAVING A MEASUREMENT CONFIGURATION FOR COLLECTING MEASUREMENT INFORMATION TO BE REPORTED TO A NETWORK ENTITY, THE MEASUREMENT INFORMATION COMPRISING BEAM QUALITY INFORMATION
902
TRANSMIT A MEASUREMENT CONFIGURATION TO A USER-EQUIPMENT (UE)
904
RECEIVE ANOTHER MESSAGE HAVING THE MEASUREMENT INFORMATION CORRESPONDING TO THE MEASUREMENT CONFIGURATION.
906

FIG. 9

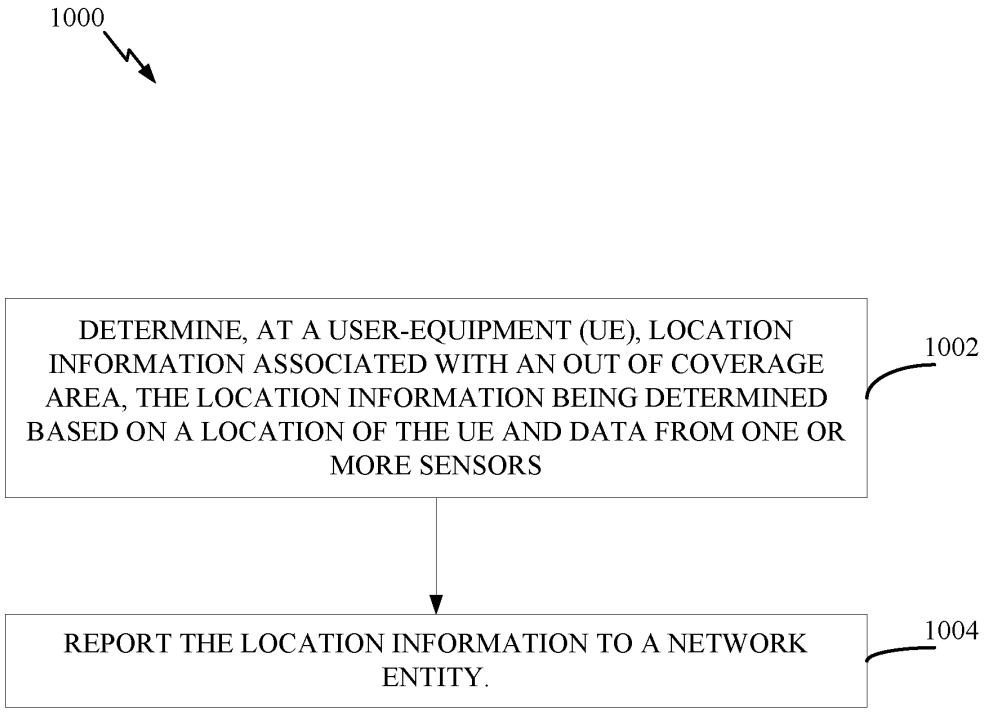
1000
DETERMINE, AT A USER-EQUIPMENT (UE), LOCATION INFORMATION ASSOCIATED WITH AN OUT OF COVERAGE AREA, THE LOCATION INFORMATION BEING DETERMINED BASED ON A LOCATION OF THE UE AND DATA FROM ONE OR MORE SENSORS
1002
REPORT THE LOCATION INFORMATION TO A NETWORK ENTITY.
1004

FIG. 10

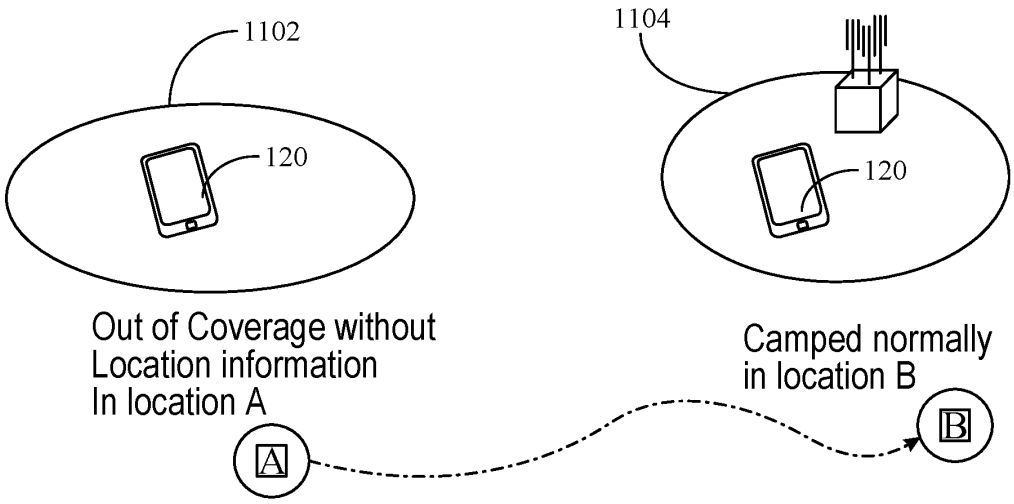
1102
120
Out of Coverage without
Location information
In location A
A
1104
120
Camped normally
in location B
B

FIG. 11

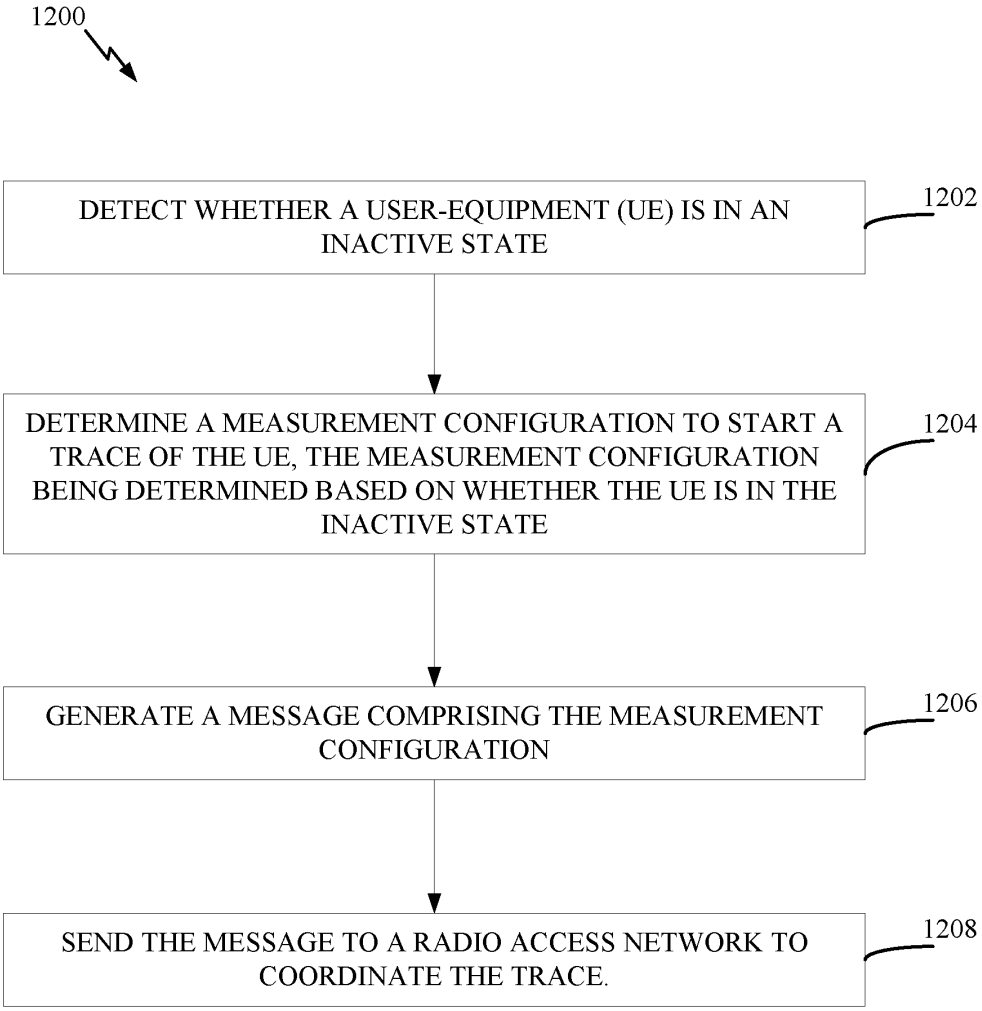
1200
DETECT WHETHER A USER-EQUIPMENT (UE) IS IN AN INACTIVE STATE
1202
DETERMINE A MEASUREMENT CONFIGURATION TO START A TRACE OF THE UE, THE MEASUREMENT CONFIGURATION BEING DETERMINED BASED ON WHETHER THE UE IS IN THE INACTIVE STATE
1204
GENERATE A MESSAGE COMPRISING THE MEASUREMENT CONFIGURATION
1206
SEND THE MESSAGE TO A RADIO ACCESS NETWORK TO COORDINATE THE TRACE.
1208

FIG. 12

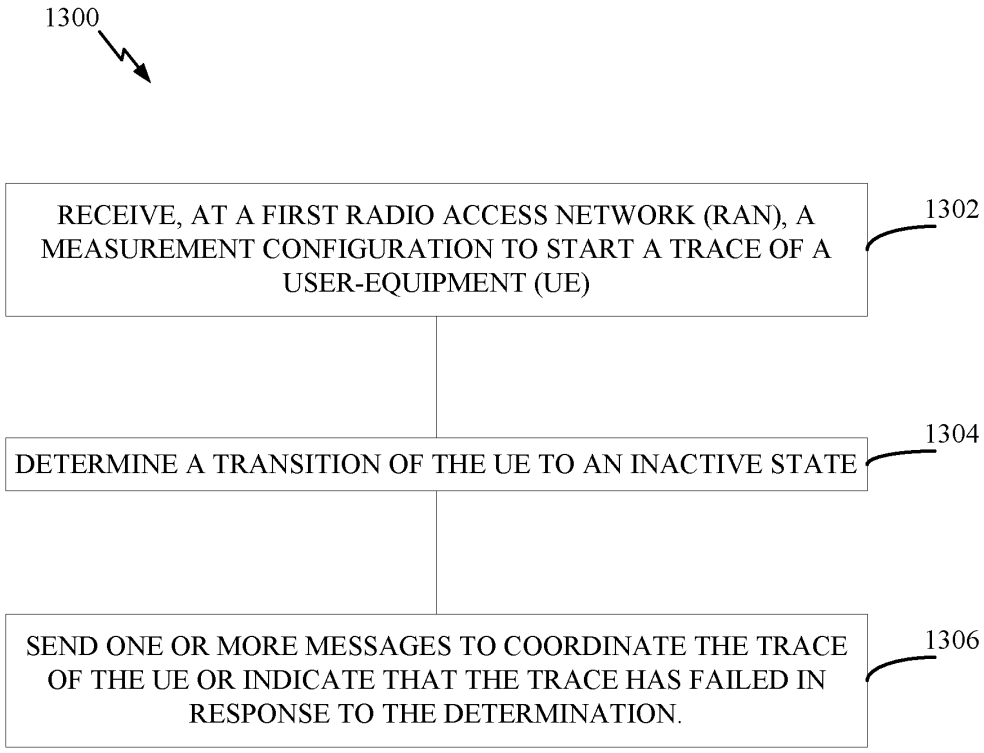
1300
RECEIVE, AT A FIRST RADIO ACCESS NETWORK (RAN), A MEASUREMENT CONFIGURATION TO START A TRACE OF A USER-EQUIPMENT (UE)
1302
DETERMINE A TRANSITION OF THE UE TO AN INACTIVE STATE
1304
SEND ONE OR MORE MESSAGES TO COORDINATE THE TRACE OF THE UE OR INDICATE THAT THE TRACE HAS FAILED IN RESPONSE TO THE DETERMINATION.
1306

FIG. 13

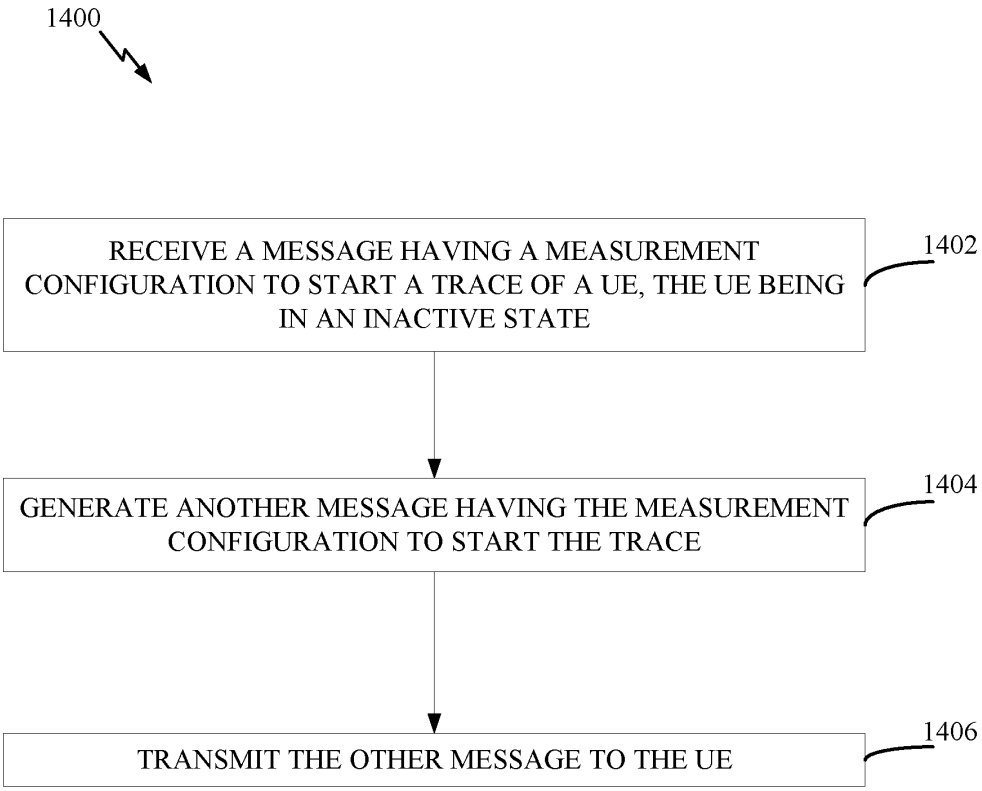
1400
RECEIVE A MESSAGE HAVING A MEASUREMENT CONFIGURATION TO START A TRACE OF A UE, THE UE BEING IN AN INACTIVE STATE
1402
GENERATE ANOTHER MESSAGE HAVING THE MEASUREMENT CONFIGURATION TO START THE TRACE
1404
TRANSMIT THE OTHER MESSAGE TO THE UE
1406

FIG. 14

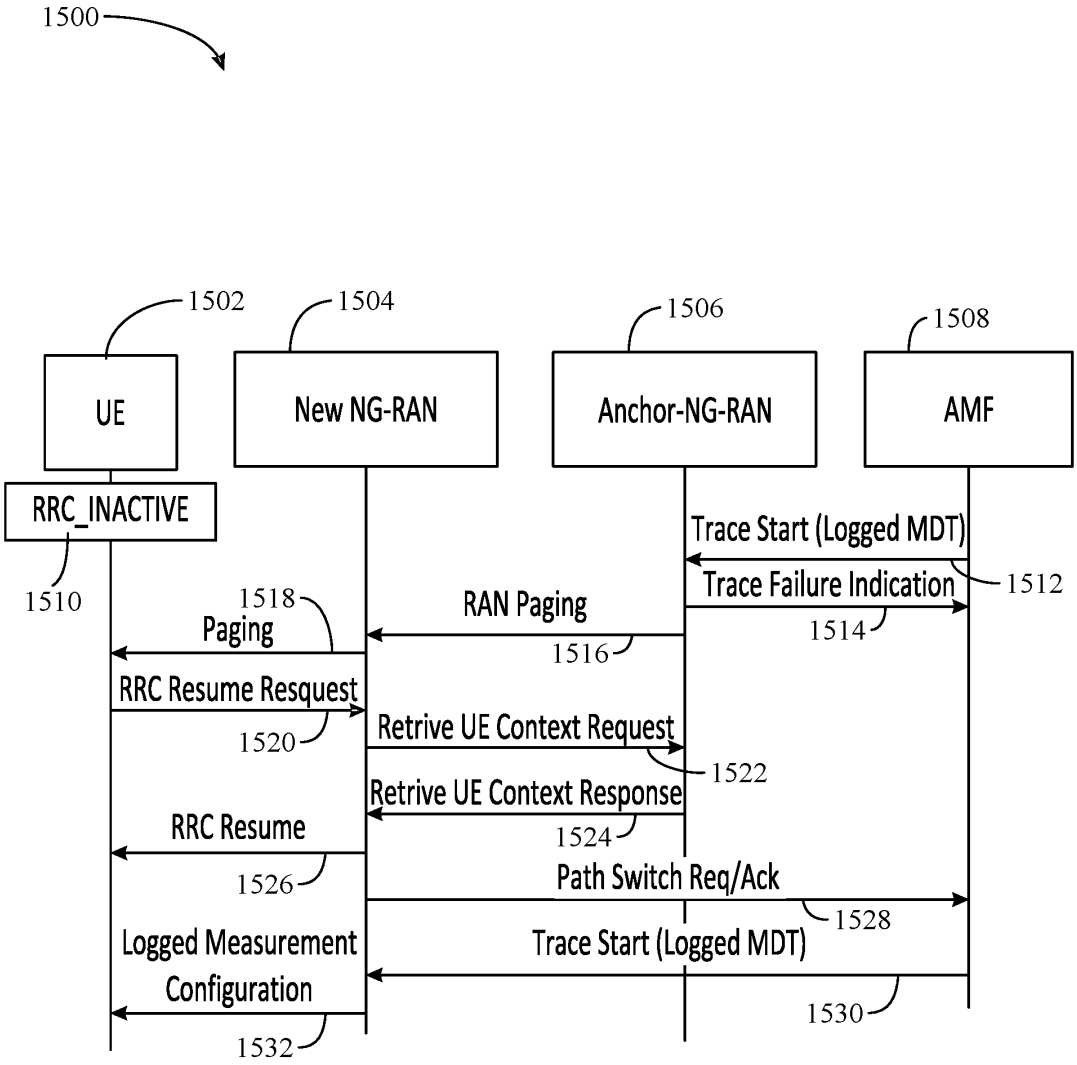
1500
1502
1504
1506
1508
UE
New NG-RAN
Anchor-NG-RAN
AMF
RRC_INACTIVE
1510
Trace Start (Logged MDT)
Trace Failure Indication
1512
1514
1518
Paging
RAN Paging
1516
RRC Resume Resquest
1520
Retrive UE Context Request
1522
Retrive UE Context Response
1524
RRC Resume
1526
Path Switch Req/Ack
1528
Logged Measurement Configuration
Trace Start (Logged MDT)
1530
1532

FIG. 15

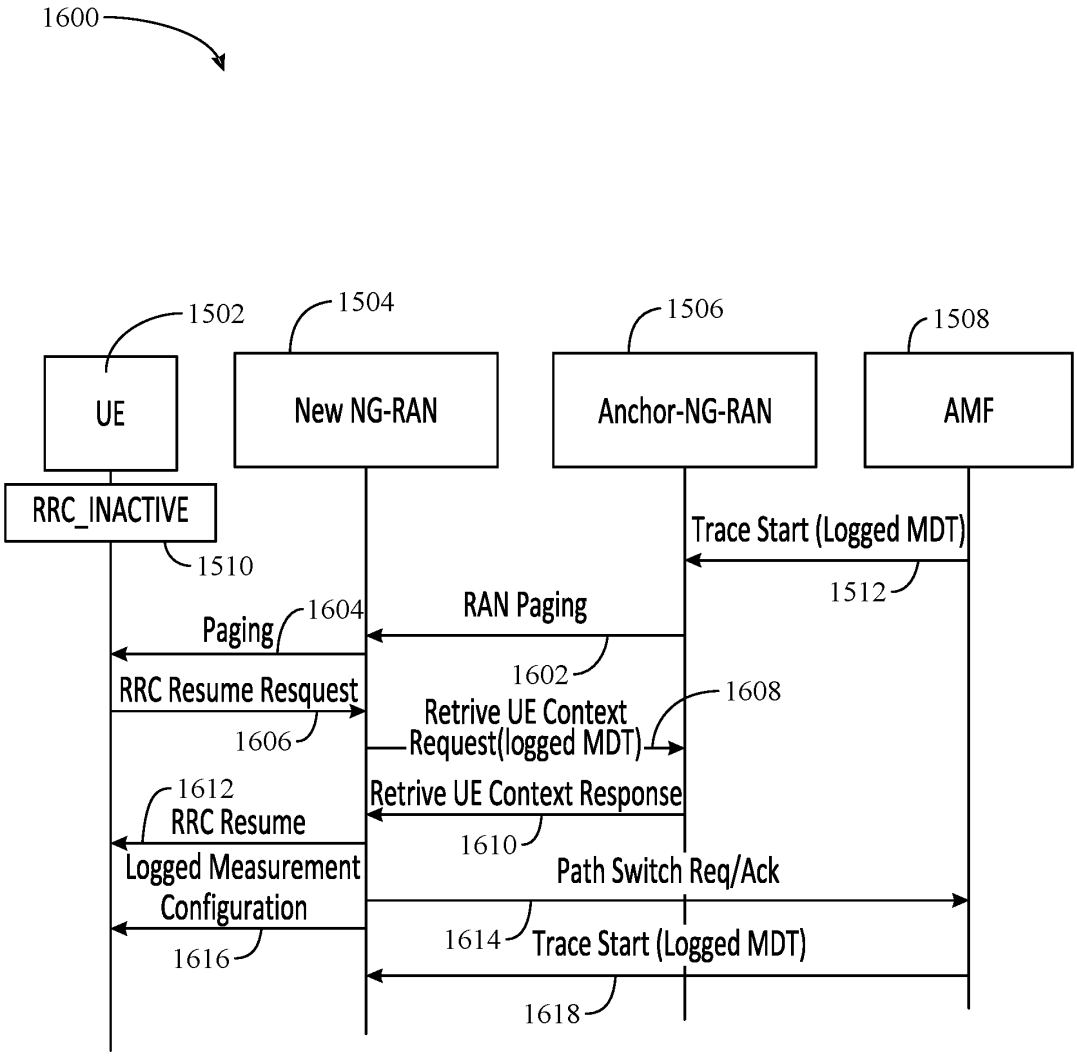
1600
1502
1504
1506
1508
UE
New NG-RAN
Anchor-NG-RAN
AMF
RRC_INACTIVE
1510
Trace Start (Logged MDT)
1512
RAN Paging
1602
Paging
1604
RRC Resume Resquest
1606
Retrive UE Context
Request(logged MDT)
1608
Retrive UE Context Response
1610
1612
RRC Resume
Logged Measurement
Configuration
1616
Path Switch Req/Ack
1614
Trace Start (Logged MDT)
1618

FIG. 16

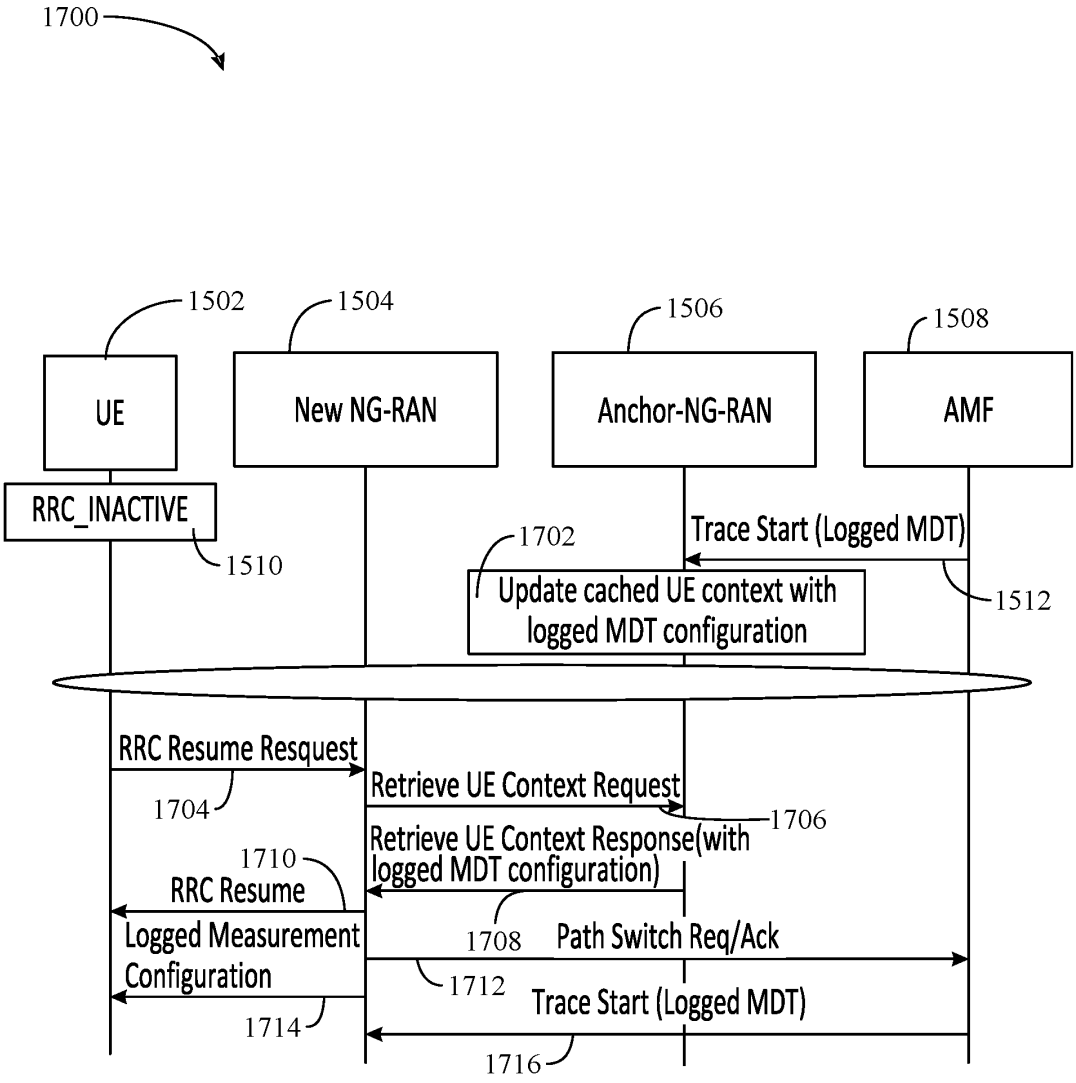
1700
1502
1504
1506
1508
UE
New NG-RAN
Anchor-NG-RAN
AMF
RRC_INACTIVE
1510
1702
Trace Start (Logged MDT)
Update cached UE context with logged MDT configuration
1512
RRC Resume Resquest
1704
Retrieve UE Context Request
1706
Retrieve UE Context Response(with logged MDT configuration)
1710
RRC Resume
Logged Measurement Configuration
1708
Path Switch Req/Ack
1712
Trace Start (Logged MDT)
1714
1716

FIG. 17

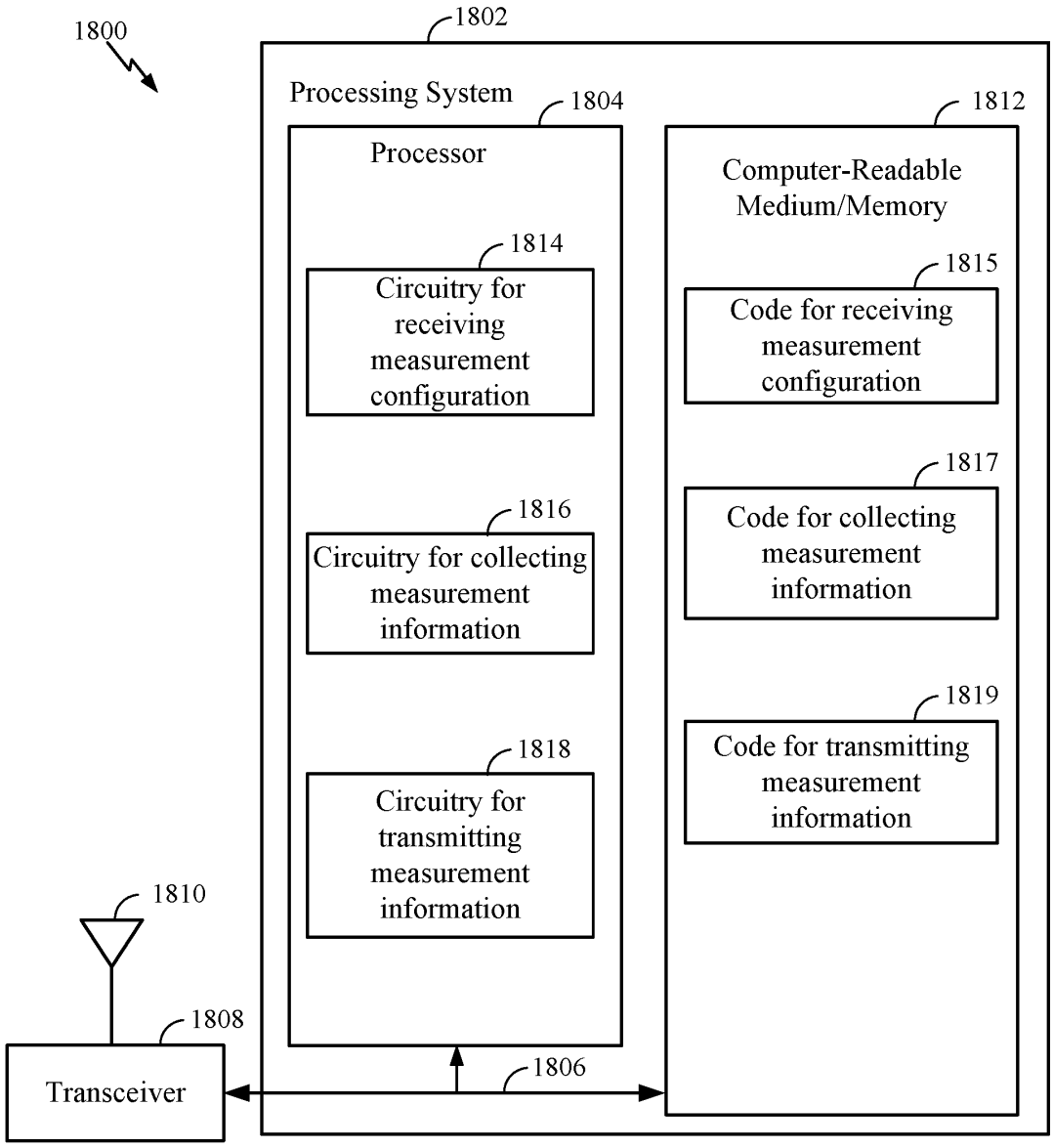
1800
1802
Processing System
1804
Processor
1812
Computer-Readable Medium/Memory
1814
Circuitry for receiving measurement configuration
1815
Code for receiving measurement configuration
1816
Circuitry for collecting measurement information
1817
Code for collecting measurement information
1818
Circuitry for transmitting measurement information
1819
Code for transmitting measurement information
1810
1808
Transceiver
1806

FIG. 18

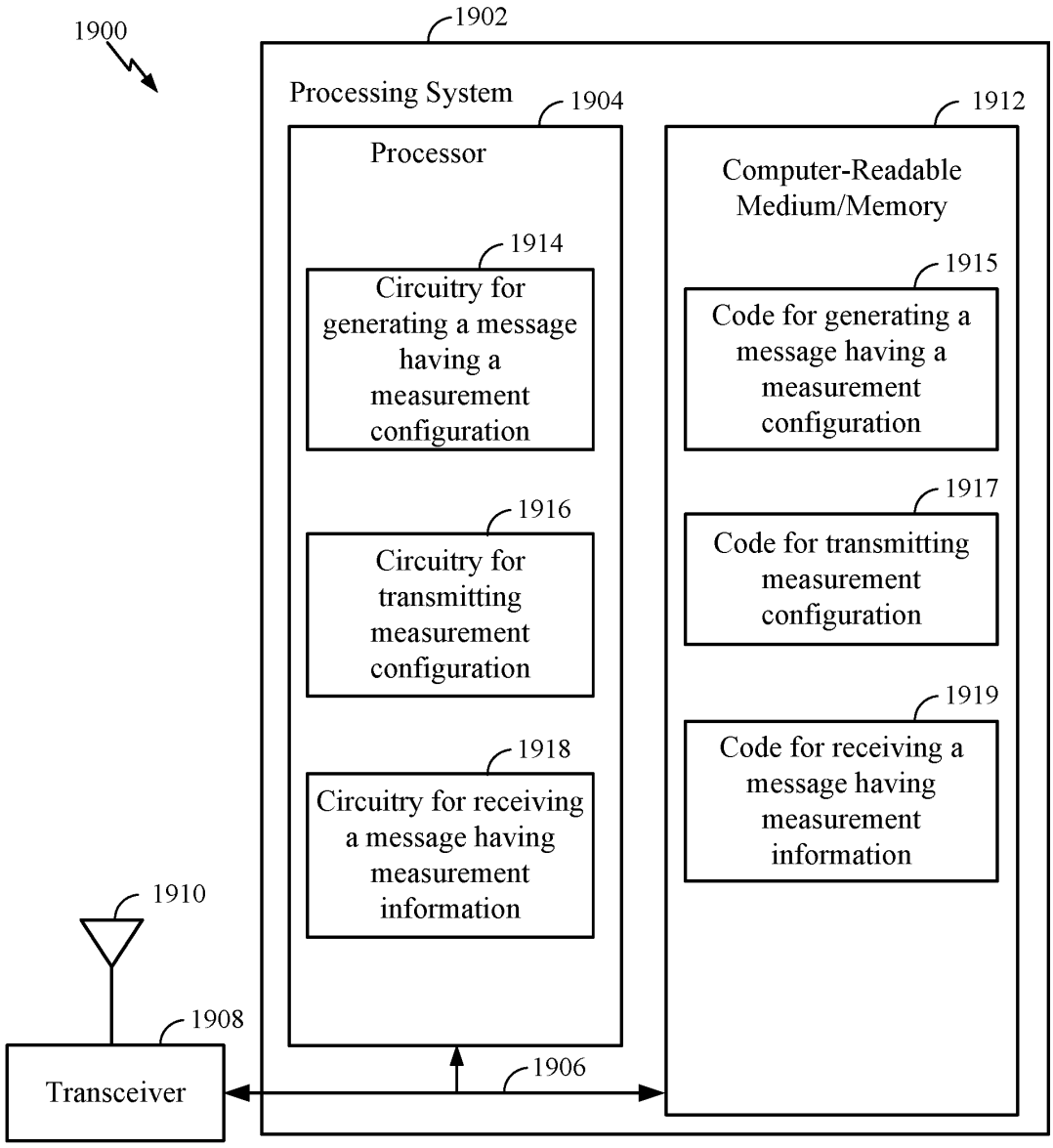
1900
1902
Processing System
1904
Processor
1914
Circuitry for generating a message having a measurement configuration
1916
Circuitry for transmitting measurement configuration
1918
Circuitry for receiving a message having measurement information
1912
Computer-Readable Medium/Memory
1915
Code for generating a message having a measurement configuration
1917
Code for transmitting measurement configuration
1919
Code for receiving a message having measurement information
1910
1908
Transceiver
1906

FIG. 19

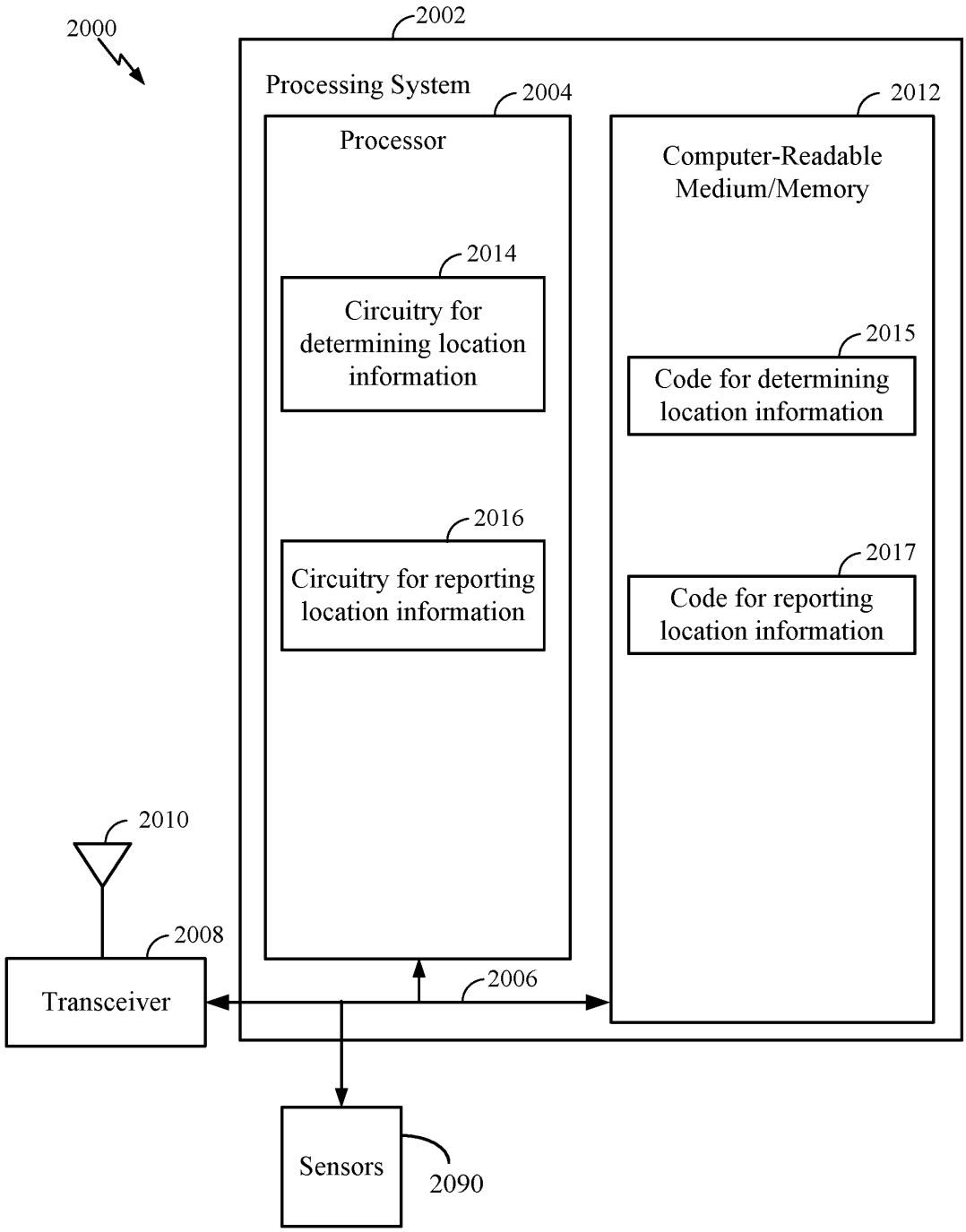
2000
2002
Processing System
2004
Processor
2012
Computer-Readable Medium/Memory
2014
Circuitry for determining location information
2015
Code for determining location information
2016
Circuitry for reporting location information
2017
Code for reporting location information
2010
2008
Transceiver
2006
Sensors
2090

FIG. 20

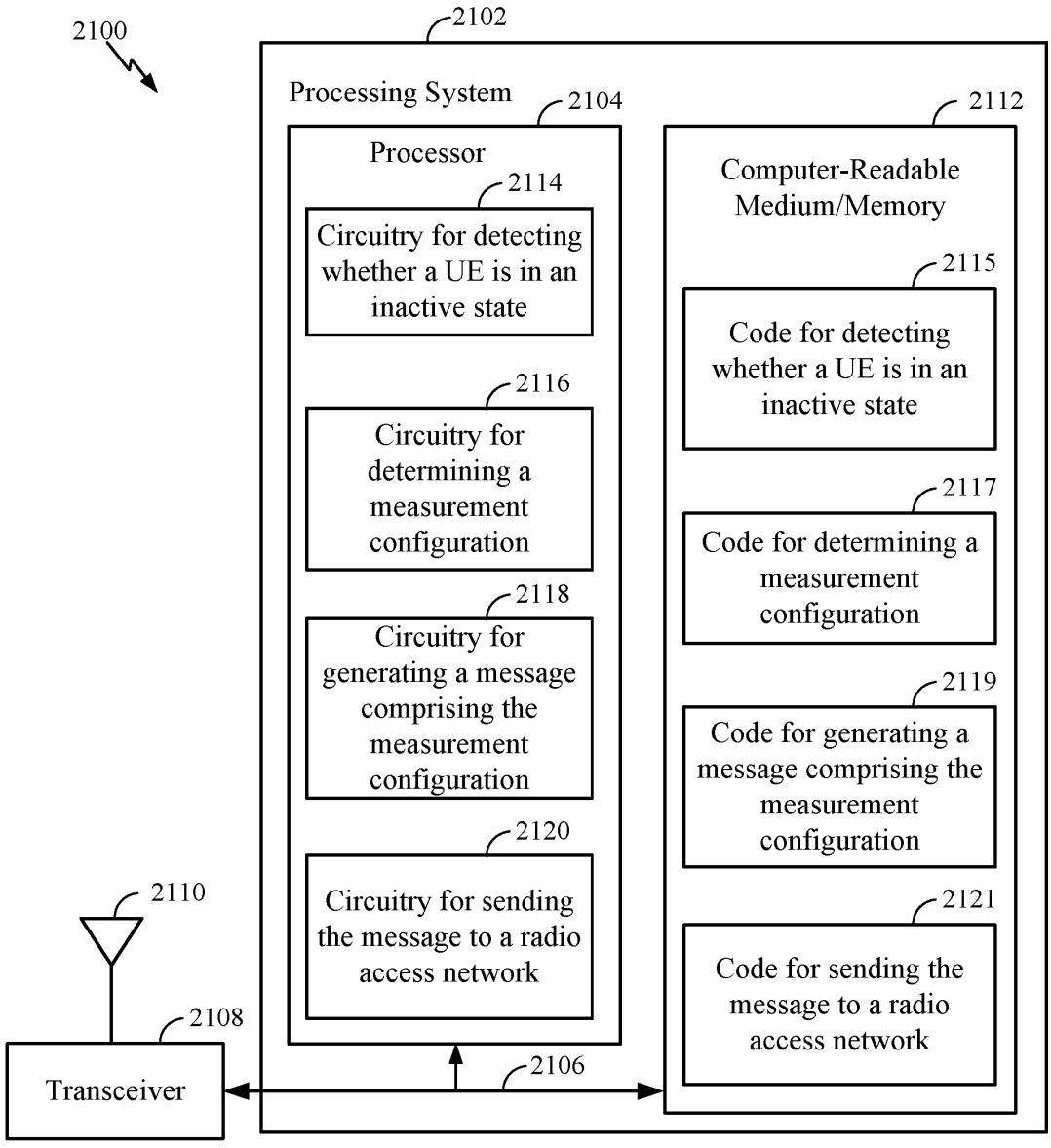
2100
2102
Processing System
2104
Processor
2114
Circuitry for detecting whether a UE is in an inactive state
2116
Circuitry for determining a measurement configuration
2118
Circuitry for generating a message comprising the measurement configuration
2120
Circuitry for sending the message to a radio access network
2112
Computer-Readable Medium/Memory
2115
Code for detecting whether a UE is in an inactive state
2117
Code for determining a measurement configuration
2119
Code for generating a message comprising the measurement configuration
2121
Code for sending the message to a radio access network
2110
2108
Transceiver
2106

FIG. 21

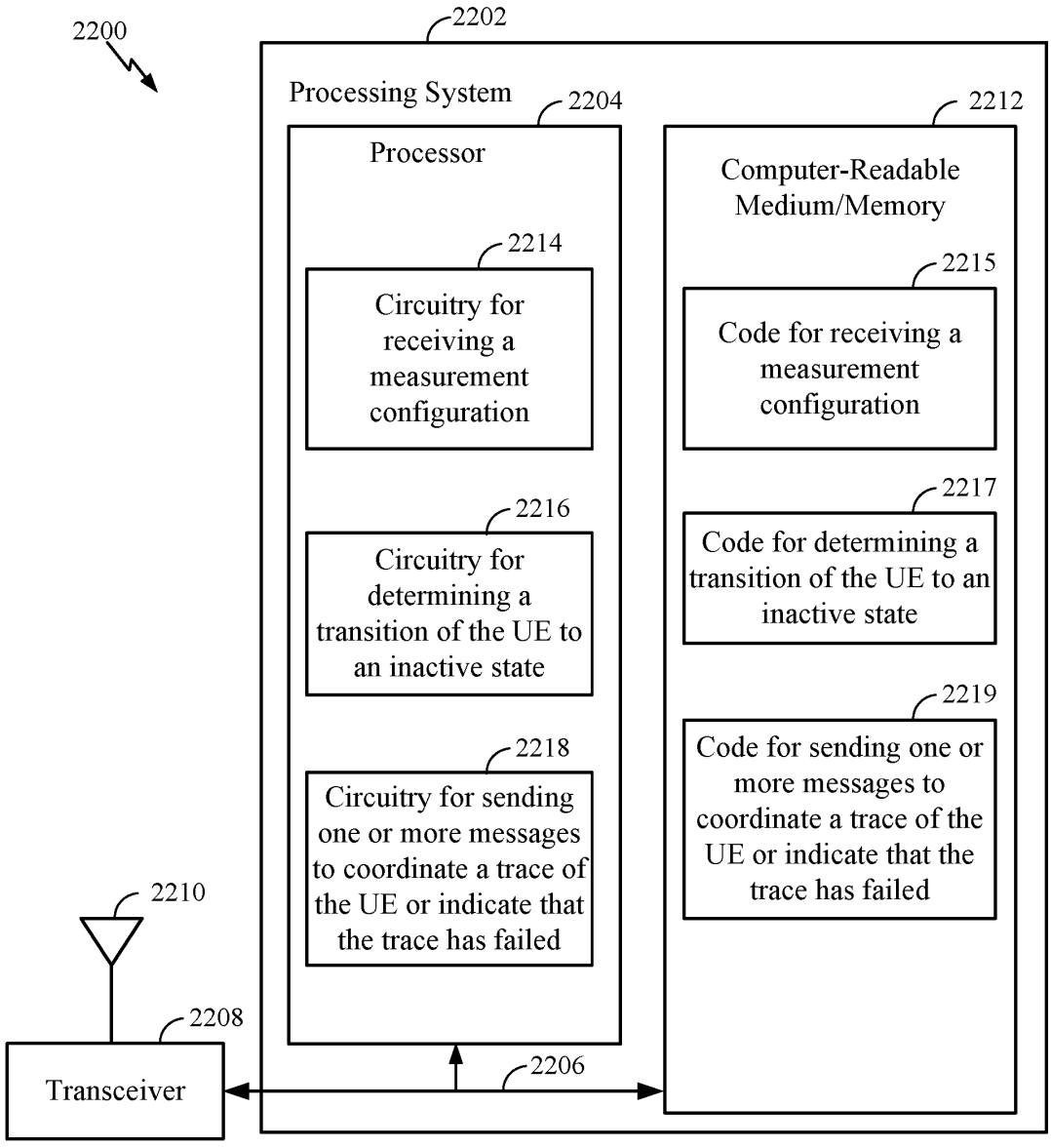
2200
2202
Processing System
2204
Processor
2212
Computer-Readable Medium/Memory
2214
Circuitry for receiving a measurement configuration
2215
Code for receiving a measurement configuration
2216
Circuitry for determining a transition of the UE to an inactive state
2217
Code for determining a transition of the UE to an inactive state
2218
Circuitry for sending one or more messages to coordinate a trace of the UE or indicate that the trace has failed
2219
Code for sending one or more messages to coordinate a trace of the UE or indicate that the trace has failed
2210
2208
Transceiver
2206

FIG. 22

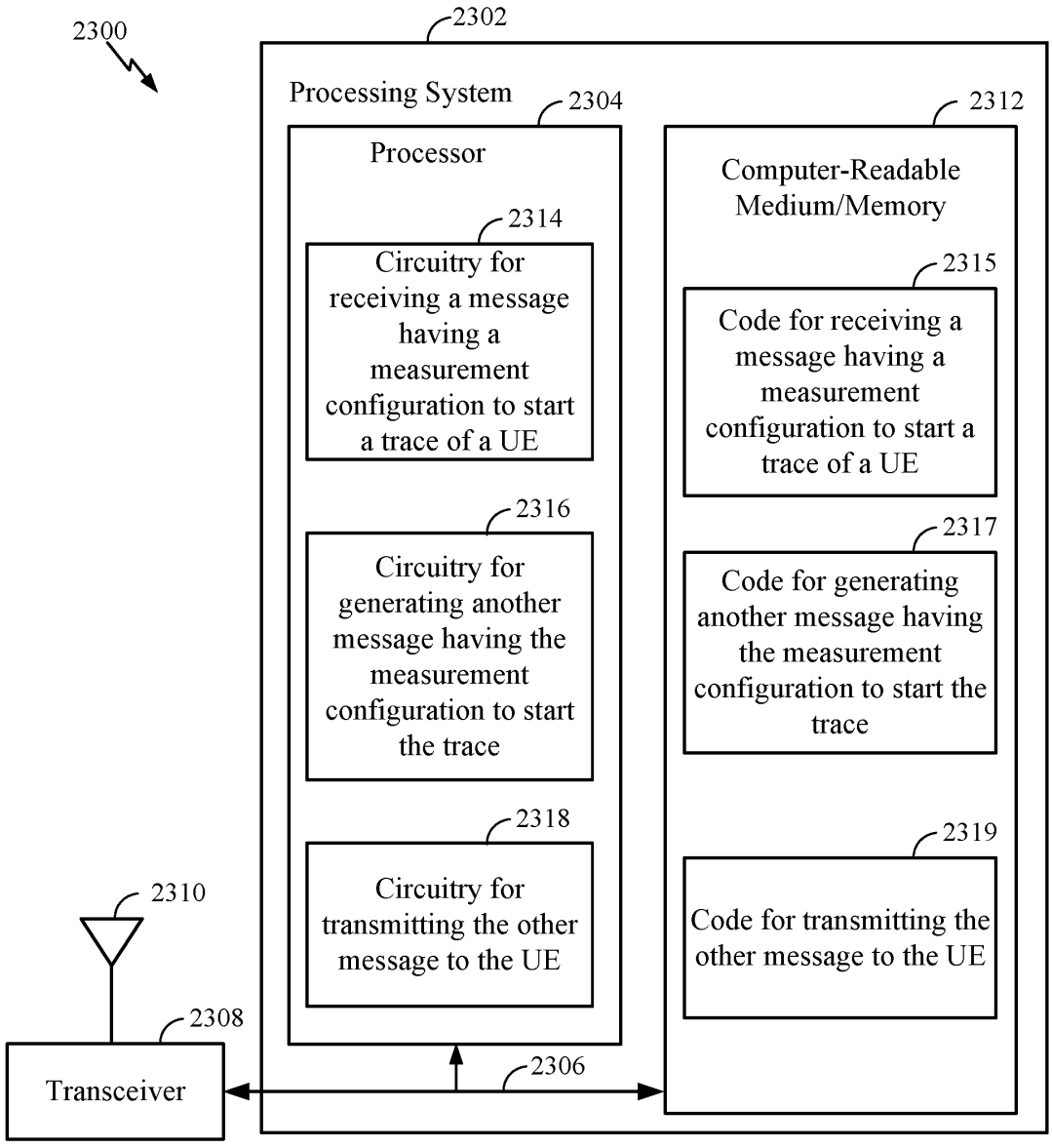
2300
2302
Processing System
2304
Processor
2314
Circuitry for receiving a message having a measurement configuration to start a trace of a UE
2316
Circuitry for generating another message having the measurement configuration to start the trace
2318
Circuitry for transmitting the other message to the UE
2312
Computer-Readable Medium/Memory
2315
Code for receiving a message having a measurement configuration to start a trace of a UE
2317
Code for generating another message having the measurement configuration to start the trace
2319
Code for transmitting the other message to the UE
2310
2308
Transceiver
2306

FIG. 23