

TRANSMITTING AND RECEIVING STATION COMPRISING A DISTRIBUTED RADIO HEAD

The invention relates to a transmission and reception station
5 comprising a distributed radio head and applies notably to the field of
wireless telecommunications.

The current wireless telecommunication systems are based on
transmission and reception stations enabling user terminals to access the
10 services offered to them by one or more operators.

Some systems, like WiFi, do not manage the mobility of the user
terminals. The transmission and reception stations used allow access to the
services within an area corresponding to the coverage area of the station or
stations deployed.

15 Other systems manage the mobility of the user terminals in order
to ensure continuity of service despite any movements of these users. Such
is the case notably with the second, third and fourth generation mobile radio
systems. One example of second generation system is the GSM system,
GSM being the acronym for "Global System for Mobile communications". An
20 example of third generation system is the UMTS system, UMTS being the
acronym for "Universal Mobile Telecommunication system". An example of
fourth generation is the LTE system, LTE being the acronym for "Long Term
Evolution". The transmission and reception stations of the GSM system are
called base station and are designated by the acronym BTS, standing for
25 "Base Transceiver Station". The transmission and reception stations of the
UMTS system are called NodeB and those of the LTE system are called
eNodeB. Hereinafter in the description, the term "station" designates a
transmission and reception station.

To ensure continuity of service, it is then necessary, for the
30 implementation of a mobile radio system, to deploy enough stations to cover
all of the area targeted by the operator of the system. Furthermore, in areas

of high population density such as urban areas, the number of stations will have to be all the greater because the radio resources to be shared between the users are limited.

The current architectures of the radio access networks are evolving toward architectures comprising stations combining an ever-increasing number of functions. Such a station combines, for example, radio frequency processing operations such as filtering and base band conversion but also digital processing operations such as channel coding and encryption. Such is the case notably with the BTS, nodeB and eNodeB stations used respectively in the GSM, UMTS and LTE technologies.

In UMTS, the NodeB acts as gateway with a second equipment item of the radio access network called RNC, which stands for "Radio Network Controller".

More recently, the LTE standard defines an access network architecture made up of a single type of element called eNodeB. Most of the functions traditionally implemented by the RNC are distributed between the eNodeB and the system core network. The LTE access network is therefore made up solely of eNodeB. The aim of these trends is to simplify the architecture of the radio access network and to simplify the deployment of the radio access network.

This approach does however present a number of drawbacks. The stations are very costly, so the operators are interested in reducing their number in order to generate enough income. Thus the area covered by a station has to be as wide as possible. Hereinafter in the description, this area is called coverage area. Minimizing the number of stations involves relatively high transmission and reception power levels. These levels are necessary in order for all the user terminals present in this area to be able to access the system. The power densities are therefore high in the areas covered by these systems and the population worries about the impact of these power densities on the health of living beings. Furthermore, these stations are usually large. Their visibility is a source of problems in their installation

because these stations are becoming less and less accepted by the population, notably because of their size and therefore their visibility.

Moreover, because of the high transmission powers, the energy consumption is significant. This means it is difficult to use solar energy by using a panel located at the station. In practice, the current power yield of the stations is generally contained by the power amplifier(s) used and by the computation processors.

Another solution is to use WiFi terminals or "Set-top boxes" installed in the subscribers' homes and use them as a radio access point. The energy billing for the operator is in this case effectively reduced but to the detriment of that of the subscriber. Furthermore, the subscriber is subject to significant and permanent electromagnetic radiation in his or her home because of the shared use of his or her equipment. Furthermore, in this type of solution, radio coverage outside the buildings in which the set top boxes are located is made difficult because of the penetration losses due to the walls.

One aim of the invention is notably to mitigate the abovementioned drawbacks.

To this end, subjects of the invention are a wireless transmission and reception station comprising a distributed radio head enabling user terminals present in a geographic area covered by said station to access the services offered by a wireless telecommunication system. Said radio head is composed of distribution frame equipment, a plurality of distributed access points distributed in the coverage area and communication means between the distribution frame equipment and the distributed access points. The distribution frame comprises means for transmitting samples of a base band signal to be transmitted in the coverage area to all the distributed access points. The distributed access points comprise radio frequency processing means making it possible to transpose said signal to a carrier frequency

before transmitting it in the form of radio waves to the user terminals present in the coverage area.

According to one aspect of the invention, the distributed access points comprise means for transposing into base band radio signals received from user terminals before transmitting them to the distribution frame equipment.

The distribution frame equipment comprises, for example, means for combining the signals from the radio access points.

In one embodiment, the distribution frame equipment combines the signals from the distributed access points by a weighted sum.

The result of the weighted sum is, for example, used to do the digital antenna beam forming.

According to another aspect of the invention, the communication means between the distribution frame equipment and the distributed access points correspond to optical links of CPRI type.

The distribution frame equipment is, for example, linked to each distributed access point by optical fibers of identical lengths so as to avoid generating a spread of delays of the signals transmitted and received by said distribution frame equipment.

The communication means between the distribution frame equipment and the distributed access points correspond, for example, to wired links or dedicated radio links.

In one embodiment, a distributed access point is off when no user terminal is detected in proximity.

As an example, a distributed access point that is off wakes up periodically in order to verify whether a user terminal is located in proximity, the presence of a user terminal being verified when the received power level is greater than a predefined threshold value.

The position of a user terminal is, for example, estimated by triangulation performed on the basis of a plurality of signals received by

different distributed access points, said estimation being implemented at the distribution frame.

The system is, for example, adapted for one or more of the following technologies: GSM, UMTS, LTE.

5 Another subject of the invention is a distributed radio head enabling user terminals to access the services offered by a wireless telecommunication system, said radio head being composed of distribution frame equipment, a plurality of distributed access points distributed in a coverage area and communication means between the distribution frame
10 equipment and the distributed access points, the distribution frame equipment comprising means for transmitting a signal to be transmitted in the coverage area to all the distributed access points, said distributed access points comprising radio frequency processing means making it possible to transpose said signal to a carrier frequency before transmitting it in the form
15 of radio waves to the user terminals present in the coverage area.

According to one aspect of the invention, the distributed access points comprise means for transposing into base band radio signals received from user terminals before transmitting them to the distribution frame equipment.

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Other features and advantages of the invention will become apparent from the following description which is given as an illustrative and non-limiting example, in light of the attached drawings in which:

- 25 - figures 1a and 1b give two examples of transmission and reception station architecture;
- figure 2 shows an example of a wireless telecommunication system using a station with distributed radio head;
- figure 3 gives an example of an architecture in which the
30 distributed radio heads can be implemented;

- figure 4 shows a simplified example of an architecture that can be used for distribution frame equipment;
- figure 5 shows an example of distributed access point architecture.

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Figures 1a and 1b give two examples of the transmission and reception station architecture.

The manufacturers of transmission and reception stations seek to establish architecture standards, for example in the framework of consortiums such as the OBSAI, which stands for “Open Base Station Architecture Initiative”. The objective of these standards is to reduce the infrastructure costs borne by the telecommunications operators. For this, the base station is made up of a plurality of standardized and therefore compatible modules. An operator can therefore make up his own stations from modules originating from different manufacturers.

For the same reasons, the standardization of an interface protocol between the different modules that make up a station is also of interest. The CPRI interface, CPRI standing for “Common Public Radio Interface”, is one example of this.

Recent stations are composed of one or more radio heads 101, 102, 104, 105, 106 and a control equipment item 100, 103. The CPRI interface is an example of standardized interface making it possible to easily link the elements that make up the station together. In this standard, the radio heads are designated by the acronym RE standing for “Radio Equipment” and the control equipment items are designated by the acronym REC, standing for “Radio Equipment Control”.

Figure 1a gives a first example of a base station composed of a plurality of modules linked together using a standardized interface. In this example, a control equipment item 100 is linked to a first radio head 101 by using a standardized link 107. Said radio head 101 is then also linked to a second radio head 102 using a second standardized link 108. The

standardized links are, for example CPRI links. The links of CPRI type make it possible to construct a distributed station architecture in which a radio control equipment item is linked remotely to one or more radio heads via fiber optic links for example. The use of standardized links has the effect of
5 reducing the costs for the service providers. In practice, the radio heads often have to be positioned in places that are difficult to access whereas the control equipment, notably consisting of digital processors, can be positioned in more easily accessible remote areas. For a given station the different radio heads RE are assigned some of the radio resources that can be used by the
10 system. In order to reduce the interferences, the radio heads covering parts of the area covered by the station to which they belong use distinct radio resources. The example figure 1a shows an architecture in which the radio heads are linked in series. The CPRI links are given as example, but are nonlimiting example, other types of standardized links being able to be
15 implemented in the scope of the invention.

Figure 1b gives a second example of a base station composed of a plurality of modules linked together using a standardized interface. In this example, a control equipment item 103 is linked to a first radio head 104 by using a standardized link 109. This radio head 104 is also linked to two other
20 radio heads 105, 106 by using two standardized links 110, 111. These standardized links 109, 109, 110, 111 are, for example, CPRI links. It appears that the radio heads can be connected together by a series, parallel or even hybrid network.

25 Figure 2 shows an example of a wireless telecommunication system using a station with a distributed radio head.

In this example, a mobile radio system is considered, but the invention can be applied to a wireless telecommunication system that does not manage the mobility of the user terminals.

30 Five cells 200, 201, 202, 203, 204 make it possible to cover an area defined in the deployment phase of the system, the radio resources of

the system being distributed between said cells. Depending on the technology used, these resources may be frequency-domain resources, time-domain resources and/or multiple access codes.

For a given cell, one or more radio heads of the same type as those described with the help of figures 1a and 1b can be used, a subset of radio resource being allocated for each of these radio heads. These radio heads are called conventional radio heads. Thus, in a first cell 200, four conventional radio heads 210, 211, 212, 213 are used. In a second cell 201, four conventional radio heads 213, 214, 215, 216, one conventional radio head 213 being used both for the first cell 200 and for the second cell 201. In a third cell 202, a conventional radio head 217 is used. In a fourth cell 203, a conventional radio head 218 is used. The fifth cell 204 of the system is covered by a distributed radio head. A distributed radio head differs from a conventional radio head. It is composed of distribution frame equipment 209 and a plurality of distributed access points PAD 205, 206, 207, 208, said distributed access points being distributed in such a way as to cover all of the cell 204. The distribution frame equipment 209 communicates with the distributed access points by using base band digitized signals. This makes it possible to gain band width and safe guard the signal from disturbances.

In order to communicate with a core network and/or with an external network, the stations are connected either directly or indirectly to a control equipment item 218.

Figure 3 gives an example of architecture in which distributed radio heads can be implemented.

The system comprises at least one control equipment item 300. This equipment item 300 can be linked to one or more radio heads 301, 302. A control equipment item 300 can also be linked to one or more distributed radio heads 303. As mentioned previously, a distributed radio head is composed of an equipment item called distribution frame 304 and one or more distributed access points PAD 308, 309, 310, 311, 312. A control

equipment item 300 can be linked to distribution frame equipment belonging to a distributed radio head and/or to conventional radio heads 301, 302 by using, for example, a standardized interface. This standardized interface can be an optical link of CPRI type, a wired link or a dedicated radio link. The
5 conventional radio heads 301, 302 and the distributed radio heads 303 receive and transmit data to user terminals 305, 306, 307 by using radio resources that are allocated to them. Depending on the radio technology implemented, these radio resources may correspond to a set of carrier frequencies, a set of CDMA codes and/or a set of time slots.

10 In other words, when a conventional radio head 301, 302 is used to cover a given geographic area, the radio resources that are available to it are used by the user terminals 305, 306, 307 present in this area by virtue of an access point located at said radio head. A conventional radio head comprises an antenna or a plurality of antennas co-located to form an
15 antenna array when multi-antenna technologies are used.

When a distributed radio head 303 is used, the same radio resources are used over all of the area covered by this. The distributed access points PAD 308, 309, 310, 311, 312 are distributed geographically in this area in such a way that a user terminal always has proximity to a PAD.
20 The geographic distribution of the PADs notably has the advantage that the power emitted by these equipment items is reduced because of the proximity of the user terminals. The manner in which the access points are distributed forms part of the general knowledge of a radio engineer establishing link budgets. Because of the proximity of the user terminals and of the distributed
25 access points PAD, the dimension of the antennas used can be minimized. Advantageously, the reduced size of these distributed access points PAD allows for a discrete installation that is harmoniously integrated in the environment, which facilitates relations with the population during their installation. Since the power of the transmitter is low, the power efficiency of
30 the power amplifiers is improved. Advantageously, no cooling device is

required and a power supply to the distributed access points PAD by using a solar panel can be envisaged.

Another advantage is that the signals will be less distorted because the phenomenon of temporal spreading of the signals that is well known to those skilled in the art is limited. In fact, because the distributed access points RP 308, 309, 310, 311, 312 are distributed over all of the coverage area, the probability for a user terminal to be in direct visibility with the antenna of a distributed access point is improved compared to systems based only on conventional radio heads comprising a single radio access point. The lowering of the bit rate offered to the users at the cell border is a phenomenon that is well known due to the reduced power density. This lowering will here be reduced because the power density is virtually uniform over the entire cell thanks to the distributed nature of the PADs.

In the fourth generation systems like LTE, the use of relays is provided to combat the effects of the areas of shadow and improve the bit rate available at the cell border. A relay receives the signals from the different channels of a cell, amplifies them and retransmits them. These transmissions may suffer from problems of glare and of degradation because of the noise factor. In a system implementing distributed radio heads, the area of shadow will be covered by a PAD linked to the distribution frame by a dedicated link, for example of fiber type.

Solutions belonging to the prior art propose implementing pico-cells, that is to say conventional radio heads covering coverage areas of small sizes. In this type of solution, the user terminals are also as close as possible to the pico-cells. However, pico-cells positioned side by side use radio resources that are specific to them. These resources are potentially different from those allocated to their neighbors. The consequence is that the mobility of the user terminals moving from one from one pico-cell to another has to be managed. It is therefore necessary to put in place means to ensure

the continuity of the communications during these movements, this continuity usually being implemented using so-called "handover" techniques.

In the system illustrated by figure 3, the same radio resources are
5 used over all of the area covered by a distributed radio head by using N distributed access points PAD. There is therefore no need to put in place these "handover" techniques when a user terminal is moving around within the area covered by a distributed radio head.

In a preferred embodiment, a distributed access point PAD is off
10 when no user terminal is detected in proximity. As an example, a distributed access point that is off can wake up periodically in order to verify whether a user terminal is located in proximity. For this, it can verify the received power level in the frequency band of the system and compare it to a threshold value. A distributed access point PAD wakes up, for example, every P
15 seconds for a period of 20 ms.

Once installed, the distributed access points PAD have a known position. Because of their proximity, a terminal is often in radio visibility with a plurality of radio access points. This radio visibility is reflected in the
20 existence of direct paths. Thus, the position of a terminal can be estimated by triangulation performed on the basis of a plurality of signals received by different distributed access points. Alternatively, the position of a terminal can be estimated by using identifiers ID allocated to each of the distributed access points PAD, the knowledge of the identifier(s) ID of the PAD(s) with
25 which a terminal communicates allowing for this estimation.

Such a position estimation can be implemented at the distribution frame.

Figure 4 shows a simplified example of an architecture that can be
30 used for distribution frame equipment.

In this example, the distribution frame equipment comprises means for connecting to one or more distributed access points PAD. These means correspond, for example, to input ports 400, 401, 402, 403 to which a data management module 404 is linked. The function of this module is to
 5 format and synchronize the data received on the ports 400, 401, 402, 403 and the data to be transmitted on these same ports.

Each port 400, 401, 402, 403 is, for example, linked to a distributed access point PAD by optical fibers of identical lengths so as to avoid generating a spread in the delays of the signals transmitted and
 10 received by the distribution frame equipment. This link makes it possible to transmit the digital samples of a signal in base band.

The equipment also comprises a digital signal processing module 405. The main function of this is to combine the digitized signals received from the different input/output ports 400, 401, 402, 403 by using a simple
 15 weighted sum given by the following expression:

$$y[k] = \sum_{i=1}^M \alpha_i \times x_i[k]$$

in which:

$x_i[k]$ represent the kth sample of the signal received on the ith port;

20 α_i represents the weighting factor applied to the signal received by the ith port;

$y[k]$ represents the signal that is the result of the weighted sum.

M represents the total number of input/output ports used and therefore of signals originating from the distributed access point PAD.

25 The signal processing module also comprises, for example, channel coding and decoding, source coding and decoding and anti-interference filtering and processing functions. The choice of the functions to be implemented depends on the transmission technology used. The system

according to the invention can be implemented, for example, for UMTS or LTE.

The distribution frame equipment also comprises means for connecting one or more control equipment items. These means correspond
5 to management means of an interface, for example of CPRI optical type. Thus, the equipment comprises an optical input and output port 407 followed by a first data management module 406. The aim of this module is to format the packets received and to send over the optical interface. It combines functions corresponding to layers 1 and 2 of the "Open Systems
10 Interconnection" OSI reference model.

Figure 5 shows an example of distributed access point architecture. A distributed access point RP comprises an input and output port 500 and a data management module 501 making it possible to manage
15 the sending and the receiving of digital data from the distributed access point PAD to the distribution frame equipment via an interface 505, for example optical. The aim of the module 501 is to format the packets received and the packets to be sent over the optical interface. It combines, for example, functions corresponding to layers 1 and 2 of the OSI reference model.

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A digital signal processing module 502 can be used to implement one or more digital filters. A conversion module 503 is used and comprises an analog-digital converter ADC and a digital-analog converter DAC so as to perform the requisite conversions of the signals received and of the signals
25 to be transmitted from the access point RP to the user terminals. A radio frequency module 504 is then used notably for the base band conversion of the analog signals originating from the user terminals and the transposition to carrier frequency of the signals to be transmitted to said terminals.

In an alternative embodiment, the distributed access points do not comprise a conversion module, the signals being exchanged in analog form between these two equipment items.

CLAIMS

- 1- A wireless transmission and reception station comprising a distributed radio head (303) enabling user terminals (305, 306, 307) present in a geographic area covered by said station to access the services offered by a wireless telecommunication system, said radio head (303) being composed of distribution frame equipment (209, 304), a plurality of distributed access points (205, 206, 207, 208, 308, 309, 310, 311, 312) distributed in the coverage area and communication means between the distribution frame equipment and the distributed access points, the distribution frame (209) comprising means for transmitting samples of a base band signal to be transmitted in the coverage area to all the distributed access points, said distributed access points comprising radio frequency processing means making it possible to transpose said signal to a carrier frequency before transmission in the form of radio waves to the user terminals (305, 306, 307) present in the coverage area.
- 2- The transmission and reception station as claimed in claim 1, in which the distributed access points comprise means for transposing into base band radio signals received from user terminals (305, 306, 307) before transmitting them to the distribution frame equipment (209, 304).
- 3- The transmission and reception station as claimed in claim 2, in which the distribution frame equipment (209, 304) comprises means for combining the signals from radio access points.
- 4- Transmission and reception station as claimed in claim 3, in which the distribution frame equipment (209, 304) combines the signals from

distributed access points (205, 206, 207, 208, 308, 309, 310, 311, 312) by a weighted sum.

5 5- The transmission and reception station as claimed in claim 4, in which the result of the weighted sum is used to do the digital antenna beam forming.

10 6- The transmission and reception station as claimed in one of the preceding claims, in which the communication means between the distribution frame equipment (209, 304) and the distributed access points (205, 206, 207, 208, 308, 309, 310, 311, 312) correspond to optical links of CPRI type.

15 7- The transmission and reception station as claimed in claim 6, in which the distribution frame equipment (209, 304) is linked to each distributed access point (205, 206, 207, 208, 308, 309, 310, 311, 312) by optical fibers of identical lengths so as to avoid generating a spread of delays of the signals transmitted and received by said distribution frame equipment.

20 8- The transmission and reception station as claimed in one of the preceding claims, in which the communication means between the distribution frame equipment (209, 304) and the distributed access points (205, 206, 207, 208, 308, 309, 310, 311, 312) correspond to
25 wired links or dedicated radio links.

30 9- The transmission and reception station as claimed in one of the preceding claims, in which a distributed access point (205, 206, 207, 208, 308, 309, 310, 311, 312) is off when no user terminal is detected in proximity.

10- The transmission and reception station as claimed in claim 9, in which a distributed access point (205, 206, 207, 208, 308, 309, 310, 311,

312) that is off wakes up periodically in order to verify whether the user terminal is located in proximity, the presence of a user terminal being verified when the received power level is greater than a predefined threshold value.

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11- The transmission and reception station as claimed in one of the preceding claims, in which the position of a user terminal (305, 306, 307) is estimated by triangulation performed on the basis of a plurality of signals received by different distributed access points, said
10 estimation being implemented at the distribution frame.

12- The transmission and reception station as claimed in one of the preceding claims, adapted for one or more of the following technologies: GSM, UMTS, LTE.

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13- A distributed radio head (303) enabling user terminals (305, 306, 307) to access the services offered by a wireless telecommunication system, said radio head (303) being composed of distribution frame equipment (209, 304), a plurality of distributed access points (205, 206, 207, 208, 308, 309, 310, 311, 312) distributed in a coverage area
20 and communication means between the distribution frame equipment and the distributed access points, the distribution frame equipment (209) comprising means for transmitting a signal to be transmitted in the coverage area to all the distributed access points, said distributed
25 access points comprising radio frequency processing means making it possible to transpose said signal to a carrier frequency before transmitting it in the form of radio waves to the user terminals (305, 306, 307) present in the coverage area.

30 14- The distributed radio head (303) as claimed in claim 12, in which the distributed access points comprise means for transposing into base

band radio signals received from user terminals (305, 306, 307) before transmitting them to the distribution frame equipment (209, 304).