Data Center Basics

What are data centers?
What is a hyperscale data center?

Summary outline

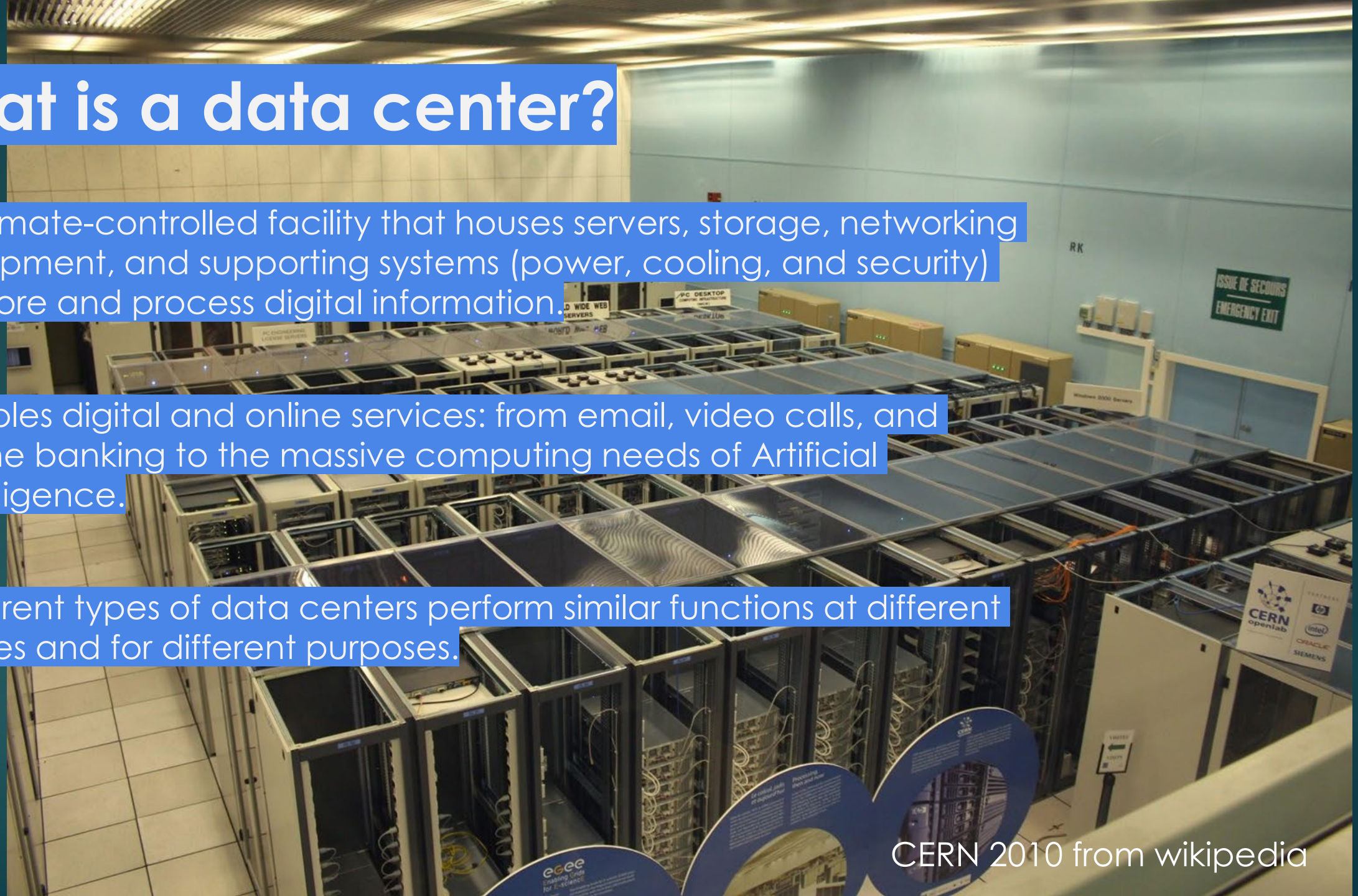
- A plain-language definition of data centers and common types (enterprise, colocation, cloud/hyperscale, edge).
- How data centers use electricity, water, and backup generation—and why hyperscale facilities can be different.
- A planning/land-use lens: typical impacts, and questions to ask applicants.

Terry Bradshaw - Who Am I

- 22 years and counting in UW Madison's central data center (29 in IT)
- a few years doing industrial automation/controls - paper, wastewater, chemical industries
- key personnel in data center aggregation efforts and migration work
- client lead for UW madison data center infrastructure upgrade (2009) and various other upgrades

What is a data center?

- A climate-controlled facility that houses servers, storage, networking equipment, and supporting systems (power, cooling, and security) to store and process digital information.
- Enables digital and online services: from email, video calls, and online banking to the massive computing needs of Artificial Intelligence.
- Different types of data centers perform similar functions at different scales and for different purposes.

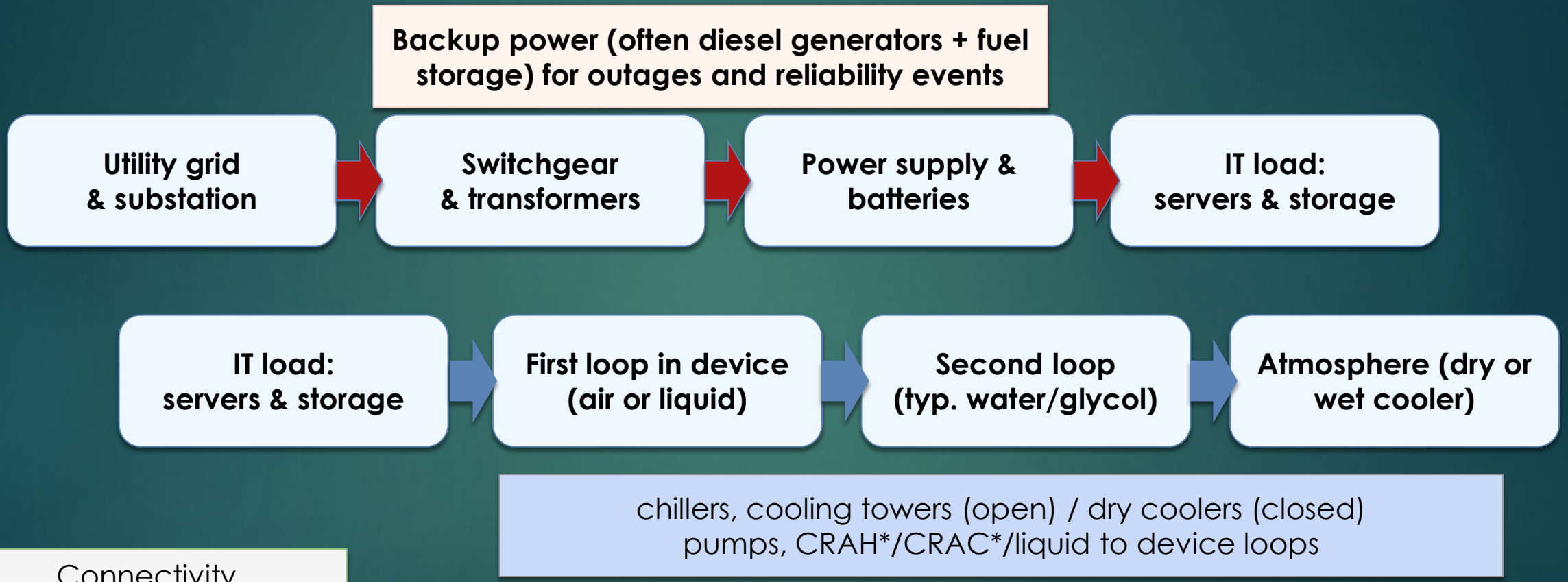


CERN 2010 from wikipedia

Common data center types

Type of Data Center	Typical characteristics
Enterprise (single organization)	Operated for one entity (e.g., a hospital system, university, or agency). Often smaller and integrated into a larger campus.
Colocation (shared facility)	Operator rents space/power/cooling to many customers.
Edge	Closer to end users or devices, reducing data transit time and latency. Functions as a connection between multiple networks.
Cloud / Hyperscale	Very large, standardized buildings and/or campuses serving cloud/AI providers; can drive major utility upgrades.

Anatomy of a data center



*CRAH = "Computer Room Air Handler" CRAC = "Computer Room Air Conditioner"

What makes “hyperscale” different?

- Hyperscale data centers:
  - Contain at least 5,000 computer servers
  - Occupy at least 10,000 (~0.25 acres) square feet of physical space
  - Have an electric power rating exceeding 100 megawatts (MW; one megawatt is equal to 1 million watts).
  - 100 MW of electric power is sufficient to support the electricity needs of 80,000 U.S. households

Energy Demand & Grid Stability

- High Energy Consumption: A single hyperscale data center can consume as much electricity as 100,000 homes.
- Grid Strain: US data center demand is projected to rise from 4% of total electricity in 2023 to 9–12% by 2028, leading to potential supply shortfalls.
- Ratepayer Impact: Concerns over the cost of expensive grid upgrades (transmission lines and substations) falling to ratepayers.
- Overbuilding of supply could lead to “stranded assets” representing further burden on ratepayers.
- Reliability Risks: Rapid growth is outpacing new energy supply leading to higher risks of brownouts.

Water and Environmental Impact

- Evaporative Cooling: Open loop hyperscalers can use up to 5 million gallons of water daily—comparable to the usage of a small city.
- Ecological Health: Water used for open loop cooling is lost to evaporation or returned with high salt/contaminant concentrations, impacting local watersheds and aquatic life.
- The "Efficiency" Trade-off: Strategies to save energy often involve evaporative cooling, which saves electricity but consumes significantly more water. Whereas strategies to save water (“closed loop cooling”) lead to increased electricity usage.

Local Community Quality of Life

- Noise Pollution: The constant "droning hum" from massive cooling fans and rooftop HVAC systems can reach 85–100 decibels, leading to resident complaints of sleep disruption and headaches.
- Land Use Competition: Average sites now cover over 200 acres, displacing prime agricultural land or encroaching on other established land uses.
- Backup Power Emissions: In the event of grid failure, these facilities rely on diesel generators that emit nitrogen oxides, particulate matter, and other air pollutants.
- Environmental Justice: Research suggests nearly half of US data centers are sited in areas already facing above-median environmental burdens.

Industry Moves to Address Concerns

- Power Autonomy: Some hyperscalers now building their own power plants or offsetting their usage with renewable energy power purchase agreements.

- Community Benefit Agreements (CBAs): Contractual agreements being pursued to ensure developers pay for their own infrastructure, and meet other community objectives (e.g., hire locally, support community programming, meet noise and emission standards).

A few questions to ask every data center applicant

- Power: What is the maximum contracted MW? What upgrades are needed, who pays, and what's the schedule risk?
- Water/cooling: What cooling technology will be used? Any high-capacity wells or wastewater discharges? Pollutants in wastewater? Fan noise levels?
- Backup generation: How many engines, how often tested, fuel storage volumes, and air/noise mitigation?
- Community benefits & accountability: Enforcement mechanisms? What reporting will be provided annually?

Thank you!

Question Time!