DESCRIPTION

FTTH Test lab automation:
Towards the path of excellence

- Current certification process has a high portion of “Waste” (there are too many manual intervention and a lot of lab resources underused).
- Manual execution of a Test Plan takes a long time (usually several weeks) where 70% of committed time is devoted to tasks with less value added (i.e. resources set up and test plan execution). Due to time pressure, there is a high risk of lack of dedication to tasks of greater added value that lead to a growth in the likelihood of “diagnostic error”.

Current testing drawbacks

<table>
<thead>
<tr>
<th>Inaccuracy</th>
<th>Subjective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results not repeatable</td>
<td>Unstable Test Efficiency</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Days/TCs</th>
<th>No TCs for stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problems to meet deadlines</td>
<td>Poor Test Coverage</td>
</tr>
</tbody>
</table>

An automated testing tool is able to playback pre-recorded and pre-defined actions compare the results to the expected behavior and report the success or failure to a testing engineer. Automated tests can be easily be repeated and extended to perform tasks impossible with manual testing.

GPONDoctor Test Automation solution, T-REX is a powerful and affordable automated software-testing tool that is supported on all GPONDoctor products. It addresses the full range of CPE/ONU testing challenges that FTTH operators (QA engineers) have to deal with.

FTTH Test Lab Automation:
Moving from WASTE TO VALUE

The automation of all tasks related to resources set up, T-REX es FTTH GPON Test Lab Automation test plan execution and test report generation has a drastic impact on Test plan completion time. What it took weeks, now are hours (less than one day). These savings in time will lead to a continuous pursuit of perfection (better Test Plans) and staff recognised professional roles (Test Plan designers and Test results).
To an Optimized Certification process

- Current certification process has a high portion of "Waste" (Excess manual intervention, very high resource waiting times).
- Risk of lack of dedication to tasks of greater added value and therefore increase the likelihood of “diagnostic error”.
- LEAN methodology typical scenario (prioritize Action, continuous pursuit of perfection and staff new role).

With improvements thanks to automation in both ONUs testing...

<table>
<thead>
<tr>
<th>Task</th>
<th>Automation Degree</th>
<th>Time Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer 2 throughput</td>
<td>100%</td>
<td>75%</td>
</tr>
<tr>
<td>HSI profiles QoS</td>
<td>100%</td>
<td>70%</td>
</tr>
<tr>
<td>Speed Test for HSI</td>
<td>100%</td>
<td>65%</td>
</tr>
<tr>
<td>IPTV Service</td>
<td>80% (**)</td>
<td>70%</td>
</tr>
<tr>
<td>VoIP Service (*)</td>
<td>80% (**)</td>
<td>80%</td>
</tr>
<tr>
<td>IPVPN</td>
<td>100%</td>
<td>80%</td>
</tr>
<tr>
<td>QoS at GPON level</td>
<td>100%</td>
<td>80%</td>
</tr>
<tr>
<td>T-CONT/GEM port</td>
<td>100%</td>
<td>80%</td>
</tr>
<tr>
<td>DBA per ONT</td>
<td>100%</td>
<td>80%</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>75%</td>
</tr>
</tbody>
</table>

* Only connectivity ** "watch TV", "make phone calls".

Foreseen benefits: ONTs’ Service Test Plan

Test time is reduced due to a decrease in actions that demand human intervention:
- Reduced by a factor of x4.
- Some actions may still demand human intervention: watch TV, make phone calls.

Productivity rise due to 95% Test Plan automation:
- Plus additional capacity as it is available 24×7.
- It goes from running 1 Test Plan per WEEK to 2 Test Plans per DAY.

And OLTs interoperability...

<table>
<thead>
<tr>
<th>Task</th>
<th>Automation Degree</th>
<th>Time Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profiles &amp; Documentation</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>General Tests</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Boundaries</td>
<td>50%</td>
<td>65%</td>
</tr>
<tr>
<td>Protocols</td>
<td>80%</td>
<td>75%</td>
</tr>
<tr>
<td>Physical Layer</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Load</td>
<td>100%</td>
<td>65%</td>
</tr>
<tr>
<td>Services</td>
<td>80%</td>
<td>75%</td>
</tr>
<tr>
<td>Security</td>
<td>50%</td>
<td>65%</td>
</tr>
<tr>
<td>IOT</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>40%</td>
</tr>
</tbody>
</table>

Foreseen benefits: OLTs’ Tests

- Test time is reduced due to a decrease in actions that demand human intervention.
- Total Testing time is reduced in a 40%.
- Productivity rise due to 60% Test Plan automation.
- Plus additional capacity as it is available 24×7.
- Very easy to run complex Test Cases -No need to be an expert.
- Productivity is increased in a factor of x2.

Additional improvements

- Test Equipment consolidation located in multiple places.
- Host multiple providers while keeping privacy (i.e. Alcatel-Lucent, Huawei, ZTE).
- Segregated access for each Test team (from the own company or external) so they can work in parallel.
- Resource reservation management mechanism with an approval scheme.
- Equipment usage test with the option to be invoiced per consumption.
- Report generation adapted to different profiles (management, technicians, DUT providers, etc.).
**SOLUTIONS**

**One Customer - One solution**

GPONDOCTOR has been working with all the players involved in the FTTH GPON world since 2009. Our engineers have worked hand in hand with our customers’ technical engineers and learning from them what are their main concerns. They all share the same wish “have Testing done in an automatic way” but they all differ in the kind of Tests it should address.

Therefore, GPONDOCTOR has developed a family of products designed to meet all the needs of the FTTH GPON industry regarding Test Automation, GPONDOCTOR T-REX.

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**Broadband Connectivity Services (Access Network Providers)**

Their main concern is to guarantee the Quality of the connection pipes in terms of Bandwidth, Jitter and Delay as lack of compliance could lead to serious problems with their customers — the Retailers. GPONDOCTOR T-REX will help them to achieve full interoperability and performance among all the devices involved in the communication in “hours instead of weeks”.

**Service Providers (IPTV, VoIP and HSI)**

Their main concern is that their users enjoy the services always with the best quality (satisfying the Service Level Agreement). GPONDOCTOR T-REX will help them to check “Services” level of support of their Customer Premises Equipment (against “Emulated” or “Real” Services platforms). Their Test Plans usually involved “functional test cases”.

**WholeSale Providers**

They are the combination of a Network Service Provider (NSP) and an Application Service Provider (ASP) and thus providing Triple play services as well as connectivity pipes. GPONDOCTOR T-REX will provide them a combination Test lab for conformity, interoperability, and performance as well as functional for Service support.

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For those with needs to launch new devices, services and network features as well as to improve the Quality of Service and Quality of Experience. GPONDOCTOR T-REX, can “help” to define Test Plans, requirements, device acceptance process, policies and procedures as well as Test environments.

**GPON ONUs’ Manufacturers**

GPONDOCTOR T-REX will help them to demonstrate that their solution is 100% compatible with the standards and with the systems their customers already have. It is also a suitable tool for validation check during production.

**GPON OLTs’ Manufacturers**

GPONDOCTOR T-REX will help them to troubleshoot in Multi vendor environments, in order to verify other parties ONUs interoperability with manufacturer OLT products and Firmware releases.

No matter whether you are system vendors, Customer devices manufacturers or Application/ Network Services providers, your Test Plans will be automated by one of our T-REX solution. Just focus on tasks that provide value to your company, T-REX will take care of the rest.

**HOW IT WORKS**

GPONDOCTOR T-REX is a Test automation platform that orchestrates a lab infrastructure topology where pre-defined Test plans are executed. Results are collected from all the testing elements involved and compared against validation criteria to determine a PASS/FAIL. Different level reports are also generated automatically.

**GPONDoctor T-REX has two kind of users:**

- **Automation Producers:** From a pre-defined set of testing resources stored in the block repository, they are in charge in the implementation of the Test Cases that are part of each Test Plan to be executed by T-REX.
- **Automation Consumers:** In charge to load Test plans into the system, schedule their execution and collecting the results and reports.
Physical Topology Orchestration

GPONDoctor T-REX will provide all the APIs needed to control all the devices involved in the Test Plan, including OLTs, Optical Matrix, Switches, Traffic Generators/Testers, GPON Testers, Variable Optical Attenuators, IP Power units, ONUs/ONTs, Home Gateway Units, CPEs, ACS and many others. All of them are controlled from a central server and will be provided with the proper configuration according to the specifics of each test case.

Test Execution Orchestration

Once the Test Plan is loaded in the system, GPONDoctor T-REX will get from the Configuration Repository the devices involved in each Test Case as well as the Validation Criteria. It communicates with the Topology orchestration module in order to setup all the devices involved accordingly while the Test Case is been executed. All the data generated during this process is tested and compared with the expected results and finally a report is generated and stored in the “Results Repository” together with the tested data. Once a Test Case is completed the next will be executed until all associated to the Test Plan loaded are finalised.

Customized Report Generation

GPONDoctor T-REX is able to generate different types of Reports, from very intuitive where at a glimpse it is possible to see the Test plan/associated Test Cases/ PASS-FAIL. To very detailed reports where it is possible to access to all data generated during the execution of the Test Case in order to find out the issues that have leaded the Test Case to FAIL.

Teams working in parallel

GPONDoctor T-REX allows several teams working in parallel, even combinations of Test automation producers and Test automation consumers. It is also possible to run the Test Plan and consult the results REMOTELEY.

Absolute Providers’ Segregation

GPONDoctor T-REX guarantees Absolute Providers’ Segregation. Device manufacturers could access ONLY to the results of their device under test completely isolated from the other manufacturers.
T-REX GPON OLT emulation—
ONU Interoperability
Lab Automation BBF TR.255

T-REX 255 automation module with OLT Emulation. Advances, easy to use automation solution for verifying if an OLT-e and ONU pairing is able to interoperate within the functional requirements of BBF TR-156 and ITU-T G.988.

OLT-ONU interoperability test cases:

### VLAN manipulation in a N:1 Architecture
- Untagged U-interface
- Priority-tagged U-interface
- Q-tagged U-interface
- Configurable Value of the S-tag TPID Value

### VLAN manipulation in a 1:1 Architecture
- Untagged U-interface, Single Tagged V-interface
- Untagged U-interface, Double Tagged V-interface
- Tagged U-interface, Single Tagged V-interface
- Tagged U-interface, Double Tagged V-interface

### VLAN manipulation in VLANs for Business Ethernet Services
- Untagged U-interface, Single Tagged V-interface
- Priority-tagged interface U-interface, Single Tagged V-interface
- Q-tagged U-interface, Double Tagged V-interface
- S-tagged U-interface, Single Tagged V-interface
- Double Tagged interface U-interface, Double Tagged V-interface

### QoS: Frame classification (derivation and manipulation of P-bits)
- Setting of P-bit value based on received VID
- Setting of p-bit value based on received P-bit
- Setting of p-bit value based on received Ethertype
- Setting of p-bit value based on UNI port
- Setting of p-bit value based on received DSCP value

### QoS: Drop Precedence
- Indicating drop precedence using p-bit upstream
- Indicating drop precedence using DEI bit upstream
- Indicating drop precedence using p-bits downstream
- Indicating drop precedence using DEI bits downstream

### IGMP controlled multicast
- Downstream Transport of IGMP messages
- Upstream Transport of IGMP messages
- Configurable discard of upstream IGMP messages
- White and black listing of multicast channels
- Blocking of user generated multicast traffic
- Rate-limiting of user generated IGMP messages
- IGMPv3 transparent snooping functions
- IGMP immediate leave
- Discard of user generated proxy query solicitations
- Marking of upstream IGMP messages with Ethernet P-bits
- Configurable maximum number of simultaneous multicast groups
- Silent discard of upstream IGMPv1 messages

### Non-IGMP controlled multicast and broadcast
- Silent discard of frames with unknown MAC addresses
- Flooding of frames with unknown MAC addresses
- Silent discard of downstream broadcast frames
- Flooding of downstream broadcast frames

### Security
- Test for Providing service to users with duplicated MAC addresses
- Test for Denying service to users with duplicated MAC addresses
- Test for mechanism to prevent Broadband Network gateway MAC addresses spoofing
T-Rex OLT-ONU Interoperability

Test for mechanisms to handle ARP broadcasts
Test for mechanism to prevent IP address spoofing
Test for mechanism to prevent MAC flooding attacks

Filtering
MAC source address allowing filter
MAC source address denying filter
MAC destination address allowing filter
MAC destination address denying filter
Group MAC destination address filter
EtherType allowing filter (PoE)
EtherType allowing filter (PPPoE)
EtherType denying filter (PoE)
EtherType denying filter (PPPoE)

Port identification and characterization
Basic PPPoE Intermediate function
PPPoE Intermediate function option 82 Overwriting
PPPoE Intermediate function with Multiple clients
PPPoE Intermediate function with Unicast PADI message
Basic DHCP Relay Agent functions
DHCP Relay agent functions Option 82 Overwriting
DHCP Relay agent functions with Multiple clients
DHCP Relay agent functions with Unicast DHCP Discover message

Initial provisioning of ONU
ONU provisioning according to serial number
ONU provisioning according to registration-ID

ONU Bring up
ONU bring-up for New ONU
ONU Bring-up method for Old ONU
ONU Bring-up method with encrypted OMCC
MIB synchronization

Alarms
Alarms synchronization

Software download
Software Download, Valid Image
Software Download, Corrupt Image
Switch Active Software Instance
Switch Committed Software Instance

Performance and QoS: Frame Mapping
Strict priority upstream scheduling among 4 queues on ONU and OLT based on pbit values (1:1 VLAN, single user port)
Strict priority upstream scheduling among 4 queues on ONU and OLT based on VID values (1:1 VLAN, single user port)
Strict priority upstream scheduling among 4 queues on ONU and OLT based on VID & pbit values (1:1 VLAN, single user port)
Strict priority upstream scheduling among 4 queues on ONU and OLT based on VID, VID & pbit values (1:1 VLAN, multiple user port)
Strict priority downstream scheduling among 4 queues on ONU and OLT based on pbit values (1:1 VLAN, single user port)
Strict priority downstream scheduling among 4 queues on ONU and OLT based on VID values (1:1 VLAN, single user port)
Strict priority downstream scheduling among 4 queues on ONU and OLT based on VID, VID & pbit values (1:1 VLAN, single user port)
Strict priority downstream scheduling among 4 queues on ONU and OLT based on VID, VID & pbit values & MAC DA (VBES, single user port)
Strict priority downstream scheduling among 4 queues on ONU and OLT based on SVID, CVID & pbit values (1:1 VLAN, multiple user port)
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