

MIMO SIGNAL EXTENSION APPARATUS

TECHNICAL FIELD

The present invention relates to a multiple input multiple output (MIMO) signal extension apparatus for extending, by a predetermined distance, a MIMO signal which is applied to a multiple access scheme wireless communication system such as a long term evolution (LTE) communication system, together with a signal of a different frequency band or different communication scheme, such as LTE, WCDMA and CDMA 1X, using a single cable.

BACKGROUND ART

Wireless communication systems are widely developed to provide various types of communication contents, such as voice and data. These systems may be multiple access systems that are capable of supporting communication with many users by sharing available system resources, for example, band widths or transmission power. Examples of the multiple access systems include code division multiple access (CDMA) systems, time division multiple access (TDMA) systems, frequency division multiple access (FDMA) systems, 3GPP long term evolution (LTE) systems, and orthogonal frequency division multiple access (OFDMA) systems.

In general, a wireless multiple access communication system can support communications with a plurality of wireless terminals simultaneously. Each of the plurality of wireless terminals communicates with one or more base stations through transmission in a forward link and a backward link. The forward link (or referred to as a downlink or downstream link) refers to a communication link from the base stations to terminals, and the backward link (or referred to as an uplink or upstream link) refers to a communication link from the terminals to the base stations. These communication links may be set using a single input single output (SISO) method, a multiple input single output (MISO) method, or a multiple input multiple output (MIMO) method.

Systems using the MIMO method use a plurality of (NT) transmission antennas and a plurality of (NR) receiving antennas so as to perform data transmission. MIMO channels formed by NT transmission antennas and NR receiving antennas may be divided into NS independent channels. These NS independent channels may be called

spatial channels. Each of the NS independent channels corresponds to a dimension. When additional dimensions generated by a plurality of transmission and receiving antennas are used, the MIMO systems may provide improved performance, for example, higher throughput and/or higher reliability.

Meanwhile, in the MIMO communication method, a repeater (or referred to as a MIMO signal extension apparatus) needs to be configured in an area which covers a propagation shadow region or installation cost for base stations of which is uncomfortable.

However, a plurality of transmission cables corresponding to the number of MIMO antennas are required to extend, by a predetermined distance, a MIMO signal or to transmit the MIMO signal from the base station or the repeater to a plurality of antennas. Due to installation of the plurality of transmission cables, a cable purchasing cost, a working time, and manpower are increased such that a facility cost increases remarkably and there are many limitations in an installation space.

DETAILED DESCRIPTION OF THE INVENTION

TECHNICAL PROBLEM

The present invention provides a multiple input multiple output (MIMO) signal extension apparatus for extending, by a predetermined distance, a MIMO signal which is applied to a multiple access scheme wireless communication system such as a long term evolution (LTE) communication system, together with a signal of a different frequency band or different communication scheme, such as LTE, WCDMA and CDMA 1X, using a single cable to effectively relay the MIMO signal.

TECHNICAL SOLUTION

According to an aspect of the present invention, there is provided a multiple input multiple output (MIMO) signal extension apparatus including: a main unit MU, wherein the main unit MU may include: a first input/output port through which an upstream/downstream main signal of a first base station device is input/output; a second input/output port through which a (combined) main signal obtained by combining an upstream/downstream main signal of one or more different communication scheme system base stations (hereinafter, referred to as second base station devices) with an upstream/downstream main signal of the first base station device, is input/output; a

signal combiner configured to combine a MIMO signal from the first base station device with a MIMO signal input through a third input/output port from at least one from among the second base station devices and to downstream output a combined signal; a first downstream signal amplification unit configured to frequency down and amplify a downstream MIMO signal output from the signal combiner; and a multiplexer (MUX) configured to combine the downstream MIMO signal output from the first downstream signal amplification unit and a downstream (combined) main signal input through the second input/output port with each other to output a combined signal through a fourth input/output port connected to one end of a single cable or to output an upstream main signal input through the fourth input/output port from the single cable through the second input/output port. The first base station device may include: a main signal processing unit configured to upstream or downstream process a main signal; a signal separation unit connected between the main signal processing unit and the first input/output port and configured to separate the main signal into an upstream main signal and a downstream main signal; and a MIMO signal processing unit configured to downstream process the MIMO signal.

The MIMO signal extension apparatus may further include a service unit SU, wherein the service unit SU may include: a fifth input/output port to which the other end of the single cable is connected; a sixth input/output port for connecting a main antenna; a seventh input/output port for connecting a MIMO antenna; a second signal separation unit connected to the fifth input/output port and configured to separate the main signal and the MIMO signal from each other; a bypass line configured to connect between the second signal separation unit and the sixth input/output port; and a second downstream signal amplification unit connected between the second signal separation unit and the seventh input/output port and configured to frequency up and amplify a downstream MIMO signal.

In a superheterodyne amplifier including a first part in which a frequency down converter and an amplifier are sequentially connected in series, and a second part in which a frequency up converter and an amplifier are sequentially connected in series, the first part and the second part of the superheterodyne amplifier being connected in series, the first downstream signal amplification unit may include the first part of the superheterodyne amplifier, and the second downstream signal amplification unit may include the second part of the superheterodyne amplifier.

The first base station device may include a base station device or relay device of a long term evolution (LTE) system and may have a service area of a micro cell, a pico cell, a Femto cell or a macro cell.

The second base station devices may use a different communication scheme or different frequency band from that of the first base station device.

DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a transmission/receiving system of a multiple input multiple output (MIMO) signal in a multiple access scheme wireless communication system;

FIG. 2 is a view of a wireless relay apparatus according to the related art;

FIG. 3 is a view of a configuration of a MIMO signal extension apparatus (a MIMO relay apparatus) according to an embodiment of the present invention;

FIG. 4 is a view of a detailed configuration of a first downstream signal amplification unit of FIG. 3;

FIG. 5 is a view of a detailed configuration of a second downstream signal amplification unit of FIG. 3; and

FIG. 6 is a view of a configuration of a superheterodyne amplifier according to the related art.

MODE OF THE INVENTION

Hereinafter, the present invention will be described in detail by explaining exemplary embodiments of the invention with reference to the attached drawings. A phenomenon caused by one or more reflected waves in a period of wireless signal transmission is a main cause for lowering receiving performance of a communication system. Frequency efficiency may be improved by using this multiple reflected wave phenomenon. This technique method is a multiple input multiple output (MIMO) system. MIMO is a technique, whereby, as known from the name, a plurality of antennas are used in both a transmission side and a receiving side so that performance improvements, such as transmission speed, a capacity increase, and a coverage increase, are achieved.

As a simple example, when, in a 2 X 2 system in which two antennas are present in a transmission side and two antennas are present in a receiving side, as illustrated in FIG. 1, when characteristics of a channel between a first transmission antenna and a first

receiving antenna are h_{11} , characteristics of a channel between a second transmission antenna and the first receiving antenna are h_{12} , characteristics of a channel between the first transmission antenna and a second receiving antenna are h_{21} , characteristics of a channel between the second transmission antenna and the second receiving antenna are h_{22} and channel characteristics in this case are gathered, a channel matrix shown in Equation 1 is made.

[Equation 1]

$$\mathbf{y} = \mathbf{H} \cdot \mathbf{x} + \mathbf{n}$$

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \end{bmatrix}$$

x_1, x_2 : transmission signal

y_1, y_2 : received signal

n_1, n_2 : channel noise

In this case, x_1 and x_2 are transmission signals transmitted from the first and second transmission antennas, respectively, and n_1 and n_2 are noises that exist in the first and second receiving antennas, and y_1 and y_2 are received signals.

Two examples shown in the following Equations 2 and 3 are made based on the above basic equation.

[Equation 2]

$$\begin{bmatrix} 6 \\ 12 \end{bmatrix} = \begin{bmatrix} 1 & 2 \\ 2 & 4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

[Equation 3]

$$\begin{bmatrix} 6 \\ 12 \end{bmatrix} = \begin{bmatrix} 3 & -2 \\ 2 & 4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

An example of a matrix of Equation 2 is analyzed as $6=1x_1+2x_2$ and $12=2x_1+4x_2$, two formulae are the same formula in which information quantity is one. On the other hand, in a matrix of Equation 3, two formulae are different from each other. Thus, values of different transmission signals x_1 and x_2 can be obtained by solving the matrix or simultaneous equations. In linear algebra, a rank of a 2 X 2 matrix of Equation 2 is referred to as 1, and a rank of the matrix of Equation 3 is referred to as 2.

In the following Equation 4, a system configured of two transmission antennas and two receiving antennas, having a 2 x 2 channel matrix and maintaining the condition of rank 2 shows a basic format in which transmission signals are extracted from signals received from each antenna by applying an inverse matrix of the channel matrix.

[Equation 4]

$$\begin{bmatrix} \tilde{x}_1 \\ \tilde{x}_2 \end{bmatrix} = H^{-1} \begin{bmatrix} y_1 \\ y_2 \end{bmatrix}$$

In Equations 1 and 4, $\tilde{x}_1$ and $\tilde{x}_2$ are values obtained by demodulating signals estimated to be transmitted to each antenna.

Such a MIMO method is referred to as a MIMO spatial multiplexing (SM) method, and the number of different data streams that can be simultaneously transmitted, is limited to a smaller number between the number M of transmission antennas and the number N of receiving antennas, and general MIMO has a structure in which the number of transmission antennas and the number of receiving antennas are the same.

FIG. 2 is a view for describing a relay apparatus according to the related art. As illustrated in the same drawing, a wireless relay apparatus 210 according to the related art is configured to have access to one receiving antenna 210a that receives signals transmitted from a base station 220 and one re-transmission antenna 210b directed toward a service zone, i.e., a user terminal 230, with respect to downstream MIMO signals that transmit MIMO communication signals from the base station 220 having two transmission/receiving antennas to the user terminal 230 having two transmission/receiving antennas and to amplify the received signals by using a downstream signal amplification unit 213 and to re-transmit the amplified signals.

In this case, the number of antennas connected to each other in a link between the base station and the relay apparatus is 2 and 1, respectively, i.e., 2x1, and the number of antennas connected to each other in a link between the relay apparatus and a terminal is 1 and 2, respectively, i.e., 1x2 so that transmission and restoration of the MIMO signals are not possible. This phenomenon also occurs in a case where an upstream signal that transmits a signal from the user terminal 230 to the base station 220 is a MIMO signal.

In FIG. 2, reference numerals 211 and 212 are duplexers for separating an upstream signal and a downstream signal, and reference numeral 214 is an upstream signal amplification unit.

As described above, a basic principle of MIMO is that different pieces of data are transmitted to the terminal through two or more different paths (including antennas) from the base station or repeater by using spatial reflected wave signals so that transmission efficiency can be increased in the same frequency within the same time. Two or more unmixed paths need to be formed so that two or more MIMO signals are transmitted from the base station or repeater to two or more service antennas and the effect of MIMO is achieved between service antennas and the terminal. To this end, when two or more cables are installed, an installation cost thereof increases greatly.

According to an embodiment of the present invention, as shown in Equation 1, a transmission channel matrix between service antennas and the terminal is made as 2×2 , a MIMO signal of the base station or repeater is transmitted to the service antennas by using one cable, and one or more transceivers (or referred to as downstream signal amplification units) are disposed in the repeater so as to form two or more paths in one cable, and a frequency down part and a frequency up part of the transceiver are separated from each other and are implemented at a main unit side and a service unit side, respectively, so that two or more different independent paths can be formed in one cable. Also, according to an embodiment of the present invention, no backward path exists in the MIMO paths so that a manufacturing cost of the repeater can also be reduced.

As a result, according to an embodiment of the present invention, two independent channels that are fully separated from each other are formed between the donor connected to the base station or repeater for MIMO communication in a wired or

wireless manner and the service antenna so that complete spatial MIMO signals can be relayed. A description of a detailed embodiment thereof will be provided below.

FIG. 3 is a view of a configuration of a MIMO signal extension apparatus (or referred to as a MIMO relay apparatus) according to an embodiment of the present invention. As illustrated in the same drawing, the MIMO signal extension apparatus may include a main unit MU 300 installed at a domain side and a service unit SU 400 installed at a service side.

First, the main unit MU 300 of FIG. 3 will be described.

The main unit MU 300 may include a plurality of input/output ports 301 to 304, a base station device 310, a signal combiner 320, a downstream signal amplification unit 330, and a multiplexer (MUX) 340.

The plurality of input/output ports 301 to 304 formed on the main unit MU 300 are used to connect the main unit MU 300 to a signal combiner 540 of an existing mobile communication system 500, a MIMO path of a base station 510 of the existing mobile communication system 500, and the service unit SU 400.

Each of the input/output port 301 and the input/output port 302 is a port for connecting the main unit MU 300 to the signal combiner 540 outside the main unit MU 300.

The signal combiner 540 that is used to combine one or more multiple band signals of different communication schemes of the existing mobile communication system 500 with each other and to transmit or receive combined signals, in a forward path, combines a downstream main signal from one or more different base station devices 510, 520, and 530 of the existing mobile communication system 500 such as LTE, WCDMA and CDMA 1X with a downstream main signal from the base station device 310 of the main unit MU 300 output through the input/output port 301 with each other and outputs a combined signal, and in a backward path, transmits an upstream main signal input from the main unit MU 300 through the input/output port 302 to the corresponding base station devices 510, 520, and 530 or to the base station device 310 through the input/output port 301 of the main unit MU 300.

That is, the input/output port 301 is used to connect the base station device 310 of the main unit MU 300 to the external signal combiner 540, and in the forward path, the downstream main signal output from the base station device 310 of the main unit MU 300 is output to the outside through the input/output port 301 and is input to the signal

combiner 540, and in the backward path, the upstream main signal output from the signal combiner 540 is input to an inside of the main unit MU300 through the input/output port 301 and is input to the base station device 310 of the main unit MU 300.

Also, the input/output port 302 is used to connect the MUX 340 of the main unit MU 300 to the external signal combiner 540, and in the forward path, the downstream main signal combined by the external signal combiner 540 is input to the MUX 340 of the main unit MU 300 through the input/output port 302, and in the backward path, the upstream main signal output from the MUX of the main unit MU 300 is input to the external signal combiner 540 through the input/output port 302.

The base station device 310 that is built in the main unit MU 300 may include a main signal processing unit 311 for upstream or downstream processing a main signal, a MIMO signal processing unit 312 for downstream processing a MIMO signal, an amplifier 313 for amplifying the main signal, and a signal separation unit 314 that is connected between the main signal processing unit 311 and the input/output port 301 and separates the main signal into an upstream main signal and a downstream main signal.

The base station device 310 may be a base station device of a LTE system or a relay device of the base station device of the LTE system and may have a service area of a micro cell, a pico cell, a Femto cell or a macro cell.

The base station devices 510, 520, and 530 of the existing mobile communication system 500 that are peripheral base station devices that use a different communication scheme or different frequency band from that of the base station device 310 may include one or more from among base stations of LTE, WCDMA, and CDMA 1X schemes, as illustrated in the drawing.

The signal combiner 320 is used to combine a MIMO signal from the MIMO signal processing unit 312 of the base station device 310 with a MIMO signal input through the third input/output port 303 from the LTE base station device 510 that follows a MIMO scheme from among the base station devices 510, 520, and 530 of the existing mobile communication system 500 and to downstream output a combined signal.

The downstream signal amplification unit 330 that is used to frequency down and amplify the downstream MIMO signal output from the signal combiner may include an amplifier **a**, frequency down converters **b** and **c** including a local oscillator **b** and a mixer **c**, an amplifier **d**, a filter **e**, and an amplifier **f**, as illustrated in FIG. 4.

For example, as illustrated in FIG. 6, in a traditional superheterodyne amplifier in which an amplifier **a**, frequency down converters **b** and **c** including a local oscillator **b** and a mixer **c**, an amplifier **d**, a filter **e**, amplifiers **f** and **g**, frequency up converters **h** and **i** including a local oscillator **h** and a mixer **i**, an amplifier **j**, a filter **k**, an amplifier **l**, a variable attenuator **m** and an amplifier **n** are sequentially connected in series, when, for convenience of explanation, the configuration of the traditional superheterodyne amplifier is classified into configurations **a** to **f** referred to as a first part and configurations **g** to **n** referred to as a second part, the downstream signal amplification unit 330 of FIG. 4 may include the first part (**a** to **f** of FIG. 6) of the traditional superheterodyne amplifier of FIG. 6.

The MUX is used to combine the downstream MIMO signal output from the downstream signal amplification unit 330 with the downstream (combined) main signal input through the input/output port 302 to output a combined signal through the input/output port 304 connected to one end of a single cable 10 or to output an upstream main signal input through the input/output port 304 from the single cable 304 through the input/output port 302.

Next, the service unit SU 400 of FIG. 3 will be described.

The service unit SU 400 may include a plurality of input/output ports 401 to 403, a signal separation unit 410, a bypass line 420, and a downstream signal amplification unit 430.

The input/output port 401 is used to connect the main unit MU 300 and the service unit SU 400 to each other via the single cable 10, and both ends of the single cable 10 are connected to the input/output port 304 of the main unit MU 300 and the input/output port 401 of the service unit SU 400, respectively.

The input/output port 402 is used to connect service antennas of the main signal, and the input/output port 403 is used to connect service antennas of the MIMO signal.

The signal separation unit 410 is connected to the input/output terminal 401 and is used to separate the main signal and the MIMO signal from each other.

The bypass line 420 is used to connect between the signal separation unit 410 and the input/output port 402 and to bypass the upstream/downstream main signal.

The downstream signal amplification unit 430 is connected between the signal separation unit 410 and the input/output port 403 and is used to frequency up and amplify the downstream MIMO signal. As illustrated in FIG. 5, the downstream signal

amplification unit 430 may include an amplifier **g**, frequency up converters **h** and **i** including a local oscillator **h** and a mixer **i**, an amplifier **j**, a filter **k**, an amplifier **l**, a variable attenuator **m**, and an amplifier **n**.

For example, as illustrated in FIG. 6, in the traditional superheterodyne amplifier in which the amplifier **a**, the frequency down converters **b** and **c** including the local oscillator **b** and the mixer **c**, the amplifier **d**, the filter **e**, the amplifiers **f** and **g**, the frequency up converters **h** and **i** including the local oscillator **h** and the mixer **i**, the amplifier **j**, the filter **k**, the amplifier **l**, the variable attenuator **m** and the amplifier **n** are sequentially connected in series, when, for convenience of explanation, the configuration of the traditional superheterodyne amplifier is classified into the configurations **a** to **f** referred to as a first part and the configurations **g** to **n** referred to as a second part, the downstream signal amplification unit 430 of FIG. 5 may include the second part (**g** to **n** of FIG. 6) of the traditional superheterodyne amplifier of FIG. 6.

The operation of the MIMO signal extension apparatus according to the embodiment of FIG. 3 will be described using a forward path and a backward path divided.

First, the forward path will be described.

A downstream main signal output from the main signal processing unit 311 of the base station device 310 of the main unit MU 300 passes through the amplifier 313 and the signal separation unit 314 and is transmitted to the external signal combiner 540 through the input/output terminal 301.

The external signal combiner 540 combines the downstream main signal from one or more different base station devices 510, 520, and 530 of the existing mobile communication system 500 with the downstream main signal transmitted from the base station device 310 of the main unit MU 300 and then transmits a combined signal to the MUX 340 through the input/output terminal 302 of the main unit MU 300.

A downstream MIMO signal output from the MIMO signal processing unit 312 of the base station device 310 of the main unit MU 300 and a downstream MIMO signal output from the LTE base station device 510 of the existing mobile communication system 500 and input through the input/output terminal 303 are combined with each other by the signal combiner 320, and a combined signal is frequency-down and amplified by the downstream signal amplification unit 300 and is transmitted to the MUX 340.

The MUX 340 combines the downstream main signal received through the input/output terminal 302 of the main unit MU 300 and the downstream MIMO signal received from the downstream signal amplification unit 330 with each other and outputs a combined signal, and a downstream (main + MIMO) signal output from the MUX 340 is extended by a predetermined distance and is transmitted through the single cable 10 connected to the input/output port 304 and is transmitted to the service unit SU 400.

The downstream (main + MIMO) signal input through the input/output port 401 of the service unit SU 400 is input to the signal separation unit 410, and the signal separation unit 410 separates the input downstream (main + MIMO) signal into a downstream main signal and a downstream MIMO signal and outputs the downstream main signal and the downstream MIMO signal to the bypass line 420 and the downstream signal amplification unit 430, respectively. The downstream signal amplification unit 430 frequency ups, restores and amplifies the input downstream MIMO signal and then outputs it.

The downstream main signal via the bypass line 420 and the downstream MIMO signal output from the downstream signal amplification unit 430 are radiated and output to the outside through two service antennas (not shown) connected to two input/output ports 402 and 403 of the service unit SU 400.

Next, the backward path will be described.

A backward, upstream signal from a user terminal (not shown) input through one 402 of two input/output terminals 402 and 403 of the service unit SU 400 is input to the signal separation unit 410 via the bypass line 420 and is output in a backward direction, and an upstream signal output from the signal separation unit 410 is output through the input/output port 401, is extended by a predetermined distance and is transmitted through the single cable 10 and is transmitted to the main unit MU 300.

An upstream signal input through the input/output port 304 of the main unit MU 300 is input to the MUX 340, and the MUX 340 transmits the upstream signal to the signal combiner 540 through the input/output port 302, and the signal combiner 540 separates the upstream signal according to a corresponding base station, transmits a separated signal to the base station devices 510, 520, and 530 of the existing mobile communication system, and furthermore, the upstream signal corresponding to the base station device 310 of the main unit MU 300 is transmitted to the main unit MU 300 via the input/output port 301.

An upstream signal input through the input/output port 301 of the main unit MU 300 is input to the main signal processing unit 311 of the base station device 310 via the signal separation unit 314 and the amplifier 313 and is upstream processed.

INDUSTRIAL APPLICABILITY

As described above, according to the present invention, a multiple input multiple output (MIMO) signal which is applied to a multiple access scheme wireless communication system such as a long term evolution (LTE) communication system, can be extended, by a predetermined distance, to a plurality of service antennas using a single cable and can be effectively relayed together with a signal of a different frequency band or different communication scheme, such as LTE, WCDMA and CDMA 1X, can be extended, by a predetermined distance, to a plurality of service antennas.

That is, signals of various communication schemes and various bands (base stations or repeaters) that different communication business operators or the same communication business operator uses, can be relayed using a single relay apparatus (i.e., a MIMO signal extension apparatus) of a single cable so that a facility cost of the relay apparatus can be remarkably reduced.

In addition, the MIMO signal applied to the multiple access scheme wireless communication system, such as a long term evolution (LTE) communication system, can be effectively relayed without any distortion.

In addition, when the MIMO signal is extended by a predetermined distance or is transmitted from a base station or repeater to a plurality of antennas, a plurality of transmission cables corresponding to the number of MIMO antennas can be commonly used as one transmission cable so that a facility cost of the relay apparatus can be remarkably reduced.

CLAIMS

1. A multiple input multiple output (MIMO) signal extension apparatus comprising a main unit MU, wherein the main unit MU comprises:

a first input/output port through which an upstream/downstream main signal of a first base station device is input/output;

a second input/output port through which a (combined) main signal obtained by combining an upstream/downstream main signal of one or more different communication scheme system base stations (hereinafter, referred to as second base station devices) with an upstream/downstream main signal of the first base station device, is input/output;

a signal combiner configured to combine a MIMO signal from the first base station device with a MIMO signal input through a third input/output port from at least one from among the second base station devices and to downstream output a combined signal;

a first downstream signal amplification unit configured to frequency down and amplify a downstream MIMO signal output from the signal combiner; and

a multiplexer (MUX) configured to combine the downstream MIMO signal output from the first downstream signal amplification unit and a downstream (combined) main signal input through the second input/output port with each other to output a combined signal through a fourth input/output port connected to one end of a single cable or to output an upstream main signal input through the fourth input/output port from the single cable through the second input/output port.

2. The MIMO signal extension apparatus of claim 1, wherein the first base station device comprises:

a main signal processing unit configured to upstream or downstream process a main signal;

a signal separation unit connected between the main signal processing unit and the first input/output port and configured to separate the main signal into an upstream main signal and a downstream main signal; and

a MIMO signal processing unit configured to downstream process the MIMO signal.

3. The MIMO signal extension apparatus of claim 1, further comprising a service unit SU, wherein the service unit SU comprises:

- a fifth input/output port to which the other end of the single cable is connected;
- a sixth input/output port for connecting a main antenna;
- a seventh input/output port for connecting a MIMO antenna;
- a second signal separation unit connected to the fifth input/output port and configured to separate the main signal and the MIMO signal from each other;
- a bypass line configured to connect between the second signal separation unit and the sixth input/output port; and
- a second downstream signal amplification unit connected between the second signal separation unit and the seventh input/output port and configured to frequency up and amplify a downstream MIMO signal.

4. The MIMO signal extension apparatus of claim 3, wherein, in a superheterodyne amplifier comprising a first part in which a frequency down converter and an amplifier are sequentially connected in series, and a second part in which a frequency up converter and an amplifier are sequentially connected in series, the first part and the second part of the superheterodyne amplifier being connected in series, the first downstream signal amplification unit comprises the first part of the superheterodyne amplifier, and the second downstream signal amplification unit comprises the second part of the superheterodyne amplifier.

5. The MIMO signal extension apparatus of claim 1, wherein the first base station device is a base station device of a long term evolution (LTE) system.

6. The MIMO signal extension apparatus of claim 5, wherein the first base station device is a relay device of the base station device of the LTE system.

7. The MIMO signal extension apparatus of claim 5, wherein the first base station device has a service area of a micro cell, a pico cell, a Femto cell or a macro cell.

8. The MIMO signal extension apparatus of claim 1, wherein the second base station devices use a different communication scheme or different frequency band from that of the first base station device.

9. The MIMO signal extension apparatus of claim 8, wherein the second base station devices comprise one or more from among base stations of LTE, WCDMA, and CDMA 1X.