

Performance Analysis of GPON ONT-OLT Interoperability in Multi-Vendor FTTH Environment

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ABSTRAK

Interoperabilitas antara Optical Line Terminal (OLT) dan Optical Network Terminal (ONT) merupakan aspek penting dalam implementasi jaringan Fiber to the Home (FTTH) berbasis GPON pada lingkungan multi-vendor. Meskipun standar ITU-T G.984 telah mendefinisikan kerangka interoperabilitas, perbedaan implementasi OMCI dan mekanisme manajemen perangkat antar vendor masih berpotensi memengaruhi performa layanan. Penelitian ini bertujuan mengevaluasi interoperabilitas satu ONT Merek A terhadap empat platform OLT melalui pengujian registrasi OMCI, konfigurasi Layer-2, aktivasi ACS, serta verifikasi layanan data, suara, dan video. Hasil pengujian menunjukkan bahwa seluruh tahapan pengujian berhasil dengan tingkat keberhasilan 100% pada semua platform OLT, serta kinerja layanan yang stabil tanpa degradasi signifikan. Temuan ini menegaskan bahwa ONT Merek A memenuhi persyaratan standar ITU-T G.984 dan dapat dioperasikan secara andal dalam jaringan GPON multi-vendor.

Kata kunci: GPON, FTTH, interoperabilitas ONT-OLT, OMCI, multi-vendor testing

ABSTRACT

Interoperability between Optical Line Terminals (OLTs) and Optical Network Terminals (ONTs) is an important aspect of GPON-based Fiber to the Home (FTTH) deployments in multi-vendor environments. Although the ITU-T G.984 standard defines an interoperability framework, variations in OMCI implementation and device management mechanisms across vendors may still affect service performance. This study aims to evaluate the interoperability of a Vendor A ONT with four OLT platforms through OMCI registration testing, Layer-2 configuration, ACS activation, and verification of data, voice, and video services. The test results show that all evaluation stages were successfully completed with a 100% success rate across all OLT platforms, and that service performance remained stable without significant degradation. These findings confirm that the Vendor A ONT complies with the ITU-T G.984 standard and can be reliably deployed in multi-vendor GPON networks.

Keywords: GPON, FTTH, ONT-OLT interoperability, OMCI, multi-vendor testing

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1. INTRODUCTION

The development of fiber-optic-based access technologies has encouraged telecommunications operators worldwide to expand the deployment of Fiber to the Home (FTTH) networks. This architecture is widely adopted due to its ability to provide significantly higher transmission capacity, improved operational cost efficiency, and long-term scalability compared to copper-based technologies **(Naeem et al., 2019) (Horvath et al., 2020)**. Within the FTTH ecosystem, the Gigabit Passive Optical Network (GPON) has become the most widely implemented technology, as defined in the ITU-T G.984.x series of standards, which specify physical layer characteristics, communication protocols, and service provisioning mechanisms. Despite being governed by the same standard framework, GPON device implementations across different vendors are not always homogeneous, which may affect the level of interoperability between ONTs and OLTs, particularly in multi-vendor deployment scenarios **(International Telecommunication Union (ITU), 2008) (Adhikary et al., 2018)**.

It is often assumed that devices compliant with the GPON standard will automatically operate compatibly with one another. However, in practice, each vendor implements specific variations in OMCI profiles, management features, and provisioning procedures. As a result, when devices from different vendors are integrated, performance inconsistencies may arise **(Merayo et al., 2022)**. Telecommunications operators also frequently assume that deploying multi-vendor equipment will not introduce technical issues, whereas several studies have shown that such integration can contribute to a degradation of Quality of Service (QoS) or even trigger certain functional failures **(Arokkiam et al., 2015)**.

Although a single-vendor approach is generally perceived as more stable, this strategy introduces other risks, including a high dependency on a single manufacturer (vendor lock-in), limited procurement flexibility, and constraints in adapting to evolving network requirements **(Mahajan et al., 2021)**. In contrast, multi-vendor configurations offer advantages such as price competition, technological flexibility, and diversified equipment sources. Nevertheless, this approach requires more comprehensive interoperability testing to ensure consistent and reliable network performance **(Mohammadani et al., 2023)**.

Considering these challenges, the issue of ONT-OLT interoperability has become increasingly critical in contemporary FTTH deployments. This study evaluates the performance of an ONT from Vendor A when connected to multiple OLT platforms from different vendors, with a focus on validating OMCI communication, provisioning success, and the performance of essential services such as IPTV/video, VoIP, and Internet/data access parameters that directly reflect the quality of user experience **(Abdellaoui et al., 2022) (Sultan & Arefin, 2011)**. The findings of this research are expected to provide an objective assessment of the feasibility of multi-vendor configurations and to support more efficient procurement strategies that are not tied to a single vendor.

In addition to its practical contributions, this study also offers strategic value by enhancing the understanding of inter-vendor incompatibility patterns. Such insights can serve as a basis for formulating interoperability guidelines, refining OMCI profiles, and developing technical certification schemes at both national and international levels **(Torres-Ferrera et al., 2022)**.

2. METODOLOGY

2.1 Test Design and Topology

The research methodology was designed to ensure systematic interoperability validation across heterogeneous GPON platforms. Rather than presenting configuration steps as isolated technical procedures, the methodology integrates device specification analysis, controlled configuration sequencing, error reproduction scenarios, and structured validation criteria. This integrated approach ensures that interoperability assessment is supported by traceable configuration logic and reproducible validation procedures rather than isolated functional observations.

Interoperability testing was conducted in a laboratory environment specifically prepared to replicate a GPON-based Fiber to the Home (FTTH) architecture similar to that of an operational network. A series of procedures was designed to evaluate the capability of an ONT from Vendor A when paired with various OLT platforms from four different vendors. The testing covered device registration, service provisioning, and end-to-end functional verification. The laboratory environment was isolated from the public network to ensure that traffic measurements and signaling exchanges were not affected by external variables. The test network topology is illustrated in Figure 1.

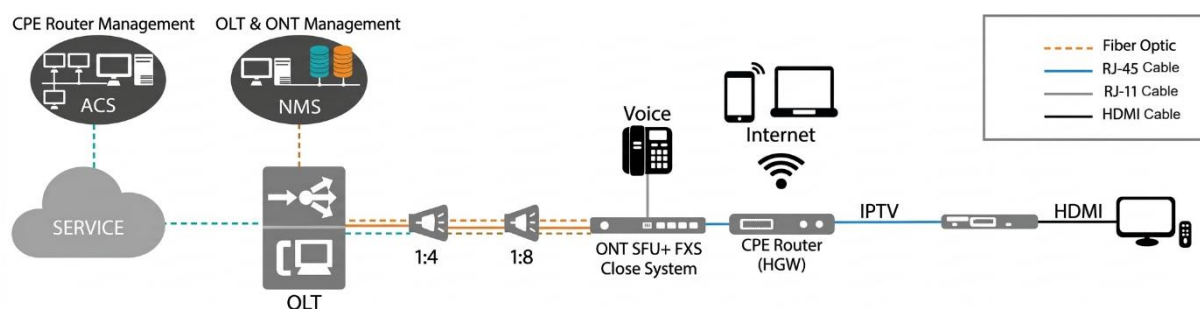


Figure 1. Test Network Topology

The testing traced the service flow from the core network side to the customer premises equipment (CPE), encompassing three main domains: device management, service distribution through the OLT, and service termination at the ONT and customer premises devices. On the upstream side, device management involved an Auto-Configuration Server (ACS) for TR-069-based CPE/ONT management. TR-069 is a protocol defined by the Broadband Forum that allows for the remote management of end-user devices. Additionally, a Network Management System (NMS) was used for managing OLTs and ONTs within the optical access network. Both systems were connected to the service platform, which contains the configurations for data, voice, and video services.

From the core network, services are forwarded to the OLT, which acts as the central distribution point of the GPON system. The OLT transmits optical signals to subscribers through two levels of splitters, namely 1:4 and 1:8 splitters, designed to emulate passive optical network (PON) conditions in real-world deployments. This split ratio ensures that the optical budget is within the range defined by the ITU-T G.984 standard, typically providing an attenuation of approximately 18-20 dB, which represents a typical suburban fiber deployment. Interconnections between devices are established using G.652 standard optical fiber cables, as indicated by the orange lines in the diagram.

After passing through the splitters, the optical signals are received by an SFU+FXS-type ONT (Brand A), which serves as the termination device at the customer side. This ONT provides service outputs through multiple physical interfaces to support different service types. Voice services are delivered via an RJ-11 port connected to an FXS adapter for traditional telephony (**Fu, 2022**). For data services, the ONT provides multiple RJ-45 ports connected to a CPE router or Home Gateway (HGW). In addition, separate VLANs are configured for video/IPTV services, where the connection is forwarded to a Set-Top Box (STB).

The cable colors in the diagram represent the types of connectivity used: optical fiber (orange), RJ-45 for data services (blue), RJ-11 for voice services (gray), and HDMI for IPTV services (black). With this design, all GPON service aspects data, voice, and video can be comprehensively tested to ensure ONT interoperability across various OLT platforms under conditions that closely resemble real-world deployments.

Table 1. Device Specification

Device	Specification / Detail
ONT (Vendor A)	GPON SFU + FXS, 1x GPON Port (SC/APC), 4x GE RJ-45, 1x RJ-11
OLT Platforms A1	Rack-mounted 10U, GPON OLT Chassis, 1 Control board, 1 Uplink Board (4 ports GE), 1 GPON boards (16 ports), GPON Class B+ SFP modules, 1:128 max split per port.
OLT Platforms A2	Rack-mounted 10U, XGSPON+GPON OLT Chassis, 1 Control board, 1 Uplink Board (2x1GE, 2x10GE), 1 GPON boards (16 ports), GPON Class B+ SFP modules, 1:128 max split per port.
OLT Platforms B1	Rack-mounted 10U, GPON OLT Chassis, 1 Control board, 1 Uplink Board (4 ports GE), 1 GPON boards (16 ports), GPON Class B+ SFP modules, 1:128 max split per port.
OLT Platforms B2	Rack-mounted 10U, XGSPON+GPON OLT Chassis, 1 Control board, 1 Uplink Board (2x1GE, 2x10GE), 1 GPON boards (16 ports), GPON Class B+ SFP modules, 1:128 max split per port.
OLT Platforms C1	Rack-mounted 10U, GPON OLT Chassis, 1 Control board, 1 Uplink Board (4 ports GE), 1 GPON boards (16 ports), GPON Class B+ SFP modules, 1:128 max split per port.
OLT Platforms C2	Rack-mounted 2U, XGSPON+GPON Mini-OLT Chassis, 1 Control board, 1 Uplink Board (2x1GE, 2x10GE), 1 GPON boards (16 ports), GPON Class B+ SFP modules, 1:128 max split per port.
OLT Platforms D	Rack-mounted 10U, GPON OLT Chassis, 1 Control board, 1 Uplink Board (4 ports GE), 1 GPON boards (16 ports), GPON Class B+ SFP modules, 1:128 max split per port.
Fiber Media	G.652D Single Mode Fiber
Splitter Ratio	Two-stage: 1:4 and 1:8 (Total 1:32)
Core Systems	ACS (TR-069), NMS (SNMP), IPTV Headend, IMS (SIP), BRAS/BNG (Internet)

The test topology involved a single ONT from Vendor A that was alternately connected to seven Optical Line Terminal (OLT) platforms from four different vendors (A, B, C, and D). These platforms consisted of two OLT units from Vendor A (OLT A1 and OLT A2), two units from Vendor B (OLT B1 and OLT B2), two units from Vendor C (OLT C1 and OLT C2), and one unit from Vendor D used as an additional reference. This configuration enabled a structured evaluation of ONT compatibility in a multi-vendor environment, where each OLT potentially operated with different firmware versions, line profiles, or management configurations. Supporting test equipment included a personal computer for data service verification, an IP telephone for voice service testing, and a Set-Top Box (STB) connected to a television for IPTV

validation. All platforms were configured using standardized ITU-T G.984 parameters to ensure consistency across test cycles (**International Telecommunication Union (ITU), 2014**).

Device specifications are presented to clarify the hardware and firmware context of the interoperability evaluation. Since interoperability behavior may be influenced by chipset architecture, software version, and GPON profile implementation, detailed device specifications are necessary to interpret validation outcomes objectively. The detailed specifications of the devices used can be seen in Table 1.

Prior to implementing the standardized configuration framework proposed in this study, preliminary cross-vendor integration attempts under the specified hardware and firmware conditions revealed several inconsistencies. One representative error scenario is described below to illustrate the practical motivation for structured interoperability validation.

2.2 Testing Procedure

The testing procedure was conducted sequentially and consistently for each testing cycle across all ONT-OLT combinations under evaluation. To enhance methodological clarity and reproducibility, the configuration process is summarized in a structured logical sequence to reflect the ordered dependency between configuration stages. Figure 2 illustrates the sequential validation process required for multi-vendor integration. The initial stage of testing began with the ONT registration process. Registration was performed through an auto-discovery mechanism based on the ONT serial number. At this stage, the OLT monitors for a "Serial Number" message from the ONT. Once detected, the OLT assigns an ONT-ID and enters the OMCI synchronization phase. This stage included the selection of the GPON profile and OMCI mapping in accordance with each vendor's specific implementation requirements.

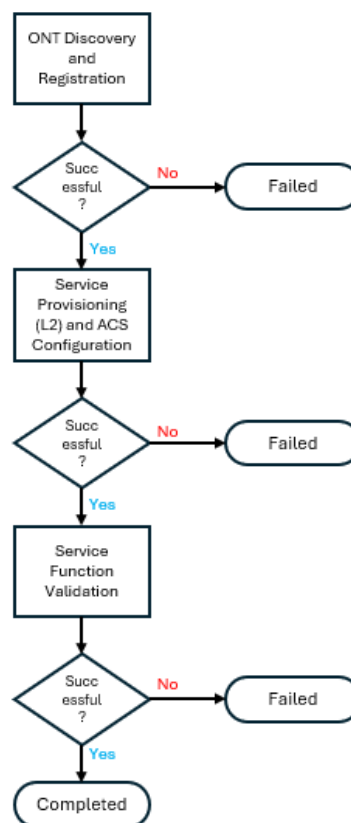


Figure 2. The sequential validation process

Following successful registration (reaching the O5 state), the next stage involved service provisioning. At this stage, VLAN tagging was applied for data, voice, and video services using the appropriate S-VLAN (Service VLAN) and C-VLAN (Customer VLAN) tagging configurations. In addition, GEM ports were mapped to ensure traffic isolation among services. GEM ports are the fundamental units for traffic encapsulation in GPON, and their correct mapping is vital for QoS. Device parameter activation and synchronization were carried out through the Auto-Configuration Server (ACS) using the TR-069 protocol, which allows the management of application-level settings like SIP credentials and Wi-Fi SSIDs.

The subsequent stage focused on functional service validation. Data services were tested by verifying Layer-2 and Layer-3 connectivity as well as web access through a browser. Voice services were evaluated through SIP registration and bidirectional call testing to ensure audio clarity and no signaling timeouts. Meanwhile, video services were tested by streaming multicast IPTV content (using IGMPv2 or IGMPv3) and performing channel zapping tests to measure the latency of joining and leaving multicast groups. All test results were systematically recorded for every ONT–OLT combination to ensure a robust data set for analysis.

2.3 Scope and Limitations

This method focuses on the verification of functional interoperability, including Layer-2 connectivity, Layer-3 connectivity, and basic service functionality (**Octavianus et al., 2023**). The testing is designed to validate if the cross-vendor devices "can talk to each other" and provide the expected services to the end-user. The testing does not include quantitative performance benchmarking or stress-based load analysis, nor does it include multi-user load testing or advanced OMCI-related evaluations like FEC (Forward Error Correction) efficiency or Rogue ONT detection.

In addition to the physical topology, the methodology also considers the service management architecture employed during ONT provisioning and monitoring. The service configuration diagram is shown in Figure 3.

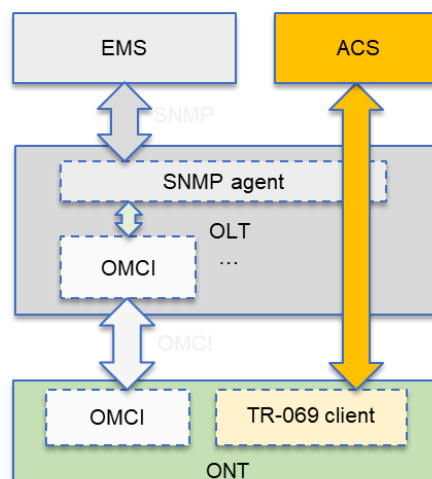


Figure 3. Service Configuration

In this architecture, the Element Management System (EMS) functions as the central platform for network element management and communicates with the OLT via the Simple Network Management Protocol (SNMP) for configuration, operational monitoring, and fault information collection. The OLT utilizes an internal SNMP agent to translate EMS instructions into configuration actions (**Derevianko et al., 2019**).

At the GPON layer, the OLT operates the OMCI module as the primary channel for ONT provisioning. All fundamental configurations ranging from ONT activation, VLAN mapping, and GEM port allocation to service configuration are performed through OMCI sessions. The stability of OMCI communication serves as a key indicator of interoperability success.

In addition, the ONT is equipped with a TR-069 client that interacts with the Auto-Configuration Server (ACS) for application-level settings, IP parameter management, and the activation of additional services. The TR-069 channel enables the ONT to be evaluated not only from the optical transport perspective but also in terms of service configuration compliance.

The combination of OMCI and TR-069 mechanisms allows comprehensive testing from the optical layer to the application layer, enabling a thorough assessment of ONT interoperability across various OLT platforms from both network management and service activation perspectives.

Although the primary objective of this study centers on functional interoperability validation, additional performance-related observations such as throughput stability, latency variation, and packet integrity were considered qualitatively to enrich the analytical depth of the evaluation.

Through this structured methodology, interoperability assessment is positioned not merely as a procedural configuration activity but as a controlled experimental framework. Each validation stage, beginning from physical layer synchronization, continuing through OMCI provisioning and management-plane activation, and concluding with service-layer verification, is logically sequenced to ensure traceable cause effect relationships between configuration actions and observed outcomes. By integrating device specification analysis, standardized configuration logic, predefined validation criteria, and representative error scenarios, the methodology establishes both reproducibility and analytical rigor. Consequently, the results presented in the following section can be interpreted within a clearly defined experimental boundary rather than as isolated functional observations.

3. RESULTS

3.1 Registration and Provisioning Test Results

The initial stage of testing focused on the ability of the ONT from Vendor A to successfully perform the registration process on four different OLT platforms (A, B, C, and D). The evaluated parameters included OMCI registration, Layer-2 configuration, and activation through ACS/TR-069.

In order to ensure objective interpretation of validation outcomes, operational status was classified into normal and abnormal categories based on predefined technical validation thresholds rather than subjective observation. A summary of the test results is presented in Table 2. All OLT platforms were able to automatically recognize the ONT, initiate OMCI sessions, and apply basic configurations without any error messages. The complete success across all evaluated parameters indicates that the OMCI implementation on the ONT from Vendor A operates consistently across the various OLT platforms used in the testing.

Representative system confirmation messages were observed during successful provisioning cycles. OMCI registration was indicated by the ONT-ID reaching the O5 operational state with a registered status. Layer-2 configuration did not always generate explicit system log notifications; however, successful activation was verified through stable service availability and

VLAN functionality. ACS configuration success was confirmed through TR-069 session establishment followed by successful execution of the "SetParameterValues" remote procedure call. These confirmation indicators provide traceable evidence that configuration parameters were applied without synchronization failure.

Table 2. Summary of ONT Registration and Provisioning Test Results

OLT Vendor	OMCI Registration	L2 Configuration	ACS Configuration
A	Success	Success	Success
B	Success	Success	Success
C	Success	Success	Success
D	Success	Success	Success

The successful Layer-2 configuration indicates that the ONT is capable of adapting to differences in VLAN schemes and GEM port mappings across vendor platforms. In addition, the consistent activation of the Auto-Configuration Server (ACS) confirms that the ONT uniformly supports TR-069 implementation on all OLT platforms.

Following the confirmation of stable registration and provisioning behavior, the evaluation proceeded to service-level verification to determine whether configuration consistency translated into end-user service stability.

3.2 Service Validation: Data, Voice, and Video

After the provisioning process was completed, the testing proceeded to service verification. Verification was performed on three primary service categories: data services in the form of Internet access, voice services based on VoIP/SIP, and video services based on multicast IPTV.

Beyond operational status classification, full interoperability was determined through cumulative validation rather than single-event success. Successful device registration alone was considered insufficient; instead, interoperability was confirmed only when configuration stability persisted across repeated activation cycles, no service-layer anomalies were detected, and no rollback or management synchronization errors occurred throughout the validation period.

The normal and abnormal criteria of this test can be seen in table 3. The results are presented in Table 4. All services operated normally on each OLT platform, with no observed quality degradation, significant packet loss, or session failures.

Table 3. Normal and Abnormal Criteria

Service	Normal (Pass) Criteria	Abnormal (Fail) Criteria
Data	<ul style="list-style-type: none"> ▪ PPPoE connection established successfully. ▪ Internet browsing operates normally. ▪ Speed test results are within the expected range. 	<ul style="list-style-type: none"> ▪ PPPoE Connection Failed. ▪ No DNS Resolution
Voice	<ul style="list-style-type: none"> ▪ SIP registration successful. ▪ Bi-directional audio (two-way voice communication). 	<ul style="list-style-type: none"> ▪ SIP registration timeout. ▪ One-way audio. ▪ High jitter affecting call quality.
Video	<ul style="list-style-type: none"> ▪ Live TV and TVOD services operate normally. ▪ Video playback is smooth (no freezing, buffering, or stuttering). 	<ul style="list-style-type: none"> ▪ Multicast join (IGMP) failure. ▪ Live TV or TVOD service not operational.

Table 4. GPON Service Test Results

OLT Vendor	Data Service	Voice Service	Video Service	Remarks
A	Normal	Normal	Normal	Full interoperability
B	Normal	Normal	Normal	Full interoperability
C	Normal	Normal	Normal	Full interoperability
D	Normal	Normal	Normal	Full interoperability

All ONT–OLT combinations successfully supported the tested services. No quality degradation, packet loss, or session failures were observed. The stability of both unicast and multicast VLAN-based services demonstrates that the ONT from Vendor A complies with the ITU-T G.984 standard and is capable of operating reliably across all tested OLT platforms.

3.3 Technical Interpretation

Based on the conducted tests, service behavior did not exhibit any inter-vendor differences, indicating that the fundamental GPON functions have been implemented in a uniform manner. The OMCI stack on the ONT is compatible with variations in Management Information Base (MIB) structures and line profiles across different vendors. In addition, the TR-069 process operated consistently, ensuring that ACS-based services, such as Wi-Fi configuration and CPE parameter settings, could be applied without obstacles. The test results also demonstrate that video services, which are sensitive to delay and packet loss, operated normally, further reinforcing the indication of operational interoperability readiness.

Although an in-depth analysis of OMCI behavior was not conducted, the smooth registration and service activation processes indicate that the ONT meets the fundamental requirements of the GPON standard. In real-world deployments, variations in firmware versions and configuration templates may still introduce minor differences.

From a service perspective, the testing shows that data services are capable of providing stable and error-free Internet access. Voice services also demonstrated good performance, as indicated by successful SIP registration and uninterrupted call sessions lasting 15 minutes. Furthermore, multicast IPTV-based video services were delivered without noticeable jitter or delay.

These findings indicate that the ONT from Vendor A is suitable for deployment in multi-vendor networks and can support flexible procurement strategies without the risk of vendor lock-in. Nevertheless, this interoperability testing did not include quantitative performance measurements such as throughput, latency, jitter, or high-load scenario testing. Further evaluations are required to ensure performance under more diverse operational conditions.

The 100% success rate observed in this study stands in stark contrast to previous operational scenarios where testing was conducted in a sporadic and piecemeal fashion. In those instances, it was often assumed that an ONT successful on Vendor A's OLT would automatically interoperate with Vendor B, leading to immediate operational implementation without a full test matrix. This lack of comprehensive validation resulted in critical service disruptions at the customer side.

3.4 Comparative Analysis Across Vendors

Although all vendors demonstrated uniform results, several factors may explain this alignment. First, the testing focused only on basic features. Advanced functionalities such as Dynamic Bandwidth Allocation (DBA), multicast optimization, or VLAN stacking may reveal differences across vendors. Second, the tested ONT has been optimized for cross-vendor interoperability.

Third, the controlled laboratory environment does not fully represent operational networks with real traffic fluctuations.

Overall, all four OLT platforms exhibited full interoperability with the ONT from Vendor A. Each vendor successfully completed OMCI provisioning, activated Layer-2 and ACS services, and delivered data, voice, and video services without issues. This outcome indicates that, within the evaluated test scope, the GPON standard implementations across these vendors demonstrate consistent functional alignment. Table 5 summarizes the position of each vendor from the perspectives of performance and standards compliance.

Table 5. Comparative Summary of Vendor Positions

Aspect	Vendor A	Vendor B	Vendor C	Vendor D	Remarks
OMCI	✓	✓	✓	✓	High standards compliance
L2	✓	✓	✓	✓	Consistent VLAN configuration
ACS	✓	✓	✓	✓	Stable TR-069 operation
Data	Normal	Normal	Normal	Normal	No throughput degradation
Voice	Normal	Normal	Normal	Normal	Consistent QoS
Video	Normal	Normal	Normal	Normal	Optimized IGMP
Overall	Full Interop	Full Interop	Full Interop	Full Interop	No cross-vendor issues

Full interoperability, as summarized in Table 4, was determined through cumulative validation rather than single-event success. Successful device registration alone was considered insufficient; instead, interoperability was confirmed only when configuration stability persisted across repeated activation cycles, no service-layer anomalies were detected, and no rollback or management synchronization errors occurred throughout the validation period.

3.5 Additional Insights for Test Development

Building upon the functional interoperability findings, further test development perspectives are outlined to strengthen future validation frameworks. To highlight clearer performance differentiation across vendors in future research, several aspects should be considered. First, high-traffic scenarios (stress testing) should be conducted to see how the ONT-OLT pair handles congestion. Second, dynamic bandwidth allocation (DBA) configuration and evaluation should be included to ensure that upstream traffic is distributed fairly among multiple ONTs. Third, scalability assessments involving hundreds of ONTs on a single PON port should be performed to test the OLT's processing limits.

Furthermore, future tests could include "Interoperability under Failure" scenarios, such as how quickly an ONT re-registers after a fiber cut or an OLT card reset. These insights would provide a more holistic view of network resilience in a multi-vendor environment. For now, the successful functional verification provides a solid baseline for operators to consider Brand A ONT as a versatile alternative in their network expansion plans.

To provide a more comprehensive analysis in future studies, the testing framework may evolve beyond binary functional verification (Success/Failure) to include quantitative performance measurements. Key parameters that are proposed to enhance the test include Throughput (T), Latency (Δt), and Packet Jitter (J).

4. CONCLUSION

The results of the GPON interoperability testing demonstrate that the ONT from Vendor A operates effectively across all four tested OLT platforms. All OLT vendors were able to perform the provisioning process consistently, including OMCI registration, Layer-2 configuration, and activation via ACS/TR-069, without encountering any issues. The three primary services—data, voice, and video—also functioned normally across all ONT–OLT combinations, with no indications of performance degradation or inconsistencies in standard implementation. This consistency indicates that the four OLT vendors have implemented the ITU-T G.984 and TR-069 standards with a high degree of uniformity, enabling full interoperability for basic GPON services. These findings provide evidence that a multi-vendor strategy can be adopted by operators without introducing operational disruptions to triple-play services or risks of configuration inconsistencies. Furthermore, the use of cross-vendor equipment offers operators the opportunity to reduce dependency on a single equipment manufacturer, thereby improving procurement flexibility and cost efficiency. Nevertheless, the scope of this study was limited to functional aspects and did not include quantitative performance evaluations such as throughput, latency, jitter, or stress testing. Therefore, further research is required to assess device performance under high traffic conditions and evaluate advanced features such as Dynamic Bandwidth Allocation (DBA). Overall, the results confirm that the tested ONT exhibits a high level of compatibility across all OLT platforms and is suitable for deployment in GPON networks using a multi-vendor configuration.

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