OUR FIBER FUELS GLOBAL INNOVATION

Technical Description

Zayo's IP VPN is a Layer-3 any-to-any network solution that utilizes an underlying multiprotocol label switched (MPLS) core network. Within the MPLS network, Zayo creates a virtual router with unique and private routing instances and tables which securely separates customer traffic. Zayo offers BGP and static routing as standard with IP VPN.

IP VPN offers a secure environment where the provider and the customer routes traffic.

Use Cases

IP VPN is ideal for organizations requiring full mesh connectivity among multiple locations.

- **Interconnect private and public clouds** - any company storing, processing, accessing and analyzing data in both a private and public cloud environment can use IP VPN to create a global networked cloud.
- **Create a global "WAN"** - Organizations are treated to ample bandwidth to conduct business in a secure environment among a large number branch offices around the world.
- **Ensure remote worker connections** securely while aggregating global productivity.
- **Leave the routing to Zayo** - Organizations with smaller IT staffing and lower bandwidth requirements can provide the secure network their users need.

INTERFACES AND PROTOCOL STANDARDS

IP VPN Protocols and Handoffs				
Protocol Channel	Speed and Line Rate	Typical Reach	Standard Handoff	Ports
100baseT	100Mbps	100m	Copper	GigE
1000baseT	1Gbps	100m	Copper	GigE
1000baseSX, 1G-SX	1Gbps	275m-550m	MMF	GigE
1000baseLX, 1G-LX	1Gbps	5km-10km	SMF	GigE
10GbaseSR, 10G-SR	10Gbps	Varies (OM1-OM4)*	MMF	10GigE
10GbaseLR, 10G-LR	10Gbps	10km	SMF	10GigE
10GbaseER, 10G-ER	10Gbps	30km-40km**	SMF	10GigE
10GbaseZR, 10G-ZR	10Gbps	80km***	SMF	10GigE
100GbaseLR4	100Gbps	8km	SMF	100GigE
100GbaseER4	100Gbps	28km (no FEC)****	SMF	100GigE

* OM = Optical Multimode Fiber
 OM1 has a core size of 62.5 µm and can support up to 10G at lengths of 33 meters
 OM2 has a core size of 50 µm and can support up to 10G at lengths of 82 meters
 OM3 has a core size of 50 µm and can support up to 10G to 300 meters, or 100G to 100 meters
 OM4 is backwards compatible with OM3 fiber and supports 10G to 550m, or 100G to 150 meters
 ** ER beyond 30km requires link budget engineering
 *** ZR not defined by IEEE, requires coordination of transceiver specs
 ****without Forward Error Correction

CONFIGURATION

IP VPN Technical Standards	
Bandwidth Options	100Mbps - 900Mbps (Available in increments of 100) 1Gbps - 9Gbps (Available in increments of 1G) 10Gbps - 40Gbps (Available in increments of 10G)
Supported Client Handoffs	100/1000 Copper RJ45, 1GE/10GE/100GE Optical Fiber
Standard Equipment Installed at Customer Site	Zayo will deploy a network interface device (NID) as part of the standard IP VPN service. The NID can be configured with redundant power or battery backup. The customer will provide appropriate space, power source, and environment for the equipment. Zayo will own, monitor, and maintain this equipment.
Equipment Provisioning	Customer-Provided Equipment (CPE) owned and managed by customer, interfacing to Zayo's service must comply with the applicable IEEE 802.3 standards for physical handoff and 802.1 standards for protocol interworking. Configurations for optional features such as protection may require coordination of other technical parameters prior to activation.

Diversity Options	• Fiber Diversity
	   ° Dual diverse building entrances or diverse Minimum Points of Entry (MPOEs)
	   ° Single entrance with two fiber pairs
	• Provider Edge (PE) Router Diversity – one Zayo Point of Presence (PoP)
	• Card Diversity - diverse cards within a single chassis
	• Chassis Diversity - diverse routers
	• Zayo PoP Diversity
	   ° Two different Zayo PoPs in the same market
	   ° Two different Zayo PoPs in geographically diverse markets
	• Technology Diversity - multiple transport mechanisms (e.g. MPLS over Waves) provide diversity of equipment and underlying network topology.

Protection Options	• Metro Access Protection – Zayo utilizes Link Aggregation Groups and Link Aggregation Control Protocol (LAG/LACP) as a primary protection methodology at the Layer-2 level for all Layer-2 and Layer-3 (L2/L3) services. LAG/LACP will load-share across multiple links in active/active mode to provide sub second failover in the event of link failure. This solution can be deployed over most of the various diversity models. • Equipment Protection – Zayo's NID will aggregate the protected service into a single handoff, or the customer may accept a 4 fiber handoff and participate in the LAG/LACP. • Protected, Single Provider Edge router (PE) – uses protection technology and is deployed using the same chassis. Zayo may use LAGs to aggregate multiple physical circuits from a single PE router, and function as a single logical circuit. Should any LAG member fail, the logical circuit continues to function across the remaining members. • Protected, Dual PE – redundant pairs of circuits deployed using separate LAG groups to different routers and different chassis making a much more robust offering. • BGP protection – for BGP peered connections, similar diversity scenarios as LAG/LACP are supported, with failover time proportional to BGP keepalive interval. Optionally, BFD can be enabled for faster failure detection. • MPLS core infrastructure protection – Zayo's core L2/L3 network is inherently protected and self-healing. The core nodes in the network are at minimum N+1 connected to adjacent core nodes and will reroute automatically when faults are identified. The fault protection is based on MPLS-FRR (MPLS Fast Reroute).
Security Features	• Fully private virtual routing and forwarding instances (VRFs) • Protected physical access to Zayo sites • No access to customer data • No Address Resolution Protocol (ARP) redirection or spoofing • No VLAN jumping or trunking attacks
Compliance	MEF, IEEE, ITU, IETF, ISO, NANOG