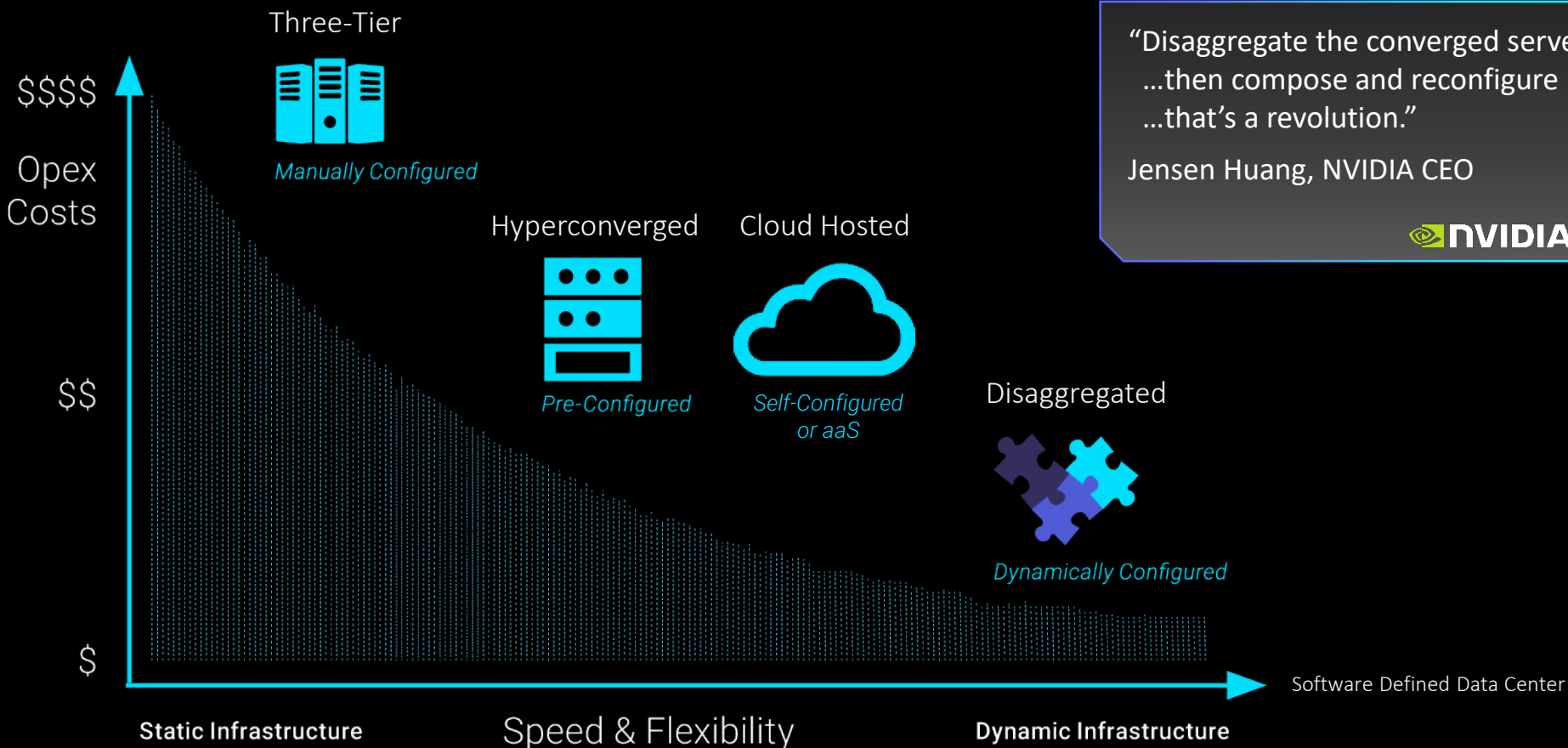# Breaking out of the Physical: Composable infrastructure of the software defined server

Scott Houppermans

Senior Solutions Architect – Federal & Enterprise
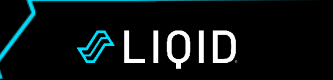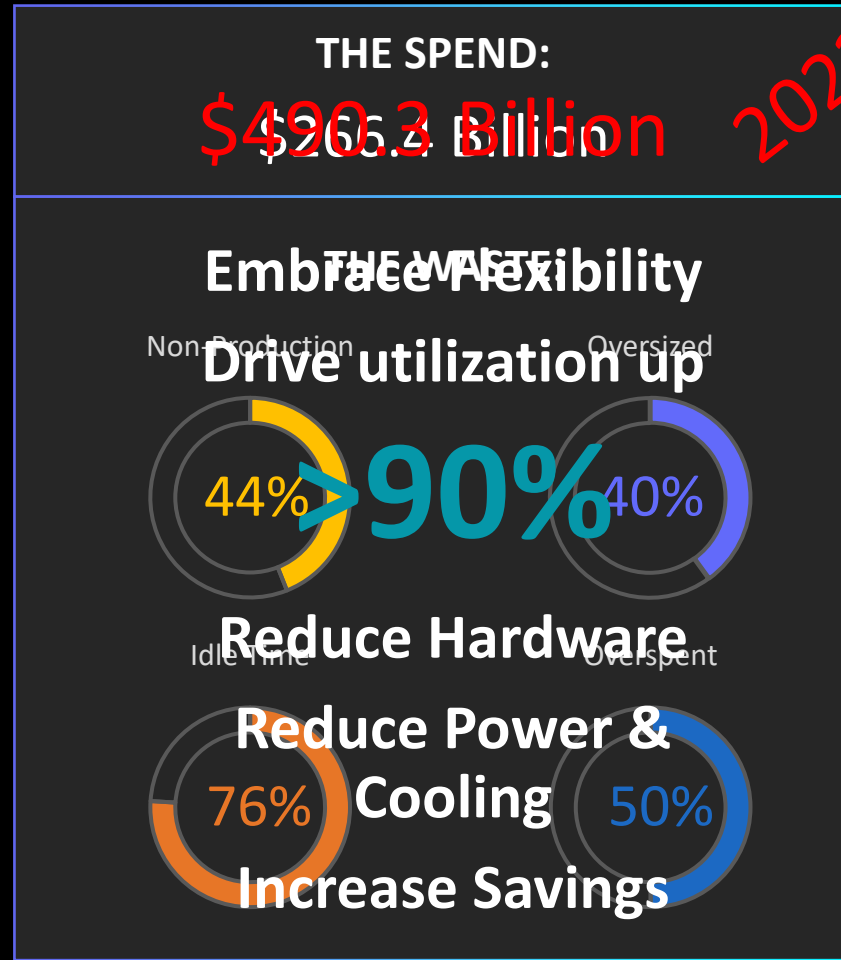
Datacenter Transformation

Opex Costs

$$$$

$$

$

Three-Tier

Manually Configured

Hyperconverged

Pre-Configured

Cloud Hosted

Self-Configured or aaS

Disaggregated

Dynamically Configured

Static Infrastructure

Speed & Flexibility

Dynamic Infrastructure

Software Defined Data Center

"Disaggregate the converged server …then compose and reconfigure …that's a revolution."

Jensen Huang, NVIDIA CEO

NVIDIA

Gartner.

Source: Gartner

LIQID

Worldwide Cloud Spend & Utilization Rate

THE SPEND:

$296.4 Billion

$490.3 Billion 2022

THE WASTE:

Embrace Flexibility

Drive utilization up

Non-Production

Oversized

44% >90% 40%

Idle Time

Overspent

Reduce Hardware

Reduce Power & Cooling

76% 50%

Increase Savings

Source: https://bit.ly/3uYLoUs
https://tinyurl.com/4fy93zfp

LIQID

Cloud Service Complexity

COMPUTE

Service	Description
Cloud Functions	Event-driven serverless functions
App Engine	Managed app platform
Cloud Run	Serverless for containerized applications
Kubernetes Engine (GKE)	Managed Kubernetes/containers
Compute Engine	VMs, GPUs, TPUs, Disks
Bare Metal Solution	Hardware for specialized workloads
Preemptible VMs	Short-lived compute instances
Shielded VMs	Hardened VMs
Sole-tenant Nodes	Dedicated physical servers
VMware Engine	VMware on Compute Engine

STORAGE

Service	Description
Cloud Filestore	Managed NFS server
Cloud Storage	Multi-class multi-region object storage
Persistent Disk	Block storage for VMs
Local SSD	VM locally attached SSDs

DATABASE

Service	Description
Cloud Bigtable	Petabyte-scale, low-latency, non-relational
Cloud Firestore	Serverless NoSQL document DB
Cloud Memorystore	Managed Redis and Memcached
Cloud Spanner	Horizontally scalable relational DB
Cloud SQL	Managed MySQL,PostgreSQL,SQL Server
Database Migration Service	Migrate to Cloud SQL
DB Insights	SQL Inspector

DATA AND ANALYTICS

Service	Description
Query	Data warehouse/analytics
Query BI Engine	In-memory analytics engine
Query ML	Query model training/serving
Composer	Managed workflow orchestration service
Data Fusion	Graphically manage data pipelines
Dataflow	Stream/batch data processing
Dataprep	Visual data wrangling
Dataproc	Managed Spark and Hadoop
Pub/Sub	Global real-time messaging
Data Catalog	Metadata management service
Data Studio	Collaborative data exploration/dashboarding
Looker	Enterprise BI and Analytics

HYBRID AND MULTI-CLOUD

Service	Description
Anthos	Enterprise hybrid/multi-cloud platform
Anthos Clusters	Hybrid/on-prem Kubernetes Engine
Anthos Config Management	Policy and security automation
Anthos Service Mesh	Managed service mesh (Istio)
Cloud Run for Anthos	Serverless development for Anthos
GCP Marketplace for Anthos	Pre-configured containerized apps
Migrate for Anthos	Migrate VMs to Kubernetes Engine
Operations	Monitoring, logging, troubleshooting
Cloud Build	Continuous integration/delivery platform
Traffic Director	Service mesh traffic management
Apigee API Management	API management, development, security

API PLATFORM AND ECOSYSTEMS

Service	Description
API Analytics	API metrics
API Monetization	Monetize APIs
Apigee API Platform	Develop, secure, monitor APIs
API Gateway	Fully managed API Gateway
Apigee Hybrid	Manage hybrid/multi-cloud API environments
Apigee Sense	API protection from attacks
Cloud Endpoints	Cloud API gateway
Cloud Healthcare API	Healthcare system GCP interoperability
Developer Portal	API management portal
GCP Marketplace	Partner & open source marketplace
AppSheet	No-code App creation

MAPS PLATFORM

Service	Description
Directions API	Get directions between locations
Distance Matrix API	Multi-origin/destination travel times
Geocoding API	Convert address to/from coordinates
Geolocation API	Derive location without GPS
Maps Embed API	Display iframe embedded maps
Maps JavaScript API	Dynamic web maps
Maps SDK for Android	Maps for Android apps
Maps SDK for iOS	Maps for iOS apps
Maps Static API	Display static map images

AI/ML

Service	Description
AI Platform Data Labeling	Data labeling by humans
AI Platform Deep Learning VMs	Preconfigured VMs for deep learning
AI Platform Deep Learning Containers	Preconfigured containers for deep learning
AI Platform Notebooks	Managed JupyterLab notebook instances
AI Platform Pipelines	Hosted ML workflows
AI Platform Predictions	Autoscaled model serving
AI Platform Training	Distributed AI training
AI Platform	Managed platform for ML
AutoML Natural Language	Custom text models
AutoML Tables	Custom structured data models
AutoML Translation	Custom domain-specific translation
AutoML Video Intelligence	Custom video annotation models
AutoML Vision	Custom image models
Cloud Natural Language API	Text parsing and analysis
Cloud Speech-To-Text API	Convert audio to text
Cloud Talent Solutions API	Job search with ML
Cloud Text-To-Speech API	Convert text to audio
Cloud TPU	Hardware acceleration for ML
Cloud Translation API	Language detection and translation
Cloud Video Intelligence API	Scene-level video annotation
Cloud Vision API	Image recognition and classification
Contact Center AI	AI in your contact center
Dialogflow	Create conversational interfaces
Document AI	Analyze, classify, search documents
Explainable AI	Understand ML model predictions
Recommendations AI	Create custom recommendations
Vision Product Search	Visual search for products

NETWORKING

Service	Description
Carrier Peering	Peer through a carrier
Direct Peering	Peer with GCP
Dedicated Interconnect	Dedicated private network connection
Partner Interconnect	Connect on-prem network to VPC
Cloud Armor	DDoS protection and WAF
Cloud CDN	Content delivery network
Cloud DNS	Programmable DNS serving
Cloud Load Balancing	Multi-region load distribution/balancing
Cloud NAT	Network address translation service
Cloud Router	VPC/on-prem network route exchange (BGP)
Cloud VPN (HA)	VPN (Virtual private network connection)
Network Service Tiers	Price vs performance tiering
Network Telemetry	Network telemetry service
Traffic Director	Service mesh traffic management
Cloud Service Mesh	Service-aware network management
Virtual Private Cloud	Software defined networking
VPC Service Controls	Security perimeters for API-based services
Network Intelligence Center	Network monitoring and topology

GAMING

Service	Description
Cloud Game Servers	Orchestrate Agones clusters

INTERNET OF THINGS (IOT)

Service	Description
Cloud IoT Core	Manage devices, ingest data

IDENTITY AND SECURITY

Service	Description
Access Transparency	Audit cloud provider access
Assured Workloads	Workload compliance controls
Binary Authorization	Kubernetes deploy-time security
Certificate Authority Service	Managed private CAs
Cloud Asset Inventory	All assets, one place
Cloud Audit Logs	Audit trails for GCP
Cloud DLP	Classify and redact sensitive data
Cloud HSM	Hardware security module service
Cloud EKM	External keys you control
Cloud IAM	Resource access control
Cloud Identity	Manage users, devices & apps
Cloud Identity-Aware Proxy	Identity-based app access
Cloud KMS	Hosted key management service
Cloud Resource Manager	Cloud project metadata management
Security Command Center	Security management & data risk platform
Cloud Security Scanner	App engine security scanner
Confidential Computing	Encrypt data in-use
Context-aware Access	End-user attribute-based access control
Event Threat Detection	Scans for suspicious activity
Managed Service for Microsoft Active Directory	Managed Microsoft Active Directory
Secret Manager	Store and manage secrets

IDENTITY AND SECURITY (CONT.)

Service	Description
Security Key Enforcement	Two-step key verification
Shielded VMs	Hardened VMs
Titan Security Key	Two-factor authentication (2FA) device
VPC Service Controls	VPC data constraints

MANAGEMENT TOOLS

Service	Description
Cloud APIs	APIs for cloud services
Cloud Billing API	Programmatically manage GCP billing
Cloud Billing	Billing and cost management tools
Cloud Console	Web-based management console
Cloud Deployment Manager	Templated infrastructure deployment
Cloud Mobile App	iOS/Android GCP manager app
Private Catalog	Internal Solutions Catalog
Cloud Debugger	Live production debugging
Error Reporting	App error reporting
Cloud Logging	Centralized logging
Cloud Monitoring	Infrastructure and application monitoring
Cloud Profiler	CPU and heap profiling
Cloud Trace	App performance insights
Transparent SLIs	Monitor GCP services

DEVELOPER TOOLS

Service	Description
Cloud Build	Continuous integration/delivery platform
Cloud Code for IntelliJ	IntelliJ GCP tools
Cloud Code for VS Code	VS Code GCP tools
Cloud Code	Cloud native IDE extensions
Cloud Tools for Eclipse	Eclipse GCP tools
Cloud Tools for Visual Studio	Visual Studio GCP tools
Gradle App Engine Plugin	Gradle App Engine plugin
Maven App Engine Plugin	Maven App Engine plugin
Cloud SDK	CLI for GCP
Cloud Shell	Browser-based terminal/CLI
Artifact Registry	Universal package manager
Cloud Source Repositories	Hosted private git repos
Container Registry	Private container registry/storage
Container Analysis	Automated security scanning
Eventarc	Event-driven Cloud Run services
Cloud Scheduler	Managed cron job service
Cloud Tasks	Asynchronous task execution
Cloud Workflows	HTTP services orchestration

MIGRATION TO GCP

Service	Description
BigQuery Data Transfer Service	Bulk import analytics data
Cloud Data Transfer	Data migration tools/CLI
Transfer Appliance	Rentable data transport box
Storage Transfer Service	Online/on-premises data transfer
Migrate for Anthos	Migrate VMs to GKE containers
Migrate for Compute Engine	Compute Engine migration tools
Migrate from Amazon Redshift	Migrate from Redshift to BigQuery
Migrate from Teradata	Migrate from Teradata to BigQuery
VM Migration	VM migration tools
Cloud Foundation Toolkit	Infrastructure as Code templates
KF	Cloud Foundry to Kubernetes

ADDITIONAL RESOURCES

Cloud Home Page
Cloud Blog
Cloud Platform Podcast
Kubernetes Podcast
Cloud Open Source
GCP Medium Publication
Apigee Blog
Firebase Blog
Workspace Developers Blog
Workspace GitHub
Workspace Twitter
Cloud Certifications
Cloud System Status
Cloud Training
Developers Blog
Maps Platform Blog
Open Source Blog
Security Blog
Kaggle Home Page
Kubernetes Blog
Regions and Network Map
DORA - Software & Delivery Research

MAPS PLATFORM (CONT.)

Service	Description
Maps SDK for Unity	Unity SDK for games
Maps URLs	URL scheme for maps
Places API	Rest-based Places features
Places Library, Maps JS API	Places features for web
Places SDK for Android	Places features for Android
Places SDK for iOS	Places feature for iOS
Roads API	Convert coordinates to roads
Street View Static API	Static street view images
Street View Service	Street view for JavaScript
Time Zone API	Convert coordinates to timezone

WORKSPACE

Service	Description
Admin SDK	Manage Workspace resources
AMP for Email	Dynamic interactive email
Apps Script	Extend and automate everything
Calendar API	Create and manage calendars
Classroom API	Provision and manage classrooms
Cloud Search	Unified search for enterprise
Docs API	Create and edit documents
Drive Activity API	Retrieve Drive activity
Drive API	Read and write files
Drive Picker	Drive file selection widget
Email Markup	Interactive email using schema.org
Workspace Add-ons	Extend Suite apps
Workspace Marketplace	Storefront for integrated applications
mail API	Enhance mail
Hangouts Chat Bots	Conversational bots in chat
People API	Manage user's Contacts
Sheets API	Read and write spreadsheets
Slides API	Create and edit presentations
Task API	Search, read & update Tasks
Vault API	Manage your organization's eDiscovery

MOBILE

Service	Description
Cloud Firestore	Document store and sync
Cloud Functions for Firebase	Event-driven serverless applications
Cloud Storage for Firebase	Object storage and serving
Crashlytics	Crash reporting and analytics
A/B Testing	Create A/B test experiments
App Distribution	Trusted tester early access
Authentication	Drop-in authentication
Cloud Messaging	Send device notifications
Dynamic Links	Link to app content
Extensions	Pre-packaged development solutions
Hosting	Web hosting with CDN/SSL
In-App Messaging	Send in-app contextual messages
Performance Monitoring	App/web performance monitoring
Predictions	Predict user targeting
Realtime Database	Real-time data synchronization
Remote Config	Remotely configure installed apps
Test Lab	Mobile testing device farm
Analytics	Mobile app analytics
ML Kit	ML APIs for mobile

LIQID

Dynamic Datacenter Infrastructure

Legacy Infrastructure

Static Servers
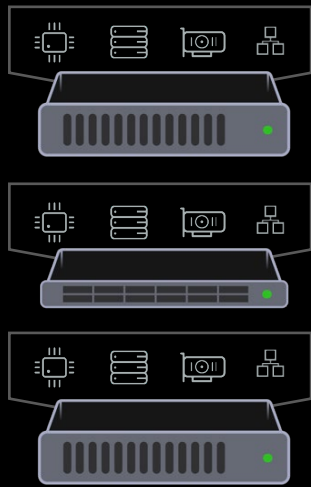
Statically Configured

Modern Infrastructure
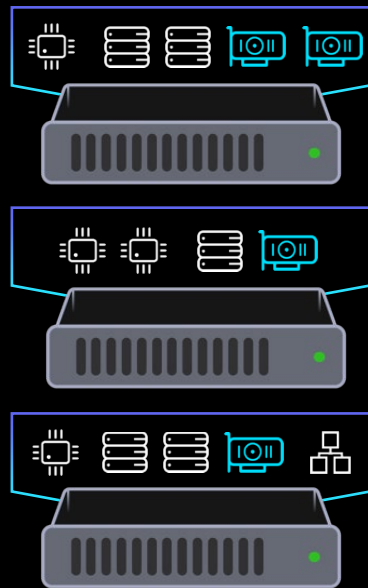
Disaggregated Resource Pools

Dynamically Configured Servers

Servers
Intel / AMD / ARM

Storage
NVMe Flash / Optane

Accelerators
GPU / FPGA / DPU

Networking
NIC
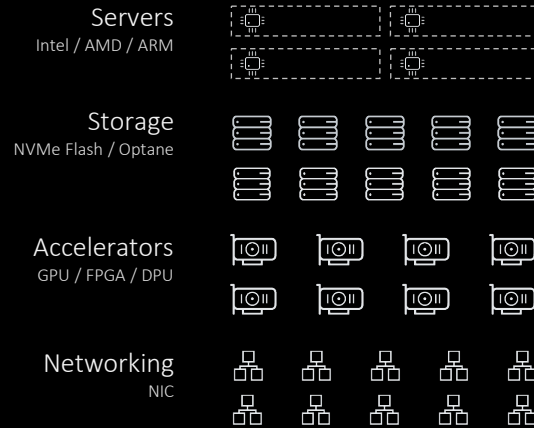
Dynamically Configurable Software Defined Hardware

LIQID

Use Case: GPU Workload Sharing

Daytime Workload

Nighttime Workload

GPU Pool

7am to 4pm
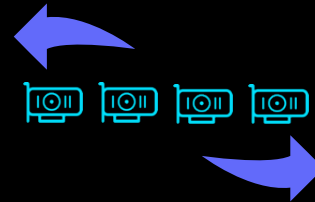
4pm to 7am

Radically Improve
GPU Utilization

LIQID
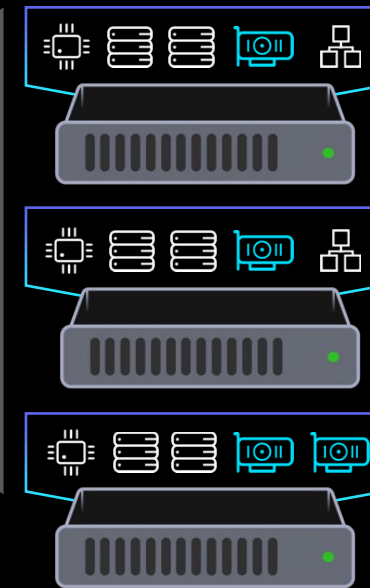
Use Case: GPU On-Demand/HPC Cloud Provisioning

Statically Configured GPUs

Dynamic Configurable GPUs

Composable GPU On-Demand
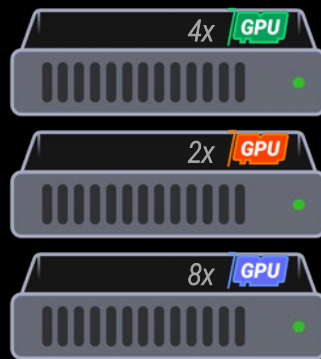
- Limited Scalability
- Inflexible
- Poor Resource Utilization
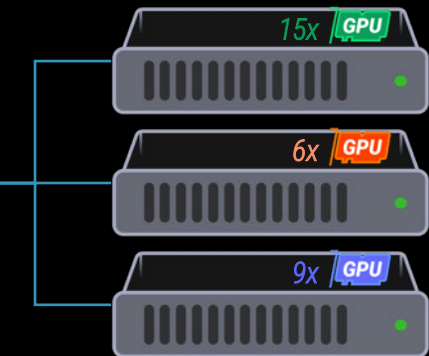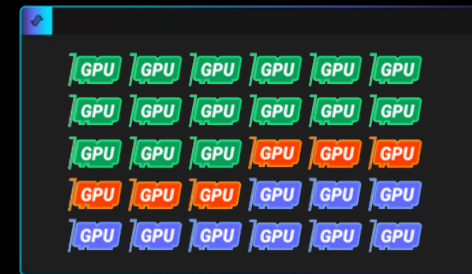
- High GPU Density
- Rapid Deployment and Scaling
- Increased Resource Utilization

LIQID

- Recent Higher Ed Installation
  - 24 Dell C6525 servers (2U/ 4 node)
  - 56 A100 80GB GPUs
    - Expandable for additional GPUs
  - Liqid IO Accelerators w Intel Optane PS

- Recent DoD installations
  - Three HPC clusters
  - More than 2000 compute nodes
  - 892 Nvidia A100 GPUs

LIQID

Where do we go from here?

LIQID

Compute Express Link

Rapid expansion of cloud computing

Growth of AI and analytics

Industry demands faster data
processing, higher performance, lower latency

LIQID

Compute Express Link

New class of CPU to device

interconnect for heterogenous systems

- PCIe Gen5 physical & electrical paths
- CPU/Memory/Device sharing
- Very tight latency tolerances for disaggregated memory

LIQID

Compute Express Link

Features	CXL 1.0 / 1.1	CXL 2.0	CXL 3.0
Release date	2019	2020	1H 2022
Max link rate	32GTs	32GTs	64GTs
Flit 68 byte (up to 32 GTs)	✓	✓	✓
Flit 256 byte (up to 64 GTs)			✓
Type 1, Type 2 and Type 3 Devices	✓	✓	✓
Memory Pooling w/ MLDs		✓	✓
Global Persistent Flush		✓	✓
CXL IDE		✓	✓
Switching (Single-level)		✓	✓
Switching (Multi-level)			✓
Direct memory access for peer-to-peer			✓
Enhanced coherency (256 byte flit)			✓
Memory sharing (256 byte flit)			✓
Multiple Type 1/Type 2 devices per root port			✓
Fabric capabilities (256 byte flit)			✓

CXL Consortium 2022

LIQID

CXL 3.0 – *The* building block for disaggregation

"Modern datacenters require heterogenous and composable architectures to support compute intensive workloads for applications such as Artificial Intelligence and Machine Learning – and we continue to evolve CXL technology to meet industry requirements…"
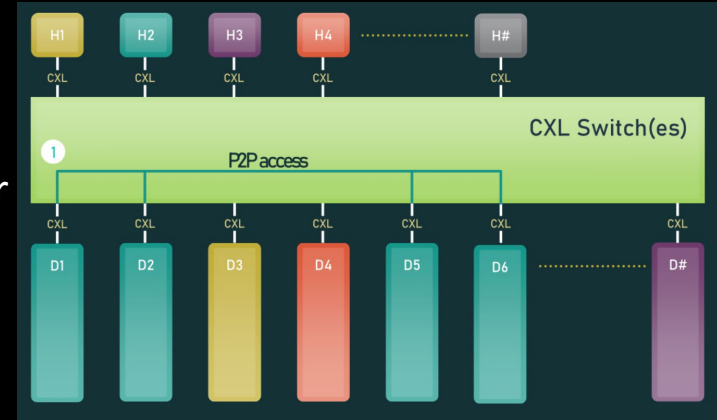
Siamak Tavallaei, CXL Consortium President Aug 2022
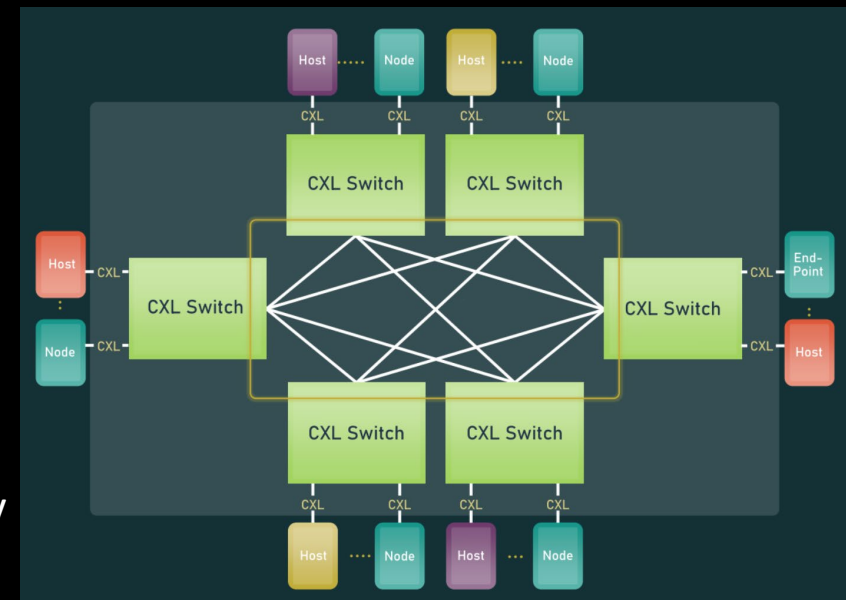
Device Peer 2 Peer memory sharing

CXL Consortium 2022
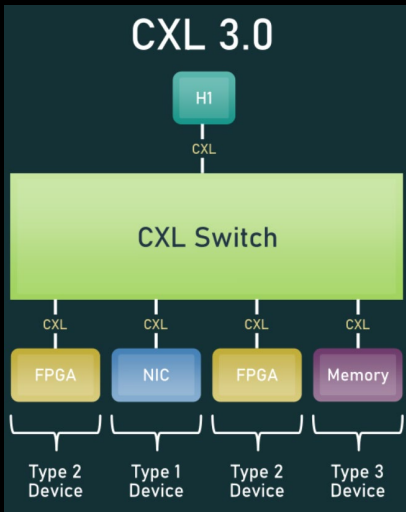
Multi-device to host

CXL Consortium 2022

Node agnostic fabric connections
- Hosts
- Devices w Cache
- Devices w Cache + Memory
- Devices w Memory

CXL Consortium 2022

Thank You