

# NETWORKING IN THE CLOUD



Scott Taylor

Network Architect

**Internet2**



ipv6tech

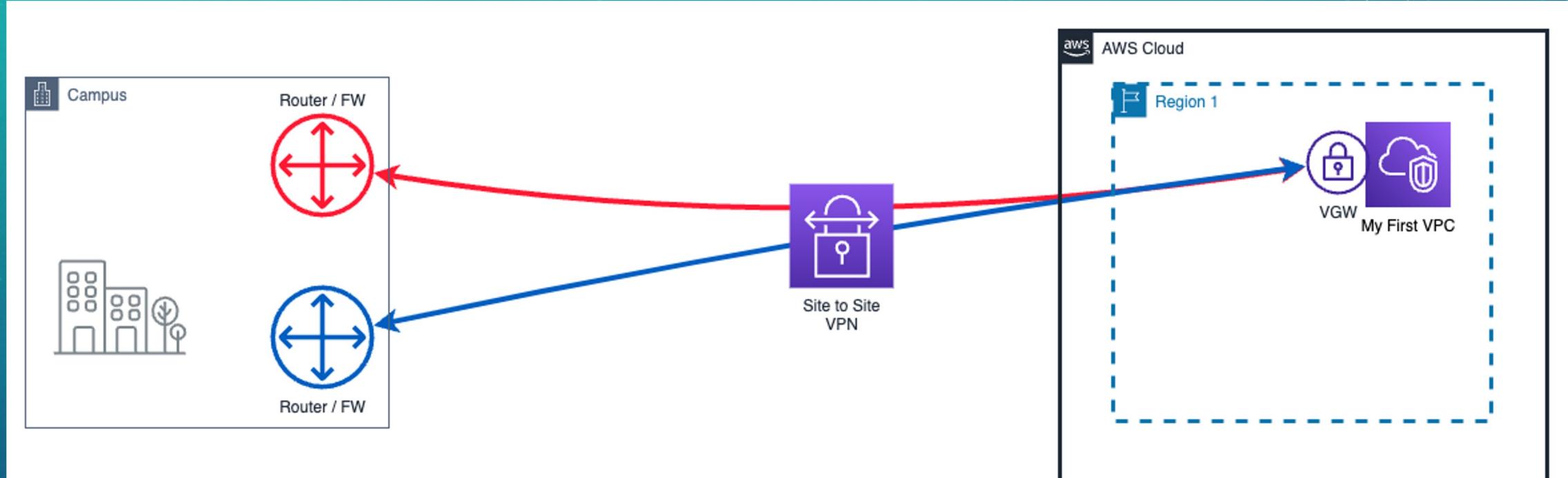


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# HYBRID AND MULTICLOUD



# Hybrid



# Multicloud

## Multicloud definition

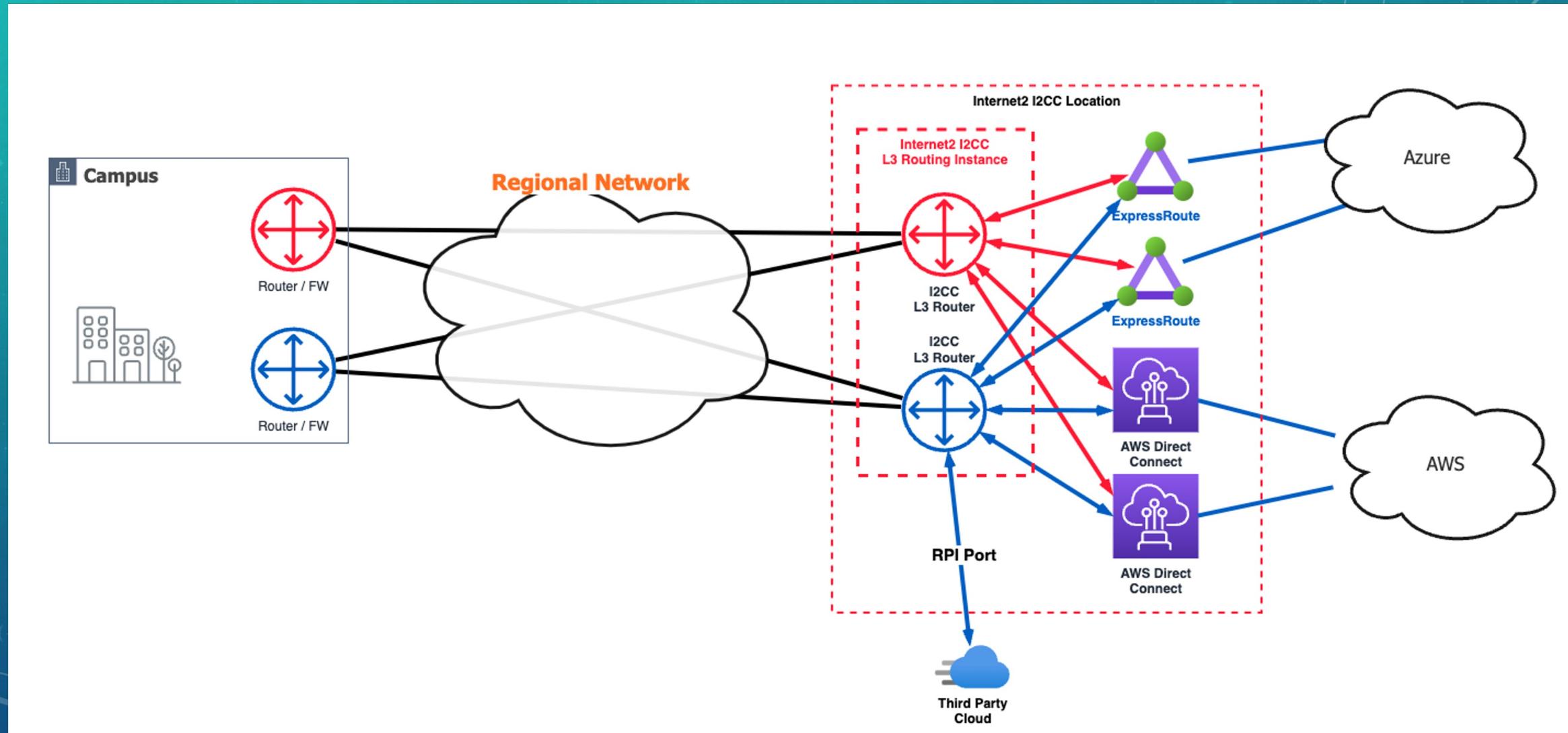
Source: Google Cloud

Multicloud refers to using services from more than one public cloud provider at the same time. A multicloud environment allows your cloud environments to be private, public, or a combination of both.

The primary goal of a multicloud strategy is to give you flexibility to operate with the best computing environment for each workload.



# Multicloud



# INTERNET2 CLOUD CONNECT

## I2CC

# Internet2 Areas of Focus in Support of R&E



## COMMUNITY

Internet2 is a community providing network, cloud and identity solutions, as well as research support and services tailored for R&E.

Our trusted, secure network empowers higher education, research institutions, government entities and cultural organizations.

# Getting to the Cloud



## Internet2 Peer Exchange

**I2PX** Use of the community's existing 3Tbps of peering capabilities to the major cloud providers for access to cloud SaaS services (e.g., Zoom or Office 365)

## Internet2 Cloud Connect

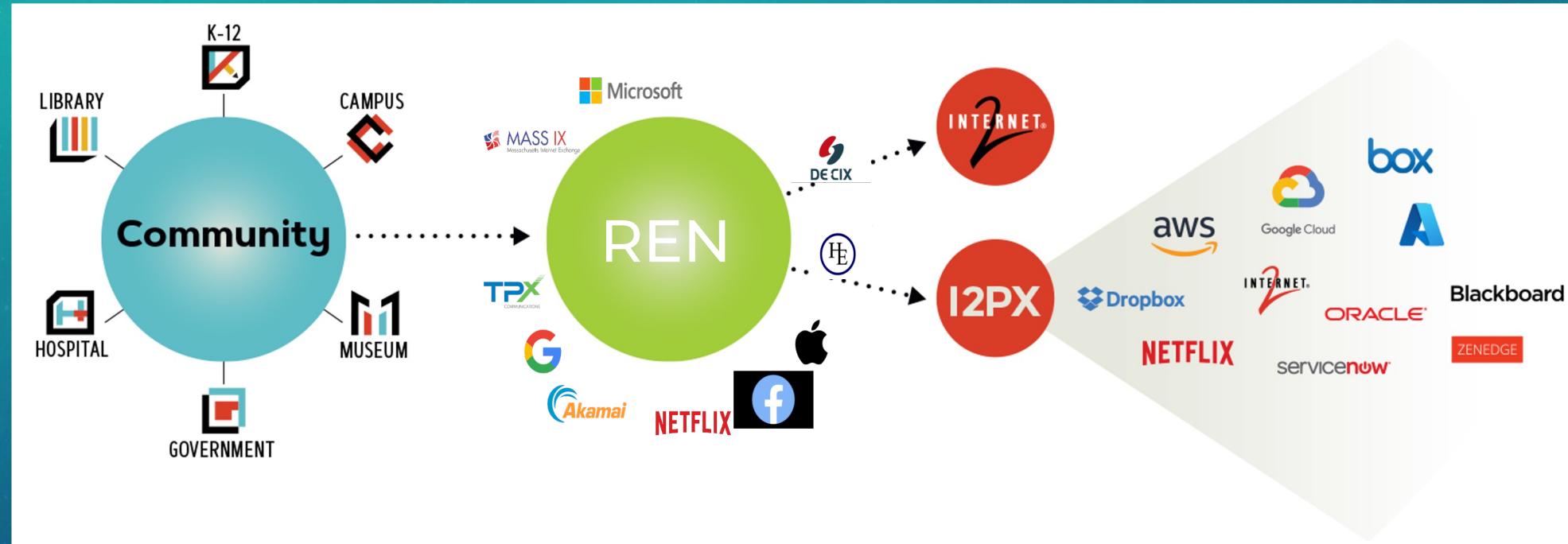
**I2CC** Enables members to use the Internet2 and their regional's infrastructure to obtain up to 5Gbps of "direct-connect" private Layer 2 and Layer 3 access to Amazon, Google, Microsoft, or Oracle cloud platforms at no additional fee. Extending your data center to the cloud. (Cloud provider fees apply)

## Internet2 Rapid Private Interconnect

**I2RPI** Provides private 10G interconnections at major peering points across the country at low annual rates. Leverages current investment in <regional network> and Internet2 infrastructures to reach cloud providers, for dedicated access or improved resiliency. May be used to connect to any commercial provider located at the peering point.

# DESIGNED FROM THE GROUND UP TO MEET THE R&E NEEDS

## Internet2 Peer Exchange I2PX



Allows REN to have high performing on-net access to cloud service providers, avoiding the commodity internet

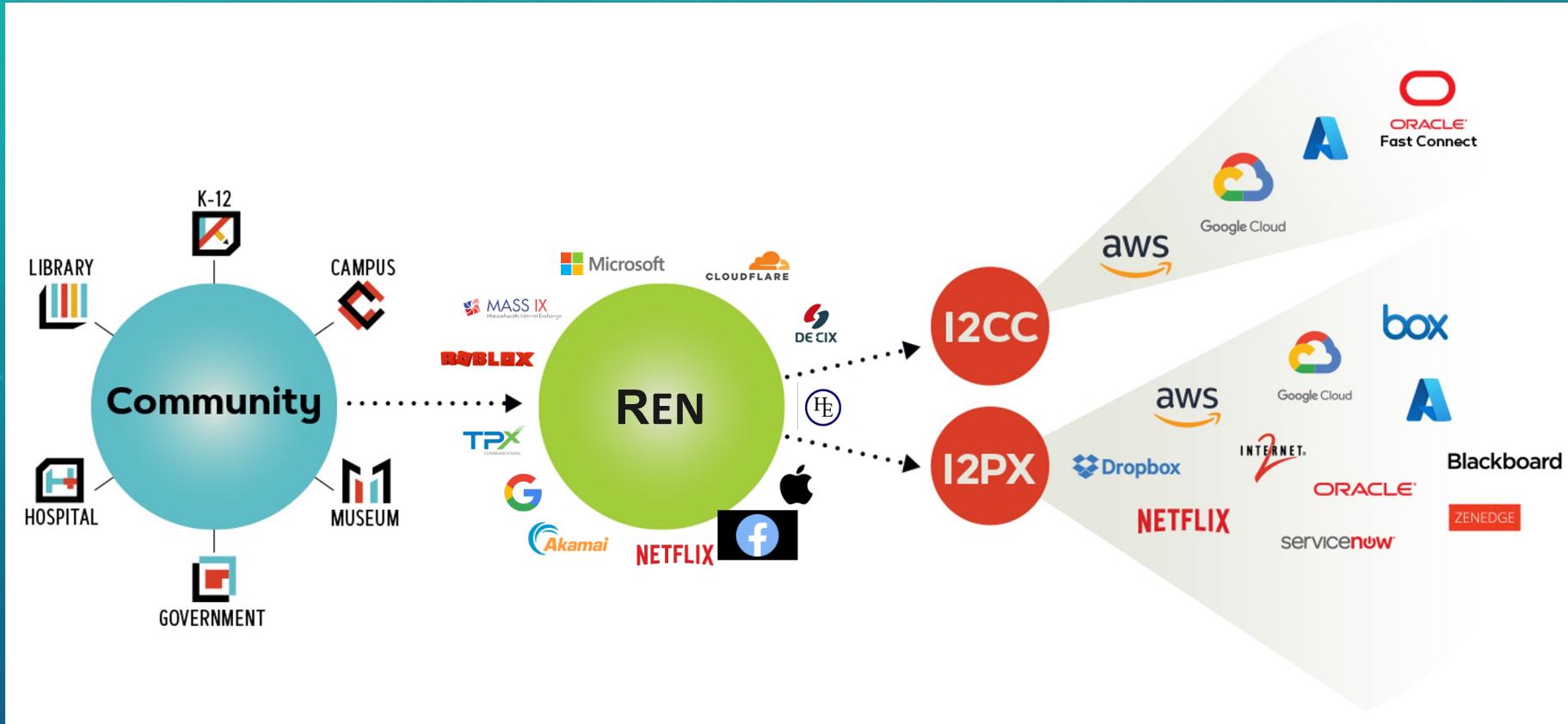
Designed from the ground up to focus on hosting cloud providers most valued by the R&E community

Available to REN members today at no additional fee

# Leveraging R&E Networks for Direct Cloud Connections

## Internet2 Cloud Connect

### I2CC



REN members can connect at Layer 2 or Layer 3

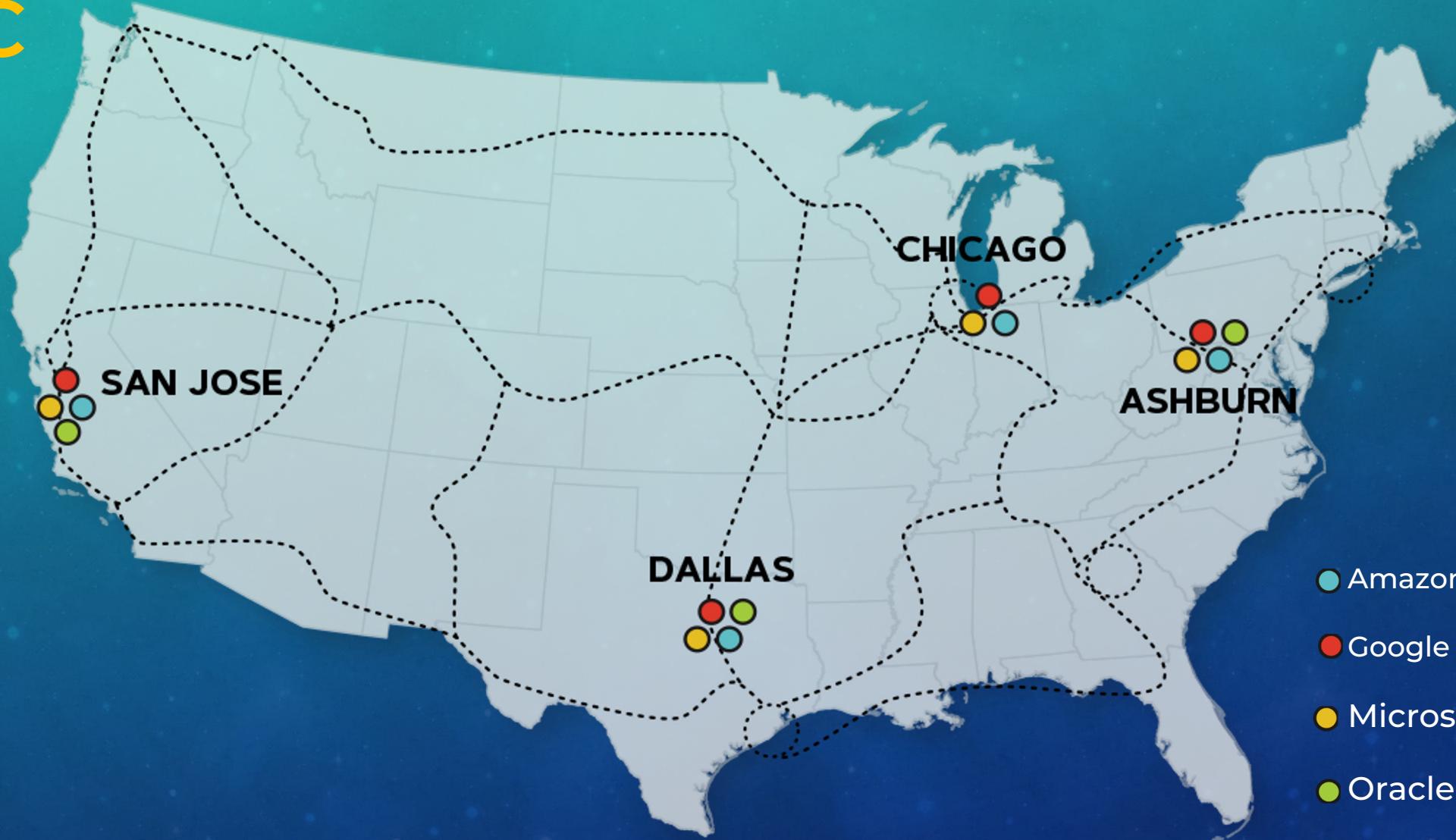
REN members can use Cloud Connect with up to 5Gbps connections to Amazon Direct Connect, Google Cloud Partner Interconnect, Microsoft Azure Express Route or Oracle FastConnect services

Available to REN members today at no additional fee

# Nationwide Connectivity

Internet2 Cloud Connect

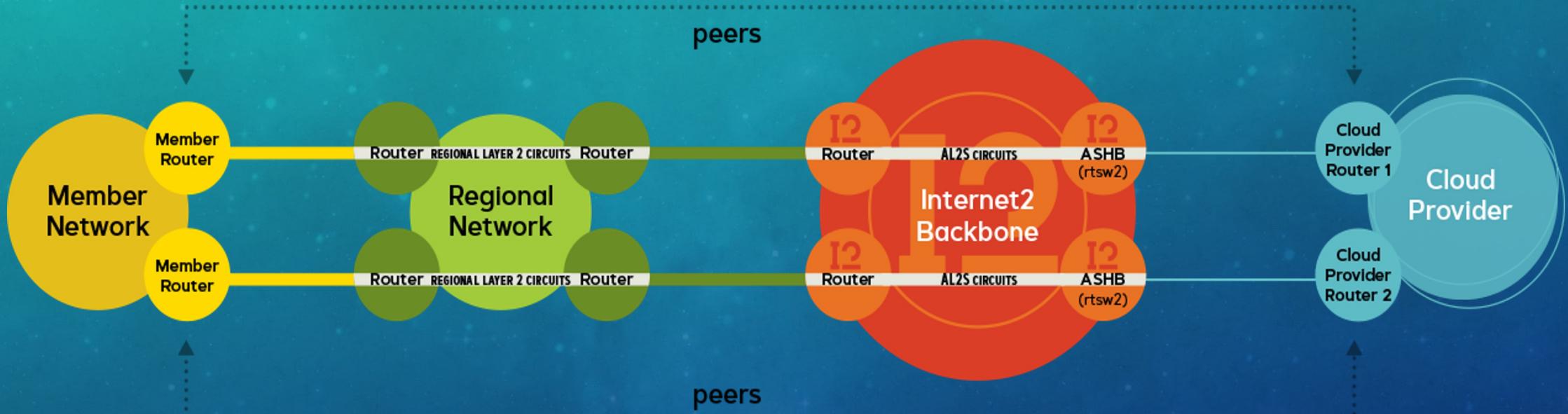
I2CC



# Layer 2 Connection Option

## Internet2 Cloud Connect

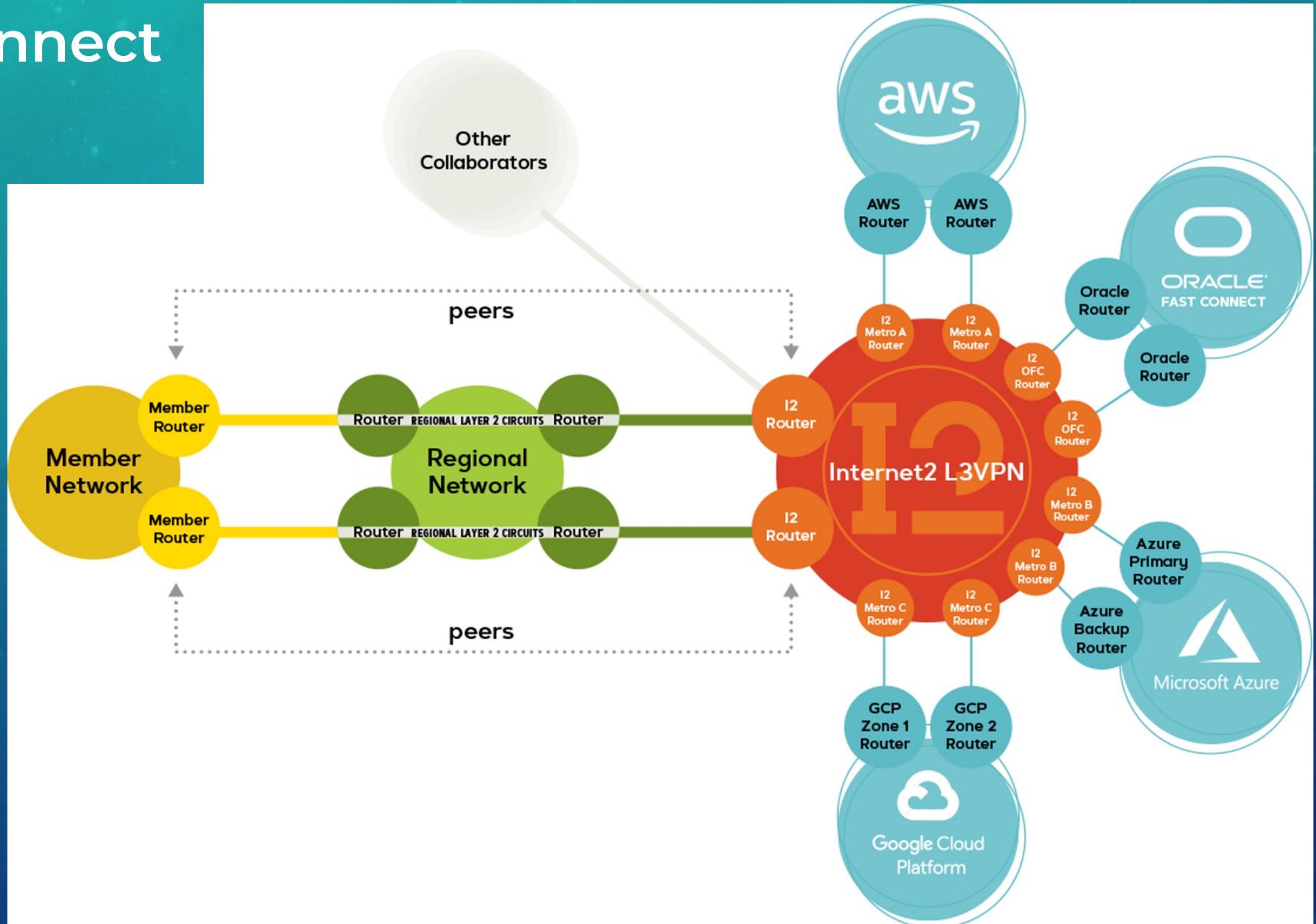
I2CC



# Layer 3 Connection Option

## Internet2 Cloud Connect

I2CC



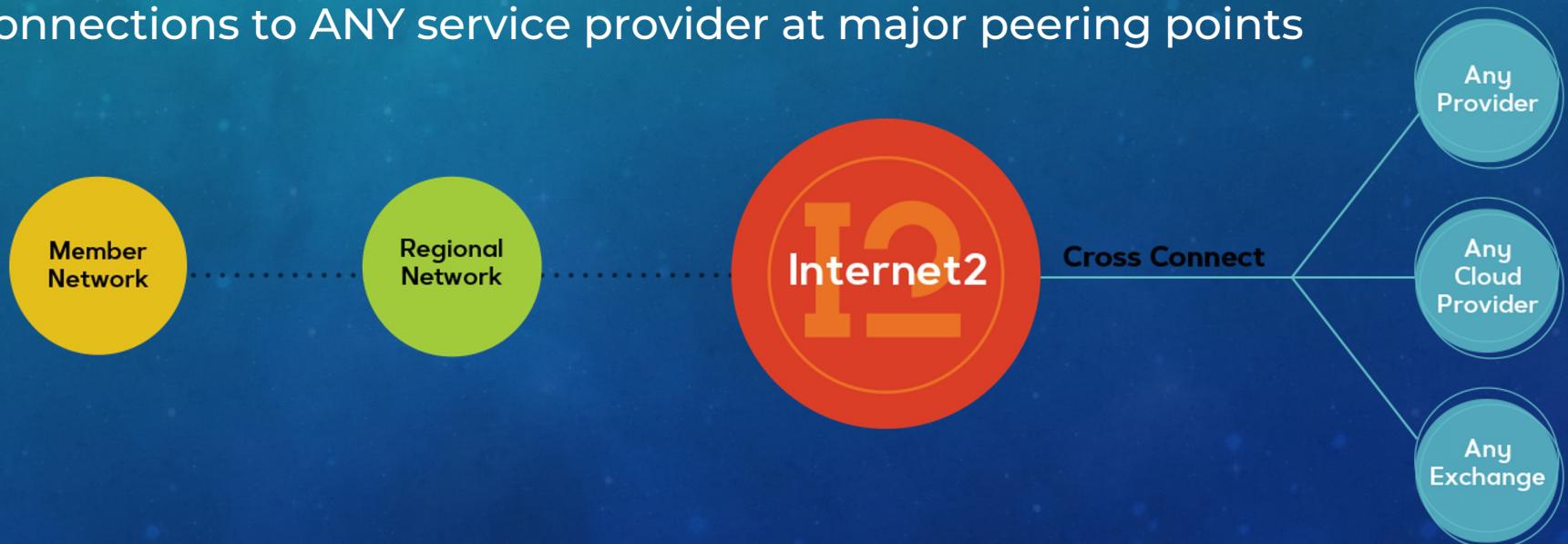
# Flexible Connections to Any Provider

## Internet2 Rapid Private Interconnect

### I2RPI

Available through Network Connectors for an additional fee

- Connect at Layer 2 or Layer 3
- Private 10G dedicated connections to Amazon Direct Connect, Google Cloud Interconnect, Microsoft Azure ExpressRoute, or Oracle Fast Connect services
- Private 10G dedicated connections to ANY service provider at major peering points



# Nationwide Connectivity

## Internet2 Rapid Private Interconnect

I2RPI can be used to provide private direct connects to any provider with some examples being 10G connections to SIP service providers, esports exchanges or other cloud providers.



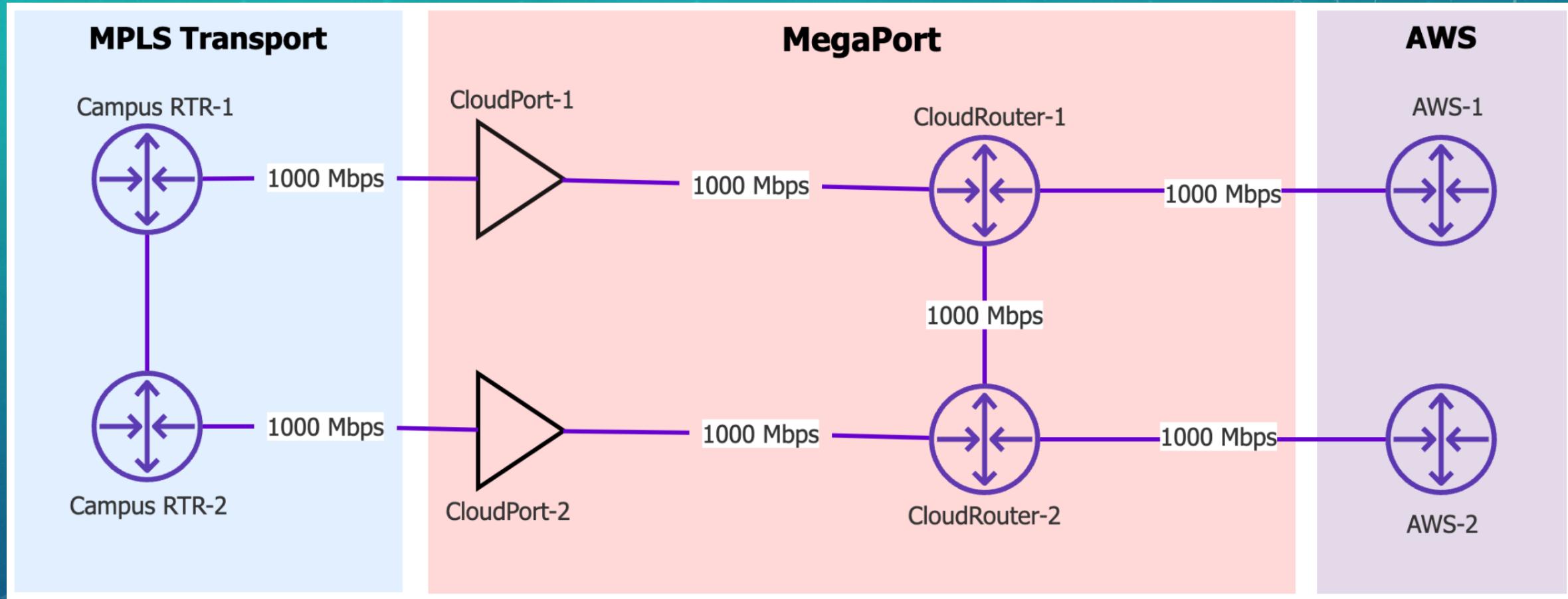
# WHY, HOW, AND WHEN TO USE I2CC

# Why, how, and when to use I2CC

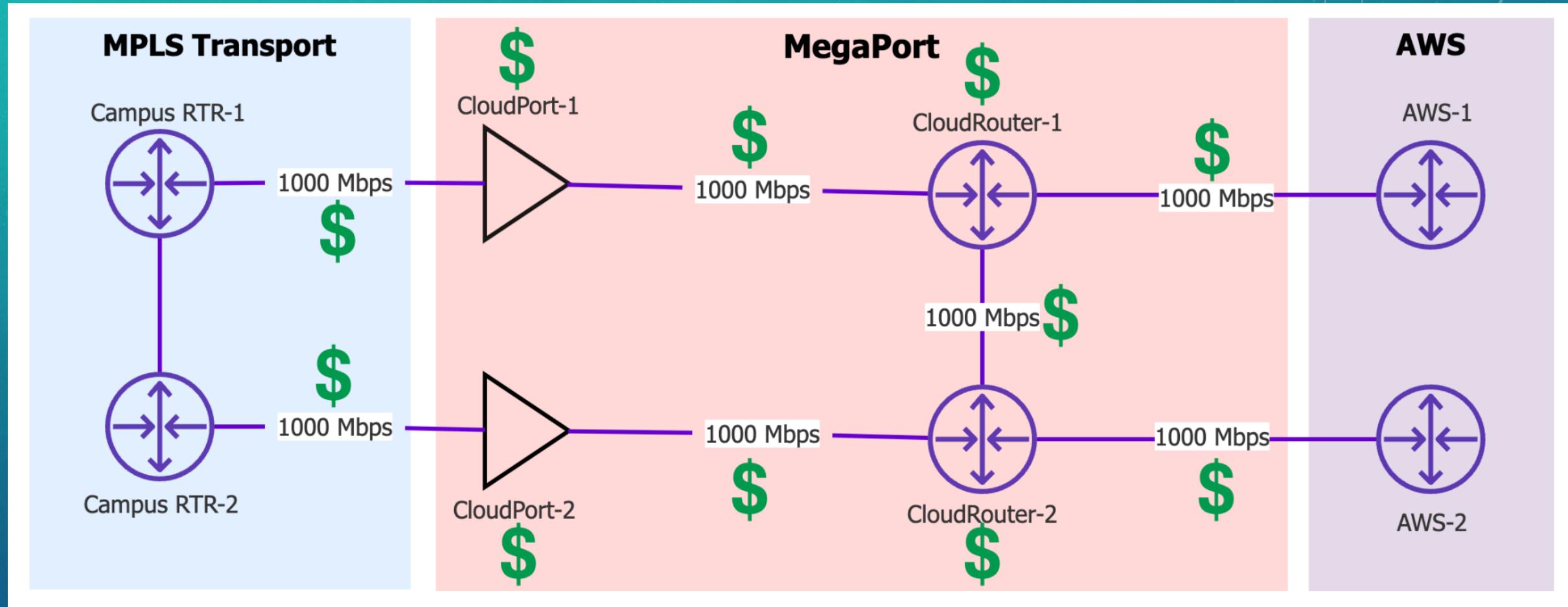
- Boost Network Performance
- Architect for Resiliency
- Simplify Connectivity
- Better Supportability
- Reduce Costs



# Reduce Costs

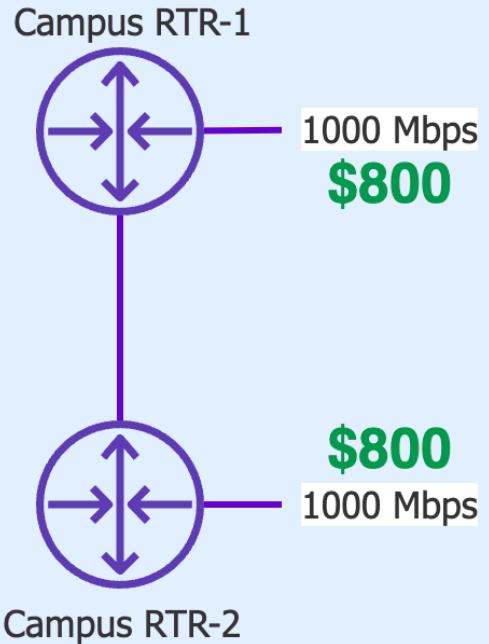


# Commercial Example



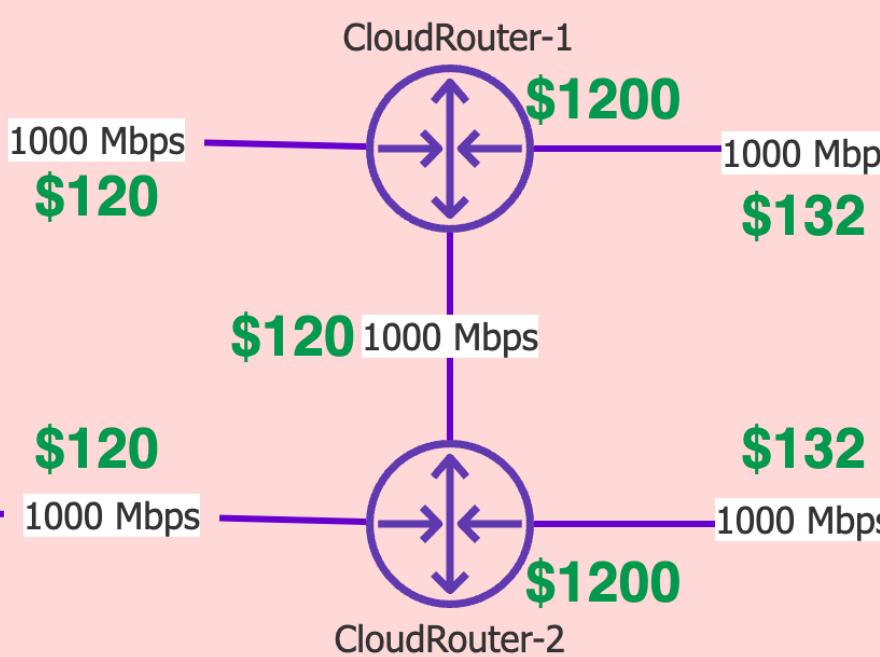
# Monthly Expense

## MPLS Transport



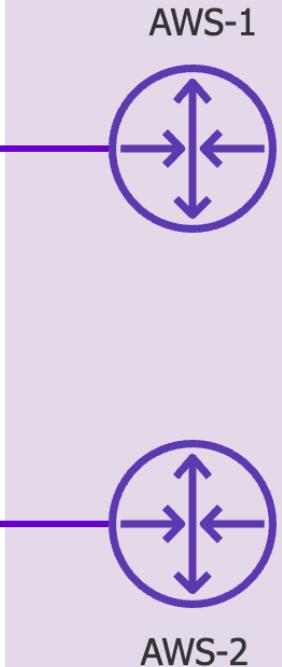
**Transport Monthly  
Expense = \$1600**

## MegaPort



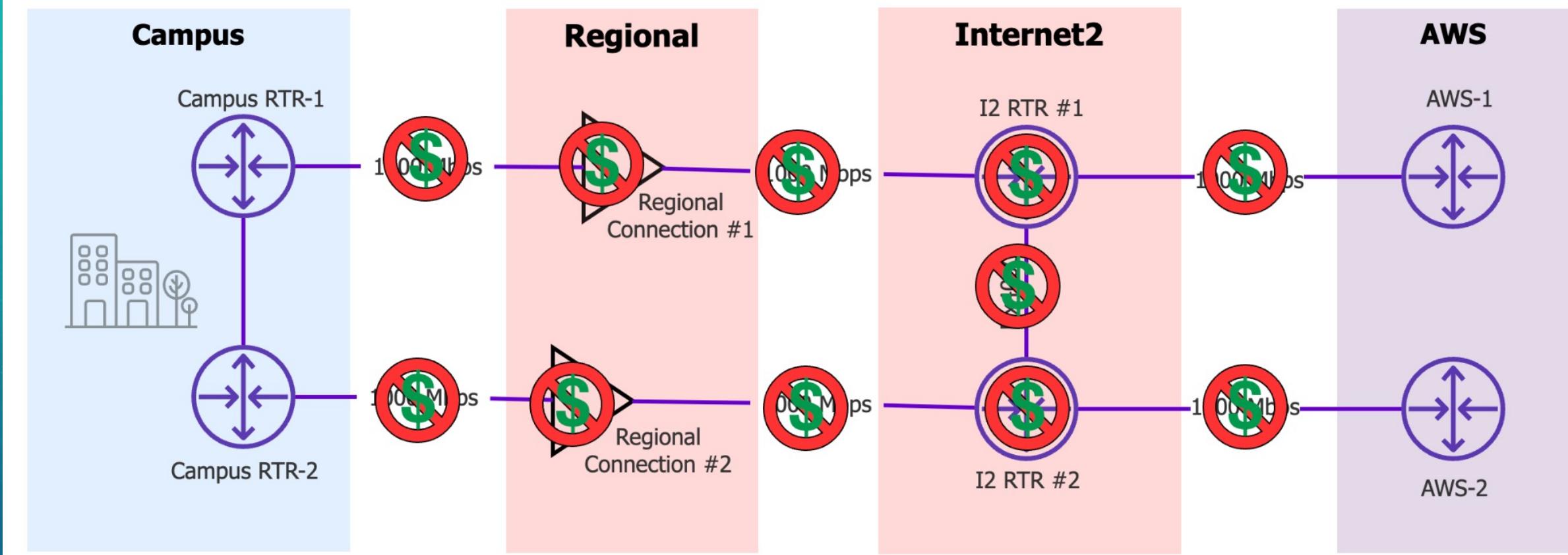
**Megaport Monthly  
Expense = \$4024**

## AWS



**Total Monthly  
Expense = \$5624**

# I2CC Monthly Savings



Total monthly saving: \$5,624

# INSIGHT CONSOLE OVERVIEW

# Internet2 Insight Console

## Sections covered

- Community – Organize child organizations and add users
- Interfaces – View interfaces or VLANs and delegate VLANs to other Orgs
- Virtual Networks – Configure new connections/services
- Looking Glass – Troubleshoot

# Internet2 Insight Console

<https://console.internet2.edu/#/>

The screenshot shows the Internet2 Network visualization, which displays a map of North America with major cities. Overlaid on the map are several network connection routes, each represented by a line of a specific color. A vertical color scale on the left indicates the utilization percentage of these connections, ranging from 0% (blue) at the bottom to 100% (purple) at the top. The colors correspond to the following utilization ranges: 0-1.9% (blue), 2.0-3.2% (light blue), 3.3-4.9% (light green), 5.0-7.4% (medium green), 7.5-11.0% (yellow-green), 11.1-16.1% (yellow), 16.2-23.3% (orange), 23.4-33.6% (dark orange), 33.7-48.3% (red-orange), 48.4-69.2% (red), 69.3-99.0% (dark red), and 99.1-100% (purple). The network appears to be highly interconnected, with many routes connecting major urban centers like Seattle, San Francisco, Los Angeles, Denver, Chicago, and New York.

Internet2 Network

Sign in

Virtual Networks  
Build private L3VPNs and L2VLANs

Looking Glass  
Run commands on Internet2 routers

Interfaces  
View stats and manage VLANs

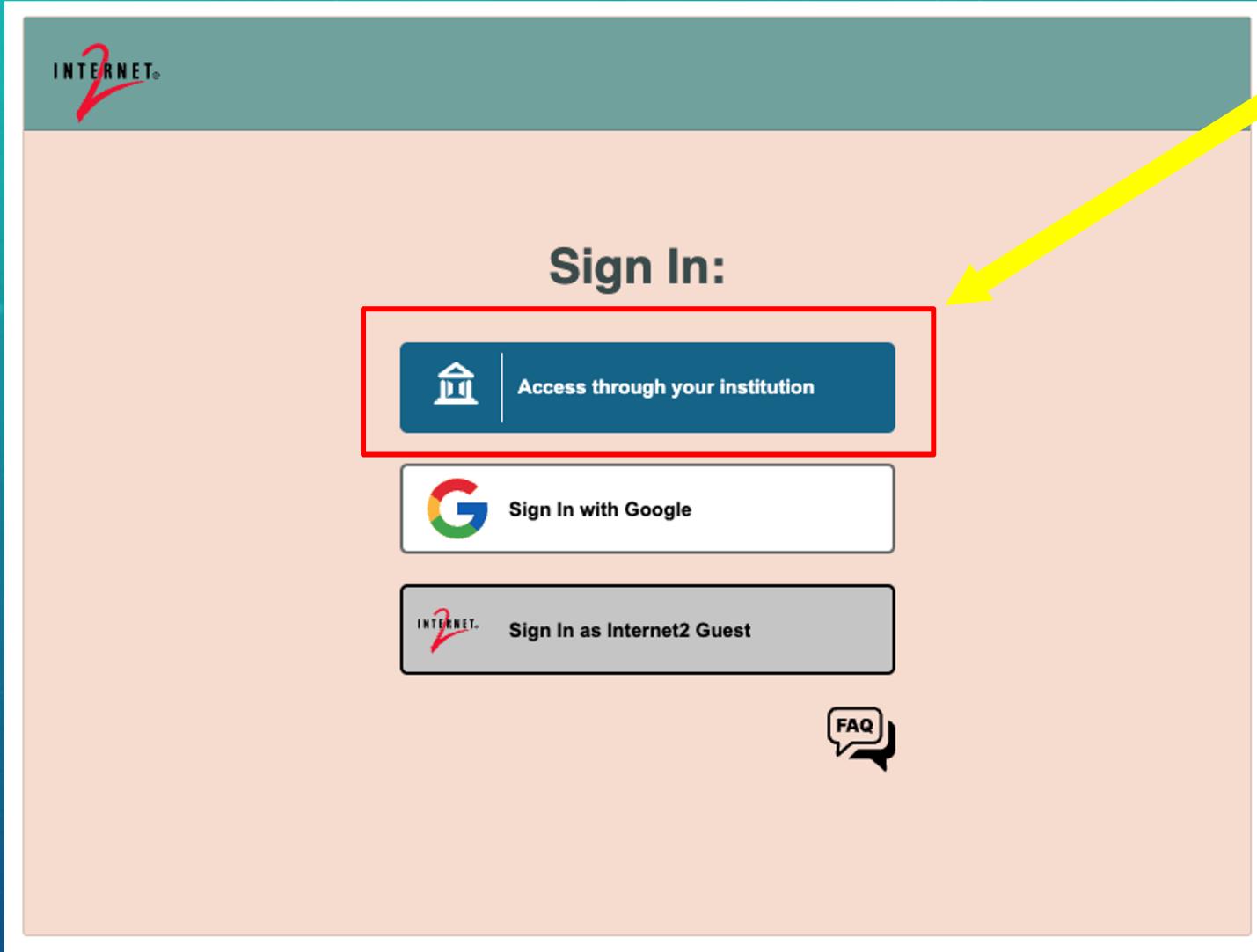
Community  
Manage organizations and people

Grafana  
View statistics

Network Operations Center  
Service Requests, Ops Calendar

Documentation  
Learn how to use Insight Console

# Internet2 Insight Console



- Access through your institution is the preferred method.
- If your institution uses Incommon you'll likely have the ability to sign in.
- You might need Internet2 to create or move your institution into the correct hierarchical tree structure.

# Community

Organize child organizations and add users

Insight Console

Search Organizations and Virtual Networks

Home Virtual Networks Looking Glass Community Interfaces

Organizations

No organization selected

- NoX (Northern Crossroads)
  - American Antiquarian So...
  - Assumption College
  - Bay Path University
  - Bentley University
  - Berklee College
  - Boston College
  - Boston University
  - Bowdoin College
  - Brandeis University
  - CAP Maine
  - CAP Massachusetts
  - CAP New Hampshire
  - CAP Vermont
  - Champlain College
  - College of the Holy Cross
  - Community College Syst...
  - Dartmouth College

# Interfaces

The screenshot shows the 'Interfaces' section of the Internet2 Insight Console. On the left, there's a sidebar with 'Organizations' and a filter for 'Harvard University'. The main area displays two sections: 'Interfaces owned by me' and 'Interfaces delegated to me'. The 'Interfaces owned by me' section shows an entry for Harvard University (Boston, MA) with interface 'HundredGigE0/0/0/24' assigned to 'core1.bost2'. The 'Interfaces delegated to me' section shows entries for NoX (Northern Crossroads) (Albany, NY) and NoX (Northern Crossroads) (New York, NY), both with interface 'HundredGigE0/0/0/24' assigned to 'core1.alba' and 'core2.newy32aoa' respectively. A yellow arrow points from the 'Interfaces delegated to me' section towards the right panel. The right panel shows a detailed view for the interface 'core2.newy32aoa.net.internet2.edu - HundredGigE0/0/0/24', including a graph of traffic over time (May 17-23, 2024) and VLAN delegation information.

Search Organizations and Virtual Networks

Impersonate | Provide Feedback | Document

Scott Taylor |

You are impersonating an Engineer at Harvard University | Change

Organizations Show All Hide All

Filter

Harvard University

Interfaces owned by me

Harvard University Boston, MA Platform

HundredGigE0/0/0/24 core1.bost2

Interfaces delegated to me

NoX (Northern Crossroads) Albany, NY Platform

HundredGigE0/0/0/24 core1.alba

NoX (Northern Crossroads) New York, NY Platform

HundredGigE0/0/0/24 core2.newy32aoa

NoX (Northern Crossroads) Platform Interface

HundredGigE0/0/0/24 core2.newy32aoa

Statistics

core2.newy32aoa.net.internet2.edu - HundredGigE0/0/0/24

Graph

core2.newy32aoa.net.internet2.edu - HundredGigE0/0/0/24

Gb/s

40 Gb/s

30 Gb/s

20 Gb/s

10 Gb/s

0 b/s

05/17 00:00 05/18 00:00 05/19 00:00 05/20 00:00 05/21 00:00 05/22 00:00 05/23 00:00

Mean Last \* Max

core2.newy32aoa.net.internet2.edu - HundredGigE0/0/0/24 - Input [13.7m averages] 16.6 Gb/s 13.4 Gb/s 29.2 Gb/s

core2.newy32aoa.net.internet2.edu - HundredGigE0/0/0/24 - Output [13.7m averages] 6.74 Gb/s 8.02 Gb/s 48.5 Gb/s

VLAN Delegations

VLAN range start	VLAN range end	Delegated to
3521	3530	Harvard University

View interfaces or VLANs and delegate VLANs to other organizations

# VIRTUAL NETWORKS

Insight Console | Services | Search Organizations and Virtual Networks | Impersonate | Provide Feedback | Documentation | Scott Taylor

Virtual Network Spaces / Space

**Virtual Network Space**

Title: Azure ExpressRoute - Ashburn - DAS-BE...  
Name: VNSPACE-10027  
Owner: CEN (Connecticut Education Network)  
Last Modified: 2023-10-27T21:13:16.101246+00:00 by OESS  
Created: 2023-10-27T21:13:16.101240+00:00 by OESS  
Virtual Space ID: 504f5084-49f0-4b5a-ac8a-e3fa5cb017c1  
Notes: OESS Workgroup CEN; OESS L3VPN 3506;  
Objects:

- Virtual Network Space
- VNROUTER-10027
  - CEN (Connecticut Education Network)
  - Microsoft
  - Microsoft
  - CEN (Connecticut Education Network)
  - Microsoft
  - Microsoft

Add:

- Add Virtual Router
- Add Virtual Switch

Collaborators: i

**Connection** **Live** **Details**

CEN (Connecticut Education Network) ↔ Internet2 Hartford, CT

**ASN**  
65003 55038

**IPv6**  
Not configured Not configured

**IPv4** ✓ Up  
10.199.254.1/30 10.199.254.2/30

**Internet2 Subinterface**  
HundredGigE0/0/0/25.752 on core1.hart2

Grafana



200 Mb/s  
0 b/s  
03:00 06:00 09:00 12:00

core1.hart2.net.internet2.edu - HundredGigE0/0/0/25.752 - core1.hart2.net.internet2.edu - HundredGigE0/0/0/25.752 -

**Provisioning Status** Provisioned  
[2023-10-27T22:21:02+00:00] [NSO] [PROVISIONED]

**Connection** **Live** **Details**

Internet2 Ashburn, VA ↔ Microsoft Washington DC

**ASN**  
55038 12076

**IPv6**  
Not configured Not configured

**IPv4** ✓ Up  
192.168.100.249/30 192.168.100.250/30

**Internet2 Subinterface**  
TenGigE0/0/0/12/2.30 on agg3.ashb

Grafana



100 Mb/s  
0 b/s  
03:00 06:00 09:00 12:00

agg3.ashb.net.internet2.edu - TenGigE0/0/0/12/2.3005 - agg3.ashb.net.internet2.edu - TenGigE0/0/0/12/2.3005 -

**Provisioning Status** Provisioned  
[2023-10-27T22:21:13:16+00:00] [Azure] [PROVISIONED]  
[2023-10-27T22:21:02+00:00] [NSO] [PROVISIONED]

**Connection** **Live** **Details**

Internet2 New York, NY ↔ CEN (Connecticut Education Network)

**ASN**  
55038 65003

**IPv6**  
Not configured Not configured

**IPv4** ✓ Up  
10.199.254.6/30 10.199.254.5/30

**Internet2 Subinterface**  
Bundle-Ether260.3766 on core1.newy32aoa

Grafana



200 Mb/s  
100 Mb/s  
0 b/s  
03:00 06:00 09:00 12:00

# NETWORKING COMPONENTS

# Hosted v Dedicated Cloud Connections

The Internet2 Cloud Connect “*Hosted*” connections are often referred to as *Partner* or *Provider* connections

Feature	Hosted	Dedicated (RPI Interface)
Supported Cloud Service Providers (CSP)	<ul style="list-style-type: none"><li>• AWS Hosted Connect</li><li>• Google Cloud Partner Interconnect</li><li>• Microsoft Azure Express Route</li><li>• Oracle Cloud FastConnect (via I2CC)</li></ul>	<ul style="list-style-type: none"><li>• AWS Dedicated Connect</li><li>• Google Cloud Dedicated Interconnect</li><li>• Microsoft Azure ExpressRoute Direct</li><li>• Oracle Cloud FastConnect</li></ul>
Shared Port (with rate shaping)	Yes	No
Speeds	50 Mbps through 10 Gbps <i>(depends on the CSP)</i>	10 Gbps
Time to Provision	< 10 minutes <i>(depends on the CSP)</i>	Typically 72 hours or more <i>(could be up to 30 days)</i> <i>(depends on the CSP and colocation facility)</i>

# Best Practices

Build dedicated connections into each region that you have infrastructure

Leverage redundant connections in each region

Consider VPN for backup connectivity

Use BGP where possible for dynamic routing

Use BFD wherever possible for quicker failover (< 1-second)  
(typical default holdtime is 90 – 180 seconds)

# Why Layer 3

We came here to learn and play with networking and routing, right?

While we can build Layer 2 connections into the clouds at some point you need to configure Layer 3 addressing and routing to move bits around.

BGP is universally leveraged for dynamic routing

Static routes are universally leveraged for static routing

# IP Address Planning

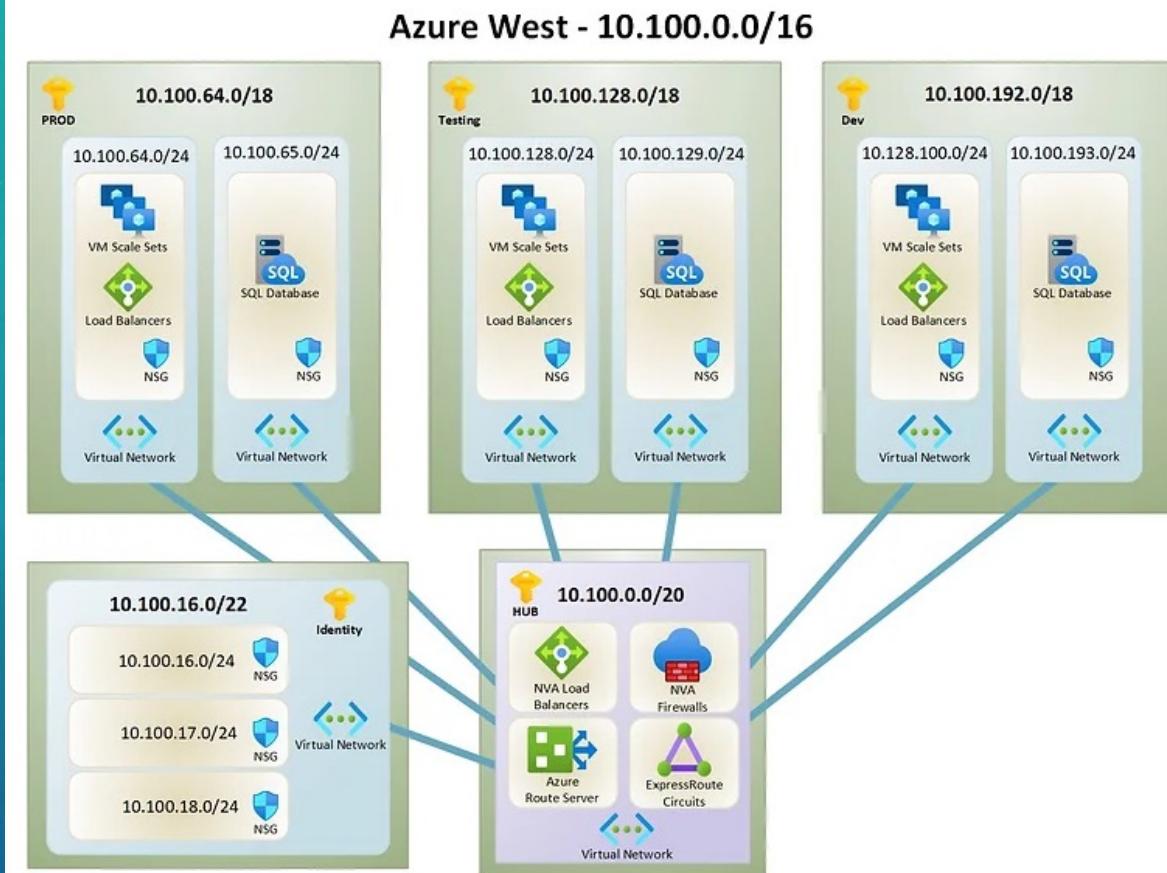
## IP Planning is critical !!!

- Ensure nonoverlapping address / CIDR ranges are used
- Don't use entire private CIDR ranges
- Plan and reserve space for future
- Fewer large virtual networks rather than multiple small virtual networks to prevent overhead
- Use IPv6 where possible
  - Gain experience
  - Future proof services
  - Same rules as above apply to IPv6 space

# IP Address Planning

## Private IPv4 addresses

RFC 1918 name	IP address range	Largest CIDR block (subnet mask)
24-bit block	10.0.0.0 – 10.255.255.255	10.0.0.0/8 (255.0.0.0)
20-bit block	172.16.0.0 – 172.31.255.255	172.16.0.0/12 (255.240.0.0)
16-bit block	192.168.0.0 – 192.168.255.255	192.168.0.0/16 (255.255.0.0)



## Identity-West-Vnet - 10.100.16.0/22

1. Production-DC-Subnet 10.100.16.0/24
2. Testing-DC-Subnet 10.100.17.0/24
3. Dev-DC-Subnet 10.100.18.0/24

## Identity-East-Vnet - 10.200.16.0/22

1. Production-DC-Subnet 10.200.16.0/24
2. Testing-DC-Subnet 10.200.17.0/24
3. Dev-DC-Subnet 10.200.18.0/24

# IP Address Planning



IP addressing  
still matters!



Even numbered  
**/16** allocated to all  
non-production



Odd numbered  
**/16** allocated to  
all production



3<sup>rd</sup> octet matches between  
NonProd and Prod VPCs.

```
> ipcalc 10.240.0.0/12
Address: 10.240.0.0
Netmask: 255.240.0.0 = 12
Wildcard: 0.15.255.255
=>
Network: 10.240.0.0/12
HostMin: 10.240.0.1
HostMax: 10.255.255.254
Broadcast: 10.255.255.255
Hosts/Net: 1048574
00001010.1111 0000.0000000.00000000
11111111.1111 0000.0000000.00000000
00000000.0000 1111.1111111.11111111
00001010.1111 0000.0000000.00000000
00001010.1111 0000.0000000.00000001
00001010.1111 1111.1111111.11111110
00001010.1111 1111.1111111.11111111
Class A, Private Internet
```

# ASN Planning

- Internet2 Cloud/Virtual Router to use ASN 55038
- Google Cloud Router to use ASN 16550 (*for partner interconnects*)
- Azure ExpressRoute to use ASN 12076
- Oracle FastConnect to use ASN 31898
- AWS DirectConnect to use a private ASN you configure << DANGER!

# ASN Planning

- ASN Planning is important especially as you enter multiple clouds and want to extend your private network or combine CSP's into a multicloud environment.
- Know your campus/data center ASN architecture
- Best practice to use a unique ASN for each Cloud Region
- Leverage private 16-bit and 32-bit ASNs
  - Private ASN ranges (RFC 6996): 64512 - 65534; 4200000000 - 4294967294

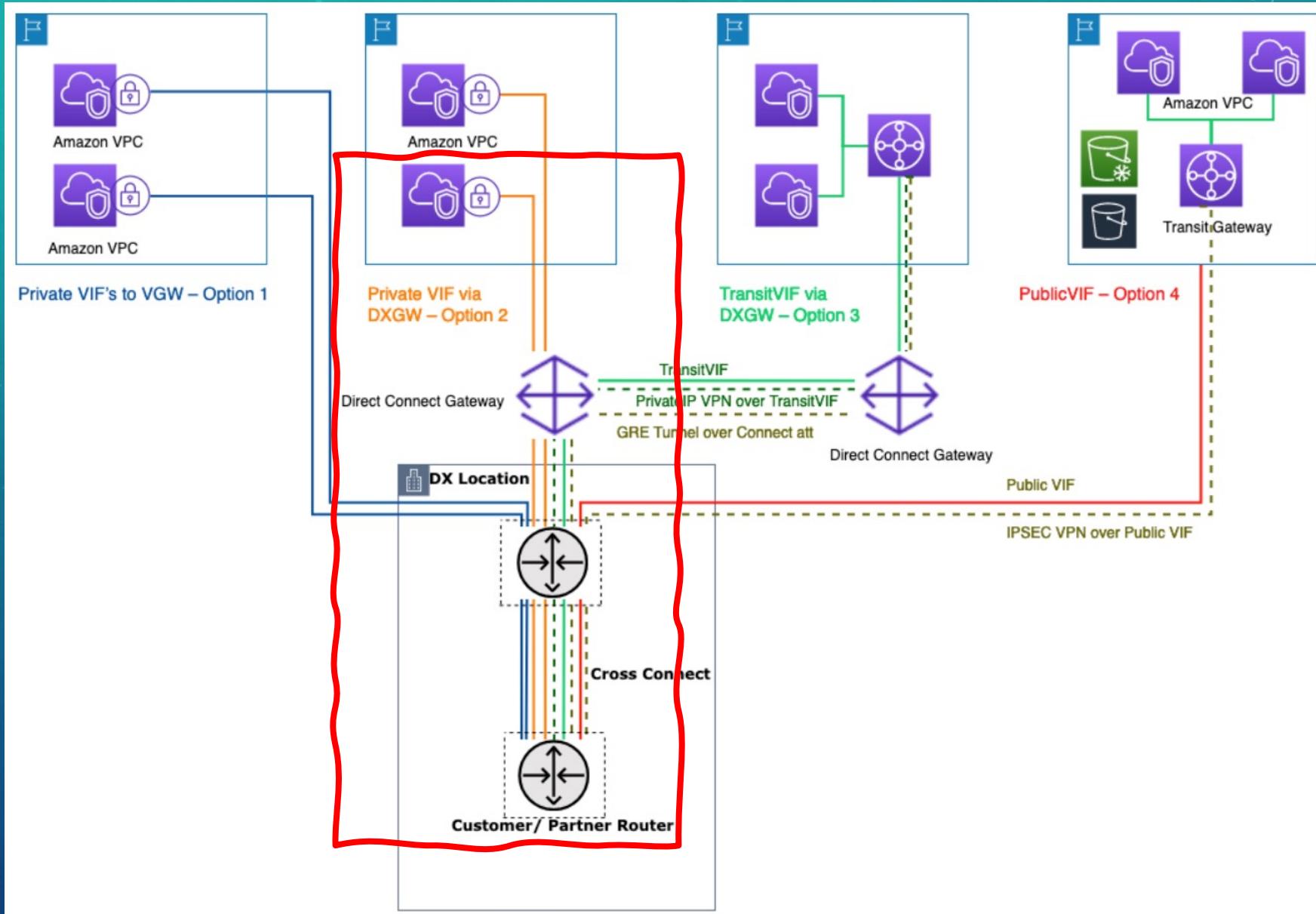
AWS connections start in Insight Console/Virtual Networks  
Accept the hosted connection in the AWS Console > AWS Direct Connect > Connections

- AWS services typically makes use of private ASN range 64512 – 65534

Specific Services:

- DXGW: ASN Range: 64512 – 65534
- VPG: ASN Default: 64512 (Custom allowed 64512 – 65534)
  - TGW: ASN Range: 64512 – 65534

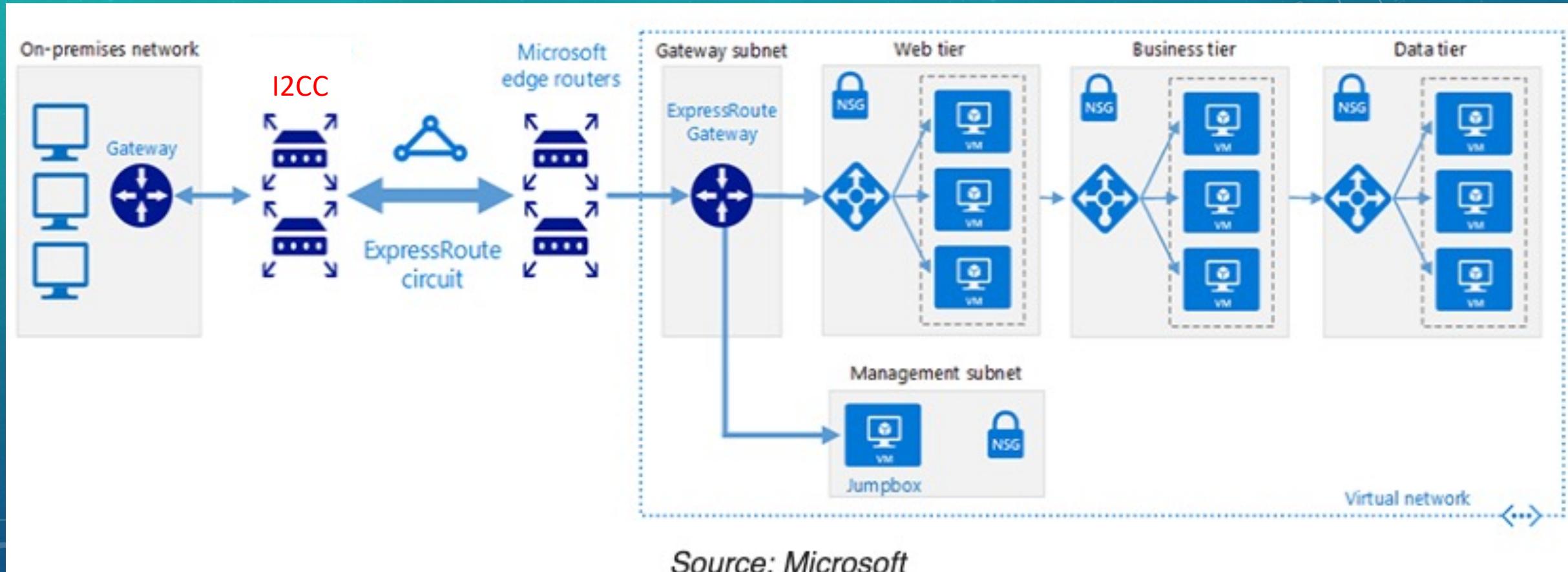
# AWS: Let me count the ways



# Azure

Azure connections start in the Azure portal

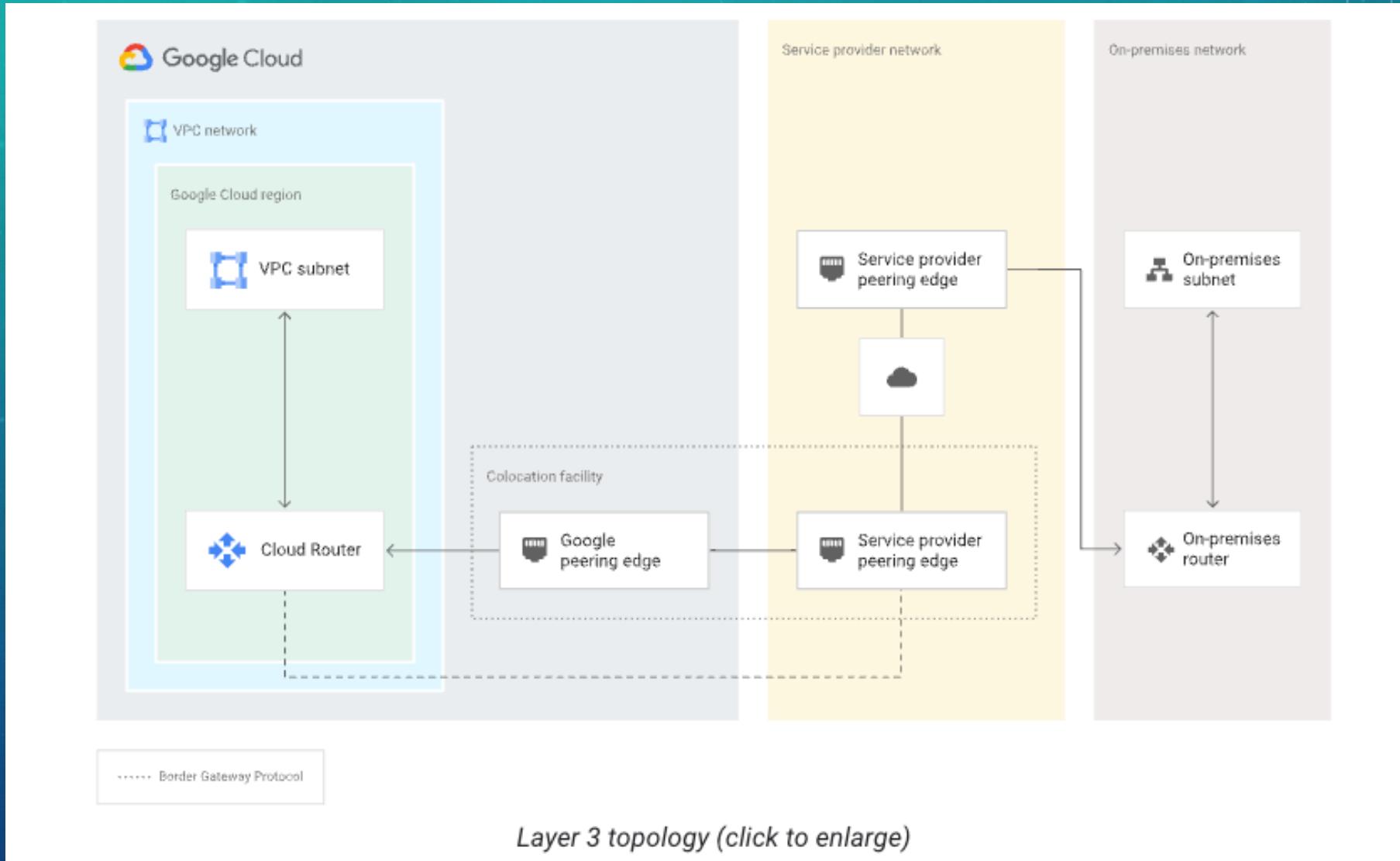
- Create a new ExpressRoute; copy the “SERVICE ID”
- Use service ID in Insight Console



Source: Microsoft

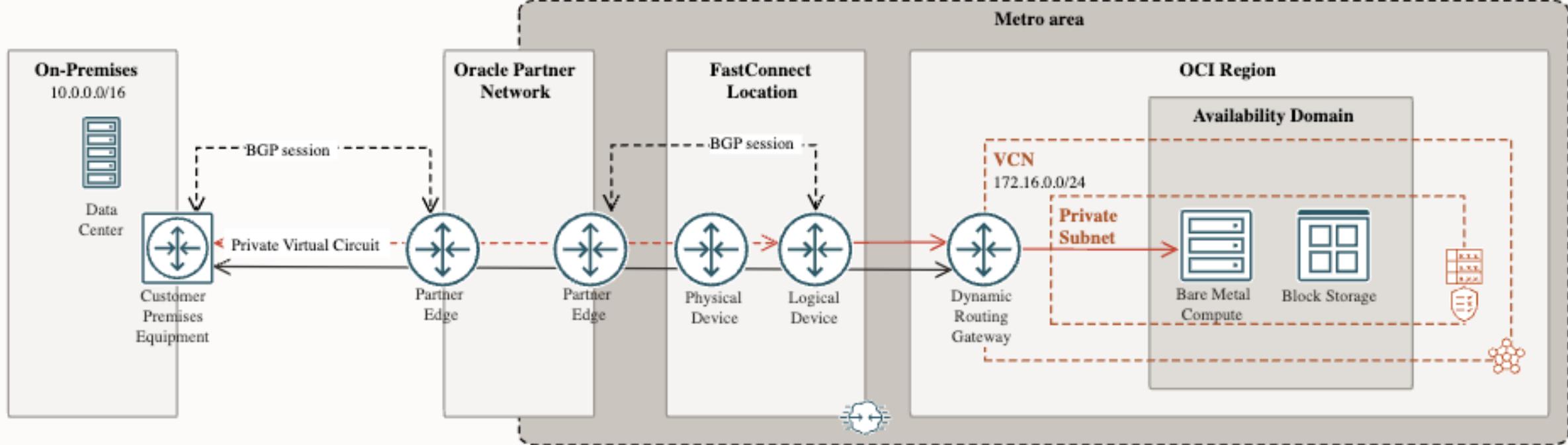
# Google Cloud

Google Partner Interconnect connections start in Google Cloud



# Oracle Cloud

Oracle FastConnect connections start in Oracle Cloud



# PREFIX LIMITS

## AWS Direct Connect

Private peering: Accepts up to 100 prefixes each for IPv4 and IPv6

Public peering: Accepts up to 1000 prefixes

BGP state goes to idle (BGP peering goes down)

## Azure Express Route

Private peering: Accepts up to 4000 prefixes

Public peering: Accepts up to 200 prefixes

BGP session is dropped

## Oracle FastConnect

Public peering: Accepts up to 200 prefixes

Private peering: Accepts up to 2000 prefixes

BGP session brought down?

## Google Cloud Interconnect/Cloud Router

Less straightforward, no published limits on Interconnect; limits exist on Cloud Router Important number to keep in mind is 250 prefixes

BGP doesn't go down instead uses deterministic route dropping behavior

# FOLLOW ALONG HANDS ON LAB

# CONCEPT

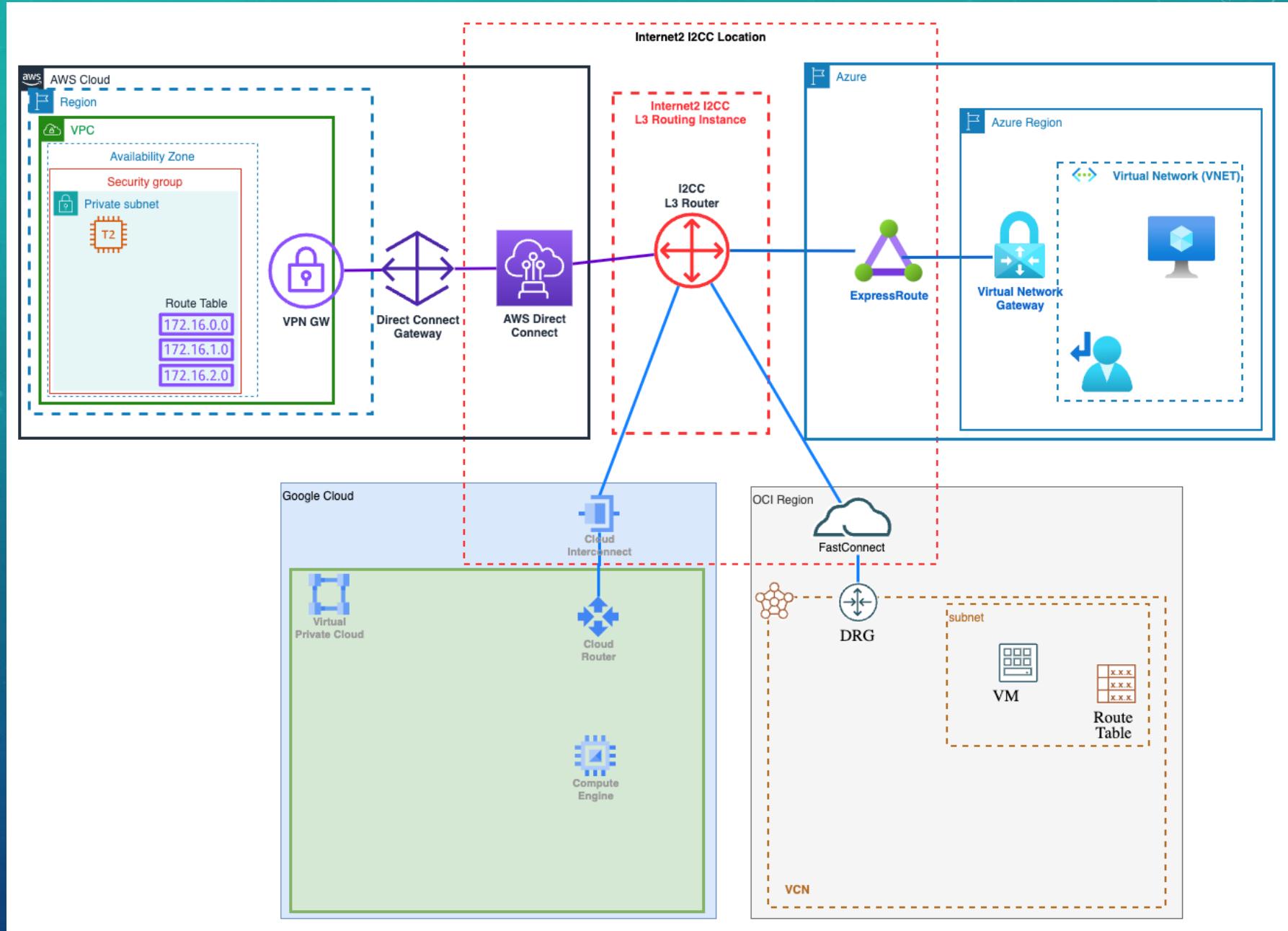
Leveraging Internet2 Cloud Connect we will establish private connections to the cloud service providers and learn how to inspect prefixes seen on the Internet2 Cloud Router.

- Private peerings
- Non-redundant connections
- Lowest bandwidth
- Internet2 Virtual Routers / Cloud Routers are a distributed resource and fully redundant.
  - It is not necessary to have more than one Internet2 Cloud Router

! Today you can't peer the Internet2 cloud routers together

IPv6 addressing is optional

# Multicloud



# Multicloud

AWS – 10.1.0.0/16

Subnet – 10.1.1.0/24 (public)

Azure – 10.2.0.0/16

Subnet – 10.2.1.0/24 (gateway)

Subnet – 10.2.2.0/24 (public)

Google – 10.3.0.0/16

Subnet – 10.3.1.0/24 (public)

Oracle – 10.4.0.0/16

Subnet – 10.4.1.0/24 (public)

# Insight Console Access

Everyone registered by July 7<sup>th</sup> was added to a workshop Organization

If you registered after July 7th let us know in the chat

Navigate to <https://console.internet2.edu>

Under Virtual Networks> search for **class-workshop**

# Insight Console Access

Suggest that everyone create a new Virtual Network Space

Create a router in your network space

We do not have a mock campus environment for this hand-on lab

# LOOKING GLASS

## TIPS & TRICKS

# Looking Glass Tip & Tricks

- 1 Bookmark your query so you can quickly return and re-run the same query

The screenshot shows the Looking Glass Insight Console interface. The browser address bar contains the URL: `https://console.internet2.edu/#/looking-glass?command=show+bgp+vrf+I2PX+neighbor+198.71.47.247+routes&nodes=core1.hart2`. A yellow box highlights this URL. The main window displays a command-line interface output for the query `show bgp vrf I2PX neighbor 198.71.47.247 routes`. On the left, there is a list of nodes under the heading "Core Router". The node `core1.hart2` is selected, indicated by a checked checkbox and highlighted with a yellow box. Other nodes listed include `core1.houh`, `core1.hous`, `core1.indi`, `core1.jack`, `core1.jcsn`, and `core1.kans`. The right pane shows the detailed output of the BGP route table for the selected node.

```
Nodes selected: 1 show bgp vrf I2PX neighbor 198.71.47.247 routes

core1.hart2 > show bgp vrf I2PX neighbor 198.71.47.247 routes

Tue Apr 30 13:14:44.560 UTC
BGP VRF I2PX, state: Active
BGP Route Distinguisher: 163.253.0.7:8
VRF ID: 0x60000002
BGP router identifier 163.253.0.7, local AS number 11537
Non-stop routing is enabled
BGP table state: Active
Table ID: 0xe0000002 RD version: 2591868684
BGP main routing table version 2591869012
BGP NSR Initial initSync version 6697447 (Reached)
BGP NSR/ISSU Sync-Group versions 0/0

Status codes: s suppressed, d damped, h history, * valid, > best
               i - internal, r RIB-failure, S stale, N Nexthop-discard
Origin codes: i - IGP, e - EGP, ? - incomplete
Network          Next Hop          Metric LocPrf Weight Path
Route Distinguisher: 163.253.0.7:8 (default for vrf I2PX)
Route Distinguisher Version: 2591868684
* 38.81.108.0/22    198.71.47.247      0    200      0 22742 i
* 38.81.109.0/24    198.71.47.247      1    200      0 22742 i
* 38.81.110.0/24    198.71.47.247      0    200      0 22742 i
```

# Looking Glass Tip & Tricks

- ② Show Interface state/counters/link flaps/etc.

Useful for:

- Network Connector Interfaces  
e.g. *CEN - Hart2 HundredGigE0/0/0/25*

The screenshot shows the Insight Console Looking Glass interface. On the left, a list of nodes under 'Hart' shows 'core1.hart2' selected. The main area displays the output of the command 'show interfaces HundredGigE0/0/0/25' for the selected node. The output details the interface's state, hardware, and various performance metrics over a 30-second period.

```
core1.hart2 > show interfaces HundredGigE0/0/0/25
Wed May 1 19:41:35.381 UTC
HundredGigE0/0/0/25 is up, line protocol is up
  Interface state transitions: 105
  Hardware is HundredGigE, address is 0476.b0da.50c4 (bia 0476.b0da.50c4)
  Description: PDP HART2-CONN-CEN-1 | I2-HART2-HART2-100GE-12551
  Internet address is Unknown
  MTU 9144 bytes, BW 10000000 Kbit (Max: 10000000 Kbit)
    reliability 255/255, txload 6/255, rxload 40/255
  Encapsulation ARPA,
  Full-duplex, 100000Mb/s, 100GBASE-LR4, link type is force-up
  output flow control is off, input flow control is off
  loopback not set,
  Last link flapped 21w6d
  Last input 00:00:00, output 00:00:00
  Last clearing of "show interface" counters never
  30 second input rate 15797211000 bits/sec, 2899048 packets/sec
  30 second output rate 2554667000 bits/sec, 261790 packets/sec
    25428498791272 packets input, 18291684330219271 bytes, 821 total input drops
    0 drops for unrecognized upper-level protocol
    Received 745789 broadcast packets, 39633355 multicast packets
      0 runts, 0 giants, 0 throttles, 0 parity
    821 input errors, 759 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    14878724838711 packets output, 18986751873135763 bytes, 0 total output drops
    Output 5002468 broadcast packets, 18385283 multicast packets
    0 output errors, 0 underruns, 0 applique, 0 resets
    0 output buffer failures, 0 output buffers swapped out
    109 carrier transitions
```

# Looking Glass Tip & Tricks

The screenshot shows the Insight Console interface with the "Looking Glass" tab selected. On the left, a sidebar lists nodes: "agg3.ashb" (selected), "agg3.dall3", "agg3.eqch", and "agg3.sanj". The main panel displays the output of the command "show interfaces TenGigE0/0/0/12/2.5005" for the selected node. The output details the interface's state, hardware, and statistics. To the right, the "Internet2" virtual network configuration is shown, including IPv4 and IPv6 addresses, ASN, MTU, bandwidth, and BFD settings. A red arrow points from the "agg3.ashb" node in the sidebar to the "agg3.ashb" entry in the network configuration. A green arrow points from the "agg3.ashb" entry in the configuration to the corresponding interface in the traffic graph below. The traffic graph at the bottom shows input and output traffic over time for the "agg3.ashb.net.internet2.edu - TenGigE0/0/0/12/2.5005" interface.

Nodes selected: 1 show interfaces TenGigE0/0/0/12/2.5005

agg3.ashb > show interfaces TenGigE0/0/0/12/2.5005

Wed May 1 20:19:49.357 UTC

TenGigE0/0/0/12/2.5005 is up, line protocol is up

Interface state transitions: 1

Hardware is VLAN sub-interface(s), address is 00bc.6055.6832

Description: ASHB-CONN-MICROSOFT-3, SDP VRNROUTER-10027-VNL3CONN-10117, OESS-VRF-3506

Internet address is 192.168.100.249/30

MTU 9152 bytes, BW 10000000 Kbit (Max: 10000000 Kbit)

reliability 255/255, txload 0/255, rxload 0/255

Encapsulation 802.1Q Virtual LAN, VLAN Id 30, 2nd VLAN Id 30,

loopback not set,

Last link flapped 6w4d

ARP type ARPA, ARP timeout 04:00:00

Last input 00:00:00, output 00:00:00

Last clearing of "show interface" counters never

30 second input rate 3244000 bits/sec, 528 packets/sec

30 second output rate 1416000 bits/sec, 559 packets/sec

4894514353 packets input, 2269037165025 bytes, 0 total input drops

0 drops for unrecognized upper-level protocol

Received 2 broadcast packets, 0 multicast packets

9110510098 packets output, 11105261187453 bytes, 0 total output drops

Output 0 broadcast packets, 0 multicast packets

IPv6 Address

IPv4 Address

192.168.100.249/30

ASN

55038

Interface

Microsoft Washington DC

TenGigE0/0/0/12/2.30

agg3.ashb

Subinterface\*

agg3.ashb.net.internet2.edu - TenGigE0/0/0/12/2.5005

100 Mb/s

0 b/s

05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00

agg3.ashb.net.internet2.edu - TenGigE0/0/0/12/2.5005 - Input [60s averages]

agg3.ashb.net.internet2.edu - TenGigE0/0/0/12/2.5005 - Outout [60s averages]

# Looking Glass Tip & Tricks

## 3 View routing table for Virtual Networks

Newer: `show bgp vrf VNROUTER-XXXXX`

- unless migrated from OESS -

Older: `show bgp vrf OESS-VRF-XXXX`

The screenshot shows the Insight Console interface with the "Looking Glass" tab selected. A search bar at the top right contains the command `show bgp vrf OESS-VRF-[REDACTED]`. The main area displays the BGP routing table for the VRF OESS-VRF-XXXX. The table includes columns for Network, Next Hop, Metric, LocPrf, Weight, and Path. The table shows several routes, all via the router `core1.alba`, with a route distinguisher of `163.253.0.8:1505`. The routes include various IP prefixes like `10.0.0.0/8`, `163.253.0.81/16`, and `163.253.0.81/15`.

The screenshot shows the Insight Console Services interface with the "Virtual Network Spaces" tab selected. A search bar at the top right contains the command `show bgp vrf OESS-VRF-XXXX`. On the left, a detailed view of a Virtual Network Space titled "Azure ExpressRoute - Ashburn - DAS-BE..." is shown. The "Notes" section at the bottom left is circled in red and contains the text "OESS Workgroup CEN; OESS L3VPN 3506;". A yellow arrow points from this circled text to the "Virtual Router" section on the right. The "Virtual Router" section shows the identifier `VNROUTER-10027` and its connection to "CEN (Connecticut Education Network)" and "Internet2 Hartford, CT". Below this, detailed information for "Internet2" is provided, including its ASN (55038), IPv6 (Not configured), IPv4 (Up, 10.199.254.1/30), and its subinterface `HundredGigE0/0/0/25.752` on the router `core1.hart2`. A yellow arrow also points from the "Notes" section to this "Internet2" configuration.

# Clean-up your cloud

## Don't forget!!!

> **Delete** all your resources in the various CSP's

Don't want a large bill at the end of the month!

Thank you!

