Controls and Instrumentation for Hyperscale Data Centres

18th April 2023

Presented by Chris Openshaw

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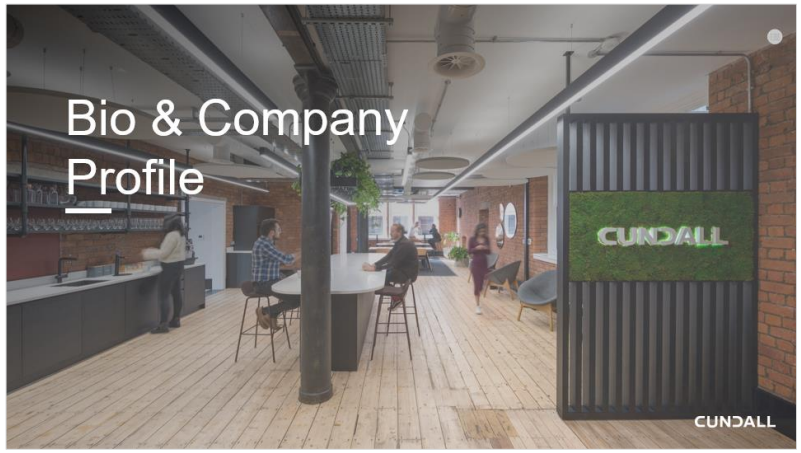
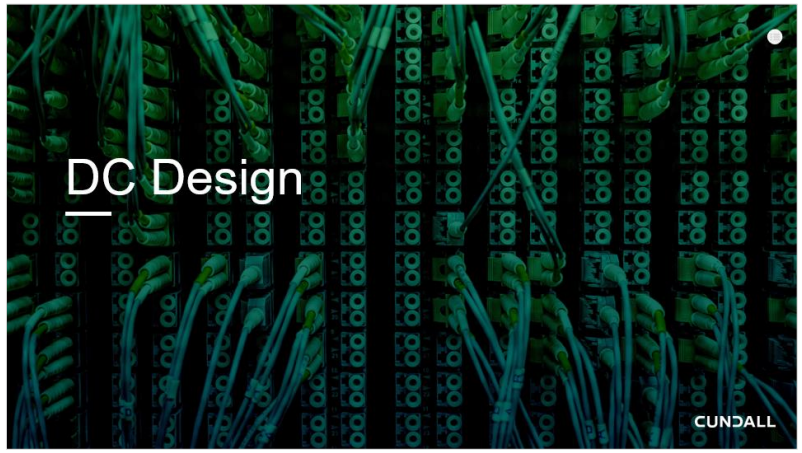
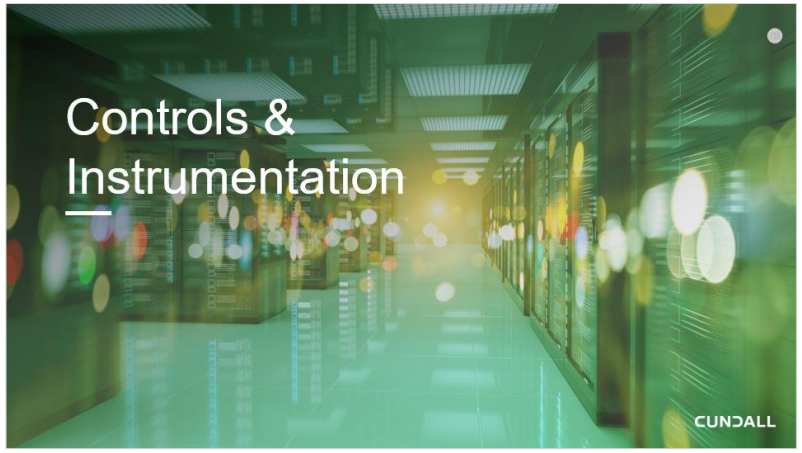
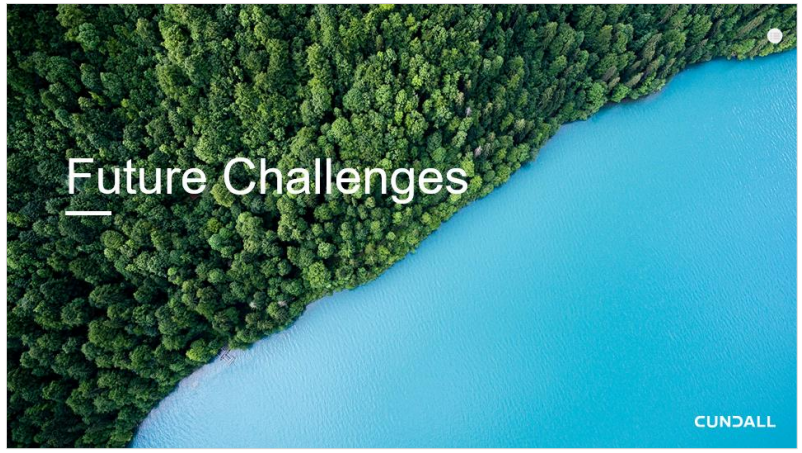
Topics for discussion









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Bio & Company Profile

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Bio: Chris Openshaw Principal Engineer – Building Automation

Apprentice trained controls engineer with 25 years' experience across multiple sectors.

Sectors

- Automotive
- Oil & Gas
- Industrial & Infrastructure
- Critical Systems

Companies

- Ford & Tier 1 suppliers
- Rockwell Automation
- Wood (Amec Foster Wheeler)
- Red Engineering
- Vantage Data Centres
- Cundall

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About Cundall

24

OFFICES GLOBALLY

ESTABLISHED IN

1976

1000+

PEOPLE WORLDWIDE

PROJECTS DELIVERED IN

50+ **COUNTRIES**

500+

AWARDS WON

ZERO CARBON DESIGN 20 30

ALL PROJECTS WILL BE NET ZERO CARBON BY

2030

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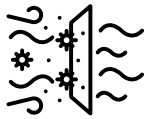
Cundall services

Acoustics



Air quality and odour

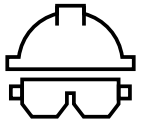
Audio Visual (AV)

Building automation

Building Performance Services (BPS)

Building services engineering

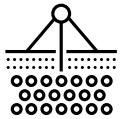
Civil engineering



Construction design and management consultancy

Digital engineering

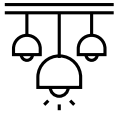
Fire engineering



Geotechnical and geoenvironmental

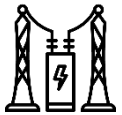
Health, wellbeing and productivity

Information technology



Lighting design

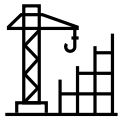
Planning



Power

Security

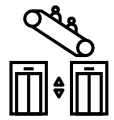
Smart buildings



Structural engineering

Sustainability

Transportation



Vertical transportation

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Cundall sectors

Aviation

Critical Systems

Global corporate real estate

Government

Healthcare and life sciences

Higher education

Hotels

Industrial

Infrastructure

Masterplanning and urban design

Mixed use

Residential

Retail and placemaking

Schools and colleges

Sport and leisure

Workplace

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Data Centre Overview

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A Brief Data Centre History Lesson

As the computer age expanded so did the need to store data.

Business users began to centralise data in silos, on premises initially.

The internet took hold and the dot com boom of the 90s significantly increasing our need to process and store data. Early 00s mobile devices became more than just a phone.

Not just businesses, everyone was starting to use and store more.

Then we saw the rise of virtual computing and the advent of the modern cloud. The concepts of how and where to compute and store data began to change…..

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The ‘Data Centre’ and a cloud of possibilities

Noun: cloud computing

The practice of using a network of remote servers hosted on the internet to store, manage, and process data, rather than a local server or a personal computer.

<u>Common cloud services</u>

Microsoft Office 365

Amazon shopping

On demand TV services

Social media platforms

Online gaming

Where is the cloud?

It’s in data centres

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Hyperscale

What is a hyperscale data centre?

Hyperscale data centres are massive facilities built by companies with vast data processing and storage needs.

> 5,000 servers

> 930 square meters (10,000 square feet)

Income comes directly from the applications or websites the equipment supports, or sell technology management services to third parties.

Many hyperscale facilities are single-tenant or owner/occupied across an entire site.

Others are multi-tenant (also known as Colo. or Co-location) taking a part of a floor, a whole floor or building at a time.

Council Bluffs Google Data Center

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The Data Centre facts and figures

Global data centre power consumption estimates vary between 1-3% of global electricity consumption today. (info graphic for prediction)

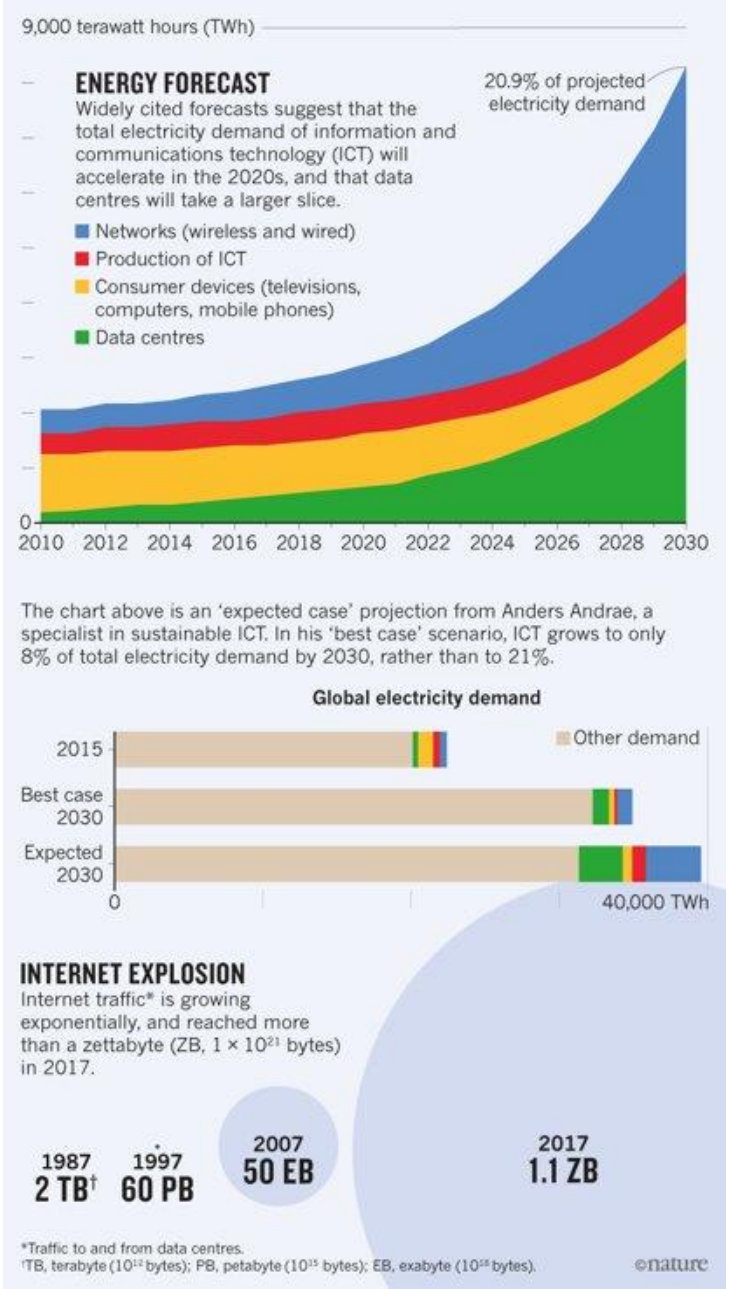
The average hyperscale facility consumes 20-50MW – theoretically enough electricity to power up to 37,000 homes. Some are much larger!

Almost all the energy consumed is converted to heat!

Global IT data centre spending is expected to reach **$222 billion in 2023**

The global data centre market is expected to reach **$410.40 billion by 2027.**

(Statista)



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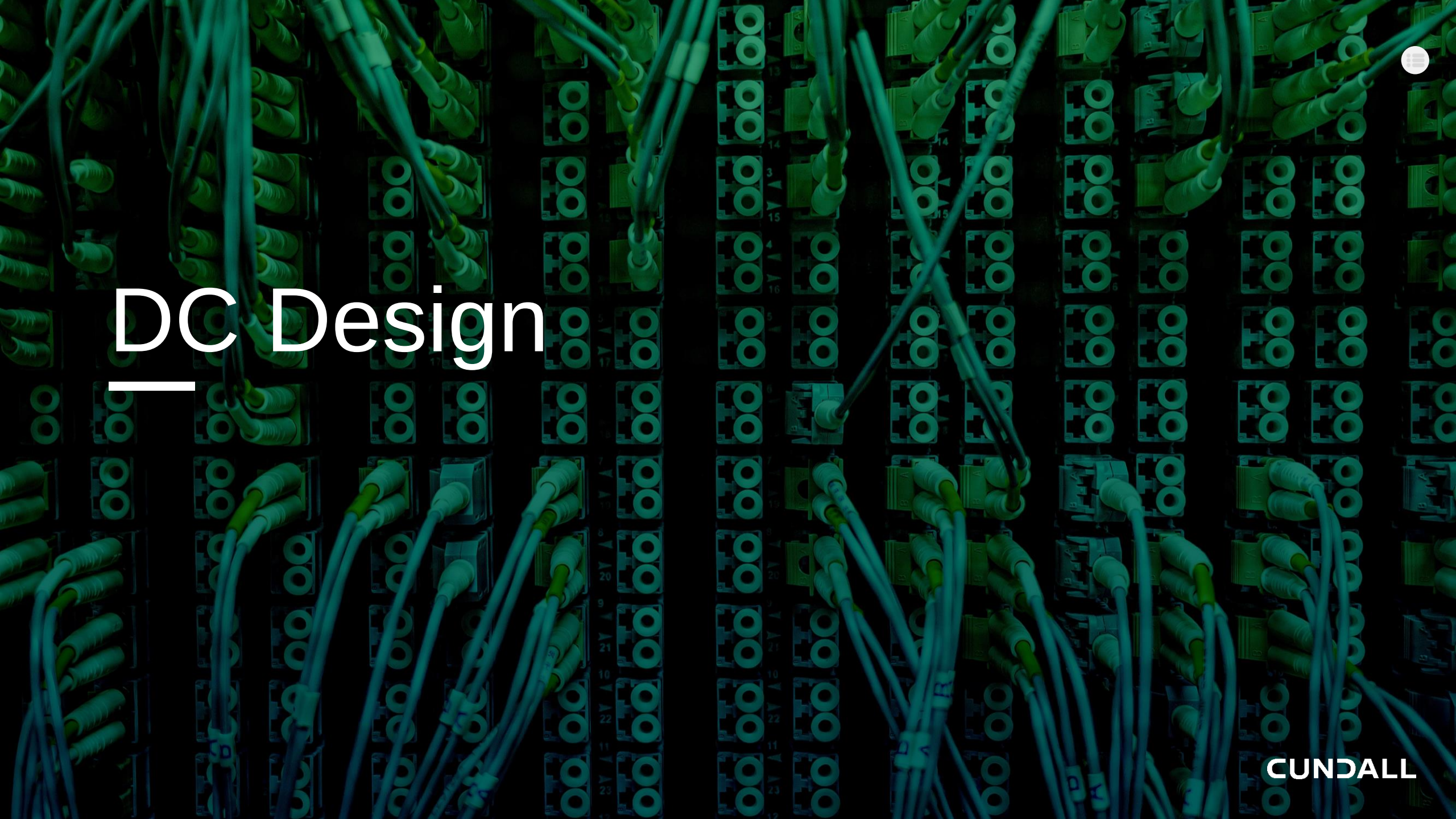

DC Design

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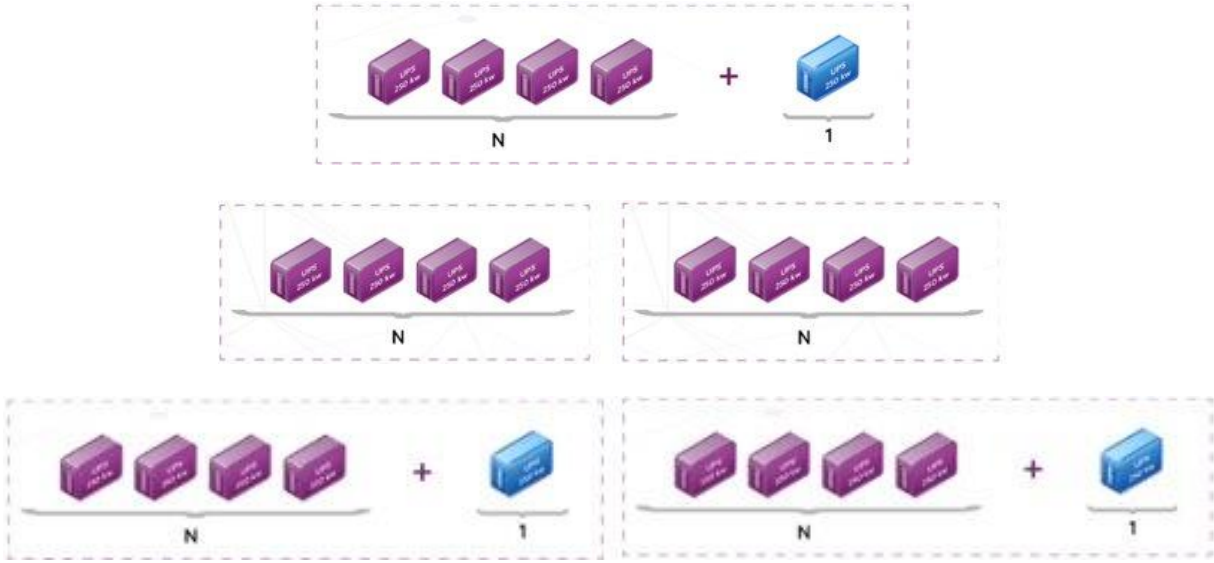
Power & Control

Redundancy & concurrent maintainability – Typical features

- All critical power and plant designed for resilience and fault tolerance
- An always-on strategy, expansion & maintenance without loss of service (up to five 9s – 99.999% uptime)
- UPS and/or generator backed
- Control systems industrial grade for critical parts of the system and architectures fault tolerant
- SCADA and server architectures fault tolerant and secure



Example of the cost of an outage:

TSB Bank, a major outage that left two million customers of the UK bank without current account access in April 2018 was due to a failure to test a new data centre. TSB has had to pay nearly £370m in "post-migration charges" as a result of the prolonged outage, including for the £25m investigation.

(DCD)

Facebook, Instagram and WhatsApp went dark for ~6hrs - bringing the economic engine of Facebook, Inc. to a halt. Approximately $164,000 a minute in revenue was lost, while stock's decline wiped away more than $40 billion in market cap

(MarketWatch)

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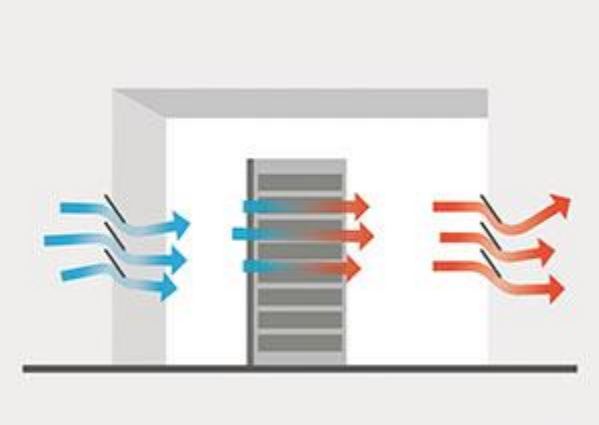
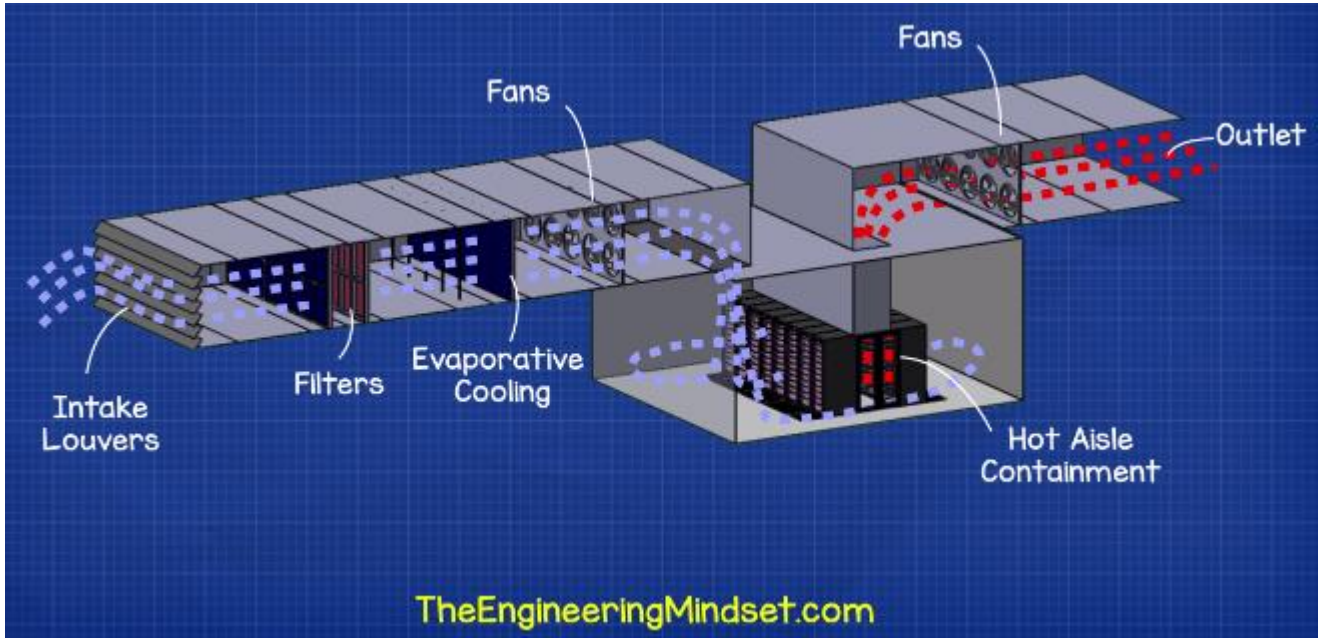
Cooling Methods

- *Direct Air*
  - Cool outside air is drawn into the data centre space and hot air is expelled
  - Water maybe evaporated into the supply air to further cool the outside air (adiabatic effect)





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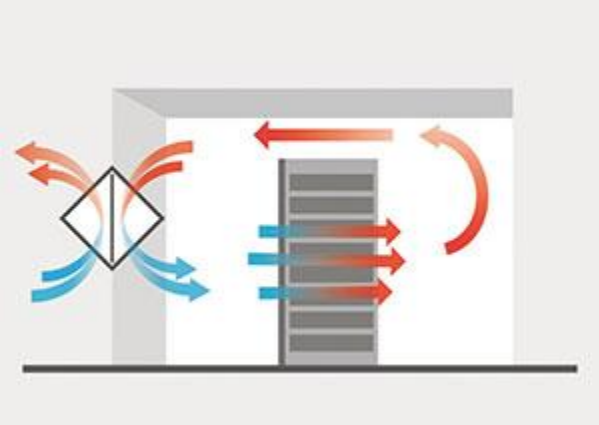
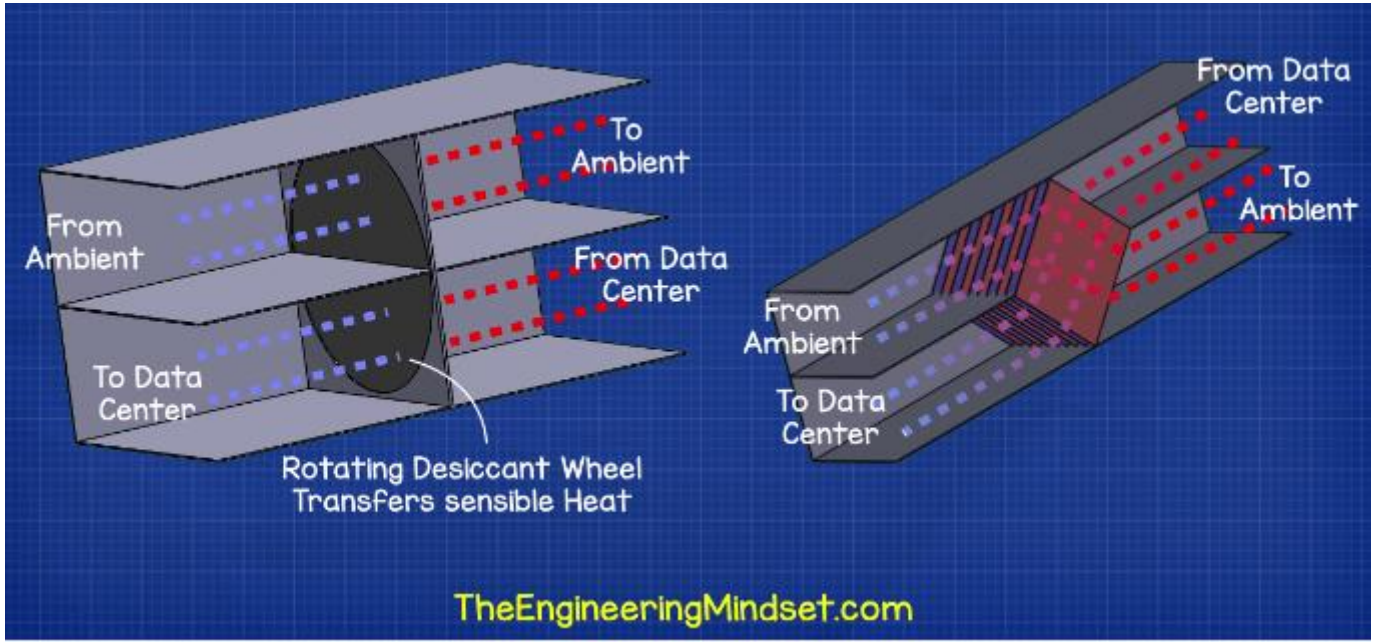
Cooling Methods (cont.)

- *Indirect Air*
  - As previous, however an air-to-air heat exchanger is used so the cooled humid air does not enter the data centre.
  - Air inside the data centre does not mix directly with outside air.





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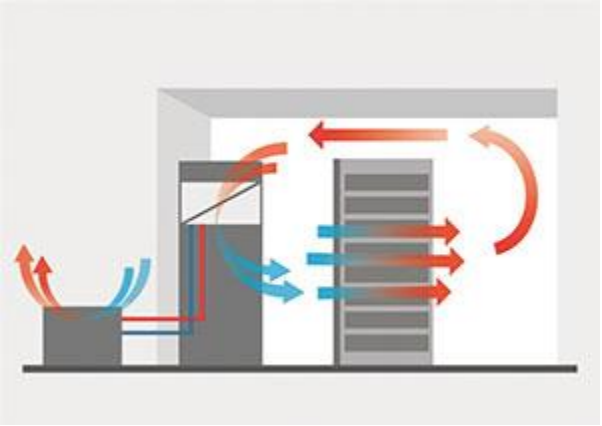
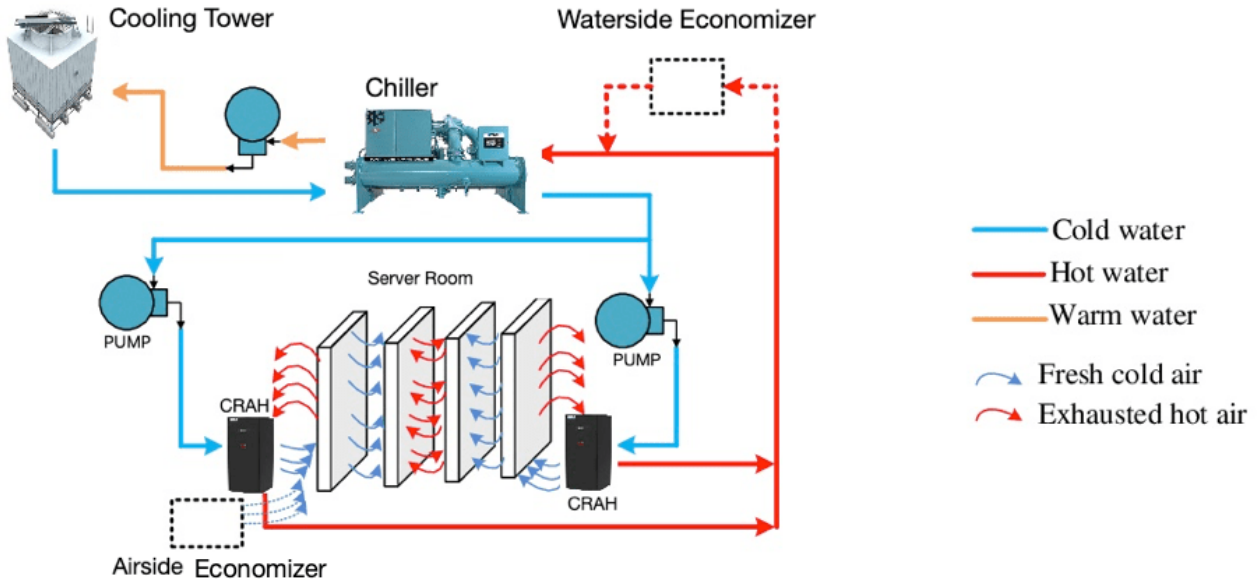
Cooling Methods (cont.)

- *Hydronic*
  - A closed loop chilled water liquid circuit is used to transfer heat. Water based coils and fans are used to cool the air, which is then passed over the servers.
  - Heat from the data centre is absorbed within the data hall cooling coils.
  - The collected heat is then transported in pipes and rejected to the atmosphere with the help of heat rejection plant. e.g. chillers, cooling towers etc.
- *Direct Expansion (Refrigeration)*
  - Not typically used on its own in most designs, due to F-Gas & power consumption.





Credit: Smart Data Center Insights

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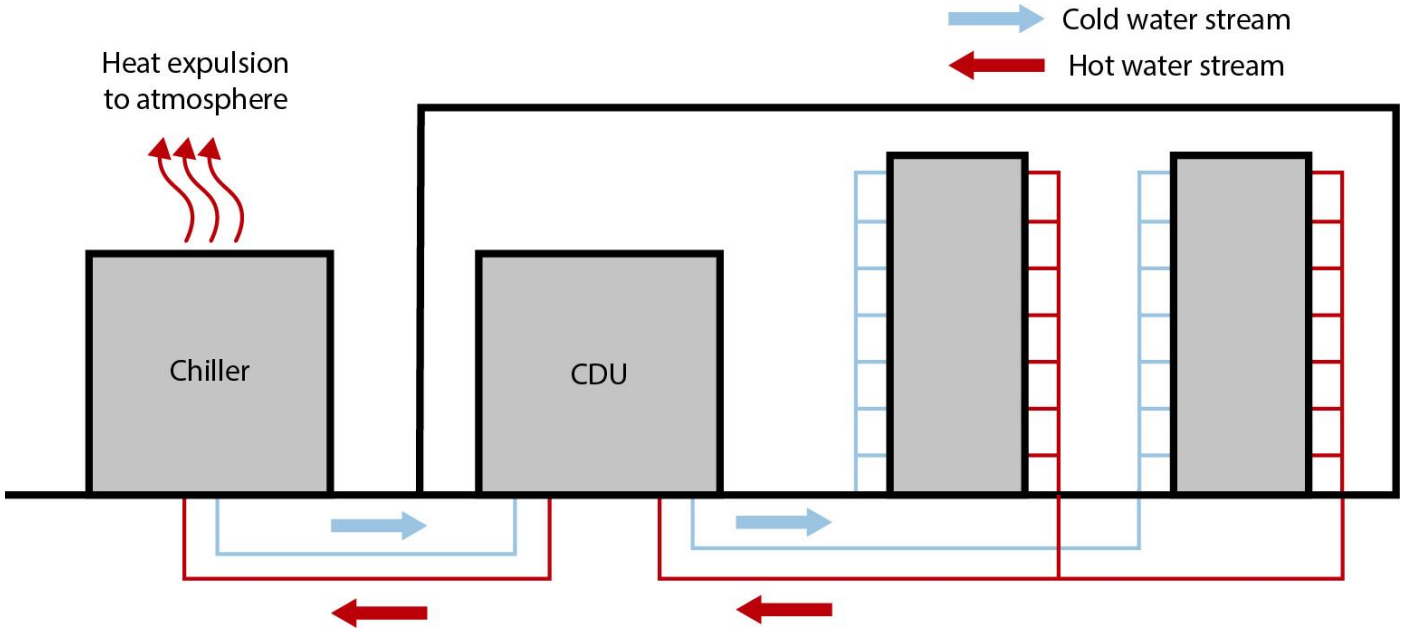
Cooling Methods (cont.)

- *Liquid Cooled – Higher Rack Power Density*
  - As per hydronic system with a separate fluid circuit in lieu of the cooling coils and fans.
  - The fluid is passed directly into the server to collect the heat and this is rejected into the main hydronic circuit via a special small heat exchanger called a CDU (Coolant Distribution Unit).
  - Liquid cooling covers a family of emerging technologies. Some target all or just parts of the server using special local heat sinks, partial or total immersion of the server electronics.



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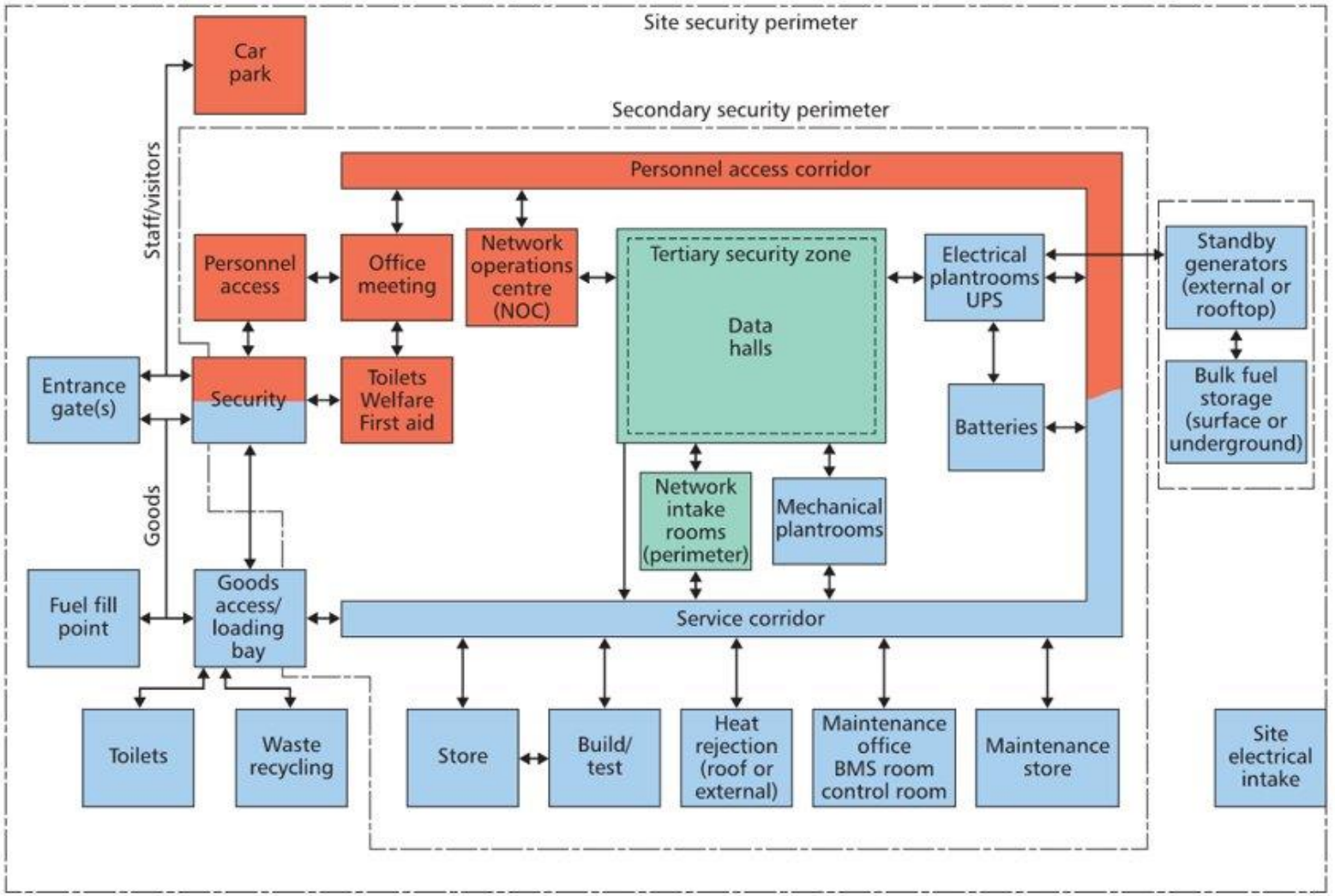
Auxiliary spaces

- *Mechanical plant rooms*
- *Generators*
- *UPS + Battery rooms*
- *Electrical rooms*
- *Fire riser*
- *IT Network rooms*
- *Control room*
- *Security room*
- *+ Non-critical spaces for people to work, rest & play.*



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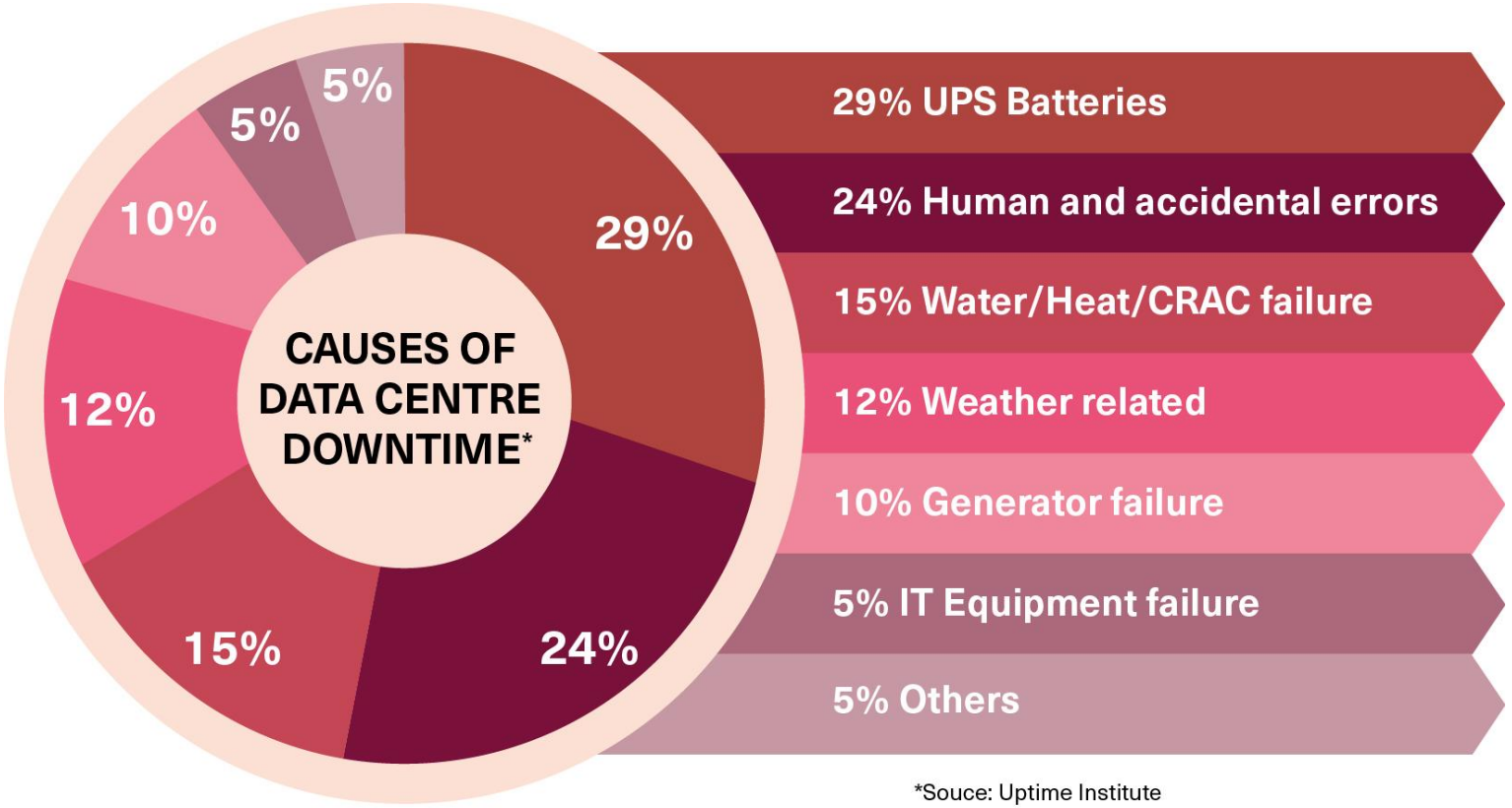
Data Centre Failures



*Souce: Uptime Institute

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Instrumentation
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BMS

Building Management System

A typical system might monitor:

- Packaged plant with on board control
  - Air or water cooled chillers
  - Air Handling Units
  - Computer Room Air Conditioning or Handler
  - In-room Dx air conditioners
  - Dry Coolers
  - Heat pumps
- Room condition for service level agreements
- Cooling systems status and management
- Discrete pump and fan or damper control

The systems typically use a combination of hardwired IO and comms protocols, such as Modbus or BACnet to talk to higher level devices.

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BMS

BMS Network topology features

Redundancy: Data centres typically have redundant BMS networks to ensure high availability and reliability. This is achieved by having multiple network paths and switches to prevent single points of failure. In the event of a failure on one network path, the BMS system will automatically switch to an alternative path to ensure continuity of operations.

Scalability: The BMS network topology is designed to accommodate growth and expansion of the data centre. As the data centre grows, additional devices and systems can be added to the BMS network.

Security: The BMS network is typically protected by robust security measures, including firewalls, intrusion detection systems, and access control mechanisms. This is necessary to prevent unauthorized access to critical systems and data.

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Measurement & Control - BMS

Typical points for measurement in a BMS:

- Flow
- Temperature
- Pressure
- Level
- Space condition (air temperature humidity + quality)
- Water analysis (pH, conductivity)

Typical points of control:

- Dampers
- Valves
- Fans (EC)
- Pumps (VFD)

Note: Instruments/equipment tend to be a higher grade and accuracy when compared to typical commercial building services applications.

EPMS

Electrical Power Management System

An electrical power management system (EPMS) in a data centre is a critical system that monitors and controls the electrical power distribution and consumption in the facility.

The EPMS typically measures a variety of electrical parameters to ensure the efficient and reliable operation of the data centre's electrical infrastructure. Here are some of the typical points that may be measured:

- Switchgear status
- Power quality
- Power usage
- Battery monitoring
- Generator monitoring
- Efficiency (PUE)

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SCADA & Optimisation

SCADA

SCADA

A data centre SCADA (Supervisory Control and Data Acquisition) system is used to monitor and control the critical infrastructure of a data centre, including power, cooling, and environmental conditions.

This type of system allows operators to monitor and control data centre equipment remotely, and can provide real-time data and analytics to help identify and address issues before they become critical.

BMS may be separate or combined depending on the client needs

Key Typical Features

- Secure
- Resilience
- Situational awareness
- Intuitive design
- Historical data & reporting

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AI Optimisation

Is the future AI for data centres?

AI can be used to improve their operations and energy efficiency of data centres.

AI algorithms may be used to optimize cooling and ventilation systems, which can result in significant energy savings as the systems learn what is optimal.

AI could also be used to monitor and predict equipment failures, helping data centre operators address issues before they become critical and prevent downtime.

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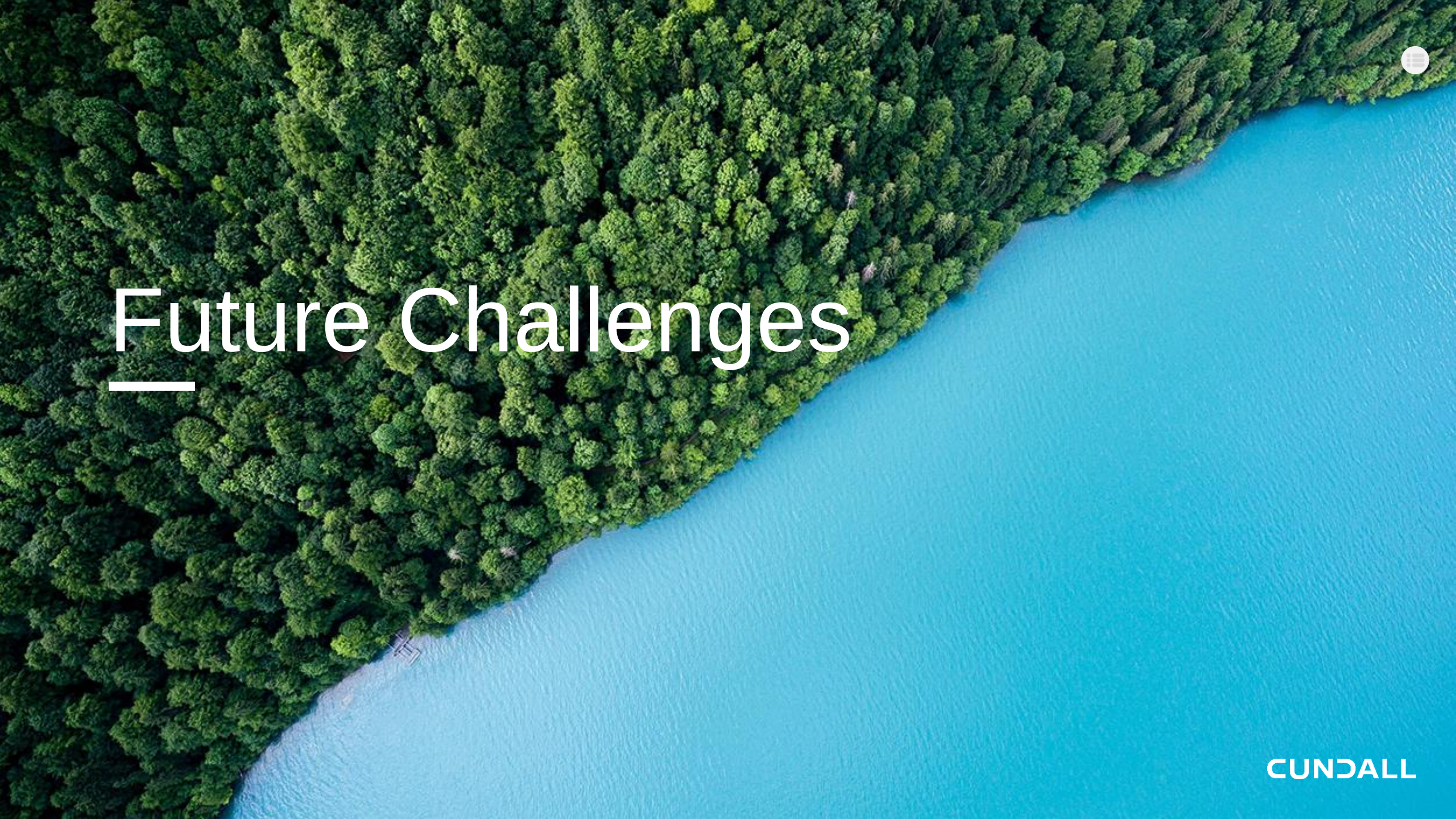
Future Challenges
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Data Centre Challenges

- Power availability and source
- Tougher environmental, social and governance (ESG) directives and more stringent regulatory landscapes
- Deployment in regions of water scarcity or non-temperate climate zones
- Rack power density (AI/ML)
- Net zero & embodied carbon
- A talent shortage in the industry
- Politics

Q&A

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