Delivering Gigabit to the Home
Positron GAM-4-MRX, GAM-8-MRX and GAM-4-CRX
Rugged / Extended Temperature Reverse Power Fed GAM Devices

"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, highly disruptive 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 the Rugged Outdoor Positron GAM Devices

The Positron G.hn Access Multiplexer (GAM) family now includes rugged versions for deployment in harsh environments (outdoor) where there is no local power source. These GAM devices obtain their power from the G1001-MR over the copper wiring or G1001-CR over the COAX cabling. The outdoor GAM devices offer the same feature and management capabilities as their indoor counterpart. They optimize coverage of Gigabit Internet services in an MDU and operate over twisted-pair cabling in Point-to-Point mode while operation over a coax infrastructure is in Point-to-Multipoint mode where each COAX port can serve up to sixteen (16) G1001-CR devices.

GAM-4-CRX

GAM-4-MRX / GAM-8-MRX

The GAM-4-MRX and GAM-8-MRX respectively have four (4) and eight (8) MIMO ports and support Reverse Power Feed (RPF) from G1001-MR devices, one per G.hn port. The GAM-4-CR has four (4) COAX ports and supports RPF mode from G1001-CR devices, one or more (in Point-to-Multipoint mode) per G.hn port.

The G1001-MR and G1001-CR (G.hn to Ethernet Managed Demarcation Point devices) power the Positron rugged IP67 (outdoor and Extended Temperature) GAM family with support for the ETSI RPF standard. Support for RPF facilitates the installation of the GAM outside of the MDU and in areas where it is not simple or cost effective to install a local power source. Each G.hn port of an outdoor GAM is powered from a G1001-MR (copper) or G1001-C (coax).

About G.hn

The ITU-T G.9960 G.hn Wave-2 standard leverages the existing telephone wiring (UTP, CAT-3 or CAT-5/5e) or RG-6/RG-59 coax cabling as an access technology that delivers a Gigabit Internet service to each subscriber at a lower cost and without the 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. Operators increasingly rely on G.hn to extend fiber or fixed wireless Gigabit services and avoid the high capital and operational expenses of a fiber retrofit. 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 buildings 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 and Reverse Power Feed Support

When operating in a Reverse Power Feed mode, the outdoor GAM devices will always make sure that each G.hn End-Point devices it serves evenly contribute to provide power to the GAM via RPF. This means that the outdoor GAM will reject G.hn End-Point devices that do not provide their share of the power required by the GAM. A single subscriber is sufficient to power its serving G.hn port and the main circuitry of the GAM, including the uplink port.

The G1001 devices control how a Residential Gateway (or User CPE) connects to the G.hn Access Network under the control of the Positron GAM. In this role, they make sure the information transmitted over the G.hn link is secure with strong AES-128 encryption. When used in Point-to-Multipoint mode (coaxial wiring), the G1001-CR operates under control of the GAM to isolate the traffic from each subscribers that share the same coax splitter. **NOTE:** when there are multiple G1001-CR devices on the same GAM Coax port, each of the G1001-CR will share the power load evenly amongst them.

Simplified Commissioning of GAM Devices

The RPF versions of the GAM support a local -12Vdc power input accessible inside the IP67 enclosure and can accept any suitable power sources such as the accessory power outlet of a technician service truck or a portable battery. This is particularly useful to validate the uplink upon the installation of the GAM and to handle the initial provisioning of the GAM. You can do this via VIRTUOSO using its Auto-Discovery and Provisioning capabilities or via the embedded WEB GUI / CLI of the GAM via its Management or Craft ports. The -12Vdc power input can also be used to power the GAM during normal operation if desired.

The Positron GAM leverages a non-blocking CE 2.0 Carrier Ethernet Core ASIC for the reliable delivery of managed Gigabit services. The GAM is a Fiber to the Distribution Point (FTTDp) solution. The GAM-8-MRX / GAM-4-MRX and GAM-4-CRX come with one (1) 10 Gigabit SFP+ interface to support any type of fiber or PON standards (using an ONT as required).
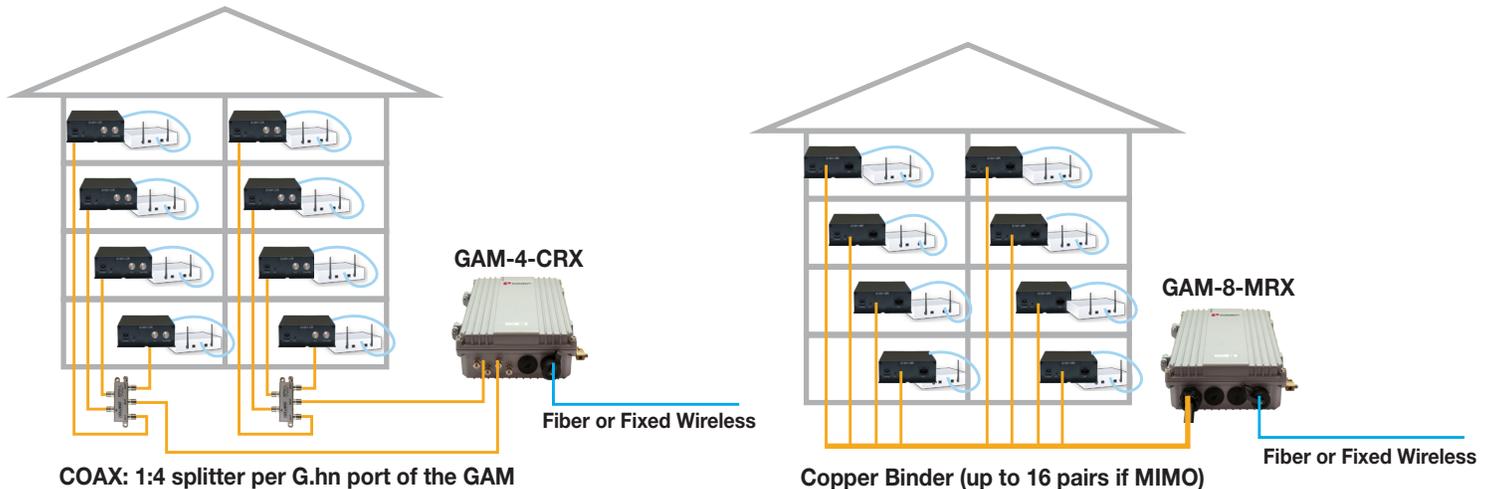
G.hn Delivers Superior Bandwidth

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-MR and G1001-CR. 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-4-MRX and GAM-8-MRX optimize the bandwidth for each subscriber based on the real-time condition. These GAM devices operate over twisted pair and support 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 devices optimize coverage in an MDU / MTU over the existing wiring infrastructure. Since these GAM devices are Reverse Power Fed by the G1001-MR or G1001-CR End-Point devices, they are deployable anywhere, even outdoors where they can withstand harsh environmental conditions. The GAM devices are enclosed in a rugged IP67 enclosure and support operating temperature of -40℃ to +65℃. 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 4-port GAM can serve up to 64 G.hn subscribers with up to 16 subscribers per port.

GAM-4-CRX

Fiber or Fixed Wireless

COAX: 1:4 splitter per G.hn port of the GAM

GAM-8-MRX

Fiber or Fixed Wireless

Copper Binder (up to 16 pairs if MIMO)

The Positron GAM takes advantage of Positron's VIRTUOSO software-based Domain Controller to control and manage GAM devices. VIRTUOSO presents a native management interface to the existing OSS and BSS systems of operators. VIRTUOSO operates as a standalone management server. VIRTUOSO also acts as a Persistent Management Agent (PMA) for powered off GAM due to the lack of active subscribers that provide the Reverse Power Feed. The PMA function will cache any configuration or firmware updates and will apply them to the GAM when it reports it is back in action.

Whether interfacing with an ILEC/CLEC or a Cable Operator, 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. A Fixed Wireless Access (FWA) radio link can be used instead of fiber.
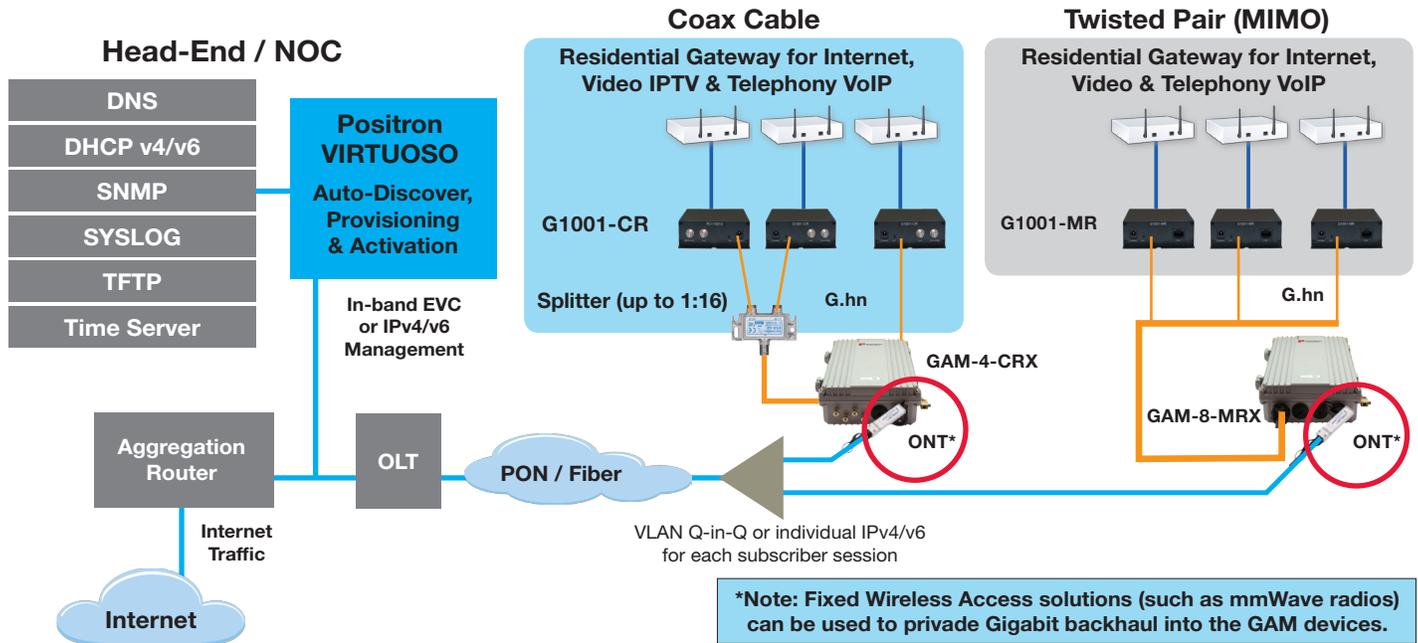
Self-Installation and Zero-Touch Provisioning

The Positron GAM family 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-4-MRX	4 port G.hn Access Multiplexer (GAM) for use over Twisted Pair wiring for 1 pair (SISO) or 2 pairs (MIMO) per G.hn port IP67-rated with extended temperature operation (-40°C to +65°C) Supports ETSI Reverse Power Feed (acting as a Powered Device - PD)
GAM-8-MRX	8 port G.hn Access Multiplexer (GAM) for use over Twisted Pair wiring for 1 pair (SISO) or 2 pairs (MIMO) per G.hn port IP67-rated with extended temperature operation (-40°C to +65°C) Supports ETSI Reverse Power Feed (acting as a Powered Device - PD)
GAM-4-CRX	4 port G.hn Access Multiplexer (GAM) for use over Coaxial cable (F-Type connector) with up to 16 G1001-CR devices per Coaxial port IP67-rated with extended temperature operation (-40°C to +65°C) Supports ETSI Reverse Power Feed (acting as a Powered Device - PD)
G1001-MR	G.hn Wave-2 to Ethernet Bridge over Twisted Pair Supports Multiple Input Multiple Output (MIMO) and Single Input Single Output (SISO) modes G.hn port (RJ45 port) One (1) 10/100/1000BaseT RJ45 port Supports ETSI Reverse Power Feed (acting as a Power Sourcing Equipment - PSE)
G1001-CR	G.hn Wave-2 to Ethernet Bridge over Coax G.hn port (F-type connector) CATV port (F-type connector) One (1) 10/100/1000BaseT RJ45 port Supports ETSI Reverse Power Feed (acting as a Power Sourcing Equipment - PSE)

Specifications

Part Number	10 GigE SFP+	G.hn Ports / Type	Out-of-band Management Ports
GAM-4-MRX	1	4 x MIMO (MIMO - Copper) (8 pair 110 punch-down block)	1 x 10/100/1000BaseT 1 x serial
GAM-8-MRX	1	8 x MIMO (MIMO - Copper) (16 pair 110 punch-down block)	1 x 10/100/1000BaseT 1 x serial
GAM-4-CRX	1	4 x COAX (F-type)	1 x 10/100/1000BaseT 1 x serial

Environmental	
Dimensions	8" W x 12" H x 3" D / 200 mm W x 300 mm H x 75 mm D
Weight	6.4 lbs / 2.9 kg
Reverse Power Feed	Complies with ETSI TS 101 548 v.2.2.1 in SR3 mode
Power Source	Reverse Power Fed from G1001-MR or G1001-CR
Alternate Power Source	12Vdc 4A power connector inside the GAM-4-MRX / GAM-8-MRX and GAM-4-CRX to temporarily power the GAM device in the absence of subscribers to facilitate the initial provisioning of the GAM and to validate the uplink connection. Can also be used to power the GAM for normal operation
Certification	CE Mark, FCC Part 15 Class A
Operating Temperature	-40ºC to +65ºC
Storage Temperature	-40ºC to +70ºC
Operating Humidity	Up to 95% relative, non-condensing

10 Gbps Network-Network Interface (NNI)	
1 x SFP+ port	SFP+ offer versatile support for Active Ethernet and for GPON, EPON, 10GEPON, NG-PON2 and XGS-PON via external ONU/ONT devices Also compatible with 3rd 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 • G.9960 Amendment 2 - System Architecture and PHY Layer • G.9961 Data Link Layer • G.9962 Management • G.9964 PSD
Ease of Deployment	Support G.hn operation over telephone wiring (1 or 2 copper 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 sixteen (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 (Singe Input Single Output - SISO) and 2 pairs (Multiple Input Multiple Output - MIMO) per 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 FEXT (Far-End Crosstalk) 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 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 G.hn ports
VLAN	Supports up to 4K VLANs simultaneously (out of 4096 VLAN IDs) • Port-based VLAN • IEEE 802.1Q tag-based VLAN • IEEE 802.1ad (Q-in-Q) double tag VLAN • MAC-based VLAN • Management VLAN • Private VLAN Edge (PVE)
Multi-VLAN Registration (MVR)	Protocols for automatically propagating and configuring VLANs in a Multicast Domain for IPTV and other multicast services
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 receiver
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
TR-101	Uses DHCP Option 82 to provide Circuit-ID and Remote-ID to the BRAS for seamless BSS integration
PPPoE Intermediate Agent	Uses PPPoE to provide Circuit-ID and Remote-ID to the BRAS for seamless BSS integration

Layer 3 Support

IPv4 Static Routing	Static routing of IPv4 unicast traffic
IPv6 Static Routing	Static routing of IPv6 unicast traffic

Security

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
Quality of Service	
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
Carrier Ethernet Protocol and features	
IEEE 802.3ah Ethernet OAM	Link Fault Management (LFM) for Ethernet links as 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
Management	
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