



A PON Analyzer - Understanding communication between an OLT and ONU(s)

BACKGROUND

While the number of wired broadband subscriptions is estimated to have reached 1 billion connections worldwide in 2018, Telecom players are continuing to deploy optical fiber to provide broadband services to the populations.

Within the infrastructure, Passive Optical Network (PON) technology is one of the most common technologies adopted worldwide. It requires an Optical Line Terminal (OLT) at the service provider's premises and Optical Network Units (ONU) or Optical Network Terminals (ONT) at the end user's side.

A standards group named the ITU (International Telecommunication Union) developed a Gigabit-capable Passive Optical Networks (GPON) standard in 2004 to be used on a PON infrastructure. It is also called G.984 and it allows 2.5 Gbits/s of downstream bandwidth and 1.2 Gbits/s of upstream bandwidth. In 2011, XG-PON standard (G.987) was released and increased the downstream bandwidth to 10 Gbit/s and upstream to 2.5Gbits/s. More recently, in 2016, a new standard, named XGS-PON or 10G-PON, describes a 10 Gbits/s symmetrical passive optical network system for residential, business, mobile back-haul and other applications. Similar to the other standards, the system operates over a point to multi-point optical access infrastructure.

WHAT IS A PON ANALYZER ?

A PON Analyzer is a Broadband test equipment system which highlights all communication exchanges between an OLT and ONU(s) using the PON technology.

Thanks to an optical head placed on a PON infrastructure, a PON Analyzer receives part of the light going through the optical fiber. As a passive element, a PON Analyzer does not interfere with the communication on any part the two equipments. It displays the configuration datagram exchanges which initiate the service and may also monitor and capture the user traffic data.

While some access to the exchanges & configuration may be communicated between the OLTs or ONUs, a PON Analyzer offers a neutral, transparent, non-intrusive and comprehensive reading on what is happening on a PON tree, with no effect on subscriber data.

WHERE DO YOU PLACE YOUR PON ANALYZER ?

A PON Analyzer can be plugged anywhere on a PON tree. It depends on the information on wishes to capture.

On a multi-ONU topology, if you place your optical head between an OLT and a splitter, you will then be able to see all downstream and all ONU(s) upstream messages (ref. figure 1).

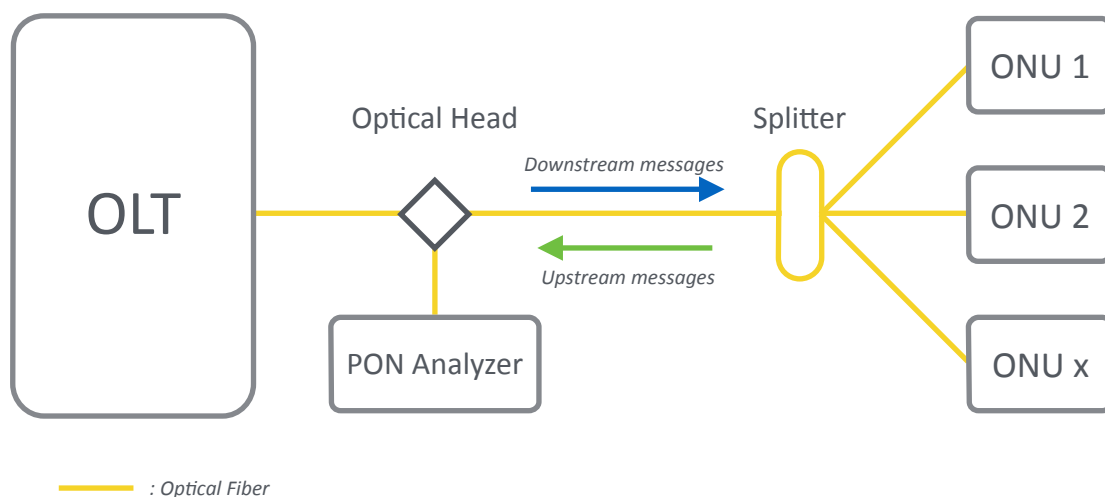


Figure1 - Placing an optical head between an OLT and a splitter

However, if you are interested in analyzing on the message from one specific ONU, you can place your optical head between a splitter and the chosen ONU. In that particular case, you will see all downstream messages but only the specific ONU's upstream messages.

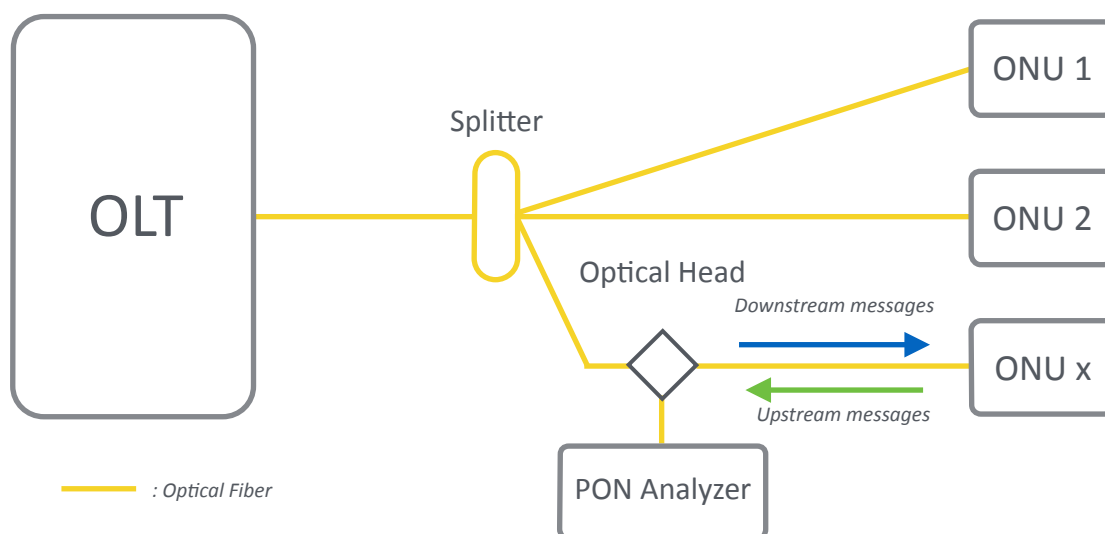


Figure 2 - Placing an optical head between a splitter and an ONU x

WHAT DO YOU SEE WITH A PON ANALYZER ?

On protocol layers, a PON analyzer offers multiple information elements such as:

- Full GTC (GPON Transmission Convergence) frames for G-PON and XGTC frames for XG/XGS-PON. It includes PCBd (Physical Control Block downstream) and the payload ;

[illegible]

Figure 3 - Full GTC frame displayed

- PLOAM/OMCI messages which are the OLT/ONUs dialogue about ONU configuration ;

	timestamp	side	superframe	rate	name	id	status	content
722	14:11:43:625:804764	Upstream OMCI	0x001acbbe	1.24..	OMCI::MIB Upload Next Response (ONU_	1	✓ OK	015a2e0a0002000001158053fff0000ccc.
723	14:11:43:649:451408	Downstream OMCI	0x001acbdc	2.48..	OMCI::MIB Upload Next (ONU Data)	1	✓ OK	015b4e0a00020000015800000000000000..
724	14:11:43:654:179764	Upstream OMCI	0x001acc01	1.24..	OMCI::MIB Upload Next Response (ONU_	1	✓ OK	015b2e0a0002000001158053000f000000..
725	14:11:43:719:329076	Downstream OMCI	0x001ace0d	2.48..	OMCI::MIB Upload Next (ONU Data)	1	✓ OK	015c4e0a00020000015900000000000000..
726	14:11:43:723:929764	Upstream OMCI	0x001ace2f	2.48..	OMCI::MIB Upload Next Response (ONU_	1	✓ OK	015c2e0a0002000001158054fff0000ccc.
727	14:11:43:809:057953	Downstream OMCI	0x001ad0da	1.24..	OMCI::MIB Upload Next (ONU Data)	1	✓ OK	015d4e0a00020000015a00000000000000..
728	14:11:43:813:554764	Upstream OMCI	0x001ad0fc	1.24..	OMCI::MIB Upload Next Response (ONU_	1	✓ OK	015d2e0a0002000001158054000f000000..
729	14:11:43:817:482400	Downstream OMCI	0x001ad11d	2.48..	OMCI::MIB Upload Next (ONU Data)	1	✓ OK	015e4e0a00020000015b00000000000000..
730	14:11:43:822:054764	Upstream OMCI	0x001ad140	1.24..	OMCI::MIB Upload Next Response (ONU_	1	✓ OK	015e2e0a0002000001158055fff0000ccc.
731	14:11:43:827:735358	Downstream OMCI	0x001ad170	2.48..	OMCI::MIB Upload Next (ONU Data)	1	✓ OK	015f4e0a00020000015c00000000000000..
732	14:11:43:832:304764	Upstream OMCI	0x001ad192	1.24..	OMCI::MIB Upload Next Response (ONU_	1	✓ OK	015f2e0a0002000001158055000f000000..
733	14:11:43:909:485230	Downstream OMCI	0x001ad3fd	2.48..	OMCI::MIB Upload Next (ONU Data)	1	✓ OK	01604e0a00020000015d00000000000000..
734	14:11:43:914:054764	Upstream OMCI	0x001ad420	1.24..	OMCI::MIB Upload Next Response (ONU_	1	✓ OK	01602e0a0002000001158056fff0000ccc.
735	14:11:43:919:009985	Downstream OMCI	0x001ad44b	2.48..	OMCI::MIB Upload Next (ONU Data)	1	✓ OK	01614e0a00020000015e00000000000000..
Transaction corr... 0x0000015d								
Priority Low								
Acknowledge Requ... 1								
Message Type 14								
Device Id Baseline OMCI								
0000	01 5d 4e	0a 00 02 00 00	01 5a 00 00 00 00 00 00					
0010	00 00 00	00 00 00 00 00	00 00 00 00 00 00 00 00	.).....Z.....				
0020	00 00 00	00 00 00 00 00	00 00 00 28 ba ce 19 fe(....				

timestamp: 0000000001ae2c1
displayed: 764 stored: 764 captured: 764

Figure 4 - PLOAM/OMCI messages displayed

- GEM (GPON Encapsulation Methods) Ports are discovered and displayed in real time. They provide an access to the user data traffic.

	GEM Port	ONU	Alloc-ID	PCAP Files	Instant Data rate	Frames Counter	VLANs
<input checked="" type="checkbox"/>	All				<div> <div></div> Up : 904.4 Mb/s <div></div> Down : 799.8 Mb/s </div>	Up : 17 144 163 Down : 15 114 791	
<input checked="" type="checkbox"/>	1	1	1	<div> <div></div> <div>Store to file : <input type="text"/> ... View</div> </div>	<div> <div></div> Up : 0.0 Mb/s <div></div> Down : 0.0 Mb/s </div>	Up : 818 Down : 806	
<input checked="" type="checkbox"/>	3470	1	3470	<div> <div></div> <div>Store to file : <input type="text"/> ... View</div> </div>	<div> <div></div> Up : 904.4 Mb/s <div></div> Down : 799.8 Mb/s </div>	Up : 17 143 345 Down : 15 113 985	3972

Figure 5 - GEM Ports displayed

- Bandwidth Map allocation which is assign to the ONU(s).

	timestamp	superframe	status	content
0	17:37:03:638:750000	0x000000000004f401	OK	0005004000d300743638ffff00d307d5
1	17:37:03:638:875000	0x000000000004f402	OK	0005004000d300743638ffff00d307d5
2	17:37:03:639:000000	0x000000000004f403	OK	0005004000d300743638ffff00d307d5
3	17:37:03:639:125000	0x000000000004f404	OK	0005004000d300743638ffff00d307d5
4	17:37:03:639:250000	0x000000000004f405	OK	0005004000d300743638ffff00d307d5
5	17:37:03:639:375000	0x000000000004f406	OK	0005004000d300743638ffff00d307d5
6	17:37:03:639:500000	0x000000000004f407	OK	0005004000d300743638ffff00d307d5
7	17:37:03:639:625000	0x000000000004f408	OK	0005004000d300743638ffff00d307d5
8	17:37:03:639:750000	0x000000000004f409	OK	0005004000d300743638ffff00d307d5
9	17:37:03:639:875000	0x000000000004f40a	OK	0005004000d300743638ffff00d307d5
10	17:37:03:640:000000	0x000000000004f40b	OK	0005004000d300743638ffff00d307d5
11	17:37:03:640:125000	0x000000000004f40c	OK	0005004000d300743638ffff00d307d5
12	17:37:03:640:250000	0x000000000004f40d	OK	0005004000d300743638ffff00d307d5
13	17:37:03:640:375000	0x000000000004f40e	OK	0005004000d300743638ffff00d307d5
14	17:37:03:640:500000	0x000000000004f40f	OK	0005004000d300743638ffff00d307d5
15	17:37:03:640:625000	0x000000000004f410	OK	0005004000d300743638ffff00d307d5
16	17:37:03:640:750000	0x000000000004f411	OK	0005004000d300743638ffff00d307d5
17	17:37:03:640:875000	0x000000000004f412	OK	0005004000d300743638ffff00d307d5
18	17:37:03:641:000000	0x000000000004f413	OK	0005004000d300743638ffff00d307d5
19	17:37:03:641:125000	0x000000000004f414	OK	0005004000d300743638ffff00d307d5
<div> <div>Burst</div> <div> <div>Allocation</div> <div>Alloc-ID:1;DBRu:0;PLOAMu:1;StartTime:64;GrantSiz...</div> </div> <div> <div>Alloc-ID</div> <div>1</div> </div> <div> <div>Flags</div> <div> <div>DBRu</div> <div>..0.</div> <div>PLOAMu</div> <div>...1</div> <div>StartTime</div> <div>64</div> </div> </div> </div>				
	0000	00 05 00 40 00 d3 00 74	36 38 ff ff 00 d3 07 d5	...@...t 68.....

Figure 6 - Bandwidth Map messages displayed

On the user data traffic, a PON analyzer has the ability to detect traffic on the fiber but also to isolate the traffic.

WHY SHOULD YOU USED A PON ANALYZER ?

PON Analyzers are used to:

- **Establish a precise diagnostic of a PON Tree.** Thanks to a PON Analyzer, you should see all devices connected on both end of the optical fiber. With a high level of information view, you have access to details such as ONU(s) connected, activated or not, device details (S/N, Vendor ID, ONU ID, ...). It allows you to understand and confirm the setup environment which you are working with.
- **Monitor a PON Tree.** A PON Analyzer provides real time analysis and allows you to monitor continuously your PON tree. It displays all of the events occurring on your network set up. It gives an multiple levels of details which help you to better understand what's happening.
- **Validate a device.** A PON Analyzer allows you to understand, verify and troubleshoot the communication between an OLT and a ONU. Then, in your lab or on the field, by operating your PON Analyzer, you see protocol exchanges with downstream and upstream messages. You can then detect precisely if your equipment is communicating within the standard. If not, a PON Analyzer should allow you to point out the issue (Rogue ONU, Faulty SFP or devices, Non-compliant standard behavior, performance vs. SLA, subscriber bandwidth issues, network resource and scalability management, correlation between many PON specs and subscriber L2 - L7, etc...).
- **Access Traffic user data.** A PON Analyzer provides a multi-layer analysis with a clear view of the protocols layers and also the traffic information such as instant downstream and upstream data rate, VLANs counters, but also the upper services layer analysis.
- **Highlight Interoperability issues.** In a multiple vendors topology, Service Providers often experience mis-communication between an OLT and ONU(s). Most of the time, problems and issues start at the protocol layers. Equipment manufacturers might have a different interpretations of the standard. As a result, ONU(s) configuration often does not work at a first time and some step by step debugging may be necessary. Thanks to a PON Analyzer, mis-communication events are flagged immediately. You will be able to isolate a problem and begin a discussion with the appropriate contact.

CONCLUSION

A PON Analyzer offers numerous benefits for Service Providers, Equipment and Chipset manufacturers looking to highlight and understand what is happening on a PON tree.

For Service Providers, a PON Analyzer brings in a neutral & objective point of view. It will help Service Providers make their own opinion and advance discussions with Equipment Manufacturers.

For Equipment manufacturers, a PON Analyzer helps to present and understand the behavior of their own product facing different OLT/ONU brands. It is also a way to ensure that their product follows the PON standards.

Performing real time analysis on a long time period also allows one to fully understand the different events which occur in your set up. In a lab environment, users can easily detect rogue behavior, configuration issues, faulty ONU(s) or SFP(s) and validate the equipment before entering into a real deployment. In a deployed FTTH network, a PON analyzer will help to detect and understand the events. It will ensure all issues are resolved much faster.

MT2 - leads the industry in FTTH GPON and 10G PON network test, troubleshooting, monitoring deep analysis products, and 'single-click' automated test suite solutions. MT2's analyzers and OLT emulators have the unique powerful features to allow the user to simply 'software-select' , and switch between GPON, XG-

PON, XGS-PON or NG-PON2, all within the same single system, for full validation coverage of your fiber network. We ensure the complicated protocols and subscriber internet access traffic complies with every spec, automatically. Powerful and intuitive user interface, cost effectiveness, high precision, and innovative design. MT2 leads the industry as a test equipment vendor, with Broadband Forum (BBF) FTTH automated test suites for functionality and performance, covering BBF.247 and TR-255, critical to ensure system quality for the complete validation of your fiber network. Find out more: www.network-testers.com

Authorised Partner UK & Ireland

