

# Delivering Gigabit to the Home

## Positron G.hn Aggregation Multiplexer Product Family

**GAM-12-M****GAM-24-M****GAM-12-C****GAM-24-C**

“Fiber to the Home” is far from the only and most efficient technology to deliver Gigabit Internet access to subscribers. Retrofitting an existing (brownfield) Multi-Dwelling Unit (MDU) with fiber is complex and expensive. **With the G.hn Aggregation Multiplexer (GAM), Positron Access addresses the key challenge of delivering Gigabit Internet access to subscribers in MDUs as well as dense Single Family Unit (SFU) homes by leveraging the existing telephone or coaxial infrastructure to deliver near symmetrical Gigabit services at a fraction of the cost of alternatives.**

### About G.hn

The ITU-T G.9960 G.hn Wave-2 standard is designed to leverage the existing telephone wiring, (UTP, CAT-3 or CAT-5/5e) or RG-6/RG-59 coax cabling to deliver a Gigabit Internet service to each subscriber without the cost, complexity and delays associated with in-building fiber installation. G.hn is used as an Access technology by Operators looking to simplify their access network and backend infrastructure with an Ethernet-like technology that is highly scalable without some of the inherent complexity of DSL-related technologies. With G.hn, Operators deliver advanced services such as Gigabit High Speed Residential Internet and 4K IPTV without the high capital and operational expenses associated with a fiber retrofit. Each G.hn subscriber port supports up to 1.7 Gbps of dynamically allocated bandwidth for near symmetrical Gigabit services over the existing telephone wire or coaxial cable. The Positron GAM solution is MEF CE 2.0 compliant and is ideally suited to deliver Business Ethernet services in an MDU and/or MTU deployment.

### G.hn is a Proven Carrier-Grade Access Technology

G.hn is widely used by large Operators in multiple markets where it provides Gigabit services into MDU of all sizes as well as for residential neighborhoods. These Operators leverage the robustness of G.hn and its predictable bandwidth to scale to large deployments that complement their investment in their PON infrastructure.

As is the case with other ITU DSL and PON standards, G.hn offers extensive management and troubleshooting features and capabilities to simplify its deployment, activation and support. These management capabilities cover all operational aspects, from dealing with wiring issues to service-aware QoS and bandwidth management. The G.hn ecosystem is very solid and includes verified interoperability between the three (3) main chipset vendors based on extensive testing by the University of New Hampshire (UNH) lab.

## About the Positron G.hn Access Multiplexer (GAM)

**The Positron GAM leverages a non-blocking CE 2.0 Carrier Ethernet Core ASIC to reliably deliver managed Gigabit services.** The GAM is a Fiber to the Distribution Point (FTTDp) solution that is typically installed inside a wiring closet. Each GAM comes with two (2) 10 Gigabit SFP+ interfaces to support any type of fiber or PON standards (using an ONT as required). These SFP+ ports are also used to support additional GAM devices in medium to large MDUs and share the fiber backhaul link.

### G.hn Delivers Superior Bandwidth

G.hn consistently delivers superior bandwidth over twisted pair wire and coaxial cable. G.hn dynamically adjusts the allocation of the bandwidth between the downstream and upstream direction to reflect the real-time traffic conditions for optimal and near-symmetrical performance under all conditions.

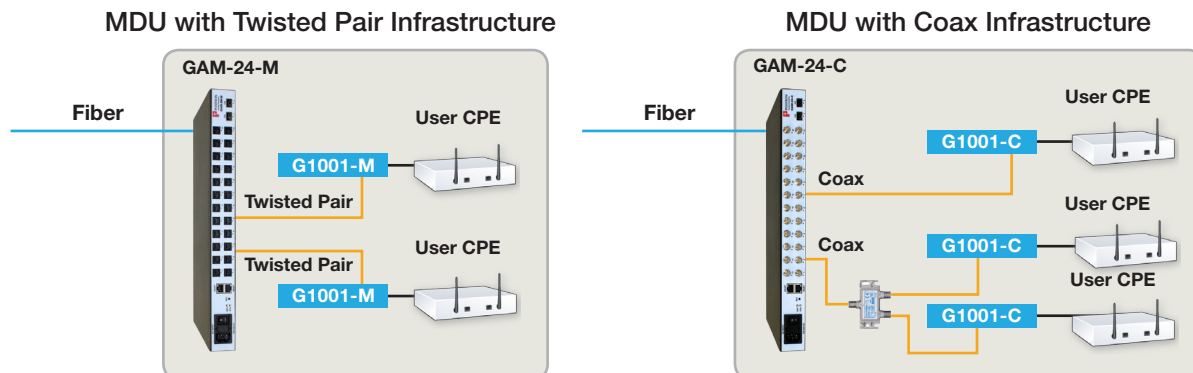
**With the Positron GAM, high-speed Gigabit Internet Services are more stable, reducing support calls and customer churn.** The GAM software extends its management capabilities to the G.hn end-point (aka G.hn to Ethernet Bridge) devices (such as the Positron G1001). The GAM hardware enforces per-subscriber bandwidth profiles and guarantees a fair and balanced use of the backhaul link at all times for value-added services such as IPTV, streaming and telephony. Its extensive support for VLAN (including Q-in-Q) allows for seamless integration with the operator fiber services and the OSS and BSS functions already in place. The service OAM capabilities of the GAM provide real-time information to the operator about the overall grade of services without any additional cost or complexity.

With hardware-assisted synchronization to improve the efficiency of Vectoring, the GAM optimizes the bandwidth for each subscriber based on the real-time condition.

The Positron GAM is available in 24 and 12 port configurations for either coaxial cable or twisted pair with support for Single Input Single Output (SISO) mode, (1 pair per port) and Multiple Input Multiple Output (MIMO) mode (2 pairs per port). Using MIMO instead of DSL pair bonding means that there is no need to allocate two (2) ports to serve a single subscriber, lowering costs and avoiding the complexity of pair bonding.

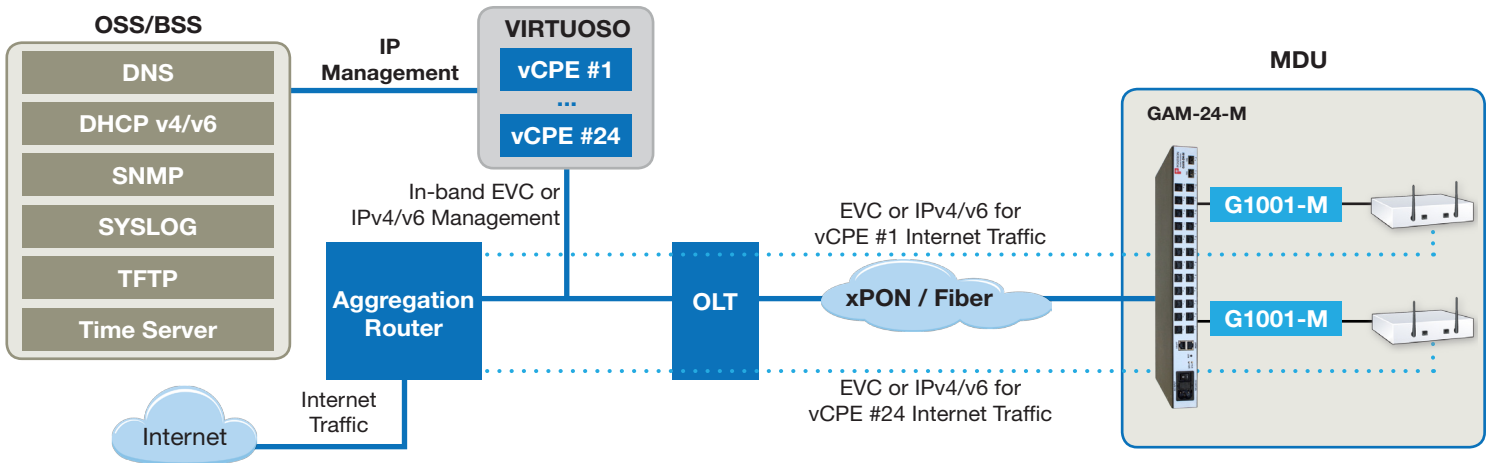
### Deploying the GAM in an MDU / MTU

The GAM is designed to optimize coverage in an MDU / MTU over the existing wiring infrastructure to avoid the high cost of installing new fiber inside these buildings. While operation over twisted-pair wiring is always Point-to-point, operation over a coaxial cabling infrastructure can be Point-to-Multipoint using standard coax splitters. In this mode, a 24-port GAM can serve up to 384 G.hn subscribers with up to 16 subscribers per port. The GAM terminates the links with a G.hn client device such as the Positron G1001-M or G1001-C managed end-points from Positron. Compliant Residential Gateways with built-in G.hn client support or with SFP ports are also fully supported.

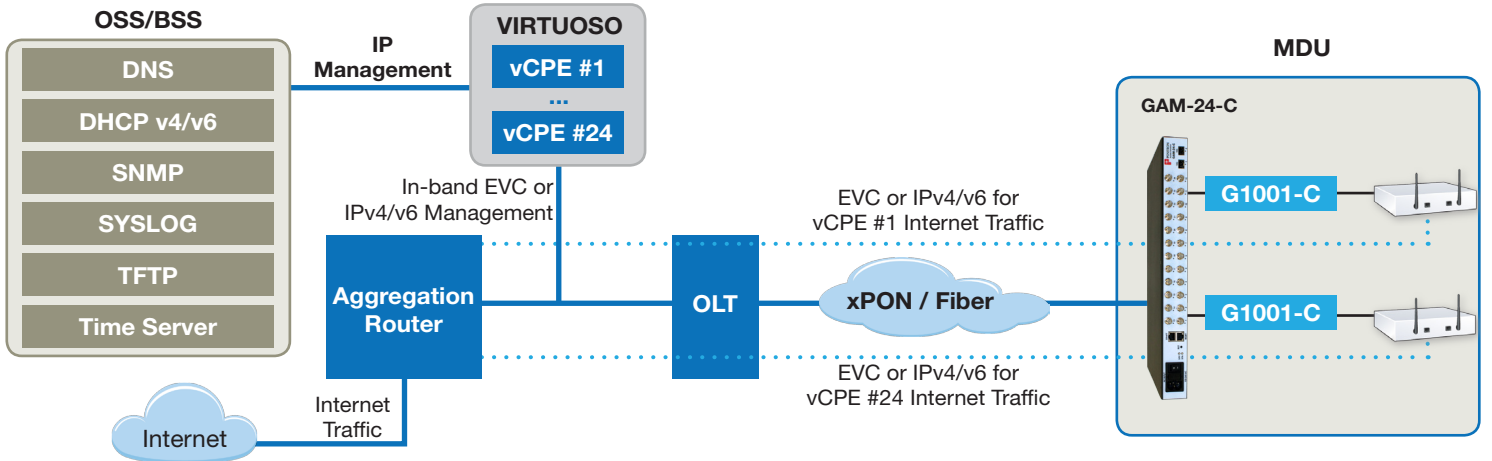


The Positron GAM takes advantage of Positron’s SDN-ready VIRTUOSO software Domain Controller to control and manage GAM devices. VIRTUOSO presents a native management interface to the existing OSS and BSS systems of operators. VIRTUOSO can operate either as a standalone management plane server or under the control of standard-based Orchestration Platforms such as Open Daylight and others.

When interfacing with an ILEC/CLEC, the VIRTUOSO Domain Controller handles the management of the G.hn end-node served by a GAM. The OLT and Aggregation Router transparently handle Internet traffic with a single or double VLAN tag per subscriber.



The same approach is leveraged when interfacing with a Cable MSO.



### Self-Installation and Zero-Touch Provisioning

The Positron GAM facilitates subscriber’s Self-Installation with Zero-Touch provisioning and automated activation. Automatically adding new subscribers has never been easier.

## Ordering Information

Part Number	Description
GAM-12-M	12 port G.hn Access Multiplexer (GAM) for use over Twisted Pair wiring for 1 pair (SISO) or 2 pairs (MIMO) per RJ45 port
GAM-12-C	12 port G.hn Access Multiplexer (GAM) for use over Coaxial cable (F-Type connector)
GAM-24-M	24 port G.hn Access Multiplexer (GAM) for use over Twisted Pair wiring for 1 pair (SISO) or 2 pairs (MIMO) per RJ45 port
GAM-24-C	24 port G.hn Access Multiplexer (GAM) for use over Coaxial cable (F-Type connector)
Managed G.hn to Ethernet Bridge devices (G1001 family)	
G1001-M	G.hn Wave-2 to Ethernet Bridge over Twisted Pair Multiple Input Multiple Output (MIMO) mode G.hn port (RJ45 port) One (1) 10/100/1000BaseT RJ45 ports
G1001-MP	G.hn Wave-2 to Ethernet Bridge over Twisted Pair Multiple Input Multiple Output (MIMO) mode G.hn port (RJ45 port) Telephone port (via built-in POTS splitter) One (1) 10/100/1000BaseT RJ45 ports
G1001-C	G.hn Wave-2 to Ethernet Bridge over Coax G.hn port (F-type male connector) CATV port (F-type male connector) One (1) 10/100/1000BaseT RJ45 ports

## Specifications

Part Number	10 GigE SFP+	G.hn Ports / Type	Out-of-band Management Ports	Maximum Power Consumption
GAM-12-M	2	12 MIMO (RJ45)	1 x 10/100/1000BaseT 1 x serial	76W
GAM-24-M	2	24 MIMO (RJ45)	1 x 10/100/1000BaseT 1 x serial	125W
GAM-12-C	2	12 Coax (F-type)	1 x 10/100/1000BaseT 1 x serial	48W
GAM-24-C	2	24 Coax (F-type)	1 x 10/100/1000BaseT 1 x serial	98W

Environmental	
Dimensions	17.4" Width x 1.73" Height x 10.0" Depth / 442 mm W x 44 mm H x 254 mm D
Power Source	100-240 Vac / 50-60 Hz
Certification	CE Mark, FCC Part 15 Class A
Operating Temperature	0°C to 45°C
Storage Temperature	-40°C to +65°C
Operating Humidity	10% to 90% relative, non-condensing

## 10 Gbps Network-Network Interface (NNI)

2 x SFP+ ports	SFP+ offers versatile support for Active Ethernet and for GPON, EPON, 10GEPON, NG-PON2 and XGS-PON via external ONU/ONT devices Also compatible with 3 <sup>rd</sup> party PON SFP ONT modules
----------------	---

## G.hn Specification

G.hn Standards	G.hn Wave-2 Domain Master on all GAM ports (MIMO or Coax) Based on GigaWire Alliance specification and fully compliant with the following ITU-T standards <ul style="list-style-type: none"> <li>• G.9960 Amendment 2 - System Architecture and PHY Layer</li> <li>• G.9961 Data Link Layer</li> <li>• G.9962 Management</li> <li>• G.9964 PSD</li> </ul>
Ease of Deployment	Support G.hn operation over telephone wiring (RJ45 with 1 or 2 pairs) and coax cabling (F-type connector)
Point-to-point and Point-to-multipoint support	Point-to-point (twisted pair and coax) Point-to-multipoint operation (coax) for up to 16 Subscriber CPEs per G.hn port
Ease of Operation	Supports firmware and configuration management of G.hn end-point devices
Encryption	AES-128 encryption with individual keys for each end-node. The Positron GAM Master Node is also acting as the G.hn Security Controller
Modulation and Frequency Band	Supports OFDM 200 MHz. Telephone wiring supports 1 pair (Single Input Single Output - SISO) and 2 pairs (Multiple Input Multiple Output - MIMO) per RJ45 port Radio Band Notching function allows cohabitation with legacy analog cable TV channels on coax cabling and concurrent use with POTS and DSL on telephone pairs
Bandwidth Management with Dynamic Time Allocation	Up to 1.7 Gbps with Dynamic Time Allocation to optimize throughput based on nature of traffic flows with TDD Multiplexing for programmable upstream / downstream ratio
Vectoring (Telephone Wiring)	Support for VectorBoost™ vectoring for Far-End Crosstalk (FEXT) mitigation and improved performance over telephone wiring
Mitigation of Near-end Crosstalk	Near End Crosstalk (NEXT) mitigation and support for Neighbor Domain Interface Mitigation (NDIM)
PSD	Programmable PSD mask for coexistence with xDSL / radio and Far End Crosstalk (FEXT) mitigation via Cloud-based VectorBoost™ vectoring
Reliability and Resiliency	State of the art LDPC Forward Error Correction (FEC)

## Layer 2 Switching

Spanning Tree Protocol (STP)	IEEE 802.1d Standard Spanning Tree IEEE 802.1w Rapid Spanning Tree (RSTP) IEEE 802.1s Multiple Spanning Tree (MSTP)
MAC Table	Up to 32K MAC addresses
Trunking	Link Aggregation Control Protocol (LACP) IEEE 802.3ad for any SFP+ ports
VLAN	Supports up to 4K VLANs simultaneously (out of 4096 VLAN IDs) <ul style="list-style-type: none"> <li>• Port-based VLAN</li> <li>• IEEE 802.1Q tag-based VLAN</li> <li>• IEEE 802.1ad (Q-in-Q) double tag VLAN</li> <li>• MAC-based VLAN</li> <li>• Management VLAN</li> <li>• Private VLAN Edge (PVE)</li> </ul>
Multi-VLAN Registration (MVR)	Protocols for automatically propagating and configuring VLANs in a Multicast Domain for IPTV and other multicast services

<b>Layer 2 Switching (con't)</b>	
IGMP v1/v2/v3 Snooping	IGMP limits bandwidth-intensive multicast traffic to only the requesters Supports 1024 multicast groups
IGMP Proxy	IGMP snooping with proxy reporting or report suppression actively filters IGMP packets in order to reduce load on the multicast router
IGMP Query	IGMP query is used to support layer-2 multicast domain in the absence of a multicast router
MLD v1/v2 Snooping	Deliver IPv6 multicast packets only to the required receivers
DHCP Server	Supports DHCP server to assign addresses to IPv4 client devices
DHCP Snooping	DHCP snooping provides security by filtering un-trusted DHCP messages and by building and maintaining a DHCP snooping binding table
DHCP Relay	By supporting DHCP option 82, it is possible to forward DHCP requests to another specific DHCP server via DHCP relay. The DHCP server may be on another network
<b>Layer-3 Support</b>	
IPv4 Static Routing	Static routing of IPv4 unicast traffic
IPv6 Static Routing	Static routing of IPv6 unicast traffic
<b>Security</b>	
Secure Shell (SSH) Protocol	SSH secures Telnet traffic in and out of the switch, SSH v1, v2 are supported
Secure Sockets Layer (SSL)	SSL encrypts the HTTP traffic, allowing advanced secure access to the browser-based management GUI in the switch
IEEE 802.1X	IEEE 802.1X: RADIUS authentication, authorization and accounting, MD5 hash, single / multiple host mode and single / multiple sessions Supports IGMP-RADIUS based 802.1X Dynamic VLAN assignment
RADIUS/ TACACS+	Supports RADIUS and TACACS+ authentication G.hn Aggregation Multiplexer acting as a RADIUS client
Layer 2 Isolation Private VLAN Edge (PVE)	PVE (also known as protected ports) provides L2 isolation between clients in the same VLAN, supports multiple uplinks
IP Source Guard	Prevents datagram with spoofed addresses from being in the network
Storm Control	Prevents traffic on a LAN from being disrupted by a broadcast, multicast, or unicast storm on a port
ACLs	Supports up to 256 entries Drop or rate limitation based on source and destination MAC, VLAN ID or IP address, protocol, port, differentiated services code point (DSCP) / IP precedence, TCP / UDP source and destination ports, 802.1p priority, Ethernet type, Internet Control Message Protocol (ICMP) packets, IGMP packets, TCP flag
<b>Quality of Service</b>	
Hardware Priority Queue	Support 8 hardware queues per port
Scheduling	Strict priority and Weighted Round-Robin (WRR) Queue assignment based on DSCP and class of service (802.1p / CoS)
Classification	Port based; 802.1p VLAN priority based; IPv4/IPv6 precedence / Type of Service (ToS) / DSCP based; Differentiated Services (DiffServ); classification and re-marking ACLs, trusted QoS
Rate Limiting	Ingress policer; egress shaping and rate control; per VLAN, per port and flow based
IPv6 Support	Web / SSL, Telnet / SSH, ping, Simple Network Time Protocol (SNTP), Trivial File Transfer Protocol (TFTP), SNMP, RADIUS, Syslog, DNS Client, protocol based VLANs

<b>Carrier Ethernet Protocol and Features</b>	
IEEE 802.3ah Ethernet OAM	Link Fault Management (LFM) for Ethernet links is defined in IEEE 802.3ah
IEEE 802.1ag Ethernet CFM	IEEE 802.1ag Ethernet CFM function that provides connectivity fault management
ITU-T Y.1731	ITU-T service OAM standard Y.1731 divides a network into maintenance domains in the form of hierarchy levels
ITU-T G.8031 and G.8032v2	Provides the standards-based method of delivering high-performance Carrier Ethernet services over a multi-node ring protection switching to serve large MDUs or MTUs
<b>Management</b>	
Web GUI Interface	Built-in configuration utility for browser-based device configuration (HTTP/ HTTPS). Supports configuration, system dashboard, maintenance and monitoring
Firmware Upgrade	Web browser upgrade (HTTP/ HTTPS) and FTP Secure upgrade through console port
Dual Firmware Image	Dual image and firmware partition provides independent primary and secondary OS files for backup while upgrading. Each firmware image has its corresponding firmware partition
SNMP	SNMP version1, 2c and 3 with support for traps and SNMP version 3 user-based security model (USM)
Remote Monitoring (RMON)	Embedded RMON software agent supports RMON groups 1,2,3,9 (history, statistics, alarms and events) for enhanced traffic management, monitoring and analysis
IPv4 and IPv6 Dual Stack	Coexistence of both protocol stacks to support a seamless migration
Port Mirroring	Traffic on a port can be mirrored to another port for Legal Interception (CALEA) or analysis with a network analyzer or RMON probe. Up to N-1 (N is Switch's Ports) ports can be mirrored to single destination port. A single session is supported
Network Time Protocol	Network Time Protocol (NTP) for clock synchronization over packet switched networks
Discovery	Link Layer Discovery Protocol (LLDP) (IEEE 802.1ab) with LLDP-MED extensions