



# Welcome: Welsh Azure User Group

Thursday, May 20, 2021

Mark O'Neill  
Customer Engagement Team



Microsoft Technology Centers

# Datacenter Experience - Virtual



Please let us know if you have any special accommodations, we can help



We will take breaks, but if you need an extra one, please let us know!



If you can use a headset instead of a speaker phone that will generally allow all participants to hear you better



Please use Video if you have it, makes it fun for everyone!



Please say your name the first time you speak and if you have not spoken for a while



If you have a question you can also post it in the chat. We will be monitoring (if possible) the chat and make sure we address it.



Please mute yourself when you are not speaking, if your environment has background noise that can be disruptive.



# Topics

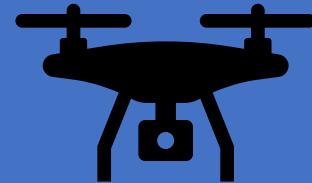
Global  
Reach



DC  
Generations



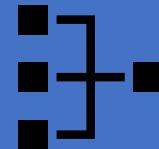
Datacenter 360 site examples



Inside  
Servers



Inside  
Network



Inside  
Storage



Datacenter  
Security



Microsoft  
Sustainability



What is  
Next?



## Global Network –

Dedicated Microsoft  
Cloud services  
backbone

185+ PoP / edge sites  
165k+ miles of fiber

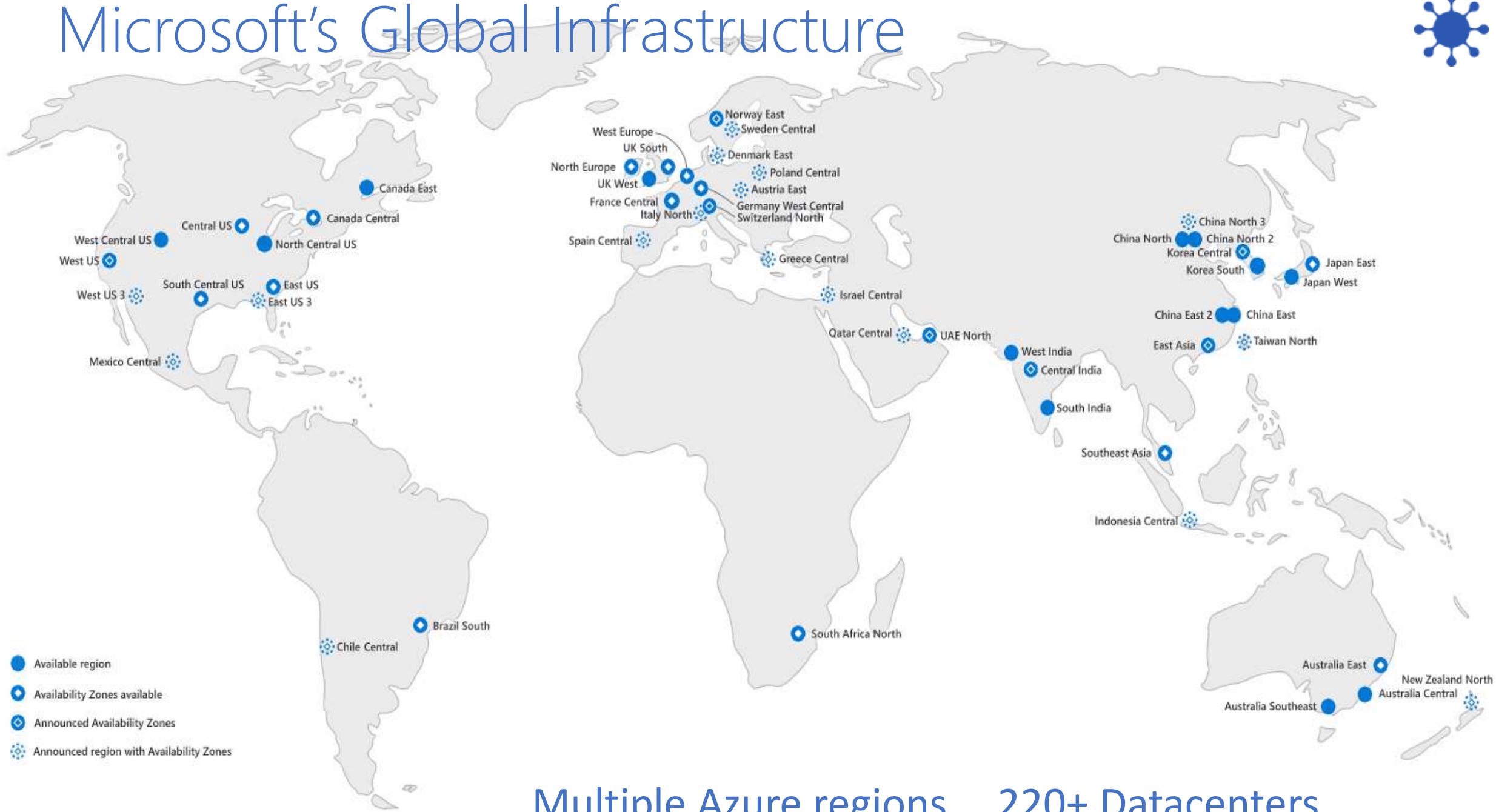


- Show coming soon
- Geographies
  - All regions
  - Region with Availability Zones
  - Region
- Networking
  - Network PoP
  - WAN links
- Ground stations

**Each Azure geography -**  
contains one or more regions  
and helps customers meet  
specific data residency and  
compliance requirements

220+ datacenters

# Microsoft's Global Infrastructure



Multiple Azure regions

220+ Datacenters

# Reliability with Microsoft Azure

**99.9% SLA (3 9s)**  
VM availability (monthly)

**Single VM**   
with premium/ultra disks



**99.999999999% (11 9s)**  
Storage durability (annually)

**Locally Redundant Storage (LRS)\*** 

-  Virtual machine | Compute options
-  Storage account | Storage options
- \* Optional: Azure Backup
-  Link

**99.95% SLA (3½ 9s)**  
VM availability (monthly)

**Availability Set (2+ VMs)**   
within a datacenter

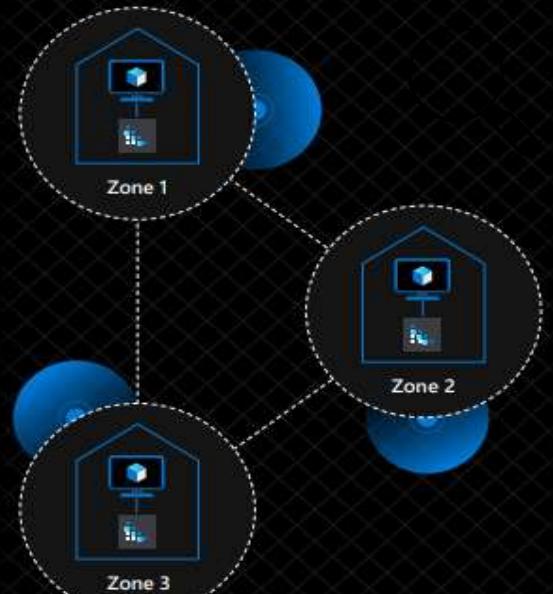


**99.999999999% (11 9s)**  
Storage durability (annually)

**Locally Redundant Storage (LRS) with Azure Managed Disks\*** 

**99.99% SLA (4 9s)**  
VM availability (monthly)

**Availability Zones (2+ VMs)**   
within a region



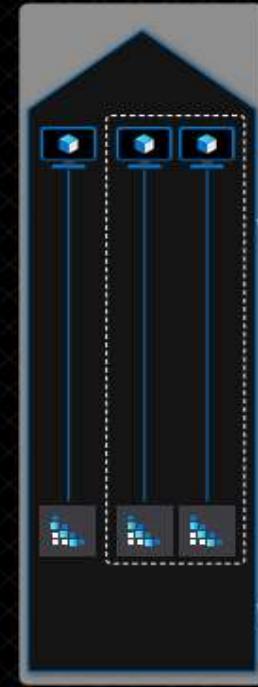
**99.999999999% (12 9s)**  
Storage durability (annually)

**Zone-Redundant Storage (ZRS)** 

**Industry-Leading**  
RPO and RTO

**Azure Site Recovery** 

**Primary region**



**Failover**

Azure Site Recovery

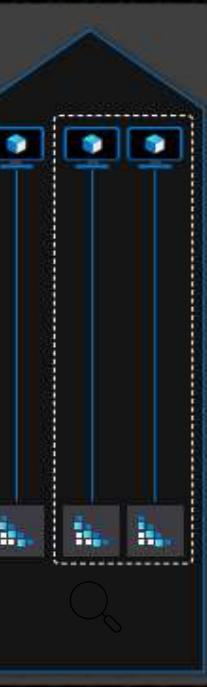
**Failback**

**Failover**

Storage replication

**Failback**

**Secondary region**



**99.9999999999999% (16 9s)**  
Storage durability (annually)

**Geo-Redundant Storage (GRS)\*** 

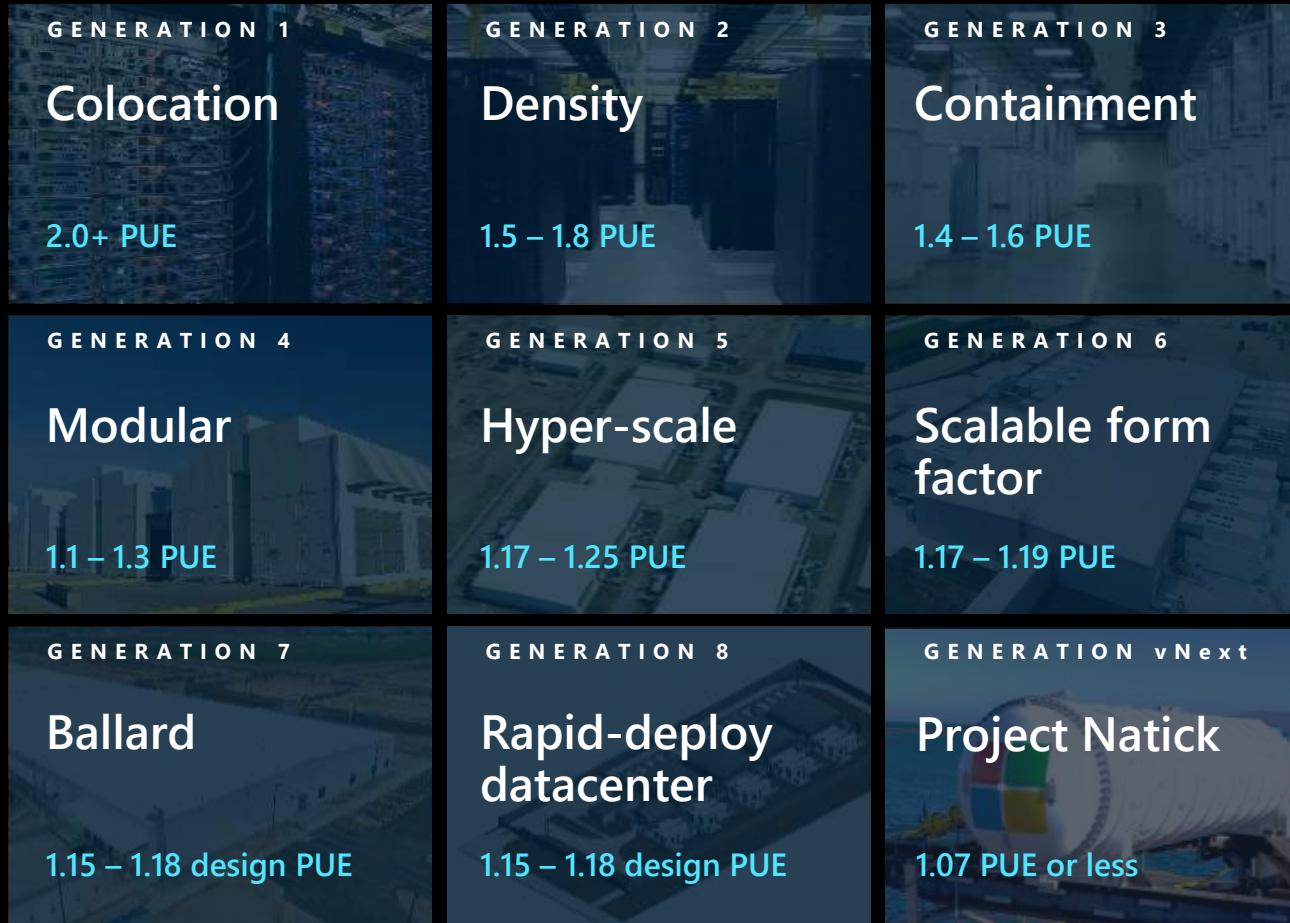
# Datacenter generations 1989-2021



# Datacenter generations 1989-2021

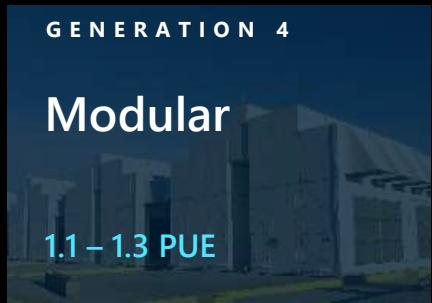
## Innovation aspects:

- Speed to market
- Operational efficiency
  - Intelligent operations
- Cost management
- Environmental impact
  - Footprint
  - Water usage (WUE)
- Scale – flexibility – re-use
- Energy
  - Power Usage (PUE)



**PUE = Total Facility Power / IT Equipment Power**

# Datacenter generations



## FUTURE

### Project Natick

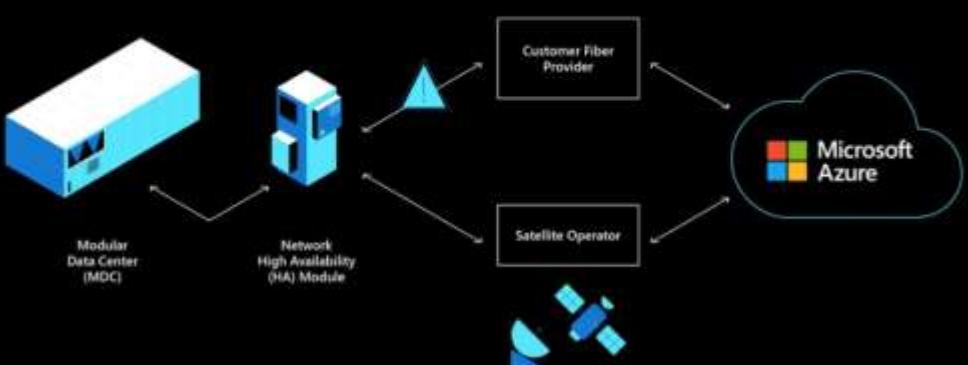
- ✓ Rapid deployment
- ✓ Close to population centers
- ✓ High energy density (40 kW/rack)
- ✓ 5 MW platforms
- ✓ Resistant to hurricanes, solar storms, earthquakes
- ✓ 1.07 or less PUE

# Azure MDC + Azure Space



## MDC SATCOM for Resiliency

Microsoft's Network High Availability (HA) Module provides SATCOM for resiliency through partnered satellite operators.



Azure Space + Azure MDC = cloud-powered innovation on and off the planet.

Azure MDC = cloud-powered innovation even offline.

<https://youtu.be/x2IVXLoLSro>



Amsterdam – West Europe Region



Quincy, WA – West US2 Region



Dublin – North Europe Region

# Singapore



# Efficient cooling



Purpose-built  
infrastructure



vmware

ORACLE

NetApp

CRAY



# Inside cloud servers

- Microsoft is bringing hardware design and development into the open, making way for unprecedented innovation that benefits everyone.

# General compute servers

GEN2



INTEL GEN7



AMD GEN7



# General compute servers



## Gen2

**Processor** 2 x 6 core  
2.1 GHz

**Memory** 32 GiB

**Hard Drive** 6 x 500 GB

**SSD** None

**NIC** 1 Gb/s

## Intel Gen7

**Processor** 2 x 26 core  
Cascade Lake

**Memory** 576 GB DDR4

**Hard Drive** None

**SSD** 7 x 960 GB M.2  
NVMe

**NIC** 50 Gb/s + FPGA

## AMD Gen7

**Processor** 2 x 32 core  
Rome

**Memory** 768 GB DDR4

**Hard Drive** None

**SSD** 7 x 960 GB M.2 NVMe

**NIC** 50 Gb/s + FPGA

# Memory optimized servers



## Godzilla

**Processor** 2 x 16 Core 2.0 GHz

**Memory** 512 GB

**Hard Drive** None

**SSD** 9 x 800 GB

**NIC** 40 Gb/s

## Godzilla

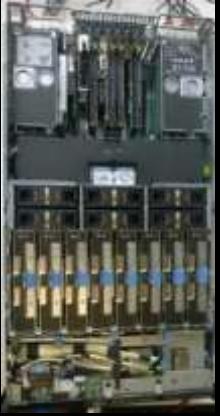
32 Cores  
512GB RAM

RAM



Cores

# Memory optimized servers

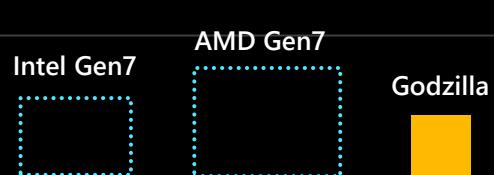


## Beast

Processor	4 x 18 Core 2.5 GHz
Memory	4096 GB
Hard Drive	None
SSD	4 x 2 TB NVMe, 1 x 960 GB SATA
NIC	40 Gb/s

## Beast

72 Cores  
4TB RAM



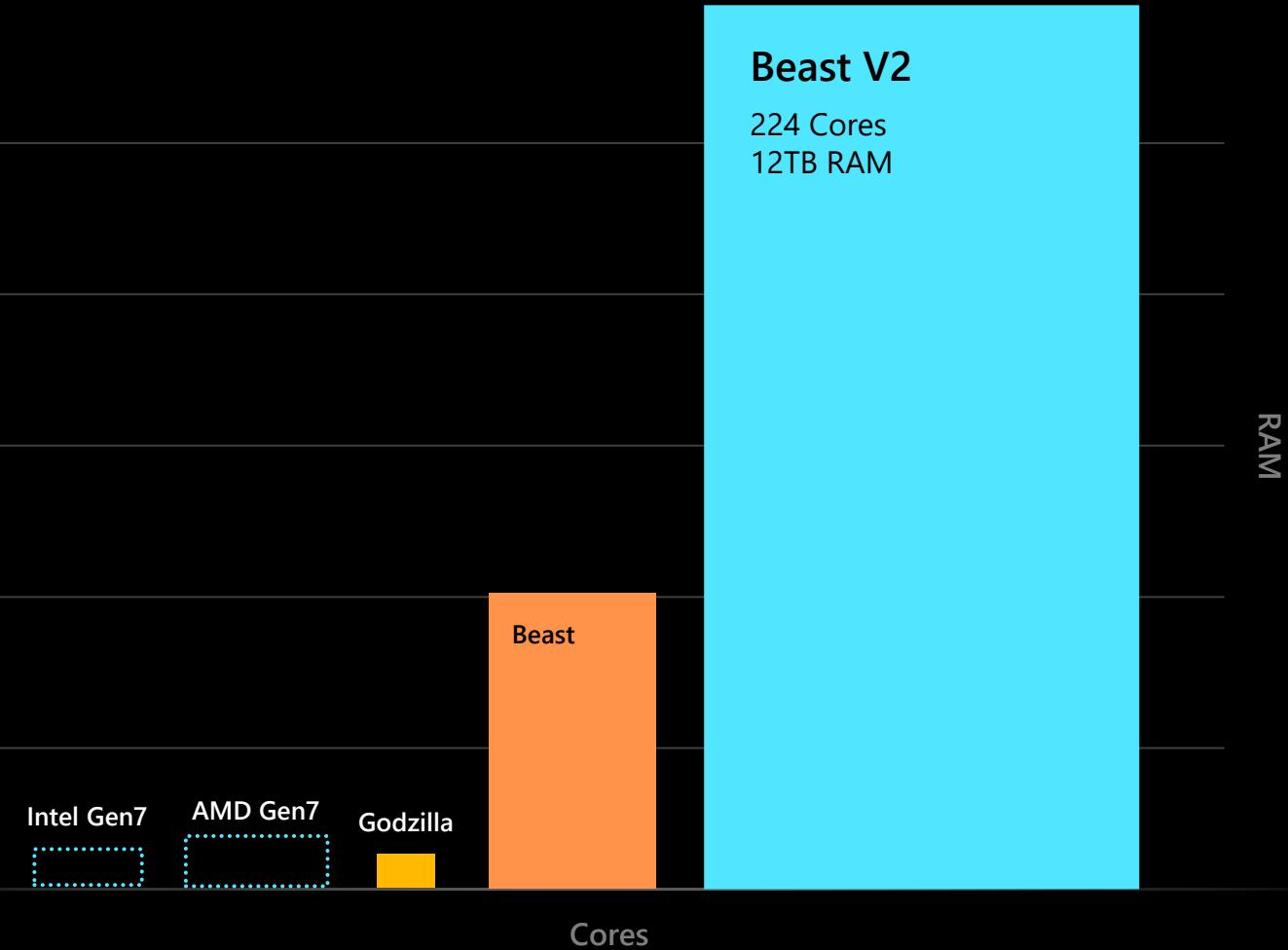
Cores

# Memory optimized servers



**Beast V2**

<b>Processor</b>	8 x 28 Core 2.5 GHz
<b>Memory</b>	12 TiB
<b>Hard Drive</b>	None
<b>SSD</b>	4 x 2 TB NVMe, 1 x 960 GB SATA
<b>NIC</b>	50 Gb/s

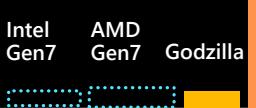


# Memory optimized servers

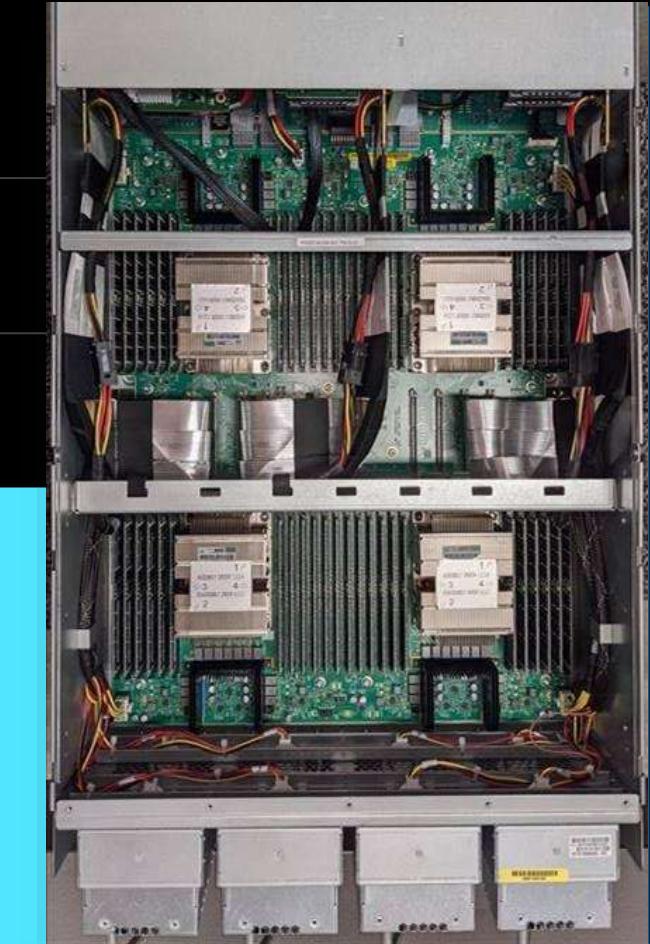


## Mega-Godzilla-Beast

<b>Processor</b>	16x Cascade Lake Platinum 8280L 28-core, 2,7Ghz (4.0 Ghz max)
<b>Memory</b>	192x128 GiB (24 TiB DDR4)
<b>Hard Drive</b>	None
<b>SSD</b>	2x 960 GB SATA SSD 4x6.4 TiB PCIe
<b>NIC</b>	50 Gb/s



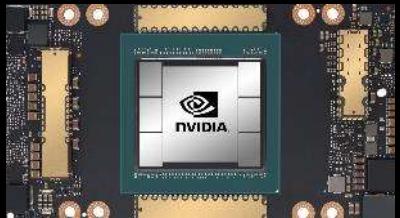
Beast V2



Cores

# NDv4: Massively scalable AI supercomputer

Single A100 GPU



→  
NCCL+NVLINK

Multi-GPU with NVLINK  
1 NDv4 VM, 8 A100s



→  
NCCL+HDR

Multi-GPU with InfiniBand HDR  
Up to hundreds of NDv4 VMs, thousands of A100s



## NVIDIA A100 Tensor Core GPU

- 40 GB of HBM2 Memory
- 2x – 20x V100 performance
- PCIe Gen 4, AMD Rome host
- 8 per VM

## NVSwitch + NVLink 3.0

- Between the 8 GPUs local GPUs within each VM
- 2.4 Terabits full-duplex, non-blocking

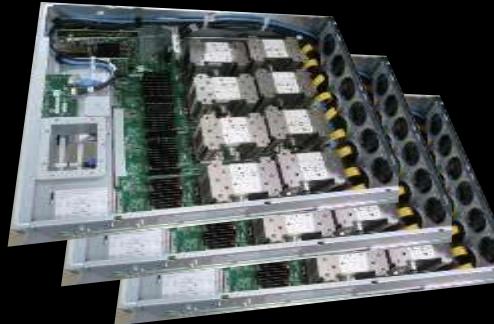
## Mellanox InfiniBand HDR Fabric

- 200 Gigabit dedicated link per GPU (1.6 Terabits/VM)
- Topology agnostic fat-tree
- Any to any, all to all, fully subscribed up to thousands of GPUs
- Dynamically provisioned via VMSS

# NDv4: Massively scalable AI supercomputer

## Multi-GPU with InfiniBand HDR

Up to hundreds of NDv4 VMs, thousands of A100s



## Mellanox InfiniBand HDR Fabric

- 200 Gigabit dedicated link per GPU (1.6 Terabits/VM)
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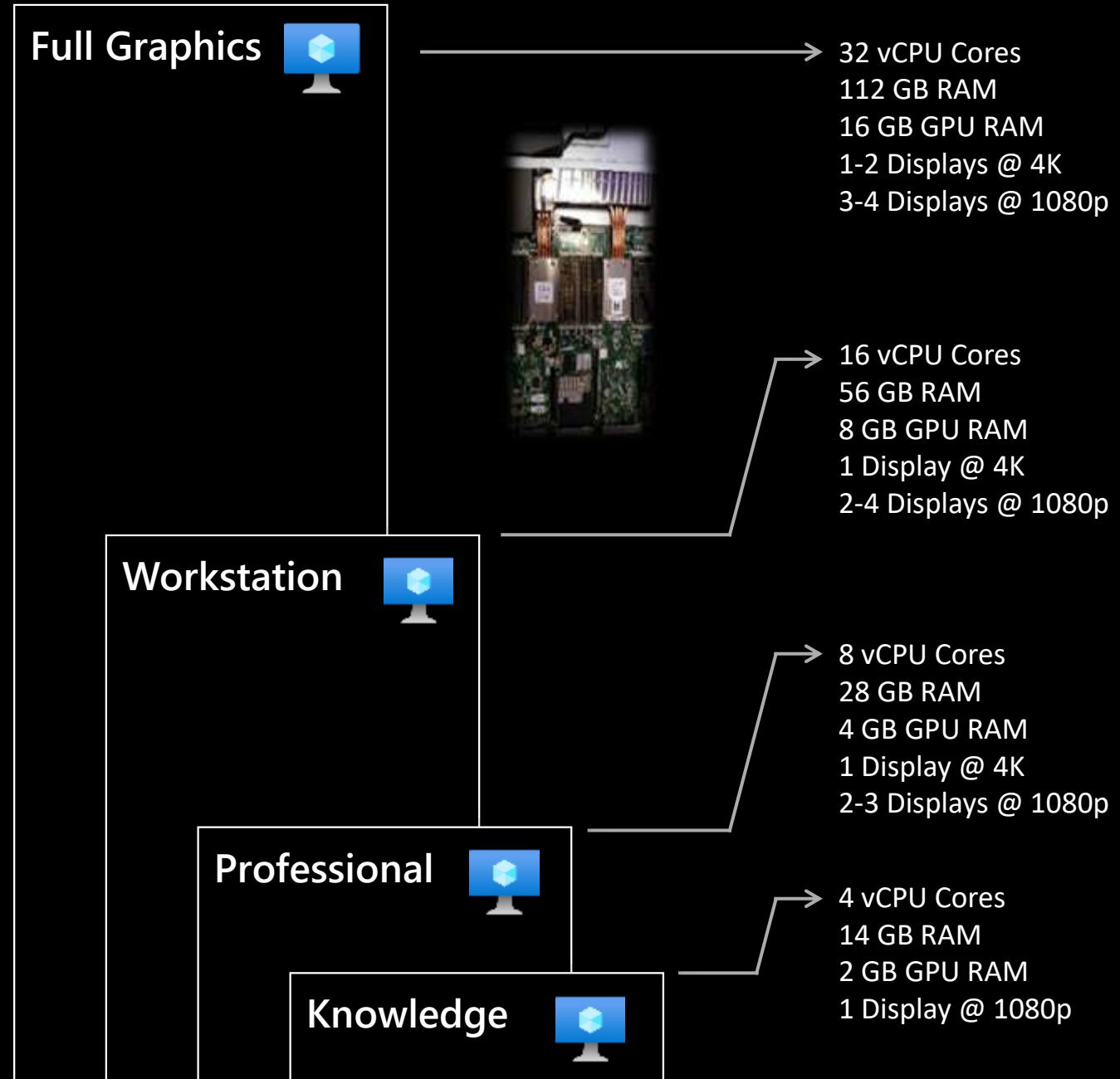
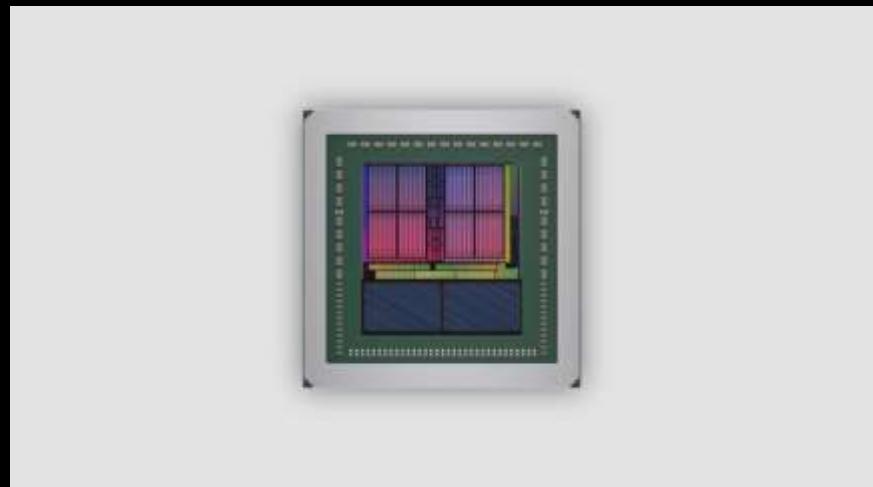
# New NVv4 VMs with fractional GPUs

AMD Rome EPYC CPU + Radeon Instinct MI25 GPU

Built on GPU partitioning technology

Whole or fractional dedicated GPU acceleration

Used by Windows Virtual Desktop



# Xbox Cloud Gaming

## Project xCloud

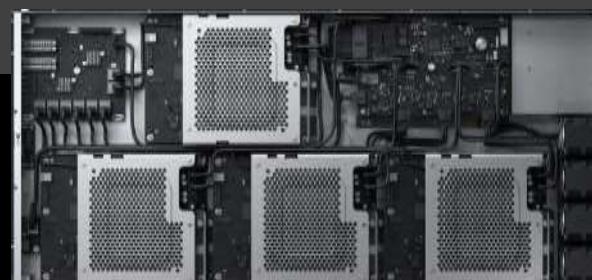
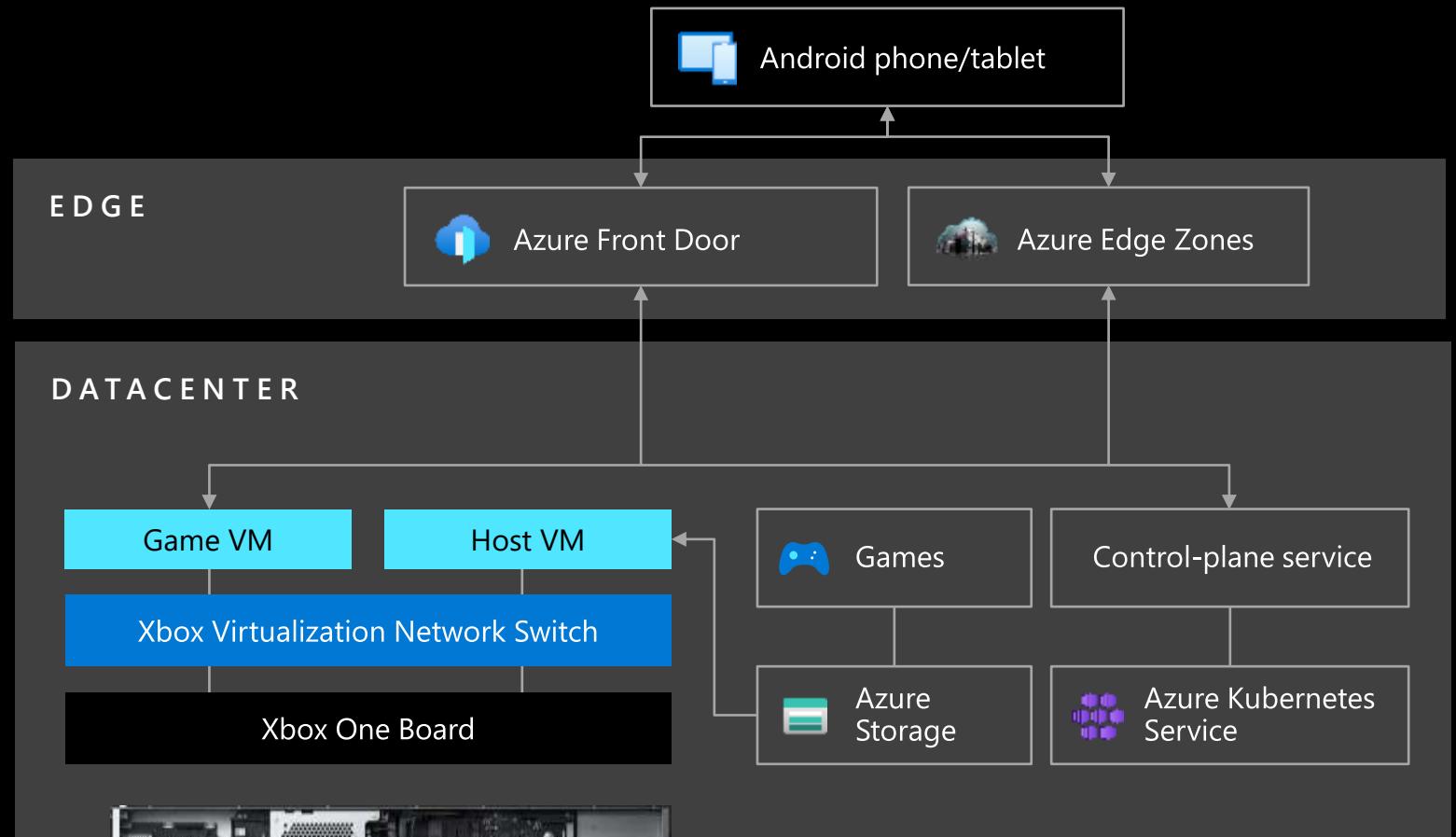
Instantly play Xbox games hosted in Azure on mobile

Xbox One based architecture

8 Xbox One boards per 2U chassis

Games housed in Azure storage instead of HDD

Optimized for low energy consumption, durability, and high density per rack



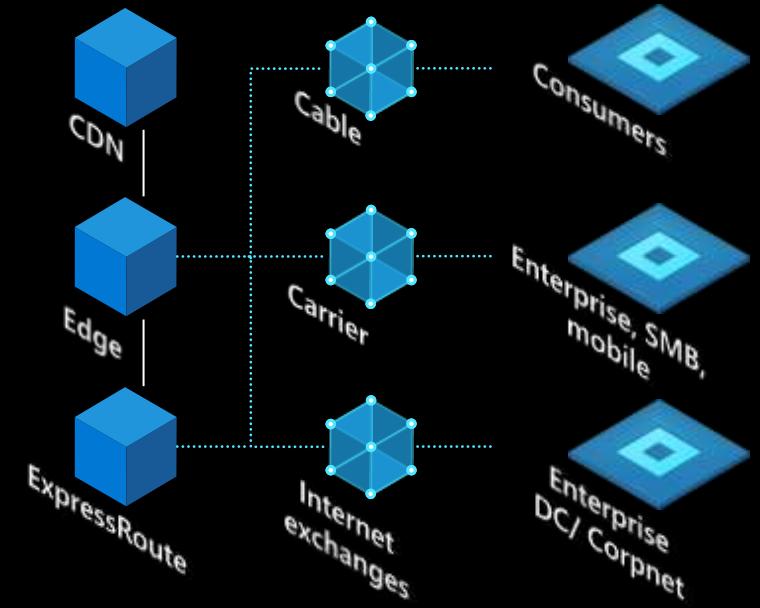
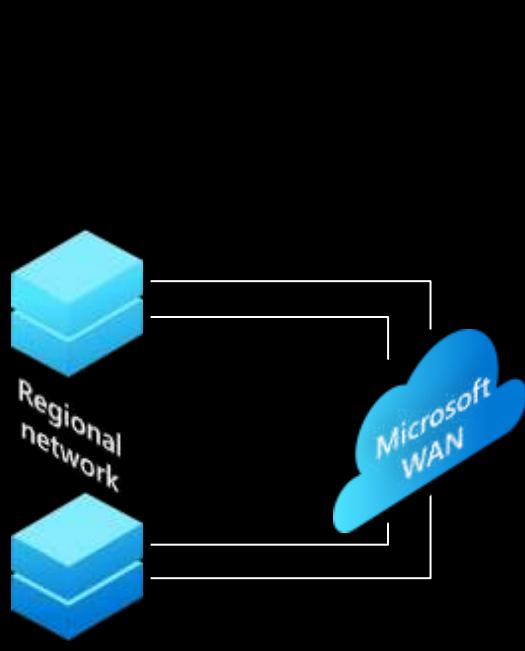
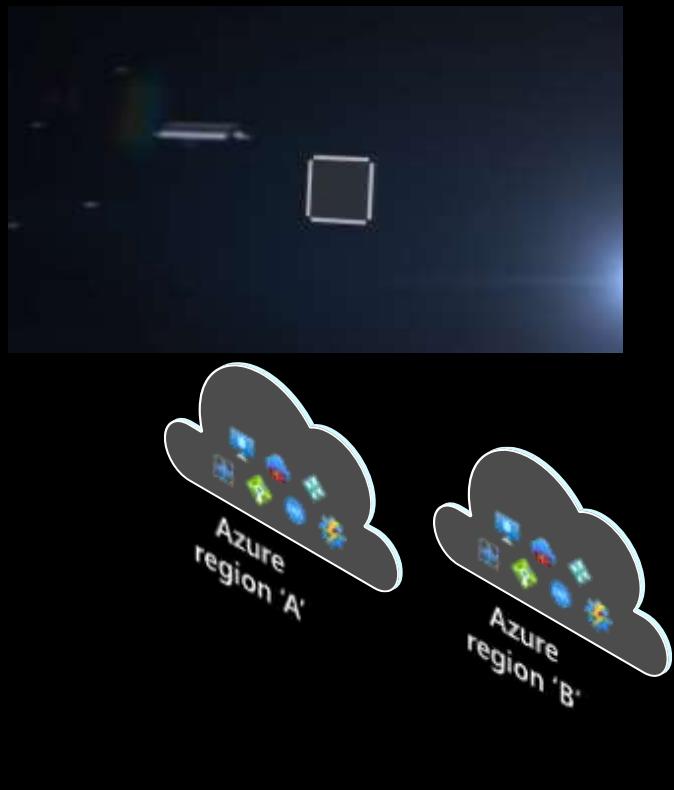


Inside Cloud Networking





# Azure networking overview



## DC hardware

SmartNIC/FPGA  
SONiC

## Services

Virtual Networks  
Load Balancing  
VPN Services  
Firewall  
DDoS Protection  
DNS and Traffic Management

## Intra-region

DC Networks  
Regional Networks  
Optical Modules

## WAN backbone

Software WAN  
Subsea Cables  
Terrestrial Fiber  
National Clouds

## CDN

Acceleration for applications and content

## Edge and ExpressRoute

Internet Peering  
ExpressRoute

## Last mile

E2E monitoring (Network Watcher, Network Performance Monitoring)

# Azure regional networks

## Edge

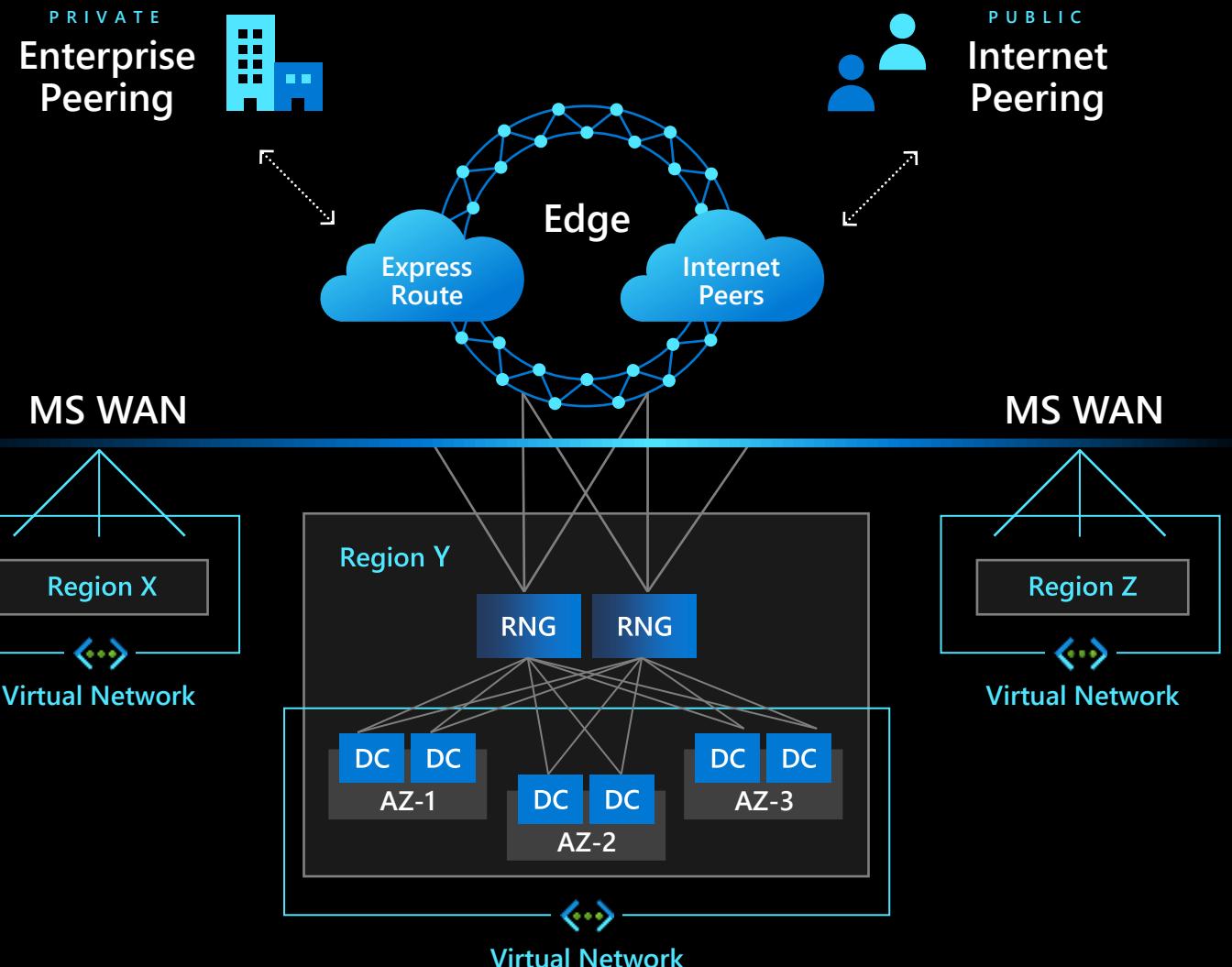
Connects Region to Internet and Enterprise peers

## Regional Network Gateway

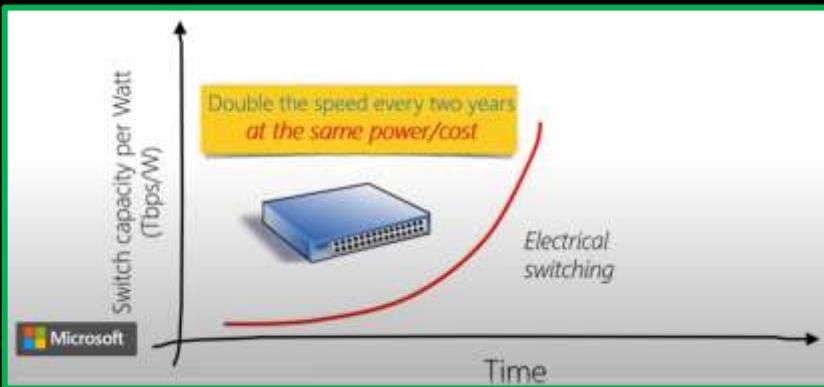
- Connects Regions to Regions, DC to DC
- Contiguous geographical area ~100km in diameter
- T-shirt sized (28 to 528MW)

## Data Centers

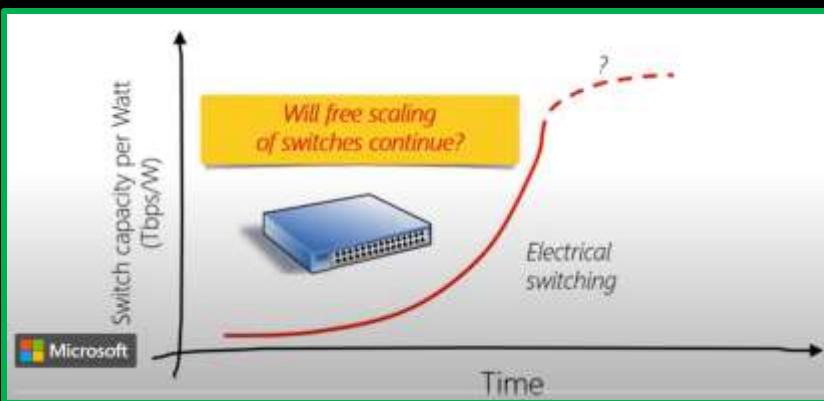
AZ to AZ latency – 2.0ms or less



# Project Sirius: the sustainable network



The end of Moore's law for networking?



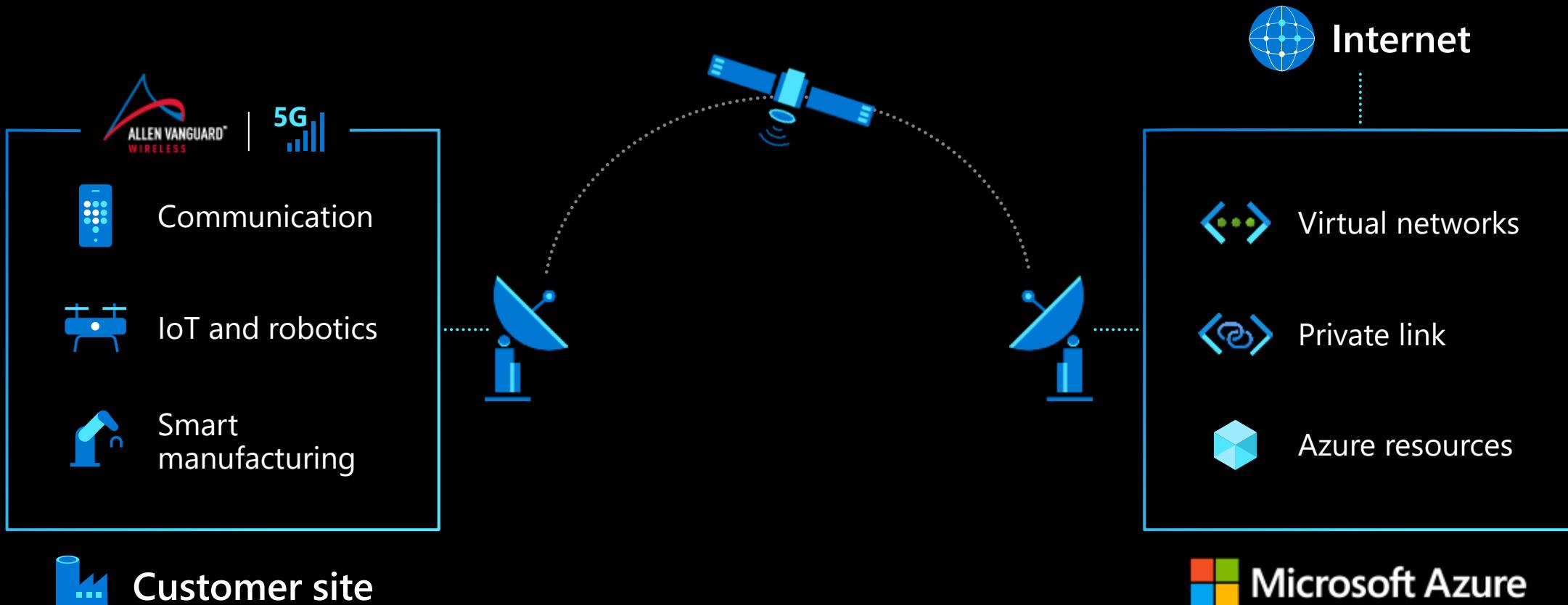
[https://youtu.be/W0ntAnqJ\\_7c](https://youtu.be/W0ntAnqJ_7c)

# Azure Orbital - **Ground Station as a Service**



Earth  
observation

# Global Communication and IoT



# Optical networking

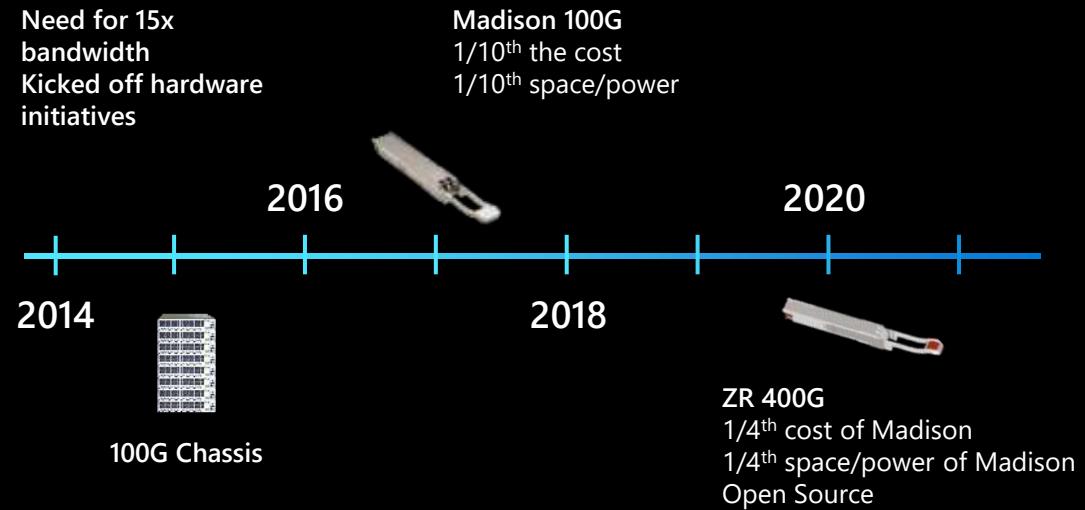
## Dense Wavelength-Division Multiplexing (DWDM)

### Regional network gateway

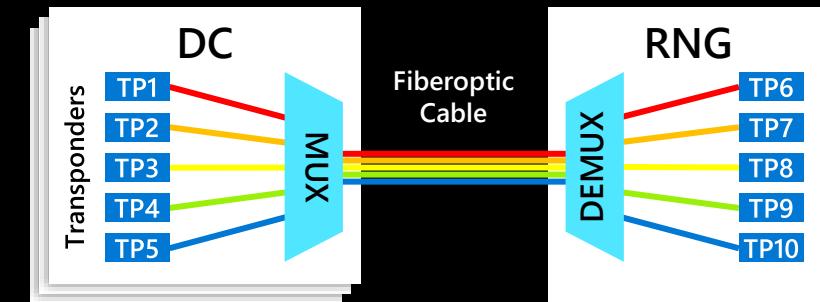
- Azure experiences up to 30 cuts/day
- Less fibers to maintain and repair

### More efficient over long distances

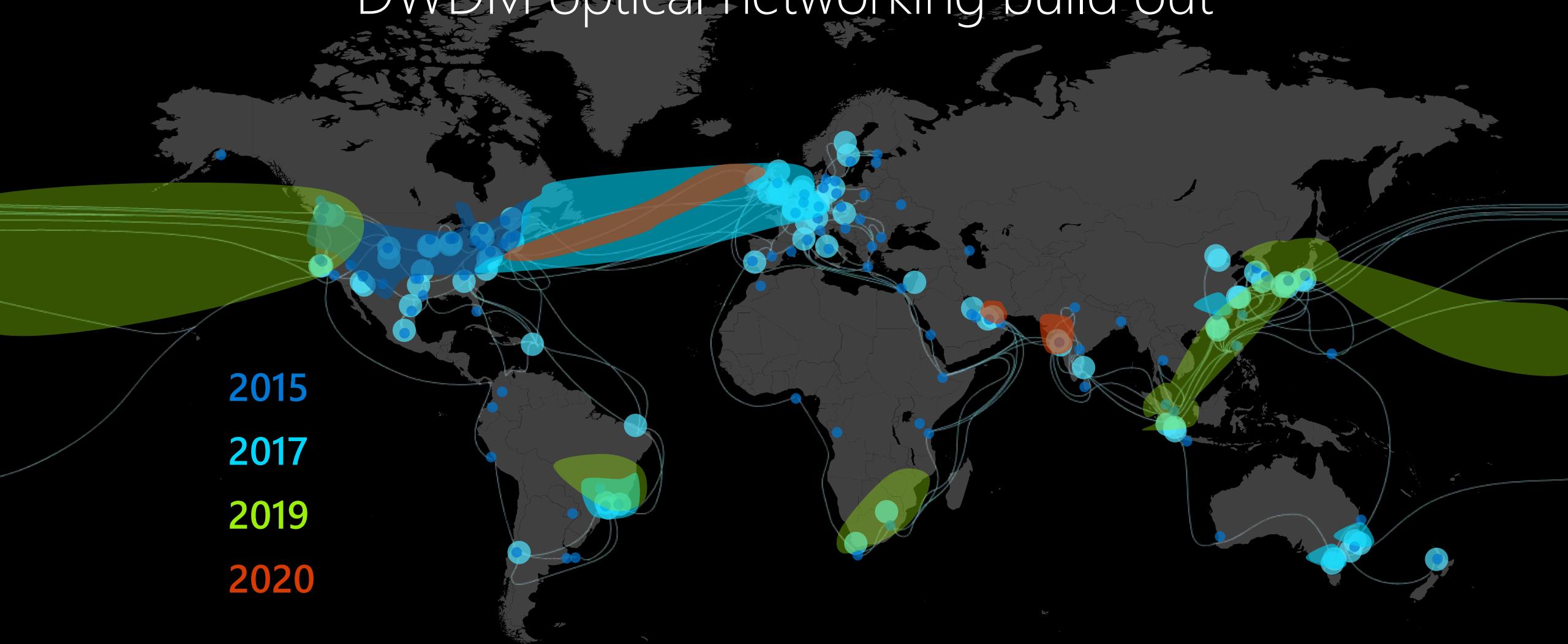
- Thousands of dollars per mile per fiber
- Single amplifier every ~80km



### Dense Wavelength-Division Multiplexing (DWDM)



# DWDM optical networking build out



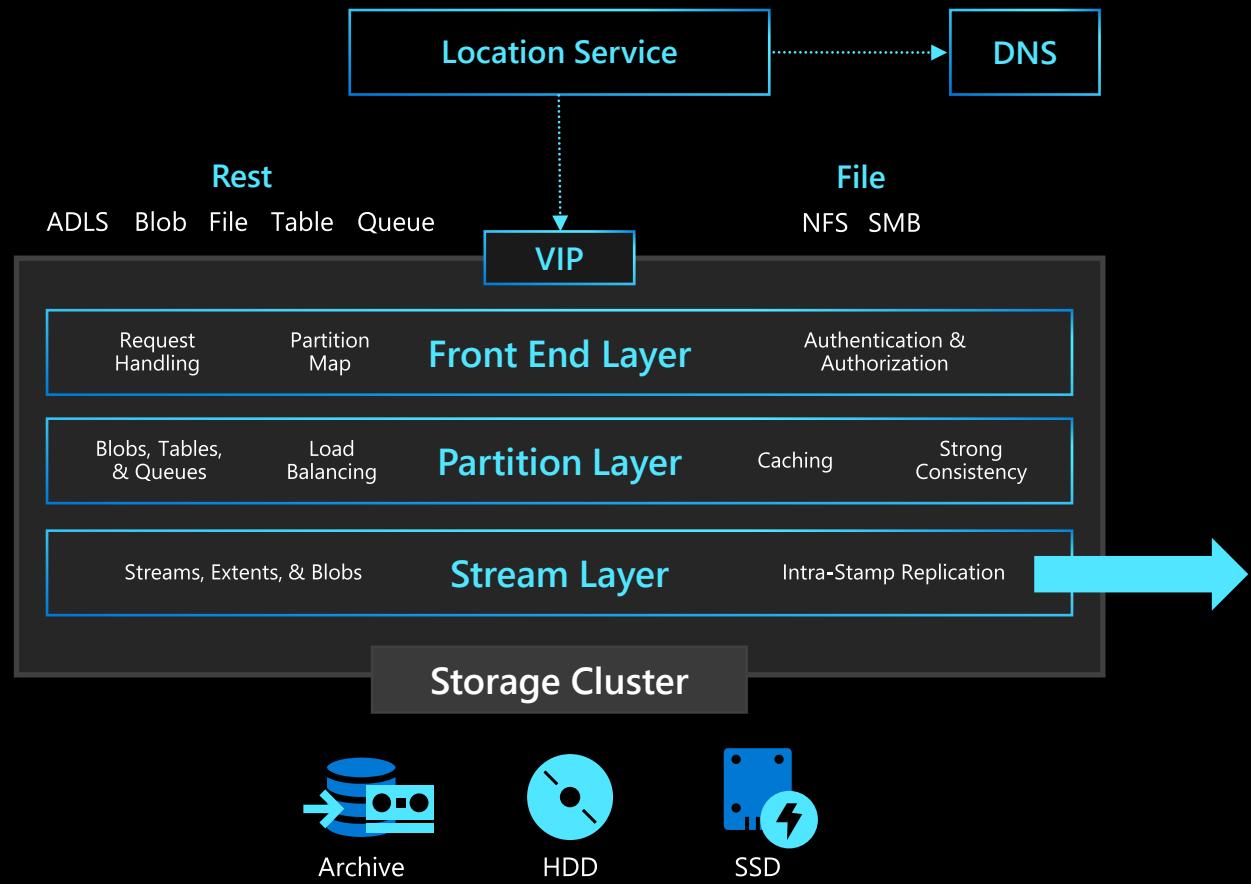


Cloud Storage





# Azure storage architecture



# Micron SCUTI-O

The world's fastest SSD with Exclusive Azure features

8us latency  
9GB/s

Reads IOPs: 2.35M  
Writes IOPs at 1.95M

128 I/O queue pairs

Quality of Service for multiple VM scaling



Uses 3DCrossPoint (3DxP)  
for high performance and durability

# DBD Decommissioning



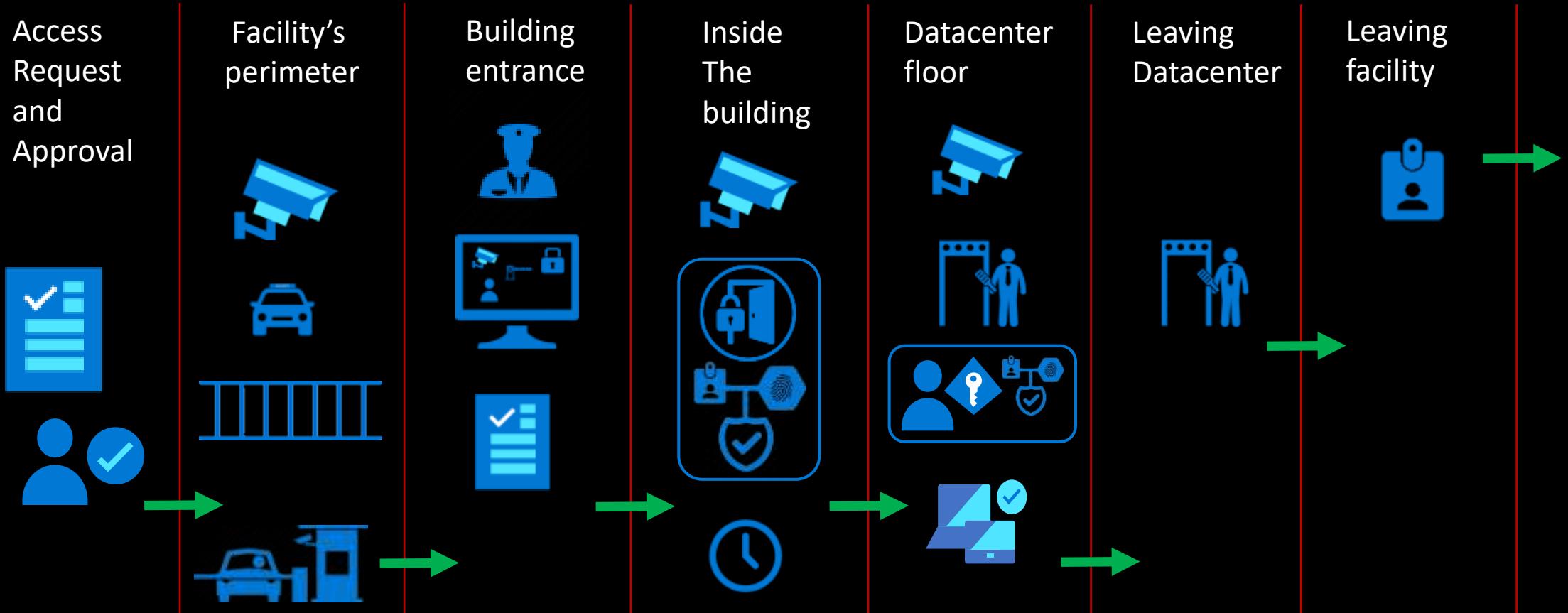
# Inside Datacenter Security

## Layered security approach



<https://youtu.be/r1cyTL8JqRg>

# Layered security approach



# Trust Your Cloud

8> trillion threat  
signals analyzed daily = 95 million signals per second

Microsoft Cyber Defense Operations Center  
Red Team / Blue Team

Uncompromising  
commitment to privacy

1B+ USD investment in security R&D  
and 3,500 cyber security experts



Datacenter personnel do not provide:  
Azure Service Management

# How is your data protected?

The main data protection concepts within Azure that are controlled by you:

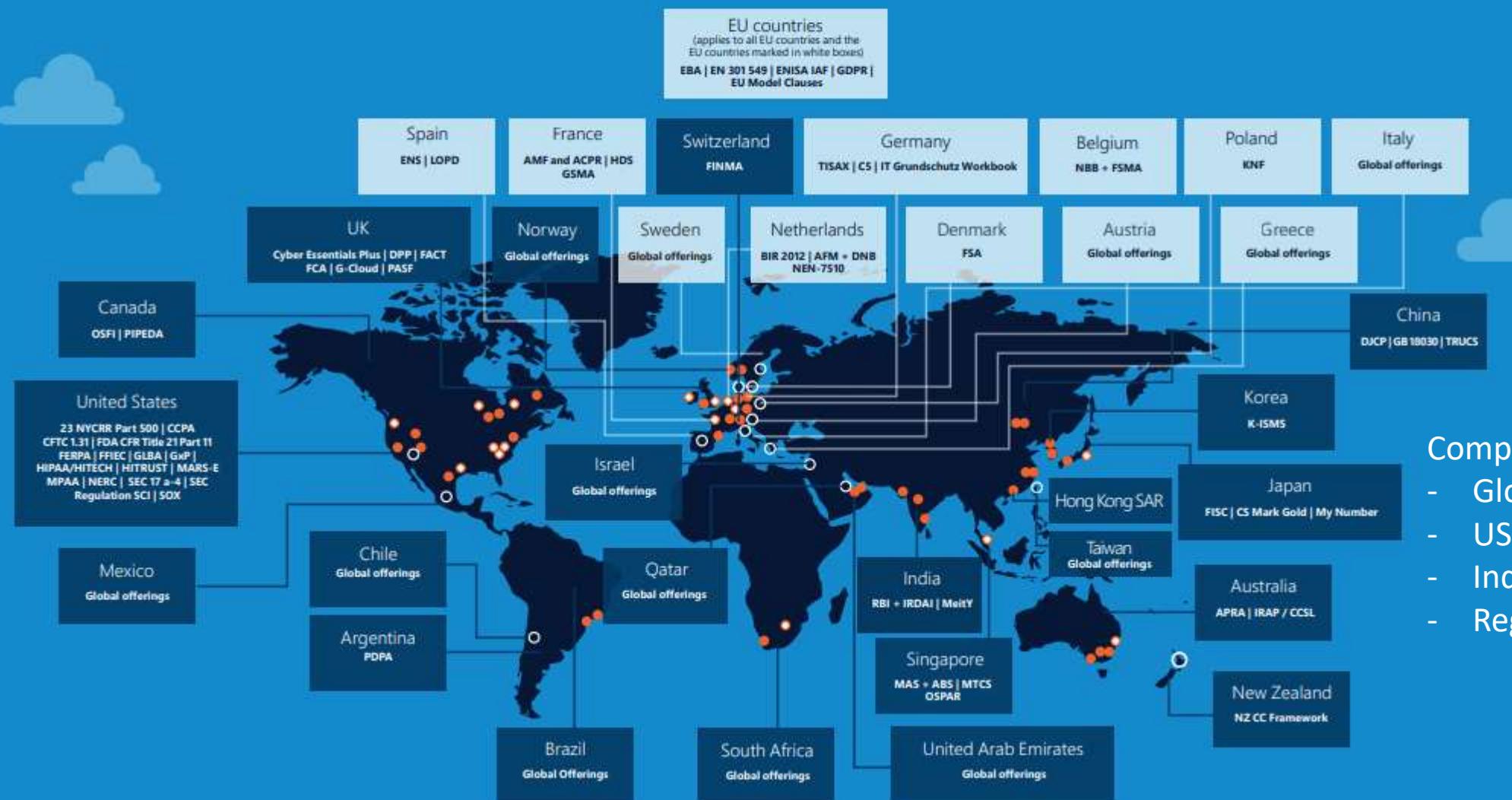
- Cryptography
  - For storing data, in applications, & on the network (encryption & decryption).
- Key management
  - Provisioning, lifecycle management, security/protection
- Authentication, authorization, & access control



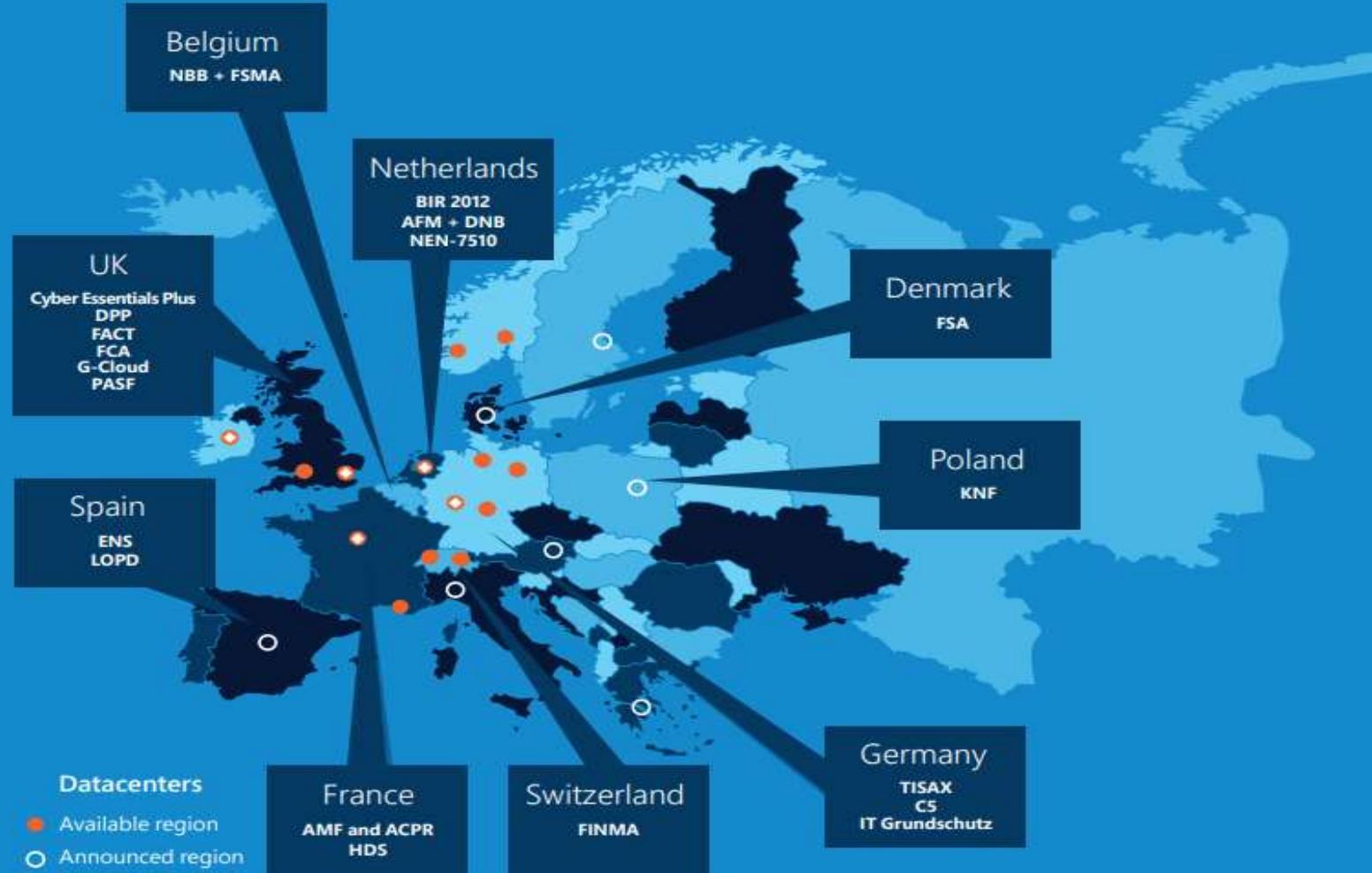
# Azure global compliance

The following compliance standards apply globally

[CIS Benchmark](#) | [CSA-STAR attestation](#) | [CSA-STAR certification](#) | [CSA-STAR self-assessment](#)  
[ISO 20000-1:2011](#) | [ISO 22301](#) | [ISO 27001](#) | [ISO 27017](#) | [ISO 27018](#) | [ISO 27701](#) | [ISO 9001](#)  
[PCI DSS](#) | [SOC](#) | [WCAG](#) | [CDSA](#) | [PCI DSS](#) | [Shared Assessments](#) | [TruSight](#)



# Compliance in Europe



Use the navigation bar below to jump to other maps

Click the compliance standards below for more information

## Local offerings

AFM +DNB  
AMF and ACPR  
BIR 2012  
C5  
Cyber Essentials Plus  
DPP  
ENS  
FACT  
FCA  
FINMA  
FSA  
G-Cloud  
HDS  
IT Grundschutz Workbook  
KNF  
LOPD  
NBB + FSMA  
NEN 7510  
PASF  
TISAX

## Global offerings

CIS Benchmark  
CSA-STAR attestation  
CSA-STAR certification  
CSA-STAR self-assessment  
ISO 20000-1:2011  
ISO 22301  
ISO 27001  
ISO 27017  
ISO 27018  
ISO 27701  
ISO 9001  
SOC  
WCAG  
CDSA  
PCI DSS  
Shared Assessments  
TruSight

## EU offerings

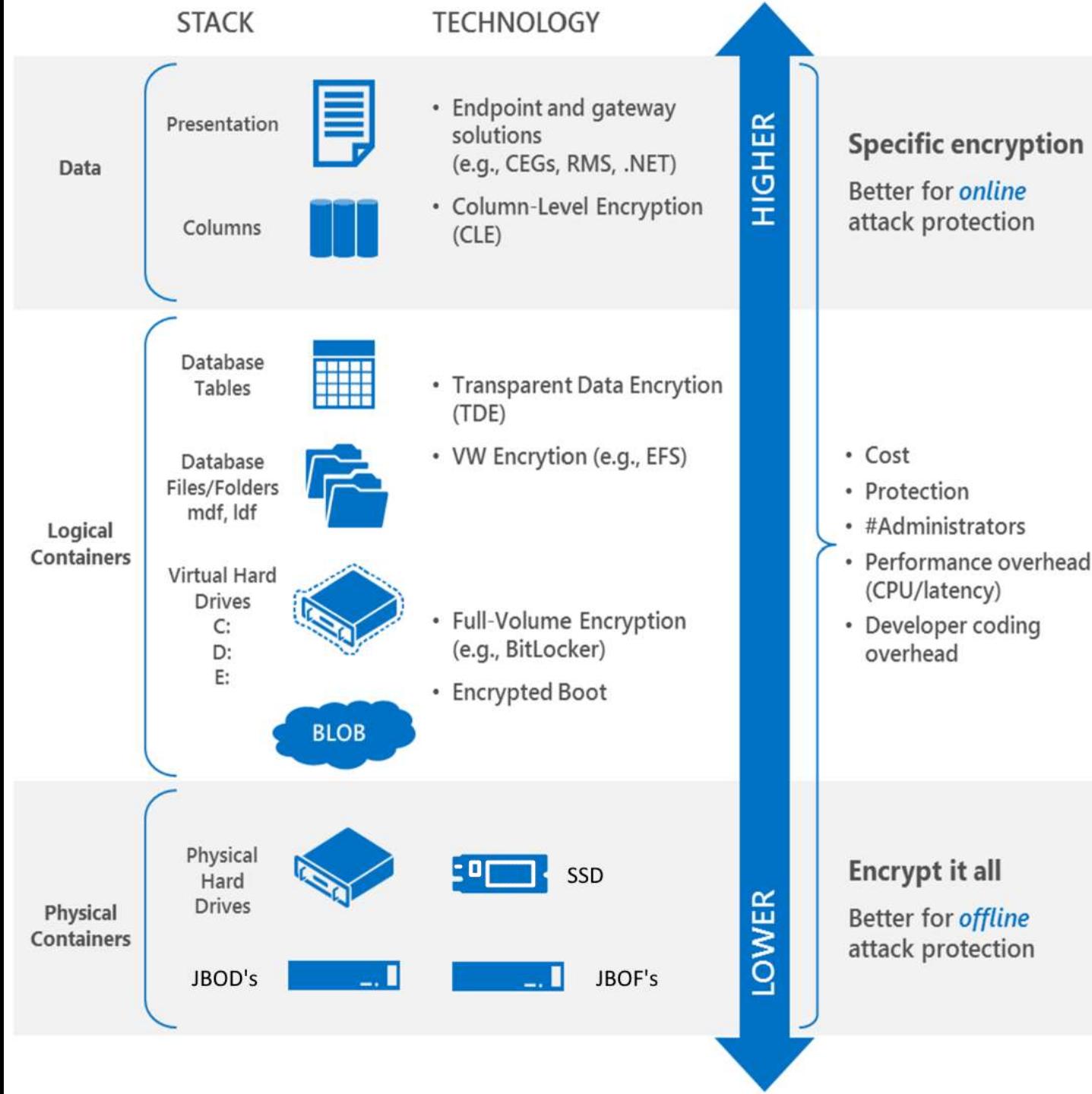
EBA  
EN 301 549  
ENISA IAF  
EU Model Clauses  
GDPR

# How is your data protected?

The main data protection concepts within Azure that are controlled by you:

- Cryptography
  - For storing data, in applications, & on the network (encryption & decryption).
- Key management
  - Provisioning, lifecycle management, security/protection
- Authentication, authorization, & access control

[Protection of customer data in Azure | Microsoft Docs](#)





# Trust Your Cloud



8> trillion threat  
signals analyzed daily

So, what does a trillion mean?

A million of seconds = approx. 12 days.

A billion of seconds = approx. 31 years.

A trillion of seconds = approx. 31688 years.

MSG is processing roughly 8 times a trillion which means  
~253500 years of seconds per day which converts into:  
approx. 341 billion signals per hour.  
approx. 5.7 billion signals per minute.  
approx. 95 million signals per second.

# Azure Energy Sustainability

For localized deployments, Microsoft Cloud is between **79 to 93% more energy efficient** than a traditional datacenter.

**315 megawatts** of new solar power in Virginia

**180 megawatts** of wind power in Netherlands

**1.189 Power Usage Effectiveness (PUE) Global Average**



When renewable energy is taken into account, carbon emissions (kg/CO<sub>2</sub>/user-year) from Azure Compute are **92–98% lower** than a traditional enterprise datacenter.



The development of new world-class datacenters in **Sweden**, intends to create some of their most advanced and sustainable to date based on their design, power from **100 percent renewable energy sources** through a **24/7 solution**, and plans for **zero-waste operations** and **Circular Centers**

Microsoft will be carbon negative by 2030 and will remove all historic emissions emitted either directly or via electricity consumption by 2050



## Sustainability Goals by 2030

Carbon  
negative

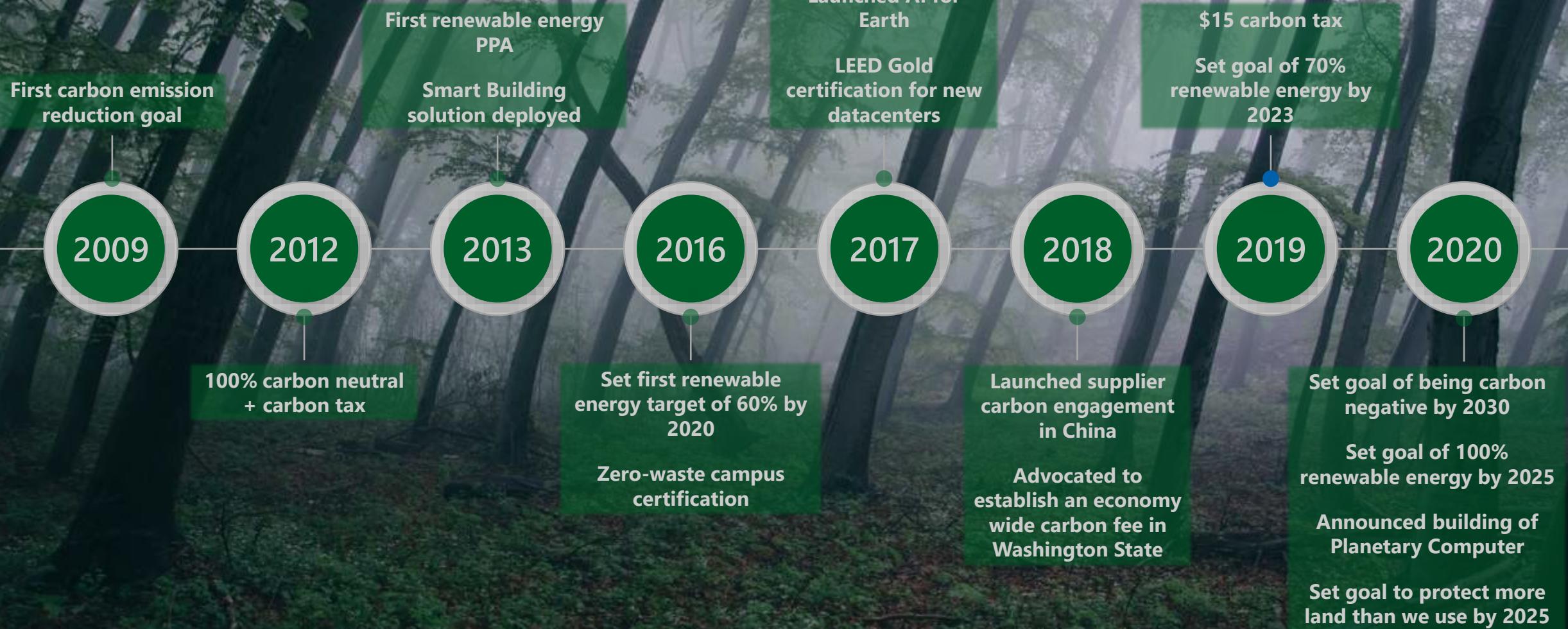
Zero Waste

Water  
positive

Restore more  
land than we  
use



# Our Sustainability journey



# The Sustainability Calculator

 Microsoft Sustainability Calculator (Preview)

Microsoft Sustainability Calc... ^

Dashboard

Emissions details

**Emissions savings**

Preparation report

Calculation methodology

Learn more

Legal information

Contoso (Demo)

Contoso (Demo)

## Emissions savings

Most recent data available: Dec 24, 2020

Enrollment ID: All ▾ Subscription Name: All ▾ Azure Service: All ▾ Region: All ▾ Year: All ▾ Month: All ▾

### Current Azure services carbon emissions

Characteristics of on-premises alternative

Efficiency: Low Medium High

Renewable energy purchases: 0% ▾

115.7	MTCO2e from on-premises alternative
- 91.3	MTCO2e saved from Microsoft efficiencies
- 2.0	MTCO2e saved from Microsoft renewable energy purchases
22.5	MTCO2e emissions from switch to Azure

80.59%	Carbon emissions saved (MTCO2e) 
93.27	Carbon emissions saved (MTCO2e) 
366.99K	Carbon emissions saved in driven distance  ML KM

**Efficiency**  
This calculation estimates emissions that result from your use of Azure services, savings relative to provision of these same services at low, medium, and high efficiency on-premises deployments, and the renewable energy projects in which Microsoft invests.

**LOW EFFICIENCY**  
Physical servers and direct attached storage in a small localized data center (500-1,999 square feet).

**MEDIUM EFFICIENCY**  
Mix of physical and virtualized servers and attached, dedicated storage in a mid-tier internal data center (2,000-20,000 square feet).

**HIGH EFFICIENCY**  
Virtualized servers and dedicated storage in a high-end internal data center (> 20,000 square feet).

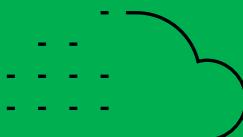
The estimated emissions include energy used in our datacenters (accounting for our low-carbon electricity purchase's) and energy used to transmit data over the internet.

**Renewable energy purchases**  
Specify a percentage of renewable energy purchases used at your on-premises datacenter. If your on-premises datacenters reside in multiple geographies, please specify an average of the geographies based on power consumption.



# Migrating to the Microsoft cloud reduced our carbon footprint

Microsoft moved over 2000 applications from **on-premises to the cloud**



Moving on-premises datacenter operations to the Microsoft cloud can reduce your carbon footprint up to

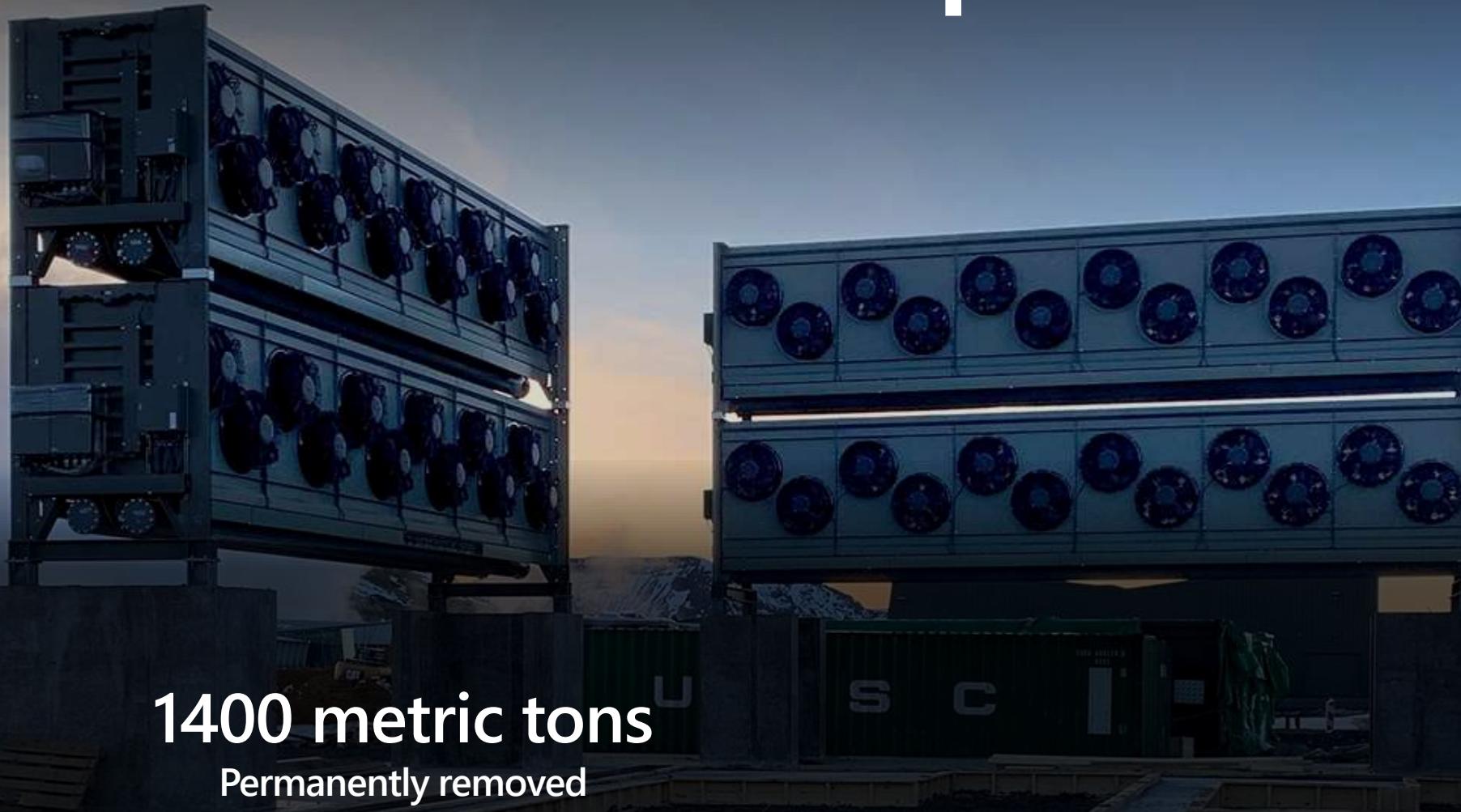
**98%\***

And up to **93%** more energy efficient.



\*Carbon footprint reductions will vary depending on your specific server usage, renewable energy purchases you make, and other factors. For details please refer to [The carbon benefits of cloud computing](#) published by Microsoft in 2018.

# Carbon Capture



1400 metric tons

Permanently removed

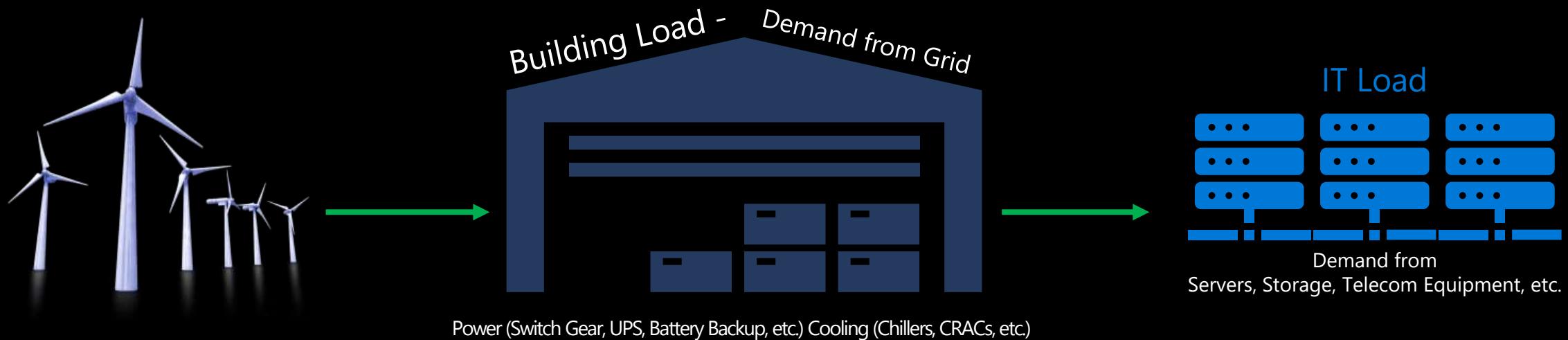
Credit: Climeworks

# Importance of Data Center Efficiency

Understanding Power Usage Effectiveness (PUE) metric:

In a typical data center, for every watt consumed for server power (PUE=1.0), there can be another 1 watt consumed for power distribution losses and cooling (PUE= 2.0)

$$\text{PUE} = \frac{\text{Total Facility Power}}{\text{IT Equipment Power}}$$



# Our waste commitments

By 2030, Microsoft will be zero waste across our direct waste footprint.



## Driving to zero waste in operations

We will reduce as much waste as we create across our direct operations, products, and packaging.



## Making fully recyclable Surface devices

We will manufacture Surface devices that are 100 percent recyclable in Organization for Economic Cooperation and Development (OECD) countries by 2030.



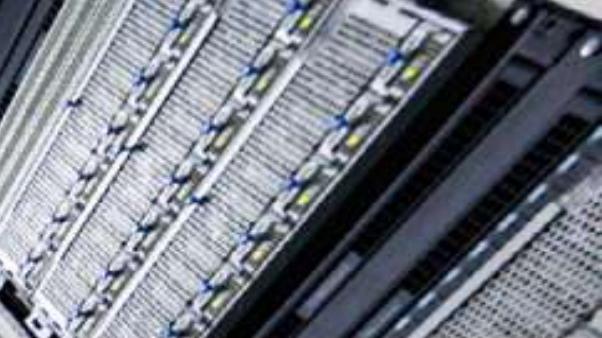
## Investing in the future of circularity

We will partner with companies around the world to drive circular economy innovation and adoption of technologies to reduce waste and reuse materials and products.



## Increasing reuse of servers and components through Circular Centers

By 2025, 90 percent of servers and components within our regional datacenter network will be reused.



## Transforming waste accounting

We will improve waste data collection to ensure auditability and reporting.

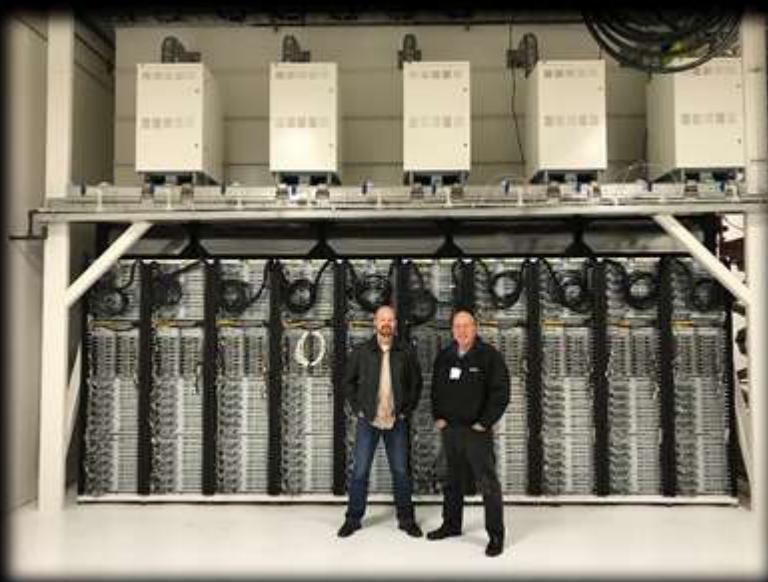
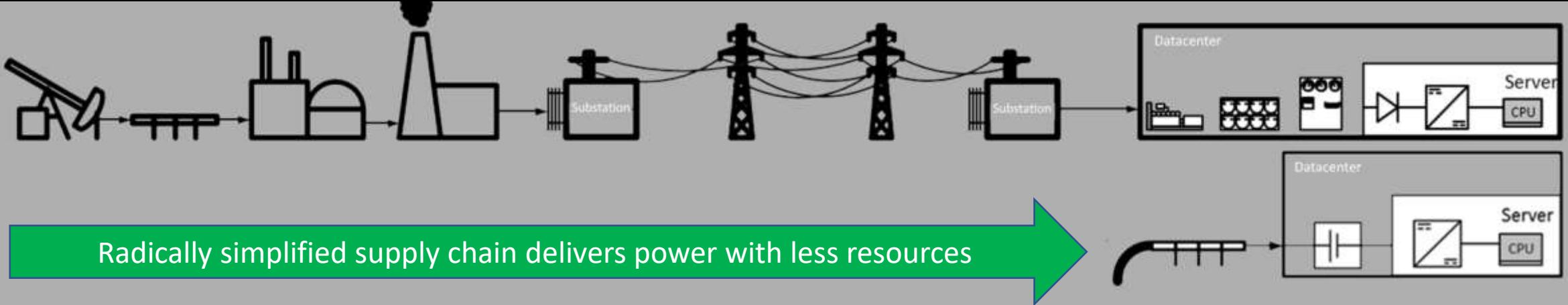


## Eliminating single-use plastics

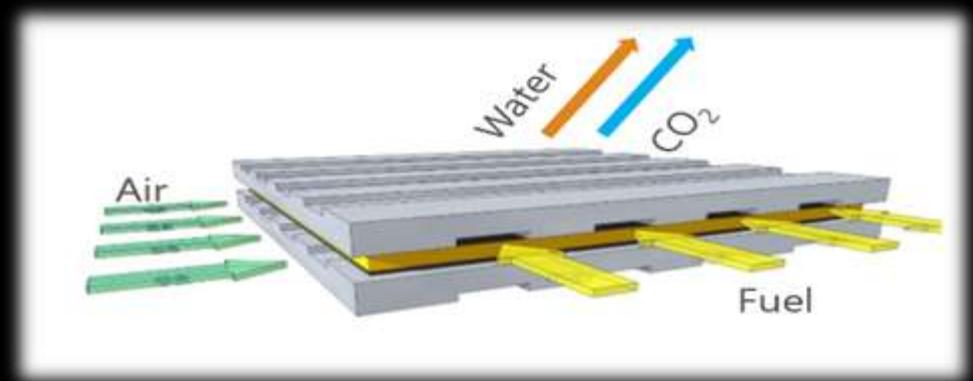
By 2025, we will eliminate single-use plastics in all Microsoft primary product packaging and all IT asset packaging in our datacenters.



# Redesigning Datacenters for an Advanced Energy Future



With this simplification comes a reduction in cost. Eliminating electrical distribution, power conditioning, and backup infrastructure makes a datacenter easier and less expensive to build, operate and manage. And more sustainable.



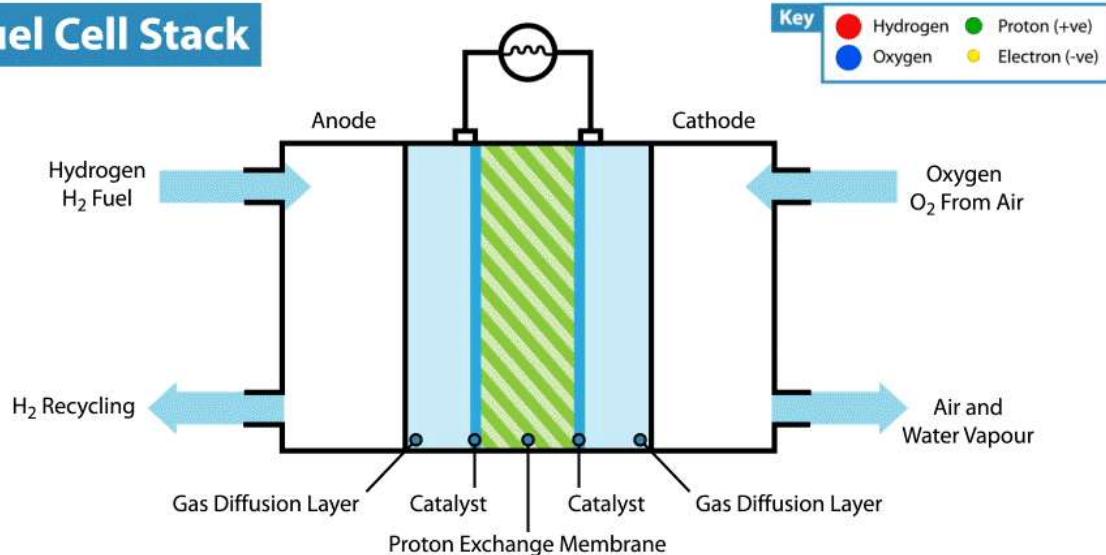
# Redesigning Datacenters for an Advanced Energy Future



Power Innovations built a 250-kilowatt fuel cell system to help Microsoft explore the potential of using hydrogen fuel cells for backup power generation at datacenters. In a proof of concept, the system powered a row of datacenter servers for 48 consecutive hours. Credit: Power Innovations.



## Fuel Cell Stack



# Liquid Cooling

Micro-channel  
Cold Plates



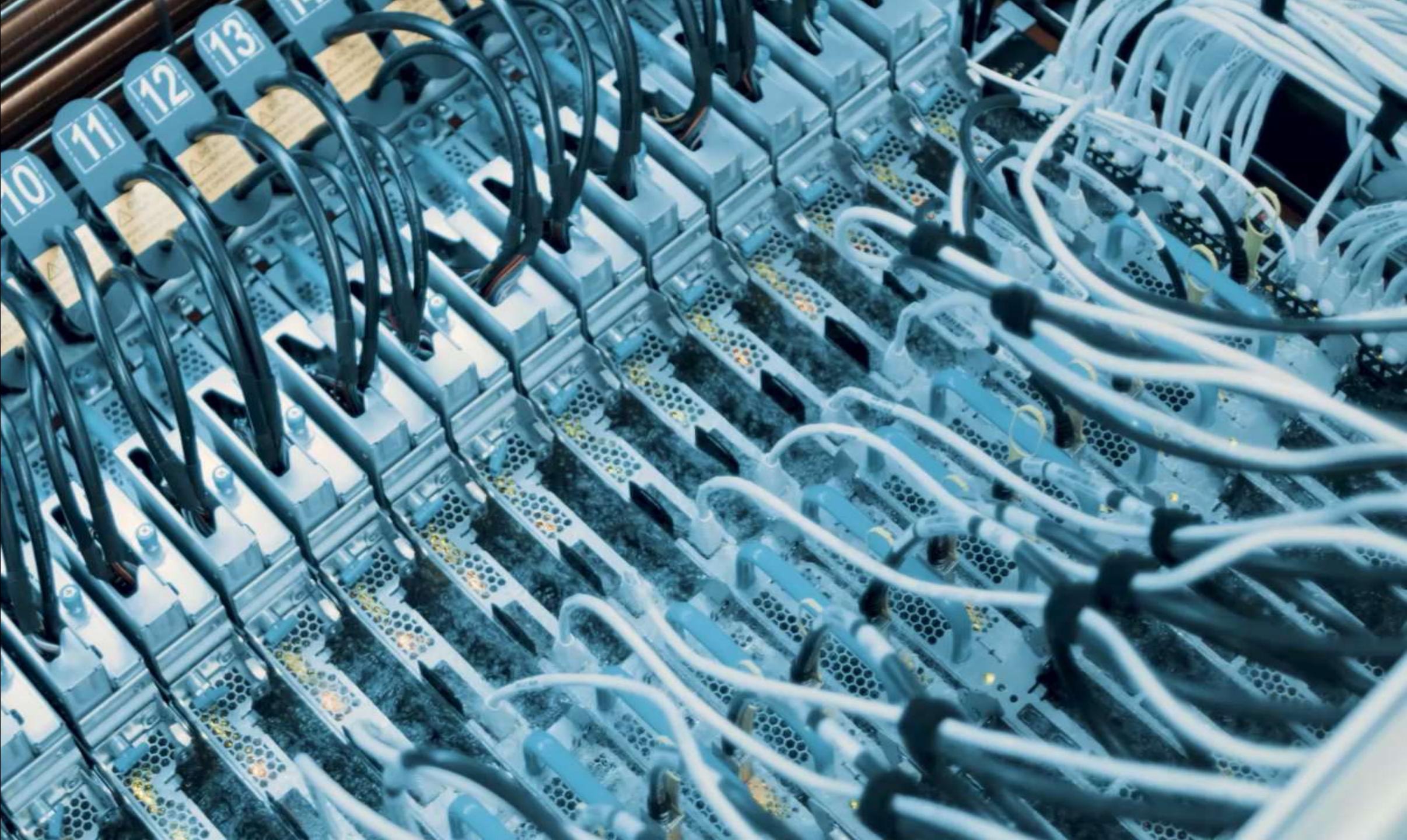
One  
phase  
immersion



Two  
phase  
immersion



Liquid Cooling



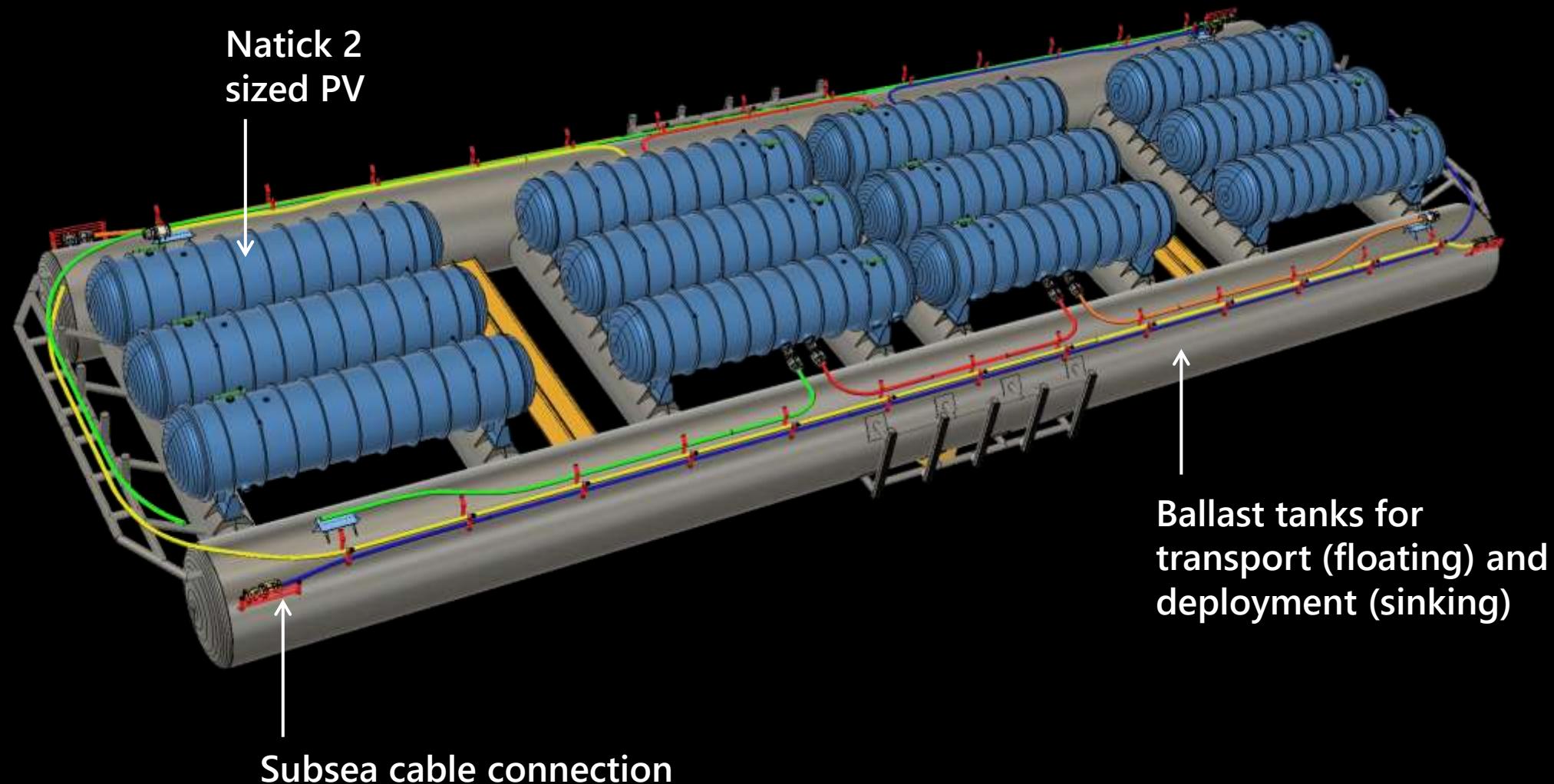


# Project Natick v2

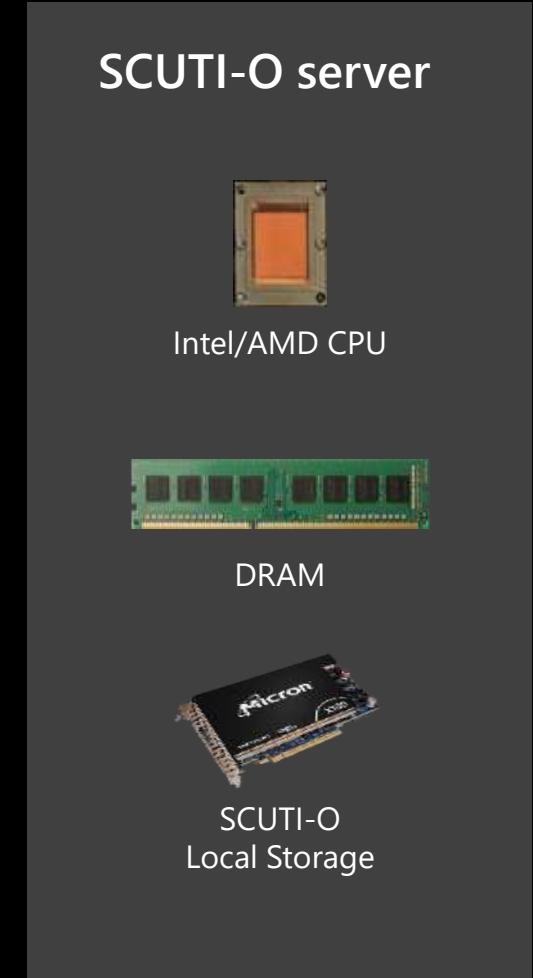
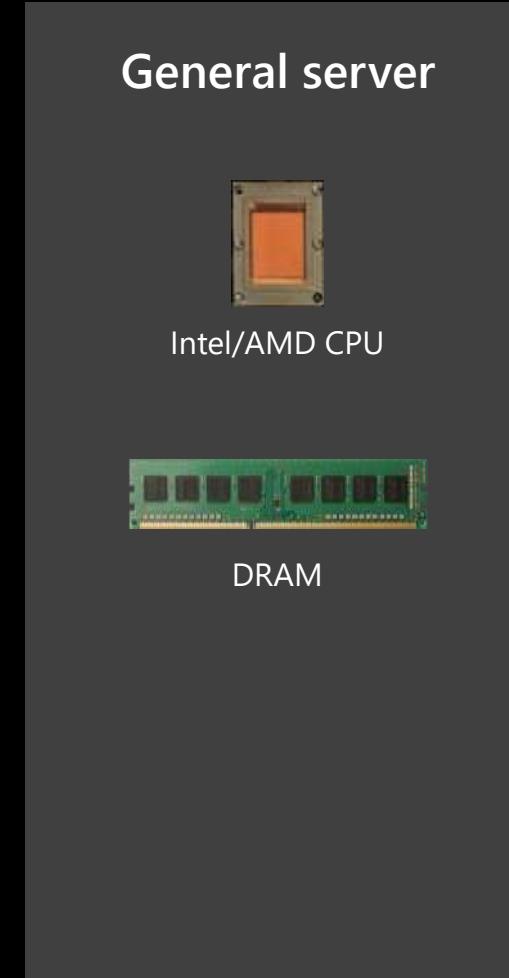
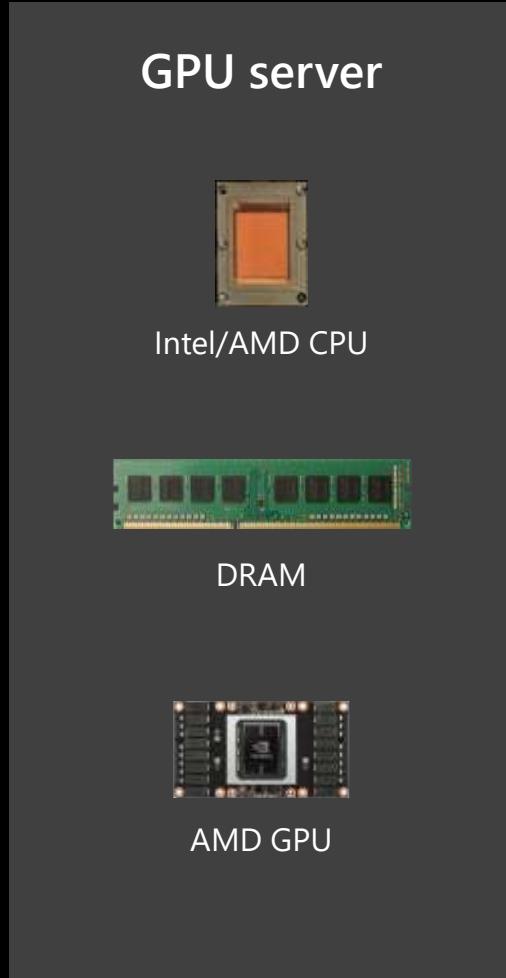
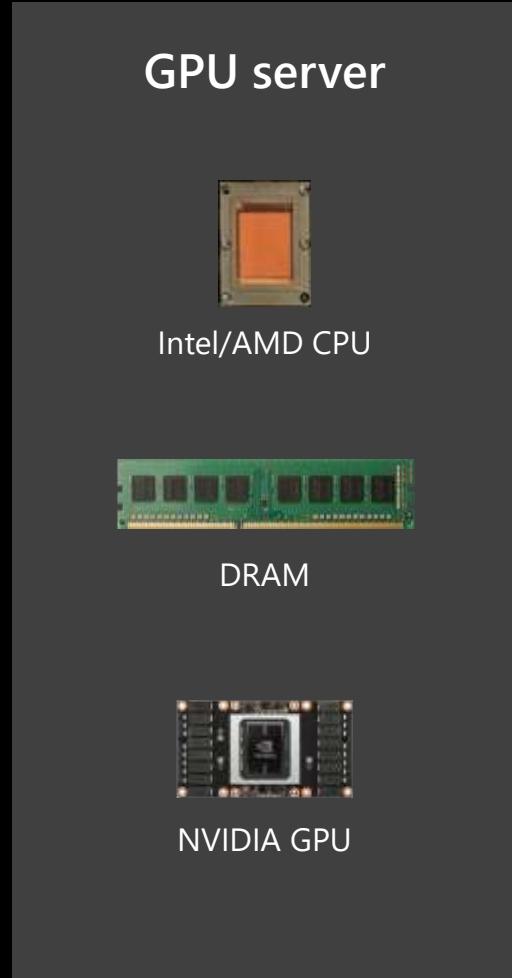
## 2018 -- 2020



# Project Natick v3

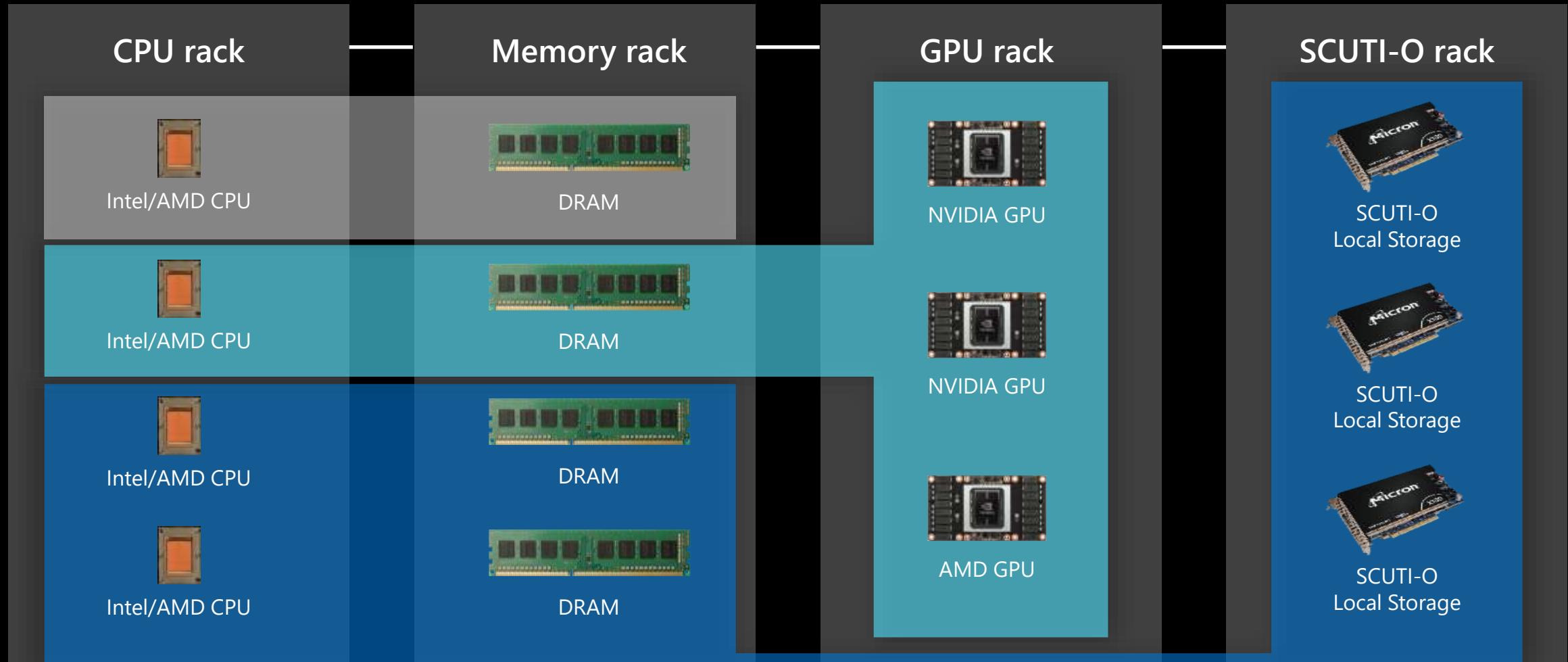


# Traditional rack architecture

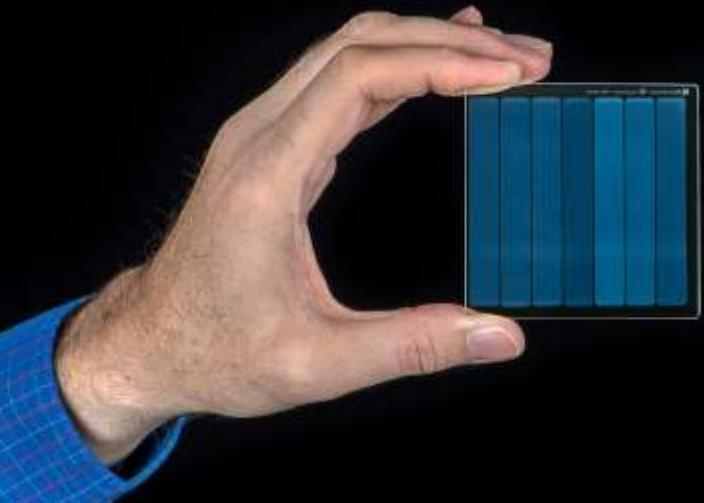


# Disaggregated rack architecture

## Software defined servers

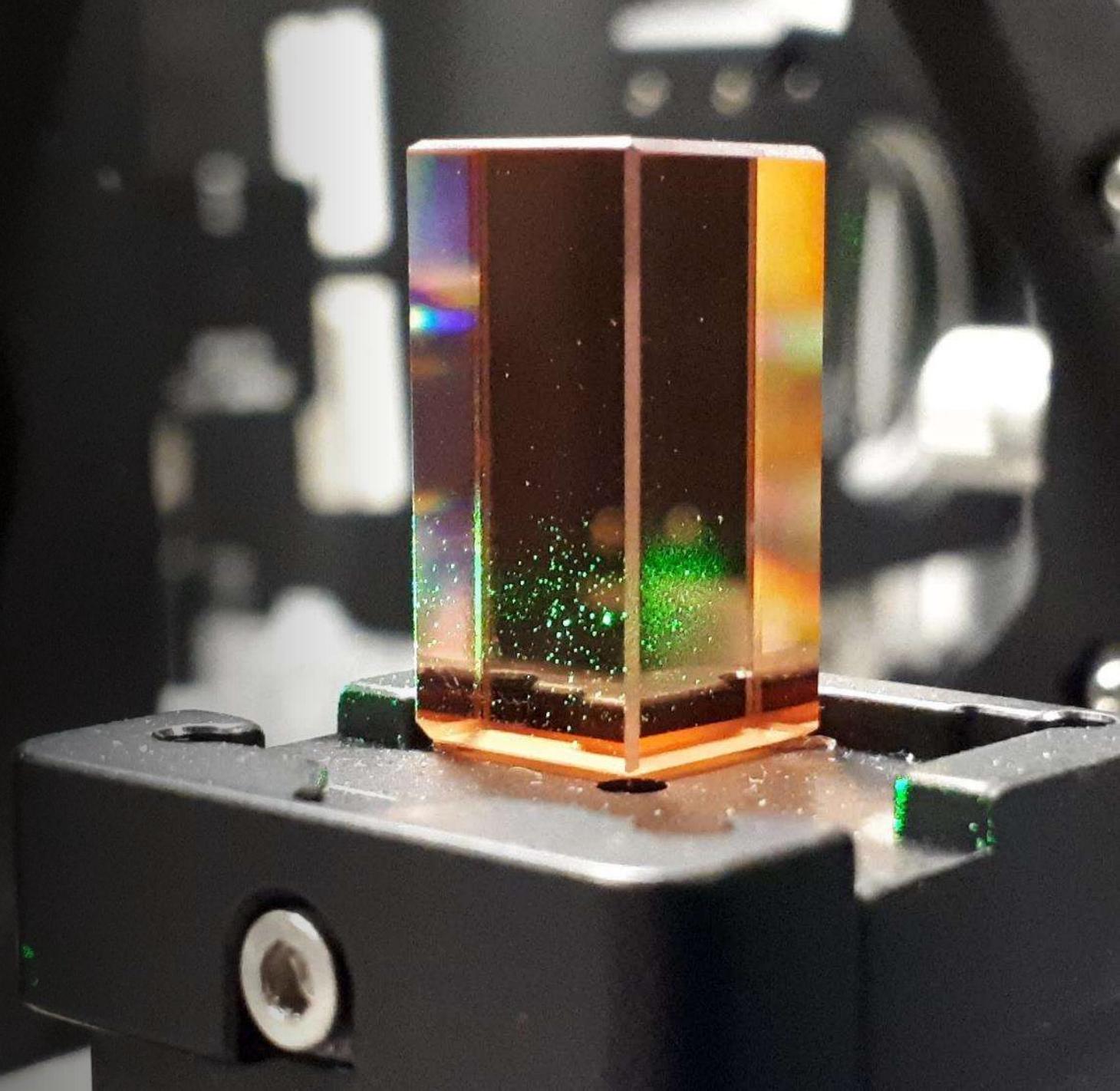


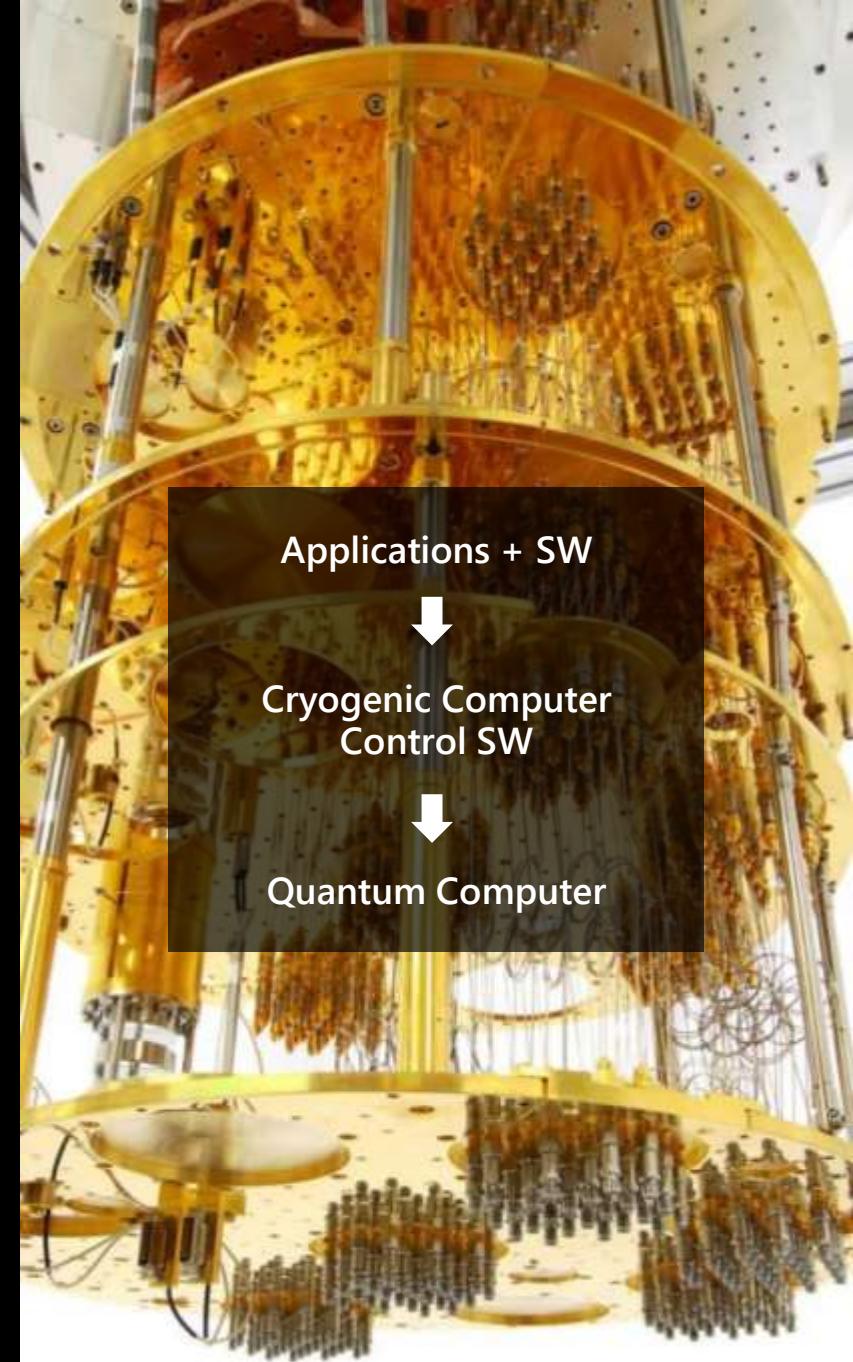
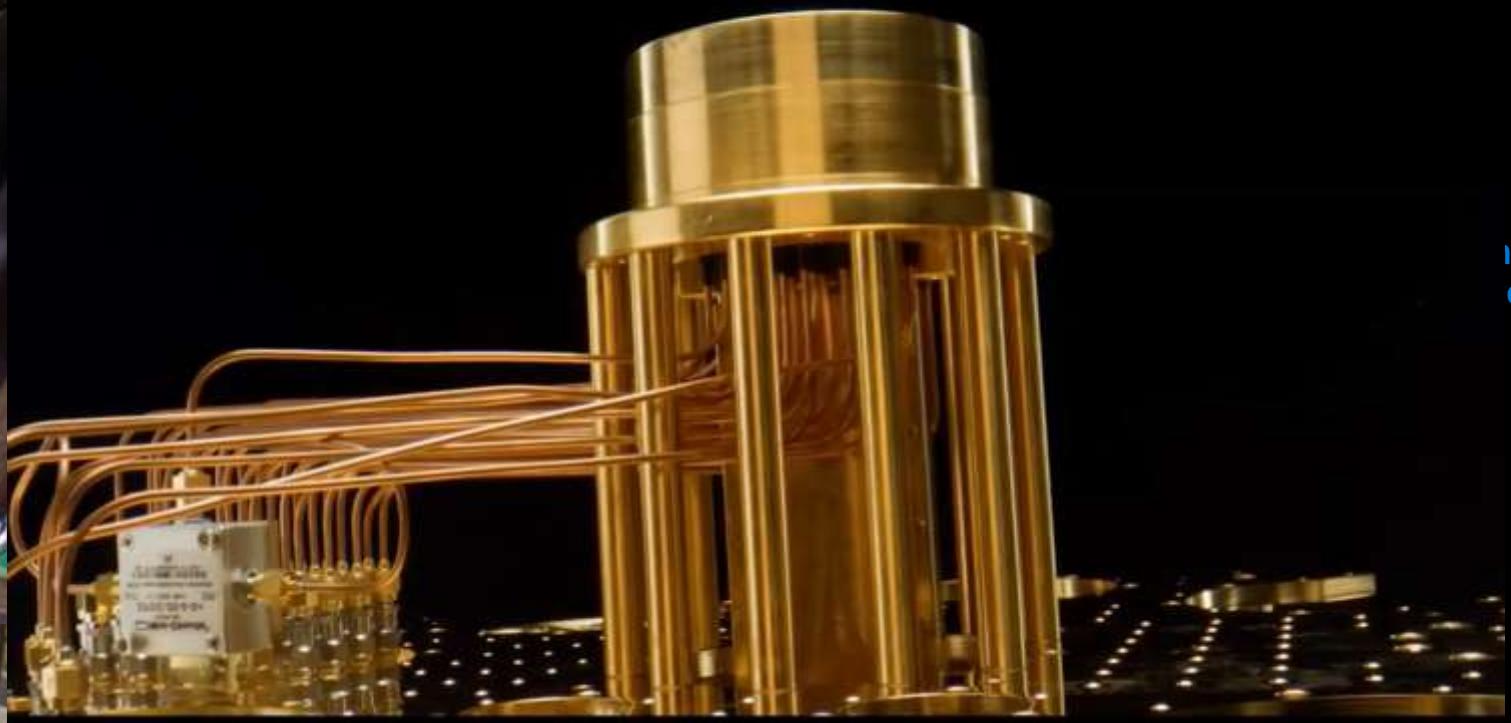
# Project Silica → Permanent Storage?



[https://youtu.be/W0ntAnqJ\\_7c](https://youtu.be/W0ntAnqJ_7c)

# Holographic storage

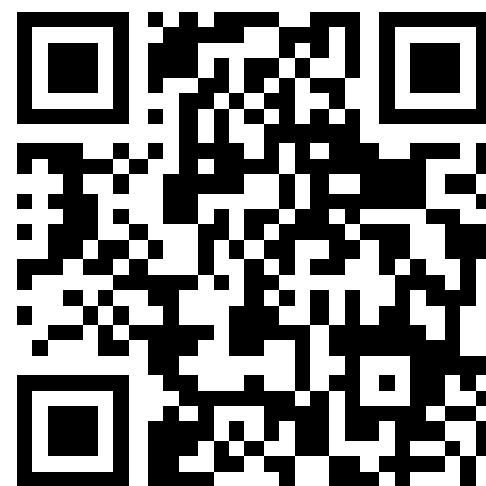




# FEEDBACK

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Please take 5 minutes and let us know the how this virtual session was for you.





An online version of Mark Russinovich's' Ignite 2021 presentation is available here:  
<https://youtu.be/o2W1bo1DjQY>

Visit our public website to read more on Azure Datacenters at:  
<https://aka.ms/MSDCInfo>

Azure business continuity: <https://azure.microsoft.com/en-us/blog/update-3-business-continuity-azure/>