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LINE RATE ETHERNET TRAFFIC TESTING

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ABSTRACT

The invention discloses a Ethernet traffic testing system for determining a packet error-rate of a link between an optical network unit (ONU) and an optical line terminal (OLT). The system determines that the ONU detects a test message from the OLT. The system then causes the ONU to send data received from the OLT back to the OLT. Further, the system causes the OLT to reflect back data received from the ONU in order to form a closed loop. The system then causes the OLT to inject data bits in the closed loop till the number of bits circulating in the closed loop saturate the link between the OLT and the ONU. Once the link is saturated, the system determines the packet error-rate of the data bits in the closed loop. Finally, the system causes the OLT and ONU to remove the closed loop by not sending back the received data.

PROBLEM STATEMENT

In a fiber-to-home network, the optical links between an optical line terminal (OLT) and an optical network terminal (ONU) carry Ethernet traffic. The OLT, located at a service provider's central office, performs conversion between the electrical signals used by a service provider's equipment and the fiber optic signals to be carried by optical fibers to a number of ONUs, located near customer's equipment. This is a "last mile" physical link between a service provider's equipment and a customer's equipment. Occasional testing of optical links is important to ensure high quality traffic-rate for the end users. During network installation and turn-up, the physical connections are first tested using optical equipment, and then layer-2

Ethernet traffic is tested to ensure end-to-end networking connectivity on the links. To detect a lossy link, caused by dirty connectors, bent optical cables, or flaky Ethernet interfaces, “line-rate traffic” tests should be run so that a packet-error rate of a link can be measured. Software-generated Ethernet traffic tests, e.g., L3 ping, are slow and are not able to reach line-rate of the physical link, and therefore they are not capable of detecting lossy links. Moreover, such line-rate traffic tests require hardware-based traffic generators and testers which in turn increases the cost related to the testing.

The IEEE 802.1 committee developed the IEEE 802.1ag standard and the ITU-T SG 13 Q5 WG developed the Y.1731 standard for Ethernet service OAM (Operations, Administration, and Management) for connectivity fault management and performance management. Currently, some existing products implement these Ethernet OAM standards and support for performance management such as frame loss measurement. However, traditional implementation of these Ethernet OAM services require additional CPU processing power and therefore suffer from a scalability point of view. Further, as OAM traffic cannot reach line-rate during testing, frame loss detection and packet-error rate measurement is only meaningful for severe lossy links. Accordingly, a method and system that performs line-rate Ethernet traffic testing over the OLT-ONU links without specialized hardware is described.

DETAILED DESCRIPTION

The system and techniques described in this disclosure relate to an Ethernet traffic testing system. The Ethernet traffic testing system can be implemented for use by a client device connected to one or more other devices via the Internet, an intranet, or in any client-server environment. The system can include program instructions implemented locally on a client device or implemented across a client device and server environment. The client device can be any electronic device such as a packet-error rate tester, Ethernet traffic tester, line-rate traffic tester, optical network unit, optical line terminal, computer, laptop, or handheld electronic device, etc.

Fig. 1 illustrates an example method 100 for testing a line rate Ethernet traffic on optical links. Method 100 can be performed by the Ethernet traffic testing system.

The system determines that an optical network unit (ONU) detects a test message from an optical line terminal (OLT) (110). For starting a line-rate Ethernet traffic test, the OLT sends the test message to the ONU, asking the ONU to loopback data traffic. The test message may be an Operations, Administration, and Management (OAM) message that can include vendor-specific message (VSM) or vendor-specific reply (VSR). OAM based messages are usually used to put the ONU in and out of a loopback mode, i.e., circulating packet-traffic between OTL and ONU.

The system then causes the ONU to send data received from the OLT back to the OLT (120). This closes the ONU's end to form one end of a closed loop. Further, the system causes the OLT to reflect back data received from the ONU in order to form the closed loop (130). This step closes the loop at the OLT's end and hence forming a complete closed loop. By forming this closed loop, the system makes the data frames circulate in the link in both directions between the OLT and the ONU. Commercial Ethernet switches can be set up at the OLT's end to perform switching functions in order to form the closed loop. Alternatively or additionally, loopback mode can be implemented using specialized hardware such as a remote loopback feature in physical layer (PHY) devices. However, when the ONU's PHY is put into remote loopback mode, it cannot be undone by the OLT. In this case, the ONU needs to implement a timer to undo its remote PHY loopback mode.

The system then causes the OLT to inject data bits in the closed loop till the number of bits circulating in the closed loop saturate a link between the OLT and the ONU (140). Saturation of the link may correspond to a point when the Ethernet traffic rate of the link reaches a link-rate. The data bits injected into the link can be Ethernet packets that are generated by a software in the system's central processing unit (CPU). The Ethernet packets injected into the closed loop may be special packets that are different from the user data packets already circulating in the closed loop. After the initial software-generated Ethernet packets are injected into the link, software and/or CPU time is no longer needed for sending or receiving the packets. Hence, the system generates line-rate traffic without using CPU processing power or without using specialized traffic generators/testers. The number of data bits required to saturate the link can be dynamically calculated by the CPU based on length of the link. In an example scenario, for 1 GB Ethernet over 20 kilometer "last mile" link, the CPU may inject about 30 initial Ethernet packets to saturate the link.

Once the link is saturated, the system then determines a packet error-rate of the data bits in the closed loop (150). With enough number of data bits being injected and circulating in the closed loop, the link is saturated with the data bits and the Ethernet traffic reaches line-rate, the system then determines the packet error-rate. The system may use hardware-based Rx (receiver) counters and/or error counters at OLT's Ethernet interface to calculate traffic rate and packet error-rate. The packet error-rate can be used to detect lossy links between the ONU and OLT that are caused by dirty connectors, bent optical cables, or flaky Ethernet interfaces, etc.

The system then determines that the ONU detects a second message to remove the closed loop from the OLT (160). Once the system has determined the packet error-rate, the system causes the OLT to send the second (OAM) message asking the ONU to undo the loopback at the ONU's end. The ONU's loopback mode is only applicable to user traffic, and therefore the ONU can still respond to OAM messages while in loopback mode.

The system then causes the OLT and ONU to remove the closed loop by not sending back the received data (170). The system causes ONU to remove its loopback mode on detection of the second message. Further, the system uses switching functions of the Ethernet switches to remove the loopback mode at OLT's end. Hence, the system determines the packet-error rate of the link without consuming additional processing power of the CPU or without using specialized hardware traffic generators and testers.

Fig. 2 illustrates an example scenario for determining packet error-rate of a link as performed by a Ethernet traffic testing system. As illustrated in Fig. 2, an optical line terminal (OLT) 210 is connected to optical network unit (ONU) 220 via a "last mile" link. The ONU (customer's equipment) and OLT (service provider's equipment) implement vendor-specific OAM (Operations, Administration, and Management) messages. The system causes the OLT 210 to send an OAM message to the ONU 220, asking the ONU 220 to loopback user data traffic. This step closes the loop at the ONU's end. The system then causes the OLT 210 to set up its Ethernet interface to send back its received frames using switching functions of Ethernet switches. This step closes the loop at the OLT's end, hence forming a closed loop.

The system then uses a software to inject initial Ethernet frames (230) into the closed loop with random patterns in its payload. With enough number of frames being injected and circulating in the closed loop, the link is saturated with the data bits and the Ethernet traffic reaches line-rate. The system then calculates a packet error-rate of the link using hardware error counters 240. After the packet-error rate is determined, the system causes the OLT 210 to remove the loopback mode at its end using the switching functions. Further, the system cause the OLT 210 to send OAM message asking the ONU 220 to undo the loopback at the ONU's end.

Fig. 3 is a block diagram of an exemplary environment that shows components of a system for implementing the techniques described in this disclosure. The environment includes client devices 310, servers 330, and network 340. Network 340 connects client devices 310 to servers 330. Client device 310 is an electronic device. Client device 310 may be capable of requesting and receiving data/communications over network 340. Example client devices 310 are personal computers (e.g., laptops), mobile communication devices, (e.g. smartphones, tablet computing devices), set-top boxes, game-consoles, embedded systems, and other devices 310' that can send and receive data/communications over network 340. Client device 310 may execute an application, such as a web browser 312 or 314 or a native application 316. Web applications 313 and 315 may be displayed via a web browser 312 or 314. Server 330 may be a web server capable of sending, receiving and storing web pages 332. Web page(s) 332 may be stored on or accessible via server 330. Web page(s) 332 may be associated with web application 313 or 315 and accessed using a web browser, e.g., 312. When accessed, webpage(s) 332 may be transmitted and displayed on a client device, e.g., 310 or 310'. Resources 318 and 318' are resources available to the client device 310 and/or applications thereon, or server(s) 330 and/or web pages(s) accessible therefrom, respectively. Resources 318' may be, for example, memory or storage resources; a text, image, video, audio, JavaScript, CSS, or other file or object; or other relevant resources. Network 340 may be any network or combination of networks that can carry data communication.

The subject matter described in this disclosure can be implemented in software and/or hardware (for example, computers, circuits, or processors). The subject matter can be implemented on a single device or across multiple devices (for example, a client device and a server device). Devices implementing the subject matter can be connected through a wired and/or wireless network. Such devices can receive inputs from a user (for example, from a mouse, keyboard, or touchscreen) and produce an output to a user (for example, through a display). Specific examples disclosed are provided for illustrative purposes and do not limit the scope of the disclosure.

DRAWINGS

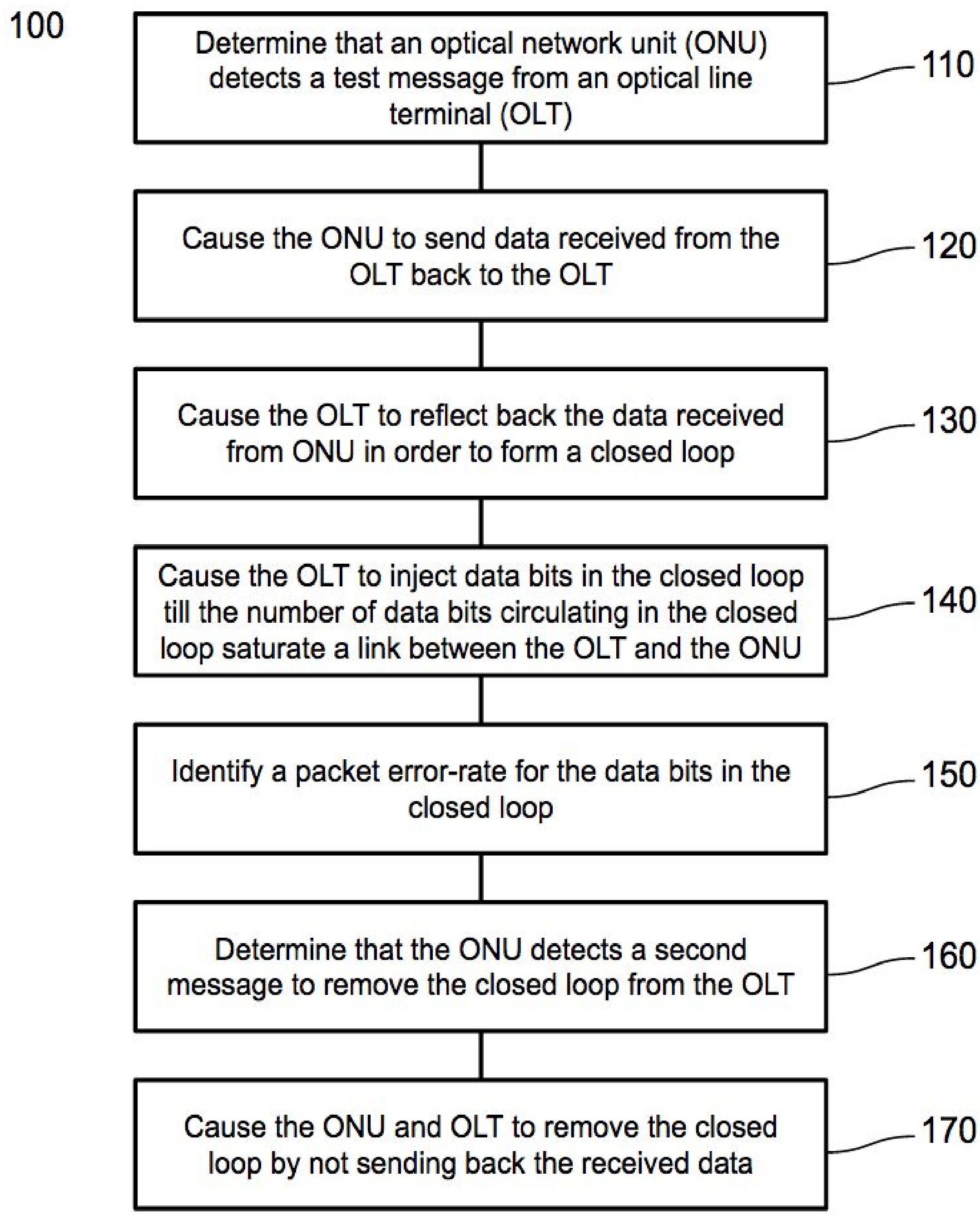

Fig. 1

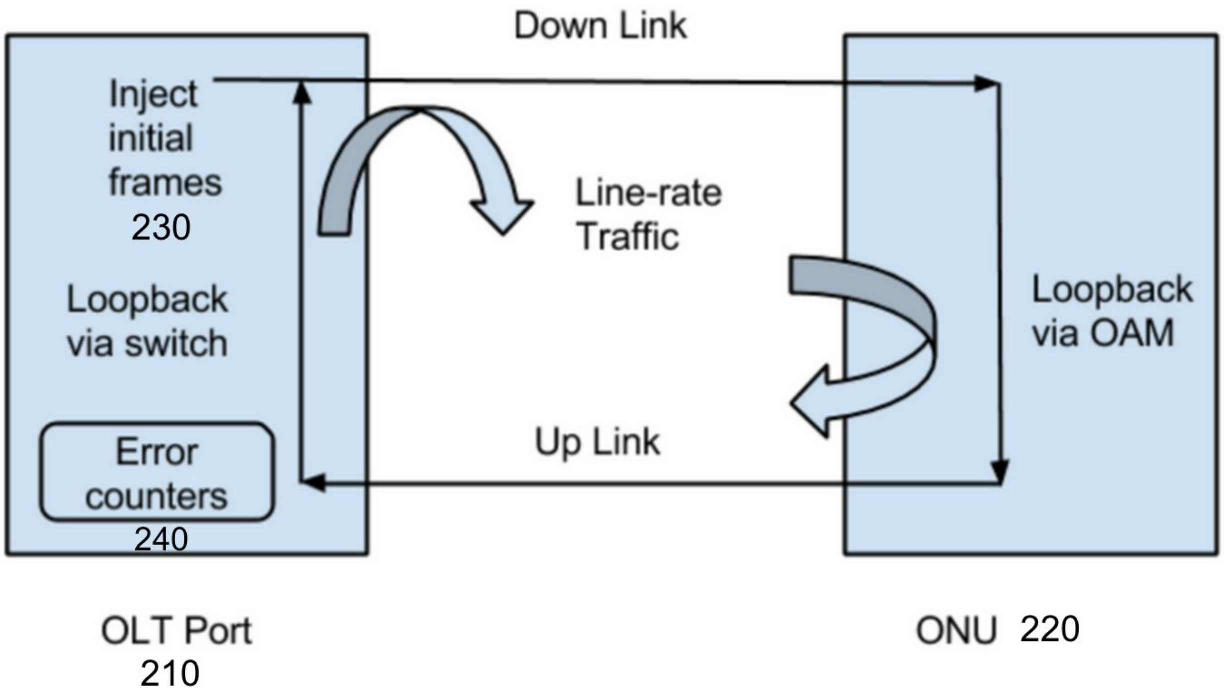
Down Link
Inject
initial
frames
230
Loopback
via switch
Error
counters
240
Line-rate
Traffic
Loopback
via OAM
Up Link
OLT Port
210
ONU 220

Fig. 2

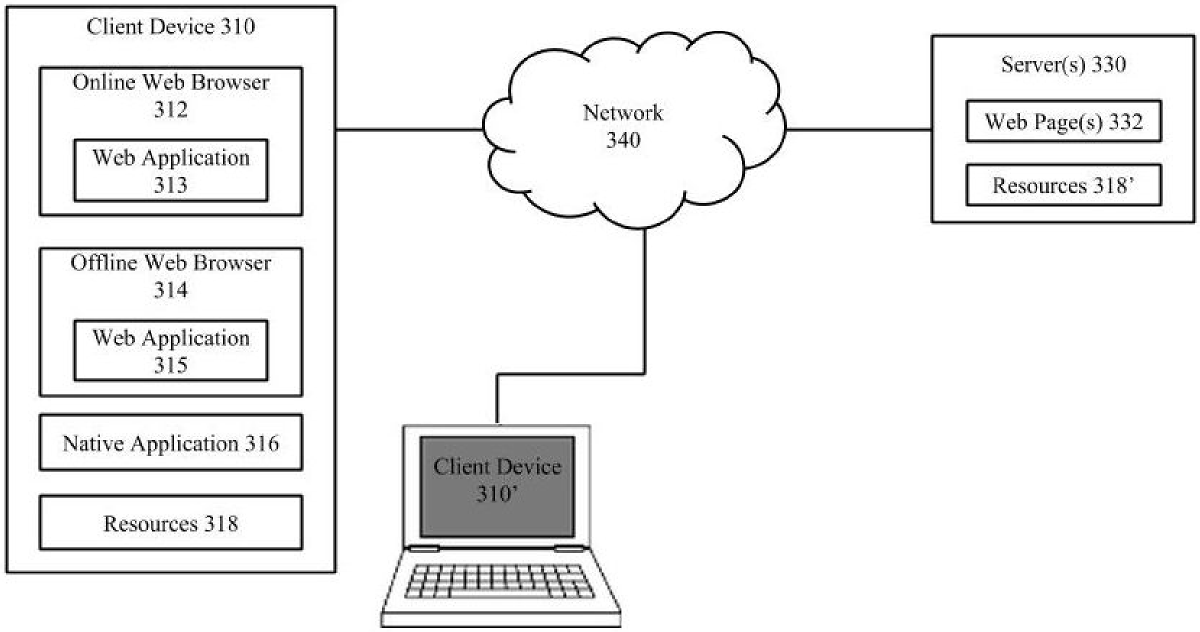
Client Device 310
Online Web Browser 312
Web Application 313
Offline Web Browser 314
Web Application 315
Native Application 316
Resources 318
Network 340
Server(s) 330
Web Page(s) 332
Resources 318'
Client Device 310'

Fig. 3