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(54) **AUTOMATIC CONFIGURATION SUB-SYSTEM FOR DISTRIBUTED ANTENNA SYSTEMS**


(71) Applicant: **ANDREW LLC**, Hickory, NC (US)

(72) Inventors: **Van E. Hanson**, Forest, VA (US); **Michael Williamson**, Clayton, NC (US)

(73) Assignee: **COMMSCOPE TECHNOLOGIES, LLC**, Hickory, NC (US)



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(51) **Int. Cl.**

| | |
|---|---|
| ***H04L 12/28*** | (2006.01) |
| ***H04W 16/18*** | (2009.01) |
| ***H04W 16/02*** | (2009.01) |
| ***H04W 16/20*** | (2009.01) |
| ***H04B 7/04*** | (2006.01) |
| ***H04W 16/04*** | (2009.01) |

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CPC ............. ***H04W 16/18*** (2013.01); ***H04B 7/0413*** (2013.01); ***H04B 17/12*** (2015.01); ***H04W 16/02*** (2013.01); ***H04W 16/04*** (2013.01); ***H04W 16/20*** (2013.01); ***H04W 24/02*** (2013.01); ***H04W 52/34*** (2013.01); ***H04W 52/346*** (2013.01); *H04W 88/085* (2013.01); *H04W 92/20* (2013.01)

(58) **Field of Classification Search**

USPC ................................. 370/252, 329, 386, 430

See application file for complete search history.



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*Primary Examiner* — John Pezzlo

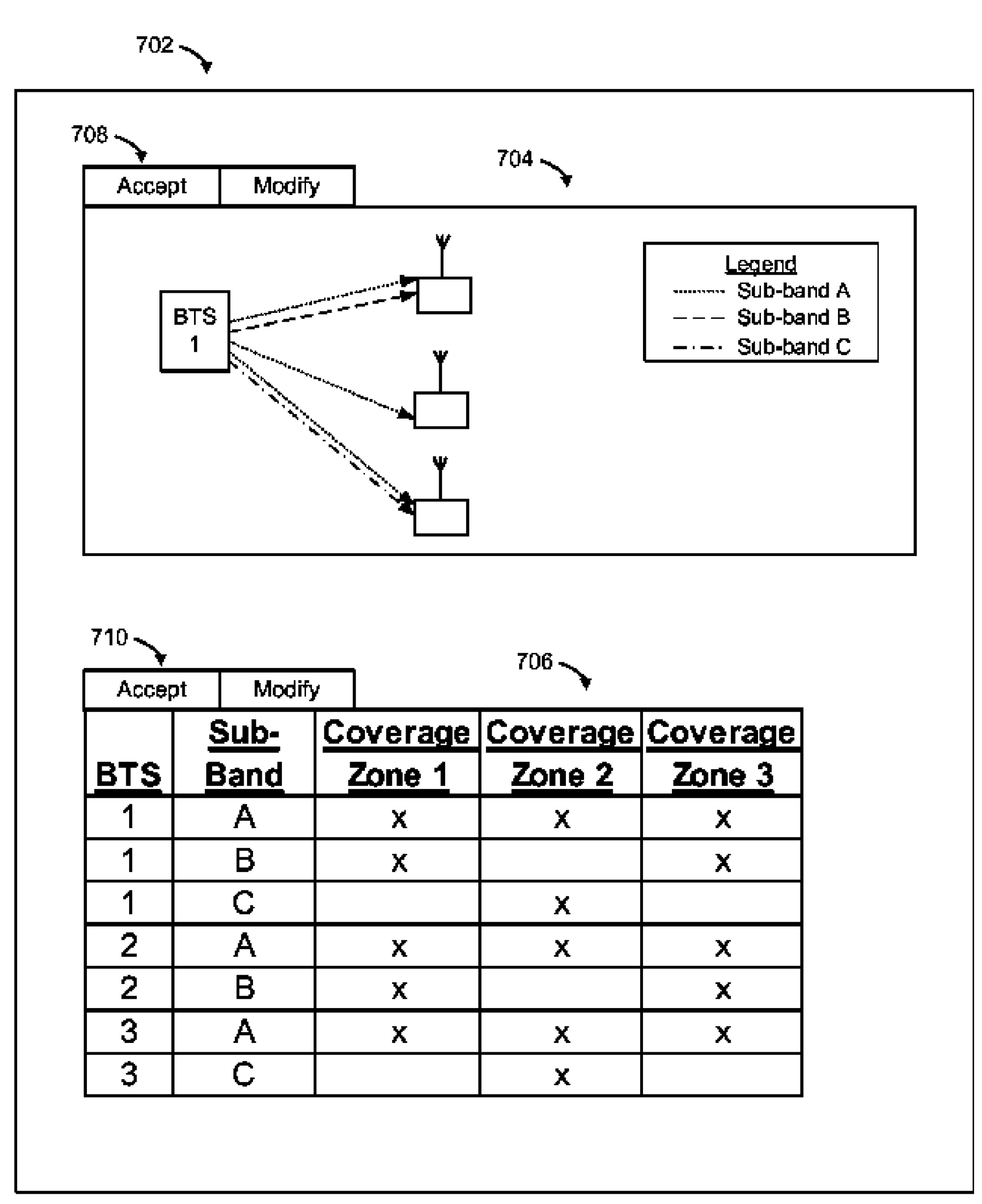
(74) *Attorney, Agent, or Firm* — Robert J. Curylo; Kilpatrick Townsend & Stockton LLP



(57) **ABSTRACT**

Systems and methods for automatically configuring a distributed antenna system are provided. A configuration sub-system of the distributed antenna system can identify signal parameters for downlink signals received from one or more base stations via inputs of a unit in the distributed antenna system. The configuration sub-system can automatically determine a configuration plan for the distributed antenna system based on the automatically identified signal parameters. The configuration plan specifies how to combine subsets of the downlink signals for routing to remote antenna units of the distributed antenna system.


**13 Claims, 6 Drawing Sheets**



(51) **Int. Cl.**

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|---|---|
| ***H04W 24/02*** | (2009.01) |
| ***H04W 52/34*** | (2009.01) |
| ***H04B 17/12*** | (2015.01) |
| *H04J 1/16* | (2006.01) |
| *H04W 88/08* | (2009.01) |
| *H04W 92/20* | (2009.01) |

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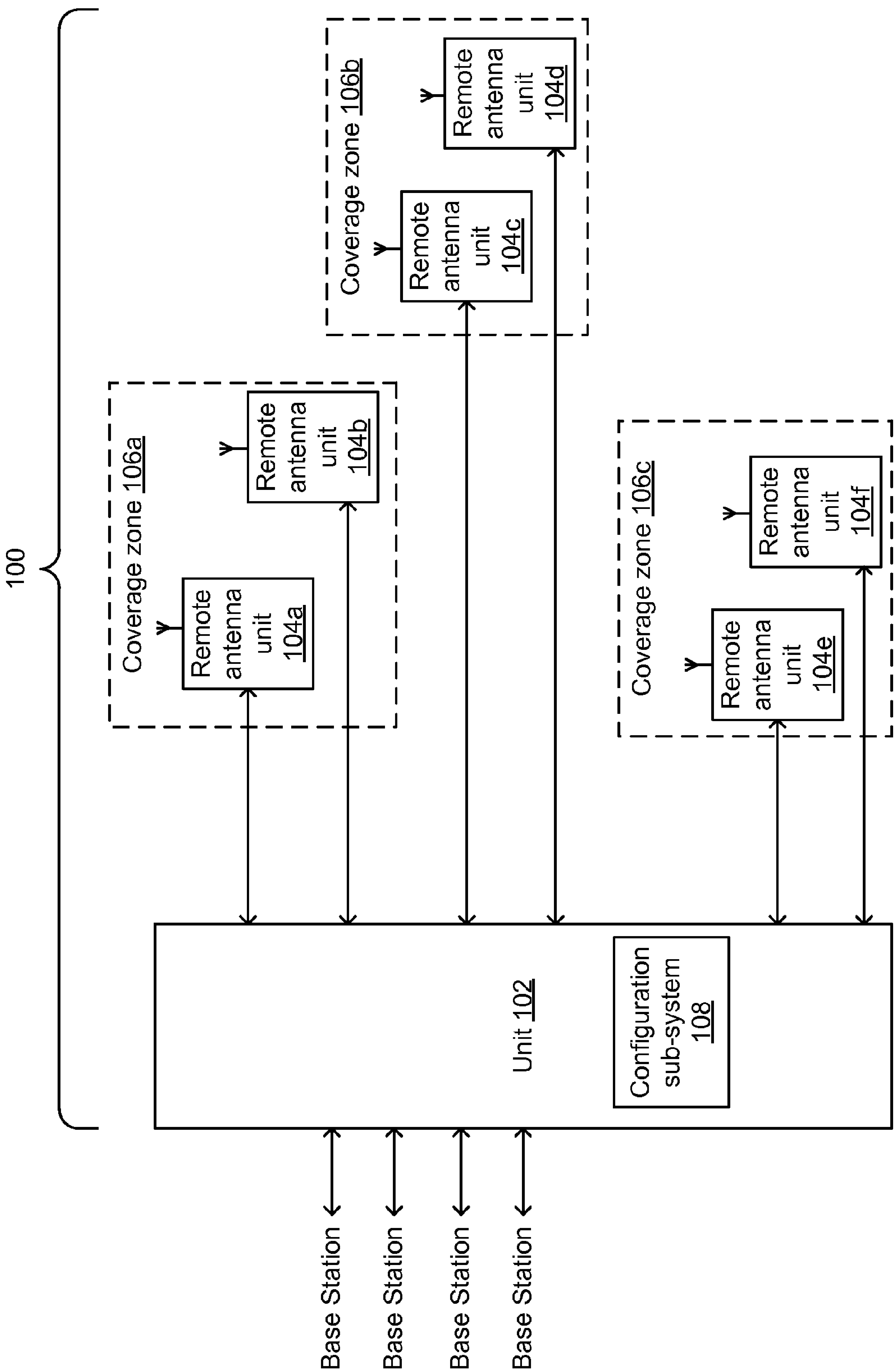

100
Coverage zone 106a
Remote antenna unit 104a
Remote antenna unit 104b
Coverage zone 106b
Remote antenna unit 104c
Remote antenna unit 104d
Coverage zone 106c
Remote antenna unit 104e
Remote antenna unit 104f
Unit 102
Configuration sub-system 108
Base Station
Base Station
Base Station
Base Station

FIG. 1

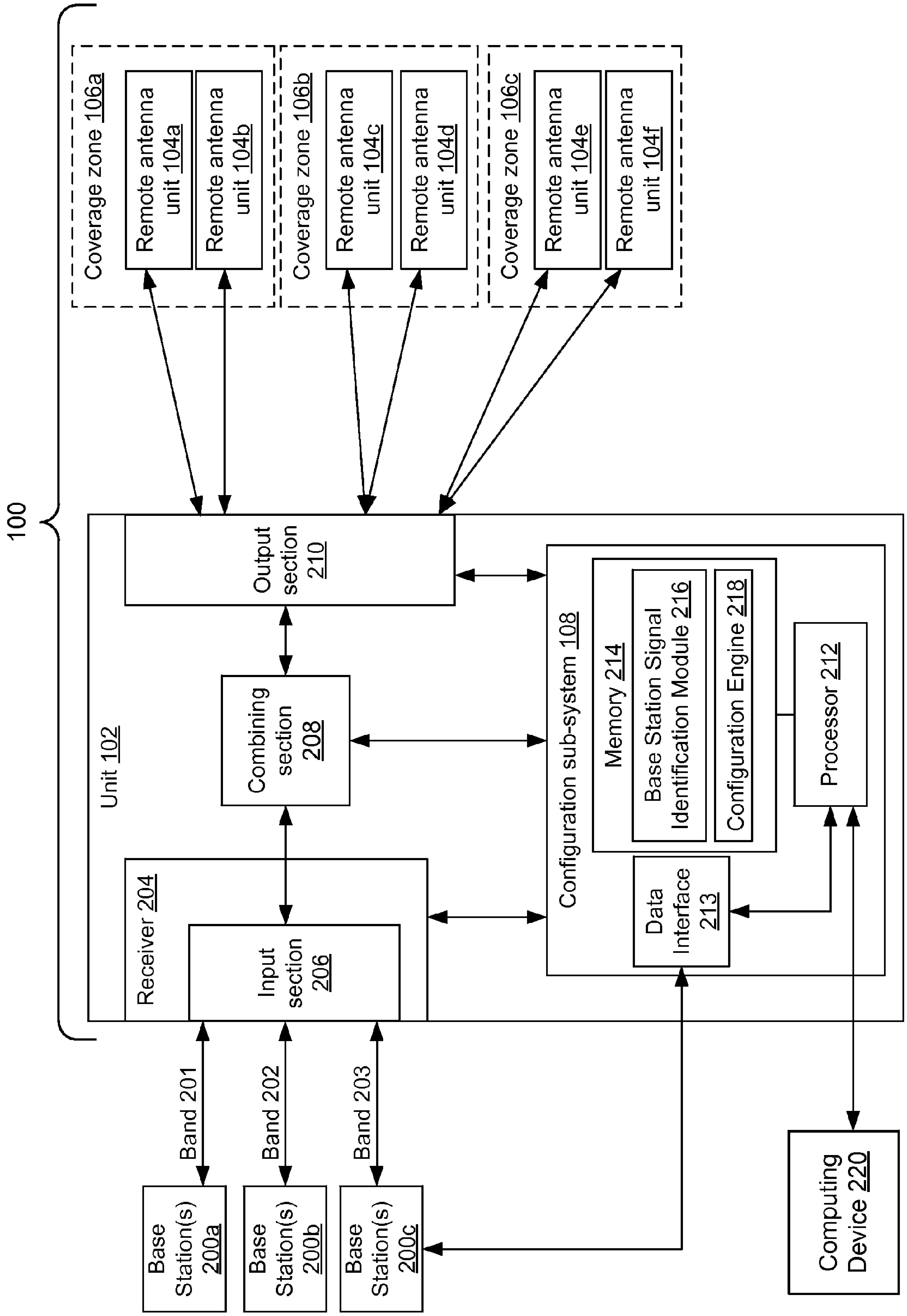

100
Coverage zone 106a
Remote antenna unit 104a
Remote antenna unit 104b
Coverage zone 106b
Remote antenna unit 104c
Remote antenna unit 104d
Coverage zone 106c
Remote antenna unit 104e
Remote antenna unit 104f
Unit 102
Output section 210
Combining section 208
Receiver 204
Input section 206
Configuration sub-system 108
Memory 214
Base Station Signal Identification Module 216
Configuration Engine 218
Processor 212
Data Interface 213
Band 201
Band 202
Band 203
Base Station(s) 200a
Base Station(s) 200b
Base Station(s) 200c
Computing Device 220

FIG. 2

FIG. 3

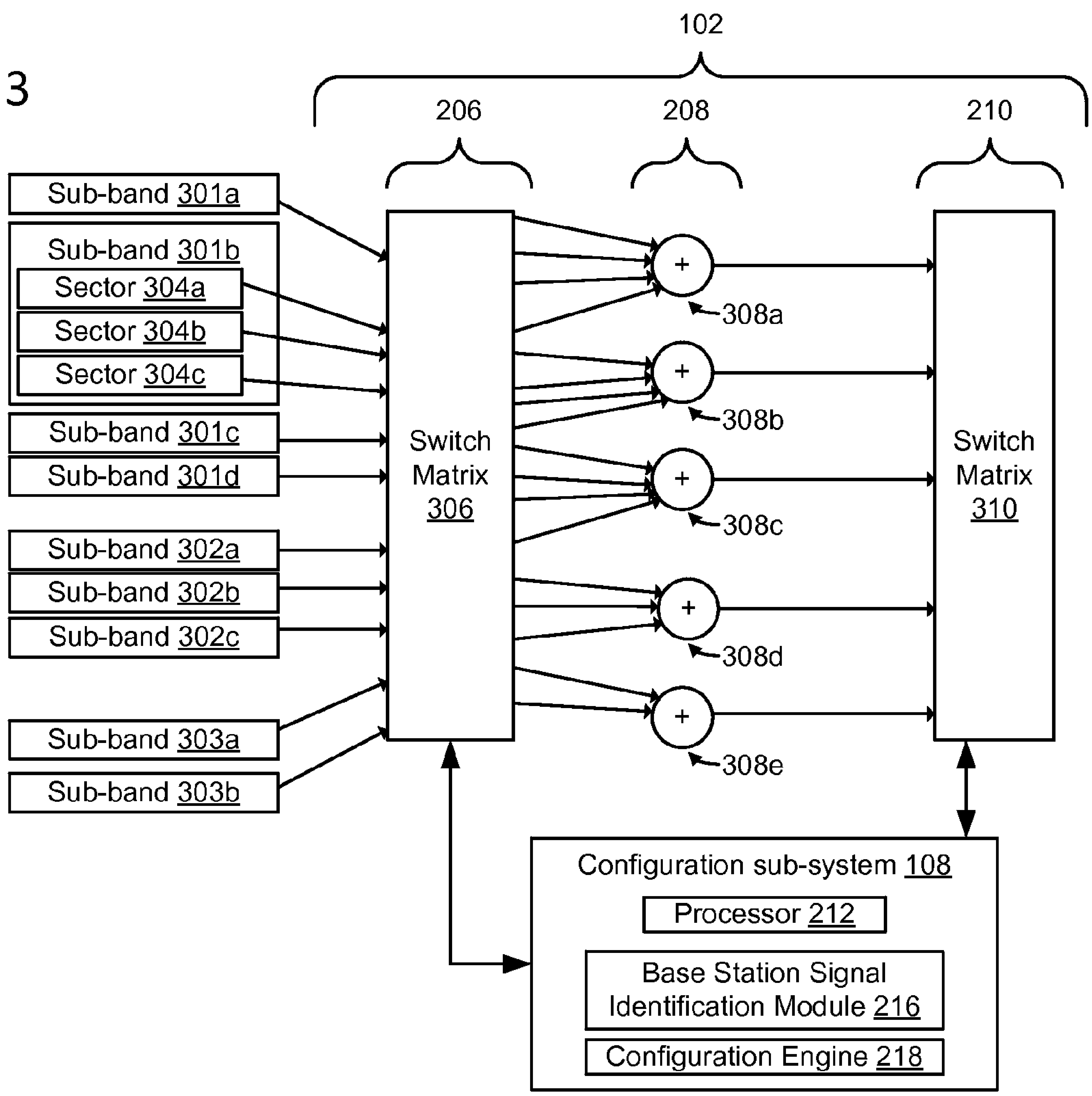



FIG. 4

| Input | Band | Sub-band |
|---|---|---|
| 1 | 201 | 301a |
| 2 | 201 | 301b |
| 3 | 201 | 301b |
| 4 | 201 | 301b |
| 5 | 201 | 301c |
| 6 | 201 | 301d |
| 7 | 202 | 302a |
| 8 | 202 | 302b |
| 9 | 202 | 302c |
| 10 | 203 | 303a |
| 11 | 203 | 303b |

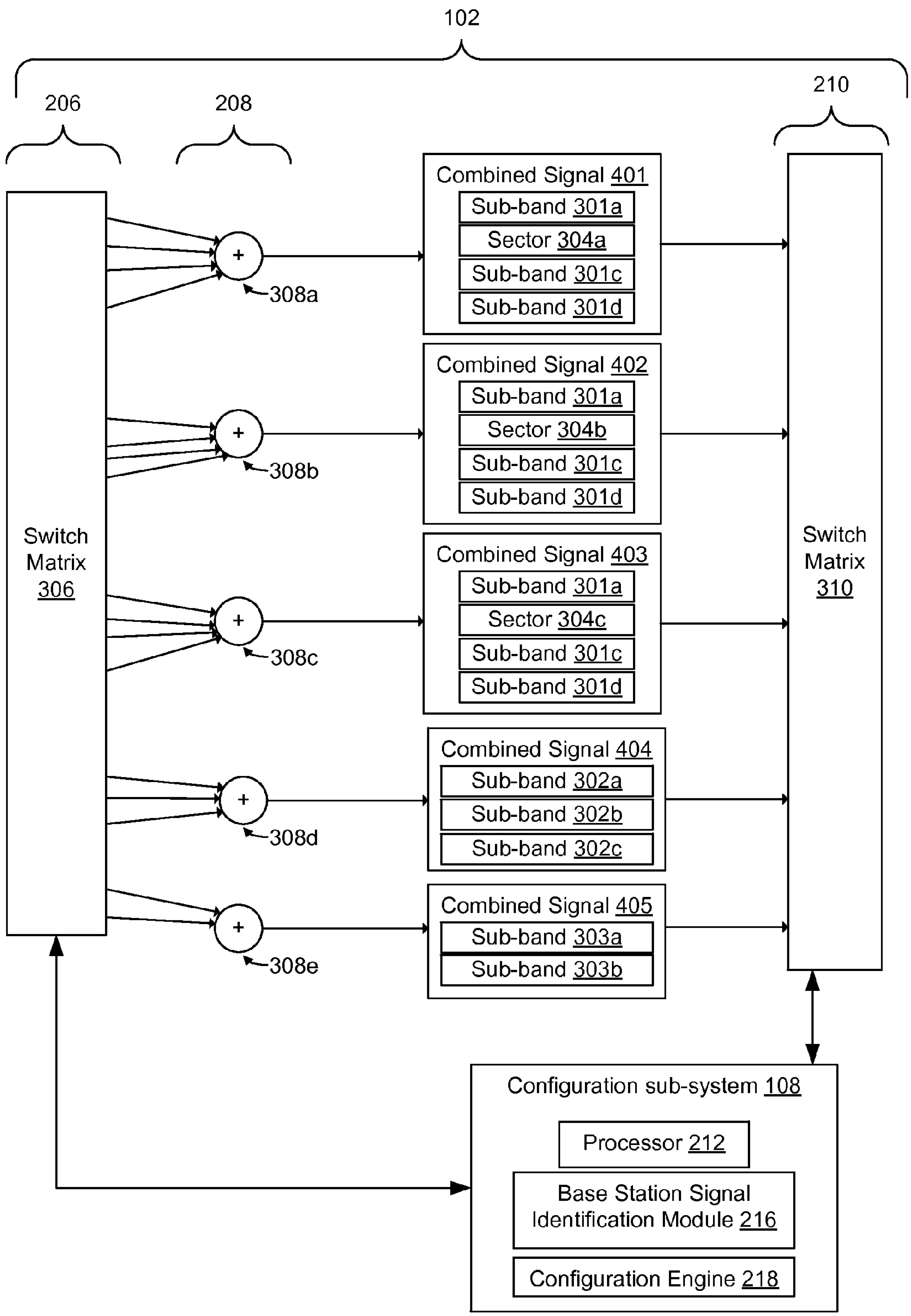
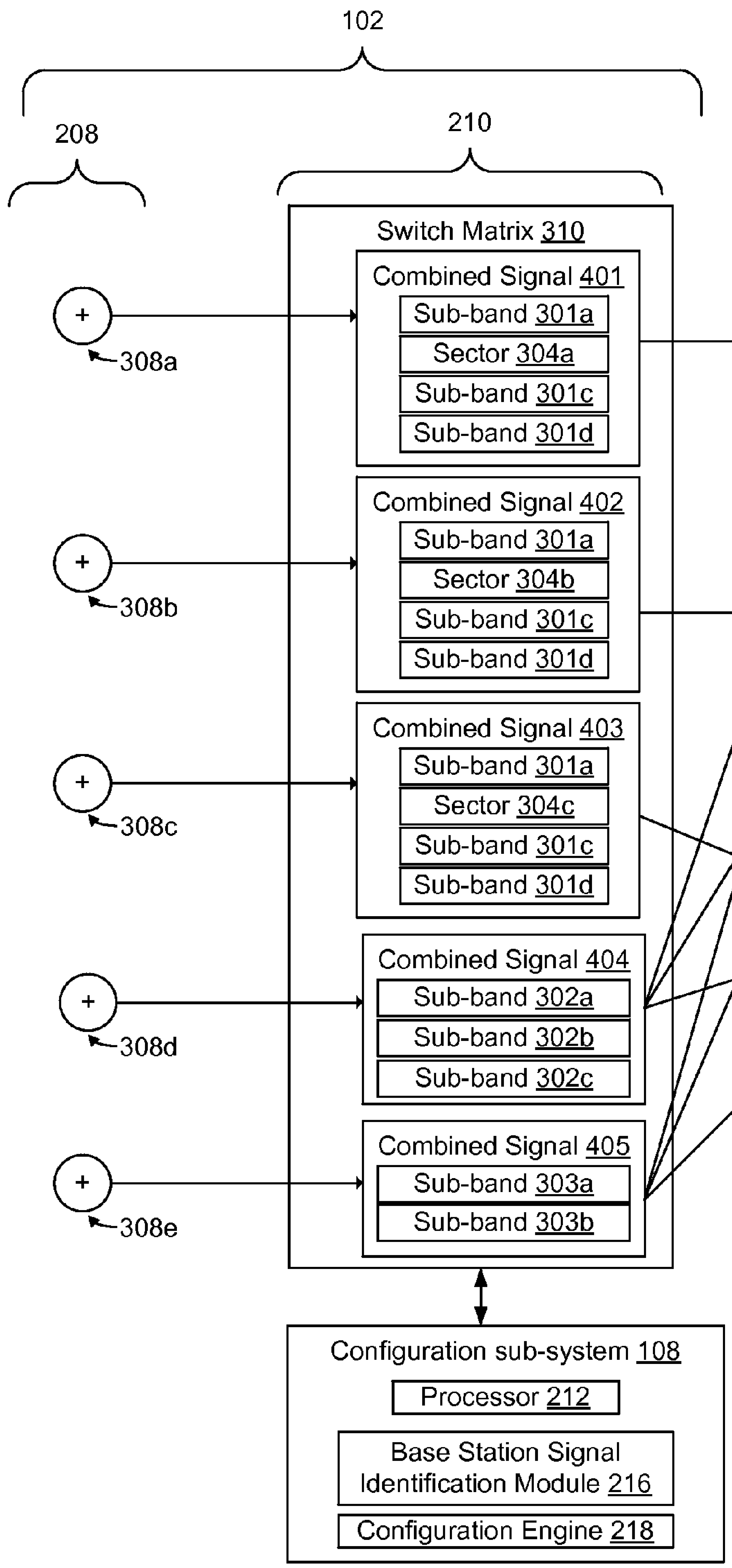

102
206
208
210
Switch Matrix 306
308a
308b
308c
308d
308e
Combined Signal 401
Sub-band 301a
Sector 304a
Sub-band 301c
Sub-band 301d
Combined Signal 402
Sub-band 301a
Sector 304b
Sub-band 301c
Sub-band 301d
Combined Signal 403
Sub-band 301a
Sector 304c
Sub-band 301c
Sub-band 301d
Combined Signal 404
Sub-band 302a
Sub-band 302b
Sub-band 302c
Combined Signal 405
Sub-band 303a
Sub-band 303b
Switch Matrix 310
Configuration sub-system 108
Processor 212
Base Station Signal Identification Module 216
Configuration Engine 218

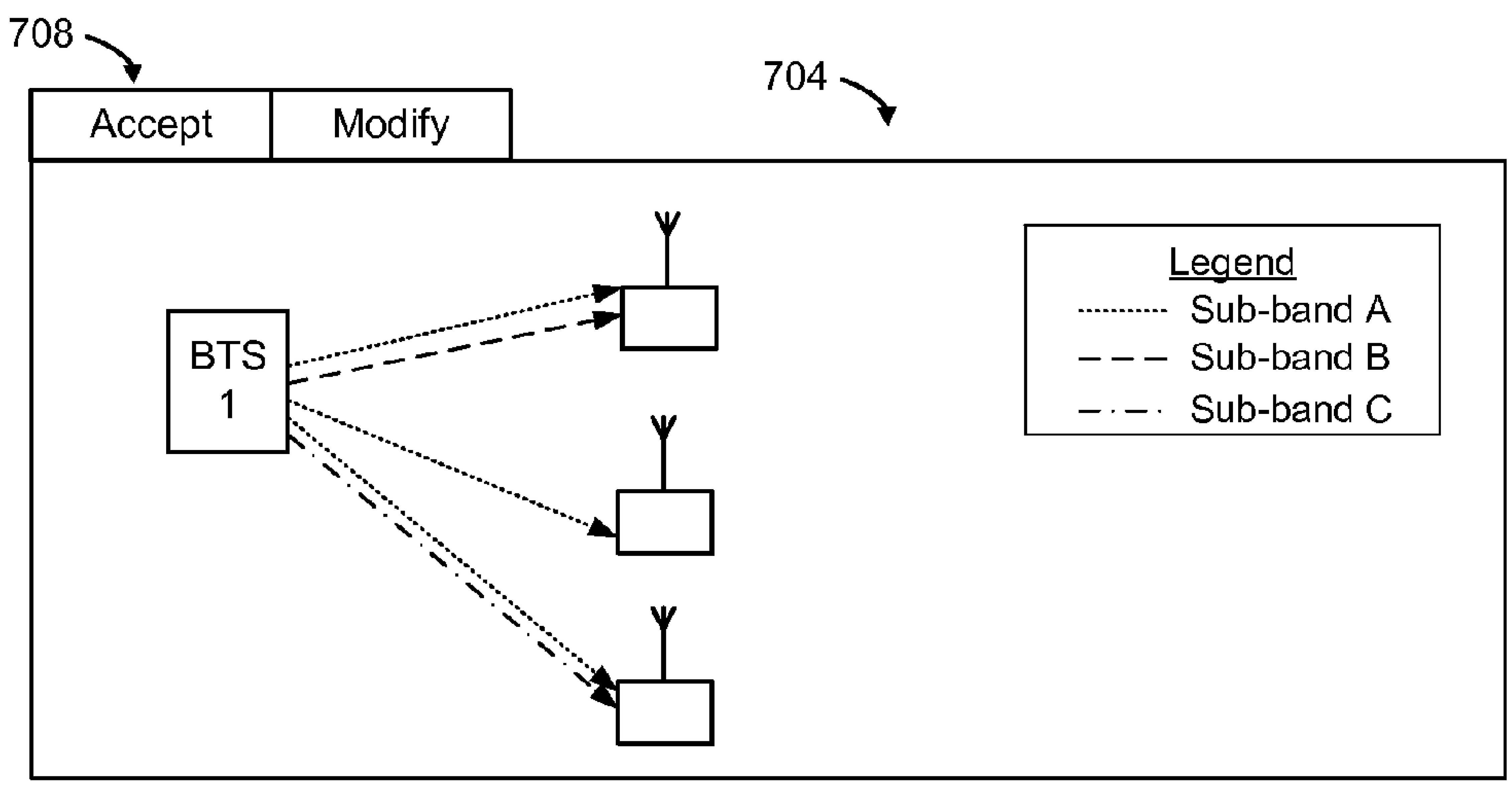
FIG. 5



102
208
210
Switch Matrix 310
Combined Signal 401
Sub-band 301a
Sector 304a
Sub-band 301c
Sub-band 301d
Combined Signal 402
Sub-band 301a
Sector 304b
Sub-band 301c
Sub-band 301d
Combined Signal 403
Sub-band 301a
Sector 304c
Sub-band 301c
Sub-band 301d
Combined Signal 404
Sub-band 302a
Sub-band 302b
Sub-band 302c
Combined Signal 405
Sub-band 303a
Sub-band 303b
+
308a
+
308b
+
308c
+
308d
+
308e
Coverage zone 106a
Remote antenna unit 104a
Remote antenna unit 104b
Coverage zone 106b
Remote antenna unit 104c
Remote antenna unit 104d
Coverage zone 106c
Remote antenna unit 104e
Remote antenna unit 104f
Configuration sub-system 108
Processor 212
Base Station Signal Identification Module 216
Configuration Engine 218


FIG. 6

702




710

706

Accept | Modify

| BTS | Sub-Band | Coverage Zone 1 | Coverage Zone 2 | Coverage Zone 3 |
|---|---|---|---|---|
| 1 | A | x | x | x |
| 1 | B | x | | x |
| 1 | C | | x | |
| 2 | A | x | x | x |
| 2 | B | x | | x |
| 3 | A | x | x | x |
| 3 | C | | x | |

FIG. 7

# AUTOMATIC CONFIGURATION SUB-SYSTEM FOR DISTRIBUTED ANTENNA SYSTEMS

## CROSS-REFERENCE TO RELATED APPLICATIONS

This is a U.S. national phase under 35 U.S.C. 371 of International Patent Application No. PCT/US2014/015772 filed Feb. 11, 2014 and titled "Automatic Configuration Sub-System for Distributed Antenna Systems," which claims the benefit of U.S. Provisional Application No. 61/763,282 filed Feb. 11, 2013 and titled "Automatic Configuration Sub-System for Distributed Antenna Systems," the entirety of both of which is incorporated herein by reference.

## TECHNICAL FIELD

The present disclosure relates generally to telecommunications systems and more particularly (although not necessarily exclusively) to automating the configuration of distributed antenna systems.

## BACKGROUND ART

A distributed antenna system ("DAS") may include master units and remote antenna units. Master units may be connected to base stations. Master units receive downlink signals from base station and distribute downlink signals in analog or digital format to multiple remote antenna units. The remote antenna units transmit downlink signals to mobile communication devices within coverage areas serviced by the remote antenna units. In the uplink direction, signals from mobile communication devices may be received by the remote antenna units. The remote antenna units may combine uplink signals and transmit the combined uplink signals to master units. Master units may transmit uplink signals to the serving base stations.

Signals from many base stations may be communicated via the DAS. The downlink signals may originate from different operators. The downlink signals may be transmitted using different frequency bands and/or different sub-bands within a frequency band. The downlink signals may be combined into various sets for transmission by the remote antenna units. Combining downlink signals may be performed in a manner to accommodate the practical limitations of the various hardware modules and provide the coverage intended by an operator using the DAS. For example, signals in different sub-bands of the same band may be combined together for transmission by a common transmitter.

Configuration of the DAS may involve manually defining which downlink signals are routed to which remote antenna units and defining how downlink signals are combined for retransmission. Signal parameters of the base stations signals may be manually entered for the DAS. Increasing the number of base stations in communication with the DAS or the number of remote antenna units in the DAS may increase the amount of time required for manually configuring the DAS.

## SUMMARY

Certain aspects and features of the present invention are directed to automating the configuration of distributed antenna systems.

In one aspect, a configuration sub-system of a distributed antenna system is provided. The configuration sub-system can include a processing device. The processing device can identify signal parameters for downlink signals received from one or more base stations via inputs of a unit in the distributed antenna system. The processing device can automatically determine a configuration plan for the distributed antenna system based on the automatically identified signal parameters. The configuration plan specifies how to combine subsets of the downlink signals for routing to remote antenna units of the distributed antenna system.

In another aspect, a unit of a distributed antenna system is provided. The unit can include an input section and a processing device communicatively coupled to the input section. The input section can receive downlink signals from at one or more base stations. The processing device can identify signal parameters for the received downlink signals. The processing device can automatically determine a configuration plan for the distributed antenna system based on the automatically identified signal parameters. The configuration plan specifies how to combine subsets of the downlink signals for routing to remote antenna units of the distributed antenna system.

In another aspect, a method for configuring a distributed antenna system is provided. The method involves a unit of the distributed antenna system receiving downlink signals from one or more base stations. The method also involves a processing device identifying signal parameters for downlink signals received from one or more base stations via inputs of a unit in the distributed antenna system. The method also involves the processing device automatically determining a configuration plan for the distributed antenna system based on the automatically identified signal parameters. The configuration plan specifies how to combine subsets of the downlink signals for routing to remote antenna units of the distributed antenna system.

These illustrative aspects and features are mentioned not to limit or define the disclosure, but to provide examples to aid understanding of the concepts disclosed in this application. Other aspects, advantages, and features of the present disclosure will become apparent after review of the entire application.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram depicting an example of a distributed antenna system that can include a unit with a configuration sub-system according to one aspect of the present disclosure.

FIG. **2** is a block diagram depicting an example of configuration sub-system that is included in the unit of the distributed antenna system of FIG. **1** according to one aspect of the present disclosure.

FIG. **3** is a block diagram depicting the unit of FIG. **2** receiving downlink signals having frequencies in different sub-bands that can be combined using the configuration sub-system according to one aspect of the present disclosure.

FIG. **4** is a table depicting frequency bands and sub-bands for signals that may be received by different input ports of the unit of FIG. **3** according to one aspect of the present disclosure.

FIG. **5** is a block diagram depicting the unit of FIG. **3** using the configuration sub-system to combine the sub-bands into combined signals according to one aspect of the present disclosure.

FIG. **6** is a block diagram depicting the unit of FIG. **3** using the configuration sub-system to provide the combined signals to the coverage zones serviced by the distributed antenna system according to one aspect of the present disclosure.

FIG. **7** is a diagram depicting an example of a graphical interface provided by the configuration sub-system for configuring a distributed antenna system according to one aspect of the present disclosure.

## DETAILED DESCRIPTION

Systems and methods are disclosed for using a configuration sub-system to automatically configure a distributed antenna system ("DAS") or other telecommunication system. The configuration sub-system can automate (either in whole or in part) the routing and combining of signals between base stations in communication with a DAS and remote antennas units in the DAS.

In some aspects, the configuration sub-system of a DAS can include a processing device that can analyze downlink signals received by a master unit or other unit in the DAS from one or more base stations in communication with the DAS. In some aspects, the processing device can be communicatively coupled to a receiver of the master unit and can receive data from the receiver describing the received downlink signals. In other aspects, the processing device can be communicatively coupled to the donor input ports of the master unit via which downlink signals are received, thereby allowing the processing device to directly monitor the downlink signals. The processing device can determine signal parameters of the received downlink signals to determine how different downlink signals may be combined and routed in the DAS. Signal parameters can include characteristics of a signal or groups of signals or other information about a signal or groups of signals. Non-limiting examples of signal parameters include a power spectral density of a received frequency band, the lowest frequency and highest frequency for the frequency band, a center frequency of all channels received by the master unit, bandwidth of all the channels, modulation types for different channels, etc. The processing device can use the signal parameters to generate a configuration plan that specifies which downlink signals from different downlink signals may be combined and which remote antenna units in the DAS are to receive the combined signals from the master unit. In some aspects, the signal parameters of the received signals, including the bandwidth and number of channels, can also be used (separately or in combination) to determine the relative signal levels of base stations signals for signals that are combined into a combined signal. The master unit or other unit can combine downlink signals in accordance with the configuration plan and provide the combined signals to remote antenna units. The remote antenna units can extract downlink signals from the combined signals for transmission in different coverage zones of the DAS.

In additional or alternative aspects, the configuration sub-system can determine whether the same set of frequencies contained within one set of downlink signals is also contained within any other downlink signals (e.g., whether 1920-1940 MHz is detected on one set of downlink signals, whether 1930-1950 MHz is detected on a second set of downlink signals, and whether 1930-1940 MHz is detected on a third set of downlink signals). This information can be used to configure the DAS such that each common set of frequencies is transmitted by a unique, non-overlapping set of remote antenna units. For example, different sectors from the same base station can be routed to different sets of remote antenna units based on the different sets of remote antenna units servicing non-overlapping coverage zones.

In additional or alternative aspects, the configuration sub-system can detect multiple-input and multiple-output ("MIMO") signals. The configuration sub-system can determine which downlink signals (or portions thereof) are part of a MIMO set. This information can be used to configure the DAS to retransmit all MIMO signals that are part of a MIMO set by the corresponding MIMO antennas in a common coverage area.

In additional or alternative aspects, the configuration sub-system can decode data included in the downlink signals that includes additional information about the source or destination of the downlink signals (e.g., a country code or network code identifying an operator using the DAS). The signal parameters and decoded data can be used (separately or in combination) by the configuration sub-system to automatically configure the DAS. Configuring the DAS can include deciding which downlink signals (or portions thereof) are routed to specific remote antenna units and which downlink signals are combined together before being operated on by a common circuit element.

For illustrative purposes, the present disclosure describes a configuration sub-system that can configure a DAS for routing downlink signals. However, other implementations are possible. In additional or alternative aspects, the configuration sub-system can be used to configure how any signals received by a device in the DAS are to be combined and routed to another device in the DAS or a device in communication with the DAS. A suitable configuration process can be performed in the uplink direction such that communication is established between mobile communication devices (or other user equipment in coverage zones) and base stations. For remote antenna units to which the downlink signals are routed, the corresponding uplink signals can be identified by matching paired channels in the uplink band that are used to route uplink signals back to the same base station. The configuration sub-system can use the routing between base stations and the remote antenna units in the downlink direction to determine the routing of uplink signals from remote antenna units to the base stations.

Detailed descriptions of certain examples are discussed below. These illustrative examples are given to introduce the reader to the general subject matter discussed here and are not intended to limit the scope of the disclosed concepts. The following sections describe various additional aspects and examples with reference to the drawings in which like numerals indicate like elements, and directional descriptions are used to describe the illustrative examples but, like the illustrative examples, should not be used to limit the present disclosure.

FIG. **1** is block diagram depicting an example of a DAS **100** that can include a unit **102** with a configuration sub-system **108**. The DAS **100** can include the unit **102** and remote antenna units **104***a-f* in communication with the unit **102**. The unit **102** can communicate with one or more base stations or other signal sources, such as repeaters. Different base stations can provide signals associated with different telecommunication operators. The DAS **100** can be positioned in a geographical area (e.g., a stadium, an office building, etc.) to extend wireless communication coverage of the base stations into coverage zones **106***a-c* of the geographical area.

The DAS **100** or other telecommunications system can include downlink paths for transporting downlink signals from the base stations to one or more of the remote antenna units **104***a-f*. The DAS **100** can receive downlink signals from the base stations via a wired or wireless communication medium. Downlink signals can include signals provided from the base stations and transmitted by the remote antenna units **104***a-f* in the coverage zones **106***a-c*. A non-limiting example of a remote antenna unit is a universal access point.

The DAS **100** or other telecommunications system can also include uplink paths for transporting uplink signals from one or more of the remote antenna units **104***a-f* to one of more of the base stations or repeaters. Uplink signals are signals at frequencies in an uplink frequency band that are recovered or otherwise received by one or more of the remote antenna units **104***a-f* from communication devices in the coverage zones **106***a-c*.

The unit **102** can communicate signals between the base stations and the remote antenna units **104***a-f*. Non-limiting examples of a unit **102** include a wireless conversion station or other master unit, a base station router, etc. In some aspects, the unit **102** can be directly connected to one or more of the remote antenna units **104***a-f*, as depicted in FIG. **1**. In other aspects, the unit **102** can be connected to one or more extension units that are directly connected to one or more of the remote antenna units **104***a-f*.

For illustrative purposes, FIG. **1** depicts a single unit **102** in communication with six remote antenna units **104***a-f*. However, a distributed antenna system **100** can include any number of units in communication with base stations or other signals sources as well as any number of remote antenna units for communicating signals between any number of signal sources and any number of coverage areas.

A DAS **100** can include other devices in addition to master units, remote antenna units, and extension units. For example, in some aspects, the DAS **100** may include a base station router or other interface device that receives signals from base stations and provides the signals to the unit **102**.

FIG. **1** also depicts a configuration sub-system **108** that is included in the unit **102**. The configuration sub-system **108** can include one or more devices for monitoring and analyzing signals received by the unit **102**, determining how the received signals are to be combined and routed, and generating a configuration plan for the DAS **100**. The configuration plan can specify how signals received by the unit **102** are to be combined and routed to other devices in the DAS **100** or in communication with the DAS **100**.

FIG. **2** is a block diagram depicting an example of configuration sub-system **108** that is included in a unit **102** of the DAS **100**. The configuration sub-system **108** can communicate with other devices in the unit **102**. For example, FIG. **2** depicts a configuration sub-system **108** in communication with devices of the unit **102** such as a receiver **204** having an input section **206**, a combining section **208**, and an output section **210**.

The input section **206** of the unit **102** can include multiple input ports for receiving downlink signals from base stations. The input section **206** can also include one or more components for communicatively coupling the input ports to the configuration sub-system **108**. A non-limiting example of a component for communicatively coupling the input ports to the configuration sub-system **108** is a switch matrix. The received downlink signals can be transmitted from the base stations to the unit **102** using different frequency bands, such as the frequency bands **201**, **202**, **203** depicted in FIG. **2**. In some aspects, the unit **102** can transmit uplink signals having frequencies in the frequency bands **201-203** to the base stations. In other aspects, the master unit can transmit uplink signals having frequencies other than the frequency bands **201-203** to the base stations.

The combining section **208** can combine signals from different base stations for routing to the remote antenna units **104***a-f* servicing the coverage zones **106***a-c*. A non-limiting example of a combining section **208** includes one or more adders or other combiners. The configuration sub-system **108** can be used to configure one or more of the receiver **204** and the combining section **208** to control which downlink signals are combined together for transmission to different remote antenna units. In one non-limiting example, the configuration sub-system **108** can communicate control signals to the receiver **204** that configure a switch matrix in the receiver **204** to route different subsets of the received downlink signals to different combining devices in the combining section **208**. In another non-limiting example, the configuration sub-system **108** can communicate control signals to the combining section **208** that configure the combining section **208** to combine different sets of downlink signals received from the receiver **204**. In another non-limiting example, the configuration sub-system **108** can output a configuration plan to a computing device **220** that describes how to route different downlink signals to different combining devices. The outputted configuration plan can be used by a control device configure the unit **102** for routing downlink signals from the receiver **204** to different combining devices in the combining section **208**.

The output section **210** can include one or more components for routing downlink signals from the combining section **208** to the remote antenna units **104***a-f*. Non-limiting examples of an output section **210** include a switch matrix, a multiplexer, and the like. The configuration sub-system **108** can be used to configure the output section **210** to control which combined downlink signals are routed to different remote antenna units. In one non-limiting example, the configuration sub-system **108** can communicate control signals to the output section **210** that configure a switch matrix in the output section **210** to route different combined downlink signals to different remote antenna units. In another non-limiting example, the configuration sub-system **108** can output a configuration plan to a computing device **220** that describes the routing of different combined downlink signals to various remote antenna units. The outputted configuration plan can be used by a control device in the DAS **100** to configure the unit **102** for routing combined downlink signals to remote antenna units.

The configuration sub-system **108** can include a processing device **212** (or group of processing devices) that includes or is communicatively coupled with a memory device **214**. The memory device **214** can be a non-transitory computer-readable medium for storing program instructions that are executable by the processing device **212**. The executable program instructions can include a base station signal identification module ("BSSIM") **216** and a configuration engine **218**. Although the BSSIM **216** and the configuration engine **218** are depicted in FIG. **2** and described herein as separate logical modules for ease of reference, other implementations are possible. In additional or alternative aspects, the configuration engine **218** and the BSSIM **216** can be implemented via a common software module.

The configuration sub-system **108** can be communicatively coupled to the receiver **204** and can thereby receive data about the downlink signals received via the input section **206**. In some aspects, the receiver **204** can transmit data about the received downlink signals to the configuration sub-system **108**. In other aspects, the configuration sub-system **108** can be directly coupled to each of the input ports of the input section **206** (e.g., via the leads of a printed circuit board).

The BSSIM **216** can determine information about downlink signals received via the input section **206**. For example, the processing device **212** can transmit one or more instructions to the receiver **204** that cause the receiver **204** to be tuned to different frequency bands in which downlink signals can be received. For a given frequency band, the BSSIM **216** can access data that is stored in the memory device **214** and that describes the types of signals transmitted using the frequency band. For example, such data may indicate that the frequency band is used to transmit signals according to the Global System for Mobile Communications ("GSM") standard, the Long Term Evolution ("LTE") standard, etc. For a given frequency band, the BSSIM **216** can execute a search algorithm to identify signals having certain characteristics, such as downlink signals with signal powers exceeding a given threshold. The configuration sub-system **108** can repeat this process to identify downlink signals in each frequency band used by the DAS **100**.

The BSSIM **216** can determine information regarding signal parameters of the downlink signals. The signal parameters can include parameters such as frequency bands of operation, frequency occupancy (i.e., difference between minimum frequency and maximum frequency at which downlink signals are transmitted), a center frequency of all channels, modulation types for the downlink signals, signal powers for downlink signals in various frequency channels, etc. The BSSIM **216** can also identify characteristics of the downlink signals such as communication standards used to transmit the downlink signals (e.g. GSM, LTE, Universal Mobile Telecommunications System ("UMTS"), code division multiple access ("CDMA"), Enhanced Voice-Data Optimized ("EV-DO"), etc.). The BSSIM **216** can also identify information elements encoded in the downlink signals, such as (but not limited to) country codes, network codes, base station ID numbers and other identification and operational data that is useful for determining how to configure the DAS **100**. In some aspects, the BSSIM **216** can decode MIMO signals received on different input ports to determine which individual MIMO signals are included in a given set of MIMO signals.

In additional or alternative aspects, the configuration sub-system **108** can include a direct data interface from the DAS **100** to one or more of base stations to obtain additional data about the signal parameters of the downlink signals. The configuration sub-system **108** can communicate with the base stations via the direct data interface to obtain data regarding one or more signal parameters of the downlink signals. In one non-limiting example, the direct data interface can include a base station sending control signals to the configuration sub-system **108** via a downlink path. For example, the configuration sub-system **108** depicted in FIG. **2** may receive control signals via downlink paths from the base stations **200***a*, **200***b* that provide information about downlink signals from the base stations **200***a*, **200***b*. In another non-limiting example, the direct data interface can include a base station sending control signals to the configuration sub-system **108** via a dedicated communication channel separate from the downlink path. For example, the configuration sub-system **108** depicted in FIG. **2** includes a data interface device **213** that communicatively couples the configuration sub-system **108** to the base station **200***c*. The configuration sub-system **108** can receive control signals via the data interface device **213** that provide information about downlink signals from the base station **200***c*. In some aspects, the configuration sub-system **108** can use a combination of signal analysis and data obtained via the direct data interface to determine the signal parameters. For example, the configuration sub-system **108** determine signal parameters of some downlink signals by communicating with the base stations via the direct data interface and can determine signal parameters of other downlink signals by analyzing the downlink signals as described above. In other aspects, the configuration sub-system **108** can determine signal parameters solely by communicating with base stations via the direct data interface.

The configuration engine **218** can perform one or more functions for generating a configuration plan for the DAS **100**. The configuration engine **218** can use information about the received downlink signals to determine which downlink signals from which base stations are to be routed to which remote antenna units **104***a-f*. The configuration engine **218** can also use information about the received downlink signals to determine which signals from different base stations can be combined together for processing. For example, the configuration engine **218** can execute a decoding algorithm to decode signals identified by the BSSIM **216** in different frequency bands used by the DAS **100**. In some aspects, the configuration engine **218** can determine information about the decoded signals that is communicated to other devices in the unit **102** (e.g., the receiver **204**, the combining section **208**, the output section **210**) in order to configure the DAS **100**. In additional or alternative aspects, the configuration engine **218** can determine information about the decoded signals that is communicated to a system controller used to configure the DAS **100**. The configuration engine **218** can thus reduce or eliminate the need to manually enter information about downlink signals.

For signals within a frequency band, the configuration engine **218** can determine whether multiple sectors are present for any subset of the band. Each sector can use a set of frequencies that are in common with one or more additional sectors. A sector can include one or more telecommunication channels to be radiated to mobile devices in coverage zones or otherwise distributed to the coverage zones, thereby providing telecommunication capacity in the coverage zones. The sector can be distributed without further subdivision. The configuration engine **218** can determine the number of sectors by determining if any of the downlink signals occupy the same frequencies or blocks of frequencies. Each sector can be transmitted in spatially separate areas to reduce or minimize co-channel interference with one another. For example, the configuration engine **218** can assign a first sector to a first subset of remote antenna units servicing a first coverage zone and assign a second sector to a second subset of remote antenna units servicing a second coverage zone. The assignment of the first and second sectors to the first and second subsets of remote antenna units can be performed based on an absence of overlap between the first and second coverage zones.

In some aspects, the configuration sub-system **108** can automatically configure the DAS **100** using the frequency band(s) of operation, the frequency occupancy for each channel, and the power of each channel. In other aspects, for a more complex DAS **100**, the configuration sub-system **108** can automatically configure the DAS **100** using the frequency bands of operation, the frequency occupancy for each channel, the power of each channel, and information describing sectors received by the unit **102** from base stations via a direct data interface.

Although FIGS. **1-2** depict the configuration sub-system **108** as part of the unit **102**, other implementations are possible. For example, the configuration sub-system **108** (including one or both of the BSSIM **216** and the configuration engine **218**) can be included in any suitable signal analysis device that is configured to process RF signals at frequencies used by the DAS **100**. A non-limiting example of a suitable signal analysis device is a digital signal processer that can analyze a digitized signal and determine information about the signal. In some aspects, the functions of the BSSIM **216** or the configuration engine **218** can be performed by one or more devices in the DAS **100** that provide other signal processing functions.

The configuration engine **218** can be used to configure the DAS **100** by determining which downlink signals are to be routed to which of the remote antenna units **104***a-f*. In a DAS

**100**, different downlink signals may be transmitted to different remote antenna units or groups of remote antenna units for retransmission to mobile communication devices or other user equipment in the coverage zones **106***a-c*. In some aspects, multiple sectors from a base station may be transmitted using the DAS **100**. Transmitting multiple sectors from the base station using a DAS **100** can involve transmitting different downlink signals (i.e., signals directed to different end user devices) that occupy the same frequency spectrum. The different downlink signals occupying the same frequency spectrum can be transmitted in spatially distinct coverage areas to reduce or prevent interference with one another. The configuration engine **218** can detect that downlink signals received from a base station via a first input of the unit **102** occupy the same frequency spectrum as downlink signals received via a second input of the unit **102**. The configuration engine **218** can determine that the downlink signals received via the two inputs are not to be combined. The configuration engine **218** can determine that the downlink signals received via the two inputs are to be routed to two different sets of remote antenna units servicing spatially distinct coverage areas (i.e., non-intersecting subsets of the remote antenna units **104***a-f*). The configuration engine **218** can determine the routing of downlink signals via any suitable algorithm for determining how to assign different downlink signals occupying the same frequency spectrum to different remote antenna units.

In additional or alternative aspects, the configuration sub-system **108** can generate a graphical interface to be provided to a user for configuring the DAS **100**. For example, the processing device **212** of the configuration sub-system **108** can be communicatively coupled to a computing device **220** external to the DAS **100** (e.g., a computing device **220** used by a technician in configuring the DAS **100**). The configuration sub-system **108** can generate and provide the graphical interface to the computing device **220**. The configuration sub-system **108** can provide a prompt to the user via the graphical interface that solicits authorization to automatically configure the DAS **100**. The user can provide input to the configuration sub-system **108** via the computing device **220** that commands the configuration sub-system **108** to automatically configure the DAS **100**. In some aspects, the configuration sub-system **108** can generate a configuration recommendation and include the configuration recommendation in the graphical interface provided to the computing device **220**. A user of the computing device **220** can manually modify the configuration recommendation, reject the configuration recommendation, instruct the configuration sub-system **108** to execute the configuration recommendation, etc.

In some aspects, a configuration recommendation may identify conflicts or other errors in the routing of signals in the DAS **100**. The configuration sub-system **108** can inform a user of the identified conflicts. The configuration sub-system **108** can provide recommendations for resolving the conflicts and/or solicit input from a user for how to resolve the conflicts. One example of a conflict or other error involves multiple sectors with overlapping frequencies being transmitted from a base station via the DAS **100**. Another example of a conflict or other error involves signals from one or more operators not being assigned to any remote antenna unit for transmission in one of the coverage areas. Another example of a conflict or other error involves the number of remote antenna units being used to transmit a sector being substantially different that the average number of remotes used to transmit a sector. For instance, the configuration sub-system **108** may determine that for each sector is being transmitted by 8-12 remote antenna units except for one sector that is being transmitted by two remote antenna units. The relatively low number of remote antenna units being used to transmit the sector may indicate an error.

The configuration sub-system **108** can execute a configuration algorithm at any suitable point during deployment, configuration, or operation of the DAS **100**. For example, the configuration sub-system **108** can execute a configuration algorithm in response to a new base station being connected to the DAS **100** or in response to any other change in base station connectivity. For instance, during a first time period, the DAS **100** may transmit two sectors, each of which is transmitted by 15 remote antennas. During a second time period, a new base station may be connected to the DAS **100**, thereby adding a new sector to be transmitted by the DAS **100**. The signals transmitted by the new base station can be detected. The BSSIM **216** can determine that the detected signals are associated with a newly added sector. The configuration engine **218** can reassign sectors among the remote antenna units such that sectors from each base station are transmitted by 10 remote antenna units. In some aspects, the configuration sub-system **108** can continuously monitor the DAS **100** to determine whether there are any system changes that may require a configuration change in the DAS **100**. The configuration sub-system **108** can output a notification to the computing device **220** regarding the change and solicit input authorizing a reconfiguration of the DAS **100**.

FIG. **3** is a block diagram depicting the unit **102** receiving downlink signals with frequencies in different sub-bands **301***a-d*, **302***a-c*, **303***a-b* that can be combined when using the configuration sub-system **108** to configure the DAS **100**. The input section **206** depicted in FIG. **3** includes a switch matrix **306**. In some aspects, the switch matrix **306** can include one or more analog-to-digital converters for converting analog downlink signals into digital downlink signals. The combining section **208** depicted in FIG. **3** includes a group of adders **308***a-e*. In some aspects, the adders **308***a-e* can be replaced with or augmented by other suitable combining devices. The output section **210** depicted in FIG. **3** includes a switch matrix **310**.

The configuration sub-system **108** can communicate with the switch matrix **306**. The switch matrix **306** is configured to receive downlink signals via donor inputs of the unit **102**. The processing device **212** executing the configuration engine **218** can cause the receiver **204** of the unit **102** to be tuned to possible frequency bands used by the DAS **100**. In some aspects, the processing device **212** can be communicatively coupled to the input ports of the switch matrix **306** and can directly measure the signal power of downlink signals received via the switch matrix **306**. For a unit **102** receiving analog signals via the input section **206**, the configuration sub-system **108** may include one or more analog-to-digital converters between the input ports and the processing device **212**. In other aspects, the processing device **212** can receive data from the switch matrix **306** or another component of the receiver **204** that describes or otherwise indicates the signal power of downlink signals received via the switch matrix **306**. For example, the receiver **204** may include one or more power measurement devices. The receiver **204** can use the power measurement device(s) to measure the signal power of received signals and provide data about the signal power to the processing device **212**.

The BSSIM **216** can analyze the received signal power data to detect individual channels, bandwidths, and power of each frequency channel within a given frequency band. For example, the BSSIM **216** can search for frequency bands that include downlink signals having a signal power that exceeds a user-defined threshold. The BSSIM **216** can thereby determine a respective sub-band occupied by each downlink signal.

The BSSIM **216** can also determine which downlink signals are in the same sub-band. The BSSIM **216** can also determine whether any signals are in the same band occupy the same sub-band. For example, FIG. **4** is a table depicting frequency bands and sub-bands for signals that may be received by different input ports of the unit **102**. Signals in sub-bands **301***a-d* of the frequency band **201** can be received via input ports **1-6**, signals in sub-bands **302***a-c* of the frequency band **202** can be received via input ports **7-9**, and signals in sub-bands **303***a*, **303***b* of the frequency band **203** can be received via input ports **10-11**.

In some aspects, signals with frequencies in different sub-bands may be received by multiple input ports. For example, signals in sub-band **301***a*, **301***c*, **301***d*, **302***a-c*, **303***a*, and **303***b* may be received via respective inputs **1** and **5-11**. In additional or alternative aspects, signals with frequencies in the same sub-band may be received by multiple input ports. For example, signals received via the inputs **2-4** may have frequencies in the same sub-band **301***b*. In additional or alternative aspects, signals associated with different base station sectors that have frequencies in the same sub-band may be received by different input ports. For example, signals in frequency sub-band **301***b* associated with sectors **304***a-c* may be received via respective input ports **2-4**.

FIG. **5** is a block diagram depicting the unit **102** combining sub-bands **301***a-c*, **302***a-c*, and **303***a-b* into combined signals **401-405** using the configuration sub-system **108**.

The configuration sub-system **108** can be used to identify frequency bands that have no overlapping sub-bands and can therefore be combined and processed by common circuitry. For example, downlink signals received via the inputs **7-9** have frequencies that are in different sub-bands **302***a-c* of the frequency band **202** and therefore do not overlap. The configuration sub-system **108** can determine that the downlink signals received via the inputs **7-9** have frequencies in the non-overlapping sub-bands **302***a-c*. The configuration sub-system **108** can configure the switch matrix **306** to provide the downlink signals received via the inputs **7-9** to the adder **308***d* to generate a combined signal **404**. In a similar manner, the configuration sub-system **108** can also determine that downlink signals received via the inputs **10-11** have frequencies that are in non-overlapping sub-bands **303***a*, **303***b* of the frequency band **203**. The configuration sub-system **108** can configure the switch matrix **306** to provide the downlink signals received via the inputs **10-11** to the adder **308***e* to generate a combined signal **405**.

The configuration sub-system **108** can also be used to identify frequency bands with different sectors in the same frequency sub-band. For example, the configuration sub-system **108** can determine that the downlink signals received via the inputs **1**, **5**, and **6** have frequencies in the respective, non-overlapping sub-bands **301***a*, **301***c*, **301***d* of the frequency band **201**. The configuration sub-system **108** can also determine that downlink signals received via the inputs **2-4** associated with sectors **304***a-c* have frequencies in the same sub-band **301***b* of the frequency band **201**. The configuration sub-system **108** can configure the switch matrix **306** to provide the downlink signals received via the inputs **1**, **2**, **5**, and **6** to the adder **308***a* to generate a combined signal **401**. As depicted in FIG. **5**, the combined signal **401** includes downlink signals with frequencies in sub-bands **301***a*, **301***c*, **301***d* as well as downlink signals with frequencies in sub-band **301***b* that are associated with sector **304***a*. The configuration sub-system **108** can also configure the switch matrix **306** to provide the downlink signals received via the inputs **1**, **3**, **5**, and **6** to the adder **308***b* and the downlink signals received via the inputs **1**, **4**, **5**, and **6** to the adder **308***c*. Adders **308***b*, **308***c* can respectively output combined signals **402**, **403**. As depicted in FIG. **5**, each of the combined signals **402**, **403** includes downlink signals with frequencies in sub-bands **301***a*, **301***c*, **301***d*. The combined signal **402** also includes downlink signals with frequencies in sub-band **301***b* that are associated with sector **304***b*. The combined signal **403** also includes downlink signals with frequencies in sub-band **301***b* that are associated with sector **304***c*.

In some aspects, the combining section **208** can include multipliers or other gain adjustment devices that can scale the relative levels of downlink signals included in each of the combined signals **401-405**. For example, multipliers or other gain adjustment devices can adjust the signal powers of downlink signals in different sub-bands the downlink signals are combined in one of the adders **308***a-e*. Scaling of signal levels can be defined by a user or automatically implemented according to pre-defined rules. In some aspects, the relative power level of the signals can be dependent on the number of channels in each sub-band. For example, sub-band **302***a* may have four channels, sub-band **302***b* may have six channels and sub-band **302***c* may have ten channels. The total power of all sub-bands may have a relative level of "1." The sub-band **302***a* can be scaled to have a relative power of "0.2," the sub-band **302***b* can be scaled to have a relative power of "0.3," and the sub-band **302***c* can be scaled to have a power of "0.5." In other aspects, relative signal levels can be determined based on the bandwidth of the sub-band. In other aspects, different downlink signal powers can be adjusted such that all downlink signals combined by one of the adders **308***a-e* have the same signal power.

Each of the combined signals **401-405** can be transmitted by the remote antenna units in a given coverage area serviced by the DAS **100**. For example, FIG. **6** is a block diagram depicting the unit **102** providing combined signals **401-405** generated using the configuration sub-system **108** to the coverage zones **106***a-c*. Different combined signals with frequencies in different frequency bands can be provided to the same remote antenna units for transmission in a given coverage area. For example, the unit **102** can provide the combined signals **401**, **404**, **405** (which collectively include downlink signals received via inputs **1**, **2**, and **5-11**) to the remote antenna units **104***a-f* servicing the coverage zone **106***a*. The unit **102** can also provide the combined signals **402**, **404**, **405** (which collectively include downlink signals received via inputs **1**, **3**, and **5-11**) to the remote antenna units **104***c*, **104***d* servicing the coverage zone **106***b*. The unit **102** can also provide the combined signals **403-405** (which collectively include downlink signals received via inputs **1**, **4**, and **5-11**) to the remote antenna units **104***e*, **104***f* servicing the coverage zone **106***c*.

Different downlink signals having frequencies in a common sub-band can be transmitted by a non-intersecting subset of remote antenna units **104***a-f* of a portion of a coverage area serviced by the DAS **100**. For example, a coverage area serviced by the DAS **100** can include portions such as coverage zones **106***a-c*. Each of the coverage zones **106***a-c* can be serviced by a subset of the remote antenna units **104***a-f* that does not transmit signals to other coverage zones (i.e., do not intersect the other coverage zones). For example, as depicted in FIG. **6**, the remote antenna units **104***a*, **104***b* service the coverage zone **106***a*, but do not transmit signals that can be received by communication devices in coverage zones **106***b*, **106***c*. The configuration sub-system **108** can determine that combined signals **401-403** each include downlink signals that are associated with different base station sectors **304***a-c* and that have frequencies in a common sub-band **301***b*. The configuration sub-system **108** can configure the switch matrix **310** to route each of the signals **401-403** to a different non-intersecting subset of remote antenna units **104***a-f* (i.e., to a different one of the coverage zones **106***a-c*).

In additional or alternative aspects, multiple remote antenna units may service the same coverage zone. Downlink signals in the overlapping sub-bands can be transmitted to a subset of the remote antenna units **104***a-f* of for a portion of the coverage zone. For example, downlink signals in overlapping sub-bands can be transmitted to approximately (1/number of overlapping sub-bands) of the remote antenna units **104***a-f*.

The BSSIM **216** can use any suitable process or set of processes for determining the relevant characteristics of the received downlink signals. For example, the frequency bands for downlink signals can include frequency bands used for telecommunication networks such as (but not limited to) UMTS systems, Personal Communications Service ("PCS") systems, Advanced Wireless Services ("AWS") systems, Advanced Mobile Phone System ("AMPS") systems, etc. The BSSIM **216** can determine the frequency bands used by downlink signal in any suitable manner. For example, the receiver bandwidth (e.g. 75 MHz) for the receiver **204** may be less that the total range of signal frequencies that can be processed by the DAS **100** (e.g. 400 MHz-2.7 GHz+). The configuration engine **218** can generate a control signal that is used by the processing device **212** to tune the receiver **204** to each band of interest. For each band of interest, the BSSIM **216** can determine the power in the received band via any suitable method, such as a fast Fourier transform ("FFT"), sum of squares, etc. The BSSIM **216** can determine that power in a given frequency band is greater than a programmable threshold. The BSSIM **216** can determine that downlink signals are transmitted in the frequency band based on the power exceeding the threshold.

For example, to identify signals in the AMPS band, the configuration sub-system **108** can tune the receiver **204** of the unit **102** to receive the frequencies included in the AMPS band. The BSSIM **216** can apply a filter to signals received by the receiver **204** to select signals in the AMPS band. The BSSIM **216** can measure the power in the AMPS band. The BSSIM **216** can respond to power being detected by performing a channel search function. The configuration engine **218** can respond to the absence of detected power by configuring a control device to tune the receiver **204** to another band, such as the PCS band. The configuration sub-system **108** can repeat this process for all defined bands to detect signals that are being transmitted at frequencies in any of the bands of operation. The BSSIM **216** can process the signals after identifying the frequencies of operation. The power within a frequency band can be measured at multiple frequencies in the band. For example, the power may be measured with an FFT. The BSSIM **216** can determine which portions of the band have signals greater than a programmable threshold based on the power measurements at multiple frequencies in the band.

The BSSIM **216** can also determine the center frequency of all channels contained within these sub-bands. The BSSIM **216** can access a list of possible channel bandwidths, channel frequencies, and modulation types for each band, and/or sub-bands. The BSSIM **216** can perform a search of possible channel frequencies and modulation types by applying demodulation algorithms that are capable of operating on the types of signals communicated via the DAS **100**.

The configuration engine **218** can decode each signal according to the detected signal characteristics. The configuration engine **218** can extract information for identifying an operator such as (but not limited to) a mobile country code ("MCC"), a mobile network code ("MNC"), a base station identifier, geographic coordinates obtained from a GPS device, etc. This data can be used to determine a geographic region of a country in which the DAS **100** is located. The configuration sub-system **108** can access a database or other data file to determine which operators are licensed to operate in different bands in the geographic region. For example, many countries assign licenses to specific operators to operate within a certain set of frequencies and assign certain frequency bands for specific uses. The country code decoded from one of the signals during a search process can be used by the configuration engine **218** to limit the number of additional bands and modulation types that are scanned during the search process.

Although FIGS. **2-3** and **5-6** depict the unit **102** combining signals having frequencies in non-overlapping sub-bands of the same frequency band, other implementations are possible. In some aspects, one or more of the remote antenna units **104***a-f* can combine signals from different sub-bands. In other aspects, a combination of the unit **102** and one or more of the remote antenna units **104***a-f* can combine signals from different sub-bands. In other aspects, some other device of the DAS **100** can combine signals from different sub-bands.

FIG. **7** is a diagram depicting an example of a graphical interface **702** that can be provided by the configuration sub-system **108** for configuring the DAS **100**. The graphical interface depicted in FIG. **7** includes a section **704** for displaying some or all aspects of a configuration plan in a graphical format. For example, section **704** graphically depicts the assignment of different sub-bands to different coverage zones with respect to one of the base stations connected to the DAS **100**. The graphical interface depicted in FIG. **7** also includes a section **706** for displaying some or all aspects of a configuration plan in a tabular format. For example, section **706** includes a table identifying the assignment of sub-bands to coverage zones of the DAS **100** with respect to each of the base stations connected to the DAS **100**. Each of the sections **704**, **706** can include respective controls **708**, **710** allowing a user to accept the configuration plan provided by the configuration sub-system **108** or modify the configuration plan.

In some aspects, the graphical interface **702** can be presented in a "wizard" or other configuration application executed at a computing device **220**. The configuration application can provide a step-by-step process that allows a user to configure a DAS. For example, the graphical interface **702** can present a proposed configuration plan with respect to each base station in section **704**. A user can select "Modify" to manually change the routing of sub-bands to coverage zones. Once the configuration plan is acceptable to the user, the user may click "Accept" to verify the configuration plan with respect to the displayed base station. The table in section **706** can be updated to include accepted configuration plan for the displayed base station. The configuration application can repeat this process for each base station connected to the DAS **100**.

In additional or alternative aspects, some or all of the graphical interface **702** can be presented as a notification to a user in response to detecting a change in the DAS **100**. For example, a user may be notified that a change in the signals receive by the DAS **100** has been detected or that some other aspect of the DAS configuration has been changed. The notification can be provided to the computing device **220**.

Although FIG. **7** depicts an example of a graphical interface **702** that includes sections **704**, **706** and controls **708**, **710**, any suitable graphical interface can be generated by the configuration sub-system **108** to assist in the configuration of the DAS **100**. A suitable graphical interface can present a configuration plan in any suitable format, such as the tabular and graphical formats depicted in FIG. **7** as well as any other suitable format. A suitable graphical interface can also include any controls suitable for viewing, modifying, verifying, or otherwise using the configuration plan.

In additional or alternative aspects, the configuration engine **218** can determine the routing of MIMO signals from one or more base stations to one or more of the remote antenna units **104***a-f*. For MIMO signals, multiple signals may be purposely transmitted on the same frequency and are to be transmitted in the same coverage area. For example, multiple antennas at the same radiating point or multiple antennas located close together can transmit the signals so that a mobile communication device or other user equipment can receive the multiple signals. For potential MIMO-capable signals that are operating at the same frequency, the configuration engine **218** can either directly decode or jointly decode the signals to determine which input signals are included in a MIMO set. Potential MIMO-capable signals can include signals having a modulation type that permits MIMO operation (e.g. LTE or High-Speed Downlink Packet Access ("HS-DPA")). The configuration engine **218** can distinguish MIMO downlink signal sets occupying the same spectrum from non-MIMO downlink signals occupying the same spectrum. The configuration engine **218** can determine that MIMO signals are to be transmitted to a common remote antenna unit or to a set of remote antenna units configured for MIMO operation in a given one of the coverage zones **106***a-c*. The configuration engine **218** can also determine that non-MIMO downlink signals occupying the same spectrum are to be transmitted to different remote antenna units or sets of remote antenna units servicing different coverage zones.

In additional or alternative aspects, the configuration sub-system **108** can manage the distribution of capacity for coverage zones serviced by a DAS **100**. The configuration sub-system **108** can determine the coverage zones that can be serviced by remote antenna units and other distribution units (e.g., master units and extension units) in the DAS **100**. The configuration sub-system **108** can determine the capacity provided from the base station(s) in communication with the DAS **100**. The configuration sub-system **108** can execute one or more preselected algorithms to distribute the capacity provided by the base stations to the coverage zones. The algorithms can assign capacity based on criteria such as maximizing capacity density, minimizing hand-over probability, delivering capacity density where it is needed based on traffic measurement in coverage zones or from externally supplied traffic measurement results. In some aspects, the configuration sub-system **108** can execute a capacity distribution service algorithm in the background during operation of the DAS **100** to monitor for events triggering a change in capacity distribution. The configuration sub-system **108** can execute the capacity distribution algorithm in response to changes in capacity available from base stations, the coverage zones to be serviced by the DAS **100**, the detected or measured traffic distribution, etc. The configuration sub-system **108** can assign available capacity to coverage zones using regional default settings, such as frequency bands specified for use in a given country or other geographic region. In some aspects, a graphical interface for distributing capacity can be provided to a user. The user can provide inputs to the configuration sub-system **108** via, for example, a "wizard" interface based on recommendations generated by the configuration sub-system. The configuration sub-system **108** can distribute capacity based on inputs received from a user.

The foregoing description of aspects and features of the disclosure, including illustrated examples, has been presented only for the purpose of illustration and description and is not intended to be exhaustive or to limit the disclosure to the precise forms disclosed. Numerous modifications, adaptations, and uses thereof will be apparent to those skilled in the art without departing from the scope of this disclosure. Aspects and features from each example disclosed can be combined with any other example. The illustrative examples described above are given to introduce the reader to the general subject matter discussed here and are not intended to limit the scope of the disclosed concepts.

What is claimed is:

**1**. A configuration sub-system of a distributed antenna system, the configuration sub-system comprising:
- a processing device configured to:
  - identify a plurality of signal parameters for a plurality of downlink signals received from at least one base station via a plurality of inputs of a unit in the distributed antenna system,
  - automatically determine a configuration plan for the distributed antenna system based on the plurality of signal parameters, wherein the configuration plan specifies how to combine subsets of the plurality of downlink signals for routing to a plurality of remote antenna units of the distributed antenna system,
  - identify at least one routing conflict with respect to a subset of the plurality of remote antenna units and a subset of the plurality of downlink signals;
  - determine at least one configuration change for resolving the at least one routing conflict; and
  - output the at least one configuration change with the configuration plan.

**2**. The configuration sub-system of claim **1**, wherein the plurality of signal parameters comprises at least one of:
- a respective power spectral density for each frequency band used by the distributed antenna system,
- a respective lowest frequency for each frequency band used by the distributed antenna system,
- a respective highest frequency for each frequency band used by the distributed antenna system,
- a center frequency of all frequency channels used by the distributed antenna system,
- a bandwidth of all frequency channels used by the distributed antenna system, and
- a respective modulation type for each of the plurality of downlink signals.

**3**. The configuration sub-system of claim **1**, wherein the processing device is configured to identify the plurality of signal parameters for the plurality of downlink signals by:
- for each frequency band used by the distributed antenna system:
  - configuring a receiver of the unit to receive respective signals in the frequency band, and
  - determining whether a respective power level for the respective signals in the frequency band exceeds a threshold;
- identifying at least one frequency band having a power level exceeding the threshold;
- determining a signal power distribution among frequencies in the at least one frequency band; and
- determining the plurality of signal parameters based on the signal power distribution.

**4**. The configuration sub-system of claim **1**, wherein the processing device is configured to automatically determine the configuration plan for the distributed antenna system by:

determining that the plurality of downlink signals includes a plurality of sectors from a common base station;

assigning a first sector of the plurality of sectors to a first subset of the plurality of remote antenna units servicing a first coverage zone; and

assigning a second sector of the plurality of sectors to a second subset of the plurality of remote antenna units servicing a second coverage zone, wherein the second sector is assigned to the second subset of remote antenna units based on an absence of overlap between the first and second coverage zones.

**5**. The configuration sub-system of claim **1**, wherein the processing device is configured to automatically determine the configuration plan for the distributed antenna system by:

determining that the plurality of downlink signals includes a first subset of downlink signals in a first frequency sub-band and a second subset of downlink signals in a second frequency sub-band at least partially overlapping the first frequency sub-band;

assigning the first subset of downlink signals to a first subset of the plurality of remote antenna units servicing a first coverage zone; and

assigning the second subset of downlink signals to a second subset of the plurality of remote antenna units servicing a second coverage zone, wherein the first and second subsets are assigned to the respective first and second coverage zones based on the second frequency sub-band at least partially overlapping the first frequency sub-band.

**6**. The configuration sub-system of claim **1**, wherein the processing device is configured to automatically determine the configuration plan for the distributed antenna system by:

determining that the plurality of downlink signals includes at least one subset of signals comprising multiple-input-multiple output signals; and

assigning the at least one subset of signals to a subset of the plurality of remote antenna units servicing a common coverage zone and configured for multiple-input-multiple output.

**7**. The configuration sub-system of claim **1**, wherein the processing device is further configured to identify the plurality of signal parameters and automatically determine the configuration plan in response to a change with respect to the at least one base station or the plurality of remote antenna units in communication with the unit.

**8**. The configuration sub-system of claim **1**, further comprising a data interface device configured to communicate with the at least one base station, wherein the processing device is further configured to receive information about at least one of the plurality of signal parameters via the data interface device.

**9**. A method for configuring a distributed antenna system, the method comprising:

receiving, by a unit of the distributed antenna system, a plurality of downlink signals from at least one base station;

identifying, by a processing device, a plurality of signal parameters for the plurality of downlink signals;

automatically determining, by the processing device, a configuration plan for the distributed antenna system based on the plurality of signal parameters, wherein the configuration plan specifies how to combine subsets of the plurality of downlink signals for routing to a plurality of remote antenna units of the distributed antenna system;

identifying at least one routing conflict with respect to a subset of the plurality of remote antenna units and a subset of the plurality of downlink signals;

determining at least one configuration change for resolving the at least one routing conflict; and

outputting the at least one configuration change with the configuration plan.

**10**. The method of claim **9**, wherein automatically determining the configuration plan further comprises:

determining that the plurality of downlink signals includes a first subset of downlink signals in a first frequency sub-band and a second subset of downlink signals in a second frequency sub-band at least partially overlapping the first frequency sub-band;

assigning the first subset of downlink signals to the first subset of the plurality of remote antenna units servicing the first coverage zone; and

assigning the second subset of downlink signals to the second subset of the plurality of remote antenna units servicing a second coverage zone, wherein the first and second subsets are assigned to the respective first and second coverage zones based on the second frequency sub-band at least partially overlapping the first frequency sub-band.

**11**. The method of claim **9**, wherein automatically determining the configuration plan comprises:

determining that the plurality of downlink signals includes at least one subset of signals comprising multiple-input-multiple output signals; and

assigning the at least one subset of signals to a subset of the plurality of remote antenna units servicing a common coverage zone and configured for multiple-input-multiple output.

**12**. The method of claim **9**, wherein the plurality of signal parameters comprises at least one of:

a respective power spectral density for each frequency band used by the distributed antenna system,

a respective lowest frequency for each frequency band used by the distributed antenna system,

a respective highest frequency for each frequency band used by the distributed antenna system,

a center frequency of all frequency channels used by the distributed antenna system,

a bandwidth of all frequency channels used by the distributed antenna system, and

a respective modulation type for each of the plurality of downlink signals.

**13**. The method of claim **9**, further comprising generating a graphical interface depicting the configuration plan, the graphical interface comprising at least one control for modifying the configuration plan.

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