



Technical Description

CloudLink provides direct private connectivity using Zayo’s carrier grade Layer-1 (Wavelengths), Layer-2 (Ethernet), or Layer-3 (IP-VPN) Multi-Protocol Label Switching (MPLS) transport services between an enterprise or datacenter location and private on-ramp location of major cloud service providers (CSPs) such as AWS, Azure, Google, and many others, bypassing the public Internet.

Ethernet provides a high-level of data networking security through the protocol’s Layer-2 attributes. Ethernet Virtual Circuits (EVCs) define and provide data paths while keeping traffic distinct and secure across Zayo’s network. The customer will configure and manage their Layer-3 interface directly between their premises-based router and the CSP gateway.

IP-VPN allows the Zayo Provider Edge (PE) router to establish Border Gateway Protocol (BGP) peering over a virtual interface directly with CSPs. Each customer location establishes BGP peering with Zayo on a Zayo PE router. Customer locations and CSP on-ramp locations are placed in a virtual routing and forwarding (VRF) networking instance with a common routing table. All customer locations are then able to communicate directly with their CSP without hair-pin routing.

Wavelengths provide a very high level of data networking security and offer dedicated, low latency bandwidth between the customer’s premises and the cloud service provider on-ramp. Unlike the MPLS, bandwidth is not shared with other customers. The customer will configure and manage their Layer-3 interface directly between their premises-based router and the CSP gateway.

INTERFACES & PROTOCOL STANDARDS

Ethernet & IP-VPN

Protocol Channel	Speed & 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

Wavelengths

Interfaces Available	Protocol Channel	Speed and Line Rate	Maximum Reach	Standard Handoff	Ports
Ethernet	1000Base-LX	1Gbps	10km	SMF	1G
Ethernet	10GBASE-LR	10Gbps	10km	SMF	10G
Ethernet	100GBASE-LR4	100Gbps	10km	SMF	100G

CONFIGURATION

CloudLink Standards		
	Ethernet & IP-VPN	Wavelengths
Supported Client Handoffs	10/100/1000 Copper RJ45, 1GE/10GE/100GE Optical Fiber	Eth - 1GE,10GE,100GE
Diversity (Higher Availability) Options	<ul style="list-style-type: none"> Fiber path Diversity Dual diverse building entrances Single building entrance, redundant fiber pairs Provider Edge (PE) Router Diversity <ul style="list-style-type: none"> Card Diversity Chassis Diversity Zayo PoP Geo Diversity CSP On-Ramp Geo Diversity 	<ul style="list-style-type: none"> Diverse Waves Fiber path Diversity Dual diverse building entrances Single building entrance, redundant fiber pairs DWDM Equipment Diversity <ul style="list-style-type: none"> Card Diversity Chassis Diversity Zayo PoP Geo Diversity CSP On-Ramp Geo Diversity
Network Availability Protection	<p>MPLS fast reroute core infrastructure protection.</p> <p>LAG protection option - multiple fiber pairs, homed to a core-network switch, and configured as a Link Aggregation Group (LAG). If any LAG member fails, the remaining LAG members are able to continue transmitting traffic.</p>	<p>Unprotected – Standard Wave, single fiber path, single handoff.</p> <p>Diverse - Two Unprotected Waves with diverse paths.</p> <p>Protected - (evaluated on an individual case basis) two linear, unprotected point to point waves on static, completely diverse routes between two sites with an Optical Switch (OSP) at each end to switch between the primary Wave and secondary Wave in the event of fiber break, or card failure.</p>
Security Features	<ul style="list-style-type: none"> Avoids public Internet Customer traffic separation using unique EVCs Protected physical access to Zayo sites No Layer-2 control protocol exchange between Zayo and customer network elements. No payload inspection of customer data Zayo network elements accessed and managed only through select hosts using secure authentication No Address Resolution Protocol (ARP) redirection or spoofing No virtual LAN (VLAN) jumping or trunking attacks 	<ul style="list-style-type: none"> Avoids public Internet Ultimate private network security Dedicated bandwidth end-to-end; not shared No visibility to customer’s Layer-2/3 traffic

HOSTED VS. DEDICATED CONNECTION

A CSP dedicated interconnect is where the customer procures a dedicated, non-shared port from the CSP. Customer provides a Letter of Authorization/Circuit Facility Assignment (LOA/CFA) for the CSP port, and Zayo orders a cross-connect between the Zayo network demarc and the customer’s dedicated CSP port.

A CSP hosted interconnect is where multiple end-customers share a single CSP port through use of a Zayo deployed network-to-network interface (NNI) with the CSP. Customer will provide Zayo with an activation key from the CSP to complete a “logical” cross-connect (i.e. complete the establishment of the Layer-2 virtual circuit).



Zayo CloudLink Direct Connections

Attribute	Hosted Connection	Dedicated Connection
Port Tenancy	Shared Zayo's connection to the CSP port is shared among multiple customers	Dedicated Zayo's connection to the CSP port is dedicated to a single customer
# Virtual Interfaces	Limited to 1 With a hosted connection, the customer is limited to 1 virtual interface per connection	Multiple With a dedicated connection, the customer can have multiple virtual interfaces per connection
Turn-Up Time	Faster Customers will experience shorter turn-up times, with automated installation (within minutes) to certain CSPs and locations	Slower Dedicated connections involve longer turn-up times in order to deploy a dedicated Zayo port and to provision a cross-connect to the customer's dedicated CSP port
Bandwidth	Subrate Port Speeds Available Customers have access to varying sub-rate port speeds if data needs don't warrant full port speeds, depending upon the CSP	Up to 100G Customers have access to up to 100G per dedicated connection, depending upon CSP
Bandwidth Changes	Sometimes Logically Modified Sometimes this function can be automated, or logically changed by Zayo. Redesign may be needed depending upon the customer's capacity needs	Sometimes Logically Modified Sometimes this function can be automated or logically changed by Zayo. New physical ports may be required for increased bandwidth
Costs / Pricing	Lower Monthly Rates Lower bandwidth customers pay only for the bandwidth they need	Higher Monthly Rates Customers pay the CSP for the full port speed
Availability	Limited – Depends on the CSP Not all CSPs offer hosted connectivity. Work with Zayo to determine your CSP's availability of hosted service	Widely Available Dedicated connections are widely available from nearly every CSP

ETHERNET E-LINE (EPL), EVPL (NNI/UNI), E-LAN

E-line Point to Point or Ethernet Private Line (EPL): An EPL is a point-to-point port-based service connecting two sites. The customer will have a dedicated port at their premises, and a dedicated port at the CSP on-ramp location. The EPL circuit is VLAN transparent, meaning the customer can assign multiple VLANs using any VLAN IDs they want without Zayo involvement and without them being altered.

EVPL or NNI/UNI: EVPL is a point-to-multipoint vlan-based service that provides a hub-and-spoke (or one-to-many) configuration where multiple point-to-point connections are homed to a single port acting as a hub or aggregation point. This aggregation port is multiplexed allowing multiple Ethernet services to share the port through VLAN tagging. Each point-to-point user-network-interface (UNI) circuit is in its own MAC address broadcast domain.

E-LAN: E-LAN is a multipoint-to-multipoint Ethernet service allowing the potential for any node on the E-LAN to communicate with another node on the same E-LAN. All nodes on the defined E-LAN are in the same MAC address domain. One or more CSP on-ramp locations can be added to an E-LAN. CSPs generally only support a single point-to-point virtual interface with a hosted connection, which will require one of the customer's locations to act as a routing hub for the customer's other enterprise locations on the E-LAN. Dedicated CSP connections will generally allow for multiple point-to-point virtual interfaces allowing for multiple enterprise nodes to communicate directly with the CSP.

IP-VPN: IP-VPN is a meshed Layer-3 service across Zayo's MPLS network connecting a customer's multiple enterprise locations and CSP on-ramp locations. Each customer location is connected to a Zayo PE router and establishes BGP peering directly with Zayo. Zayo will establish BGP peering directly with the customer's CSP. The customer is responsible for creating the CSP's cloud router and configuring the virtual interface within the cloud network for Zayo to use in establishing the BGP peer. With IP-VPN, customers do not create multiple BGP sessions directly to each of their locations or to each of their CSPs to establish the meshed network. IP-VPN simplifies WAN deployments for enterprises with lots of locations since individual point-to-point physical and logical circuits do not need to be created. With IP-VPN, there can be enterprise-to-enterprise communication, enterprise-to-CSP communication, and direct CSP-to-CSP communication across Zayo's network. CSP-to-CSP is across private IP only.

