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(54) Title: METHOD FOR RRU BYPASS IN WIRELESS COMMUNICATION NETWORK AND RRU DEVICE

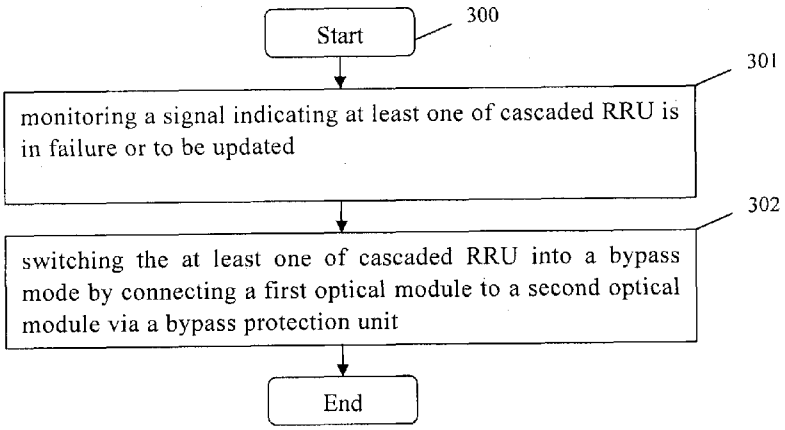

Figure 3

(57) Abstract: The invention discloses a method for RRU bypass in wireless communication network, at least two of the RRUs being cascaded, comprising: monitoring a signal indicating at least one of cascaded RRU is in failure or to be updated; and switching the at least one of cascaded RRU into a bypass mode by connecting a first optical module to a second optical module via a bypass protection unit. A new RRU device with cascading protection is also provided. This enhances the reliability and resilience of the RRU device and the RRU cascading network topology.

METHOD FOR RRU BYPASS IN WIRELESS COMMUNICATION NETWORK AND RRU DEVICE

Technical Field

The present invention relates to communication system, particularly to a method for RRU bypass in radio communication network and a RRU device.

Background

In conventional radio access network systems, the Radio Remote Unit (RRU) is adopted widely. Base on requirements of Common Public Radio Interface (CPRI) protocol and network Operators, the RRU shall support chain, tree, or ring topology architecture. (The tree topology structure may be considered as a merge of several chain topologies)

For chain topology architecture as shown in Figure 1, if any RRU located in the whole chain can not work well, all of the RRUs cascaded with that one do not work, either. For example, in a chain topology as shown in Figure 1, if RRU3 gets into fault status for some reason, it will result in that the, RRU4, RRU5, and RRU6 can not work, either.

For ring topology architecture as shown in Figure 2, if any RRU located in the whole ring can not work well, the ring topology is broken into two chains topology. For example, in a ring topology as shown in Figure 2, if the RRU3 gets into fault status for some reason, it will result in that the original ring topology is broken into two chain topology and RRU4, RRU5 and RRU6 have to build one new cascading chain (all of original configuration will lost and all of RRU4/5/6 have to be reinitialized and reconfigured).

With the increment of RRU cascading application, it has become a hot issue that how to guarantee that in case that any one or more RRUs among the chain or ring topology gets into fault, the cascaded other RRUs can continue to work; and the original chain or ring topology shall be recovered when the fault RRU gets back into normal status again.

Currently, there is no any solution to supply the protection of RRU

cascading application when some one RRU in the cascading chain come cross some failure.

Summary

To this end, the present invention proposes a new design of a RRU device with a bypass protection function and a RRU bypass method. When some fault information of RRU is monitored, the fault RRU will be bypassed, thus supply a protection scheme to the RRU cascading network (such as, chain or ring topology). When the fault RRU gets back to a normal status, it will be put into service within the original chain or ring topology automatically.

In one aspect of the present invention, a method for RRU bypass in wireless communication network where at least two of the RRUs are cascaded is proposed. The method includes: monitoring a signal indicating at least one of cascaded RRU is in failure or to be updated; and switching the at least one of cascaded RRU into a bypass mode by connecting a first optical module to a second optical module via a bypass protection unit.

In a preferred embodiment of the invention, the method further includes: if the at least one of cascaded RRU recovers to a normal working status, switching the RRU into a normal mode by connecting the first optical module to a first internal processing module in the RRU via the bypass protection unit, and connecting the second optical module to a second internal processing module in the RRU via the bypass protection unit.

In a preferred embodiment of the invention, the first internal processing module and the second internal processing module are serial and De-Serial, SERDES, modules.

In a preferred embodiment of the invention, the bypass protection unit is a unit comprising at least one of the following: cross-point switches, cross-point switches with buffer, and FPGA with two SERDES ports, the two SERDES ports being connected directly when the FPGA is in programming mode.

In a preferred embodiment of the invention, when the RRU goes into

bypass mode or returns back to normal mode, the RRU updates delay compensation values depending on an amount of preceding RRUs in failure with respect to the current RRU in a transmission direction of service data from a baseband processing unit (e.g. BBU) to RRU.

In another aspect of the invention, a new RRU device is proposed, comprising: a first optical module configured to connect to a bypass protection unit and convert between optical signal and electric signal; a second optical module configured to connect to the bypass protection unit and convert between optical signal and electric signal; a bypass protection unit configured to monitor a signal indicating the RRU is in failure or to be updated, and switch the RRU into a bypass mode by connecting the first optical module to the second optical module; a first internal processing module configured to communicate data with the first optical module via the bypass protection unit; a second internal processing module configured to communicate data with the second optical module via the bypass protection unit.

According to the above solutions of the invention, a protection scheme can be provided in the RRU chain and ring topology easily. The RRU among the chain or ring topology can be bypassed and automatically put into service via a bypass protection unit. Additionally, it provides a scheme to update/upgrade the RRU application in the whole chain one by one without affecting the remaining RRUs. When some RRU updates/upgrades its application, other RRUs may continue to work. This improves the reliability and resilience of the RRU device and the RRU cascading network.

Brief Description of the Drawings

The features and advantageous of the present invention will be more apparent from the following exemplary embodiments of the invention illustrated with reference to the accompanied drawings, in which

Figure 1 illustrates a schematic diagram of a chain topology architecture of RRU in the prior art;

Figure 2 illustrates a schematic diagram of a ring topology

architecture of RRU in the prior art;

Figure 3 illustrates a schematic diagram of a method for RRU bypass in a cascading network topology according to an embodiment of the present invention;

Figure 4 illustrates a schematic diagram of a circuit in RRU normal mode according to an embodiment of the present invention;

Figure 5 illustrates a schematic diagram of a circuit in RRU bypass mode according to an embodiment of the present invention;

Figure 6 illustrates a schematic diagram of a workflow of RRU protection according to an embodiment of the present invention; and

Figure 7 illustrates a schematic diagram of a RRU device according to an embodiment of the present invention.

Detailed Description

Embodiments of the present invention will be described more fully hereinafter with reference to the accompanied drawings, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

In this disclosure, although terminologies from radio access network system have been used to exemplify the invention, this should not be seen as limiting the scope of the invention to only the aforementioned system. Other systems and devices that can also benefit from the present invention shall be encompassed within the scope of the present invention. Given the rapid development in communications, there will of course also be future type communications systems with which the present invention may be embodied.

Figure 3 illustrates a schematic diagram of a method 300 for RRU bypass in a cascading network topology according to an embodiment of the present invention, where at least two of RRUs are cascaded.

The method 300 shown in Figure 3 particularly includes the following steps:

Step 301: monitoring a signal indicating at least one of cascaded RRU is in failure or to be updated, for example, indicating that the RRU needs to be reset when some fatal error is monitored; and an application software running on the RRU needs to be updated.

The RRU bypass protection unit or some other unit in the cascading network monitors if some fault information indicating, for example, at least one of cascaded RRU in a cascading network topology is in failure or to be updated occurs.

Step 302: switching the at least one of cascaded RRU into a bypass mode by connecting a first optical module to a second optical module via the bypass protection unit.

If the cascaded RRU in a cascading network topology is in failure or to be updated, the RRU bypass protection unit bypasses the RRU in failure or to be upgraded and provides a protection scheme to the chain or ring topology. When the bypass protection unit monitors that the fault RRU goes back to normal status, it will recover the RRU into the original ring or chain topology.

The current RRU used in cascading application has two optical modules, one is called a first optical module and the other is called a second optical module. In order to implement this RRU bypass protection function, a RRU bypass unit may be adopted. Preferably, the RRU bypass unit may be a unit including cross-point switch, more preferably including two high-speed CML cross-point switch blocks. This further improves the switching quality and provides a reliable protection. In particular, the cross point switch may be implemented as at least one of the following:

- CML cross-point switch chipset;
- CML cross-point switch chipset with buffer in order to provide data protection;
- SERDES chipset with cross-point switch function;
- Separated components built to realize the cross-point switch

function; and

- FPGA with two SERDES ports, where two SERDES ports may be connected directly when the FPGA is in programme mode.

The RRU bypass protection unit has two work modes: a normal mode and a bypass mode.

In RRU normal mode, referring to Figure 4, the transmitting port of the first optical module (for example, OIL_A_TX) is connected to the receiving port of the first internal processing module (for example, SERDES_A_RX) and the receiving port of the first optical module (for example, OIL_A_RX) is connected to the transmitting port of the first internal processing module (for example, SERDES_A_TX) via, for example, CML cross-point switch; correspondingly, the transmitting port of the second optical module (for example, OIL_B_TX) is connected to the receiving port of the second internal processing module (for example, SERDES_B_RX) and the receiving port of the second optical module (for example, OIL_B_RX) is connected to the transmitting port of the second internal processing module (for example, SERDES_B_TX) via CML cross-point switch.

In RRU bypass mode, referring to Figure 5, the transmitting port of the first optical module (for example, OIL_A_TX) is connected to the receiving port of the second optical module (for example, OIL_B_RX), and the receiving port of the first optical module (for example, OIL_A_RX) is connected to the transmitting port of the second optical module (for example, OIL_B_TX) via, for example, CML cross-point switch buffer.

When the RRU in failure goes into bypass mode and returns back into normal work mode, the RRU or BBU needs to update the delay compensation values depending on the differential delay compensation scheme. Preferably, the delay compensation values depending on an amount of prior RRUs in failure. Thus it will guarantee that all of RRUs in the chain or ring topology have the same air interface timing when the chain or ring cascading topology is updated.

For example, a delay compensation scheme may include:

Each RRU in the cascading chain is identified as in a normal or bypass mode. The compensation value of each RRU is determined in the following way, for example: if all the preceding RRUs with respect to the current RRU are in the normal mode, the compensation value of the current RRU is zero; if one preceding RRU is in bypass mode, the compensation value is delta; if two preceding RRUs are in bypass mode, the compensation value is 2 × delta. For example, in the chain topology with reference to Figure 1, in the transmission direction of service data (e.g., from BBU to RRU, in the sequence of RRU1 to RRU 6), if RRU 2 and RRU 4 are bypassed when RRU 3 needs to update the delay compensation values, the delay compensation value for RRU 3 will be delta, and the delay compensation value for RRU 5 will be 2 × delta.

Figure 6 shows the workflow of RRU according to an embodiment of the present invention. Based on the RRU status monitored, the RRU bypass protection unit determines if the RRU works in the normal mode or bypass mode.

Figure 7 illustrates a schematic diagram of a new RRU device 700 according to an embodiment of the present invention.

The RRU device 700 includes: a first optical module 701, e.g., OIL-A, configured to connect to a bypass protection unit and convert between optical signal and electric signal; a second optical module 702, e.g., OIL-B, configured to connect to the bypass protection unit and convert between optical signal and electric signal; a bypass protection unit 703, e.g., CML cross-point switch, monitor a signal indicating the RRU is in failure or to be updated, and switch the RRU into a bypass mode by connecting the first optical module to the second optical module; a first internal processing module 704, e.g. SERDES A, configured to communicate data with the first optical module via the bypass protection unit; and a second internal processing module 705, e.g. SERDES B, configured to communicate data with the second optical module via the bypass protection unit.

The first optical module 701, e.g., OIL-A, converts between optical

signal and electric signal to communicate with previous level RRU or BBU via optical signal and with bypass protection unit via electric signal.

The second optical module 702, e.g., OIL-B, converts between optical signal and electric signal to communicate with succeeding RRU via optical signal and with bypass protection unit via electric signal.

The bypass protection unit 703, e.g., CML cross-point switch, implements the supervision function of RRU status and switches the RRU work mode between normal and bypass.

Preferably, the bypass protection unit 703 is further configured to, if the RRU recovers to a normal working status, switch the RRU into a normal mode by connecting the first optical module 701 to the first internal processing module 704, and connecting the second optical module 702 to the second internal processing module 705.

The bypass protection unit 703 is a unit including at least one of the following: cross-point switches, cross-point switches with buffer, and FPGA with two SERDES ports, the two SERDES ports being connected directly when the FPGA is in programming mode.

The bypass protection unit 703 may be integrated into the RRU or separately from the RRU physically.

The first internal processing module, e.g. SERDES A, converts between high speed serial data and parallel data, and communicates the data from the first optical module to the other internal function blocks of RRU (for example, CPRI framing/de-framing function block).

The second internal processing module, e.g. SERDES B, converts between high speed serial data and parallel data, and communicates the data from the second optical module to the other internal function blocks of RRU.

In a preferred embodiment of the present invention, the RRU may further include a module for updating delay compensation values. The delay compensation value of each RRU may depends on an amount of preceding RRUs in failure or to be upgraded with respect to the current RRU in a transmission direction of service data from baseband processing

unit (e.g. BBU) to RRU when the current RRU goes into bypass mode or returns back to normal mode. The baseband processing unit may include all the devices with the same functionality as the BBU in the embodiments of the present invention.

According to the new RRU device of the present invention, it could supply a RRU cascading protection scheme in the RRU chain and ring topology easily and the RRU among the chain or ring topology can be bypassed and automatically put into service based on the monitored status. It can also provide a scheme to update the RRU application in the whole chain one by one. When some RRU updates its application, the others can continue to work. This enhances the reliability and resilience of the RRU device and the RRU cascading network topology.

The unit(s) or module(s) comprised in the device/apparatus according to some embodiments may be any unit normally used for performing the involved tasks, e.g., a hardware, such as a processor with a memory.

The invention may be implemented in any suitable form including hardware, software, firmware or any combination thereof. Specifically, the invention may be implemented as computer software running on one or more data processors and/or digital signal processors. The elements and components of an embodiment of the invention may be physically, functionally and logically implemented in any suitable way. Indeed, the functionality may be implemented in a single unit, in a plurality of units or as part of other functional units. As such, the invention may be implemented in a single unit, or may be physically and functionally distributed between different units and processors.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit to the invention. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless otherwise stated. It will be further understood that the terms “comprising”, “including” and conjugation thereof when used herein, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the

presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

Although the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made without departing from the spirit and scope of the invention as defined by the appended claims. The exemplary embodiments should be considered in descriptive sense only and not for purposes of limitation. Therefore, the scope of the invention is defined not by the detailed description of the invention but by the appended claims, and all differences within the scope will be construed as being included in the present invention.

Claims

1. A method (300) for RRU bypass in wireless communication network, at least two of the RRUs being cascaded, comprising:

monitoring (301) a signal indicating at least one of cascaded RRU is in failure or to be updated; and

switching (302) the at least one of cascaded RRU into a bypass mode by connecting a first optical module to a second optical module via a bypass protection unit.

2. The method according to claim 1, further comprising:

if the at least one of cascaded RRU recovers to a normal working status, switching the RRU into a normal mode by

connecting the first optical module to a first internal processing module in the RRU via the bypass protection unit, and

connecting the second optical module to a second internal processing module in the RRU via the bypass protection unit.

3. The method according to claim 2, wherein the first internal processing module and the second internal processing module are serial and De-Serial, SERDES, modules.

4. The method according to claim 1 or 2, wherein the bypass protection unit is a unit comprising at least one of the following: cross-point switches, cross-point switches with buffer, and FPGA with two SERDES ports, the two SERDES ports being connected directly when the FPGA is in programming mode.

5. The method according to any one of claims 1-3, wherein when the RRU goes into bypass mode or returns back to normal mode, the RRU updates delay compensation values depending on an amount of preceding RRUs in failure with respect to the current RRU in a transmission direction of service data from a baseband processing unit to RRU.

6. A RRU device (700), comprising:

a first optical module (701), configured to connect to a bypass protection unit and convert between optical signal and electric signal;

a second optical module (702), configured to connect to the bypass protection unit and convert between optical signal and electric signal;

a bypass protection unit (703), configured to monitor a signal indicating the RRU is in failure or to be updated, and switch the RRU into a bypass mode by connecting the first optical module to the second optical module;

a first internal processing module (704), configured to communicate data with the first optical module via the bypass protection unit; and

a second internal processing module (705), configured to communicate data with the second optical module via the bypass protection unit.

7. The RRU device according to claim 6, the bypass protection unit (703) is further configured to:

if the RRU recovers to a normal working status, switch the RRU into a normal mode by

connecting the first optical module (701) to the first internal processing module (704), and

connecting the second optical module (702) to the second internal processing module (705).

8. The RRU device according to claim 7, wherein the first internal processing module (704) and the second internal processing module (705) are serial and De-Serial, SERDES modules.

9. The RRU device according to claim 6 or 7, wherein the bypass protection unit (703) is a unit comprising at least one of the following: cross-point switches, cross-point switches with buffer, and FPGA with two SERDES ports, the two SERDES ports being connected directly when the FPGA is in programming mode.

10. The RRU device according to any one of claims 6-8, wherein the RRU further comprises a module for updating delay compensation values depending on an amount of preceding RRUs in failure with respect to the current RRU in a transmission direction of service data from a baseband processing unit to RRU when the RRU goes into bypass mode or returns

back to normal mode.

11. The RRU device according to 9, wherein the bypass protection unit (703) is integrated into the RRU device or separately from the RRU device physically.

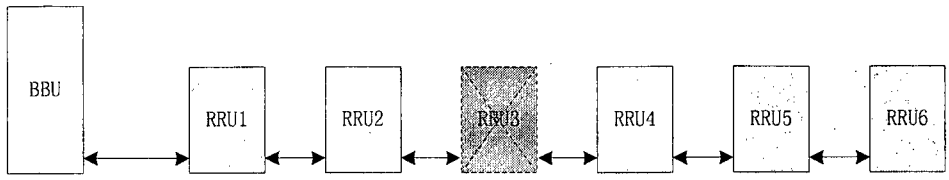

Figure 1 (Prior Art)

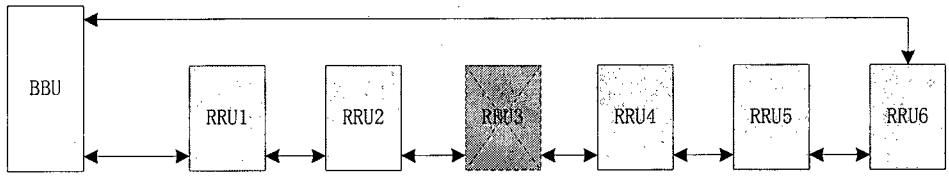

Figure 2 (Prior Art)

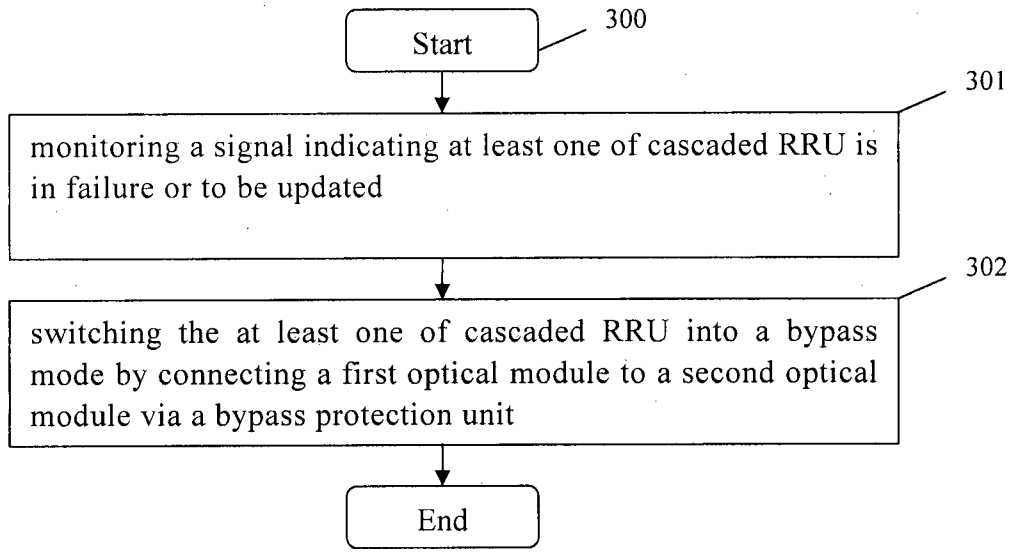

Figure 3

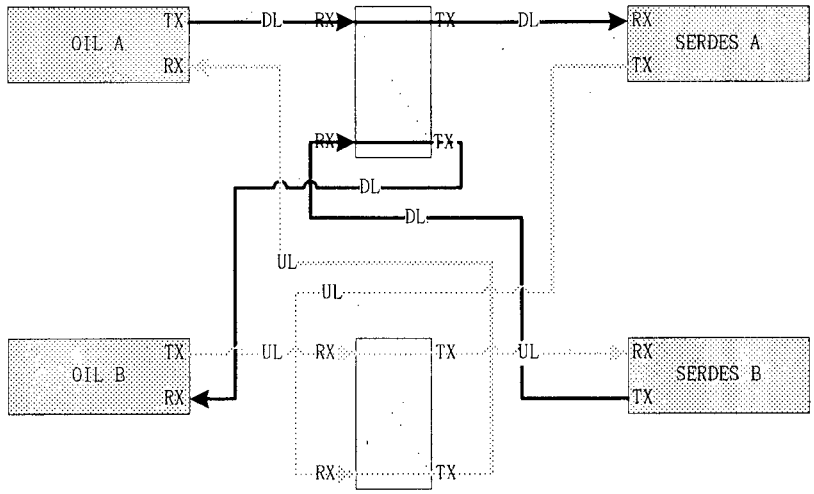

Figure 4

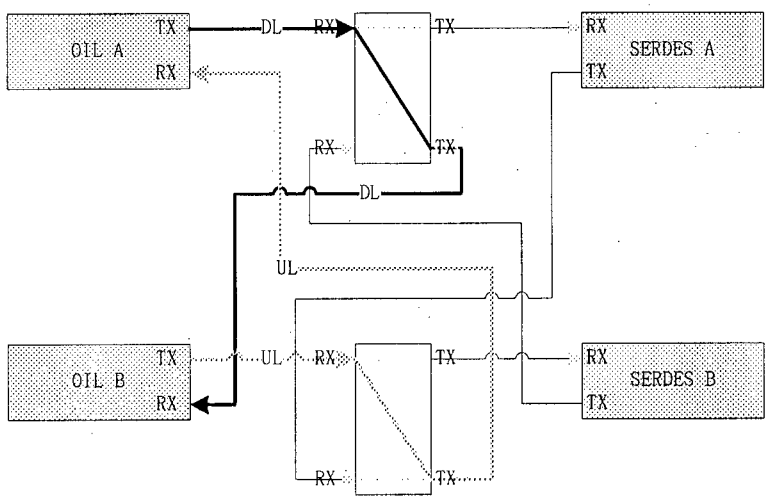

Figure 5

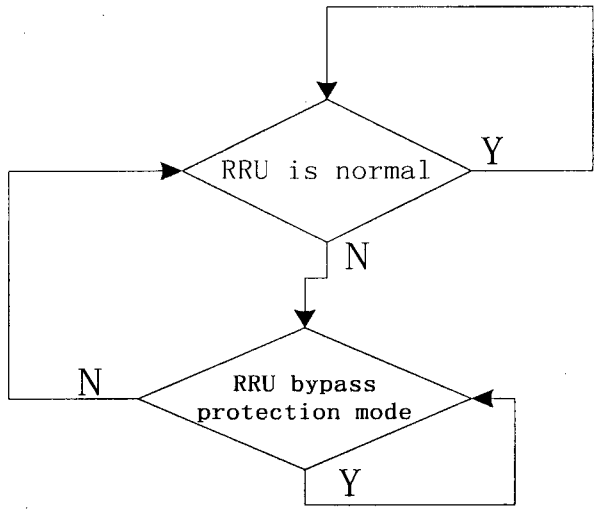

Figure 6

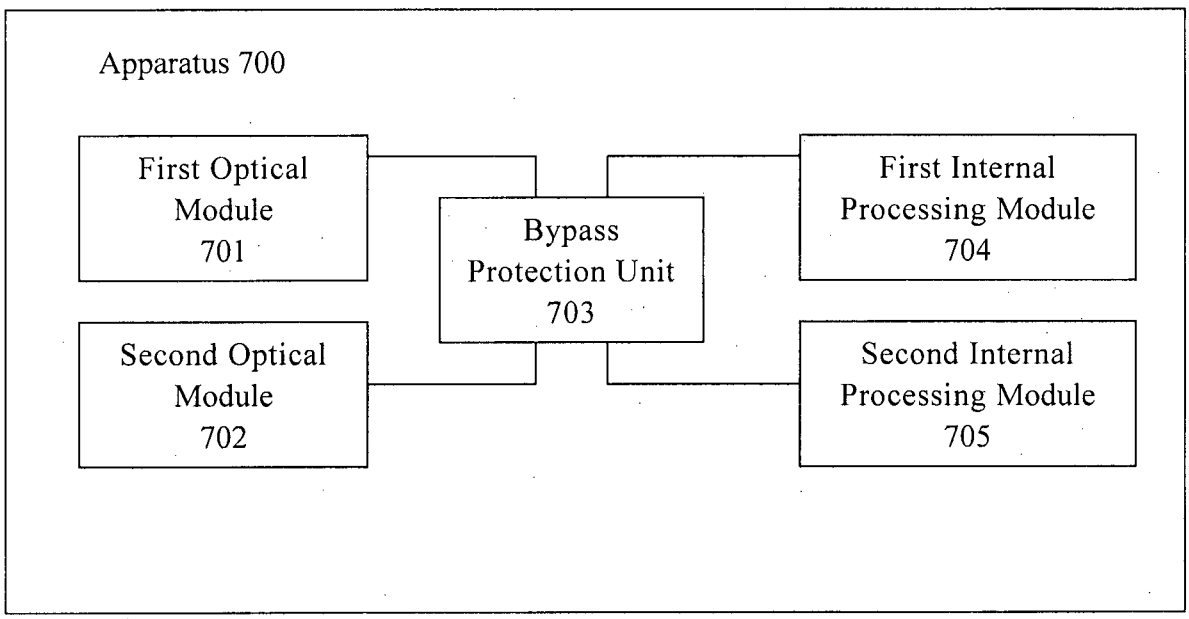

Figure 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2011/000133

A. CLASSIFICATION OF SUBJECT MATTER

H04W88/08 (2009.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04W;H04Q;H04B;H04L;H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI;EPODOC;CNKI;IEEE;CNPAT: radio,remote,unit,RRU,optical,failure,update,reset,error,fault,bypass,update.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN1885750A (SHANGHAI HUAWEI TECHNOLOGIES CO., LTD.) 27 Dec. 2006 (27.12.2006) page 2 line 4 to page 7 line 15 in description, figures 2,4a,4b,5a,5b	1-11
A	CN1852504A (SHANGHAI HUAWEI TECHNOLOGIES CO., LTD.) 25 Oct. 2006 (25.10.2006) the whole document	1-11
A	CN101325754A (HUAWEI TECHNOLOGIES CO., LTD.) 17 Dec. 2008 (17.12.2008) the whole document	1-11
A	CN101035350A (ZTE CORP.) 12 Sep. 2007 (12.09.2007) the whole document	1-11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 Aug. 2011 (29.08.2011)	**29 Sep. 2011 (29.09.2011)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer HE,Linlin Telephone No. (86-10)62413429

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN1885750A	27.12.2006	NONE	
CN1852504A	25.10.2006	WO2007009394A1	25.01.2007
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