



# Welcome : Cloud Computing Fall 2021, ReDI NRW

Tuesday, November 16, 2021

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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.

Global Reach



DC  
Generations



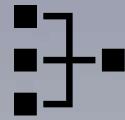
360 Sites



Servers



Network



Storage



Security



Sustainability



# WE LIVE IN THE CLOUD

Explore the hidden world of datacenters

What's Next



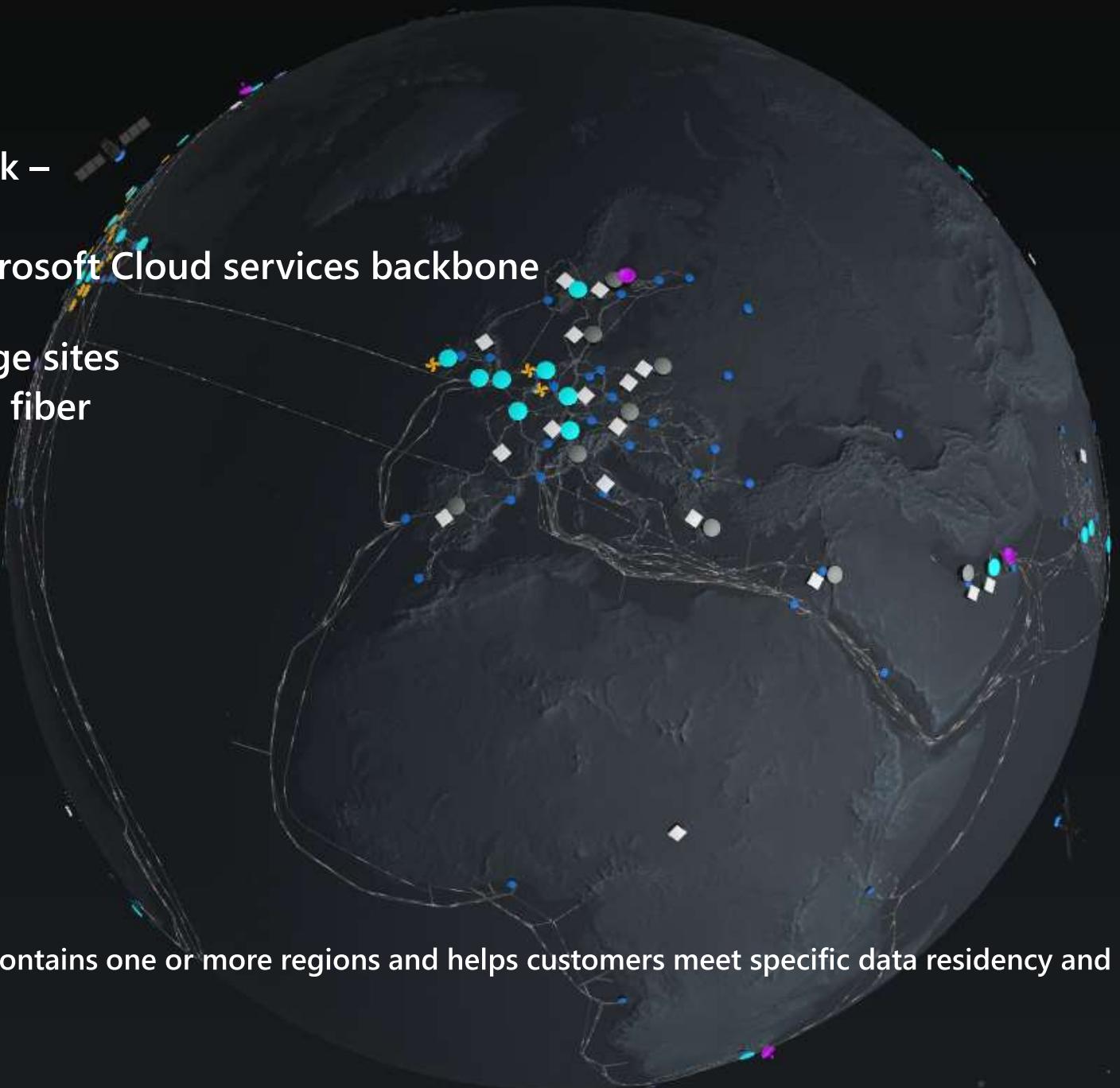
- View all
- Show coming soon
- Geographies
- Regions ?
- Networking ?
- Edge Zones
- Network PoP
- - WAN links
- Ground stations ?
- Sustainability projects
- Wind
- Solar

## Global Network –

Dedicated Microsoft Cloud services backbone

185+ PoP / edge sites

165k+ miles of fiber



# 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

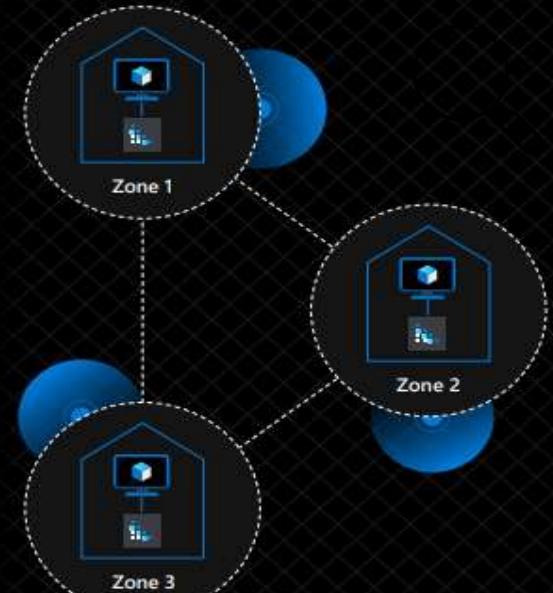


**99.999999999% (11 9s)**  
Storage durability (annually)

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

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

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

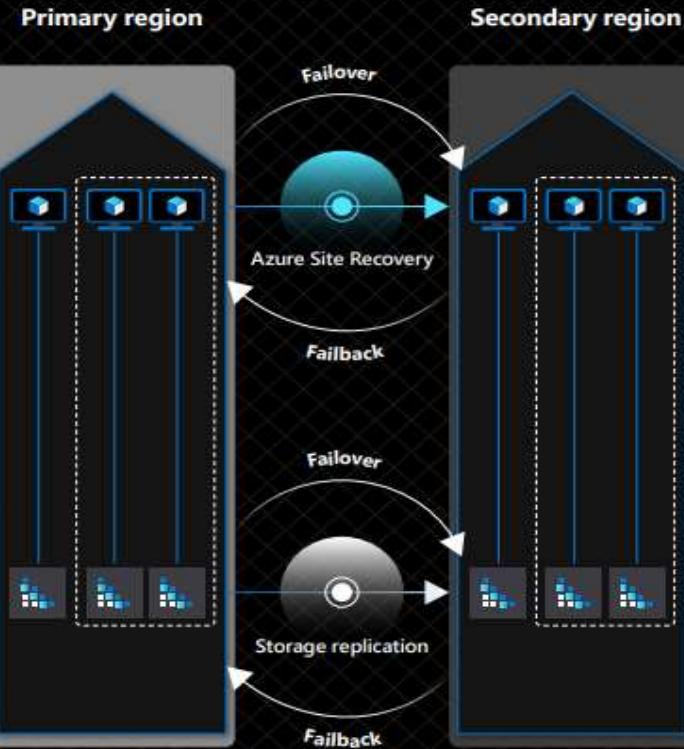


**99.999999999% (12 9s)**  
Storage durability (annually)

**Zone-Redundant Storage (ZRS)** 

**Industry-Leading**  
RPO and RTO

**Azure Site Recovery** 



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

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

# Datacenter generations 1989-2021



# Datacenter generations 1989-Today

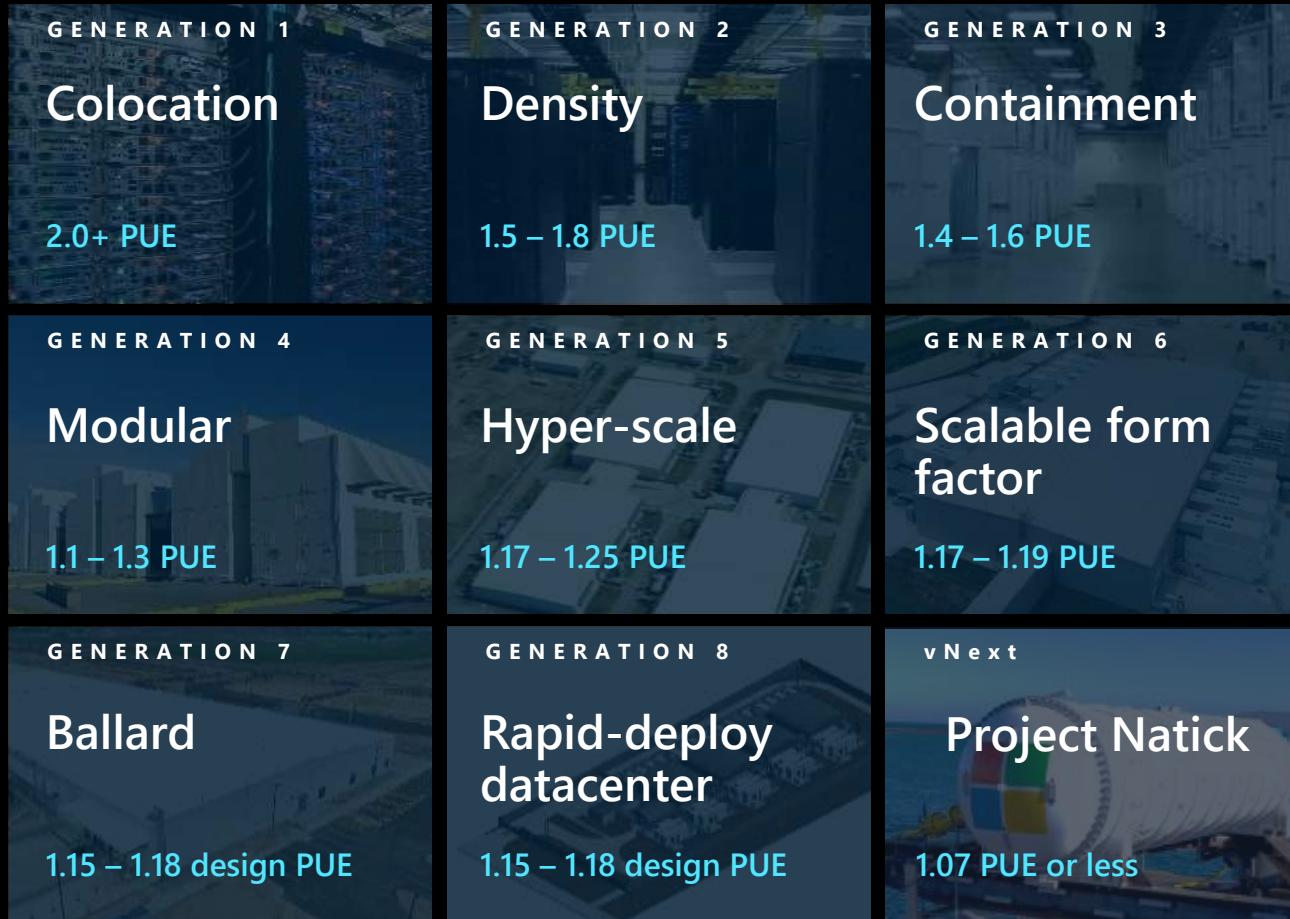
## Innovation concepts:

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



**Total Facility Power**

**IT Equipment Power**



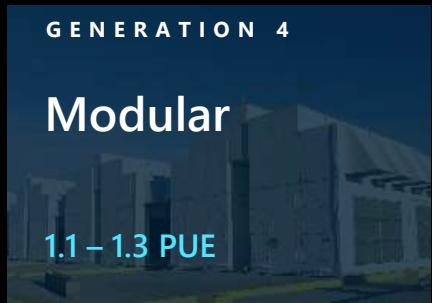
## DC Generation Design Focus:

- 2 - Scale and density
- 3 - Efficiency
- 4 - Standardization
- 5 - Scale
- 6 - Flexibility
- 7 - Optimization
- 8 - Speed to market

**1.189**

PUE global average

# Datacenter generations



## FUTURE **Project Natick**

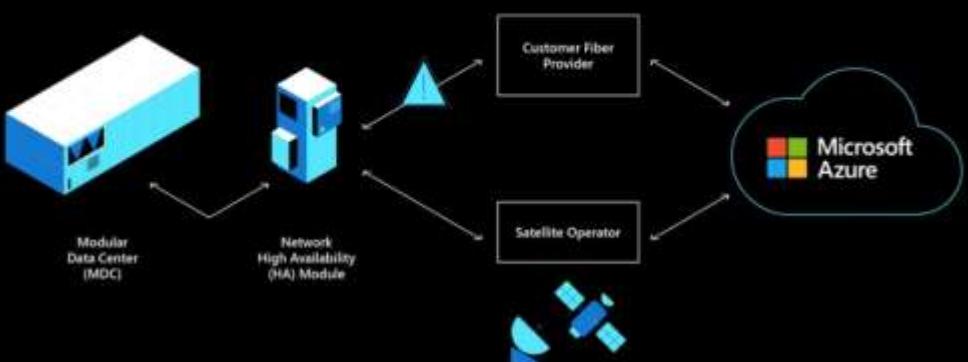
- ✓ Rapid deployment
- ✓ Close to population centers
- ✓ High energy density (40 kW/rack)
- ✓ 5 MW platforms
- ✓ Resistant to hurricanes, solar storms, earthquakes
- ✓ 1.07 or less PUE

# 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.

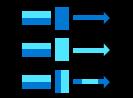
<https://youtu.be/x2IVXLoLSro>

# AIOps

-  Fast and actionable anomaly detection
-  Auto-communication
-  Automatic impacted service identification
-  Impact assessment and incident aggregation
-  Root cause service identification
-  Efficient outage management
-  Diagnostic experiences



Customer Experience



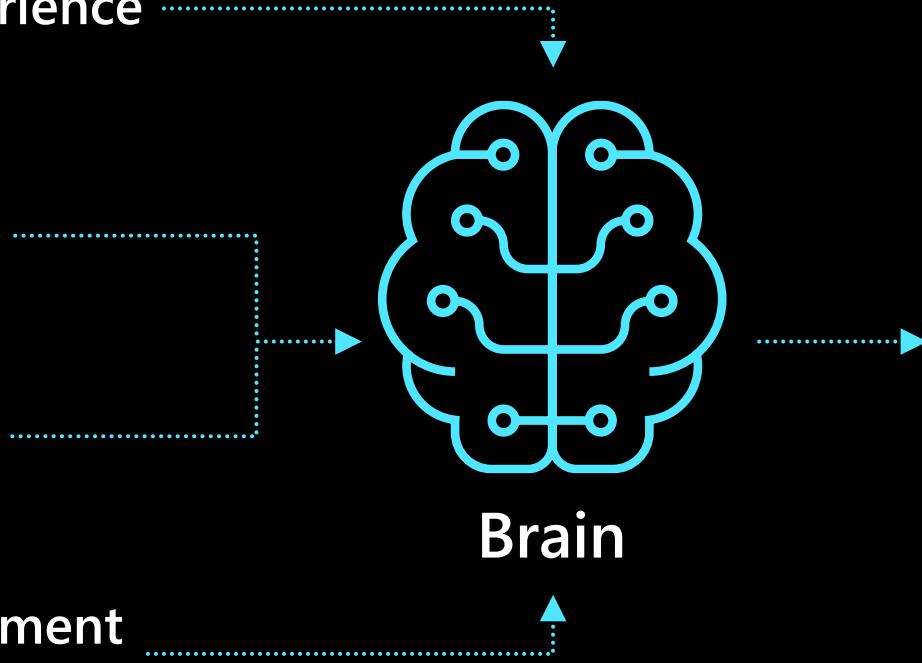
Azure Services



Infrastructure  
devices



Critical Environment  
and Mechanical





Amsterdam – West Europe Region



Quincy, WA – West US2 Region



Dublin – North Europe Region

# Efficient cooling



Purpose-built  
infrastructure



vmware

ORACLE

NetApp

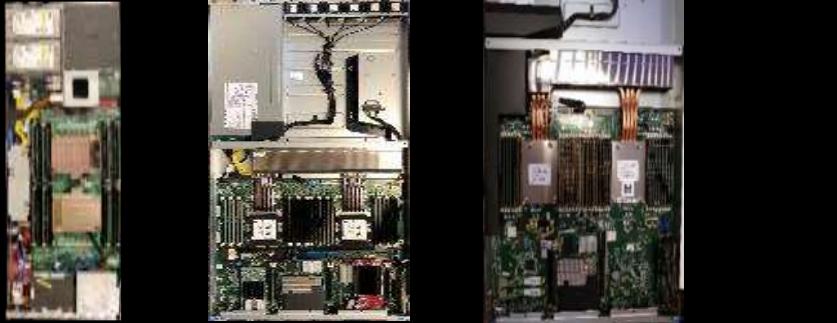
CRAY



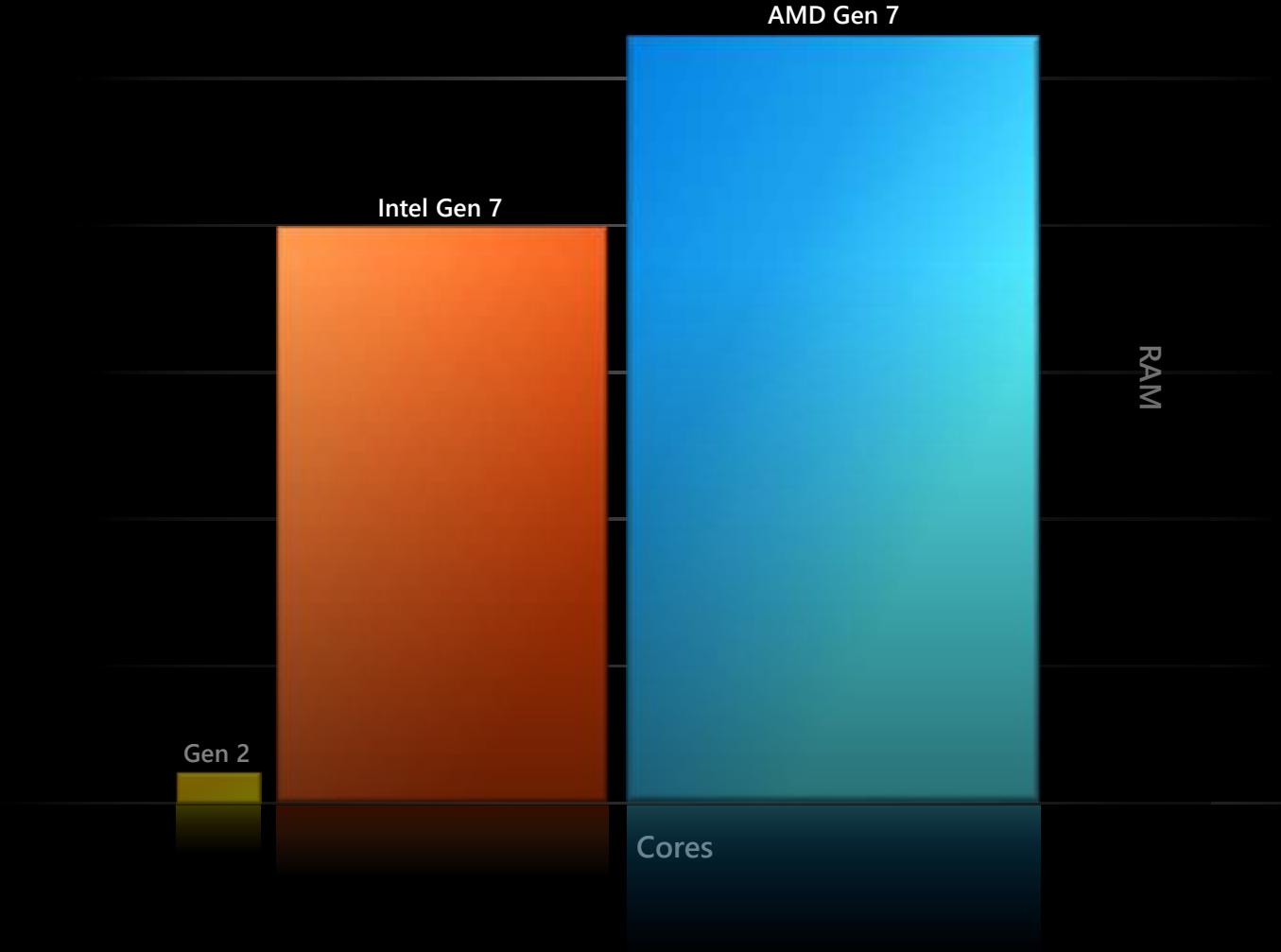
# Inside cloud servers

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

# General computer servers



Gen2	Gen7 Intel	Gen7 AMD
2 x 6 core	2 x 26 core Cascade Lake	2 x 32 core Rome
32 GiB	576 GB DDR4	768 GB DDR4
6 x 500 GB HDD	7 x 960 GB M.2 NVMe	7 x 960 GB M.2 NVMe
1 Gb/s	50 Gb/s + FPGA	50 Gb/s + FPGA



# Memory optimized servers

2020



Beast V2

Godzilla

Beast



2 x 16 core

Beast

4 x 18 core



512 GiB



9 x 800 GB  
SSD

1 x 960 GB SSD  
4 x 2TB NVMe



40 Gb/s

40 Gb/s

2019

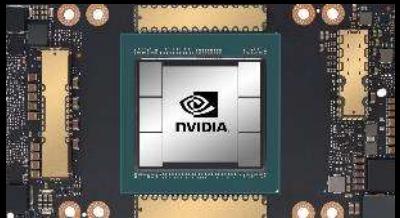
2017

2014



# 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

	Traditional IT	Cloud supported
Time to provision	Weeks/months to provision resources	Minutes/hours to provision resources via self-service access
Hardware usage	×  1 CPU for 100 hours	×  100 CPUs for 1 hour
Location	Location-dependent	Accessible everywhere

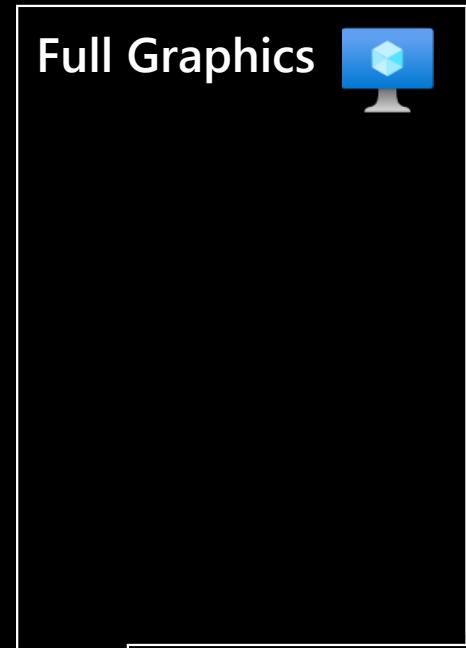
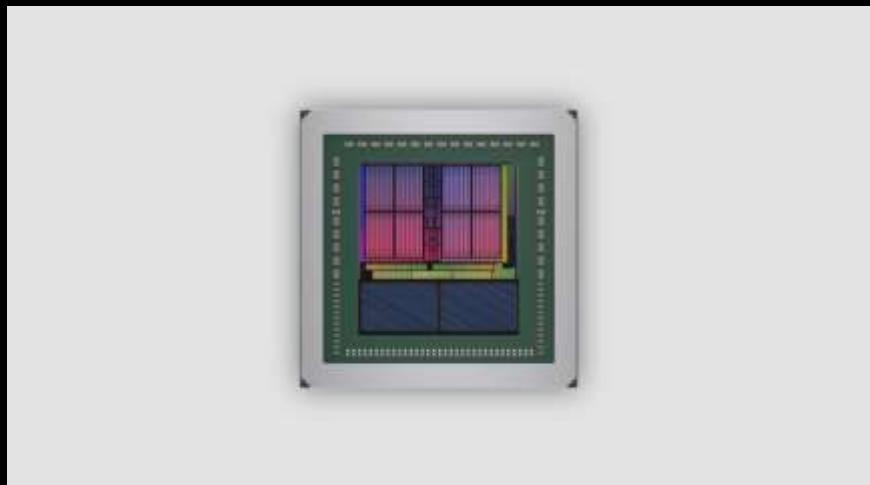
# New NVv4 VMs with fractional GPUs

AMD Rome EPYC CPU + Radeon Instinct MI25 GPU

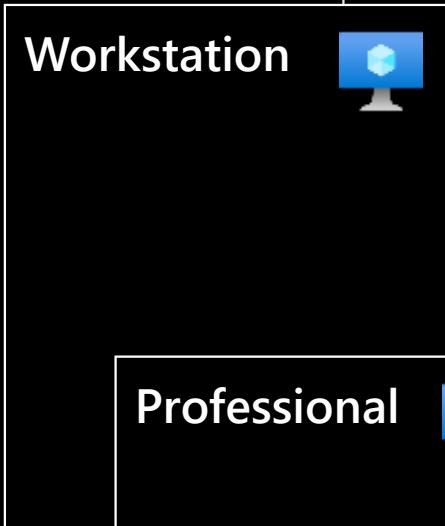
Built on GPU partitioning technology

Whole or fractional dedicated GPU acceleration

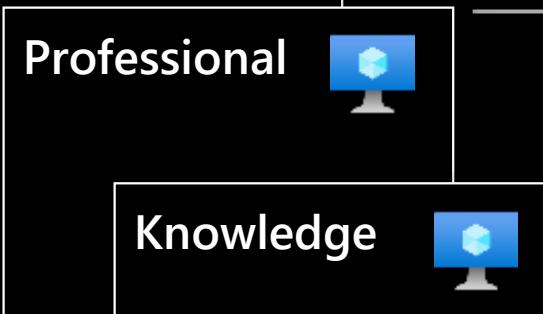
Used by Windows Virtual Desktop



→ 32 vCPU Cores  
112 GB RAM  
16 GB GPU RAM  
1-2 Displays @ 4K  
3-4 Displays @ 1080p



→ 16 vCPU Cores  
56 GB RAM  
8 GB GPU RAM  
1 Display @ 4K  
2-4 Displays @ 1080p



→ 8 vCPU Cores  
28 GB RAM  
4 GB GPU RAM  
1 Display @ 4K  
2-3 Displays @ 1080p

→ 4 vCPU Cores  
14 GB RAM  
2 GB GPU RAM  
1 Display @ 1080p



Inside Cloud Networking



# Rack hardware

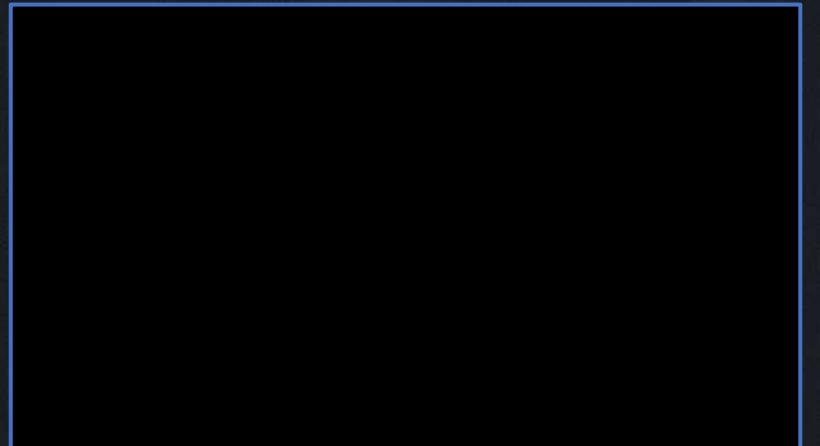
50 Gb/s SmartNIC/FPGA

200 Gb/s+ Software Defined Appliances

ToR Routers

Accelerated Networking

Container Underlay (SWIFT)



# DC hardware

1M+ miles of fiber cable per datacenter

Azure Firewall

Azure DDoS Protection

Azure Load Balancer

Software for Open Networking in the Cloud (SONiC)



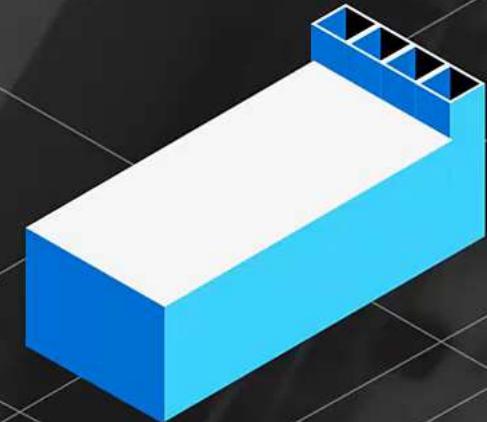
# Intra-region

**Regional network gateways**  
connect DCs and regions

**28MW** to **528MW** sized

~100km contiguous geographical area

AZ to AZ – 2.0 ms



# Microsoft WAN

130k+ miles of fiber and subsea cable

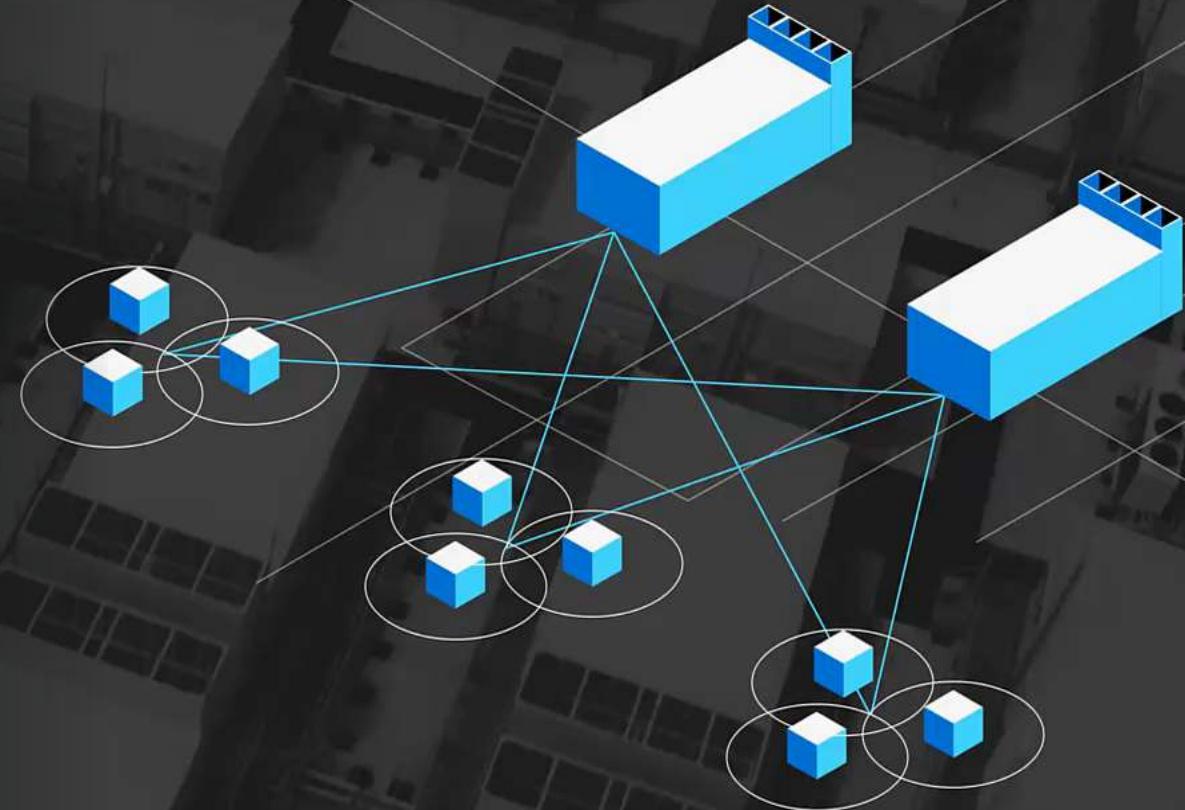
300 Tb/s added to WAN in 2020

Dedicated dark fiber WAN

Optical networking (DWDM)

Network Watcher

Network Performance Monitoring



# Last mile and enterprise connectivity

185+ edge sites

100% growth of peering capacity in 2020

ExpressRoute

CDN

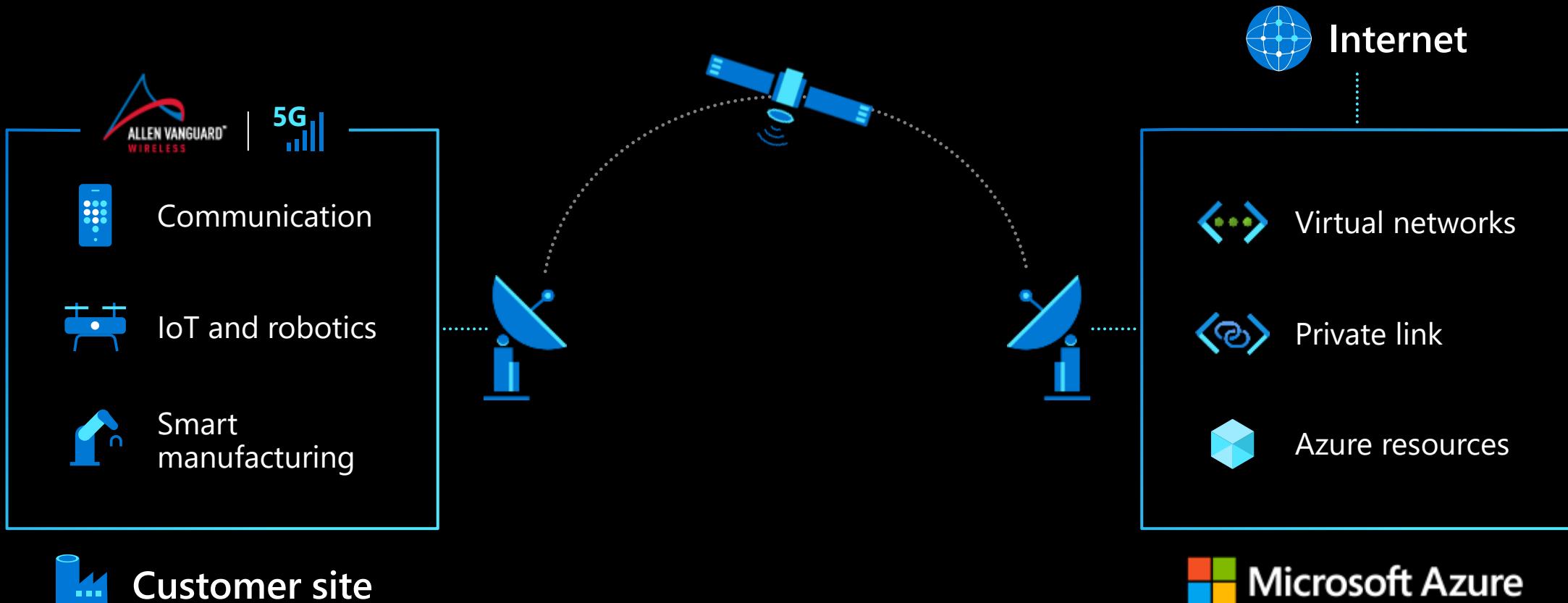


# Azure Orbital - **Ground Station as a Service**



Earth  
observation

# Global Communication and IoT



# Optical networking

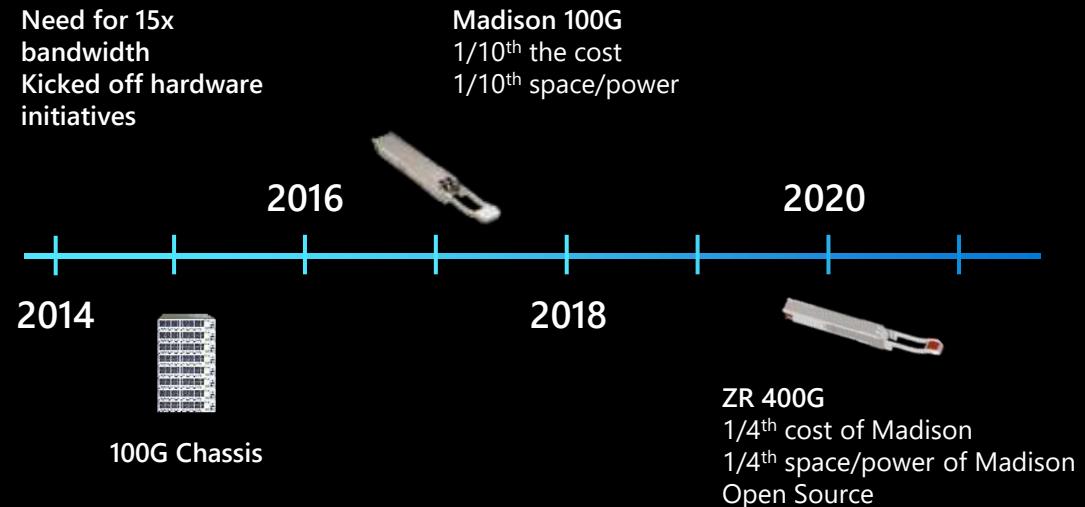
## Dense Wavelength-Division Multiplexing (DWDM)

### Regional network gateway

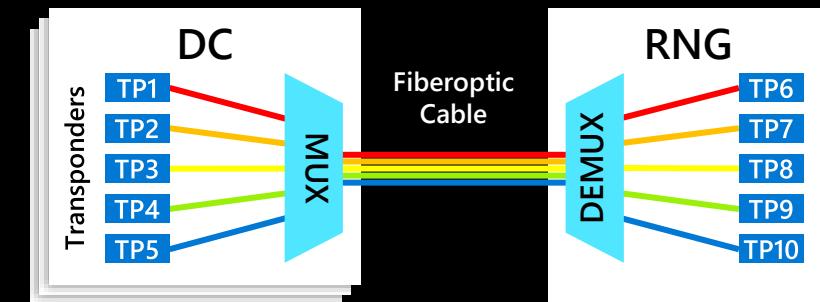
- Azure experiences up to 30 cuts/day
- Less fibers to maintain and repair

### More efficient over long distances

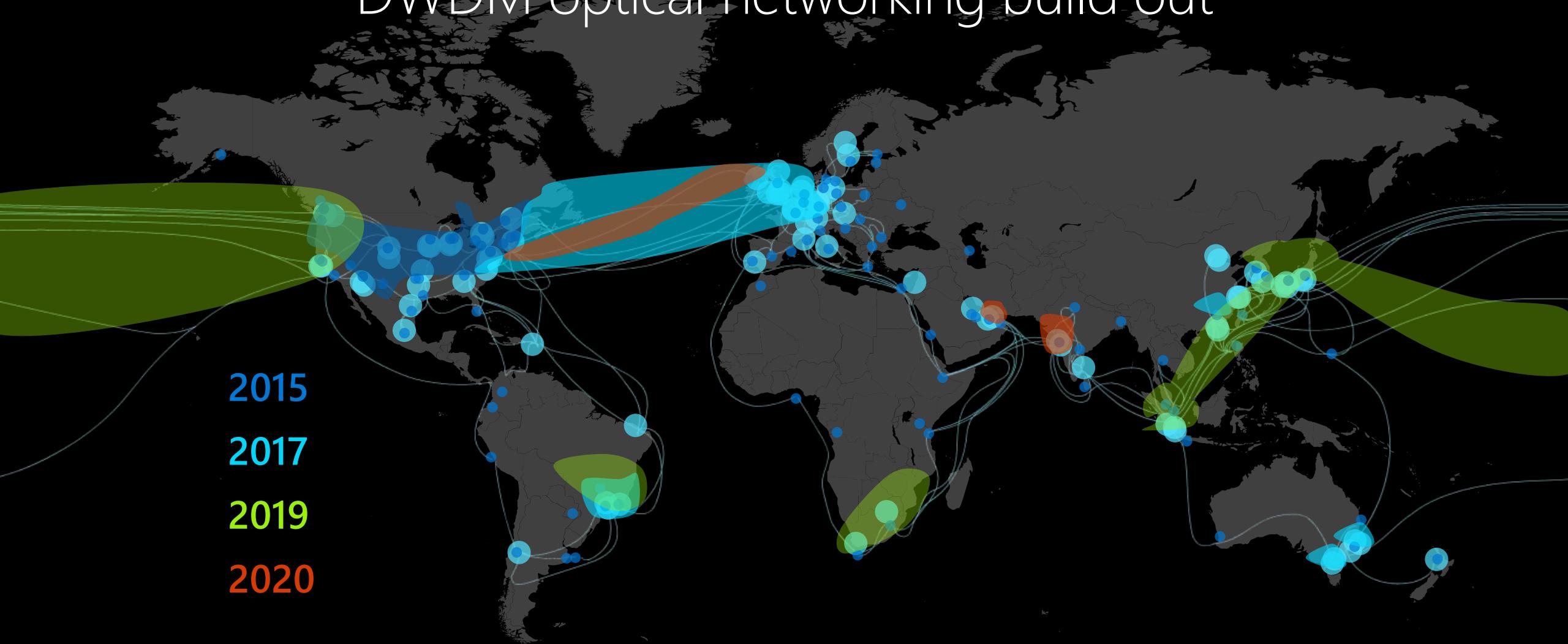
- Thousands of dollars per mile per fiber
- Single amplifier every ~80km



### Dense Wavelength-Division Multiplexing (DWDM)



# DWDM optical networking build out



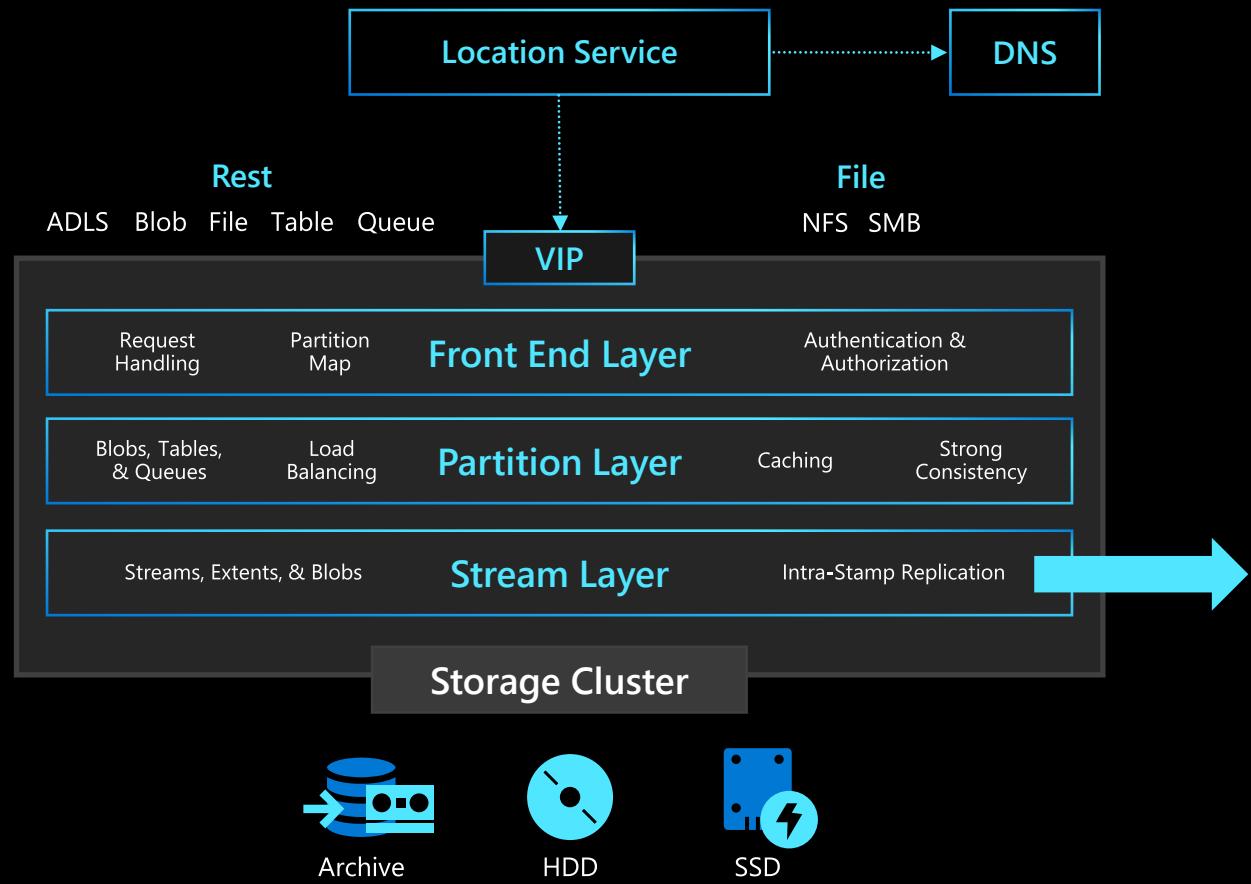


Cloud Storage





# 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

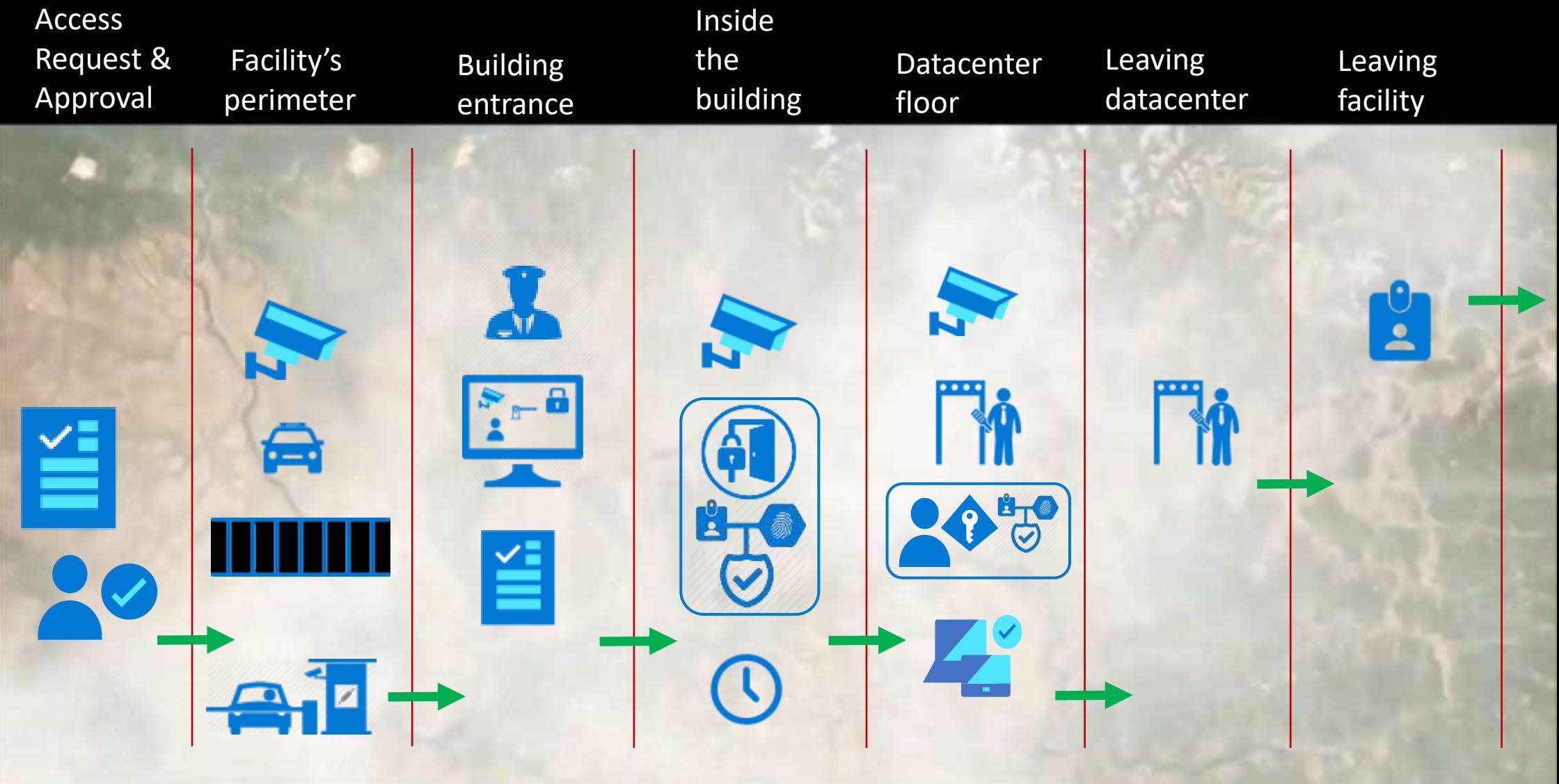


Uses 3DCrossPoint (3DxP)  
for high performance and durability

# DBD Decommissioning



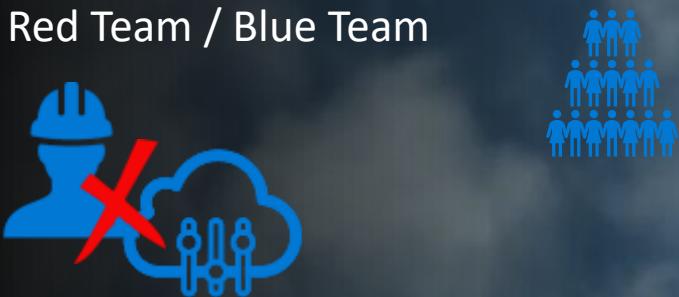
# Layered security approach



# Trust Your Cloud

24+ trillion threat  
signals analyzed daily = 16.8 billion signals per second

Microsoft Cyber Defense Operations Center  
Red Team / Blue Team



Datacenter personnel do not provide:  
Azure Service Management



Auditors using  
HoloLens and  
Remote Assist

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

# How is your data protected?

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

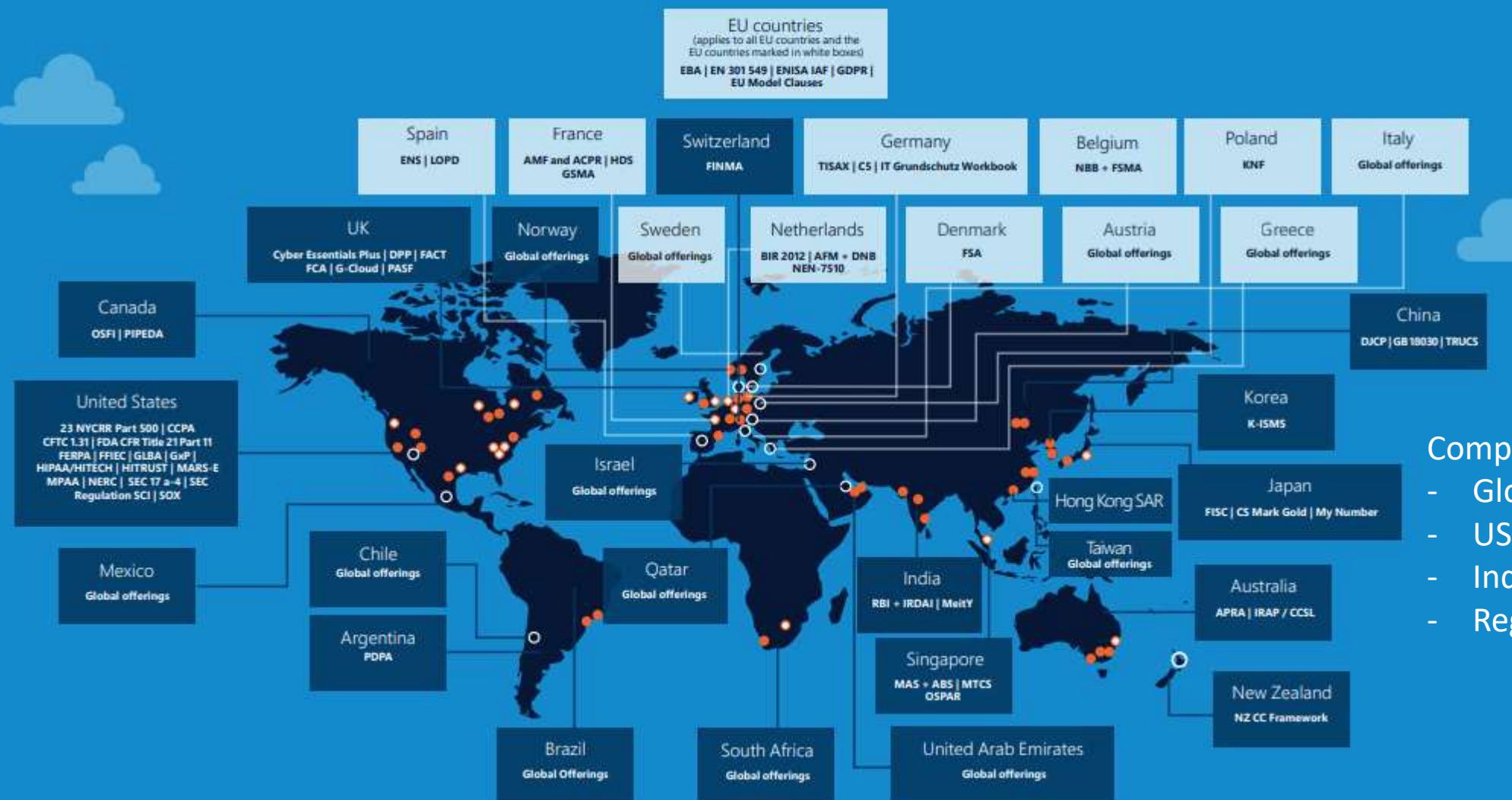
- Cryptography
  - For storing data, in applications, & on the network (encryption & decryption).
- Key management
  - Provisioning, lifecycle management, security/protection
- Authentication, authorization, & access control



# 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](#)





# Azure energy sustainability

Circular Centers  
24/7 solution  
Zero waste operations  
PUE 1.189 global average

2025

100% renewable  
energy

98% lower

carbon emissions

93% more

energy efficient than  
traditional enterprise  
datacenters



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

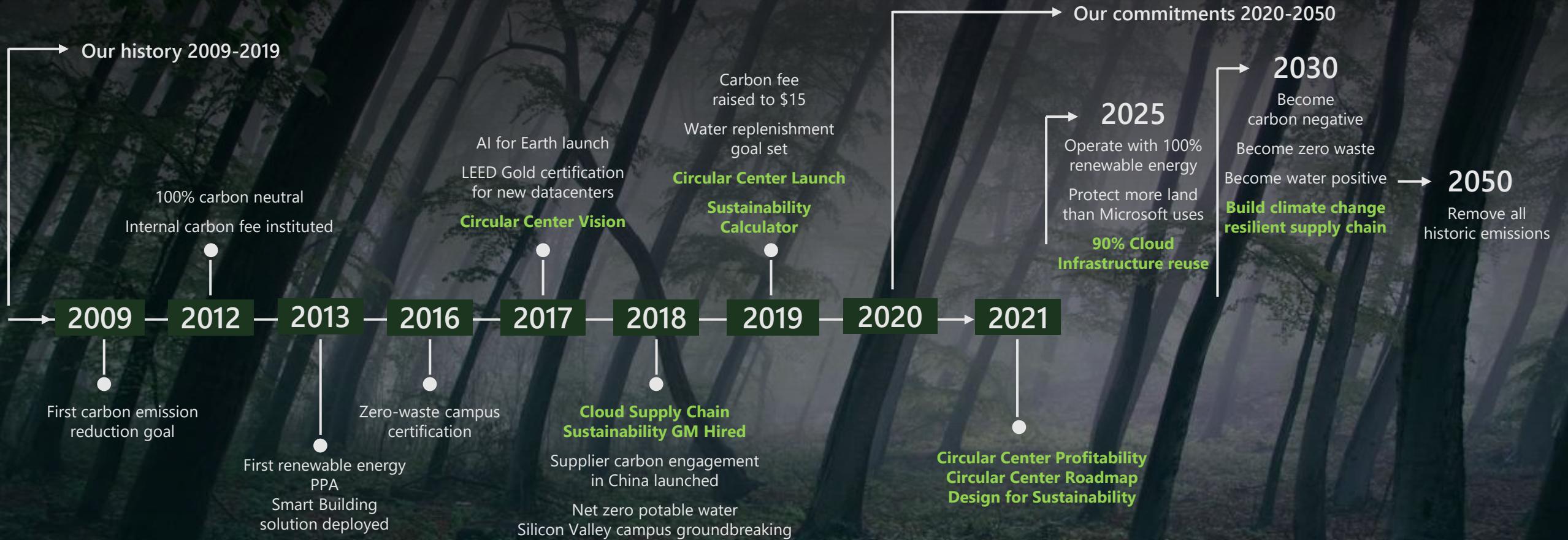
Carbon  
negative

Zero Waste

Water  
positive

Restore more  
land than we  
use

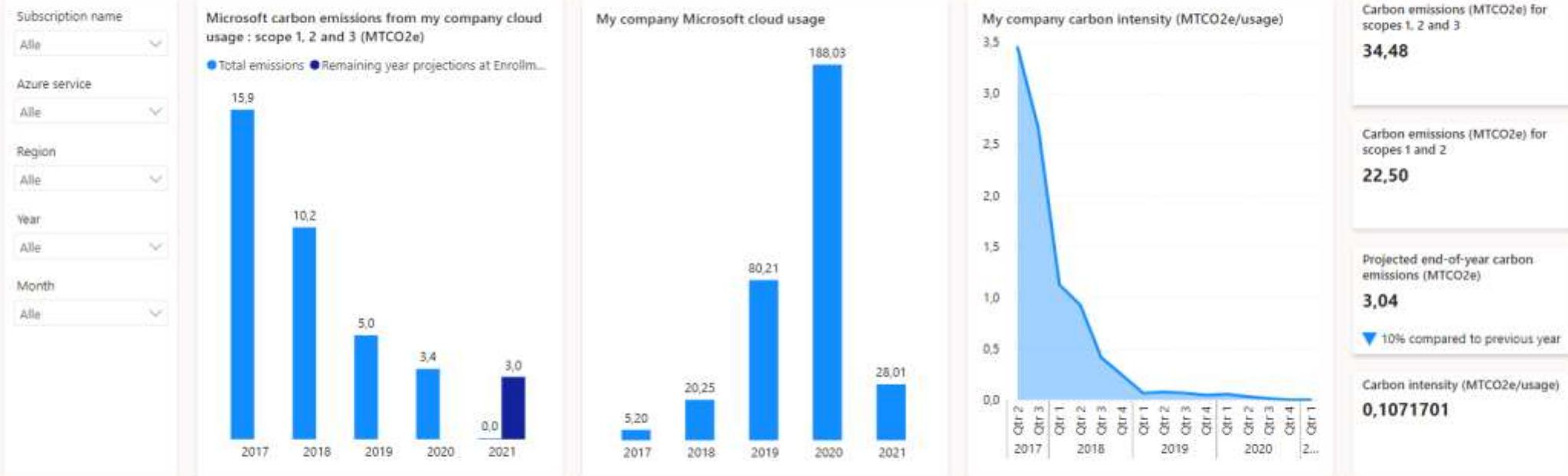
# Decades of action



# The emission impact dashboard

## Microsoft carbon emissions from my company cloud usage

Reflects activity through Jan 2021



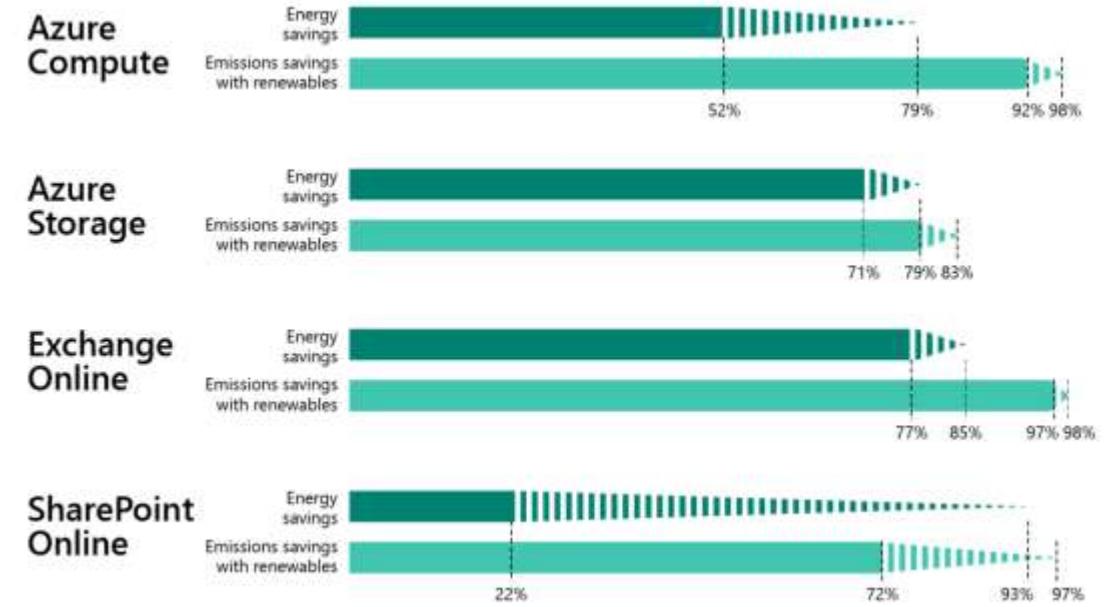
# Migrating to the Microsoft cloud reduced our carbon footprint

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

Moving on-premises datacenter op  
Microsoft cloud can reduce your ca  
between:

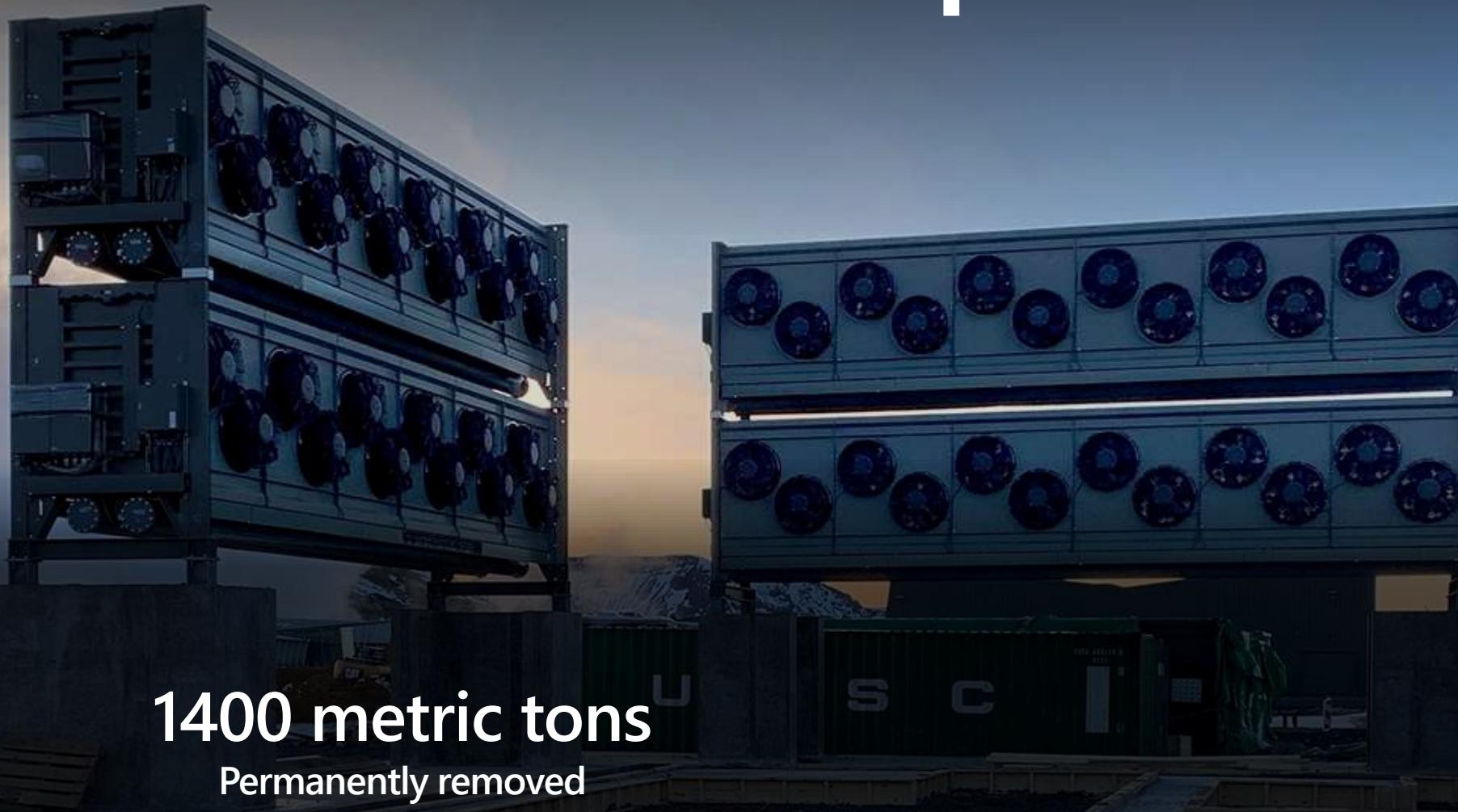
**72 - 98%**

between **22 - 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

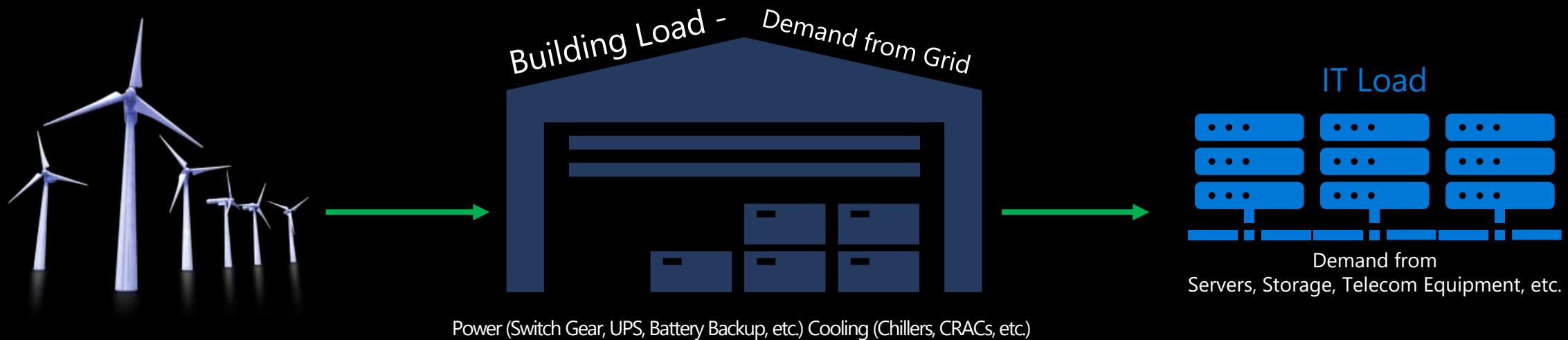
Credit: Climeworks

# 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.



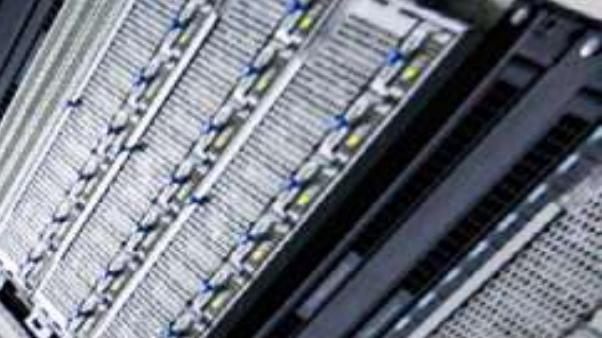
## Investing in the future of circularity

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.



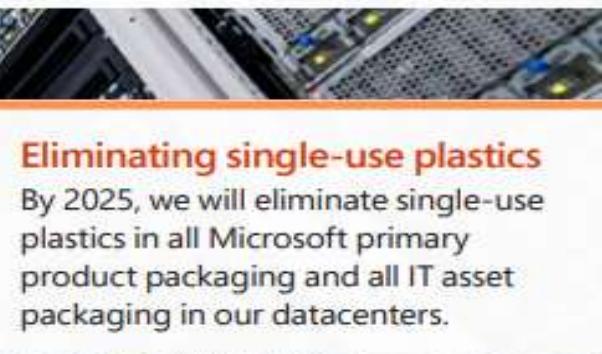
## Increasing reuse of servers and components through Circular Centers

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.

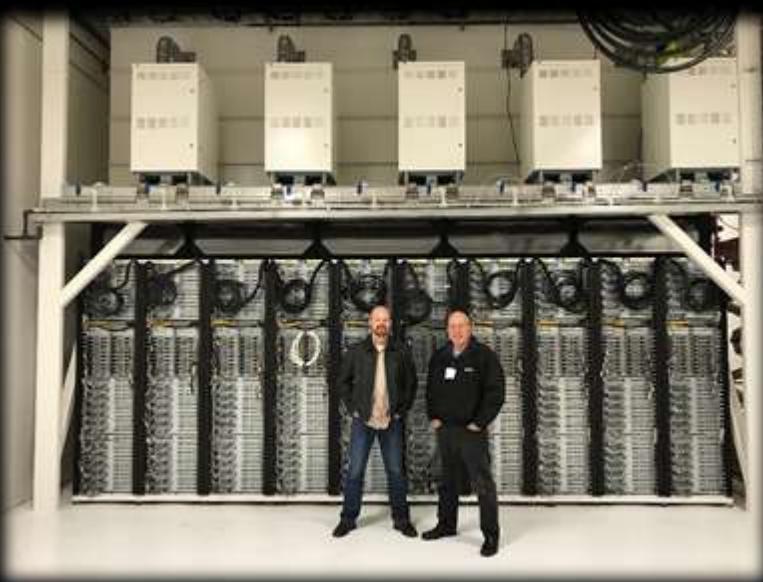
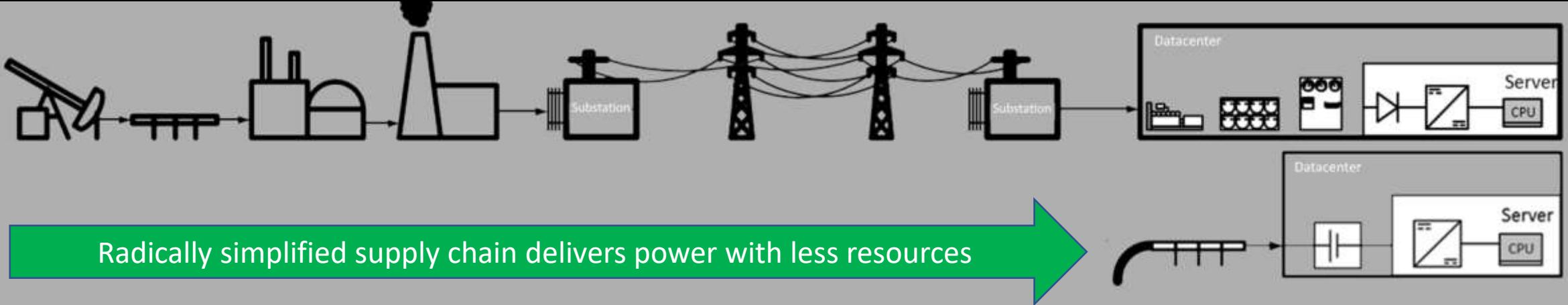


## Eliminating single-use plastics

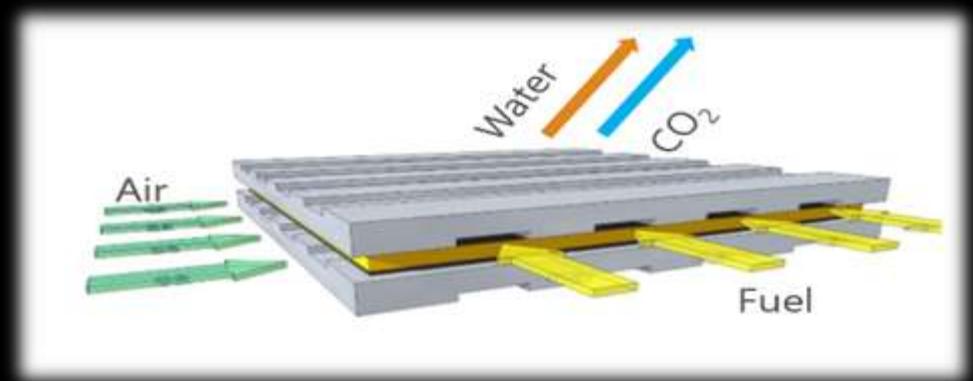
By 2025, we will eliminate single-use plastics in all Microsoft primary product packaging and all IT asset packaging in our datacenters.



# 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.

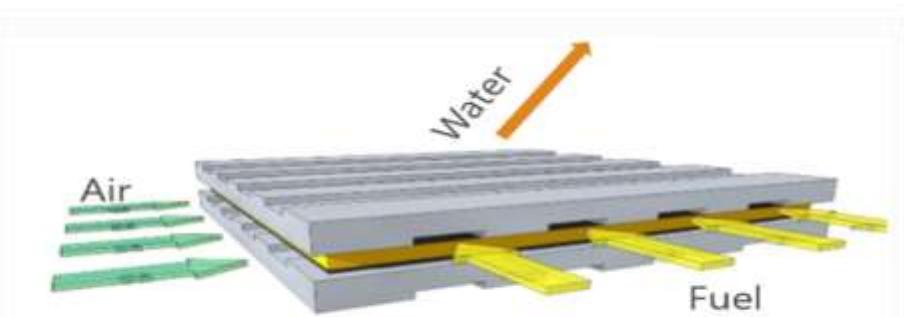
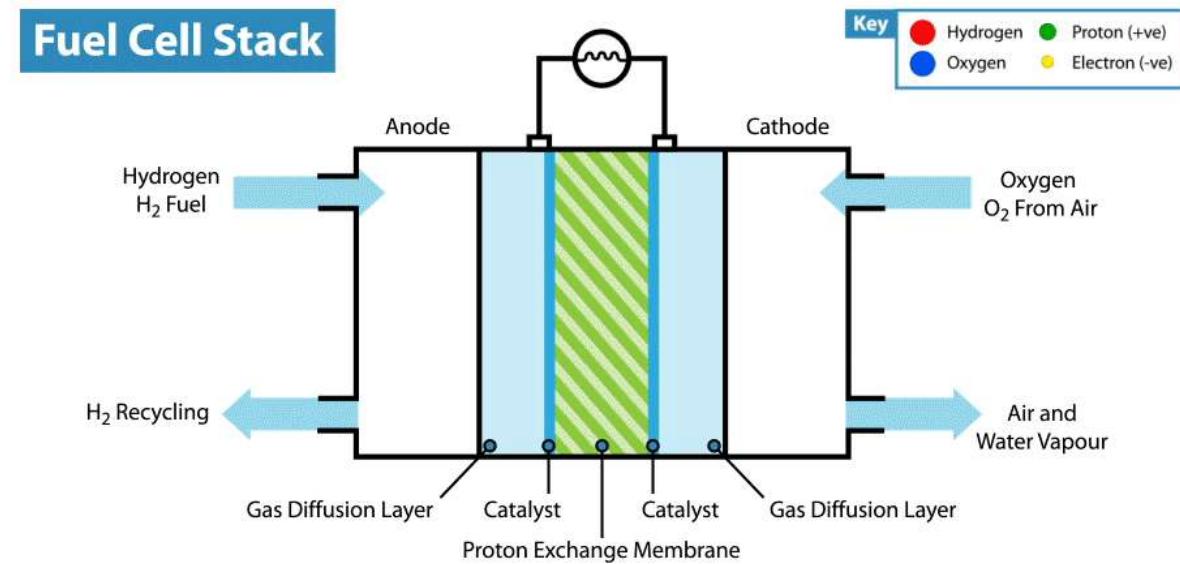


# Redesigning Datacenters for

# 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.



# Simplicity roadmap

Traditional

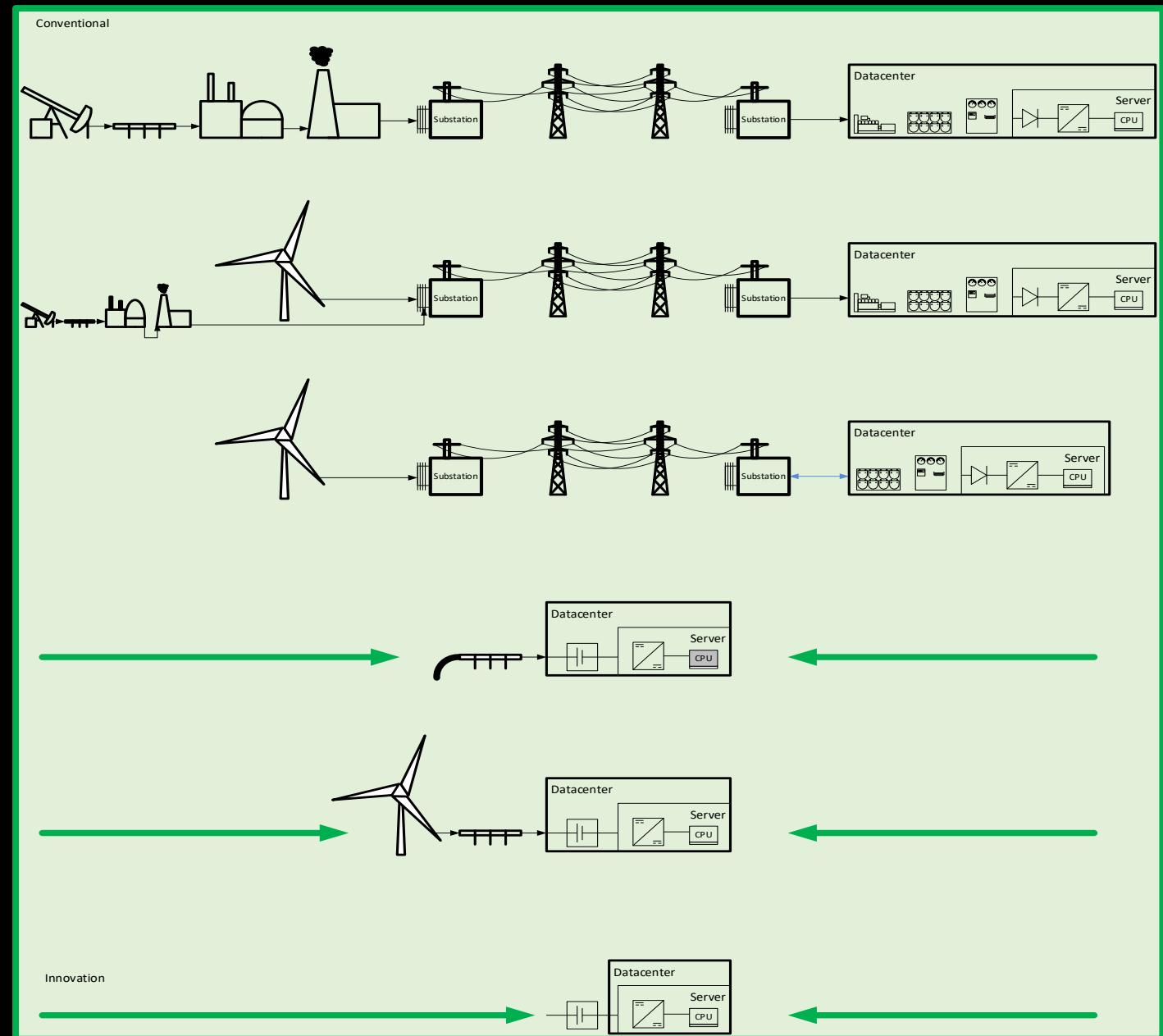
Renewable mix

100% renewable

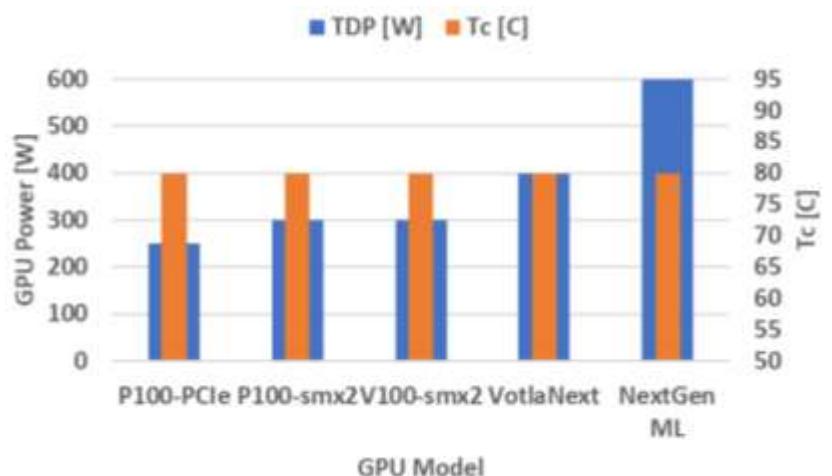
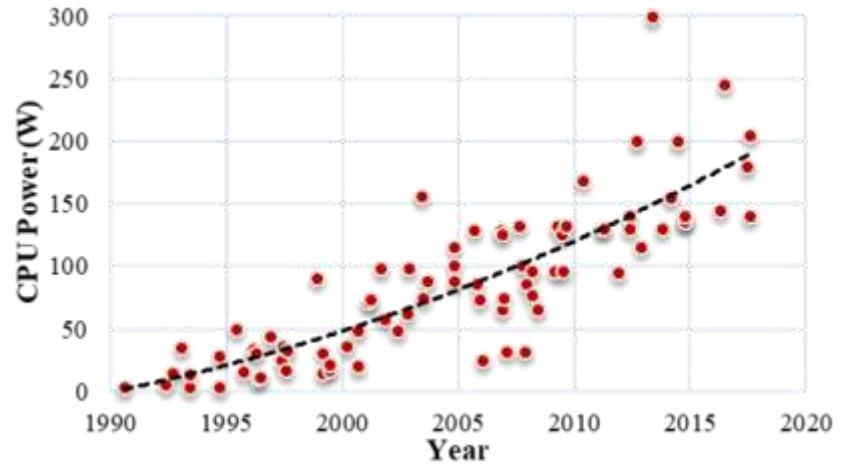
Direct gas to rack

Renewable H2

H2 economy



# Liquid Cooling



## GPU trends



MSFT G50 Expansion 4kW



Nvidia DGX-2, 10kW

# Liquid Cooling

Micro-channel  
Cold Plates



One  
phase  
immersion



Two  
phase  
immersion



# Liquid Cooling Datacenter Testing



Liquid Cooling



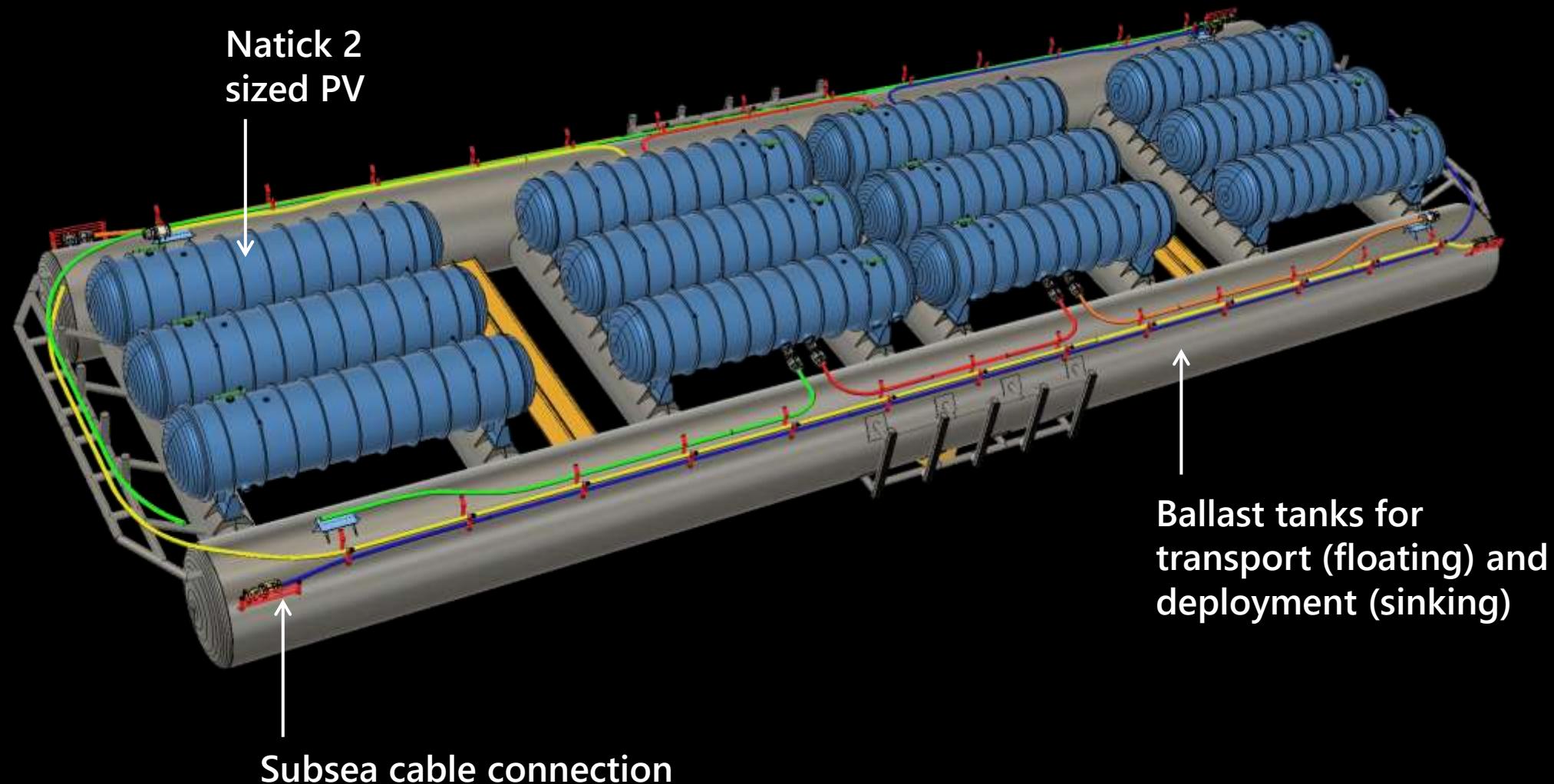


# Project Natick v2

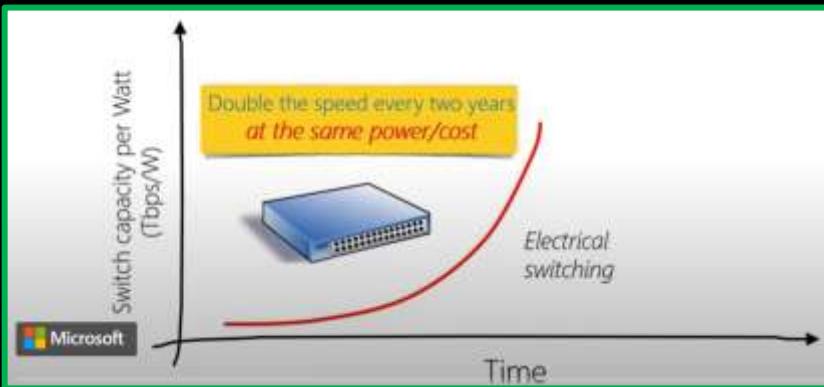
## 2018 -- 2020



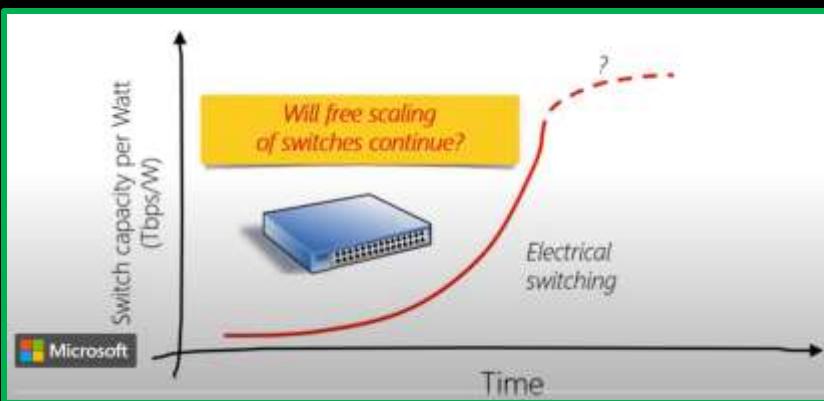
# Project Natick v3



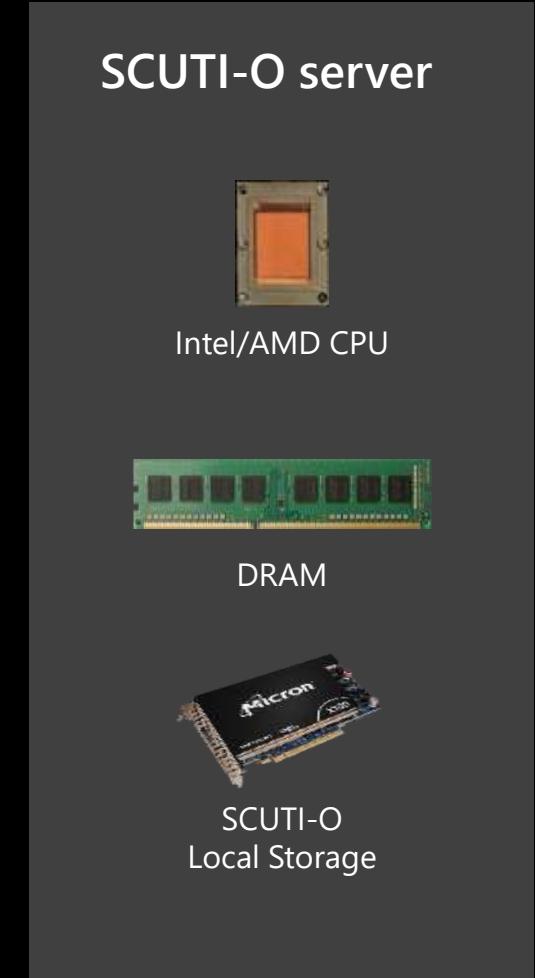
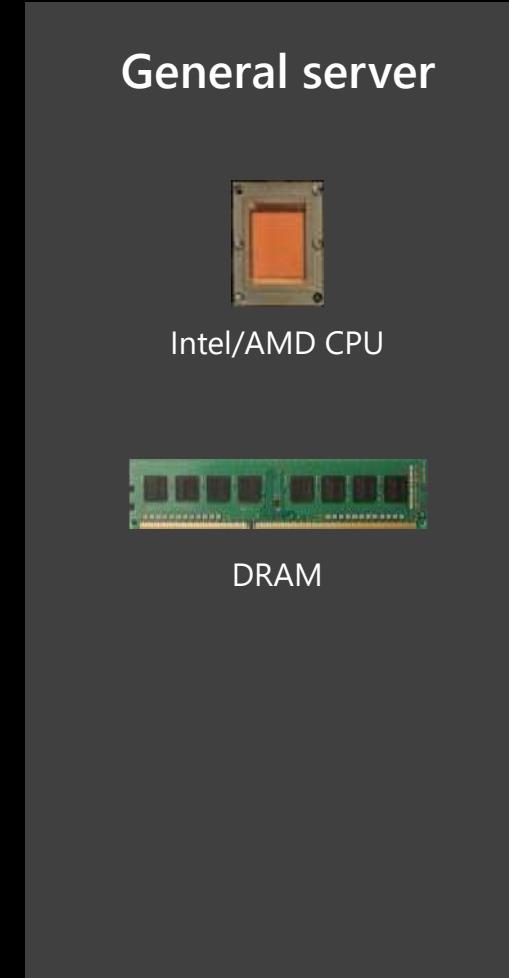
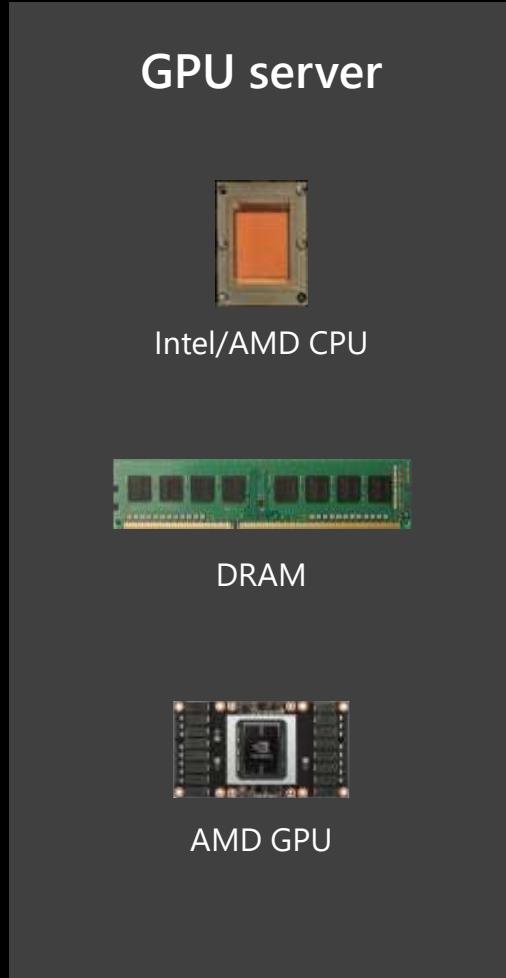
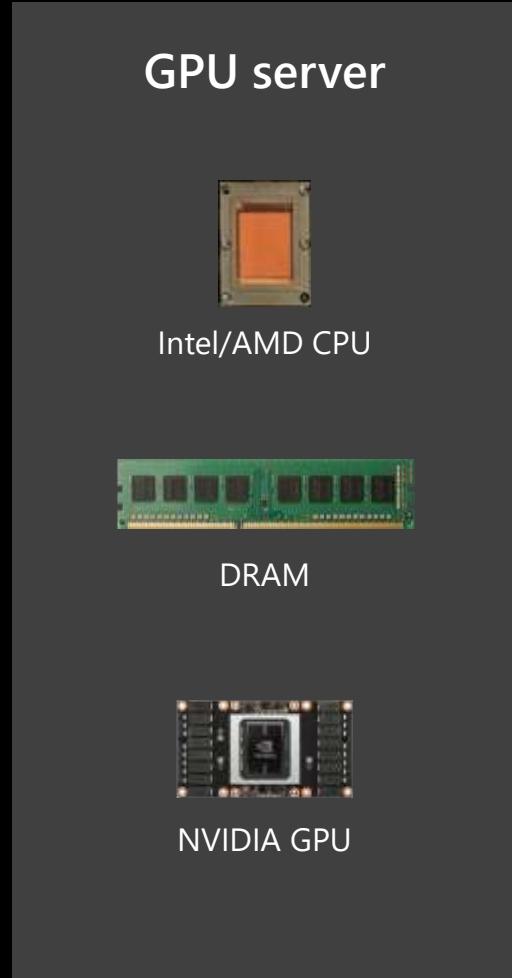
# Project Sirius: the sustainable network



The end of Moore's law for networking?

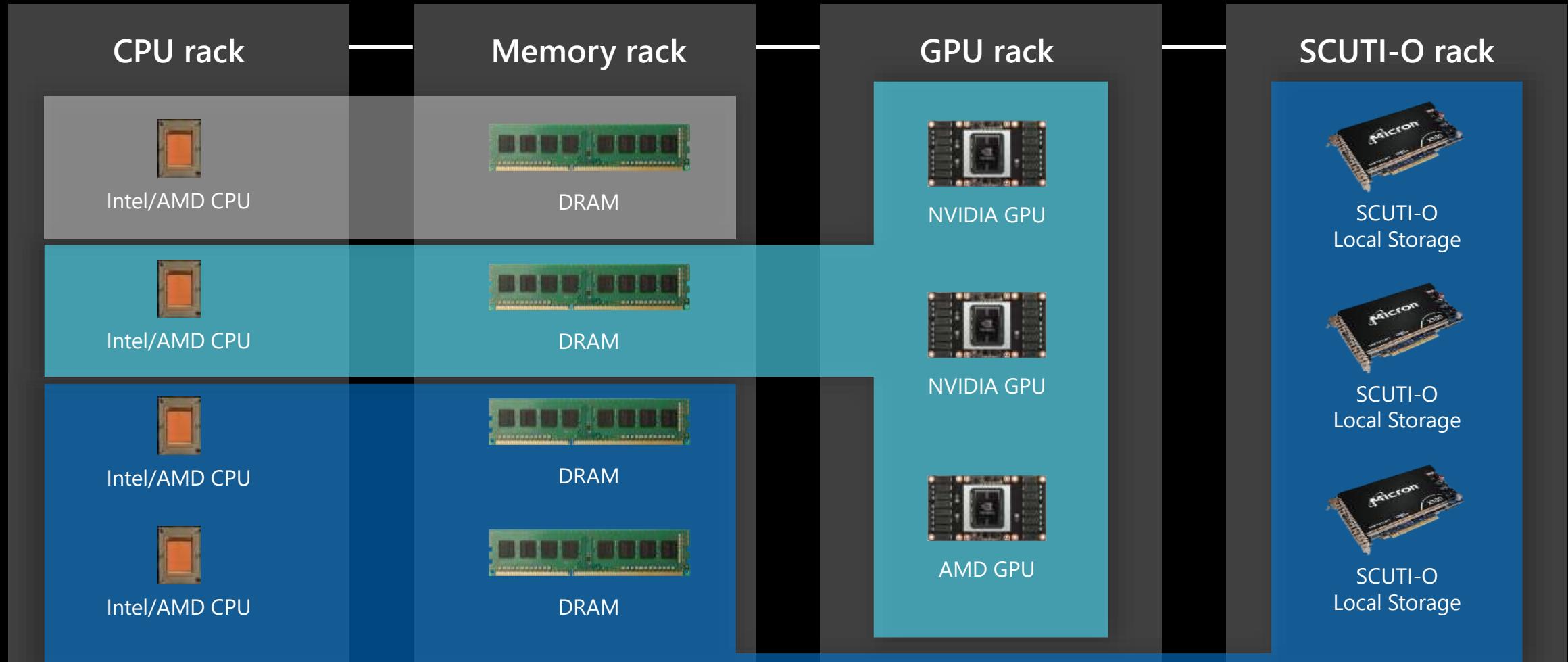


# Traditional rack architecture

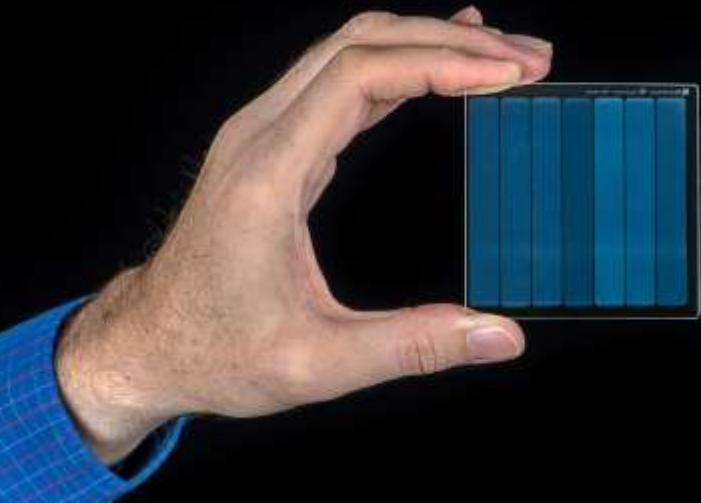


# Disaggregated rack architecture

## Software defined servers

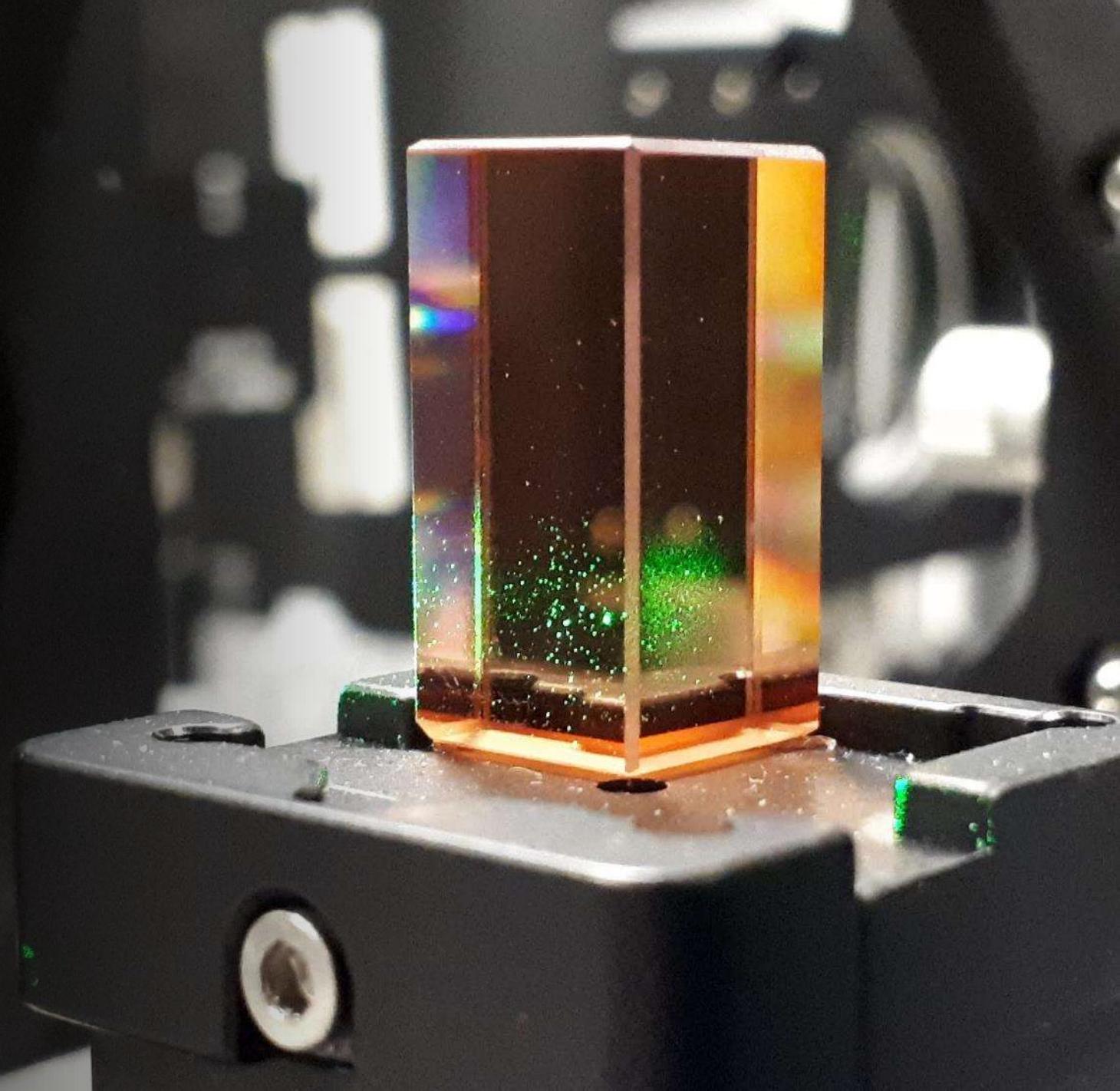


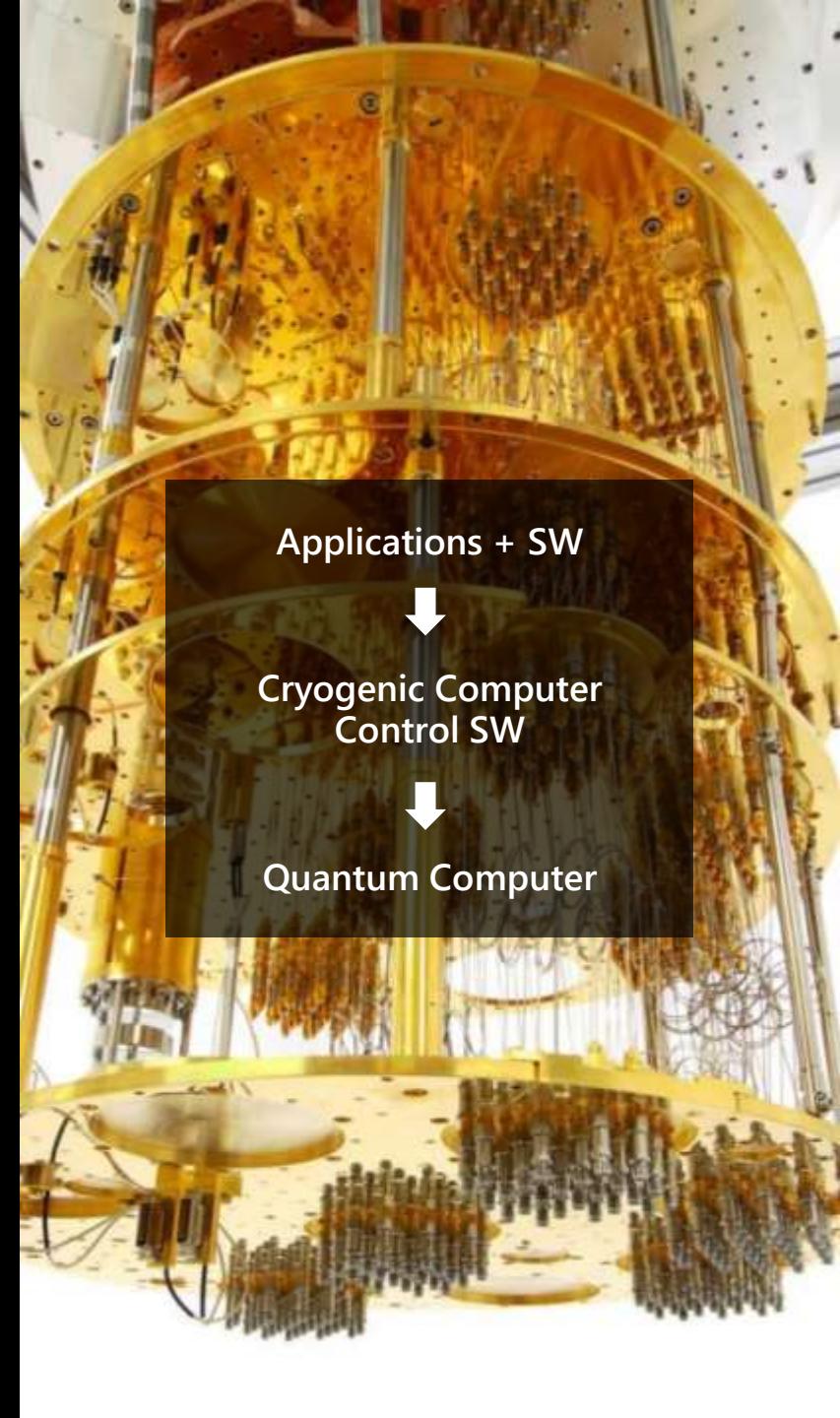
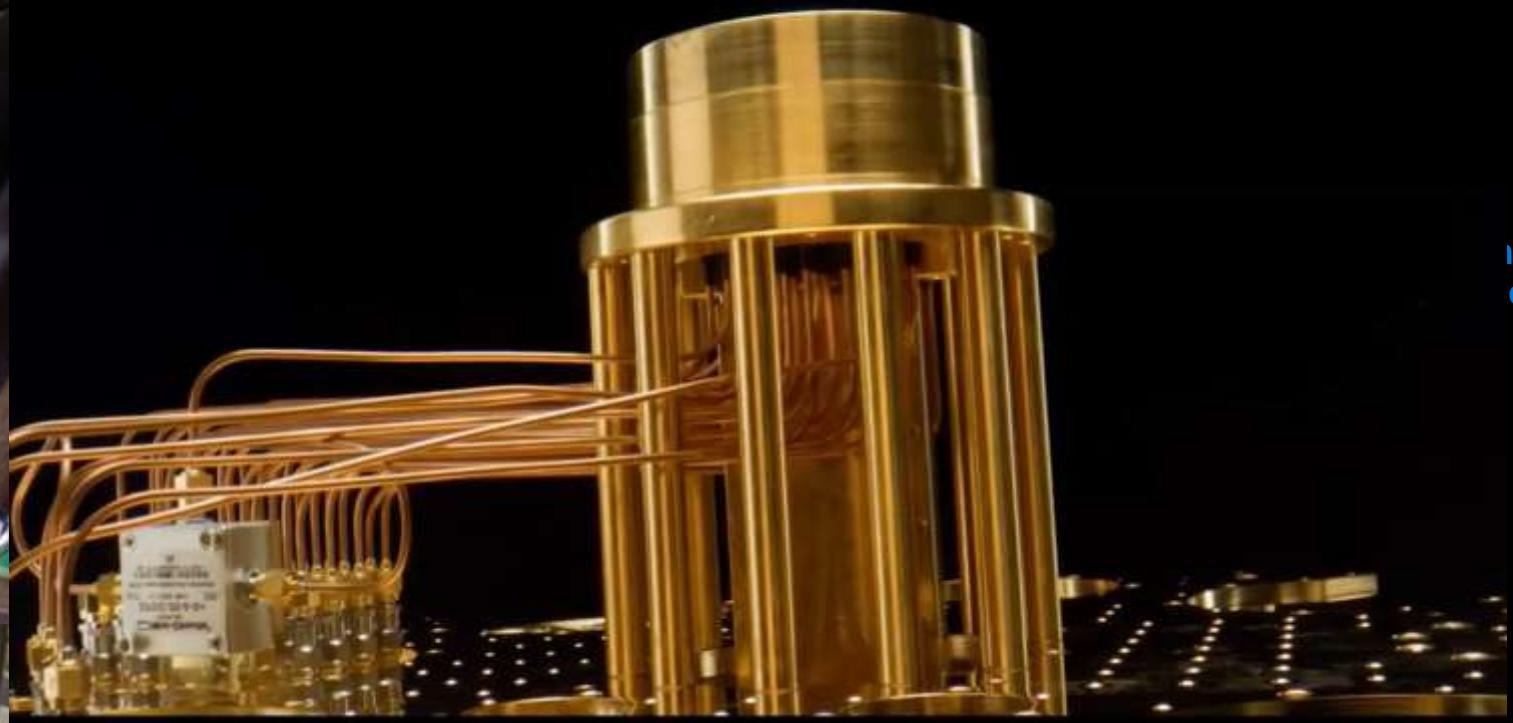
# Project Silica → Permanent Storage?



[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/>