



FIBER TO THE HOME

Overview of a Technology that Delivers Gigabit Internet Services: An Alternative Solution to Fiber

Servicing brownfield Multi-Dwelling Units (MDU) and Multi-Tenant Units (MTU) with fiber technologies can be cost prohibitive (up to \$600 USD per tenant).

Positron's G.hn technology provides managed non-blocking symmetrical Gigabit bandwidth services to subscribers over existing telephone wire or coaxial cable on extended distances, at a lower cost and with reduced complexity compared with G.fast.

About G.hn

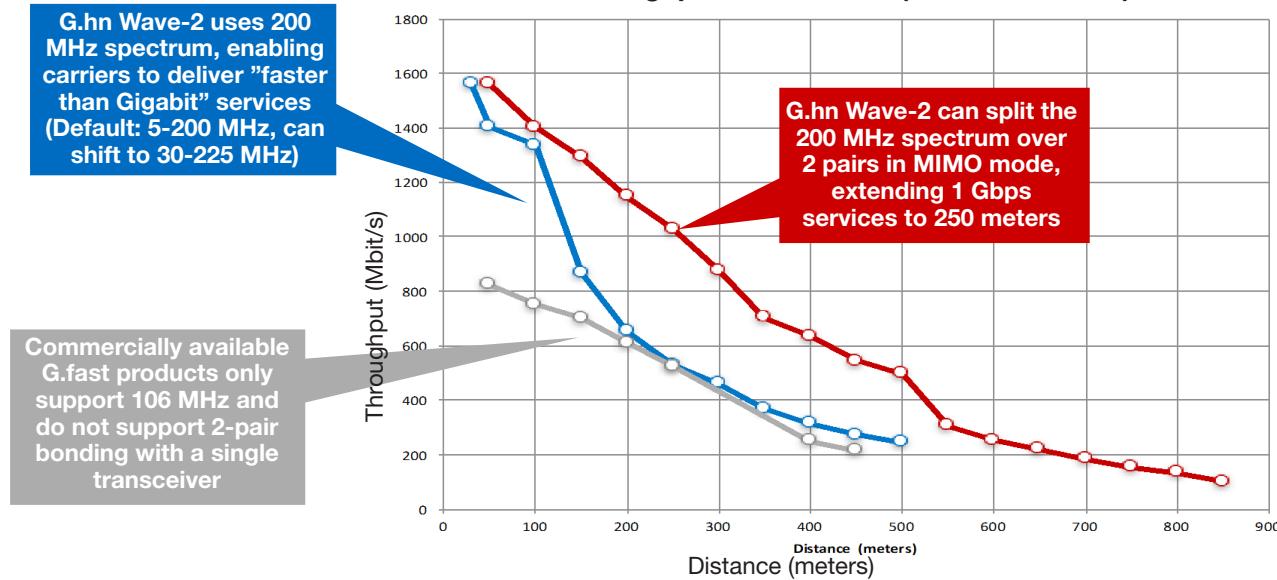
The ITU-T G.9960 G.hn Wave-2 standard is designed to leverage the existing telephone, UTP, CAT-3 or CAT-5/5e wiring or RG-6/RG-59 coaxial cable to deliver a Gigabit Internet service to each subscriber without the complexity and delays associated with in-building fiber installation. G.hn is increasingly 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 Delivers Superior Bandwidth over Twisted Pair and Coaxial Wiring Infrastructures

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.

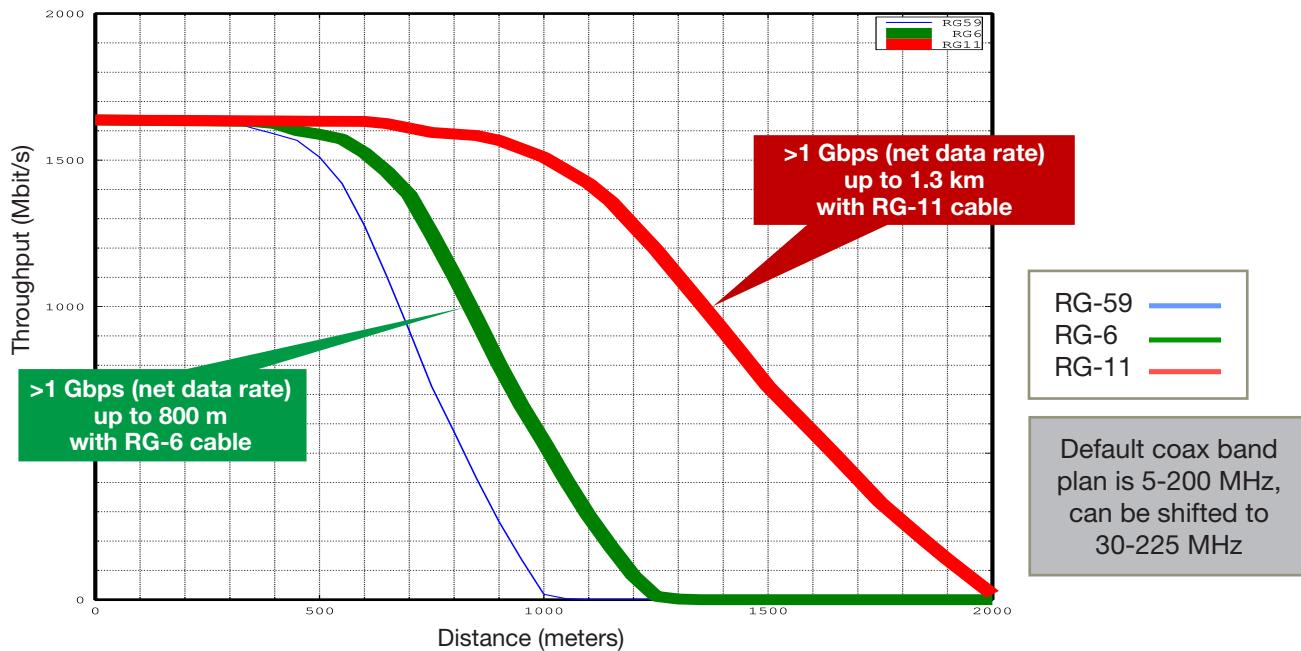
When operating on twisted pair, G.hn can operate either on a single pair (SISO) or by bonding two (2) pairs on a single port (MIMO) to extend the reach of a Gigabit service to 250 meters. The results were obtained by the TNO Institute (Netherlands) on 24 AWG (0.51 mm) wiring.

Throughput vs. Distance (TNO Test Bench)



G.hn leverages the coaxial infrastructure to deliver Gigabit performance over a distance of 800 meters on RG-6 cabling typically used inside MDUs and homes. When using a standard coaxial splitter, it is possible to serve up to 16 subscribers per G.hn port.

G.hn Throughput (in Mbit/s) for Different Types of Coaxial Cables



G.hn supports frequency notching if it needs to share the coaxial wiring with legacy (analog) RF TV signals for a smooth migration to IPTV over time while delivering maximum Internet speeds at a fraction of DOCSIS 3.x.

About the Positron G.hn Access Multiplexer (GAM)

The Positron GAM leverages a non-blocking CE 2.0 Carrier Ethernet Core 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 multiple 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.

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 to simplify and eliminate the more complex functions of the Residential Gateway. The GAM hardware enforces per-subscriber bandwidth profiles and guarantees a fair and balanced use of the backhaul link at all times including 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 mode (SISO) (1 pair per port) and Multiple Input Multiple Output mode (MIMO) (2 pairs per port).

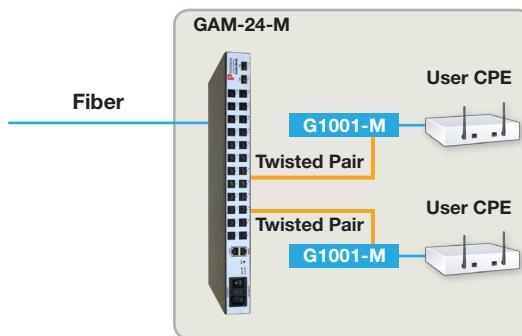
Positron is planning to introduce an 8-port version of the GAM supporting native coaxial cable and twisted pair wiring (MIMO and SISO).



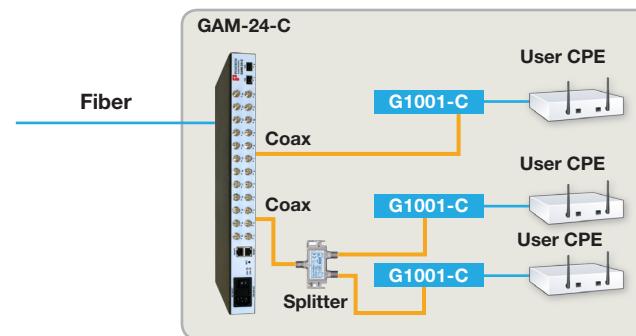
Deploying the GAM in an MDU

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, when using a 24-port GAM it is possible to serve up to 384 G.hn subscribers when using a coaxial infrastructure in Point-to-Multipoint mode with standard coax splitters (up to 1:16 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.

MDU with Twisted Pair Infrastructure



MDU with Coaxial Infrastructure



Benefits of G.hn over G.fast and GPON in addressing MDU Challenges

The key differentiators between G.hn, G.fast and GPON for Gigabit Internet services in an MDU are:

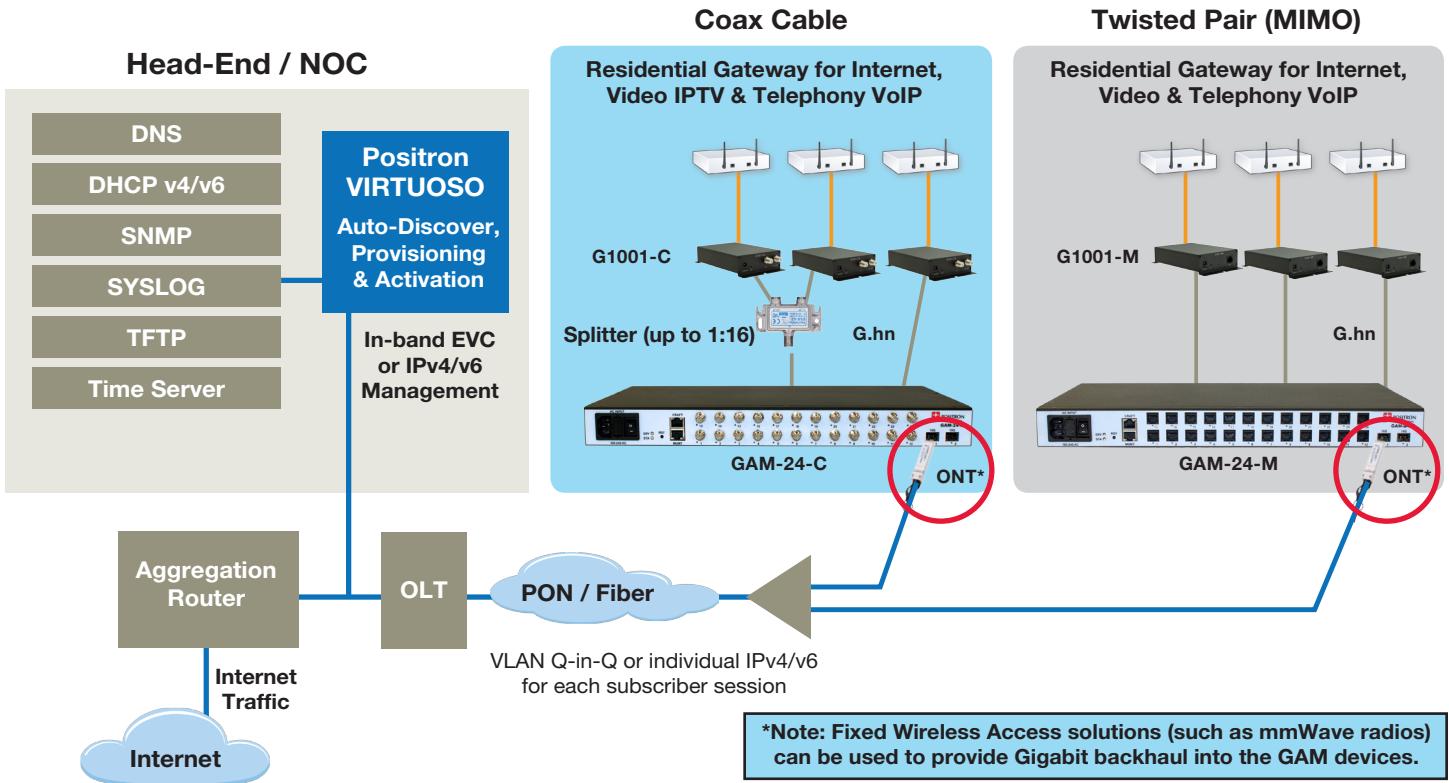
	G.hn	G.fast	GPON
Cost of Fiber Wiring in the MDU	N/A	N/A	\$600 USD per tenant
Use Existing Twisted Pair (copper) Wiring	Yes	Yes	N/A
Use Existing Coaxial Cable with Splitters	Yes	No	N/A
Support for Twisted Pair Bonding	Uses Single G.hn port (MIMO) per Subscriber	Uses 2 G.fast ports per Subscriber	N/A
Max Distance for Gigabit Service	800 meters over Coax 150 meters over Twisted Pair (SISO) 250 meters over Twisted Pair (MIMO)	150 meters over Twisted Pair (Amendment 3)	N/A
Vectoring over Twisted Pair Wiring	Software-based (Cloud)	Hardware-based vectoring engine (per DPU)	N/A
Vectoring Scalability	High Can stack multiple GAM devices to serve more subscribers without impacting vectoring efficiency	Complex Each DPU requires hardware-based vectoring engine	N/A
Multi-vendor Interoperability	Yes	Limited due to multi-vendor chipset	No
Multi-chipset Interoperability	Yes	Limited	Limited due to vendor-specific management
Seamless Integration with Fiber (GPON) OSS and BSS	Yes	Difficult	Yes

Flexible Solution for ILEC/CLEC and Cable Operators

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 or CLEC, the VIRTUOSO Domain Controller instantiates Virtual CPE (vCPE) devices for each G.hn end-node handled by a GAM. This approach maintains the native CPE management (for instance TR-069 or SDN) in the context of an MDU served by one or more GAM. The Internet traffic is handled transparently via the OLT and through a standard Aggregation Switch (Layer-2 EVC) or Router (Layer-3 IPv4 / IPv6).

The same approach is leveraged when interfacing with a Cable MSO with native support for the CableLabs DOCSIS Provisioning over EPON (DPoE) specification. The Positron GAM directly supports OLT/DPoE Server implementation that use the IEEE 802.3 Service OAM standard defined in the DPoE specification. The VIRTUOSO platform is used when the interfacing to a DPoE Server implementation that uses SDN on its southbound interface.



Subscriber Self-Installation and Zero-Touch Provisioning

When deployed with the optional GAM Captive Portal option, the Positron GAM family facilitates subscriber's Self-Installation with Zero-Touch Provisioning and Automated Activation. Automatically adding new subscribers has never been easier. The GAM Captive Portal facilitates the use of Self-Registration (walled-garden) Portals to guide new subscribers during the registration and activation process. The GAM Captive Portal facilitates seamless Wi-Fi roaming across the MDU common areas covered with Wi-Fi.

Ordering Part Numbers

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 connector
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 connector
GAM-24-C	24-port G.hn Access Multiplexer (GAM) for use over Coaxial cable (F-Type connector)
Managed G.hn Ethernet Bridge Devices	
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