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(54) **CPRI SATELLITE COMMUNICATION SYSTEM AND METHOD**

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H04B 7/185 (2006.01)

(52) **U.S. Cl.**
CPC ***H04B 7/18532*** (2013.01); ***H04B 7/1851*** (2013.01)

(58) **Field of Classification Search**
CPC H04B 7/18532; H04B 7/1851; H04B 7/18541; H04B 7/2041
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

11,804,893	B2 *	10/2023	Yao	H04W 76/10
11,956,810	B2 *	4/2024	Hata	H04W 72/535
2008/0051080	A1 *	2/2008	Walker	H04B 7/2041 455/427
2010/0198455	A1 *	8/2010	Hotta	G08G 1/20 701/31.4
2016/0117853	A1 *	4/2016	Zhong	B64U 30/20 345/634
2016/0134353	A1 *	5/2016	Lange	H04J 3/0682 370/345
2019/0058522	A1 *	2/2019	Haley	G06F 16/23
2019/0313397	A1 *	10/2019	Chen	H04B 7/0626
2020/0100291	A1 *	3/2020	Ravishankar	H04W 72/04
2020/0367097	A1 *	11/2020	Tarimala	H04L 1/1887
2022/0061004	A1 *	2/2022	Wigard	H04W 36/0088
2022/0368415	A1 *	11/2022	Panthi	H04B 7/18578
2023/0189008	A1 *	6/2023	Martch	H04B 7/185 370/320

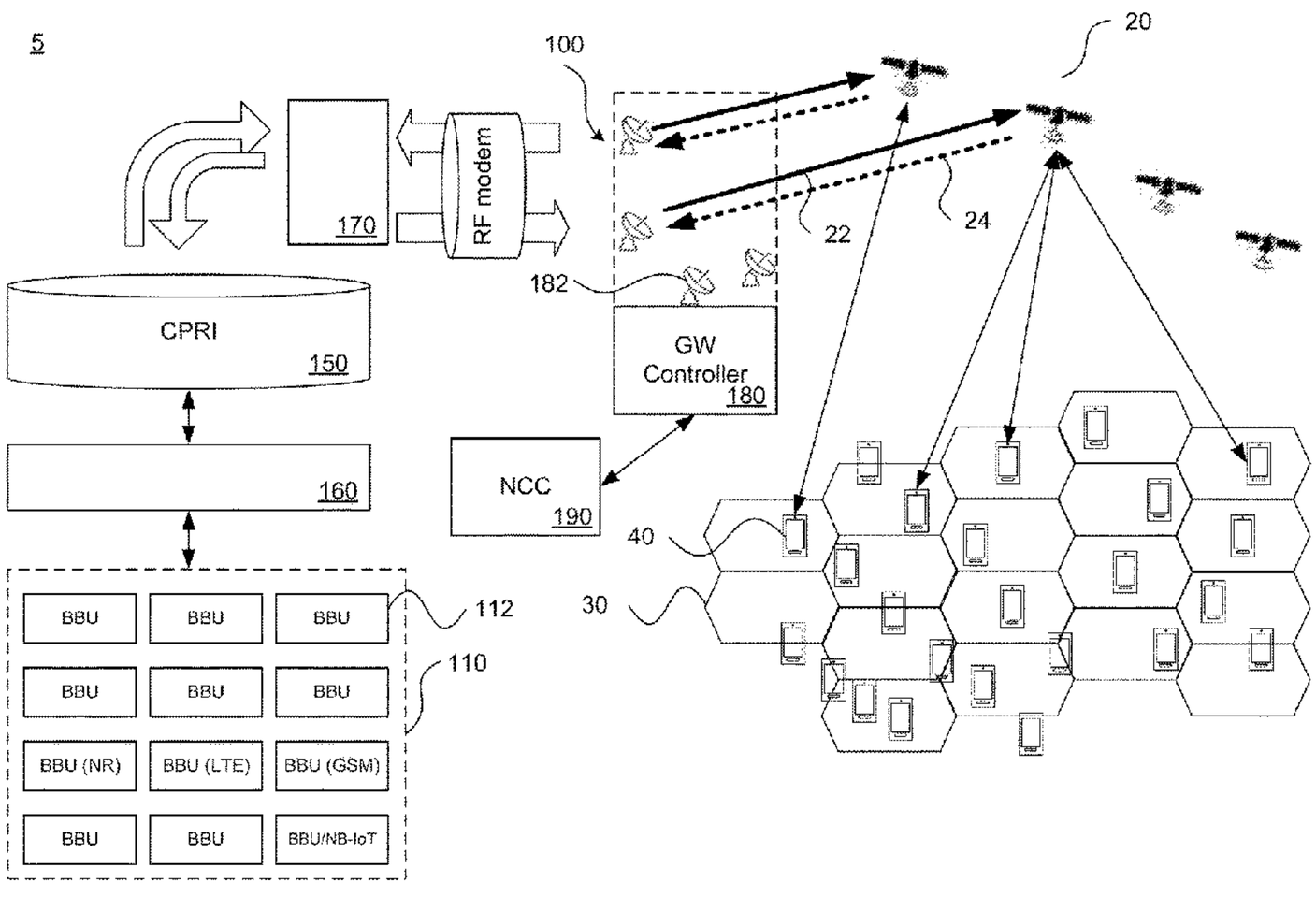
* cited by examiner

Primary Examiner — Dominic E Rego

(57) **ABSTRACT**

The technology relates to a Common Public Radio Interface (CPRI) satellite communication system and corresponding method. The satellite communication system has, in one arrangement, a base station configured to communicate with standard compliant user equipment (UE) via a satellite having a field of view. The base station includes a plurality of base band units and a base station memory configured to store control information, downlink signal information and uplink signal information associated with a cell in the field of view. The system also includes a processing device configured to cause the satellite to generate a satellite beam in accordance with the control information, downlink signal information and uplink signal information stored in the base station memory.

10 Claims, 5 Drawing Sheets



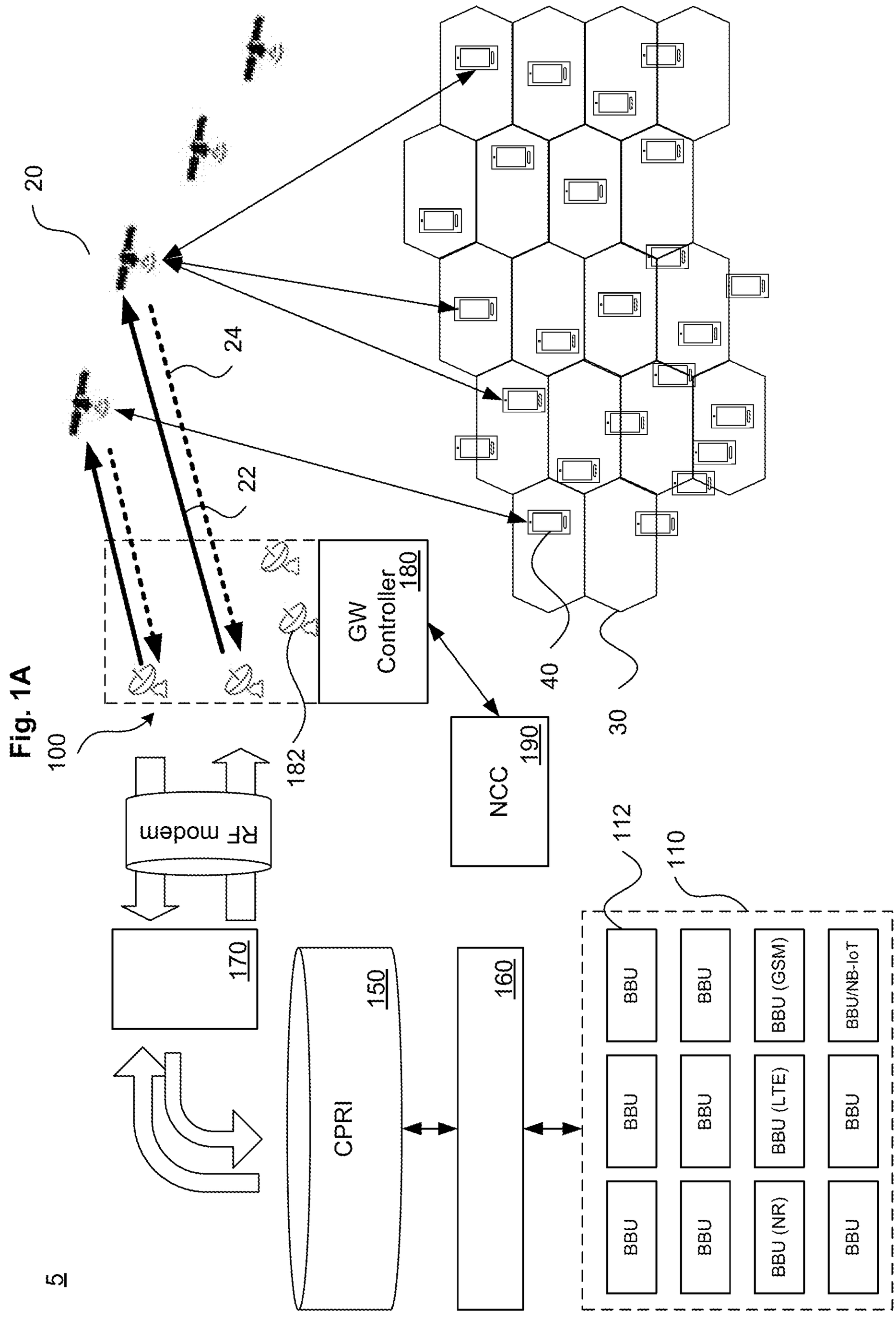

20
24
22
40
30
100
182
GW Controller 180
NCC 190
RF modem
170
112
110
CPRI 150
160
BBU
BBU
BBU
BBU
BBU
BBU
BBU (NR)
BBU (LTE)
BBU (GSM)
BBU
BBU
BBU/NB-IoT

Fig. 1A

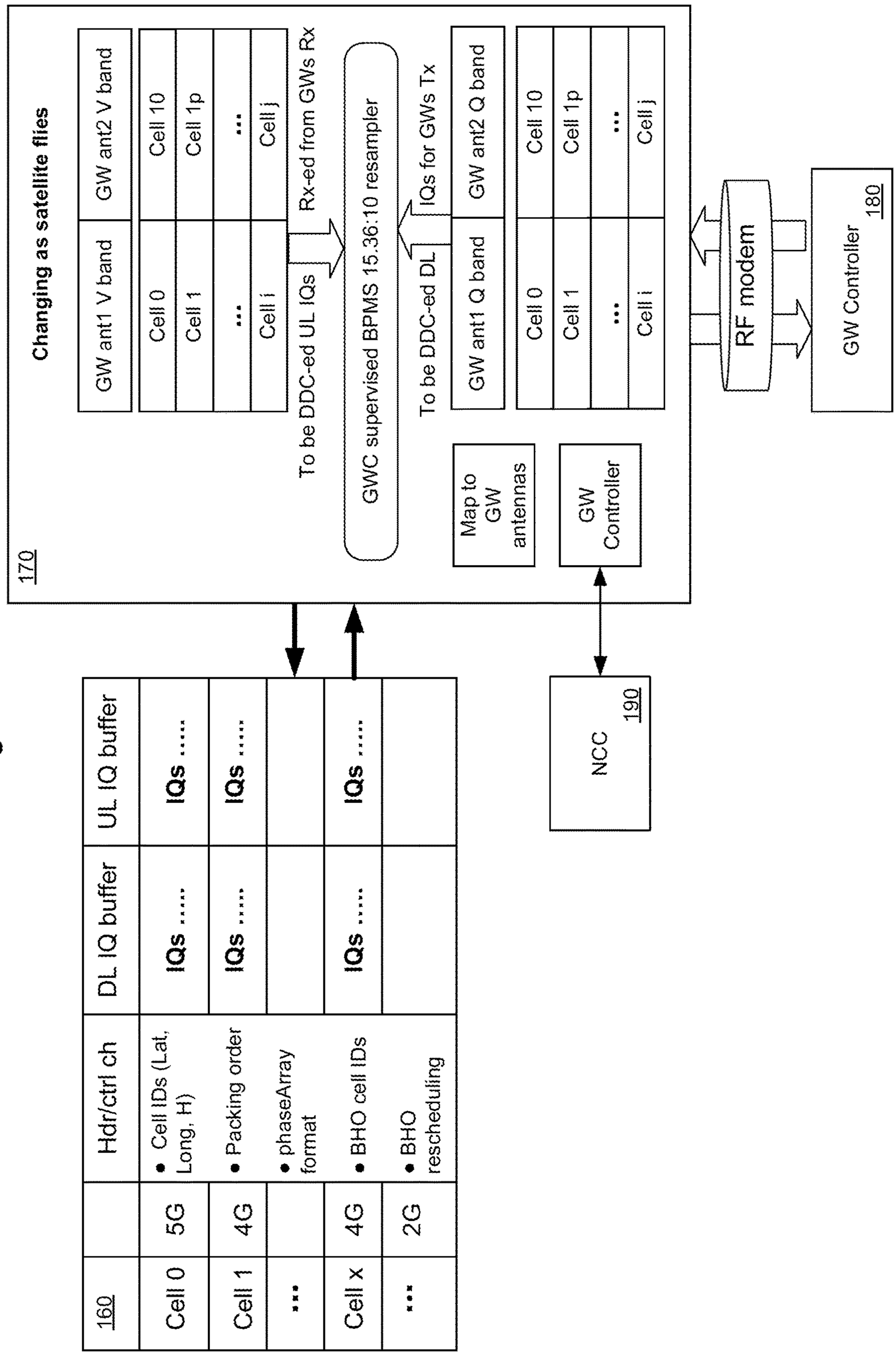
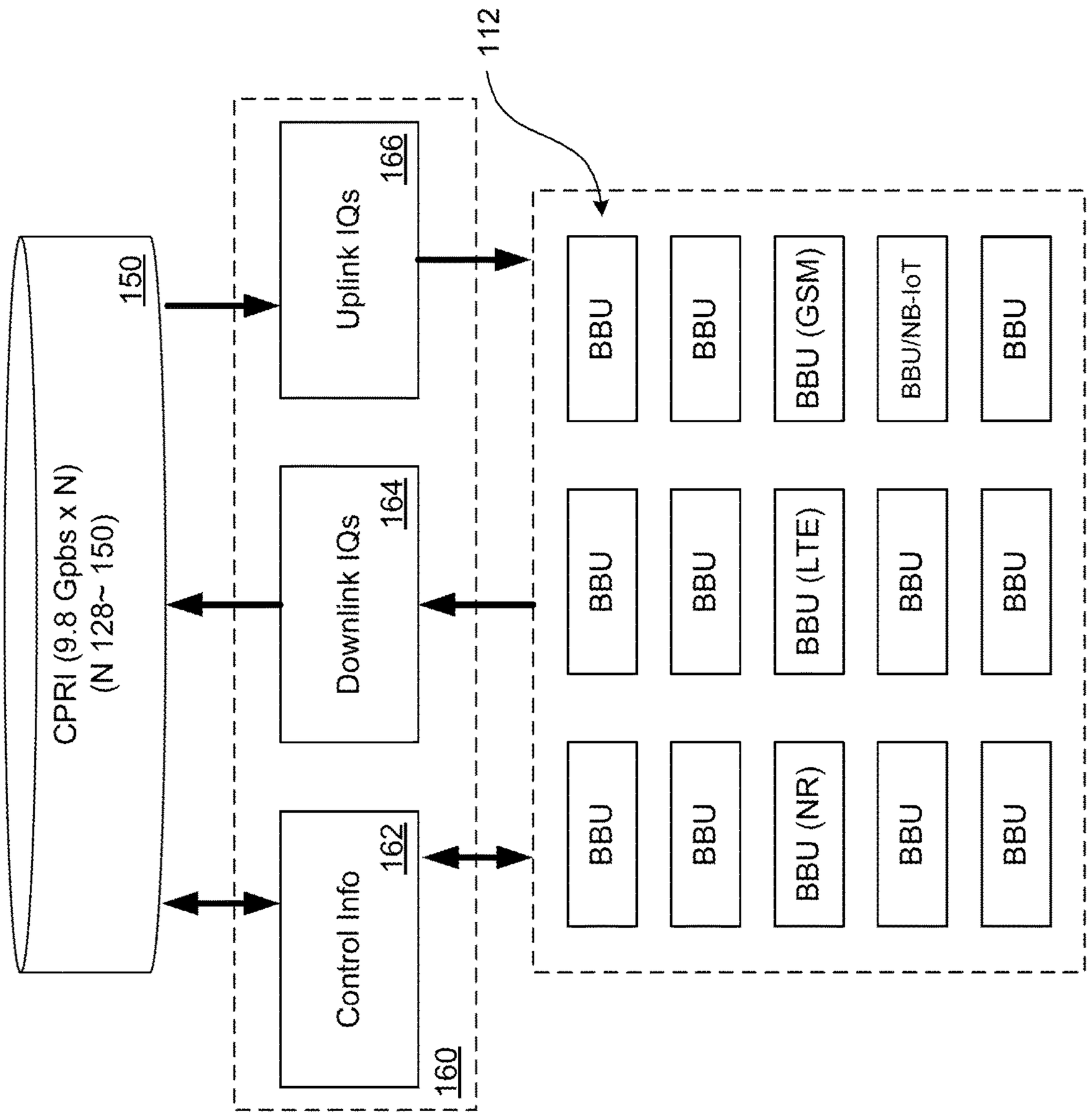

Changing as satellite flies
GW ant1 V band
GW ant2 V band
Cell 0
Cell 10
Cell 1
Cell 1p
...
...
Cell i
Cell j
To be DDC-ed UL IQs
Rx-ed from GWs Rx
GWC supervised BPMS 15.36:10 resampler
To be DDC-ed DL
IQs for GWs Tx
GW ant1 Q band
GW ant2 Q band
Cell 0
Cell 10
Cell 1
Cell 1p
...
...
Cell i
Cell j
RF modem
GW Controller
180
170
Map to GW antennas
GW Controller
NCC
190
UL IQ buffer
IQs .....
IQs .....
IQs .....
DL IQ buffer
IQs .....
IQs .....
IQs .....
160
Cell 0
5G
Hdr/ctrl ch
• Cell IDs (Lat, Long, H)
Cell 1
4G
• Packing order
• phaseArray format
...
Cell x
4G
• BHO cell IDs
...
2G
• BHO rescheduling

Fig. 1B

Fig. 2


112
150
CPRI (9.8 Gpbs x N)
(N 128~ 150)
Uplink IQs
166
Downlink IQs
164
Control Info
162
160
BBU
BBU
BBU (GSM)
BBU/NB-IoT
BBU
BBU
BBU
BBU (LTE)
BBU
BBU
BBU
BBU (NR)
BBU
BBU

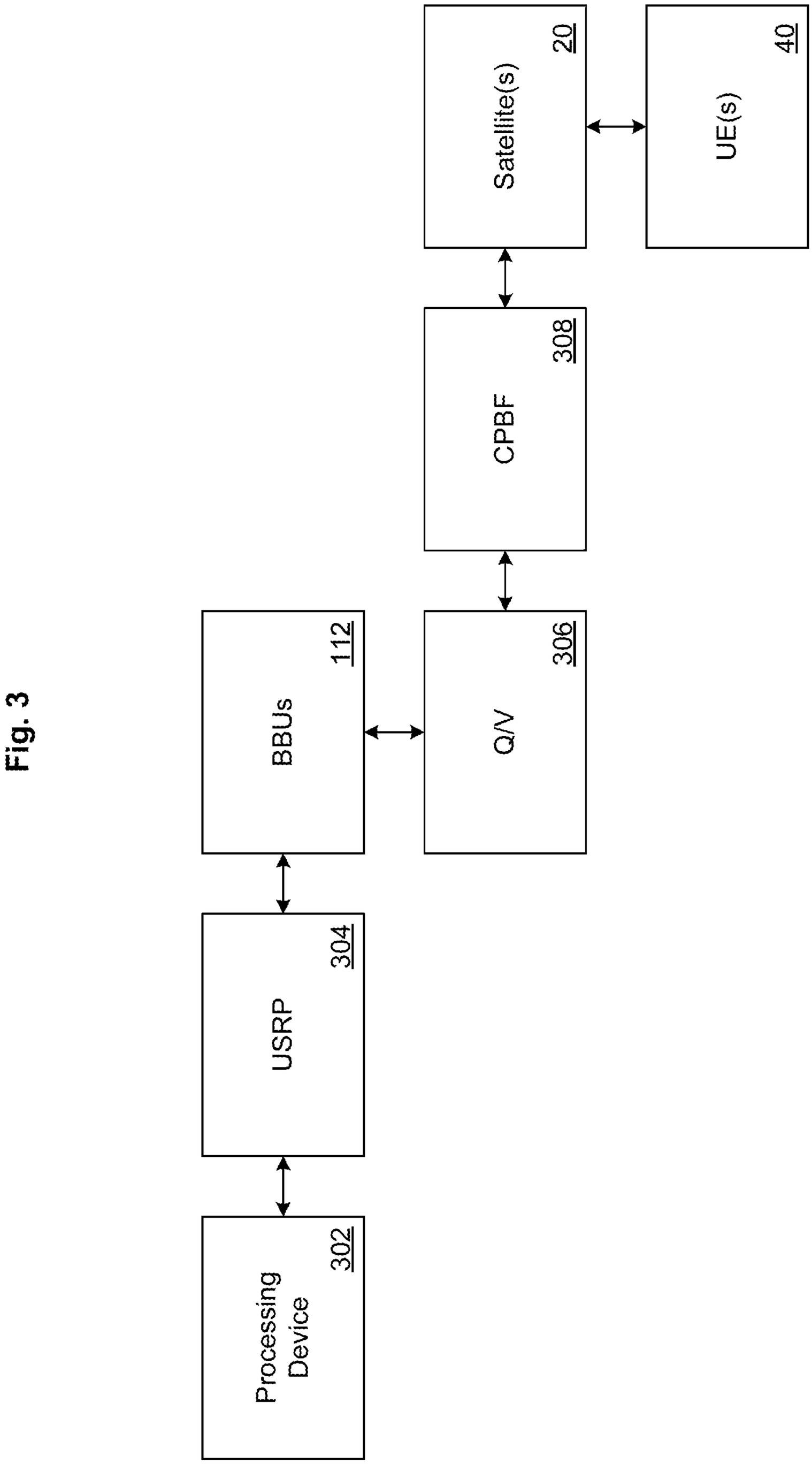
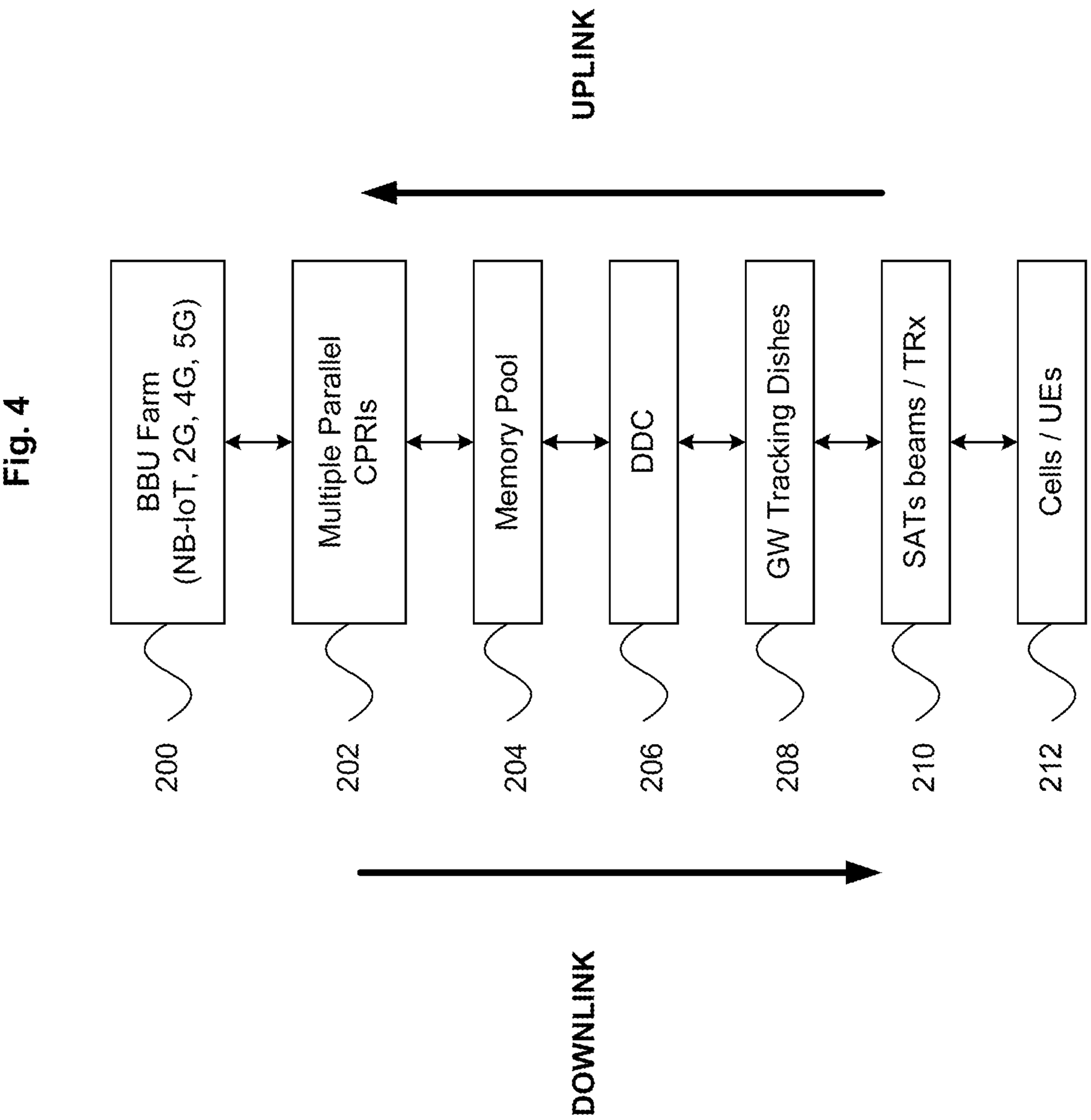

Satellite(s)
20
UE(s)
40
CPBF
308
Q/V
306
BBUs
112
USRP
304
Processing Device
302

Fig. 3

Fig. 4


UPLINK
BBU Farm (NB-IoT, 2G, 4G, 5G)
Multiple Parallel CPRIs
Memory Pool
DDC
GW Tracking Dishes
SATs beams / TRx
Cells / UEs
200
202
204
206
208
210
212
DOWNLINK

CPRI SATELLITE COMMUNICATION SYSTEM AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of and priority to U.S. Provisional Application No. 63/343,016, filed May 17, 2022, the entire disclosure of which is incorporated herein by reference.

BACKGROUND

The Common Public Radio Interface (CPRI) standard defines an interface between Radio Equipment Control (REC) and Radio Equipment (RE), and can be used to communicate data between cellular sites (e.g., cell towers) and base stations. The base stations include, for example, base transceiver stations (BTS), which provide wireless communication between user equipment (UE) (e.g., mobile phones), having an eNodeB processing device.

A low-Earth orbit (LEO) satellite constellation provides global coverage including coverage to ordinary mobile phones (UEs in 4G) that are outside the coverage area of terrestrial cell towers (including oceans). U.S. Pat. No. 9,973,266 and U.S. Publication No. 2019/0238216 show a system for assembling a large number of small satellite antenna assemblies in space to form a large array, the entire content which are incorporated herein by reference.

BRIEF SUMMARY

According to one aspect of the technology, a satellite communication system comprises a base station and a processing device. The base station is configured to communicate with standard compliant user equipment (UE) via a satellite having a field of view. The base station comprises a plurality of base band units and a base station memory configured to store control information, downlink signal information and uplink signal information associated with a cell in the field of view. The processing device is configured to cause the satellite to generate a satellite beam in accordance with the control information, downlink signal information and uplink signal information stored in the base station memory.

In an example, the UE comprises a wireless device. For instance, the UE may be a cellular phone. The satellite may be arranged to communicate directly with the UE.

In one example, the base station memory includes a control information buffer to store the control information, a downlink signal buffer to store the downlink signal information, and an uplink signal buffer to store the uplink signal information. The downlink signal information and the uplink signal information may each include in-phase and quadrature component information for respective downlink or uplink communication channels. Alternatively or additionally, the control information may include one or more of cell identifiers, a communication type, a packing order, a phase array format, beam handover (BHO) cell identifiers, or BHO rescheduling information.

According to another aspect of the technology, a satellite communication method comprises: generating, by a gateway controller module, control information and uplink signal information associated with a cell in a field of view of a satellite configured to communicate with standard compliant user equipment (UE); storing, by a common public radio interface (CPRI), the control information in a control information buffer; storing, by the CPRI, the uplink signal information in an uplink signal buffer; associating, by one or more processors, the control information and uplink signal information with one or more baseband units of a baseband unit array, wherein the control information is used by the gateway controller module to control each of the one or more baseband units; obtaining, by the CPRI, downlink signal information from the one or more baseband units; storing, by the CPRI, the downlink signal information in a downlink signal buffer; and causing the satellite to generate a satellite beam in accordance with the stored control information, downlink signal information and uplink signal information.

The downlink signal information and the uplink signal information may each include in-phase and quadrature component information for respective downlink or uplink communication channels. Alternatively or additionally, the control information may include one or more of cell identifiers, a communication type, a packing order, a phase array format, beam handover (BHO) cell identifiers, or BHO rescheduling information.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1**A-B illustrate a satellite communication system in accordance with aspects of the technology.

FIG. **2** illustrates modules of the satellite communication system of FIG. **1** in accordance with aspects of the technology.

FIG. **3** illustrates an arrangement **300** providing satellite communication in accordance with aspects of the technology.

FIG. **4** illustrates a method of operation in accordance with aspects of the technology.

DETAILED DESCRIPTION OF THE INVENTION

In describing the illustrative, non-limiting embodiments of the invention illustrated in the drawings, specific terminology will be resorted to for the sake of clarity. However, the invention is not intended to be limited to the specific terms so selected, and it is to be understood that each specific term includes all technical equivalents that operate in similar manner to accomplish a similar purpose. Several embodiments of the invention are described for illustrative purposes, it being understood that the invention may be embodied in other forms not specifically shown in the drawings.

Referring to the drawings, FIG. **1**A illustrates one embodiment of a mobile communication system, including a 1G4S (1 gateway **100** with 4 satellites **20**) satellite system, though other configurations can also be provided. In particular, FIG. **1** shows a satellite communication system **5** having one or more satellites **20** and a gateway site (GWS) or ground station (GW) **100** in accordance with one embodiment of the present disclosure. The gateway site **100** includes a gateway channel routing block **110**, CPRI interface **150**, buffer memory pool **170**, gateway controller **180**, gateway antennas **182**, and an NCC **190**. As shown, the gateway **100** communicates with user equipment (UEs) on Earth via the one or more satellites **20**. The gateway antennas **182** are directional antennas tracking the satellites.

The gateway channel routing block **110** provides the appropriate channel signals for corresponding to the gateway antennas **182** and a plurality of eNodeBs, such as Base Band Units (BBUs) **112**, for every geographical cell. The gateway site **100** is in communication with UEs via the

satellite(s) **20**, such as a setting satellite and a rising satellite. The satellites **20** communicate with the UEs over respective setting TRx beams and rising TRx beams. The gateway controller **180** communicates with the satellite(s) **20** over a V-band uplink (UL) signal **22** and an RF analog downlink (DL) signal **24**. The gateway site **100** includes gateway antennas **182**, with respect to their serving eNodeBs, such as BBUs **112** for cells **30**. The feeder link beams may, for example, have a wide bandwidth with frequency of 40-50 GHz. And the service link beams are controlled by a Network Mobile Operator (NMO).

FIG. **1** further shows the satellites **20** RAN (radio access network, e.g., GSM, LTE and 5G NR) signal footprints or field of views (FoV) on the Earth's surface. The ground cells **30** are served by the satellites **20**, which are linked to the gateway channel routing block **110**, via gateway antennas **182** that interface with the respective processing devices (i.e., eNodeBs) at the BBUs **112** serving those ground cells **30**. The BBUs **112** control communication with the UEs via the satellites **20**.

Each satellite **20** has a field of view (FoV), and has a plurality of service beams and a plurality of cells **30** in the field of view (FoV). A service beam is between a cell **30** and the satellite **20**, and thus, corresponds to the cell **30**. The service beam can have an uplink beam and downlink beam. Signals transmitted via service beams can include uplink signals from a wireless device **40** (such as mobile user equipment) in a cell to the satellite **20**, and downlink signals from the satellite **20** to a wireless device **40** in a cell.

In some examples, the ground station **100** has a routing block **110** with many base station BBUs, e.g., an eNB farm. The processing device at the BBUU **112** can be, for example, a server or computer such as RAN base station forms, such as BTS for GSM, eNodeB for LTE and gNodeB for 5G, which transmit (Tx) and receive (Rx) LTE signals and can communicate with a GWS device that is located at the ground station.

The ground station processing device (e.g., the eNodeB) at the BBU **112**, can be configured to control operation of the satellite communication system **5**, including communication between the satellite **20** and the UEs **40**, and communication between the satellite **20** and the ground station. In particular, the eNodeB **112** can dynamically configure the RAN for the satellite **20** to provide on-demand resource allocation, for example, bandwidth and/or power allocation.

In one example embodiment of the disclosure, the satellite communication system **5** includes a Network Control Center (NCC) **190**. The NCC **190** can be provided, for example, at the ground station **100**, and can include a database. The NCC **190** supervises the digital data communications (DDC) of each beam and orders base handover and specifies durations. According to one scenario, the NCC **190** is configured to control the eNodeBs to start with two ports, tells the gateway ready for which SMs, and gateway acknowledgement ready. The NCC has cell mapping knowledge, collects ENodeB/RAN base station information, decides cells serving SM orchestrates the beam handover (BHO) between eNodeBs and gateways, piggy-backs via control channel, and tracks the load balance on SM and gateway. The NCC **190**, follows the priority checklist from Q/V bandwidth to battery power, including the inactive and active beam control.

The NCC **190** database is accessed by the BBU and stores available resource data for all resources, including for example power and bandwidth. For example, the resource data can indicate how much data is being used for all cells. The BBU (e.g., eNodeB **112**) is in communication with the NCC **190** database and can access the NCC **190** database to provide resource allocation based on demand statistics stored at the NCC **190** database. The eNodeB can periodically access the NCC database, or the NCC can periodically send a demand statistics report to the eNodeB **112** via, for example, a control channel. The eNodeB **112** can then determine, for example, the appropriate operating parameters for communications between the satellite **20** and the UE **40**, as well as communications between the ground station and the satellite **20**, including for example RAN, bandwidth, power, MIMO, number of BBU.

Turning to FIG. **2**, in an embodiment of the present disclosure, the gateway station **100** has a CPRI interface device **150**, and a plurality of BBUs **112** to form an array. Each BBU includes a processing device, for example an eNodeB. In one embodiment, 500 cells **30** for one satellite **20** and one gateway station **100** would serve four satellites **20**, totaling 2048 10 MHz cells. A cell's eNodeB **112** with two RF ports can deliver the downlink and uplink signals through two gateway (GW) antennas **182** that serve two satellites **20**, each baseband unit (BBU) of a cell providing a beam signal for HO service link via feeder link for two TRx paths to the two RF ports on the eNodeB BBU **112**.

The CPRI interface **150** includes buffer/memory **160**, which includes a control information buffer **162**, downlink signal buffer **164**, and uplink signal buffer **166**. As shown, the buffer **160** can be a lookup table or the like that stores control and monitor data, downlink signal data and uplink signal data in association with each individual cell **30** of the plurality of cells **30**. In the embodiment shown, the leftmost column indicates the cell (e.g., Cell 0 . . . Cell x). The next column indicates the mobile network (e.g., 5G, 4G, etc.) for that cell. The next column is the header/control channel buffer **162** and stores control and monitor data for that cell. The next column is the downlink signal buffer **164** and stores downlink signal information, for example downlink signal component data (e.g., the signal In-phase (I) and Quadrature (Q) component information) for the downlink channels. The final column is the uplink signal buffer **166** and stores uplink signal information, for example uplink signal component data (e.g., the signal In-phase (I) and Quadrature (Q) component information) for the uplink channels.

Thus, the signal component data represent the signal, for example the signal components I and Q represent a signal x over a period of time t, whereby $x(t)=I(t)+jQ(t)$. Accordingly, the IQs for the downlink signals are stored in the downlink database **164**, and represent the In-phase and Quadrature components for the downlink signal over which the satellites **20** communicate with the UEs **40**. And, the IQs for the uplink signals are stored in the uplink database **166**, and represent the In-phase and Quadrature components for the uplink signal over which the UEs **40** communicate with the satellites **20**. It is noted that while IQs are stored in the buffer **160**, any suitable signal components can be utilized within the spirit and scope of the present disclosure.

The control information buffer **162** is in communication with each one of the BBUs **112** of the BBU array. The control buffer **162** stores control and monitor information, for example received from or generated by the gateway controller **180**. As shown, control information can include, for example, cell IDs (latitude, longitude, height), packing order, phase array format, BHO cell IDs, and BHO scheduling. The CPRI interface device **150** receives that control and monitor information from the gateway controller **180**, stores that information in the control information buffer **162**, and communicates that data to each of the plurality of BBUs **112**. For example, the BBU eNodeB can access the control data from the control information buffer **162**. Or, the control

data can be transmitted from the buffer **162** to the BBU **112** eNodeB. The gateway controller **180** uses the control data to control operation of the BBUs **112**, e.g., the eNodeBs.

The downlink information buffer **164** is in communication with each one of the BBUs **112** of the BBU array. The downlink buffer **164** stores downlink information, for example received from or generated by the BBUs **112**. As shown, the downlink information can include, for example, downlink IQs. The CPRI interface device **150** receives that downlink information from the BBUs **112**, stores that information in the downlink information buffer **164**, and communicates that data to the gateway controllers **180**. For example, the gateway controller **180** can access the downlink data from the downlink information buffer **164**. Or, the downlink data can be transmitted from the buffer **164** to the gateway controller **180**.

FIG. **1**B illustrates aspects of FIG. **1**A, in particular buffer/memory **160** and buffer memory pool **170** (which couples to the GW controller **180** via an RF modem). As shown in this example, memory **160** maintains information for a set of cells (Cell 0, Cell 1, . . . , Cell x), including the communication type (e.g., 5G, 4G, 2G, etc.), Hdr/control channel information (e.g., cell IDs, packing order, phase array format, BHO cell IDs, BHO rescheduling, etc.), downlink IQ buffer information and/or uplink IQ buffer information. GW antenna routing information is supplied to memory pool **170**, and GW antenna information is received from the memory pool **170**. The information in the memory pool may change as the satellites fly. Note that the cell index reveals where the cell centers are located.

This figure also illustrates that the NCC **190** is operatively coupled with the GW controller **180**. The NCC supervises the DDC of each beam. It is also configured to order BHO and specify the durations (e.g., eNBs start with 2 ports; NCC tells the GW ready for which satellites; GW acknowledges it is ready). The NC has the cell mapping knowledge, collects eNB/RAN base station information, decides cells serving SM orchestrates the BHOs between eNB farm and GWs, piggy-back via a control channel, tracks the load balance on the satellites and GW, and follows the priority checklist from Q/V bandwidth to battery power, including the active/inactive beams control. Each eNB (base station) may be 1:1 mapped to a given cell. The NCC may help the system to fine a UE's location. It may also provide feedback to an eNB for the e/ICIC.

Thus, with reference to FIGS. **2**, **4**, in one example embodiment, one or more of the BBU **112** eNodeBs can cause the satellite **20** to generate a downlink signal to transmit information to UEs in a selected cell **30**, step **200**. The BBU(s) **112** may be part of a BBU farm, which may support, e.g., NB-IoT, 2G, 4G and/or 5G. The BBU(s) communicate with multiple parallel CPRIs, as shown at block **202**. Via this, the BBU eNodeB retrieves the downlink signal component data (e.g., the downlink IQ data) for the selected cell **30** from the downlink buffer **164** memory pool, step **204** and transmits (e.g., via digital data communication, step **206**) the desired information and retrieved downlink signal component data to the gateway controller **180**, step **208**. The gateway controller **180**, in turn, transmits that information to the satellite **20** over a gateway uplink signal **24**, step **210**. The satellite **20** then generates a downlink signal to the UE in accordance with the selected cell and associated downlink signal component data received from the GW controller **180**, step **212**.

The uplink process operates in reverse of the downlink process. The uplink information buffer **166** is in communication with each one of the BBUs **112** of the BBU array. The uplink buffer **166** stores uplink signal information, for example received from or generated by the gateway controllers **180**. As shown, the uplink signal information can include, for example, IQs. The CPRI interface device **150** receives that uplink information from the gateway controllers **180**, stores that information in the uplink information buffer **166**, and communicates that data to the BBUs **112**. For example, the BBU **112** eNodeBs can access the uplink data from the uplink information buffer **166**. Or, the uplink data can be transmitted from the buffer **166** to the BBU **112** eNodeBs.

Accordingly, the single memory device **160** consolidates all the control information, uplink information and downlink information. That information can be communicated between the gateway controllers **180** and the plurality of BBUs **112**.

FIG. **3** illustrates an arrangement **300** providing satellite communication with UEs according to the above disclosure. In this arrangement, GWS or GW **100** includes a computer or other processing device **302**, which may have one or more Intel® i7 cores or other processors. The processing device couples to a universal software radio peripheral (USRP) **304**. The USRP **304** is operatively coupled to the BBUs **112**. Information to be communicated to the UEs **40** is upconverted to, e.g., one or more Q/V frequency bands at block **306**. Then a central processor for beamforming (CPBF) **308** is configured to generate beamforming information, which is passed to the satellite(s) **20**. The satellite(s) **20** perform downlink and/or uplink communication with the UE(s) **40** as described above.

In one embodiment, the operations described above are implemented at the base station processing device (eNodeB) **112**, including for example the operation of the CPRI. In other embodiments, the operations are implemented at the control satellite **110** by the control satellite processing device **111**.

Accordingly, the satellite **20** communicates with processing devices on Earth, such as for example a user device (e.g., user equipment such as a cell phone, tablet, computer) and/or a ground station. The present disclosure also includes the method of utilizing the satellite **20** to communicate with processing devices on Earth (i.e., transmit and/or receive signals to and/or from). The present disclosure also includes the method of processing devices on Earth communicating with the satellite **20** (i.e., transmit and/or receive signals to and/or from). In addition, while the satellite **20** is used in Low Earth Orbit (LEO) in the examples disclosed, it can be utilized in other orbits or for other applications. Still further, while the system has been described as for an array of antenna assemblies, the system can be utilized for other applications, such as for example data centers, telescopes, reflectors, and other structures, both implemented in space or terrestrially. The satellite **20** and/or a ground station (such as an eNodeB) **100** can include a processing device to perform various functions and operations in accordance with the present disclosure. The processing device can be, for instance, a computing device, processor, application specific integrated circuits (ASIC), or controller. The processing device can be provided with one or more of a wide variety of components or subsystems including, for example, wired or wireless communication links, and/or storage device(s) such as analog or digital memory or a database. All or parts of the system, processes, and/or data utilized in the present disclosure can be stored on or read from the storage device. The processing device can execute software that can be stored on the storage device. Unless indicated otherwise, the

process is preferably implemented in automatically by the processor substantially in real time without delay.

One advantage of the present system **5** is that the user equipment **40** need not be modified. Accordingly, the system **5** can be utilized with standard user equipment, as all the operation is controlled by the eNodeB **112**.

In describing the illustrative, non-limiting embodiments of the disclosure illustrated in the drawings, specific terminology will be resorted to for the sake of clarity. However, the disclosure is not intended to be limited to the specific terms so selected, and it is to be understood that each specific term includes all technical equivalents that operate in similar manner to accomplish a similar purpose. Several embodiments of the disclosure are described for illustrative purposes, it being understood that the disclosure may be embodied in other forms not specifically shown in the drawings. Numerous applications will readily occur to those skilled in the art. Therefore, it is not desired to limit the disclosure to the specific examples disclosed or the exact construction and operation shown and described. Rather, all suitable modifications and equivalents may be resorted to, falling within the scope of the disclosure.

The invention claimed is:

1. A satellite communication system comprising:

a base station configured to communicate with standard compliant user equipment (UE) via a satellite having a field of view, the base station comprising a plurality of base band units and a base station memory configured to store control information, downlink signal information and uplink signal information associated with a cell in the field of view; and

a processing device configured to cause the satellite to generate a satellite beam in accordance with the control information, downlink signal information and uplink signal information stored in the base station memory.

2. The satellite communication system of claim **1**, wherein the UE comprises a wireless device.

3. The satellite communication system of claim **1**, wherein the UE comprises a cellular phone.

4. The satellite communication system of claim **1**, wherein the satellite is arranged to communicate directly with the UE.

5. The satellite communication system of claim **1**, wherein the base station memory includes a control information buffer to store the control information, a downlink signal buffer to store the downlink signal information, and an uplink signal buffer to store the uplink signal information.

6. The satellite communication system of claim **1**, wherein the downlink signal information and the uplink signal information each include in-phase and quadrature component information for respective downlink or uplink communication channels.

7. The satellite communication system of claim **1**, wherein the control information includes one or more of cell identifiers, a communication type, a packing order, a phase array format, beam handover (BHO) cell identifiers, or BHO rescheduling information.

8. A satellite communication method, comprising:

generating, by a gateway controller module, control information and uplink signal information associated with a cell in a field of view of a satellite configured to communicate with standard compliant user equipment (UE);

storing, by a common public radio interface (CPRI), the control information in a control information buffer;

storing, by the CPRI, the uplink signal information in an uplink signal buffer;

associating, by one or more processors, the control information and uplink signal information with one or more baseband units of a baseband unit array, wherein the control information is used by the gateway controller module to control each of the one or more baseband units;

obtaining, by the CPRI, downlink signal information from the one or more baseband units;

storing, by the CPRI, the downlink signal information in a downlink signal buffer; and

causing the satellite to generate a satellite beam in accordance with the stored control information, downlink signal information and uplink signal information.

9. The method of claim **8**, wherein the downlink signal information and the uplink signal information each include in-phase and quadrature component information for respective downlink or uplink communication channels.

10. The method of claim **8**, wherein the control information includes one or more of cell identifiers, a communication type, a packing order, a phase array format, beam handover (BHO) cell identifiers, or BHO rescheduling information.

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