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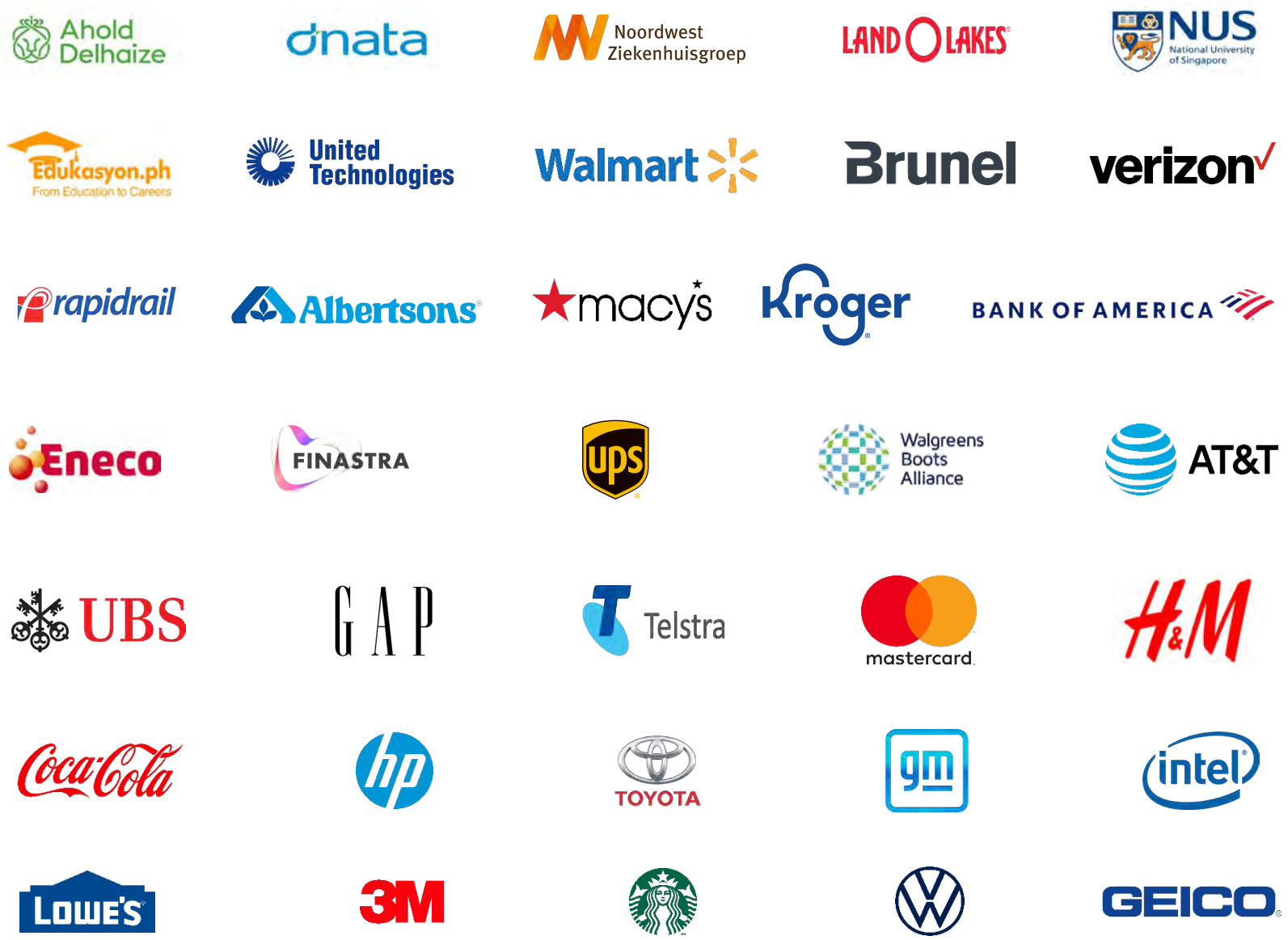
Datacenter 101

Operations, Deployment, and Demand for Electricity

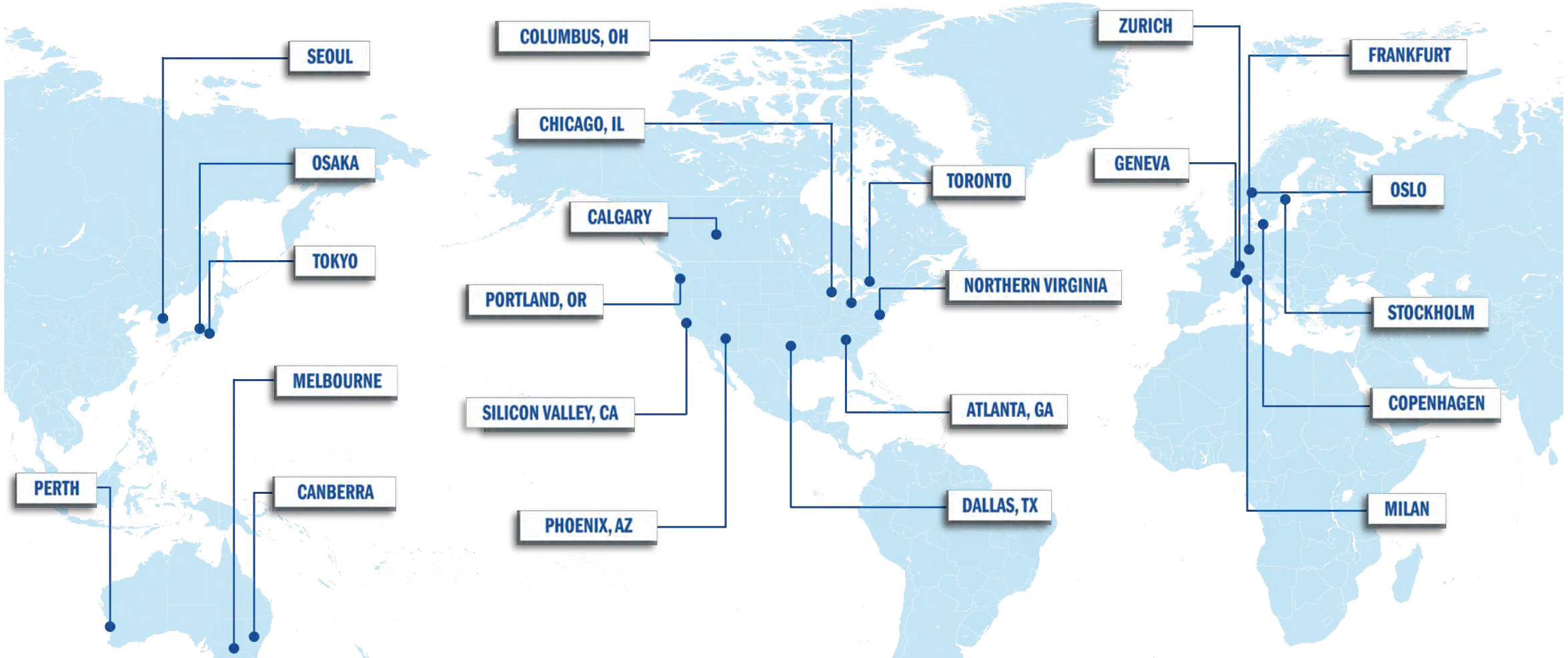
Microsoft

STACK INFRASTRUCTURE

Over 95% of Fortune 500 use the Microsoft Cloud



STACK'S GLOBAL FOOTPRINT



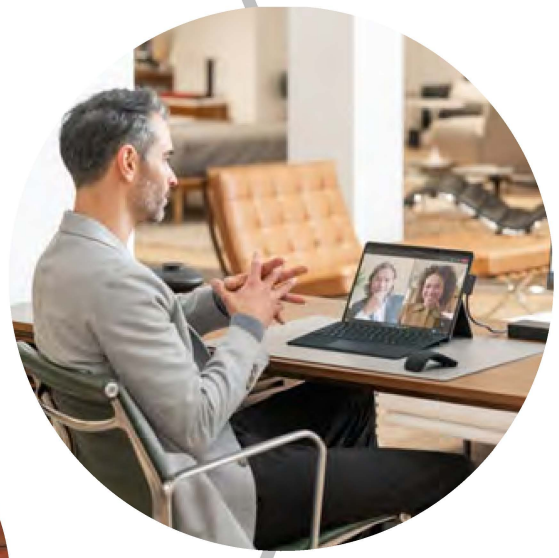
BUILT CAPACITY & UNDER DEVELOPMENT

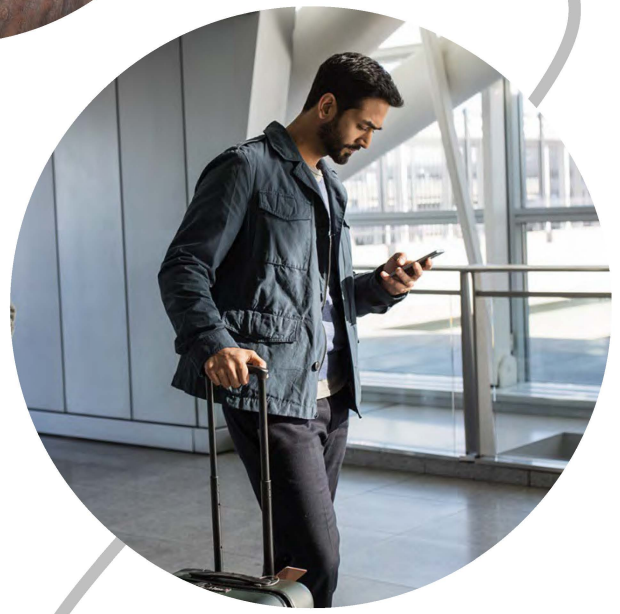
4.0+GW

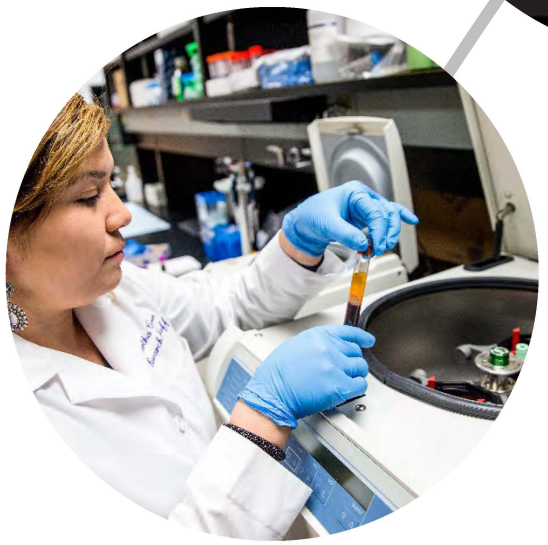
PLANNED AND POTENTIAL DEVELOPMENT

3.0+GW

Technology has become an integral part of everyday life…







...and datacenters are at the heart of the internet.

A datacenter building houses **thousands of computer servers and data storage devices** connected to the internet.

These buildings are similar in size and appearance to a **distribution warehouse**.

What Drives Internet Infrastructure Demand?

More People Getting Online

- Approximately 5.4 billion people - or 67% of the global population - are online today. This represents an increase of 45% since 2018. 2.6 billion people are not yet connected to the internet.
- On average, U.S. households have a total of 22 connected devices.

Deployment and Upgrades of Fixed and Mobile Networks

- Not all fixed and mobile networks are advanced enough to support today's digital products. So, in addition to internet adoption, mobile networks both depend on and increase demand for datacenters by allowing access to millions of applications that are housed in datacenters.

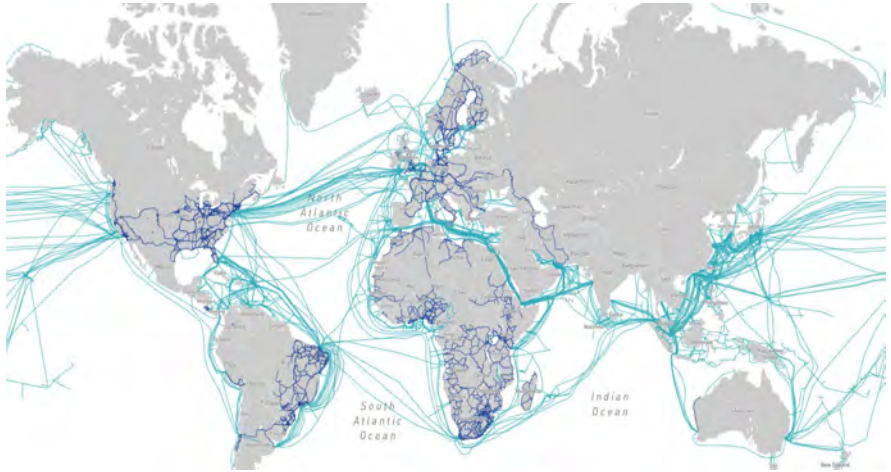
Development of New Product Experience

- The internet industry is rapidly developing new, advanced technologies that are even more storage, compute, and network intensive. This includes products like new video formats, virtual and augmented reality, artificial intelligence and machine learning, payment processing and digital wallets.

Source: International Telecommunication Union, https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx
Deloitte "2022 Connectivity and Mobile Trends Survey" (third edition), https://www2.deloitte.com/us/en/pages/about-deloitte/articles/press-releases/connectivity-and-mobile-trends.html

What Do Datacenter Providers Do?

In markets all over the world



We build, own, and operate datacenters

That provide economy of scale

- **Power** – Access reliable, low-cost power
- **Fiber** – Plan and procure global connectivity
- **Security** – Integrate robust security services
- **Sustainability** – Procure clean power

For dozens of clients in a single building

Or a single client on an entire campus

Source: Infrapedia.com, STACK Infrastructure, Microsoft

Internet Infrastructure Fundamentals

Networks

- **Fiber Networks:** Typically comprised of backbone and metro networks that connect datacenters to datacenters and datacenters to the internet.
- **Content Delivery Networks:** Geographically distributed groups of servers that are optimized for fast delivery of content like photos and videos.

Space

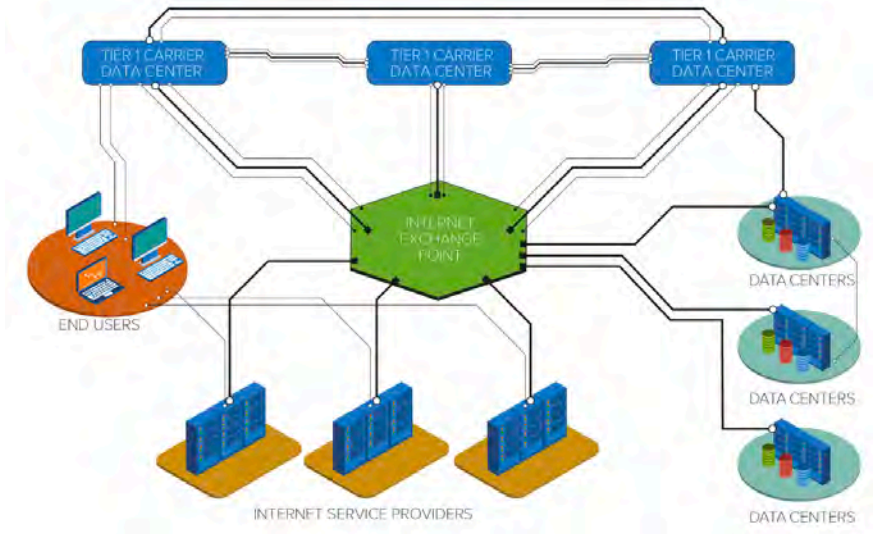
- **Data Center Building:** The physical buildings that house servers, their on-site power infrastructure, and the network rooms interconnecting to other datacenters and/or the internet.

Servers

- **Compute:** Systems designed to undertake large amounts of computations to create the experiences people enjoy online
- **Storage:** Systems designed to store large amounts of data.

Power

- **Generation:** The facilities that produce the power that serves datacenters.
- **Transmission:** The lines and wires that transmit power from generation sources to datacenters.
- **On-Site Power Path:** The power infrastructure between the substation and servers that transmits power to servers and supporting equipment.

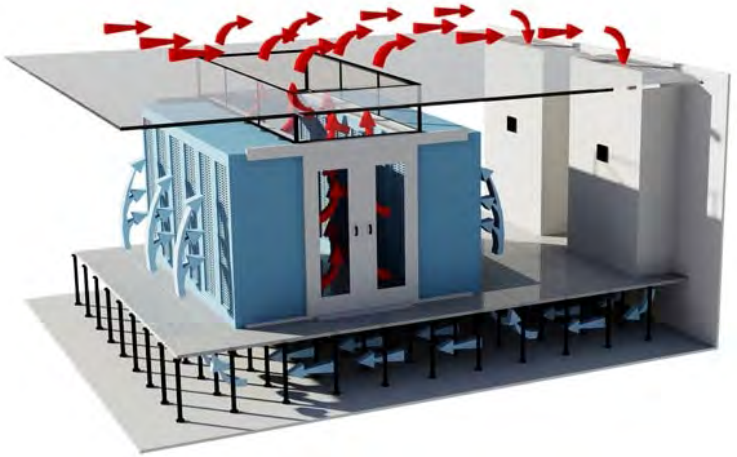


Source: https://cip.gmu.edu/2016/10/26/understanding-physical-internet-infrastructure-vulnerabilities/

Inside the Typical Datacenter

Dense arrays of servers and specialized cooling

1) Massive open spaces with rows of cabinets holding stacks of servers
2) Not all will typically operate at the same time
   - But they could (as we don't control when customers utilize the infrastructure)…
   - **We must plan for the peak**
   - Weather related, special event related
3) Facility Power Consumption
   - ~80% of all electricity delivered to datacenters is for **server operation**
   - ~20% of all electricity delivered to a datacenters is for **cooling**



Source: https://reefksa.com/dc_simulator.htm

Source: Uptime Institute 2022 Global IT Survey

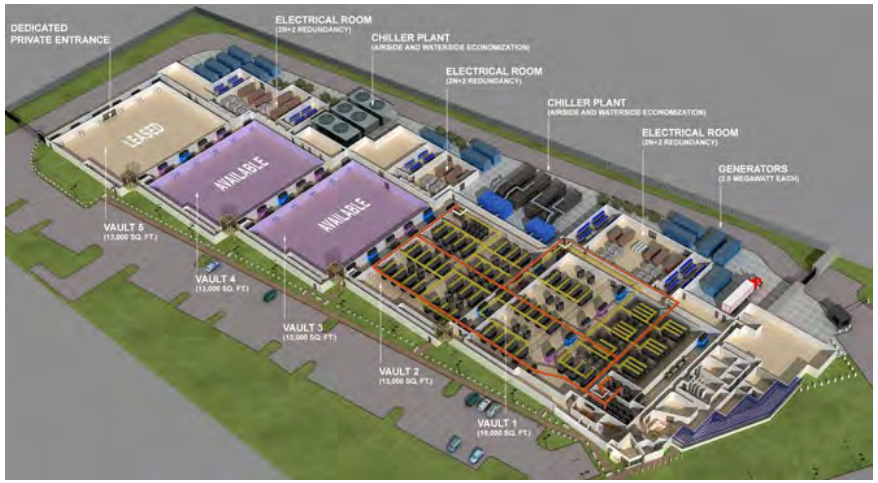
Typical Business Model (1/3)

Facilities vary in size from 50kW to 1000MW+

Datacenters sell space, power, and cooling by the kW or MW.

- Multitenant - Small rack or cage space that is co-located with other clients
- Enterprise - Larger suites or rooms in a building
- Hyperscale - Entire buildings or campuses

Datacenters require a high level of availability, for instance Microsoft's goal is 99.999% up time



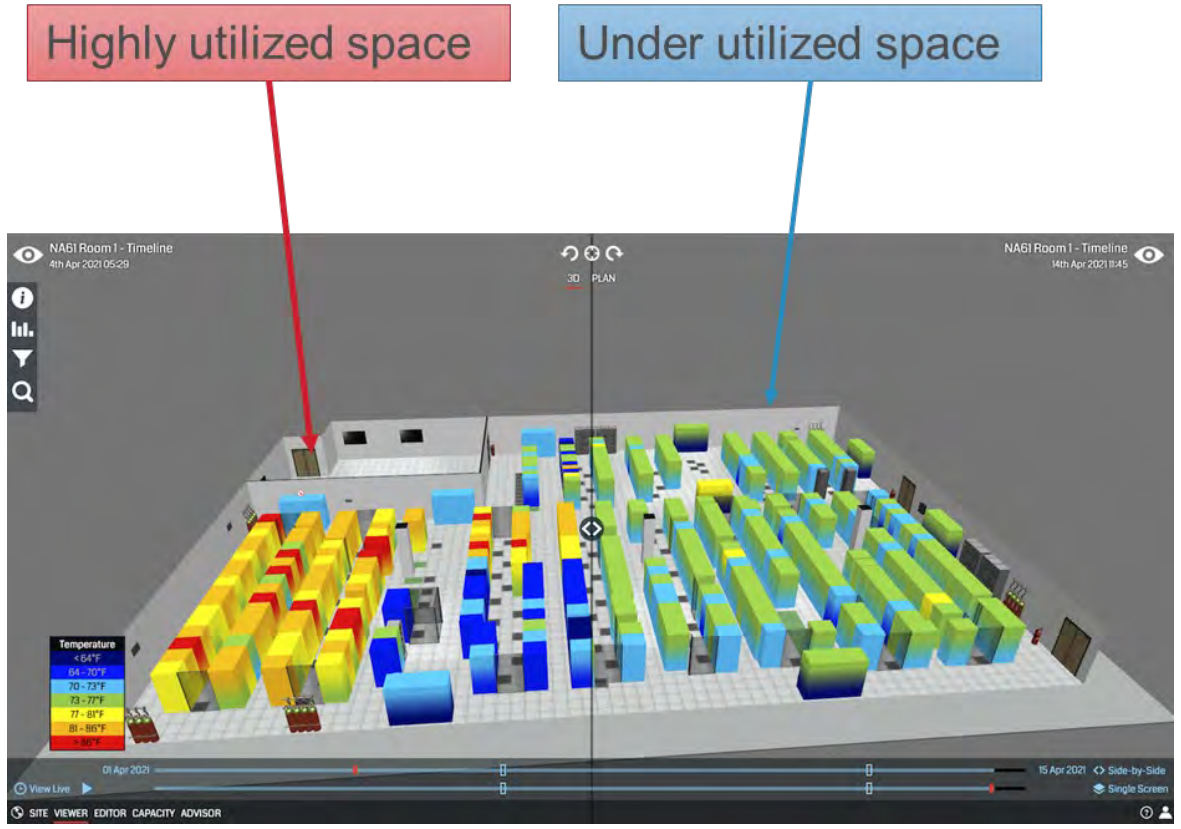
Source: RagingWire Datacenters

Source: NTT DATA

Typical Business Model (2/3)

Fit-up approach allows datacenters to ramp capacity usage into a building

1. Knowing the timing of the power ramp is a very complicated process
2. Building is constructed 100%
   - This is the point that we need to contract for utilities
3. Fit up is done in chunks as inventory to sell is balanced with signed and pipeline contracts
4. Contracts within the fit-up can be phased
5. Within contracts, deployment of servers are phased by the customer
6. Every server has a 3-5 year refresh cycle
   - Efficiency gains
   - Rolling outages of sections of the datacenter



Source: Upsite Technologies

Typical Business Model (3/3)

1. Key steps from bare dirt to commissioned datacenter – each introduces uncertainty into when a datacenter will consume energy
   - Entitlements
   - Fiber
   - Construction
   - Electric Utilities
2. Customer contracts are tied to commencement dates
   - Fully built, commissioned, powered space
3. Datacenters, utilities, and regulators must plan for years in advance of signing contracts
4. The ultimate load is planned by the datacenter, but determined by the customer usage
5. Datacenters are incentivized to right size power
   - Under-contracting for power introduces risk
   - Over-contracting for power introduces cost

Varied and variable development cycles lead to years of work prior to first energy consumption