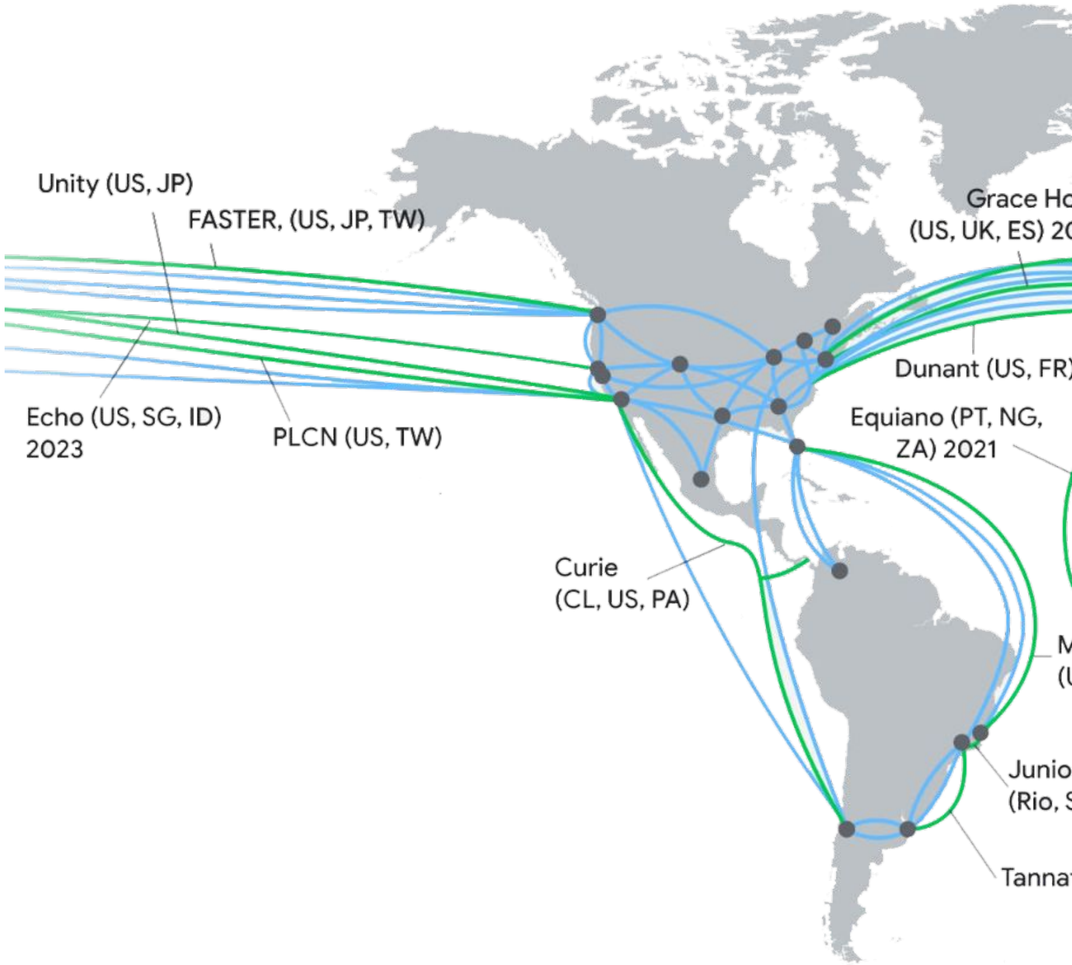
Networking 101 Sheet V3

With AI Networking



Google Cloud

Global Network

Networking 101 sheet .!!!

Network	Is a collection of connected devices for the purpose of communication. This can be a physical or logical connection
Fiber Optic Cable	Cable made up of optical pairs that transmit data using light
Internet	Public network of networks which exchanges routes through BGP
Region	A Google Cloud geographic compute location (Made up of minimum 3 zones)
Zone	Google Cloud compute facility within a region
Point of presence (PoP)	A connection point from the internet to Google's network

What are the economic advantages of using the Google Cloud network?
- Check blog **here**
- Download report **here**

On-premise	Data center belonging to an enterprise
Local Area Network (LAN)	This is a network that shares same communication lines in a distinct geographic area
Wide Area Network (WAN)	A collection of connected LANs across a large geographic area
Virtual LAN (VLAN)	A logical method to allow communication between systems that are located on different LAN segments
Cross-Cloud Network	A Google design concept that allows secure any-to-any communication (On-prem, cloud, distributed apps, global front ends)
Cloud WAN	A Google service allowing you to build your secure WAN network over Google's Global backbone
Protective ReRoute	A transport technique for shortening user-visible outages that complements routing repair
Multi-Shard isolation	Each network shard has independent data, control, and management planes

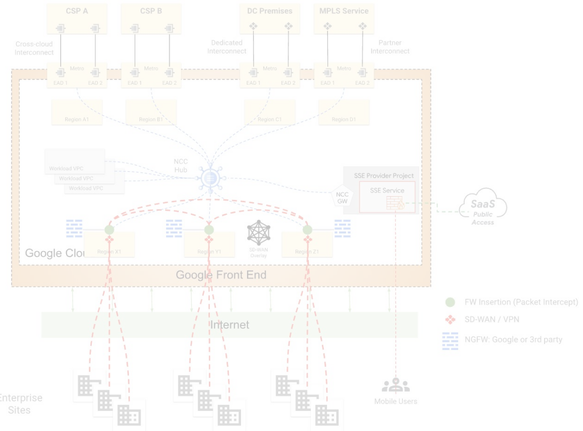
How much regions, zone and PoP exist in Google Cloud?
- Check current count **here**

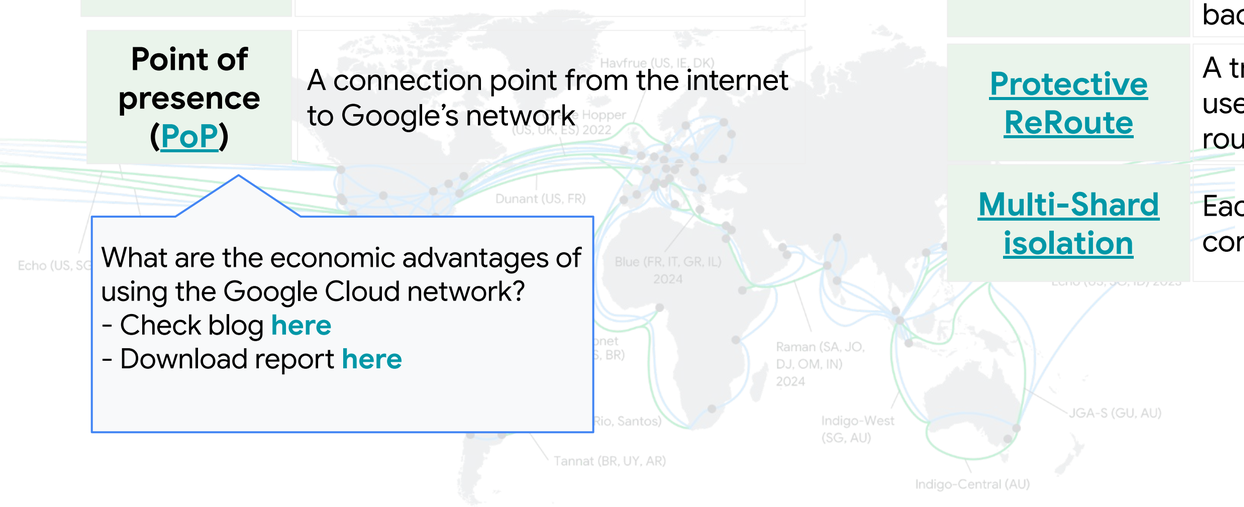
Who controls networking on-prem?
- 100% controlled by the enterprise

Where are the regions located?
- Check list **here**

What is Cloud WAN?
- Check solution brief **here**

How does Google's network support modern workload like AI?
- Check these innovation **here**





Ammett

VPC and IP addressing

Networking 101 sheet .!!!

Virtual Private Cloud (VPC)	VPC is a Logical representation of an on-prem network. This is a global construct in GCP
VPC modes	There are two modes in GCP. **Auto mode** and **custom mode**
VPC subnets	In GCP these are regional and assigned to an IP address range
IP address	A unique address used to identity host on network. Made up of network and host portions
Subnet mask	This segments and IP address into network and host portions. It determines how must host are available on the network. This can be manipulated to form **CIDR** blocks
IPv4	This is a 32 bit, 4 octet address. Written in binary or dotted decimal format. E.g. **192.168.10.20** or 11000000.10101000.00001010.00010100
IPv6	This is a 128 bit, hexadecimal address. 2001:DB8:7654:3210:FEDC:BA98:764:3203

Private IP (RFC1918)	A special range that can be used internally by anyone. These are non internet routable
Public IP	IP address that is routable on the internet
DHCP	Dynamic Host Control protocol. A method to automatically assign an IP address to a client
Static IP	An IP that does not change after being assigned
Ephemeral IP	Temporary IP that is not reserved
Bring Your Own IP (BYOIP)	Use external IP addresses that you own in Google Cloud
Alias IP	Additional addresses that can be assigned to your VM, these can be taken from the primary or secondary address range

Secondary IP	Secondary range of IP address that can be assigned to your VM
Restricted.googleapis.com IP	Access external GCP APIs via google private network. 199.36.153.4/30. Used when **VPC service controls** are enabled and you need to access only VPC service control supported APIs
Private.googleapis.com IP	Access external GCP APIs via google private network. 199.36.153.8/30
Network Time Protocol (NTP)	Is used to synchronize systems timer across a network. This is used on both internal and external networks.

What is the amount of reserved IP's in GCP subnet?
- Count 4

What is the smallest GCP private subnet?
- /29 with 4 host.
  Formular 2^n - 4

Can IPV6 be used?
- Yes, see **here**

Can I set private and public static IP's in my VPC?
- Yes, see below:
  - **External static**
  - **Internal static**

Ammett

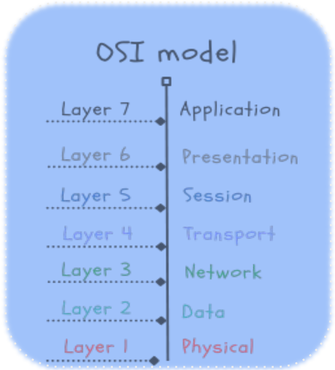
OSI model and Internet Model

Networking 101 sheet .!!!

What is the OSI Model	A 7 layer conceptual model that provides interoperability of the TCP stack
Application (Layer 7)	User interface and application. Protocols examples HTTP, HTML
Presentation (Layer 6)	Formats data to be presented. Protocols examples JPEG, ASCII, GIF
Session (Layer 5)	Creates, tracks, ends the sessions between different systems
Transport (Layer 4)	Handles message delivery using connection and connectionless protocols. Protocol examples TCP, UDP
Network (Layer 3)	Focuses on subnets, route path selection. Protocols examples IP, ICMP, Router work here
Data (Layer 2)	Focuses of transferring data frames over physical layer. Protocol, ARP, PPP, VLANS. Switches work here
Physical (Layer 1)	Transmission of raw bits over physical mediums. Examples network cables, wireless

What is the Internet Model	A 4 layer model conceptual model of the TCP/IP stack
Application Layer	User interface and application.
Transport Layer	Responsible for end to end data handling of data streams
Internet Layer	Responsible for routing packets through networks
Link Layer	From a device it interacts with physical network

Google Cloud Services operating at different OSI layers	
Layer 7	Application Load balancers, Cloud Armor, Cloud NGFW Enterprise
Layer 4	Network Load balancers
Layer 3	Cloud Interconnect
Layer 2	Cross-Site Interconnect, Vlans



What is interoperability?

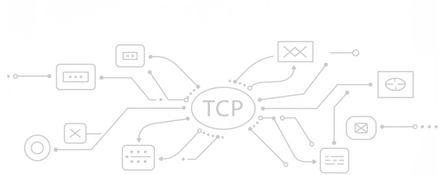
- The ability to communicate between different communication devices in a standard way.

Does a physical layer exist in the cloud?

- Yes, there are hardware devices located in **Google Data Centers**. These are 100% managed by Google.

mmett

TCP, Three-way handshake, UDP, QUIC



Networking 101 sheet .!!!

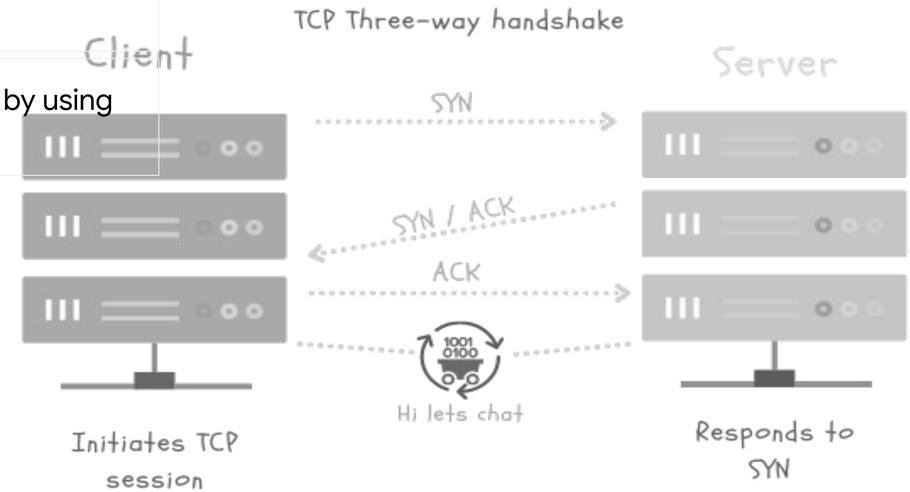
Transmission Control Protocol (TCP)	This is a connection oriented protocol that handles reliability, flow and congestion control of packets. It establishes a connection before sending a packet
Three-way handshake	This is the sequence to form a TCP connection. It involve the SYN, SYN/ACK, ACK flag exchange between client/server
Flag	These indicate the state of the connection
SYN	The SYN or synchronize flag is sent to start the TCP connection process
ACK	The ACK or the acknowledgement flag. This confirms that data was received
FIN	A flag sent to request termination of connection
User Datagram Protocol (UDP)	This is a best effort delivery protocol
Transmission Control Block (TCB)	Contains all the information about the connection and implements the sliding window
Sliding window	Determines the amount of bytes that one system can send to the other. Once the agreed bytes are received and processed, the sender sends another set of bytes to the receiver until all data is sent
Quick UDP Internet Connections (QUIC)	A Google made transport layer protocol. This is built on top of UDP
Transport Layer Security (TLS)	A protocol that provides cryptography by using certificates
Hypertext Transfer Protocol (HTTP)	Protocol used for transmitting hypermedia documents. This is a standard on the internet
HTTP(S)	Secure version of HTTP enabled by using TLS on the connection

How does TCP differ from UDP?

- TCP is connection oriented, UDP is best effort.

What layer of the OSI is TCP and UDP found?

- These exist at layer 4, transport layer.



Ammett

Packet, Frame, MTU

Networking 101 sheet .!!!

Data messages types	These are frames, packets, datagrams. They may exist at different layers of the OSI model
Maximum transfer unit (MTU)	The size of the largest unit of data that can be transmitted over the network
Time to Live (TTL)	This indicates the life of the packet it usually has a max of 255 hops. This ensures packets don't exist forever in a network
Unicast message	These are sent on a 1 to 1 basis on a network
Multicast message	These are sent to subscribed groups on a network
Broadcast message	These are sent to every device on a network

How do the different message types work?

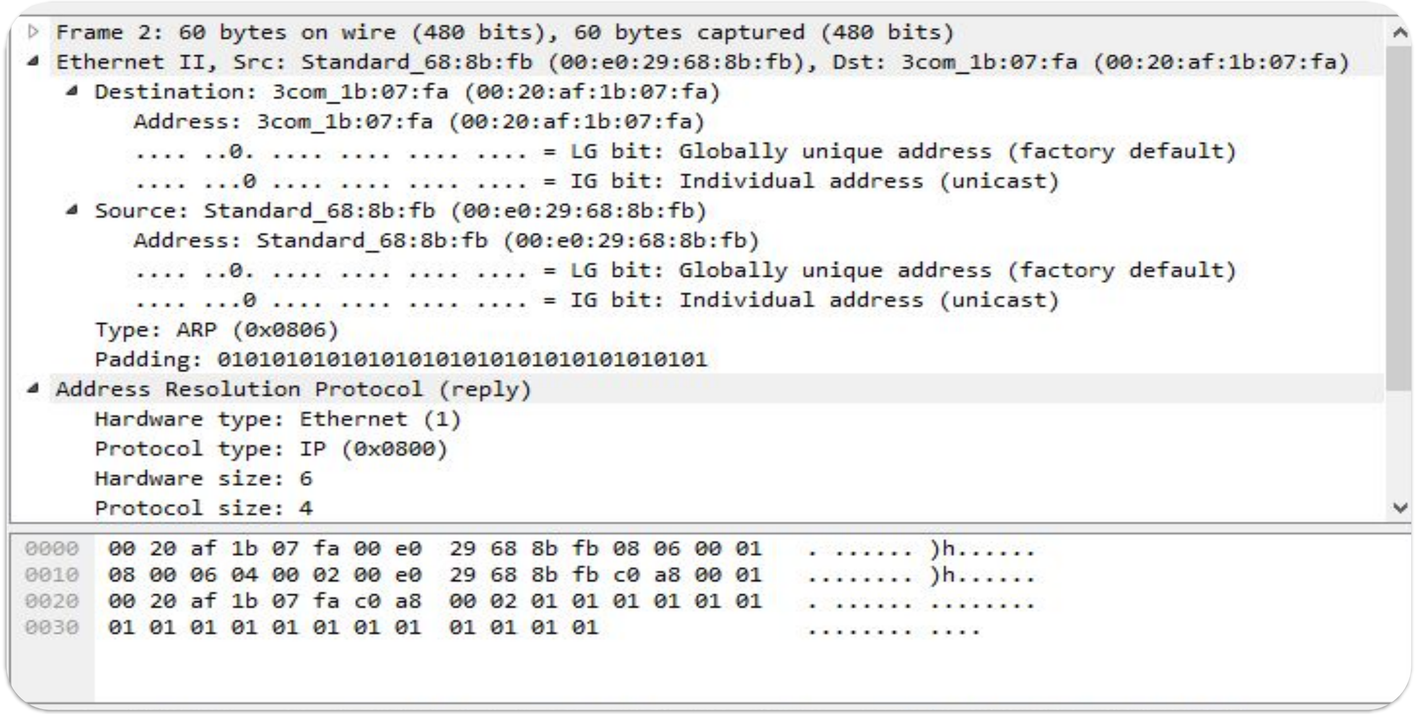
- See **guide**

What MTU option do you have in Google Cloud?

- Currently, 1440, 1460, 1500, 8896
  See options doc

Does multicast and broadcast works natively work in Google Cloud?

- Currently no.



ARP, RARP, DNS, NAT

Networking 101 sheet .!!!

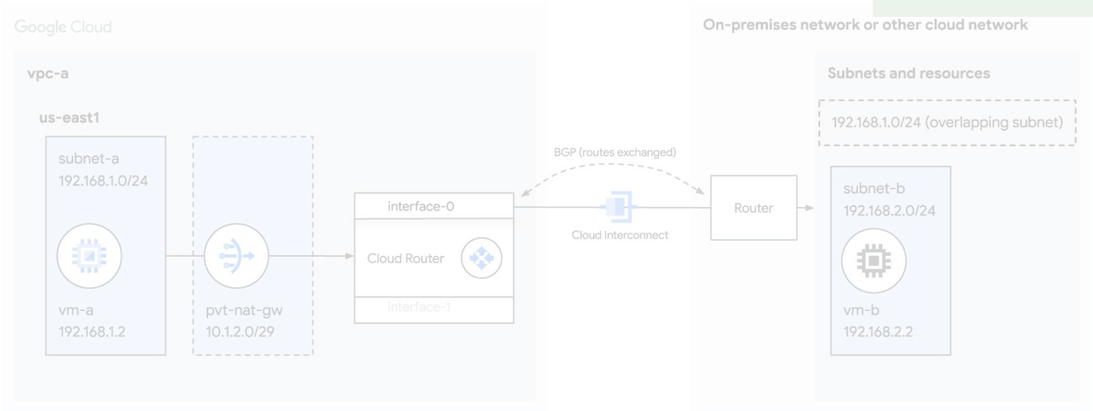
Domain Name Service	Is a collection of connected devices for the purpose of communication. This can be a physical or logical connection
Cloud DNS	Google Cloud DNS offering
Internal DNS	Used internally within a private network
DNS Security Extensions (DNSSEC)	A Google Cloud geographic compute location (Made up of minimum 3 zones)
Hybrid DNS	Google Cloud compute facility within a region

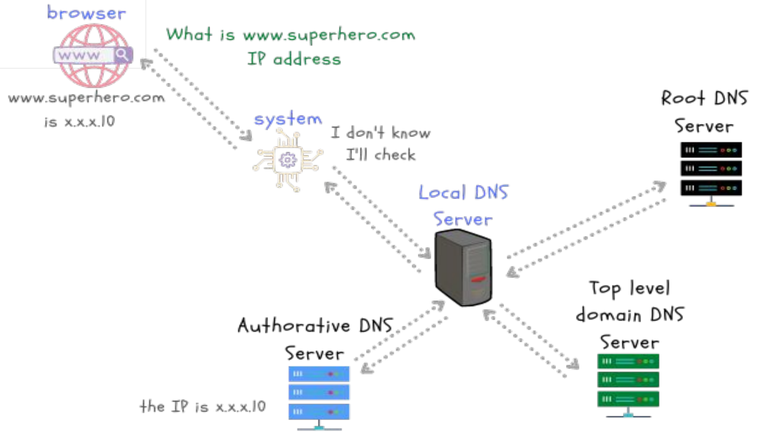
Address resolution Protocol (ARP)	Protocol used to resolve IP address to a MAC/link layer address. Maintained in the ARP table
Reverse ARP (RARP)	This is the inverse of ARP. Used to resolve MAC to IP addresses
Media Access Control address(MAC)	Unique hexadecimal identifier assigned to a network interface controller (NIC) card. Usually a 12 digit hexadecimal number
Network Address Translation (NAT)	Allows private IP ranges to communicate with the internet. Maintains a NAT table of private to public address & port mappings for communications
Cloud NAT	Google Cloud managed NAT service. Also supports private NAT

How can I configure Hybrid DNS?
- See, docs.

How is cloud NAT configured?
- See docs.

Can you use ARP inside a subnet in GCP?
- No, all communication between VMs only happens through the virtual gateway - no ARP between VMs is supported.





Ammett

Routing, Cloud Router, Dynamic Routing, BGP, MPLS

Networking 101 sheet .!!!

Routing	Selecting a path for traffic to flow within internal networks or between different networks
Router	Allows communication between different networks
Cloud Router	Google Cloud router that allows you to dynamically exchange routes between your VPC and on-prem using BGP
Routing table	A repository of all the routing information within a network
Routing modes	These are static or dynamic
Dynamic routing	These routes update automatically to reflect current state
Static routing	These routes are fixed an don't update. They usually have to be manually adjusted
Route Summarization	Used to reduce the number of route advertised to neighbours. See example

next-hop	The address of the next router in the transit route of a packet
Border Gateway Protocol (BGP)	Is the path vector protocol of the internet. Made up of Autonomous systems (AS) and uses TCP port 179
Autonomous System (AS)	Is a collection of connected Internet Protocol (IP) routing prefixes under the control of one or more network operators
Autonomous System Number (ASN)	The number used to identify an AS. This can be 16 bit or 32 bit
External BGP (eBGP)	BGP connection formed between different AS's
Internal BGP (iBGP)	Connection formed within the same AS
Multiple Exit Discriminator (MED)	This a one of several BGP attributes used to influence path selection. This is non transitive and the lower metric wins
AS-path-prepend	This is one of several BGP attributes used to influence path selection. This is a mandatory attribute. The **shorter path** should be preferred

Software Defined Networking (SDN)	A software based networking approach that uses application programming interfaces (API) to communicate with underlying infrastructure to control the network traffic
Multiprotocol label switching (MPLS)	This is a switching method that uses labels instead of IP information to transmit packets across the backbone core at high speed
Bidirectional Forwarding Detection (BFD)	This is a protocol that detects failure quickly on links when enabled. In Google Cloud you can use this feature with Cloud Router

What is Google Cloud Platform's network virtualization stack called?

- **Andromeda**

Max amount of custom BGP routes advertised from Cloud router?

- Presently 200. **See current limit here**

How can you control path selection using BGP attributes in GCP?

- **MED** is supported.
- **AS-path-prepend**

What is the ASN number used in GCP for partner interconnect?

- Presently **ASN 16550** is automatically assigned.

Ammett

Networking for AI

Networking 101 sheet .!!!

Remote Direct Memory Access (RDMA)	Enables remote direct memory access between devices, bypassing host CPU
InfiniBand	High-speed, low-latency fabric for RDMA and cluster communication
RDMA over Converged Ethernet (RoCE)	Protocol enabling RDMA data transfers over Ethernet networks
NCCL	Optimizes communication routines across multiple GPUs and nodes.
NVLink	NVIDIA NVLink is a high-speed GPU interconnect for significantly faster multi-GPU data and control code transfers than traditional PCIe
Tensor Processing Unit (TPU)	Google's custom chip; uses high-speed networks for AI/ML workloads
Graphic Processing Unit (GPU)	Specialized processor for graphics rendering and intensive parallel computations
Lossless	Network designed to prevent packet loss using flow control

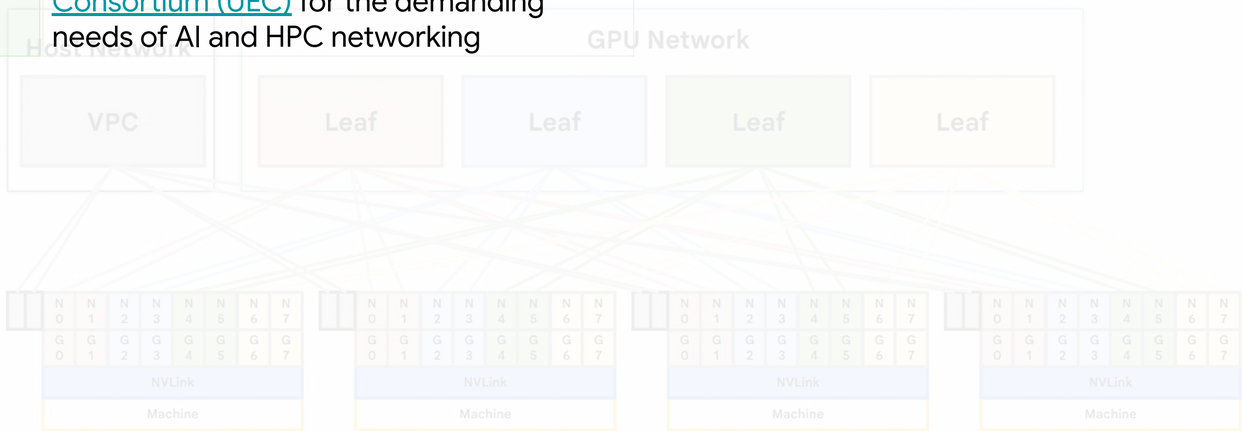
Data Center Quantized Congestion Notification (DCQCN)	DCQCN is a data center algorithm using quantized signals for fast congestion control and sender adjustment.
ECN	Network signal of congestion without dropping packets
PFC	Prevents packet loss by pausing specific traffic priorities
Rail Optimized	Network using dedicated paths ("rails") to maximize RDMA performance with high bandwidth, low latency
Ultra Ethernet	Ultra Ethernet is a new standard being developed by the Ultra Ethernet Consortium (UEC) for the demanding needs of AI and HPC networking

Does Google Support RDMA?
- Yes **here**

How do I privately network Google managed AI products like Vertex?
- Patterns **here**

How do I deploy Do it yourself AI workloads?
- Options **here**

Does Cloud Run support GPUs?
- Sure **here**



Ammett

Data Center networking

Networking 101 sheet .!!!

Optical circuit switching	Maps optical input to output ports to form a connection
Wave division multiplexing	WDM technology allows you to combine multiple optical signal onto a single optical fiber
Clos topology	A non blocking, multistage switching network, used in data center switching fabrics
Merchant switch silicon	Chip made by 3Ps that are sold to any consumers to design a product based on it
Data Center Fabric	This is a Data Center design comprised of leaf and spine switches that allows low latency and scalable data center operations.
Top-of-Rack switches	These switches are placed in the same rack as other equipment to connect all equipment in the rack and to connect to other TOR switches in the DC
OpenFlow	OpenFlow is a communications protocol that allows network controllers to directly program the network forwarding plane

Leaf and Spine	A two layer full mesh topology. Has leaf switches and spine switches
East West traffic	Communication traffic flow between devices in a Data center
North South traffic	In and out communication traffic flow between Data center and outside networks
Colocation	3P Data Center facilities where multiple tenants can house their data center equipment

How can I learn more about Google data centers?

- **Check out Discovering Data Centers**

Where are the data Centers located?

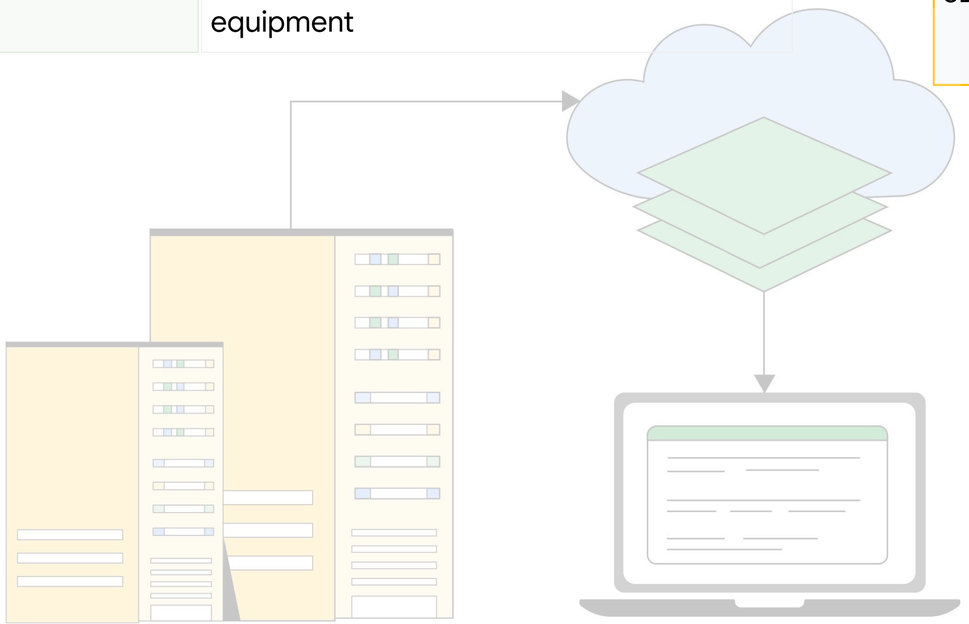
- **Locations**

Are there any interesting publications?

- **Check out Jupiter Evolving**

What is the concept of decentralized SDN?

- **A Decentralized SDN Architecture for the WAN**



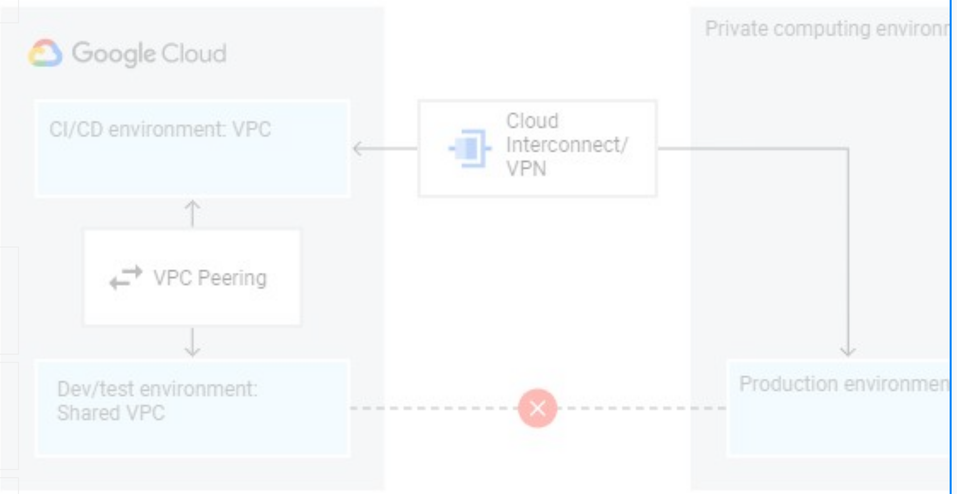
Ammett

Connectivity, Hybrid Connectivity

Networking 101 sheet .!!!

Dedicated Interconnect	Dedicated connection between Google and your private network. Available from 10 GBit/s to 100 GBit/s. Has high availability configurations and you can use multiple links
Partner Interconnect	Highly available connection between Google and your network provisioned through a Service provider. Available from 50 MBit/s to 10 GBit/s. Has high availability configuration and you can use multiple links
Cross-Cloud Interconnect	Dedicated connection between Google and your Cloud providers network. Available from 10 Gbps to 100 Gbps. Has high availability configurations and you can use multiple links
Cross-Site Interconnect	Creates a private Layer 2 connection between sites across Google Global backbone
Virtual private network	This offers a secure connection between two locations over a secure IPSEC tunnel
Cloud VPN	Google Cloud VPN service
Carrier Peering	Google Cloud service that enables you to access Google Workspace and other Google apps via service provider connection
Direct Peering	Google Cloud service that enables you to access google Workspace and other Google apps via direct connection to Google edge
Verified Peering Provider	Verified Peering Providers manage all aspects of the Direct Peering arrangements with Google

Shared VPC	Google Cloud service that allow you to provision and connect host projects, and service projects
VPC Network Peering	GCP service that allow you to connect between different VPC's in the same or separate project and organizations. 1-to-1 peering that is not transitive. Max peering per VPC is 25 connections
Cloud Service Mesh	Google Cloud service that offers a fully managed traffic control plane for service mesh



Shared VPC or **VPC** network peering?

- The best **practices VPC design document** will be helpful.

Are VPNs redundant?

- You have **high availability configuration options.**

Dedicated or Partner Interconnect?

- Depends on several **factors**.

What is Cross-Site Interconnect?

- This ia part of the Cloud WAN offerings. **Learn more**.

Can I connect to other cloud providers?

- Yes check out **Cross-Cloud Interconnect**.

Where can I find GCP Networking reference Architectures?

- **Cloud Architecture Centre**
- **Designing networking docs**

Ammett

Network Security

Networking 101 sheet .!!!

Firewalls	Allow, deny & filter traffic based on rules. Affect ingress and egress traffic
Firewalls rules	Criteria used to deny, allow access in Google Cloud. e.g. IP, source, tag, service account
Cloud NGFW	Is a fully distributed firewall service with advanced protection capabilities,
Distributed denial of service (DDoS)	This is a type of attack that affect availability of service by overloading the systems
VPC service controls	Google Cloud service that allows you the ability to create perimeters that protect resources and data

Cloud identity-Aware Proxy (IAP)	Google Cloud service that controls access to your application and restricts it to only authorized users
Security Command Center	Google Cloud service that has asset discovery, threat detection, and threat prevention components
Cloud IDS	Google Cloud's Intrusion Detection System. Detect and logs potential threats
Secure Access Service Edge (SaSE)	A cloud-native framework that converges networking and security functions
Network Security Integration	Google Cloud offering to seamlessly integrate third-party security appliances with your network
Cloud Armor	Google Cloud service that provides filtering at OSI layer 7 to 4

Tell me about Google Cloud NGFW?
- Cloud NGFW doc

What can help with **DDoS attacks?**
- Cloud Armor, Autoscaling, Load balancing.

What are some Google Cloud security services**?**
- **Security and Identity products**

How are firewall rules read?
- From lowest 0 to highest 65535.

How does Cloud firewall handle connect state?
- These are stateful firewalls

Traffic handling, Load balancing, Content Delivery

Networking 101 sheet .!!!

Load balancer (LB)	A load balancer is a device or software application that acts as a traffic director, distributing incoming network traffic across multiple servers
Application Load Balancer	These support Layer 7 HTTP/HTTP(S) traffic
Network Load Balancer	These support Layer 4 traffic for load balancing
Internal (LB)	Handles private traffic load balancing within your VPC not exposed to the internet
External (LB)	Exposes the LB to the public with an external IP address
Network Endpoint Group (NEG)	Network Endpoint Group are used to attach a backend pool to a load balancing service
Ingress	Allows HTTP(S) traffic connections to a kubernetes cluster

GKE Inference Gateway	GKE Inference Gateway is an extension to the GKE Gateway that provides optimized routing and load balancing for serving generative Artificial Intelligence (AI) workloads
Content Delivery Network (CDN)	Caches content at a distribution endpoint closest to customer
Cloud CDN	Google Cloud's standard web acceleration CDN offering
Media CDN	Google Cloud's media delivery solution. Can handle high throughput media like streaming

What is a Global LB?
- Operates globally and can load balance and spill over traffic between regions.

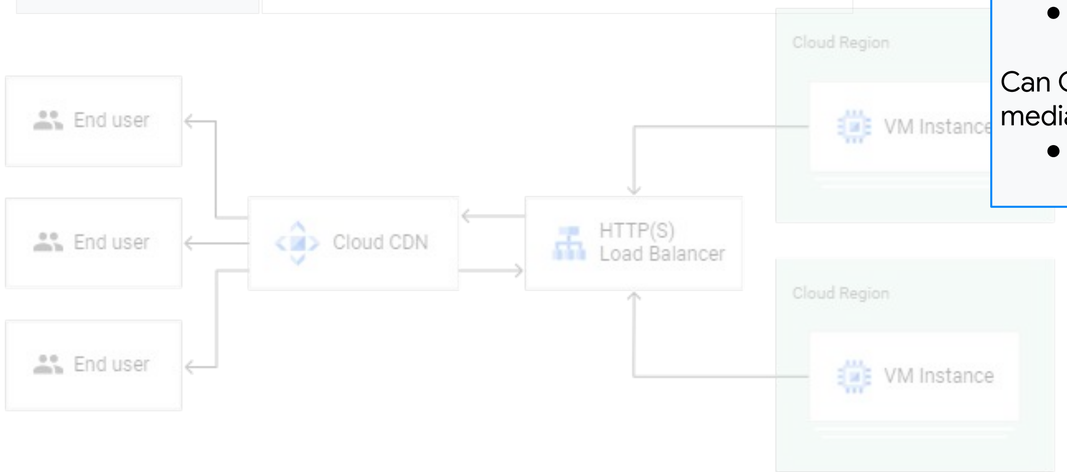
What is a regional LB?
- Operate in the region it is created.

What type of LB exist in Google Cloud?
- See **summary of LB**

How does CDN reduce latency?
- By returning traffic to the user from the closest networking point.

What is Google LB software called.
- It's called Maglev

Can Google Cloud support streaming media?
- Yes, Media CDN supports this



Ammett

Troubleshooting & Monitoring

Networking 101 sheet .!!!

ping	This tool checks the availability of host by using Internet Control Message Protocol
traceroute	Shows the hops between source and destination
nslookup	Allows you to resolve IP from host name
dig	A flexible command-line tool for querying DNS name servers
ipconfig/ ifconfig	Show the IP address, subnet and gateway information of a system
netstat	Displays active network connections, listening ports, Ethernet statistics, the IP routing table, IPv4 and IPv6 statistics.
My Traceroute (MTR)	Is an application that combines the functions of the traceroute and ping programs in one network diagnostic tool
tcpdump	tcpdump is a command-line packet analyzer
wireshark	Wireshark is a packet inspector.
lsof	Is a powerful utility used in Unix-like systems to identify and display information about files that are currently opened by processes

Flow logs	This Google Cloud service tells you about the traffic flow in your VPC
Network Intelligence Center	Google Cloud service that provides you with a few tools to gain visibility into your network
Cloud Audit Logs	Google Cloud logs that provide information on activities in your cloud. A few are; Admin Activity, Data Access, system events and Policy denied, audit logs
Cloud Operations	Google Cloud tool that allows you to monitor, log and trace application and systems in your environments
Packet Mirroring	Packet Mirroring clones the traffic on the network and forwards it for examination. See more here
Service Directory	A Google Cloud managed service that gives you a single place to publish, discover, and connect services

```
C:\Users\[redacted]>nslookup google.com
Server:  mynetwork
Address:  192.168.2.1

Non-authoritative answer:
Name:    google.com
Addresses:  2607:f8b0:400b:803::200e
          142.251.41.78
```

What protocol does ping use?

- Internet Control Message Protocol (ICMP)

Are flow logs enabled by default on GCP?

- This has to be enabled by user

What are the component of Network Intelligence Center?

- This is made up of
  - Network Topology
  - Connectivity test
  - Performance dashboard
  - Firewall Insights

```
Pinging www.google.com [142.251.32.68] with 32 bytes of data:
Reply from 142.251.32.68: bytes=32 time=3ms TTL=115
Reply from 142.251.32.68: bytes=32 time=5ms TTL=115
Reply from 142.251.32.68: bytes=32 time=5ms TTL=115
Reply from 142.251.32.68: bytes=32 time=3ms TTL=115
```

Ammett

What happens when you type www.google.com in a browser

Networking 101 sheet .!!!

1	Open browser type www.google.com
2	Browser cache is checked to see if IP information was cached
3	If #2 has no infor system checks host file for address information
4	If #3 has no info, system queries local DNS
5	If #4 has no info query sent to Service Provider (SP) DNS
6	If SP has no info query sent to Root level DNS
7	Root level returns the Top level DNS
8	Top level DNs returns the Authoritative DNS who has the record
9	Authoritative DNS returns a DNS response with the IP address and DNS TTL information
10	The system now has the IP address and initiates a TCP connection to the server
11	TCP three-way handshake takes place, TLS Secure authentication process takes place and secure connection is setup.
12	HTTP(S)/HTML process begins to return information as required