Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).
Description

Background of the Invention

Field of the Invention

[0001] This invention relates to a maintenance signal corresponding to a mini slot signal in a slot according to international standard ITU-T G.983.1 regulating a physical interface in a PON (Passive Optical Network) and a method for controlling a state in dynamic bandwidth assignment (DBA) for upstream by using the mini slot signal.

Description of the related Art

[0002] Fig. 3 illustrates an example of a configuration of a system in the PON including a DBA function, in which an OLT (optical line terminator - parent station) 101 and a plurality of ONU's (optical network terminating units - child stations) 102-104 are coupled to by a star coupler 105. Fig. 4 illustrates a downstream frame format 151 and an upstream frame format 152 in the PON according to international standard ITU-T G.983.1 regulating a physical interface in the PON according to the related art. Fig. 5 shows a state transition table for managing a state of an individual ONU dealing unit in the OLT according to international standard ITU-T G.983.1 regulating an operation by the OLT for controlling starting and halting of an individual ONU. Fig. 6 illustrates an example of a condition of detecting and resetting according to international standard ITU-T G.983.1 related to a maintenance signal provided for each of the ONU's indicating a state of receiving an ATM (asynchronous transfer mode) cell and PLOAM (Physical Layer Operation Assignment and Maintenance) cell in an upstream frame in the OLT. Further, Fig. 7 illustrates a format of a mini slot in a slot according to international standard ITU-T G.983.1 related to the upstream frame.

[0003] In Fig. 3, the OLT 101 includes an individual ONU dealing unit 106B, a generator 107 for downstream frame, a controller 108 for upstream band, a DBA controller 109B, a terminator 110 of upstream frame, and a terminator 111 of mini slot. The ONU 103 includes a terminator 112 of downstream frame, a detector 113 for upstream band, a cell buffer 114 for upstream, a monitor 115 for buffer state, and a cell generator 116 for upstream.

[0004] With reference to Fig. 3, an operation in the PON is explained.

[0005] The OLT 101 receives a main signal 122 of downstream including an ATM cell, and generates a frame signal 124 of downstream by the generator 107 for downstream frame. Particularly, the generator 107 for downstream frame receives control information 126 on the ONU from the individual ONU dealing unit 106B and information 125 on an upstream band from the controller 108 for upstream band, generates a PLOAM cell of downstream, and inserts the generated PLOAM cell into the frame signal 124 of downstream. The individual ONU dealing unit 106B exchanges information on each of the ONU's as a control signal 121 with an external operation system.

[0006] A frame signal 129 of upstream sent from each of the ONU's is terminated. A regular cell is terminated by the terminator 110 of upstream frame, and a mini slot is terminated by the terminator 111 of mini slot. The terminator 110 of upstream frame detects a PLOAM cell of upstream when the regular cell is terminated, and notifies the individual ONU dealing unit 106B of control information 130 on the ONU corresponding to the PLOAM cell. At the same time, the terminator 110 of upstream frame outputs a main signal 123 of upstream when the ATM cell besides the PLOAM cell is detected. State information 131 on a cell buffer for upstream of an ONU corresponding to the mini slot terminated by the terminator 111 of mini slot is sent to the DBA (Dynamic Bandwidth Assignment) controller 109B. Further, state information 132 corresponding to the individual ONU and information 133 on the upstream band is sent to the DBA controller 109B and the controller 108 for upstream band, and an operation of dynamic bandwidth assignment (DBA) for upstream is performed.

[0007] The ONU 103 extracts a main signal 141 of downstream including an ATM cell directed to the ONU 103 as the terminator 112 of downstream frame terminates a downstream frame signal 143. Particularly, a PLOAM cell 144 of downstream is extracted, and control information 145 on outputting the upstream cell is output to the cell generator 116 for upstream by the detector 113 for upstream band.

[0008] Further, a main signal 142 of upstream including the ATM cell is maintained in the cell buffer 114 for upstream once, and read out as information 146 on the cell based on an instruction from the cell generator 116 for upstream. A header is attached to the information 146 on the cell by the cell generator 116 for upstream, and the information 146 on the cell is output as a frame signal 149 of upstream. Information 147 on the cell buffer 114 for upstream is always monitored by the monitor 115 for buffer state, and output to the cell generator 116 for upstream as information 148 on a buffer state for mapping in the mini slot.

[0009] In the following, with reference to Fig. 4, a frame format of upstream and a downstream frame used in the PON system is explained.

[0010] In Fig. 4, the frame format 151 of downstream includes 56 ATM cells in a fixed length of 53 bytes located consecutively. Among the cells, the first cell and the 29th cell are PLOAM cells for monitoring and controlling between the OLT and the ONU.

[0011] The upstream frame format 152 includes 53 cells of 56 bytes. 56 bytes include 3 bytes of overhead and 53 bytes of ATM cells. It is also possible that the PLOAM cell is provided in an ATM cell at an arbitrary position. According to international standard ITU-T G.
In a system configuration illustrated in Fig. 3, the OLT 101 manages a state of each of the ONU’s 102-104 connected to the PON individually based on a state transition table of the individual ONU dealing unit in the OLT illustrated in Fig. 5.

[0012] In the following, a state transition operation of the individual ONU dealing unit in the OLT illustrated in Fig. 5 is explained.

[0013] In Fig. 5, columns arranged horizontally illustrate an initial state (OLT-IDV1), a state of measuring delay (OLT-IDV2), and an operation state (OLT-IDV3). The initial state (OLT-IDV1) illustrates a state of initializing a start operation temporally as a corresponding ONU is not started or there is a certain failure. The state of measuring delay (OLT-IDV2) illustrates a state of measuring a delay in-transmission of a cell due to a transmission distance between the OLT and the ONU. The operation state (OLT-IDV3) illustrates a state of transmitting an upstream cell in timing in which the ONU compensated the delay in upstream by measuring the delay in the transmission distance and informing the ONU of information on the measured delay by the OLT.

[0014] Rows arranged from a top to a bottom regulate a horizontal direction, and illustrate four state transition events: instructing to start measuring delay (n), completing measuring delay (n), detecting abnormality of measuring delay (n), and detecting each of maintenance signals (LOSi, CPEi, LCDi, OAMLi, LOAi, R-INHi). In this description, n means the number of ONU. Instructing to start measuring delay (n) is an instruction issued in the initial state when the ONU is started. Completing measuring delay (n) is issued to the ONU which is measured the delay in the state of measuring delay when the delay is measured normally. Detecting abnormality of measuring delay (n) is issued to the ONU which is measured the delay in the state of measuring delay when the delay is not measured normally. Each of the maintenance signals is a signal detected and reset in the operation state in each of conditions illustrated in Fig. 6.

[0015] With reference to Fig. 5, an operation of a third ONU (n=3) is explained as an example. The third ONU which is in the initial state (OLT-IDV1) receives a state transition event of instructing to start measuring delay (n), and a state transits to the state of measuring delay (OLT-IDV2). When measuring of the delay is completed, a state transition event of completing measuring delay (n) is received, and the state transits to the operation state (OLT-IDV3). However, when measuring of the delay is failed due to a certain reason, a state transition event of detecting abnormality of measuring delay (n) is received, and the state transits to the initial state (OLT-IDV1). The individual ONU dealing unit in the OLT corresponding to the third ONU which is in the operation state (OLT-IDV3) begins to monitor each of the maintenance signals (LOSi, CPEi, LCDi, OAMLi, LOAi, R-INHi) corresponding to the third ONU. When at least one of the maintenance signals is detected, the state transits to the initial state (OLT-IDV1). After then, the individual ONU dealing unit in the OLT corresponding to the third ONU which is not in the operation state is started to go back to the operation state by a state transition event of instructing to start measuring delay (n) which occurs regularly.

[0016] An operation of the mini slot signal illustrated in Fig. 7 is explained.

[0017] The ONU which is in the operation state communicates by using the downstream frame format 151 and the upstream frame format 152 as illustrated in Fig. 4. In a certain phase of a cell, there is a case in which a certain cell is used in a slot 162 of an upstream frame 161 illustrated in Fig. 7 and the ONU sends a mini slot signal 163. In this case, when the OLT sets a phase of an upstream cell in the slot 162, a plurality of ONU’s send the mini slot signals 163 in the slot 162. In this case, the mini slot signals 163 sent from the plurality of ONU’s are controlled by the OLT for preventing collision. For preventing the collision, the OLT sets a phase (offset) from a beginning of the slot 162 and information on length of the mini slot signal 163 corresponding to the ONU in the ONU’s individually.

[0018] In the following, as an example of operating a system using the mini slot signal illustrated in Fig. 8, control in dynamic bandwidth assignment (DBA) for upstream is explained.

[0019] The dynamic bandwidth assignment (DBA) for upstream is performed by using a mini slot signal including a function equivalent to an individual communication channel besides a regular cell from the plurality of ONU’s to the OLT. By using the mini slot signal, each of the ONU’s informs the OLT of a buffer state of upstream in the ONU. Then, the OLT extracts a content of the mini slot signal, and detects a buffer state in each of ONU’s. It is a control method for reallocating the upstream bandwidth dynamically to each of the ONU’s based on the information in the mini slot signal. For applying this control method, it is necessary that the OLT detects if the ONU can deal with the mini slot signal before controlling the bandwidth by using the mini slot.

[0020] In Fig. 8, arrangement 171 of cells in the upstream frame when the OLT provides an arbitrary band of upstream for each of the ONU’s is illustrated. In the arrangement 171 of cells for upstream, ONU#1 shows a cell sent from a first ONU in a band allocated for the first ONU. ONU#2 and ONU#3 also show cells. In this state, all of the ONU’s informs the OLT of a cell buffer state for upstream by using the mini slot signal constantly. For example, when it is judged that the cell buffer state for upstream in the first ONU exceeds a threshold value of the buffer determined by the OLT, the OLT temporarily allocates a bandwidth wider than a present bandwidth of the upstream band. Therefore, the arrangement 171 of the cells is changed to an arrangement 172 of the cells in the upstream frame. The arrangement 172 indicates that an utilized upstream band is allocated to the first ONU.
[0021] A control method using the mini slot signal in the slot according to international standard ITU-T G. 983.1 regulating the physical interface in the PON according to the related art only describes a configuration of a format of the slot. There isn’t any definition about maintenance signal by the mini slot. There isn’t also any definition of using the mini slot for DBA request, and of controlling method for the mini slot. Therefore, it is impossible to monitor and control a receiving state of the regular cell and the mini slot signal individually. For example, when the maintenance signal of the regular cell illustrated in Fig. 6 is used for the mini slot signal, even if only the mini slot signal operates in failure, it is judged as a state transition of the regular cell of the ONU by the individual ONU dealing unit 106B in the OLT illustrated in Fig. 5, and whole communication is suspended

[0022] Further, Fig. 9 illustrate a state of failure of the mini slot signal in the slot 181. As illustrated, when the ONU misjudges a phase of transmission of the mini slot signal, there is a possibility of the collision with another cell or mini slot signal sent from another ONU, located before and after the mini slot signal. In such a case, there is no method of individually controlling the mini slot signal in failure by misjudging the phase of transmission, a state of the collision is maintained, and transmission of the cell or mini slot from another ONU is prevented continuously. Particularly, when the assignment of the upstream band to the ONU is controlled dynamically by using the mini slot signal, communication by all of the other ONU’s is prevented by the failure of the mini slot signal of one ONU as in this case.

[0023] US-A-5,917,813 discusses a multiple access telecommunications network wherein a primary station is coupled to a plurality of secondary stations. The communication channels are split into access cells which are further divided into mini-slots, which are utilised for submitting access requests between the primary and secondary stations. No discussion is made, however, about setting maintenance signals at the primary station for properly aligning these mini-slots to allow uninterrupted communication.

[0024] US-A-5,963,557 discloses a method and system for communication in a network using three types of channel. Each of the channels is divided into slots or mini-slots for the transmission of data and for reservation requests for requesting specific slots from the central controller. No discussion is made as to methods for setting maintenance signals at the central controller, rather the mini-slots are stated as being reduced in size to avoid collisions.

[0025] US-A-5,953,344 introduces a system for dynamically controlling the communication traffic. Here, the number of data-slots and mini-slots is varied as a result of the type of traffic being sent, which is disclosed as being for increasing the bandwidth of the communication channel. Once more, there is no discussion as to setting maintenance signals for aligning the mini-slots, in order to give uninterrupted communication.

[0026] WO 99/09690 covers a system for dynamically associating bandwidth in a communication system, which does not simply rely on providing the maximum bandwidth to the end user. Here again, there is no discussion of the provision of maintenance signals for avoiding collisions and giving uninterrupted communication.

Summary of the Invention

[0027] It is one of objects of this invention to solve the above-stated problems in the related art. By controlling an apparatus in a method besides a control method using the regular cell, the dynamic bandwidth assignment (DBA) can be performed without interrupting the communication of the regular cell and interrupting the communication between child stations.

[0028] According to an aspect of this invention, a control system uses a mini slot signal in a passive optical network. The passive optical network includes a parent station (OLT: optical line terminal) and a plurality of child stations (ONU: optical network terminating unit) for transmitting an upstream frame and a downstream frame each other. The parent station includes an individual ONU dealing unit for providing a maintenance signal corresponding to each of the plurality of child stations concerning on a mini slot and controlling state transition in dynamic bandwidth assignment (DBA) for each of the plurality of child stations by using the maintenance signal concerning on the mini slot.

[0029] The parent station instructs a corresponding child station to transit to a state beside an operation state when one of failures of receiving an effective mini slot signal from the child station and receiving a mini slot in a correct phase is detected as a maintenance signal concerning on the mini slot signal.

[0030] According to another aspect of this invention, a control method uses a mini slot signal in a passive optical network. The passive optical network includes a parent station (OLT: optical line terminal) and a plurality of child stations (ONU: optical network terminating unit) for transmitting an upstream frame and a downstream frame each other. The control method provides a maintenance signal corresponding to each of the plurality of child stations concerning on a mini slot and controls state transition in dynamic bandwidth assignment (DBA) for each of the plurality of child stations by using the maintenance signal concerning on the mini slot by an individual ONU dealing unit in the parent station.

[0031] The control method instructs a corresponding child station to transit to a state beside an operation state by the parent station when one of failures of receiving an effective mini slot signal from the child station and receives a mini slot in a correct phase is detected as a maintenance signal concerning on the mini slot signal.

[0032] According to this invention, it is possible to monitor the mini slot signal in each of the ONU’s individually besides the regular cell by providing a maintenance signal for the mini slot signal besides the regular cell when
the OLT receives the mini slot signal.

[0033] Further features and applications of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only and they can be readily combined with each other resulting in further embodiments.

[0034] Other objects, features, and advantages of the invention will be apparent from the following description when taken in conjunction with the accompany drawings.

Brief Description of the Drawings

[0035]

Fig. 1 illustrates an example of a maintenance signal for a mini slot signal provided in Embodiment 1 of this invention;

Fig. 2 shows a state transition table corresponding to the dynamic bandwidth assignment (DBA) for upstream by using the mini slot signal in Embodiment 1 of this invention;

Fig. 3 shows a configuration chart for explaining the PON system and the function of the OLT and the ONU;

Fig. 4 illustrates a frame format of downstream and an upstream frame according to international standard ITU-T G.983.1 regulating the physical interface in the PON;

Fig. 5 shows a state transition table of the individual ONU dealing unit (n) in the OLT according to international standard ITU-T G.983.1 regulating the physical interface in the PON;

Fig. 6 illustrates an example of the maintenance signal for monitoring each of the ONU’s by the OLT according to international standard ITU-T G.983.1 regulating the physical interface in the PON;

Fig. 7 shows a configuration chart of an upstream frame, a slot and a mini slot according to international standard ITU-T G.983.1 regulating the physical interface in the PON;

Fig. 8 shows an explanatory chart of an operation of dynamic bandwidth assignment (DBA) for upstream by using the mini slot signal; and

Fig. 9 shows a chart for explaining that a mini slot signal in a slot misjudges a phase of transmission and that prevents transmission of another regular cell or mini slot signal.

Detailed Description of the Preferred Embodiments

Embodiment 1.

[0036] Embodiments of this invention are explained.

[0037] A maintenance signal for a mini slot signal and an operation of this invention are explained by Fig. 1 and Fig. 2.

[0038] In Fig. 1, as types of the maintenance signal, failure of receiving a mini slot signal (LOS-Di) 151, out-of-synchronization of the mini slot signal (LCD-Di) 152, error in a phase of receiving the mini slot signal (CPE-Di) 153, error in a block of the mini slot signal (ERR-Di) 154 are provided besides the maintenance signal of the regular cell.

[0039] Fig. 2 shows a state transition table for corresponding the maintenance signals for the mini slot signal described in Fig. 1 to a state of controlling the ONU individually by the OLT. An operation of this invention is explained by Fig. 1 and Fig. 2. As illustrated in Fig. 2, an individual ONU dealing unit 106 and a DBA controller 109, which are provided additionally, manage and control by performing the dynamic bandwidth assignment (DBA) for upstream corresponding to each of the ONU’s individually. In this embodiment, the individual ONU dealing unit 106 and the DBA controller 109 provide three states, i.e., halt state of DBA (DBA-ST1) S1, wait state of DBA operation (DBA-ST2) S2 and DBA operation state (DBA-ST3) S3 arranged horizontally in Fig. 2 as states of controlling the DBA by using the mini slot signal. Further, as state transition events for changing the states, the state transition events are regulated sequentially from the top to the bottom in Fig. 2. Event 11 of detecting the instruction for halting the DBA function for instructing if a function of the DBA is operated, and event 12 of detecting a state in which the OLT controls the ONU individually and one of maintenance signals IDV1, IDV2, LOSi, LCDi, CPEi, OAMLi, LOAi, and R-INHi are provided. Further, event I3 of detecting IDV3 without detecting the instruction of halting the DBA function, and event 14 of recognizing an ONT-DBA type are provided. Finally, an event 15 of detecting CPE-Di which is a maintenance signal of the mini slot signal is provided. A number of a child station of 1-n is shown as i.

[0040] The maintenance signal for the mini slot signal described in Fig. 1 is explained.

[0041] When an O/E receiver for dealing ONUi in the OLT does not receive an effective optical signal in an expected period for receiving an upstream mini slot signal n times consecutively, it is judged that interruption of receiving a mini slot signal (LOS-Di) is detected. When the OLT receives an optical signal matched with its slot GRANT in the DBA operation state (DBA-ST3), it is judged that the interruption of receiving the mini slot signal (LOS-Di) is reset.

[0042] When the receiver for dealing ONUi in the OLT receives an ineffective delimiter n times consecutively, it is judged that out-of-synchronization of the mini slot signal (LCD-Di) is detected. When a mini slot signal in a correct phase is received in the DBA operation state (DBA-ST3), it is judged that the out-of-synchronization of the mini slot signal (LCD-Di) is reset.

[0043] When a phase of a received mini slot signal exceeds a limit causing the OLT uncontrollable in a period when the OLT can receive a correct delimiter, it is judged
that error in a phase of receiving the mini slot signal (CPE-Di) is detected. When a mini slot signal in a correct phase is received, it is judged that the error in the phase of receiving the mini slot signal (CPE-Di) is reset.

[0044] When a result of CRC (cyclic redundancy check) attached to the mini slot signal and a result of CRC by the OLT are not matched, it is judged that error in a block of the mini slot signal (ERR-Di) is detected. When a next mini slot signal is received, it is judged that error in the block of the mini slot signal (ERR-Di) is reset.

[0045] In the PON system using the maintenance signal corresponding to the mini slot signal as explained with reference to Fig. 1, the individual ONU dealing unit 106 in the OLT relates a state of controlling the ONU individually with a maintenance signal for the mini slot signal. Further, the DBA controller 109 controls dynamic bandwidth assignment (DBA) for upstream corresponding to each of ONU's individually. The OLT performs the dynamic bandwidth assignment (DBA) for upstream based on the state transition table illustrated in Fig. 2.

[0046] With reference to Fig. 2, controlling state transition of the mini slot signal for performing the dynamic bandwidth assignment (DBA) for upstream is explained. How the individual ONU dealing unit 106 in the OLT relates a state of controlling the ONU individually with the maintenance signal for the mini slot signal is explained.

[0047] After the individual ONU dealing unit 106 in the halt state of DBA (DBA-ST1), i.e., a state before detecting an instruction of stopping DBA function, detects that a state of the individual ONU dealing unit (n) in the OLT is IDV3 (operation state), the individual ONU dealing unit 106 instructs the ONU to be in the state transits to the wait state of DBA operation (DBA-ST2). Then, when a certain maintenance signal (LOS-Di, CPE-Di, OAML-Di, LOAi, R-INHi) for the regular cell is detected or IDV1 (initial state) or IDV2 (state of measuring delay) is detected as a state of the individual ONU dealing unit in the OLT, it is judged that the concerning ONU is not in the operation state. Then, the slot GRANT is reset, and the state transits to the halt state of DBA (DBA-ST1) again.

[0048] Further, when the individual ONU dealing unit in the wait state of DBA operation (DBA-ST2) recognizes an ONT-DBA type by ITU-TG.983.2, the slot GRANT is set, and the state transits to the DBA operation state (DBA-ST3). When a certain maintenance signal (LOS-Di, CPE-Di, OAML-Di, LOAi, R-INHi) is detected, or the state of the individual ONU dealing unit (n) in the OLT is either IDV1 or IDV2, the individual ONU dealing unit (n) in the OLT which is the DBA operation state (DBA-ST3) judges that the concerning ONU is not in the operation state. Then, setting of the slot GRANT is reset, and the state transits to the halt state of DBA (DBA-ST1) again. Further, when error in the phase of receiving the mini slot signal (CPE-Di (n)) which is a maintenance signal concerning on the mini slot signal is detected, setting of the slot GRANT is reset, and the state transits to the wait state of DBA operation (DBA-ST2).

[0049] Further, when the DBA controller 109 which controls the dynamic bandwidth assignment (DBA) function individually detects the instruction of halting DBA function for a purpose of halting the dynamic bandwidth assignment (DBA) function, the state transits to the halt state of DBA (DBA-ST1).

[0050] In this embodiment, only the error in the phase of receiving the mini slot signal (CPE-Di) is set as an event. However, in addition to the error in the phase of receiving the mini slot signal (CPE-Di), it is possible to set events of out-of-synchronization of the mini slot signal (LCD-Di) and interruption of receiving the mini slot signal (LOS-Di) as OR condition.

[0051] In this embodiment, when a state as illustrated in Fig. 9 occurs, since phases of mini slot signal 1 and mini slot signal 2 are not correct, CPE-Di is detected. Therefore, this child station is controlled to become the state of DBA-ST2. Further, an instruction on the phase is sent to this child station in a downstream frame. The child station corrects the phase based on the instruction. As stated, an influence on another child station is temporary.

[0052] According to this invention, it is possible to monitor the mini slot signal in each of the ONU's individually besides the regular cell by providing a maintenance signal for the mini slot signal besides the regular cell when the OLT receives the mini slot signal. Further, by providing the state transition table corresponding to the dynamic bandwidth assignment (DBA) for upstream by using the mini slot signal, when a failure, e.g., the error in the phase of sending the mini slot signal, etc. occurs in an ONU, only the mini slot signal in failure can be separated from the regular cell and other mini slot signals of which communication is interfered with. Accordingly, it is possible to reduce an interference with the communication of other ONUs by the mini slot signal in failure.

[0053] Having thus described several particular embodiments of the invention, various alterations, modifications, and improvements will readily occur to those skilled in the art. Accordingly, the foregoing description is by way of example only and is limited only as defined in the following claims and the equivalents thereto.

Claims

1. A control system using a mini slot signal in a passive optical network including a parent station OLT (optical line terminal) and a plurality of child stations ONU (optical network terminating unit) for transmitting an upstream frame and a downstream frame to each other, the parent station comprising:

an individual ONU dealing unit (106) for providing a maintenance signal corresponding to each of the plurality of child stations for a mini slot and controlling state transition in dynamic bandwidth assignment (DPB) for each of the plurality of the child stations by using the maintenance signal

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for the mini slot,

characterized in that the parent station is adapted to set the maintenance signal by detecting at least one of the following failures:

(1) the individual ONU dealing unit does not receive an effective optical signal in an expected period for the mini slot in the upstream frame,
(2) the individual ONU dealing unit receives an ineffective delimiter consecutively n times (n is a positive integer), and
(3) the parent station fails to control exceeding phase of the mini slot while receiving a correct delimiter.

2. The control system using the mini slot signal in the passive optical network of claim 1, wherein the parent station comprises means for dynamic bandwidth assignment for the upstream corresponding to each of the child stations.

3. The control system using the mini slot signal in the passive optical network of claim 1, wherein the parent station comprises means which relate a state of controlling the child station individually with a maintenance signal for the mini slot signal for controlling the bandwidth of the stream in the upstream frame.

4. The control system using the mini slot signal in the passive optical network of claim 1, wherein the parent station comprises means which relates a state of controlling the child station individually with the maintenance signal.

5. The control system using the mini slot signal in the passive optical network of claim 1, wherein the positive integer is eight.

6. The control system using the mini slot signal in the passive optical network of claim 1, wherein the parent station comprises means for resetting the maintenance signal as a result of detecting the following states:

(1) the parent station receives an optical signal matched with its mini slot GRANT,
(2) the optical signal includes an effective mini slot signal, and
(3) the mini slot signal is at a correct phase.

7. A control method using a mini slot signal in a passive optical network including a parent station OLT (optical line terminal) and a plurality of child stations ONU (optical network terminating unit) for transmitting an upstream frame and a downstream frame each other, the control method comprising:

providing a maintenance signal corresponding to each of the plurality of child stations for a mini slot and controlling state transition in dynamic bandwidth assignment (DBA) for each of the plurality of child stations by using the maintenance signal for the mini slot by an individual ONU dealing unit in the parent station,

characterized by:

the control method further comprising:

setting the maintenance signal by detecting at least one of the following failures:

(1) not receiving an effective optical signal in an expected period for the mini slot in the upstream frame,
(2) receiving an ineffective delimiter consecutively n times (n is a positive integer), and
(3) failing to control exceeding phase of the mini slot while receiving a correct delimiter.

8. The control method using the mini slot signal in the passive optical network of claim 7, the control method comprising:

dynamic bandwidth assignment for up-stream corresponding to each of the child stations.

9. The control method using the mini slot signal in the passive optical network of claim 7, the control method comprising:

relating a state of controlling the child station individually with a maintenance signal for the mini slot signal for controlling the bandwidth of the stream in the upstream frame.

10. The control method using the mini slot signal in the passive optical network of claim 7, the control method comprising:

relating a state of controlling the child station individually with the maintenance signal.

11. The control method using the mini slot signal in the passive optical network of claim 7, wherein the positive integer is eight.

12. The control method using the mini slot signal in the passive optical network of claim 7, the control method comprising:

resetting the maintenance signal by detecting the following states:
(1) receiving an optical signal matched with its mini slot GRANT,
(2) receiving an optical signal including an effective mini slot signal, and
(3) receiving a mini slot signal of a correct phase.

Patentansprüche

1. Steuersystem, das ein Minischlitzsignal in einem passiven optischen Netzwerk verwendet, das eine Hauptstation OLT (optischer Leitungsanschluss) und mehrere Unterstationen ONU (optische Netzwerk-Abschlusseinheit) umfasst, um einander einen netzaufwärtsgerichteten Rahmen und einen netzabwärtsgerichteten Rahmen zu übertragen, wobei die Hauptstation umfasst:

   eine individuelle ONU-Bearbeitungseinheit (106) zur Bereitstellung eines Wartungssignals, das jeder der mehreren Unterstationen für einen Minischlitz entspricht und einen Zustandsübergang in der dynamischen Bandbreitenzuteilung (DBP) für jede der mehreren Unterstationen steuert, indem das Wartungssignal für den Minischlitz verwendet wird,

   dadurch gekennzeichnet, dass die Hauptstation dazu ausgelegt ist, das Wartungssignal abzusetzen, wenn mindestens einer der folgenden Fehler erfasst wird:

   (1) die individuelle ONU-Bearbeitungseinheit empfängt kein wirksames optisches Signal in einem erwarteten Zeitraum für den Minischlitz im netzaufwärtsgerichteten Rahmen,

   (2) die individuelle ONU-Bearbeitungseinheit empfängt n Mal aufeinanderfolgend einen unwirksamen Begrenzer (n ist eine positive ganze Zahl), und

   (3) die Hauptstation unterlässt es, eine über schüssige Phase des Minischlitzes zu steuern, während ein richtiger Begrenzer eingeht.

2. Steuersystem nach Anspruch 1, das das Minischlitzsignal im passiven optischen Netzwerk verwendet, wobei die Hauptstation Einrichtungen zur dynamischen Bandbreitenzuteilung (DBA) für jede der mehreren Unterstationen steuert, indem das Wartungssignal für den Minischlitz verwendet wird, dadurch gekennzeichnet, dass das Steuerverfahren darüber hinaus umfasst:

   (1) es wird kein wirksames optisches Signal in einem erwarteten Zeitraum für den Minischlitz im netzaufwärtsgerichteten Rahmen empfangen,

   (2) es wird n Mal aufeinanderfolgend ein unwirksamer Begrenzer (n ist eine positive Zahl).

3. Steuersystem nach Anspruch 1, das das Minischlitzsignal im passiven optischen Netzwerk verwendet, wobei die Hauptstation Einrichtungen umfasst, die einen Zustand des Steuerns der Unterstation individuell mit einem Wartungssignal für das Minischlitzsignal in Beziehung setzen, um die Bandbreite des Kanals im netzaufwärtsgerichteten Rahmen zu steuern.

4. Steuersystem nach Anspruch 1, das das Minischlitzsignal im passiven optischen Netzwerk verwendet, wobei die Hauptstation eine Einrichtung umfasst, die einen Zustand des Steuerns der Unterstation individuell mit dem Wartungssignal in Beziehung setzt.

5. Steuersystem nach Anspruch 1, das das Minischlitzsignal im passiven optischen Netzwerk verwendet, wobei es sich bei der positiven ganzen Zahl um Acht handelt.

6. Steuersystem nach Anspruch 1, das das Minischlitzsignal im passiven optischen Netzwerk verwendet, wobei die Hauptstation Einrichtungen zum Rücksetzen des Wartungssignals als Ergebnis des Erfas sens der folgenden Zustände umfasst:

   (1) die Hauptstation empfängt ein optisches Signal, das mit ihrem Minischlitz GRANT abgeglichen ist,

   (2) das optische Signal enthält ein wirksames Minischlitzsignal, und

   (3) das Minischlitzsignal erfolgt mit einer richtigen Phase.

7. Steuerverfahren, das ein Minischlitzsignal in einem passiven optischen Netzwerk verwendet, das eine Hauptstation OLT (optischer Leitungsanschluss) und mehrere Unterstationen ONU (optische Netzwerk-Abschlusseinheit) umfasst, um einander einen netzaufwärtsgerichteten Rahmen und einen netzabwärtsgerichteten Rahmen zu übertragen, wobei das Steuerverfahren umfasst:

   Bereitstellung eines Wartungssignals, das jeder der mehreren Unterstationen für einen Minischlitz entspricht und einen Zustandsübergang in der dynamischen Bandbreitenzuteilung (DBA) für jede der mehreren Unterstationen steuert, indem das Wartungssignal für den Minischlitz durch eine individuelle ONU-Bearbeitungseinheit in der Hauptstation verwendet wird,

   dadurch gekennzeichnet, dass das Steuerverfahren darüber hinaus umfasst:

   (1) das Wartungssignal abzusetzen, wenn mindestens einer der folgenden Fehler erfasst wird:
ganze Zahl) empfangen, und (3) es wird unterlassen, eine überschüssige Phase des Minischlitzes zu steuern, während ein richtiger Begrenzer eingeht.

8. Steuerverfahren nach Anspruch 7, das das Minischlitzsignal im passiven optischen Netzwerk verwendet, wobei das Verfahren umfasst:

   eine dynamische Bandbreitenzuteilung für den verbindungsorientierten Aufwärtskanal, der jeder der Unterstationen entspricht.

9. Steuerverfahren nach Anspruch 7, das das Minischlitzsignal im passiven optischen Netzwerk verwendet, wobei das Verfahren umfasst:

   einen Zustand des Steuerns der Unterstation individuell mit einem Wartungssignal für das Minischlitzsignal in Beziehung zu setzen, um die Bandbreite des Kanals im netzaufwärtsgerichteten Rahmen zu steuern.

10. Steuerverfahren nach Anspruch 7, das das Minischlitzsignal im passiven optischen Netzwerk verwendet, wobei das Verfahren umfasst:

   einen Zustand des Steuerns der Unterstation individuell mit dem Wartungssignal in Beziehung zu setzen.

11. Steuerverfahren nach Anspruch 7, das das Minischlitzsignal im passiven optischen Netzwerk verwendet, wobei es sich bei der positiven ganzen Zahl um Acht handelt.

12. Steuerverfahren nach Anspruch 7, das das Minischlitzsignal im passiven optischen Netzwerk verwendet, wobei das Verfahren umfasst:

   Rücksetzen des Wartungssignals, wenn folgende Zustände erfasst werden:

   (1) Empfang eines optischen Signals, das mit seinem Minischlitz GRANT abgeglichen ist,
   (2) Empfang eines optischen Signals, das ein wirksames Minischlitzsignal enthält, und
   (3) Empfang eines Minischlitzsignals mit einer richtigen Phase.

Revendications

1. Système de commande utilisant un signal de mini-créneau dans un réseau optique passif comprenant une station parent OLT (terminal de ligne optique) et une pluralité de stations enfants ONU (unité de terminaison de réseau optique) afin de transmettre entre elles une trame montante et une trame descendante, la station parent comprenant :

   une unité de traitement ONU individuelle (106) pour fournir un signal de maintenance correspondant à chacune de la pluralité de stations enfants pour un mini-créneau, et commander une transition d’état dans une allocation dynamique de bande passante (DPB) de chacune de la pluralité de stations enfants en utilisant le signal de maintenance du mini-créneau,

caractérisé en ce que

   la station parent est adaptée pour établir le signal de maintenance en détectant au moins l’une des défaillances suivantes :

   (1) l’unité de traitement ONU individuelle ne reçoit pas de signal optique efficace dans une période prévue du mini-créneau dans la trame montante,
   (2) l’unité de traitement ONU individuelle reçoit n fois de manière consécutive un délimiteur inefficace (n est un nombre entier positif), et
   (3) la station parent n’arrive pas à commander une phase en dépassement du mini-créneau tout en recevant un délimiteur correct.

2. Système de commande utilisant le signal de mini-créneau dans le réseau optique passif selon la revendication 1, dans lequel la station parent comprend des moyens d’allocation dynamique de la bande passante du flux montant correspondant à chacune des stations enfants.

3. Système de commande utilisant le signal de mini-créneau dans le réseau optique passif selon la revendication 1, dans lequel la station parent comprend des moyens qui associent individuellement un état de commande de la station enfant à un signal de maintenance du signal de mini-créneau pour commander la bande passante du flux dans la trame montante.

4. Système de commande utilisant le signal de mini-créneau dans le réseau optique passif selon la revendication 1, dans lequel la station parent comprend des moyens qui associent individuellement un état de commande de la station enfant au signal de maintenance.

5. Système de commande utilisant le signal de mini-créneau dans le réseau optique passif selon la revendication 1, dans lequel le nombre entier positif est égal à huit.
6. Système de commande utilisant le signal de mini-créneau dans le réseau optique passif selon la revendication 1, dans lequel la station parent comprend des moyens de réinitialisation du signal de maintenance suite à la détection des états suivants :  
   (1) la station parent reçoit un signal optique adapté à son mini-créneau GRANT,  
   (2) le signal optique comprend un signal de mini-créneau efficace, et  
   (3) la phase du signal de mini-créneau est correcte.

7. Procédé de commande utilisant un signal de mini-créneaux dans un réseau optique passif comprenant une station parent OLT (terminal de ligne optique) et une pluralité de stations enfants ONU (unité de terminaison de réseau optique) pour transmettre entre elles une trame montante et une trame descendante, le procédé de commande comprenant :
   la fourniture d'un signal de maintenance correspondant à chacune de la pluralité de stations enfants du mini-créneau, et la commande d'une transition d'état dans une allocation dynamique de bande passante (DBA) de chacune de la pluralité de stations enfants en utilisant le signal de maintenance du mini-créneau par une unité de traitement ONU individuelle (106),

caractérisé par le fait que :
   le procédé de commande comprend de plus :
      l'établissement du signal de maintenance en détectant au moins l'une des défaillances suivantes :
         (1) non réception d'un signal optique effectif dans une période prévue du mini-créneau dans la trame montante,  
         (2) réception n fois de manière consécutive d'un délimiteur inefficace (n est un nombre entier positif), et  
         (3) échec de la commande d'une phase en dépassement du mini-créneau tout en recevant un délimiteur correct.

8. Procédé de commande utilisant le signal de mini-créneau dans le réseau optique passif selon la revendication 7, le procédé de commande comprenant :
   une allocation dynamique de la bande passante du flux montant correspondant à chacune des stations enfants.

9. Procédé de commande utilisant le signal de mini-créneau dans le réseau optique passif selon la revendication 7, le procédé de commande comprenant :
   l'association d'un état de commande de la station enfant individuellement à un signal de maintenance du signal de mini-créneau pour commander la bande passante du train dans la trame montante.

10. Procédé de commande utilisant le signal de mini-créneau dans le réseau optique passif selon la revendication 7, le procédé de commande comprenant :
   l'association d'un état de commande de la station enfant individuellement au signal de maintenance.

11. Procédé de commande utilisant le signal de mini-créneau dans le réseau optique passif selon la revendication 7, dans lequel le nombre entier positif est égal à huit.

12. Procédé de commande utilisant le signal de mini-créneau dans le réseau optique passif selon la revendication 7, le procédé de commande comprenant :
   une réinitialisation du signal de maintenance en détectant les états suivants :
      (1) réception d'un signal optique adapté à son mini-créneau GRANT,  
      (2) réception d'un signal optique comprenant un signal de mini-créneau efficace, et  
      (3) réception d'un signal de mini-créneau dont la phase est correcte.
### Fig. 1

<table>
<thead>
<tr>
<th>Type</th>
<th>Trigger of Generation</th>
<th>Trigger of Reset</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS-Di</td>
<td>When an O/E receiver for dealing ONUi in OLT does not receive a mini slot signal n times consecutively in an expected period.</td>
<td>In DBA operation state, OLT receives an optical signal matched with its slot grant.</td>
</tr>
<tr>
<td>LCD-Di</td>
<td>When a receiver for dealing ONUi in OLT receives an ineffective delimiter n times consecutively.</td>
<td>In DBA operation state, an effective mini slot signal is received.</td>
</tr>
<tr>
<td>CPE-Di</td>
<td>When OLT can receive a correct delimiter, a phase of a received mini slot signal exceeds a limit causing the OLT uncontrollable.</td>
<td>In DBA operation state, a mini slot signal in a correct phase is received.</td>
</tr>
<tr>
<td>ERR-Di</td>
<td>A result of CRC attached to a mini slot signal and a result of CRC by OLT do not match.</td>
<td>A next mini slot signal is received.</td>
</tr>
<tr>
<td>Halt State of DBA (DBA-St1)</td>
<td>Detect a Reset of Slot Grant (DBA-St1)</td>
<td>Detect a Reset of Slot Grant (DBA-St1)</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>S1</td>
<td>=&gt; DBA-St1</td>
<td>=&gt; DBA-St1</td>
</tr>
<tr>
<td>S2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Detect an Instruction DBA Function
  Detect IDY1, LOFI, LOI, LCOI, LOAI, OAML, LOAI, and R-INV. |                                        |                                        |                                        |                                        |
| Has Not Detected an Instruction DBA Function
  And Detects IDY3 | => DBA-St2                              |                                        |                                        |                                        |
| Recognize an OMT-DBA Type
  Detect CPE-Di |                                        |                                        |                                        | => DBA-St3                              |
| **NOT CHANGED IN STATE**    |                                        |                                        |                                        | **IMPOSSIBLE EVENT**                    |
Fig. 4 RELATED ART

FRAME FORMAT OF DOWNSTREAM

T FRAME = 56 CELL (53 BYTES/CELL)

PLOAM CELL 1  ATM CELL 1  .................  ATM CELL 27  PLOAM CELL 2  ATM CELL 28  .................  ATM CELL 54

INCLUDING UPSTREAM GRANT OF SIGNAL 53

FRAME FORMAT OF UPSTREAM

T FRAME = 53 CELL/FRAME

ATM CELL(+) 1  ATM CELL(+) 2  ATM CELL(+) 3  ..................  ATM CELL(+) 53

= OVERHEAD OF 3 BYTES/CELL, CONTENT CAN BE SET BY OLT.
* UPSTREAM PLOAM OR SLOT CAN BE SENT IN ATM CELL SLOT. A SPEED IS CONTROLLED BY OLT.
### Fig. 5 RELATED ART

<table>
<thead>
<tr>
<th></th>
<th>INITIAL STATE (OLT-IDV1)</th>
<th>STATE OF MEASURING DELAY (OLT-IDV2)</th>
<th>OPERATION STATE (OLT-IDV3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSTRUCT TO START MEASURING DELAY (n)</td>
<td>=&gt; OLT-IDV2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>COMPLETE MEASURING DELAY (n)</td>
<td>-</td>
<td>SEND RANGING TIME MESSAGE 3 TIMES NOTIFY THAT MEASURING DELAY IS COMPLETED (n) =&gt; OLT-IDV3</td>
<td>-</td>
</tr>
<tr>
<td>DETECT ABNORMALITY OF MEASURING DELAY (n)</td>
<td>-</td>
<td>SEND RANGING TIME MESSAGE 3 TIMES NOTIFY THAT MEASURING DELAY IS COMPLETED (n) =&gt; OLT-IDV1</td>
<td>-</td>
</tr>
<tr>
<td>DETECT LOSi, LCDi, CPEi, OAMLi, LOAI AND R-INHI</td>
<td>-</td>
<td>-</td>
<td>=&gt; OLT-IDV1</td>
</tr>
</tbody>
</table>

**NOTE**—NOTICE OF COMPLETING MEASURING DELAY IS DESCRIBED PROPERLY, HOWEVER THIS EVENT IS DESCRIBED FOR CONVENIENCE. THEREFORE, THIS EVENT SHOULD BE HANDLED AS REFERENCE INFORMATION.

- : NO CHANGE IN STATE
<table>
<thead>
<tr>
<th>TYPE</th>
<th>TRIGGER OF GENERATION</th>
<th>TRIGGER OF RESET</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOSi</td>
<td>When an O/E receiver for dealing ONUI in OLT does not receive an effective upstream cell 8 times consecutively in an expected period.</td>
<td>When a receiver for dealing ONUI in OLT receives an ineffective HEC &amp; times consecutively.</td>
<td>A PLOM cell of ONUI is failed to receive 3 times consecutively.</td>
</tr>
<tr>
<td>LCI</td>
<td>When a receiver for dealing ONUI in OLT can receive a correct delimiter, a phase of a received cell exceeds a limit causing the OLT uncontrollable.</td>
<td></td>
<td>After sending a plurality of upstream messages indicating that there is an ACK, OLT does not receive an ACK.</td>
</tr>
<tr>
<td>CPEi</td>
<td>A PLOM cell of ONUI is failed to receive 3 times consecutively.</td>
<td></td>
<td>OLT receives R-IN ALARM (receiving alarm suppressing message) from ONUI.</td>
</tr>
<tr>
<td>OAMLj</td>
<td></td>
<td></td>
<td>Detect mismatch between BIP6 in upstream and the result of BIP8 of received signal.</td>
</tr>
<tr>
<td>LOAi</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fig. 8

RELATED ART

ARRANGEMENT OF UPSTREAM CELL

ARRANGEMENT OF DOWNSTREAM CELL

UPSTREAM BAND FOR ONU#1 INCREASED BY DBA
Fig. 9

RELATED ART

REGULAR CELL

MINI SLOT 1

MINI SLOT 2

MINI SLOT 3

MINI SLOT 4

COLLISION IN OPTICAL LEVEL

COLLISION IN OPTICAL LEVEL

COLLISION IN OPTICAL LEVEL

COLLISION IN OPTICAL LEVEL

SLOT