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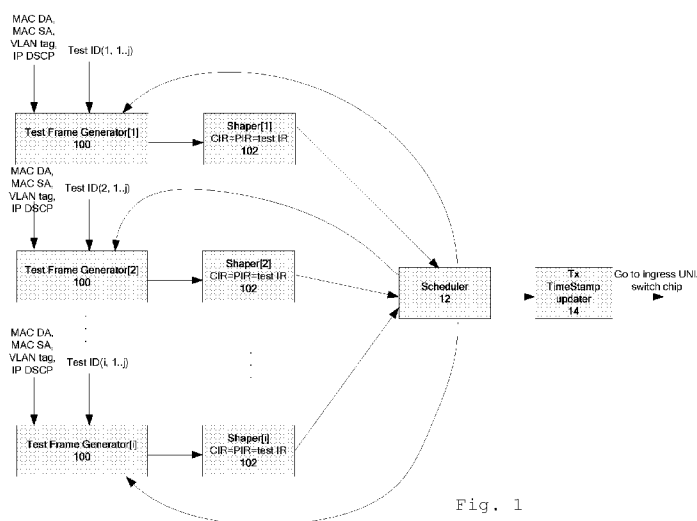
(54) Title: NETWORK SERVICE TESTING

Fig. 1

(57) **Abstract:** Current network test methods based on OAM is unable to verify Service Configuration (CIR/CBS/PIR/PBS and QoS priority), and current external test instruments cost much. The invention proposes methods in network elements for executing tests and corresponding network elements. The first network element generates test traffics, and providing them for the QoS processing, before sending it to a second network element for executing tests; wherein, the generating step comprises: scheduling one or more flows of test traffics; producing test frames for the scheduled flow; and adding Tx timestamp into the produced test frames. The second network element detects the test traffic to which the QoS processing has been carried out.

Methods in network elements for executing tests and
corresponding network elements

Technical field

5 The disclosure relates to the field of network tests.

Background art

With more and more operators' attention to qualify the network before turn-up a service, Service Activation test is becoming an important and hot technology. During past years, IETF RFC2544 has been the most widely used Ethernet service test methodology because it was the only existing standard in this area. But RFC2544 does not include all required measurements such as packet jitter, QoS measurement and multiple concurrent service levels. To resolve these issues, ITU-T has introduced Y.1564, which can simulate all types of services that will run on the network and simultaneously qualify all key SLA parameters for each of these services, and also validate QoS mechanisms provisioned in the network to prioritize the different service types, resulting in more accurate validation and much faster deployment and troubleshooting. Now more and more service providers are interested in simplifying service activation procedure by using internal CPE test functions, instead of lying on high cost external Test Instruments. Although several CPE vendors have implemented RFC2544 in their NEs, till now no CPE vendors implement new standard Y.1564. Therefore, Y.1564 built in CPE or other NEs will become a key differentiator competing in Carrier Ethernet Market.

Summary of the invention

The following are some known methods:

1. Y.1731 TST.
2. 802.1ag LB.
3. JDSU proprietary Loopback protocol
4. EXFO Y.1564.

Y.1731 TST can do one-way Service Performance test, but is unable to verify Service Configuration (CIR/CBS/PIR/PBS and QoS priority) and simulate IP packets or other upper layer packets.

802.1ag LB has the same problem as Y.1731 TST, and is able to test only round-trip test but not one-way test. In case the transport path has asymmetric performance, unidirectional performance can not be derived accurately from round-trip test result.

JDSU proprietary Loopback protocol with EVC loopback on remote NE is able to test only round-trip parameters and simulate only Layer 2 frames.

EXFO Y.1564 is the best existing solution, but it is a very expensive test instrument, and requires additional Synchronization mechanism, out-of-band signaling, and complex algorithm.

Before transmitting the user traffic, the NE carries out a QoS processing to process the incoming user traffic, including policing (CIR/CBS/PIR/PBS) -> congestion control -> queuing -> scheduling -> shaping. Some of the present test methods, such as 802.1ag LB/Y.1731 tests are based on Ethernet OAM (Operations, Administration and Maintenance) functions. OAM functions is used

for inserting OAM packets or extract OAM packets within the QoS processing in the NE, namely after the policing (CIR/CBS/PIR/PBS) processing and before the congestion control processing.

It can be seen that, OAM functions are located after
5 policing and before congestion control, therefore the OAM packets lacks the policing processing and is not exact same as the real user traffic. This is the reason why the OAM-based tests are unable to verify Service Configuration (CIR/CBS/PIR/PBS and QoS priority). Whereas, Y.1564 has the
10 purpose to validate the Service Configuration, including traffic classification and CIR/PIR/CBS/PBS and QoS parameters such as priority level. Therefore a new test method is needed to meet the requirement of Y.1564.

15 According to one aspect of the invention that is in the transmitting party of test traffics, it is provided a method in a first network element for executing tests, comprising the steps of:

- generating test traffics, and providing them for the QoS
20 processing, before sending it to a second network element for executing tests;

Wherein, the generating step comprises:

- scheduling one or more flows of test traffics;
- producing test frames for the scheduled flow;
25 - adding Tx timestamp into the produced test frames.

According to this aspect, the test traffic is injected before the QoS processing thus is identical with the real user traffic, therefore the Service Configuration (CIR/CBS/PIR/PBS

and QoS priority) can be tested, and all Y.1564 requirements can be covered. Besides, the solution is carried out in network element (NE) without using external test equipments, and the operators does not need to load test engineers on sites and use
5 high cost test instruments.

In a preferred embodiment, the method further comprises the step before the generating step:

- receiving test configuration from a network management
10 system;

Said generating step generates the test frames according to the test configuration;

the QoS processing comprises the following operations:

policing, congestion control, queuing, scheduling and
15 shaping

In this embodiment, because NE is managed by the network management system (NMS) which knows all the test configuration info done by the operator, the NMS notifies the configuration conveniently, and the two testing NEs do not need additional
20 control protocol to exchange the configuration. The operators only needs to click on the NMS GUI to accomplish the test.

In a preferred embodiment, the test configuration comprises any of the following:

- 25
- number of services to be tested and corresponding test ID;
 - test steps and duration for each step;
 - size of the test frame;
 - committed information rate;

- pattern of the test frame;
- Ethernet frame header;

the generating step further adds any of the following information into the produced test frames:

- 5 - Ethernet frame header;
- test ID identifying the flow of the test traffic;
 - sequence number of the test traffic in the flow;
 - the length of the test frame is no more than 64 bytes.

The embodiment provides the frame format for the test frame.

10

In a preferred embodiment, the method further comprises the step before the generating step:

- synchronizing the time and frequency with respect to the second network element by using their own synchronization
- 15 mechanism.

In this embodiment, the test function can make use of NE-self's synchronization mechanism (IEEE1588 or SyncE, etc) to achieve accurate one-way performance test results.

20

In a preferred embodiment, the generating step generates the test frames according to the committed information rate of the flow, wherein,

the one or more flows are provided with tokens based on the test committed information rate of the flow,

25

the scheduling step selects one flow from the one or more flows according to scheduling algorithms, and determining whether the selected flow has enough tokens:

- if it has, the test frames of the selected flow are produced;

- otherwise, the scheduling step selects the next flow according to the scheduling algorithms.

5 In the art, external test instruments have very precise clocks and plenty of accurate timers to generate the test frames. The timers are expensive. The embodiment of the invention uses a general QoS scheduling mechanism to remove the expensive timers. In this way, the design can achieve high accuracy and low cost.

10

According to another aspect of the invention that is the receiving party of the test traffic, it is provided a method in a second network element for executing tests, comprising the steps of:

15 - receiving test traffics sent by a first network element for executing tests;

- detecting the test traffic to which the QoS processing has been carried out;

Wherein, the detecting step comprises:

20 - adding Rx timestamp to the received test frames;
- classifying the received test frames into one or more flows of test traffics;

- calculating the result of the test based on the received test frames, respectively for each flow.

25 According to this aspect, the test traffics which have been transported across the network are trapped out after the QoS processing in the receiving party, thus the test traffics are identical with the real user traffics, therefore the Service

Configuration (CIR/CBS/PIR/PBS and QoS priority) can be tested, and all Y.1564 requirements can be covered. Besides, the solution is carried out in network element (NE) without using external test equipments, and the operators does not need to
5 load test engineers on sites and use high cost test instruments.

In a preferred embodiment, the calculating step comprises the steps:

- counting the number of the received test frames;
- 10 - computing the information rate, according to the length of the received test frames and the test duration starting from the time when the first test frame is received;
- computing the frame loss rate according to the number of the received test frames and the number of transmitted test
15 frames;
- computing the percentage of the service time based on the test duration starting from the time when the first test frame is received and the unavailable duration in which the frame loss rate is above a threshold for a successive period.
- 20 The embodiment provides solutions for computing the result of the test.

In a preferred embodiment, the calculating step further comprises the steps:

- 25 - computing the frame transfer delay based on the Tx timestamp and the Rx timestamp of each test frame;
- computing the frame delay variation based on the frame transfer delays.

The embodiment provides solutions for computing the result of the test.

In a third aspect of the invention, it is provided a first
5 network element for executing test, comprising a test generator which generates test traffic and provides it for the QoS processing before sending it to a second network element for executing tests, the test generator comprising:

- 10 - one or more units, respectively for one traffic flow, for producing test frames of the flow;
- a scheduler for scheduling the one or more units to produce test frames of the flow;
- a Tx timestamp updater for adding Tx timestamp into the produced test frames.

15

Preferably, the unit comprises:

- a shaper maintaining tokens based on the test committed information rate of the flow;
- a test frame generator for producing the test frames of
20 the flow;

Wherein, the scheduler selects one flow from the one or more flows according to scheduling algorithms, and being informed by the corresponding shaper about whether the shaper has enough tokens:

- 25 - if it has, the scheduler instructs the test frame generator to produce test frames of the flow;
- otherwise, the scheduling step selects the next flow according to the scheduling algorithms.

The preferable embodiment provides the modular structure of a general QoS scheduling mechanism for generating the test frames according to the information rate, to remove the expensive timers. In this way, the design can achieve high accuracy and low cost.

In a fourth aspect of the invention, it is provided a second network element for executing test, the second network element receives test traffics sent by a first network element for executing tests, comprising a test checker for detecting test traffic to which the QoS processing has been carried out;

Wherein, the test checker comprises:

- Rx timestamp updater for adding timestamp to the received test frames;
- a classifier for classifying the received test frames into one or more flows of test traffics;
- one or more units, respectively for each flow, for calculating the result of the test based on the received test frames of the flow.

These and other features of the present invention will be described in details in the embodiment part.

Brief description of the drawings

Features, aspects and advantages of the present invention will become obvious by reading the following description of non-limiting embodiments with the aid of appended drawings.

Fig. 1 shows the modules of the test generator according to a preferred embodiment of the invention;

Fig. 2 shows the modules of the test checker according to a preferred embodiment of the invention;

5 Fig. 3 shows the schematic view of unavailable duration;

Fig. 4 shows the test frame formats according to a preferred embodiment of the invention.

Wherein, the same or similar reference sign refers to the same or similar component.

10

Detailed description of embodiments

The invention proposes a method in a first network element for executing tests, comprising the steps of:

15 - generating test traffics, and providing them for the QoS processing, before sending it to a second network element for executing tests;

Wherein, the generating step comprises:

20 - scheduling one or more flows of test traffics;
- producing test frames for the scheduled flow;
- adding Tx timestamp into the produced test frames.

Correspondingly, the invention also proposes a method in a second network element for executing tests, comprising the steps of:

25 - receiving test traffics sent by a first network element for executing tests;

- detecting the test traffic to which the QoS processing has been carried out;

Wherein, the detecting step comprises:

- adding Rx timestamp to the received test frames;
 - classifying the received test frames into one or more flows of test traffics;
 - calculating the result of the test based on the received
- 5 test frames, respectively for each flow.

Preferably, before the test, the first network element and the second network element receives test configuration from a network management system (NMS). As all NEs are under the management of NMS, it does not need to use any additional

10 control protocol to notify the local configurations to the remote test functions since the operator can just use NMS to do configuration on both end NEs.

As to the first network element generating the test traffic, the test configuration includes:

- 15
- number of services to be tested and corresponding test ID;
 - test steps and duration for each step;
 - size of the test frame;
 - committed information rate;
 - pattern of the test frame;
- 20 - Ethernet frame header.

As to the second network element receiving the test traffic, the test configuration includes:

- number of service to be tested and corresponding test ID;
 - test steps and duration for each step;
- 25
- size of the test frame;
 - pattern of the test frame.

Preferably, before the test, the first network element and the second network element synchronize the time and frequency

with respect to each other by using their own synchronization mechanism. It can make use IEEE 1588 or SyncE, etc to achieve accurate one-way performance test results.

The following elucidation exemplifies a one-way test from
5 the first network element to the second network element. It should be understood that the term first and second are used for only differentiating the test traffic originator and the test traffic receiver, while in the practical implementation, a single network element can be the test traffic originator for
10 one test and also the test traffic receiver for another test.

Firstly, the first network element generates test traffics, and provides them for the QoS processing, before sending it to the second network element. The first network element comprises a test generator for this operation. The test generator
15 generates test flows to simulate the user traffic encapsulated in various transport layers (e.g. Ethernet or IP layer networks) and injects the test flow into the ingress of UNI-Ns.

Specifically, the test generator comprises:

- one or more units 10, respectively for one traffic flow,
20 for producing test frames of the flow;
- a scheduler 12 for scheduling the one or more units to produce test frames of the flow;
- a Tx timestamp updater 14 for adding Tx timestamp into the produced test frames.

25 Preferably, each unit 10 comprises:

- a shaper 100 for maintaining tokens based on the test committed information rate of the flow; and

- a test frame generator 102 for producing the test frames of the flow.

The above modules are shown in figure 1. In figure 1, each set of test frame generator[i] 102 and shaper[i] 100
5 corresponding to one test flow i.

The challenge in designing Y.1564 test generators is how to keep each test flow generated evenly and strictly at required information rate when multiple test flows are simultaneously generated and input to the same UNI. The proposed design is a
10 simple way to implement multiple test generators to meet above requirements. The shaper 100 is a token bucket generating token and controlling the generated test flow in conformance with the configured information rate. The scheduler 12 executes a scheduling algorithm (e.g. WRR, WFQ) to select one flow, and
15 inquires the shaper 100 corresponding to this flow whether it has enough token. The shaper 100 informs the scheduler 12 that it has enough tokens to allow next generated test frame to pass, then the scheduler 12 controls the test frame generator to generate a test frame and put onto the line. The test frame
20 generator 102 is simple to generate test frames in configured frame size, under the control of the scheduler 12, but does not need a complex algorithm to compute a timer to generate each frame.

The Tx TimeStamp Updater 14 adds Tx TimeStamp into the test
25 frames at line rate, as closely to the instant test frames are actually sent to UNI.

After that, the QoS processing is carried out to the test frames. Specifically, the QoS processing comprises policing

(CIR/CBS/PIR/PBS) -> congestion control -> queuing -> scheduling
-> shaping.

The test frames are then transmitted on the network to the second network element.

5 The second network element receives the test traffics sent by the first network element, and carried out QoS processing on the received traffic. The QoS processing comprises the following operations:

Classification -> congestion control -> queuing ->
10 scheduling -> and shaping.

After the QoS processing, the test traffic are detected to obtain the result of the test.

The second network element comprises a test checker for detecting test traffics, and the test checker comprises:

15 - Rx timestamp updater 20 for adding timestamp to the received test frames;

 - a classifier 22 for classifying the received test frames into one or more flows of test traffics;

 - one or more units 24, respectively for each flow, for
20 calculating the result of the test based on the received test frames of the flow.

Preferably, each unit 24 comprises:

 - a counter 240 for counting the number of the received test frames;

25 - a computing unit 242 for computing the result of the test based on the number of the received test frames and time information.

The above modules are shown in figure 2. In figure 2, each set of Rx counter[i] 240 and computing unit[i] 242 corresponds to one test flow.

The Rx TimeStamp updater 20 is placed at the ingress to add Rx TimeStamp at line rate before this packet is parsed. The classifier 22 identifies each test flow from all egress UNI traffic based on user-configured test flow definitions (e.g. MAC DA, MAC SA, VLAN ID, IP DSCP, etc). The Rx Counter 240 counts the number of received test frames per test flow. The computing unit 242 calculates the test result per test flow based on Tx Time Stamp, Rx Time Stamp, Rx Counter, and the user configured test parameters per test flow (e.g. test flow IR, test duration), where the test result computation method is proposed and detailed as follows.

To calculate one-way Y.1564 performance parameters such as IR, FLR, FTD, FDV, here proposes a simple computation method. TimeOut is the time to wait the last valid before stop the test for a specific Test ID (test flow).

- Information Rate (IR)

The information rate is calculated according to the length of the received test frames and the duration.

Average information rate of the received test traffic over Test Duration starting from the instant the first test frame is received.

$$IR = \frac{\sum_i \text{Length of Received Frame } i}{\text{Test Duration}}, \text{ (} i\text{th frame is received during } (T_{\text{Firstreceivedpackets}}, T_{\text{Firstreceivedpackets}} + \text{TestDuration}))$$

- Frame Loss Rate (FLR)

The frame loss rate is calculated according to the number of the received test frames and the number of transmitted test

frames. Wherein, the number of transmitted test frames can be informed by the NMS in the test configuration.

The total FLR is the Ratio of total lost Ethernet frame outcomes to total transmitted Ethernet Frames

$$5 \quad FLR = \frac{\sum \text{transmitted frames} - \sum \text{received frames during } (T_{\text{first received frame}}, T_{\text{first received frame}} + \text{TestDuration} + \text{TimeOut})}{\sum \text{transmitted frames}}$$

● Frame Transfer Delay (FTD)

Frame Transfer Delay (FTD)

$$A_FTD = \frac{\sum_i T_{\text{ith frame received}} - T_{\text{ith frame transmitted}}}{\sum \text{received frames}}, (\text{ith frame is received during } (T_{\text{first received frame}}, T_{\text{first received frame}} + \text{TestDuration} + \text{TimeOut}))$$

Max frame transfer delay

$$10 \quad X_FTD = \text{Max}\{T_{\text{ith frame received}} - T_{\text{ith frame transmitted}}\}$$

Min frame transfer delay

$$M_FTD = \text{Min}\{T_{\text{ith frame received}} - T_{\text{ith frame transmitted}}\}$$

● Frame Delay Variation

Average frame delay variation.

$$15 \quad A_FDV = \frac{\sum_i (FTD_{i+1} - FTD_i)}{\sum \text{received frames} - 1}, (\text{ith frame is received during } (T_{\text{first received frame}}, T_{\text{first received frame}} + \text{TestDuration} + \text{TimeOut}))$$

Max frame transfer delay.

$$X_FDV = \max\{FTD_{i+1} - FTD_i\}$$

Min frame transfer delay.

$$M_FDV = \min\{FTD_{i+1} - FTD_i\}$$

20 ● AVAIL

AVAIL is the percentage of the service time, and it is calculated according to the test duration starting from the time when the first test frame is received and the unavailable duration in which the frame loss rate is above a threshold for a successive period. As shown in figure 3, the SES_{ETH} is a severe errored second outcome occurs for a block of frames observed during a one-second interval when the corresponding FLR (i.e. the ratio of lost frames to total frames in the block) exceeds

s1. A provisioned value s1 of 0.5 is used, and different values may also be chosen depending on the class of service (CoS). Once a certain amount (10 eg.) of successive SES_{ETHS} is monitored, the link is considered as being unavailable, and the unavailable duration starts from the first SES_{ETH} of the successive SES_{ETHS}. The unavailable duration ends before the first non-SES_{ETH} followed by a certain amount (10 eg.) of successive non-SES_{ETHS}.

AVAIL is the percentage of total scheduled Ethernet Service time that is categorized as available.

$$10 \quad AVAIL = \frac{\text{TestDuration (starting from } T_{\text{first received frame}}) - \sum \text{unavailable second}}{\text{TestDuration (starting from } T_{\text{first received frame}})}$$

Since the size of the Ethernet frame is no less than 64 byte, while the test frame should be further added with padding to simulate any Ethernet frame, therefore the test frame (without padding) preferably does not excess 64 bytes. Therefore, it is better to simplify the test frame format and shorten the test frame length. Since some test information such as test duration, test pattern, test Tx information rate is specific to each test flow, and these information can be informed by the NMS in test configuration, only the test ID identifying the test flow is included in test frame to represent all these information. Besides, from the above computation formula, we can see test frame size, Tx TimeStamp and Sequence Number (for detecting out-of-order) are specific to each test frame and should be carried in each frame. Optionally, we can add End flag in each test frame to notify the test checker that the test flow is ended. The example of test frame format is shown in figure 4. Wherein, DA stands for destination address, SA stands for source address,

and FCS stands for frame check sequence. Therefore, the total test frame size is less than 64 bytes, with or without IP header.

The following table illustrates the comparison between the proposed solution and other three existing solutions (one-way on Test instrument -best existing solution, Round-trip/Loopback with EVC loopback on one-end NE, 802.1agLB/Y.1731 TST). Based on this comparison, we can see the method proposed in invention is a simple and low cost solution which can meet Y.1564 requirements and has the accuracy approximate to Test Instrument.

Table 1

	One-way on NE (embodiment of the invention)	One-way on Test Instrument	Round-trip/Loopback with EVC loopback on one-end NE	802.1ag LB/Y.1731 TST
Y.1564 Service Configuration Test (CIR/EIR/CBS/EBS)	Yes	Yes	Only round-trip parameters.	No
Y.1564 Service Performance Test (IR, FLR, FTD, FDV, AVAIL)	Yes	Yes	Only round-trip parameters.	Partially
Test Frame definition (e.g. MAC DA/SA, VLAN, 802.1p bits, IP DSCP)	Yes	Yes	Partially	Partially (IP packets cannot be simulated)
Additional Latch Up Message	No. Via NMS	Yes	Yes	Optionally
Dependency on Test Path Parameters be symmetric	No	No	Yes	Yes (802.1ag LB) No (Y.1731 TST)
Accuracy	Medium	High	Low	Low
Complexity	Low	High	Medium	Medium
Test Function Cost	Low	High	Medium	Medium
Test Engineer Field Support Cost	Not needed	High. (On both end site)	Medium. (On one end site)	Not needed

Those ordinary skilled in the art could understand and realize modifications to the disclosed embodiments, through studying the description, drawings and appended claims. All such modifications which do not depart from the spirit of the

invention are intended to be included within the scope of the appended claims. The word "comprising" does not exclude the presence of elements or steps not listed in a claim or in the description. The word "a" or "an" preceding an element does not
5 exclude the presence of a plurality of such elements. In the practice of present invention, several technical features in the claim can be embodied by one component. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim.

10

What is claimed is:

1. A method in a first network element for executing tests, comprising the steps of:

- 5 - generating test traffics, and providing them for the QoS processing, before sending it to a second network element for executing tests;

Wherein, the generating step comprises:

- 10 - scheduling one or more flows of test traffics;
 - producing test frames for the scheduled flow;
 - adding Tx timestamp into the produced test frames.

2. A method according to claim 1, further comprising the step before the generating step:

- 15 - receiving test configuration from a network management system;

Said generating step generates the test frames according to the test configuration;

the QoS processing comprises the following operations:

- 20 policing, congestion control, queuing, scheduling and shaping.

3. A method according to claim 2, wherein the test configuration comprises any of the following:

- 25 - number of services to be tested and corresponding test ID;
 - test steps and duration for each step;
 - size of the test frame;
 - committed information rate;

- pattern of the test frame;
- Ethernet frame header;

the generating step further adds any of the following information into the produced test frames:

- 5 - Ethernet frame header;
- test ID identifying the flow of the test traffic;
- sequence number of the test traffic in the flow;
- the length of the test frame is no more than 64 bytes.

10 4. A method according to claim 1, further comprising the step before the generating step:

- synchronizing the time and frequency with respect to the second network element by using their own synchronization mechanism.

15

5. A method according to claim 1, wherein the generating step generates the test frames according to the committed information rate of the flow, wherein,

the one or more flows are provided with tokens based on the
20 test committed information rate of the flow,

the scheduling step selects one flow from the one or more flows according to scheduling algorithms, and determining whether the selected flow has enough tokens:

- if it has, the test frames of the selected flow are
25 produced;

- otherwise, the scheduling step selects the next flow according to the scheduling algorithms.

6. A method in a second network element for executing tests, comprising the steps of:

- receiving test traffics sent by a first network element for executing tests;

5 - detecting the test traffic to which the QoS processing has been carried out;

Wherein, the detecting step comprises:

- adding Rx timestamp to the received test frames;

10 - classifying the received test frames into one or more flows of test traffics;

- calculating the result of the test based on the received test frames, respectively for each flow.

7. A method according to claim 6, further comprising the step before the detecting step:

- receiving test configuration from a network management system;

the QoS processing comprises the following operations:

20 classification, congestion control, queuing, scheduling, and shaping.

8. A method according to claim 7, wherein the test configuration comprises any of the following:

- number of service to be tested and corresponding test ID;

25 - test steps and duration for each step;

- size of the test frame;

- pattern of the test frame;

- service acceptance criteria, comprising:

- frame loss rate;
- frame transfer delay;
- frame delay variation;
- percentage of service time.

5

9. A method according to claim 6, further comprising the step before the detecting step:

- synchronizing the time and frequency with respect to the first network element by using their own synchronization

10

10. A method according to claim 6, wherein, the calculating step comprises the steps:

- counting the number of the received test frames;

15

- computing the information rate, according to the length of the received test frames and the duration;

- computing the frame loss rate according to the number of the received test frames and the number of transmitted test frames;

20

- computing the percentage of the service time based on the test duration starting from the time when the first test frame is received and the unavailable duration in which the frame loss rate is above a threshold for a successive period.

25

11. A method according to claim 10, wherein, the calculating step further comprises the steps:

- computing the frame transfer delay based on the Tx timestamp and the Rx timestamp of each test frame;

- computing the frame delay variation based on the frame transfer delays.

12. A first network element for executing test, comprising a test generator which generates test traffic and provides it for the QoS processing before sending it to a second network element for executing tests, the test generator comprising:

- one or more units (10), respectively for one traffic flow, for producing test frames of the flow;

- a scheduler (12) for scheduling the one or more units to produce test frames of the flow;

- a Tx timestamp updater (14) for adding Tx timestamp into the produced test frames.

13. A first network element according to claim 12, wherein the unit (10) comprises:

- a shaper (100) for maintaining tokens based on the test committed information rate of the flow;

- a test frame generator (102) for producing the test frames of the flow;

Wherein, the scheduler (12) selects one flow from the one or more flows according to scheduling algorithms, and being informed by the corresponding shaper (100) about whether the shaper (100) has enough tokens:

- if it has, the scheduler (12) instructs the test frame generator (102) to produce test frames of the flow;

- otherwise, the scheduler (12) selects the next flow according to the scheduling algorithms.

14. A second network element for executing test, the second network element receives test traffics sent by a first network element for executing tests, comprising a test checker for
5 detecting test traffic to which the QoS processing has been carried out;

Wherein, the test checker comprises:

- Rx timestamp updater (20) for adding timestamp to the received test frames;

10 - a classifier (22) for classifying the received test frames into one or more flows of test traffics;

- one or more units (24), respectively for each flow, for calculating the result of the test based on the received test frames of the flow.

15

15. A second network element for executing test, wherein the unit (24) comprises:

- a counter (240) for counting the number of the received test frames;

20 - a computing unit (242) for computing the result of the test based on the number of the received test frames and time information.

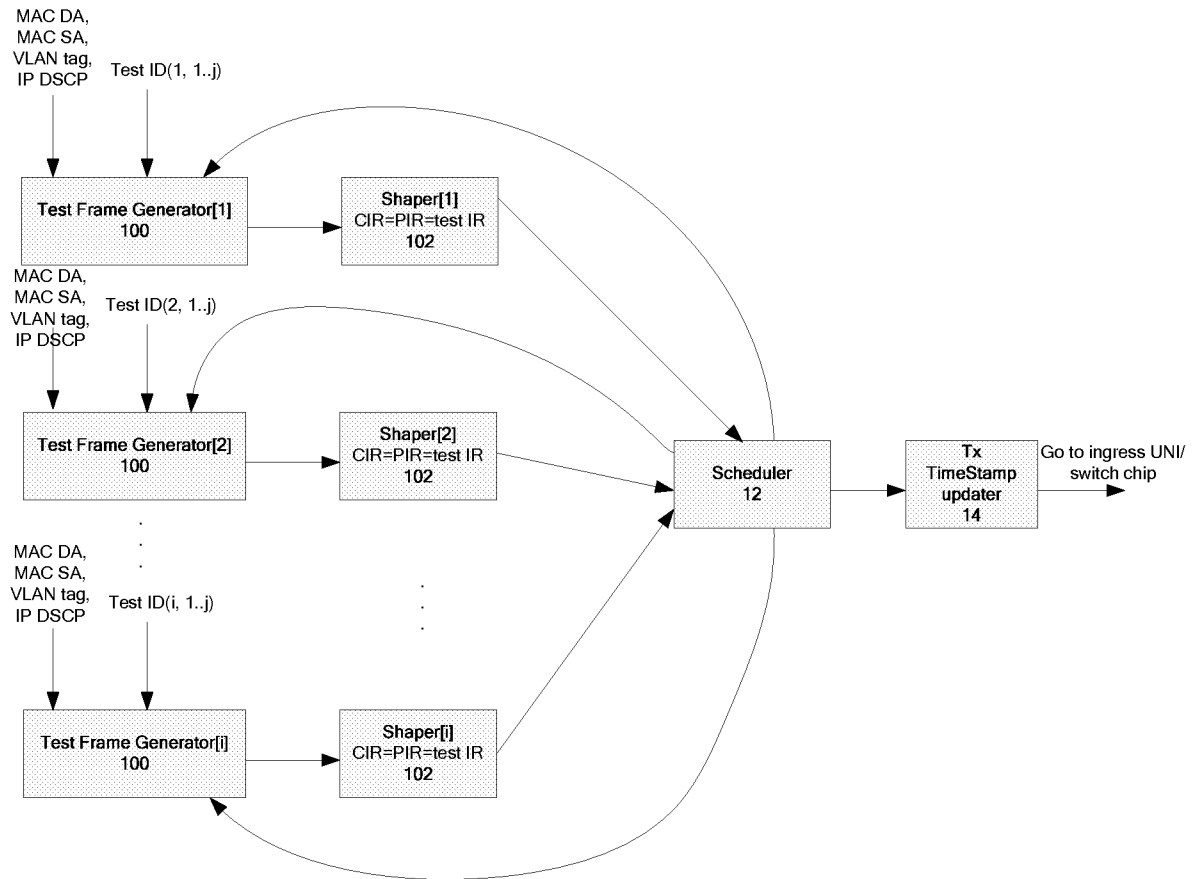


Fig. 1

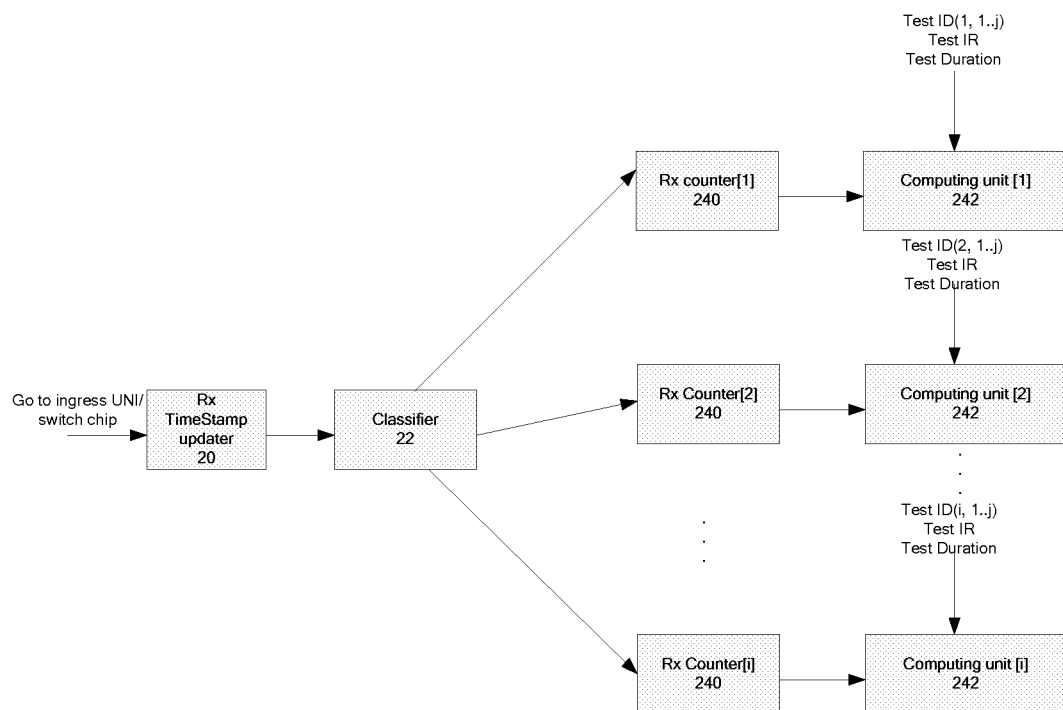


Fig. 2

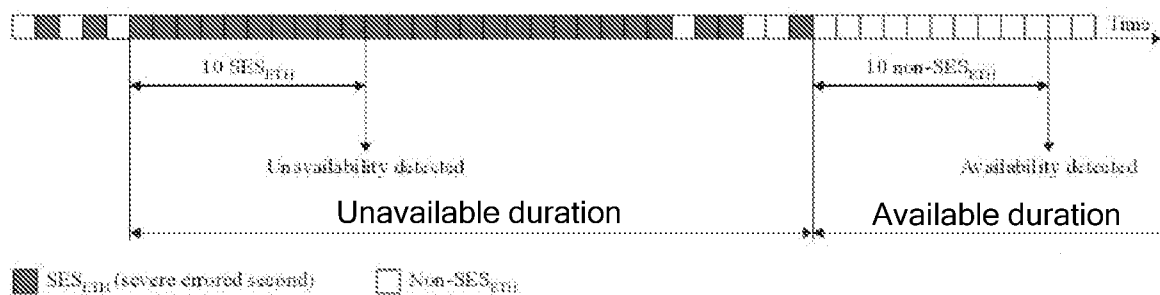


Fig. 3

No IP Header
(min. Length=40 bytes)

6	DA
6	SA
4	VLAN Tag
2	EtherType
4	Test ID
2	Test Size
4	Sequence Number
8	TxTimeStamp
N	Padding
4	FCS

with IP Header
(min. Length=60 bytes))

6	DA
6	SA
4	VLAN Tag
2	EtherType
4	Test ID
20	IP Header
2	Test Size
4	Sequence Number
8	TxTimeStamp
N	Padding
4	FCS

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/001237

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L12/24 H04L12/26
ADD.

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)
H04L

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)

EPO-Internal, COMPENDEX, INSPEC, IBM-TDB, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/170465 A1 (SPIESER FREDERIC [US] ET AL) 5 July 2012 (2012-07-05) the whole document	1-15
A	----- "Ethernet service activation test methodology; Y.1564 (03/11)", ITU-T STANDARD, INTERNATIONAL TELECOMMUNICATION UNION, GENEVA ; CH, no. Y.1564 (03/11), 1 March 2011 (2011-03-01), pages 1-36, XP017467618, [retrieved on 2011-03-23] the whole document ----- -/--	1-15

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

17 September 2013

Date of mailing of the international search report

24/09/2013

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/001237

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	BRUNO GIGUËRE ET AL: "Latest Draft for New Recommendation Y.156sam;xxx (GEN/12)", ITU-T DRAFT ; STUDY PERIOD 2009-2012, INTERNATIONAL TELECOMMUNICATION UNION, GENEVA ; CH, vol. 17/12, 20 September 2010 (2010-09-20), pages 1-30, XP017439493, [retrieved on 2010-09-20] the whole document -----	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2013/001237

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012170465	A1	05-07-2012	NONE
