Multi-frequency Multi-system Distributed Access System

Technical Field

The present invention relates to a distributed access system, and more particularly, to a multi-frequency multi-system distributed access system.

Background Art

With the increase of mobile communication systems, types and a quantity of communication devices are also increased significantly, thus increasing a difficulty of network construction, followed by problems such as a complexity of a network coverage scheme, limitation of a machine room space, and an increased cost of network construction.

At present, 2G, 3G and 4G networks will coexist for a long time, and there will be a 5G network in the future. When using a single-system device, an operator needs to use multiple sets of single-band systems to construct a mobile communication system. In order to connect various corresponding systems, there may be defects such as complication of a connecting device mechanism and configuration thereof among the systems, consumption of more optical fiber resources, a large area occupied by a project, messy connecting lines and a high cost, thus being not suitable for large-scale popularization and application.

That is to say, existing single-band access system or multi-band access system both have the following defects generally: 1. limited by a radio-frequency front-end frequency selectivity, it is inconvenient to upgrade and expand 5G hardware in the later stage, so that a potential cost is increased; 2. limited by a transmission bandwidth, an access unit and a remote coverage unit

cannot meet mainstream wireless mobile communication and wired transparent transmission; and 3. second, third and even fourth source sectors need to be introduced to coverage of telephone traffic intensive scenes such as a large gymnasium and a business district, and an independent system is added for coverage in a traditional solution, thus being inflexible in networking and complex in management.

Summary of the Invention

The present invention is intended to overcome the defects in the prior art, and provides a multi-frequency multi-system distributed access system.

In order to achieve the above objective, the present invention proposes the following technical solution: a multi-frequency multi-system distributed access system comprises an access unit and a remote coverage unit connected with the access unit. Wherein the access unit is used for accessing source signals of multiple frequency bands in a downlink, performing uplink and downlink filtering separation on the source signals, then performing signal attenuation, analog-to-digital conversion and down-conversion in sequence to obtain downlink digital signals, and then transmitting the downlink digital signals to the remote coverage unit by an optical fiber after data compression and optical/electrical conversion; and is used for receiving uplink digital optical signals transmitted from the remote coverage unit in an uplink, and performing optical/electrical conversion, up-conversion, digital-to-analog conversion and signal amplification on the digital optical signals in sequence to obtain uplink radio-frequency signals and then transmitting the same, the source signals comprising radio-frequency signals of more

than penta-band, and covering accessing of source signals in a frequency band range of 300 MHz to 3.5 GHz; and

the remote coverage unit is used for performing digital signal processing on the signals from the access unit in the downlink, performing down-conversion and digital-to-analog conversion in sequence to obtain the radio-frequency signals, then performing power amplification and then outputting the same, separating received uplink signals in the uplink, performing low-noise amplification, analog-to-digital conversion and up-conversion in sequence to obtain the digital signals, and then outputting the same to the access unit.

Preferably, the system further comprises a distribution convergence unit connected with the access unit and the remote coverage unit, which is used for distributing downlink digital optical signals of the access unit, or converging and combining the uplink digital optical signals of the remote coverage unit.

Preferably, the access unit is capable of being connected with one or more distribution convergence units, and each distribution convergence unit is capable of being cascaded with one or more distribution convergence units, and each distribution convergence unit is connected with multiple remote coverage units.

Preferably, the system further comprises an auxiliary source access unit with a hardware structure identical to a structure of the access unit, and the auxiliary source access unit is connected with the distribution convergence unit or the remote coverage unit.

Preferably, the access unit comprises a first digital radio-frequency integrated module and a first digital optical module connected with the first digital radio-frequency integrated module, the

first digital radio-frequency integrated module accesses the source signals of multiple frequency bands in the downlink, and integrately comprises multiple near-end signal processing modules, multiple first analog-to-digital conversion modules and a first frequency conversion module which are connected, the source signal of each frequency band corresponds to one near-end signal processing module and one first analog-to-digital conversion module, and the near-end signal processing module is used for performing uplink and downlink separation on the source signals in the downlink, and then performing signal attenuation and outputting the same to the first analog-to-digital conversion module, or amplifying the uplink radio-frequency signals converted by the first analog-to-digital conversion module in the uplink, and then filtering and outputting the same; the first analog-to-digital conversion module is used for performing analog-to-digital conversion on the source signals in the downlink, or performing digital-to-analog conversion on the uplink signals in the uplink to obtain the radio-frequency signals; and the first frequency conversion module is used for performing down-conversion on the source signals in the downlink, or performing up-conversion on the uplink signals in the uplink.

Preferably, the near-end signal processing module comprises a first duplex filter, a first digital attenuator and a first amplifier which are connected, in the downlink, the source signal of each frequency band is subjected to uplink and downlink separation by the corresponding first duplex filter, and then the signal is attenuated by the first digital attenuator; and in the uplink, the uplink signal of each frequency band is amplified by the corresponding first amplifier, and then filtered and outputted by the first duplex filter.

Preferably, an undistorted compression algorithm of a 2:1 compression scale is used in the access unit to perform data compression on the downlink signals.

Preferably, the distribution convergence unit comprises a digital board, a second digital optical module and a third digital module, the second digital optical module is connected with the first digital optical module of the access unit, the third digital optical module is connected with the remote coverage unit, and the digital board is used for distributing the downlink digital optical signals of the access unit, or converging and combining the uplink digital optical signals of the remote coverage unit.

Preferably, the remote coverage unit comprises a second digital radio-frequency integrated module and multiple fourth digital optical modules, the fourth digital optical modules are connected with the third digital module of the distribution convergence unit, and integrately comprise a second frequency conversion module, multiple second analog-to-digital conversion modules and multiple far-end signal processing modules which are connected, the uplink signal of each frequency band corresponds to one far-end signal processing module and the second analog-to-digital conversion module, and the second frequency conversion module is used for performing up-conversion on the downlink signals in the downlink, or performing down-conversion on the uplink signals in the uplink; the second analog-to-digital conversion module is used for performing digital-to-analog conversion on the source signals in the downlink to obtain the radio-frequency signals, or performing analog-to-digital conversion on the uplink signals in the uplink to obtain the digital signals; and the far-end signal processing module is used for performing power amplification on the signals in the downlink and then filtering and

outputting the same, or performing uplink and downlink separation on the uplink radio-frequency signals in the uplink, and then attenuating and outputting the signals.

Preferably, the far-end signal processing module comprises a second amplifier, a downlink power amplifier, an uplink low noise amplifier, a second digital attenuator and a second duplex filter which are connected; in the downlink, the downlink signal of each frequency band is subjected to signal amplification and power amplification by the corresponding second amplifier and the downlink power amplifier in sequence, and then filtered and outputted by the second duplex filter; and in the uplink, the uplink radio-frequency signal of each frequency band is subjected uplink and downlink signal separation by the second duplex filter, then subjected to power amplification by the corresponding uplink low noise amplifier, attenuated by the second digital attenuator, and then outputted.

The present invention has the beneficial effects as follows.

1. One system is used to solve public network signals, special network signals and wired services, as well as functions which can only be completed by multiple systems traditionally. Compared with a traditional access system, costs of the system on property coordination and construction, provisioning efficiency and maintenance management are all reduced.

2. Different power levels are configured for high and low frequencies of the system according to simulation results for outputting, so as to achieve compatible coverage, and a coverage end directly faces a user terminal, so that the system replaces a traditional stimulated passive distributed system and has better coverage effect.

3. 5G upgrading and expansion are more convenient, after a 5G license is issued later, a

broadband of a hardware system is compatible by using a software radio technology, and only software-related upgrading and configuration file import are needed, without any change to hardware.

Brief Description of the Drawings

Fig. 1 is a networking diagram of a system according to the present invention;

Fig. 2 is a principle structure diagram of the system according to the present invention;

Fig. 3 is a functional block diagram of an access unit according to the present invention;

Fig. 4 is a principle block diagram of the access unit according to the present invention;

Fig. 5 is a functional block diagram of a distribution convergence unit according to the present invention;

Fig. 6 is a principle block diagram of the distribution convergence unit according to the present invention;

Fig. 7 is a functional block diagram of a remote coverage unit according to the present invention; and

Fig. 8 is a principle block diagram of the remote coverage unit according to the present invention.

Detailed Description of the Preferred Embodiments

The technical solutions of the embodiments of the present invention are clearly and completely described hereinafter with reference to the accompanying drawings of the present invention.

A multi-frequency multi-system distributed access system disclosed by the present invention uses one system to cover networks of multiple frequency bands, comprising but being not limited to public network signals, specific network signals, wired services and the like, and the system may cover existing networks of all frequency bands such as 2G, 3G and 4G networks at the same time.

With reference to in Fig. 1 and Fig. 2, a multi-frequency multi-system distributed access system disclosed in the embodiment of the present invention comprises an access unit (AU), a distribution convergence unit (HU) and a remote coverage unit (RU), the units are all connected by an optical fiber for transmission, and a 10G optical fiber is used for connection in the embodiment. The access unit is connected with the distribution convergence unit, and is used for accessing source signals of multiple frequency bands in a downlink, performing digital signal processing on the source signals, and then performing data compression and transmission to the distribution convergence unit or the remote coverage unit, so as to achieve a purpose of source remote transmission coverage. Alternatively, multi-band uplink digital optical signals sent by the convergence unit or the remote coverage unit are received in an uplink, and the uplink digital optical signals are transmitted after digital signal processing.

Specifically, the source signals herein are radio-frequency (RF) signals for coupling a base station or other services, comprising but being not limited to public network mobile communication, specific network mobile communication, wired services, IoT (Internet of Things) services and digital televisions, and cover accessing of the source signals of different systems, different bandwidths and different services of 300 MHz to 3.5 GHz. In the embodiment, source

signals of penta-band may be accessed, and the five source signals are defined as BandA, BandB, BandC, BandD and BandE respectively. These signals cover existing sources of 2G, 3G, 4G and other frequency bands, and each source may be generally divided into an uplink signal and a downlink signal. For example, the BandA is divided into a BandA source TX and a BandB source RX, and the uplink and downlink signals also need to be separated to form the sources of the uplink and downlink signals, such as a TD_LTE signal.

In the embodiment, as shown in Fig. 3, the access unit mainly comprises a first digital radio-frequency integrated module and multiple first digital optical modules. In the downlink, one end of the first digital radio-frequency integrated module (close to the base station or other services) is used for accessing multiple downlink radio-frequency signals of the above penta-band, and the other end of the first digital radio-frequency integrated module (close to the distribution convergence unit) is connected with the multiple first digital optical modules. The access unit is mainly used for performing uplink and downlink filtering and separation on the source signals in sequence, and then the source signals become fundamental frequency complex signals with 0 MHz as a center frequency. The fundamental frequency complex signals are attenuated, and then subjected to A/D analog-to-digital conversion. After the ADC conversion, analog signals become digital complex signals, and then digital down-conversion (DDC) is performed on the digital complex signals to obtain baseband signals. The baseband signals are subjected to data compression, then subjected to electro-optical conversion through the first digital optical module, and then sent to the HU or the RU. In the embodiment, an undistorted compression algorithm of a 2:1 compression scale is used in the data compression, so that a

production cost of the system is reduced and a radio-frequency transmission bandwidth is effectively increased under a condition of a certain optical fiber capacity. Preferably, a standard digital optical module of a SFP+ protocol is used as the first digital optical module, and four first digital optical modules are provided in the embodiment.

With reference to Fig. 2 and Fig. 4, the first digital radio-frequency integrated module accesses the source signals of multiple frequency bands in the downlink, and mainly and integrately comprises multiple near-end signal processing modules, multiple first analog-to-digital conversion modules (ADC/DAC) and a first frequency conversion module (DDC/DUC) which are connected. The first analog-to-digital conversion module is connected with the first frequency conversion module through a 204B interface, and the first frequency conversion module is connected with the first digital optical module. In the embodiment, the source signal of each frequency band corresponds to one near-end signal processing module and one first analog-to-digital conversion module. Each near-end signal processing module is used for performing uplink and downlink separation on the corresponding source signal in the downlink, then performing signal attenuation, and outputting the same to the first analog-to-digital conversion module, or amplifying the uplink radio-frequency signal converted by the first analog-to-digital conversion module in the uplink and then filtering and outputting the same. The first analog-to-digital conversion module is used for performing the analog-to-digital conversion on the source signals in the downlink, or performing the digital-to-analog conversion on the uplink signals in the uplink to obtain the radio-frequency

signals. The first frequency conversion module is used for performing down-conversion on the source signals in the downlink, or performing up-conversion on the uplink signals in the uplink.

In the embodiment, as shown in Fig. 4, each near-end signal processing module comprises a first duplex filter, a first digital attenuator and a first amplifier which are connected. In the downlink, the source signal of each frequency band is subjected to uplink and downlink separation by the corresponding first duplex filter, and then the signal is attenuated by the first digital attenuator and then is outputted. In the uplink, the uplink signal of each frequency band is amplified by the corresponding first amplifier, and then filtered and outputted by the first duplex filter.

Certainly, when each near-end signal processing module corresponds to the source signals of different frequency bands, structures may be different. For example, the above first duplex filter is replaced by a structure combining a filter and a duplexer, and for another example, multiple first digital attenuators may be connected in series, such as two, and the first amplifier may be connected in series with a digital variable gain amplifier (DVGA), and the like. These replacement structures are all within the scope of protection of the present invention.

In addition to the first digital radio-frequency integrated module and the first digital optical module, as shown in Fig. 3, the access unit further comprises a fan, a power supply module, a switch with a safety function and a battery. In the embodiment, according to heat dissipation evaluation, two fans powered by 12V need to be used in the first digital radio-frequency integrated module for heat dissipation. A power supply (which is namely a power supply module) of the first digital radio-frequency integrated module is realized by a brick power supply of 48V

to 12V, and some external anti-thunder and safety-standard circuits may be added to the power supply module. The switch with the safety function is arranged on a case panel of the access unit for controlling a power supply of a whole machine. When the main power supply (the power supply module) loses power, the battery supplies power to some circuits of the first digital radio-frequency integrated module, and some alarm items are also able to be transmitted to an upper computer or an OMC (Operation and Maintenance Center) through power supplied by the battery. When the main power supply is operated normally, the battery is in a charged state.

In the embodiment, as shown in Fig. 5, the distribution convergence unit mainly comprises a digital board, a second digital optical module and a third digital module, wherein the second digital optical module is used for being connected with the first digital optical module of the access unit, and the third digital optical module is used for being connected with the remote coverage unit. The digital board herein has no radio-frequency function, and only distributes the downlink digital optical signals from the access unit, or converges and combines the uplink digital optical signals from the remote coverage unit. The digital board herein is a distributor/combiner in the principle block diagram of Fig. 2. Moreover, the second digital optical modules correspond to the first digital optical modules one by one, four second digital optical modules are provided, and 12 third digital optical modules are provided.

In addition, as shown in Fig. 5, the distribution convergence unit further comprises a power supply module, a switch with a safety function and a battery, wherein principles of the switch with the safety function and the battery are similar to those in the above access unit, which may refer to the above description, and will not be repeated herein. Different from the power supply

module of the access unit, the power supply module in the distribution convergence unit comprises a power supply of 48V to 12V or a power supply of 220V to 12V, and a power supply of 1000W and 220V to 48V, wherein the power supply of 48V to 12V or the power supply of 220V to 12V mainly supplies power to the digital board, and dual channel output power supplies of 1000W and 220V to 48V as well as 12V are used in a device of HU_RPS. The power supply of 1000W and 220V to 48V mainly supplies power to the digital board of the HU and the RU in a low power form.

In addition, in the embodiment, the digital board further comprises a PSE of 12 parts connected with the power supply of 1000 W and 220V to 48V, and 12 channels of downlink electrical signals outputted by the PSE respectively correspond to 12 channels of third digital optical modules of the digital board one by one, and are transmitted to the RU by an optoelectronic composite cable. The PSE of 12 parts enables the digital board to have a transparent transmission function of 12 channels of Gigabit Ethernets, which correspond to 12 channels of optical ports in the RU one by one, without Gigabit Ethernet parsing and routing functions.

Preferably, multiple distribution convergence units may be cascaded as required. As shown in Fig. 1, in the embodiment, the access unit is connected with three distribution convergence units HU1, and each distribution convergence unit HU1 is further cascaded with five distribution convergence units, which means that six distribution convergence units (HU1……HU6) are cascaded, and each distribution convergence unit is connected with 12 remote coverage units (RU1……RU12). Certainly, a number of the distribution convergence units accessed by the

access unit and a number of the cascaded distribution convergence units may be set according to actual requirements, and are not limited to those defined by the examples herein.

In addition, in other alternative embodiments, under a condition of meeting requirements of a user, the multi-frequency multi-system distributed access system of the present invention may not comprise the distribution convergence unit herein, which means that the signals do not need to be distributed/converged, and the access unit is directly connected with the remote coverage unit.

In the embodiment, as shown in Fig. 7, the remote coverage unit mainly comprises a second digital radio-frequency integrated module and multiple fourth digital optical modules, wherein the fourth digital optical modules are used for being connected with the third digital optical module of the distribution convergence unit or the first digital optical module of the access unit. In the downlink, the second digital radio-frequency integrated module mainly extracts the digital signals from the access unit AU or the distribution convergence unit HU to recover a clock and process the digital signals.

Specifically, with reference to Fig. 2 and Fig. 8, the second digital radio-frequency integrated module integrately comprises a second frequency conversion module (DUC/DDC), multiple second analog-to-digital conversion modules (DAC/ADC), and multiple far-end signal processing modules which are connected. The second frequency conversion module is connected with the fourth digital optical module, and the uplink signal of each frequency band corresponds to one far-end signal processing module and the second analog-to-digital conversion module. The second frequency conversion module is used for performing up-conversion on the downlink

signals in the downlink, or performing down-conversion on the uplink signals in the uplink. The second analog-to-digital conversion module is used for performing digital-to-analog conversion on the source signals in the downlink to obtain the radio-frequency signals, or performing analog-to-digital conversion on the uplink signals in the uplink to obtain the digital signals. The far-end signal processing module is used for amplifying the signals in the downlink and then filtering and outputting the same after downlink power amplification, or performing uplink and downlink separation on the uplink radio-frequency signals in the uplink, then performing uplink power amplification and signal attenuation, and then outputting the same.

In the embodiment, each far-end signal processing module comprises a second amplifier, a downlink power amplifier PA/LPA, an uplink low noise amplifier LNA, a second digital attenuator and a second duplex filter which are connected. In the downlink, the downlink signal of each frequency band is subjected to signal amplification and power amplification by the corresponding second amplifier and the downlink power amplifier PA/LPA in sequence, and then filtered and outputted by the second duplex filter. In the uplink, the uplink radio-frequency signal of each frequency band is subjected to uplink and downlink signal separation by the second duplex filter, then subjected to power amplification by the corresponding uplink low noise amplifier LNA, attenuated by the second digital attenuator, and then outputted.

Similar to the above near-end signal processing module, when the far-end signal processing module herein corresponds to the source signals of different frequency bands, structures may also be different. For example, the second duplex filter herein is also replaced by a structure combining a filter and a duplexer.

In addition, the remote coverage unit comprises two forms, which are a low-power RU and a high-power HPRU. A design structure of the HPRU will be described in detail hereinafter.

With reference to Fig. 7, a 232 mode is used as a monitoring mode of a downlink power amplifier LPA, which is communicated with the second digital radio-frequency integrated module. Considering independent 232 connection of each LPA, the remote coverage unit needs to be added with a 232 interface board, which means that the remote coverage unit further comprises the 232 interface board, which is used for connecting the second digital radio-frequency integrated module with the downlink power amplifier LPA. In the embodiment, five downlink power amplifiers LPAs (LPA1……LPA5) are provided to correspond to five source signals.

In addition, the remote coverage unit further comprises a power supply module, a fan battery panel, a battery pack and a fan assembly, wherein the power supply module comprises a power supply of 220V to 28V and a power supply of 48V to 12V. The power supply of 220V to 28V supplies power to five channels of LPAs, the sixth channel is supplied to the fan battery panel, and the fan battery panel supplies 12V to the second digital radio-frequency integrated module.

Preferably, a plug-in box structure design is mainly used in the HPRU. The fan battery panel and the second digital radio-frequency integrated module are designed in a plug-in box. On upper and lower layers of the plug-in box, the fan battery panel comprises functions of rotating speed management and 24V power supply of seven fans as well as 28V to 12V power conversion, and further comprises a function of battery charge and discharge management. A large-capacity

battery pack of 5000 mAH is used as the battery pack, a power loss alarm of the RU evaluated in the early stage needs to be transmitted to the AU through an optical port serdes of the FPGA (which is namely the second digital radio-frequency integrated module), so that most functions of the FPGA must be operated normally after power failure. Therefore, the large-capacity battery pack is used. The fan assembly consists of seven 24V fans with a speed control function, and is used for heat dissipation of five LPAs.

Further, in addition to the above units, the system of the present invention may further comprise an auxiliary source access unit (AAU), which is connected with the distribution convergence unit or the remote coverage unit, has the same hardware structure as that of the access unit, and is used for accessing the source signals of other frequency bands. As shown in Fig. 1, three auxiliary source access units are accessed, which means that three source sectors sector 2, sector 3 and sector 4 are added.

In addition, preferably, during digital signal processing of the access unit, the auxiliary source access unit or the remote coverage unit above, a design capability of 20 sub-bands is realized by using characteristics of a digital filter. Signals which do not need to be transmitted and amplified are highly suppressed, and power statistics and balance are performed on a signal of each sub-band. Moreover, a transmission mode of the digital signals is performed based on a CPRI (common public radio interface) protocol, and the 2:1 compression scale is used in the undistorted compression algorithm, which effectively increases a radio-frequency transmission bandwidth, and supports penta-band, source access and the radio-frequency bandwidth of 410M to the maximum.

The technical contents and technical features of the present invention have been disclosed above. However, those skilled in the art may still make various substitutions and modifications without departing from the spirit of the present invention based on the teaching and disclosure of the present invention. Therefore, the scope of protection of the present invention should not be limited to the contents disclosed in the embodiments, but should include various substitutions and modifications without departing from the present invention and be covered by the claims of the patent application.

Claim

1. A multi-frequency multi-system distributed access system, comprising an access unit and a remote coverage unit connected with the access unit, wherein

the access unit is used for accessing source signals of multiple frequency bands in a downlink, performing uplink and downlink filtering separation on the source signals, then performing signal attenuation, analog-to-digital conversion and down-conversion in sequence to obtain downlink digital signals, and then transmitting the downlink digital signals to the remote coverage unit by an optical fiber after data compression and optical/electrical conversion; and is used for receiving uplink digital optical signals transmitted from the remote coverage unit in an uplink, and performing optical/electrical conversion, up-conversion, digital-to-analog conversion and signal amplification on the digital optical signals in sequence to obtain uplink radio-frequency signals and then transmitting the same, the source signals comprising radio-frequency signals of more than penta-band, and covering accessing of source signals in a frequency band range of 300 MHz to 3.5 GHz; and

the remote coverage unit is used for performing digital signal processing on the signals from the access unit in the downlink, performing down-conversion and digital-to-analog conversion in sequence to obtain the radio-frequency signals, then performing power amplification and then outputting the same, separating received uplink signals in the uplink, performing low-noise amplification, analog-to-digital conversion and up-conversion in sequence to obtain the digital signals, and then outputting the same to the

access unit;

the system further comprises:

a distribution convergence unit connected with the access unit and the remote coverage unit, which is used for distributing downlink digital optical signals of the access unit, or converging and combining the uplink digital optical signals of the remote coverage unit;

an auxiliary source access unit, wherein the auxiliary source access unit is connected with the distribution convergence unit or the remote coverage unit.

~~2. The multi-frequency multi-system distributed access system according to claim 1, wherein the system further comprises a distribution convergence unit connected with the access unit and the remote coverage unit, which is used for distributing downlink digital optical signals of the access unit, or converging and combining the uplink digital optical signals of the remote coverage unit.~~

~~3.~~2. The multi-frequency multi-system distributed access system according to claim ~~2~~1, wherein the access unit is capable of being connected with one or more distribution convergence units, each distribution convergence unit is capable of being cascaded with one or more distribution convergence units, and each distribution convergence unit is connected with multiple remote coverage units.

~~4.~~3. The multi-frequency multi-system distributed access system according to claim ~~2~~1, wherein the ~~system further comprises an~~ auxiliary source access unit ~~with~~ having a hardware structure identical to a structure of the access unit, and the auxiliary source

access unit is connected with the distribution convergence unit or the remote coverage unit.

~~5.~~4. The multi-frequency multi-system distributed access system according to claim ~~2~~1, wherein the access unit comprises a first digital radio-frequency integrated module and a first digital optical module connected with the first digital radio-frequency integrated module, the first digital radio-frequency integrated module accesses the source signals of multiple frequency bands in the downlink, and integrately comprises multiple near-end signal processing modules, multiple first analog-to-digital conversion modules and a first frequency conversion module which are connected, the source signal of each frequency band corresponds to one near-end signal processing module and one first analog-to-digital conversion module, and the near-end signal processing module is used for performing uplink and downlink separation on the source signals in the downlink, and then performing signal attenuation and outputting the same to the first analog-to-digital conversion module, or amplifying the uplink radio-frequency signals converted by the first analog-to-digital conversion module in the uplink, and then filtering and outputting the same; the first analog-to-digital conversion module is used for performing analog-to-digital conversion on the source signals in the downlink, or performing digital-to-analog conversion on the uplink signals in the uplink to obtain the radio-frequency signals; and the first frequency conversion module is used for performing down-conversion on the source signals in the downlink, or performing up-conversion on the uplink signals in the uplink.

~~6.~~5. The multi-frequency multi-system distributed access system according to claim ~~5~~4,

wherein the near-end signal processing module comprises a first duplex filter, a first digital attenuator and a first amplifier which are connected, in the downlink, the source signal of each frequency band is subjected to uplink and downlink separation by the corresponding first duplex filter, and then the signal is attenuated by the first digital attenuator; and in the uplink, the uplink signal of each frequency band is amplified by the corresponding first amplifier, and then filtered and outputted by the first duplex filter.

~~7.~~6. The multi-frequency multi-system distributed access system according to claim 1, wherein an undistorted compression algorithm of a 2:1 compression scale is used in the access unit to perform data compression on the downlink signals.

~~8.~~7. The multi-frequency multi-system distributed access system according to claim ~~5~~4, wherein the distribution convergence unit comprises a digital board, a second digital optical module and a third digital module, the second digital optical module is connected with the first digital optical module of the access unit, the third digital optical module is connected with the remote coverage unit, and the digital board is used for distributing the downlink digital optical signals of the access unit, or converging and combining the uplink digital optical signals of the remote coverage unit.

~~9.~~8. The multi-frequency multi-system distributed access system according to claim ~~8~~7, wherein the remote coverage unit comprises a second digital radio-frequency integrated module and multiple fourth digital optical modules, the fourth digital optical modules are connected with the third digital module of the distribution convergence unit, and integrately comprise a second frequency conversion module, multiple second

analog-to-digital conversion modules and multiple far-end signal processing modules which are connected, the uplink signal of each frequency band corresponds to one far-end signal processing module and the second analog-to-digital conversion module, and the second frequency conversion module is used for performing up-conversion on the downlink signals in the downlink, or performing down-conversion on the uplink signals in the uplink; the second analog-to-digital conversion module is used for performing digital-to-analog conversion on the source signals in the downlink to obtain the radio-frequency signals, or performing analog-to-digital conversion on the uplink signals in the uplink to obtain the digital signals; and the far-end signal processing module is used for performing power amplification on the signals in the downlink and then filtering and outputting the same, or performing uplink and downlink separation on the uplink radio-frequency signals in the uplink, and then attenuating and outputting the signals.

~~10.~~9. The multi-frequency multi-system distributed access system according to claim ~~9~~8, wherein the far-end signal processing module comprises a second amplifier, a downlink power amplifier, an uplink low noise amplifier, a second digital attenuator and a second duplex filter which are connected; in the downlink, the downlink signal of each frequency band is subjected to signal amplification and power amplification by the corresponding second amplifier and the downlink power amplifier in sequence, and then filtered and outputted by the second duplex filter; and in the uplink, the uplink radio-frequency signal of each frequency band is subjected uplink and downlink signal separation by the second duplex filter, then subjected to power amplification by the corresponding uplink low noise

amplifier, attenuated by the second digital attenuator, and then outputted.