

# PATENT OWNER'S DEMONSTRATIVES

DECEMBER 8, 2023 ORAL ARGUMENT

T-MOBILE USA, INC., PETITIONER

V.

DALI WIRELESS, PATENT OWNER

CASE No. IPR2022-01293 | US PATENT 10,334,499

Patent Owner's Demonstrative Exhibit - Not Evidence

1

*T-Mobile USA, Inc. v. Dali Wireless, Inc.*

*IPR2022-01293*

*Dali Exhibit 2020*

*Page 1 of 25*

# Roadmap

1. The '499 Patent and Background of the Invention
2. Claim Construction of “digital representations of ... radio resources”
3. Neither Wu nor Hettstedt Discloses “digital representations ... of radio resources”
4. Neither Wu nor Hettstedt Discloses “at a [first/second] point in time ... a [first/second] set of radio resources for transmission at an antenna of a first remote radio unit”

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2

# The '499 patent

(12) **United States Patent**  
**Stapleton et al.**

(10) **Patent No.:** US 10,334,499 B2  
(45) **Date of Patent:** \*Jun. 25, 2019

(54) **DISTRIBUTED ANTENNA SYSTEM**

(71) Applicant: **Dali Wireless, Inc.**, Menlo Park, CA (US)

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(73) Assignee: **Dali Wireless, Inc.**, Menlo Park, CA (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.  
This patent is subject to a terminal disclaimer.

(21) Appl. No.: 16/059,434

(22) Filed: **Aug. 9, 2018**

(65) **Prior Publication Data**  
US 2019/0110239 A1 Apr. 11, 2019

**Related U.S. Application Data**

(63) Continuation of application No. 15/223,819, filed on Jul. 29, 2016, now Pat. No. 10,080,178, which is a (Continued)

(51) **Int. Cl.**  
**H04W 24/04** (2009.01)  
**H04W 40/02** (2009.01)  
(Continued)

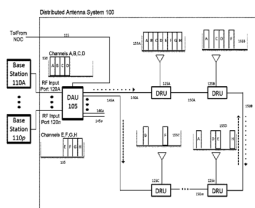
(52) **U.S. Cl.**  
CPC ..... **H04W 40/02** (2013.01); **H03F 1/3247** (2013.01); **H03F 3/24** (2013.01);  
(Continued)

(58) **Field of Classification Search**  
CPC ..... H04W 24/04; H04W 40/02; H04L 25/03; H04B 1/0475; H04B 7/022  
See application file for complete search history.

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Notification of Transmittal of The International Search Report and The Written Opinion of The International Searching Authority, or The Declaration and International Search Report and Written Opinion of The International Searching Authority for International Application No. PCT/US2011/048004 dated Jan. 5, 2012, 6 pages.  
(Continued)  
**Primary Examiner** — Wei Zhao  
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(57) **ABSTRACT**  
The present disclosure is a novel utility of a software defined radio (SDR) based Distributed Antenna System (DAS) that is field reconfigurable and support multi-modulation schemes (modulation-independent), multi-carriers, multi-frequency bands and multi-channels. The present invention enables a high degree of flexibility to manage, control, enhance, facilitate the usage and performance of a distributed wireless network such as Flexible Simulcast, automatic traffic load-balancing, network and radio resource optimization, network calibration, autonomous/assisted commissioning, carrier pooling, automatic frequency selection, frequency carrier placement, traffic monitoring, traffic tagging, pilot beacon, etc. As a result, a DAS in accordance with the present invention can increase the efficiency and traffic capacity of the operators' wireless network.

**19 Claims, 8 Drawing Sheets**



The present invention generally relates to wireless communication systems employing Distributed Antenna Systems (DAS) as part of a distributed wireless network. More specifically, the present invention relates to a DAS utilizing one or more remotely monitored and controlled digital access units configured to assign particular packet transmissions to selected ones of a plurality of remote units, which can in some embodiments be configured in a daisy-chained rings.

Ex. 1001 at 1:21-29.

Ex. 1001 ('499 Patent)

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# Background: Problem to be Solved

The '499 patent recognizes the need to meet short-term capacity needs of network subscribers at specific locations

In order to provide DAS network capacity which is high enough to meet short-term needs of network subscribers in specific locations yet also avoid costly and inefficient deployment of radio resources, DAS network planners prefer to employ DAS architectures and solutions which provide a high degree of dynamic flexibility. Therefore, it would be advantageous for wireless network operators to employ a DAS solution which has a high degree of flexibility to implement dynamic rearrangements based on ever-changing network conditions and subscriber needs. Also, the more future-proof a DAS deployment can be, generally the lower its life cycle cost.

Ex. 1001 at 1:44-55.

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# Background: The '499 Patent's Solution

The '499 patent's solution is to send digital representations of radio resources to remote radios to adjust capacity of the remote radios

monitoring module **710**. One such key function is determining and/or setting the appropriate amount of radio resources (such as RF carriers, CDMA codes or TDMA time slots) assigned to a particular DRU or group of DRUs to meet desired capacity and throughput objectives. As noted previously, the NOC **715** monitors the DAS operation and sends commands to the DAU's for configuring various functions of the DRU's as well as the DAU, in at least some embodiments.

Ex. 1001 at 4:1-8.

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# Claim Construction: “digital representations of [a first/second set of] radio resources”

What is claimed is:

1. A system for transporting wireless communications, comprising:

a baseband unit;

a plurality of signal sources, including at least a first signal source and a second signal source;

a plurality of remote units, including at least a first remote unit and a second remote unit;

wherein the baseband unit comprises a plurality of interfaces to communicatively couple the baseband unit to the plurality of signal sources;

wherein the baseband unit is configured to receive a plurality of radio resources from the first signal source and the second signal source;

wherein the baseband unit is configured to send a digital representation of a first set of radio resources to the first remote unit at a first point in time, the first set of radio resources for transmission at an antenna of the first remote unit;

wherein the baseband unit is configured to send a digital representation of a second set of radio resources to the first remote unit at a second point in time, the second set of radio resources for transmission at the antenna of the first remote unit;

wherein a number of radio resources in the first set of radio resources is different from a number of radio resources in the second set of radio resources; and

wherein the baseband unit is configured to receive digital signals from each of the plurality of remote units.

## Patent Owner's Interpretation

Information defining or describing the way data is transmitted by a remote radio unit;

Does not encompass digitized payload data

## Petitioner's Interpretation

There is no need for construction. ... If the PTAB construes the term, the PTAB should (1) adopt the plain and ordinary meaning and (2) reject PO's argument that the term states a requirement about additional 'configuration information' or 'how the DRU is configured.'

Ex. 1001 at Claim 1.

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Radio Resources includes the set: RF carriers, CDMA codes, TDMA slots.

**Radio Resources**

RF Carriers

CDMA Codes

TDMA slots

Thus, we agree with Patent Owner that “radio resources” encompass RF carriers, CDMA codes and TDMA time slots.

Institution Decision at 23.

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7

# Patent Owner's construction modifies the set {RF carriers, CDMA codes, TDMA slots} in a way that makes sense

## Patent Owner's Interpretation

**Information defining** or describing the way data is transmitted by a remote radio unit;

### Radio Resources

RF Carriers

CDMA Codes

TDMA slots



### Digital representation of radio resources

**Information defining/describing** RF Carriers

**Information defining/describing** CDMA Codes

**Information defining/describing** TDMA slots

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# Petitioner's interpretation modifies the set {RF carriers, CDMA codes, TDMA slots} in a way that doesn't make sense

## Petitioner's interpretation

There is no need for construction. ... If the PTAB construes the term, the PTAB should (1) adopt the plain and ordinary meaning and (2) reject PO's argument that the term states a requirement about additional 'configuration information' or 'how the DRU is configured.'"

### Radio Resources

RF Carriers

CDMA Codes

TDMA slots



### Digital representation of radio resources

**Digitized version of analog RF Carriers**

**Digitized version of analog CDMA Codes**

**Digitized version of analog TDMA slots**

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9

# The Board previously agreed with Patent Owner's construction

that data is being transmitted. In context, the related claim term “digital representations of radio resources” encompasses information about radio carriers, bands, codes, or other similar information for use in “transmission at the antenna” of a remote unit.

Ex. 1019 (“DECISION Denying Institution of Inter Partes Review” IPR2020-01430) at 11

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10

# Patent Owner's construction is consistent with the specification

DRU **125B** is fed by a second optical port of DRU **125A** via bidirectional optical cable **150A**. The optical cable **150A** performs the function of daisy chaining DRU **125A** with DRU**12513**. As with DRU **125A**, the software settings within DRU **125B** are configured either manually or automatically such that Carriers A, C, D and F are present in downlink output signal **155E** at the antenna port of DRU **1258**. The capacity of DRU **125B** is set to a much lower value than DRU **125A** by virtue of its specific channel settings as controlled by DAU **105**. The individual Digital Remote Units have integrated frequency selective DUCs and DDCs with gain control for each carrier. The DAU's can remotely turn on and off the individual carriers via the gain control parameters.

Ex. 1001 at 6:31-44.

POR at 15-17.

analogous to software programmability. The DAU detects which carriers and corresponding time slots are active. This information is relayed to the individual DRUs via the management control and monitoring protocol software. This information is then used, as appropriate, by the DRUs for turning off and on individual carriers and their corresponding time slots.

Ex. 1001 at 7:44-50.

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11

# Patent Owner's construction is consistent with the specification

station. In addition, those skilled in the art will recognize that a DAU is monitored and controlled by a remote network operations center (“NOC”), as indicated at bidirectional link **115** in FIG. 1. Such links are typically Ethernet connections or external modems, but can be any form of link suitable for remote monitoring and control. The NOC has the capability to remotely configure the DAU parameter settings which in turn configures the DRU's parameter settings. The NOC can request information from the DAUs. The DAUs can subsequently request information from the DRUs. The information requested includes but is not limited to uplink power, downlink power, optical error rate, gain settings, active carriers, etc.

Ex. 1001 at 4:50-62.

POR at 15-17.

The DAU Monitoring module, in addition to other functions, detects which carriers and corresponding time slots are active for each DRU. The DAU Management Control module communicates with the DRU Embedded Software Control module **720** over a fiber optic link control channel via a control protocol. In an embodiment, the control protocol comprises headers together with packets of data, such that both control information and data are transmitted to the DRU's together as a message. DRU functions or features that the header would control in the DRU are typically implementation specific and can include, among other things, measuring uplink and downlink power, measuring gain of uplink and downlink, and monitoring alarms in the DRU.

In turn, the DRU Management Control module **725** within the DRU Embedded Software Control Module sets the individual parameters of all the DRU Digital Up-Converters **730** to enable or disable specific radio resources from being transmitted by a particular DRU or group of DRUs, and also sets the individual parameters of all the DRU Digital Down-Converters **735** to enable or disable specific radio resources from being transmitted by a particular DRU or group of DRUs. In addition, the DRU Embedded Software Control Module comprises a DRU Pilot Beacon Control Module **740**, which communicates with a DRU Pilot Beacon **745**.

Ex. 1001 at 12:15-39.

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12

# Patent Owner's construction is consistent with the specification

Control function 715. If that occurs, the DAU Management Control module can adaptively modify the system configuration to begin to deploy, typically although not necessarily slowly, additional radio resources (such as RF carriers, CDMA codes or TDMA time slots) for use by a particular DRU which need those radio resources within its coverage area. At the same time, usually the DAU Management Control module adaptively modifies the system configuration to begin to remove, again typically slowly, certain radio resources (such as RF carriers, CDMA codes or TDMA time slots) for use by a particular DRU where that DRU no longer needs those radio resources within its coverage area.

Ex. 1001 at 12:58-13:2.

in FIG. 1 as DRU 125C. The software settings within DRU 125<sub>n</sub> are configured either manually or automatically such that carriers A, D, E and H are present in downlink output signal 155D at the antenna port of DRU 125<sub>n</sub>. Typically, the capacity of DRU 125<sub>n</sub> is set to a much lower value than DRU 125A, however, the relative capacity settings of each of DRU's 125A-n can be adjusted dynamically to meet the capacity needs within the coverage zones determined by the physical positions of antennas connected to those DRU's. As noted above, the ring connection is completed by interconnecting DRU 125B and DRU 125<sub>n</sub> through optical cable 150B. The ring configuration insures that any optical cable breaks will not shut down the daisy chained network. The downlink and uplink signals will be rerouted around the cable break to the respective DRUs.

Ex. 1001 at 6:55-7:2.

POR at 16, 31.

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13

# Patent Owner's construction is consistent with the specification

## Patent Owner's Construction

Embodiment in 6:31-44

Embodiment in 7:44-50

Embodiment in 4:50-62

Embodiment in 12:15-39

Embodiment in 12:58-13:2

Embodiment in 6:55-7:2

POR at 15-17, 31.

## Pet's support for its position

Disclosure in 4:63-5:6

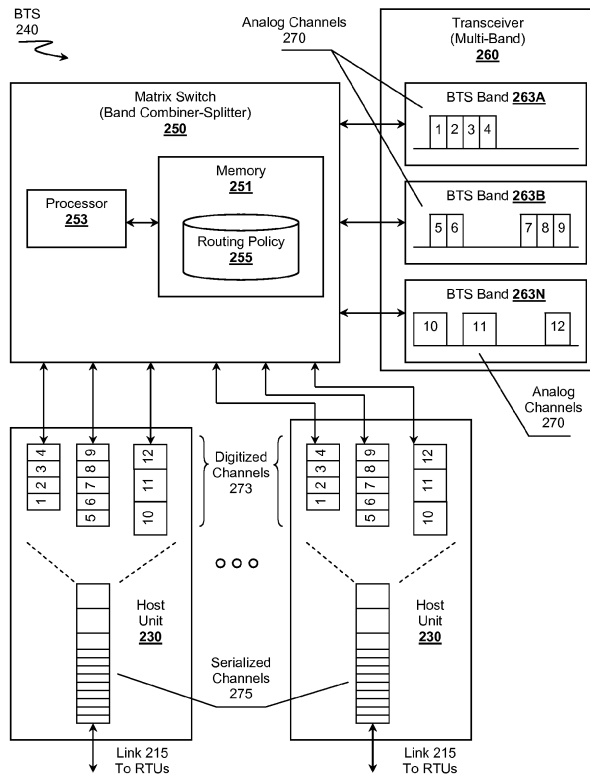
Pet.'s Reply at 2-3

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14



# Wu does not disclose “digital representations of ... radio resources”

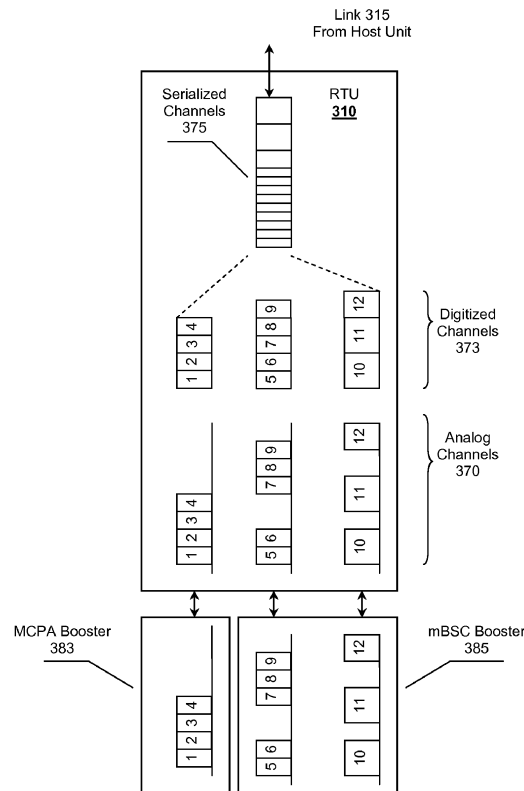


- Petitioner maps Wu’s downlink carrier channel signals to “digital representations of radio resources.” Pet. at 34-35.
- The downlink channel signals are merely digitized payload data that do not define or describe how the RTU should be configured to transmit RF signals, e.g., carriers or time slots. POR at 32-34.

Ex. 1005 at FIG. 2

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# Wu's RTUs are never taught to receive information defining or describing the way data should be transmitted



Ex. 1005 at FIG. 3

[0050] In FIG. 3, RTU 310 receives serialized channels 375 from a host unit over link 315. RTU 310 employs a reverse process as taken by host units with respect standards for exchanging data on carrier channels (e.g., CPRI, OBSAI, etc . . . ). RTU 310 de-serializes serialized channels 375 to obtain digitized channels 373. Digitized channels can be converted back into analog channels 370 using suitable Digital to Analog Converters (DAC). Channels 370 can then be distributed to one or more boosters for re-transmission as represented by MCPA booster 383 or mBSC booster 385. Suitable boosters include those produced by Bravo Tech Inc, of Cypress Calif. For example, the Bravo Tech Multi-Channel Power Amplifier (MCPA) series of products or Bravo Tech Multi-Band, multi-Standard & multi-Carrier (mBSC) systems can be deployed in the contemplated environments, including indoor or outdoor environments. The channels 370 can be allocated to the boosters as desired: one band per booster, two bands per booster, etc.

Ex. 1005 at [0050]

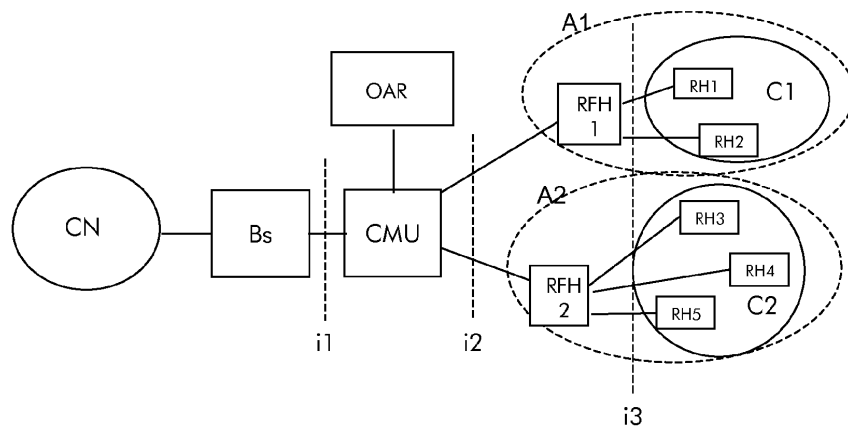
Patent Owner's Demonstrative Exhibit - Not Evidence

## Wu fails to disclose “digital representations of radio resources”

- Petitioner argues that the output of an analog-to-digital converter is “representative” of the analog inputs. Pet.’s Reply at 7.
- Digitized representations of analog input does not define or describe the way data is transmitted by a remote radio. POR at 32-34.
- Digitized representations of analog input are deserialized and upconverted, without ever providing any definition or description to the remote radio unit about how that data is to be transmitted.  
*Id.*

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## Hettstedt does not disclose “digital representations of radio resources”



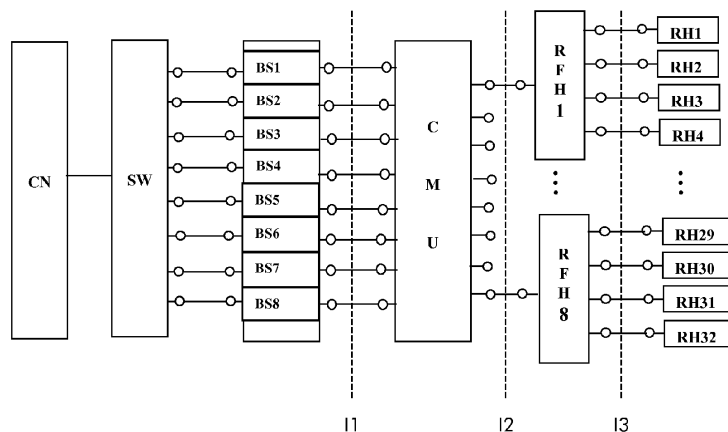
Ex. 1006 at FIG. 3.

[0040] In the downlink direction, communications core network signals intended for the mobile station inside the indoor environment, e.g. a building or a tunnel, are received by the base station Bs. Said signals are then passed in digital form through a first connection interface i1, e.g. an electrical or optical connection using Ethernet protocol or of other standards (e.g. OBSAI or CPRI), to the cell management unit CMU. The cell management unit CMU performs data packaging in downlink and forwards said digital packets through a second digital connection interface i2, e.g. an electrical or optical connection using Ethernet protocol, to the RF Hubs RFH1 and RFH2, which in turn pass the packets through a third connection interface i3, e.g. an electrical or optical connection using Ethernet protocol, to the remote radio heads RH1 to RH5.

Ex. 1006 at [0040].

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# Hettstedt teaches sending packaged data from the CMU to its radio heads using MAC



Ex. 1006 at FIG. 5

FIG. 5.

[0053] FIG. 5 shows an example of carrier distribution according to the wireless cellular indoor communications method of the invention considering four carriers per remote radio head RH-1 to RH-N. The base station Bs provides the M carriers Ca1 to CaM to the cell management unit CMU which in turn distributes it between the at least one RF Hub RFH 1 to X of the next stage. The one or more RF Hubs distribute carriers 1 to 4 to a first remote radio head RH-1 according to medium access control (MAC) addresses MA1 to MA4 in the Ethernet packets, carriers 5 to 8 to a second remote radio head RH-2 according to MAC addresses 5 to 8, and carriers M-3 to M to an N remote radio head RH-N according to MAC addresses M-3 to M, where  $M=N \times 4$ .

Ex. 1006 at [0053].

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## Packaged payload data does not satisfy information defining or describing the way data is transmitted

- Petitioner's expert stated that Hettstedt's packaged data are carriers impregnated with underlying payload data. Ex. 1003 at para 202.
- Carriers impregnated with payload data do not define or describe the way data is transmitted by the remote. POR at 54-59.
- Carriers impregnated with payload data are depacketized and upconverted without ever providing any definition or description to the remote radio unit about how that data is to be transmitted. *Id.*

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20



# Hettsted's radio heads are not reconfigurable and have no need or use for information defining or describing the way data is transmitted by an antenna

**[0042]** The base station is a conventional base station without radio equipment. The cell management unit CMU provides transparent operation of the radio heads RH1 to RH5 from the base station and comprises standard digital interfaces to the base station Bs and to the off-air repeater OAR, at least one Ethernet interface to connect the RF Hubs RFH1 and RFH2, an intelligent switching unit for data distribution and cell organization configurable in size and functionality according to system dimensions, a complex matrix function to combine different base stations with a number of RF hubs, multi-service and multi-operator functionality for full transparency, flexible cell management for static cell configurations, automatic cell management for adaptive cell configurations.

Ex. 1006 at FIG. 3.

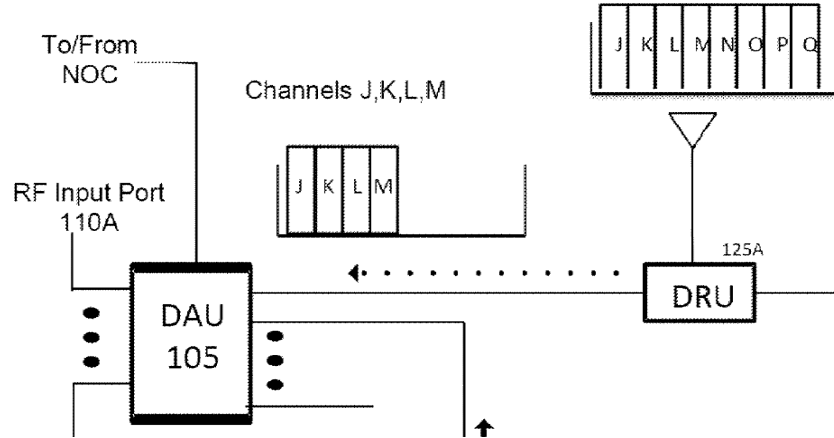
**[0044]** means for supporting efficient load balancing at and between base stations through adaptive cell reconfiguration, especially through the shifting of un-used carriers from radio heads inside areas of low traffic load to radio heads inside areas of high traffic load, e.g. means for individual load identification for each carrier on each of the radio heads by air interface activity detection and interference sensing. Air interface activity detection thereby is realized on the basis of the individually supported air interface protocols; means for de-activation of un-used carriers per radio head on an individual basis; means for shifting carriers from radio heads, where these carriers are not used for radio heads with high load on their active carriers, means for activation of the shifted carriers at locations (radio heads) of high loading. The cell management unit mechanism of adaptive cell reconfiguration thereby will neither require any changes to the load balancing mechanisms at or between the access nodes (e.g. BTS, Node-B, WiMAX base station) nor any dedicated messaging between access nodes and CMU for supporting load balancing.

Ex. 1006 at [0044].

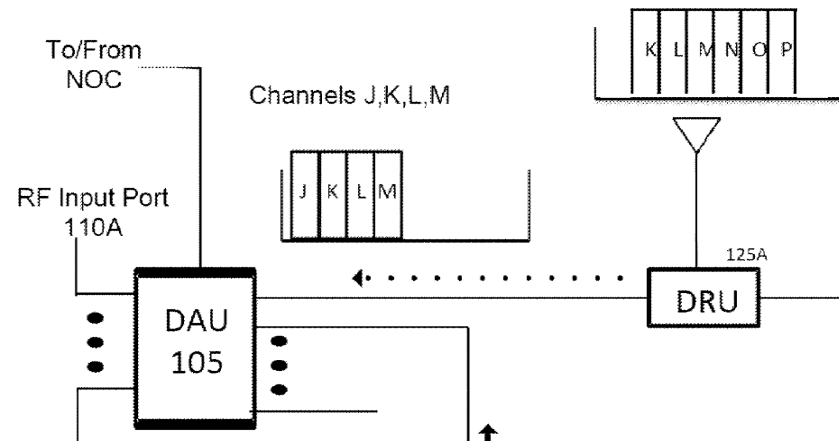
Patent Owner's Demonstrative Exhibit - Not Evidence

# Claim term: “at a [first/second] point in time ... a [first/second] set of radio resources for transmission at an antenna of a first remote radio unit”

First point in time: First set of radio resources “J, K, L, M, N, O, P, Q”



Second point in time: Second set of radio resources “K, L, M, N, O, P”



Ex. 1001 at FIG. 1 (modified)

The first set of radio resources is **different from** the second set of radio resources

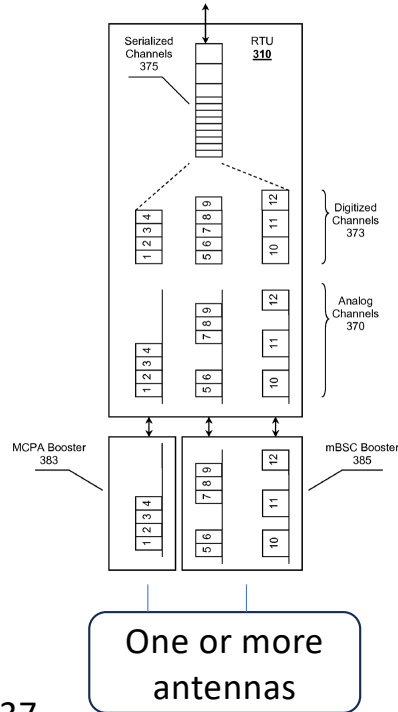
POR at 35-36.

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22

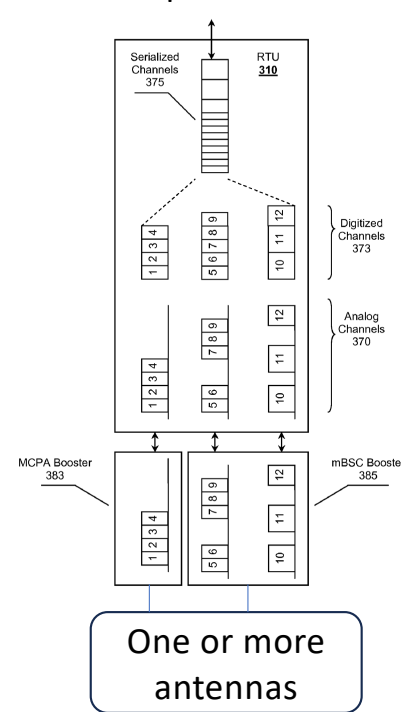
# Wu does not disclose that the same one or more antennas get different sets of radio resources

First point in time: "1-12"



The set of channel carrier signals is **the same** between first and second points in time

Second point in time: "1-12"



POR at 35-37.  
POPR at 39.

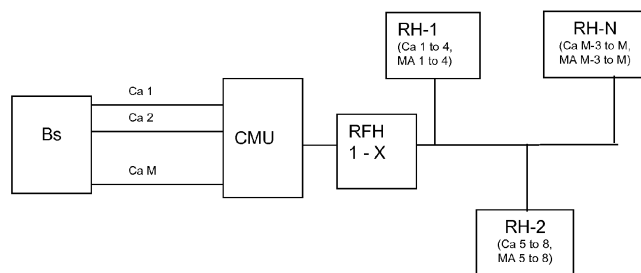
Ex. 1005 at FIG. 3  
(annotated)

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# Hettstedt does not disclose that the same one or more antennas get differing sets of radio resources

First point in time:

Figure 5

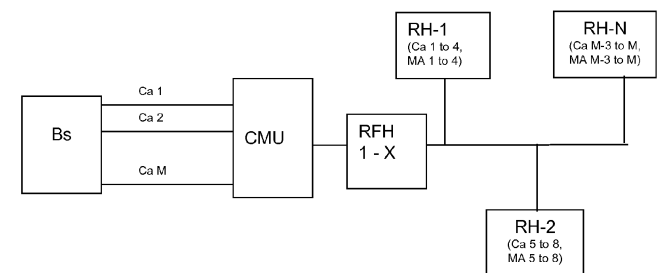


Ex. 1006 at FIG. 5

The first and second sets of carriers are **the same** between first and second points in time

Second point in time:

Figure 5



Ex. 1006 at FIG. 5

POR at 59-61.  
POPR at 51-52.

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# FOLIO LAW GROUP PLLC

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25

*T-Mobile USA, Inc. v. Dali Wireless, Inc.*

*IPR2022-01293*

*Dali Exhibit 2020*

*Page 25 of 25*