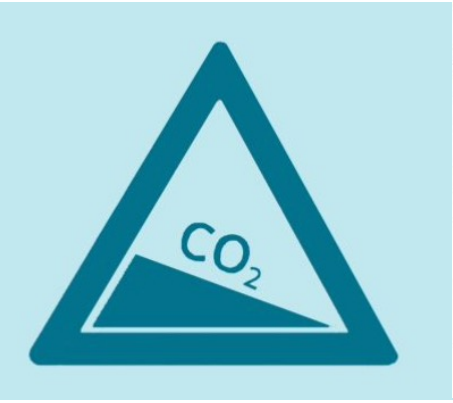
APNIC 52

ONLINE
13 - 16 September 2021

Cooperation SIG Forum 14 Sep 2021

Internet's environmental impact: how ISPs and datacentres address energy efficiency and environmental sustainability?

September 2021



National Supercomputing Centre

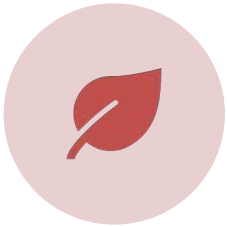
National Supercomputing Centre

A National Research Infrastructure of the
NATIONAL RESEARCH FOUNDATION
PRIME MINISTER'S OFFICE
SINGAPORE

Decarbonisation of NSCC Data Centres

14 September 2021

USE LESS ENERGY



USE GREEN ENERGY

COMPUTE ELSEWHERE

USE LESS ENERGY

- Energy-efficient chips vs store/transmit/compute less data
- Energy-efficient Data Centres
  - Less Cooling – run DC hotter
  - Better heat transfer
  - Efficient Operations – IoT-AI-Digital Twin
  - Industrial symbiosis – use waste cold energy

ASPIRE 1 Supercomputer (2016-2022)

1 PFLOP System

- ***1,288 nodes*** *(dual socket, 12 cores/CPU E5-2690v3)*
- ***31,320*** *cores*
- ***128 GB*** *DDR4 RAM/node*
- ***10 Large memory nodes*** *(1x6 TB, 4x2 TB, 6x1 TB)*

13 PB Storage

- ***I/O bandwidth up to 500 GB/s***
- ***GPFS and Lustre File System***

EDR Interconnect

- ***EDR (100 Gbps) Fat Tree within cluster***
- ***InfiniBand connection*** *to* ***remote login nodes*** *at stakeholder campuses*

Accelerator nodes

- ***128 nodes*** *with GPUs*
- ***1 x Tesla K40 per node***

Visualisation nodes

- ***2 nodes*** *R940 graphic workstations*
- *Each with* ***2 x NVIDIA Quadro K4200***
- *NVIDIA Quadro Sync support*

Supporting up to 280 million core-hours per year

ASPIRE 2A – Jan 2022
Key Architectural Components

Main System – HPE Cray XE

768 nodes of

2 x AMD EPYC™ 7713 CPU
(2.0 GHz – 3.675 GHz)
128 cores (64 per Socket)
512 GB Memory

98,304 cores

Accelerated Nodes

- 76 units of

4 x Nvidia A100 GPU
512 GB memory

- 6 units of

8 x Nvidia A100 GPU
1 TB memory

352 A100 GPU

High-Frequency Nodes

16 nodes of

2 x AMD EPYC™ 75F3 CPU
(2.95 GHz – 4.0 GHz)
64 cores (32 per Socket)
512 GB Memory

1,024 cores

Large Memory Nodes

12 Units with 2 TB RAM
4 Units with 4 TB RAM
HPE DL385 Gen 10+ Version 2

Scratch Disk – Lustre

I/O bandwidth –
300 GB/s (sustained)

10 PBytes

Home/Project – GPFS

5 PB online
18 PB near-line
20 PB remote near-line

43PBytes

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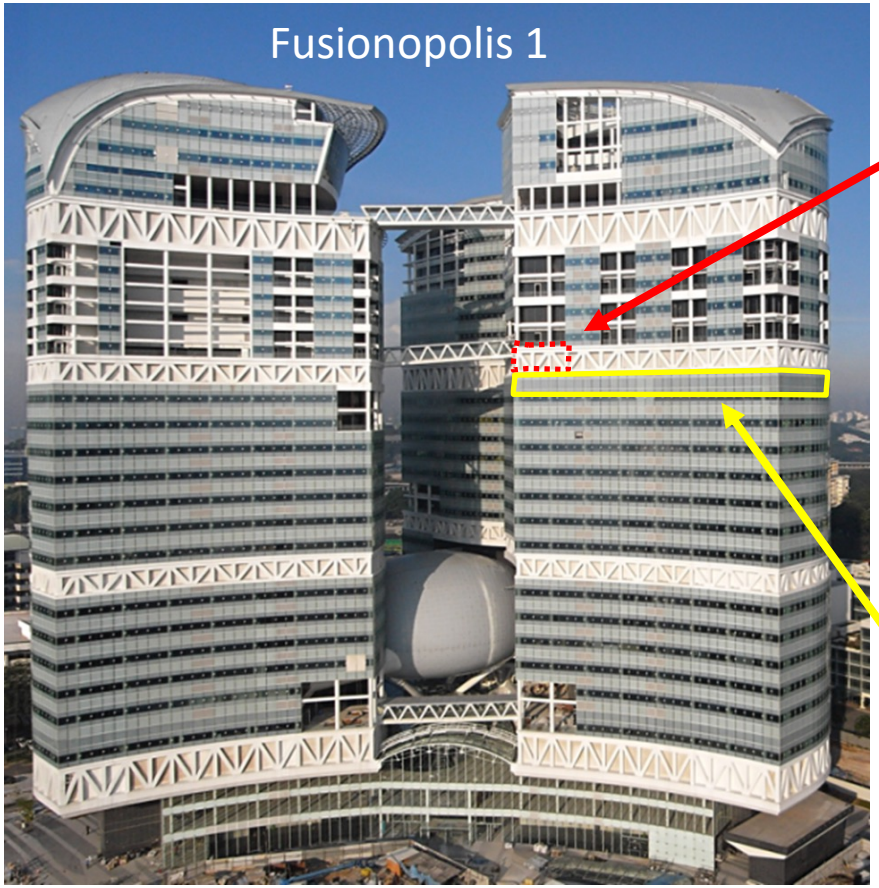
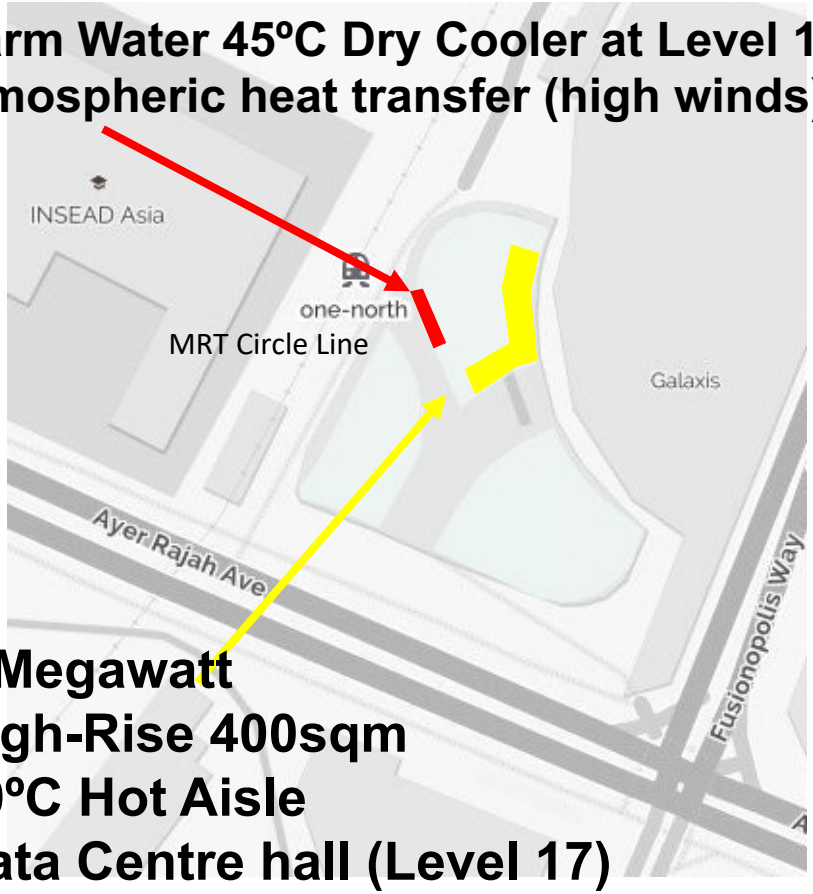
ASPIRE 1 Data Centre
Fusionopolis One-north



Warm Water 45ºC Dry Cooler at Level 18S
Atmospheric heat transfer (high winds)



1 Megawatt
High-Rise 400sqm
40ºC Hot Aisle
Data Centre hall (Level 17)

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ASPIRE 1 Data Centre – Cooling System

Combination of 3 Integrated Cooling Systems to achieve maximum efficiency

Zero-Evaporative Energy-Efficient Warm Water Dry Coolers 45ºC

Liquid Cooling

Warm water cooling direct-to-chip

Minimal Air Cooling

Computer Room Air Handler (CRAH) units

Chilled Water Cooling

Rear door heat exchangers

Hot Aisle – Cold Aisle Insulation

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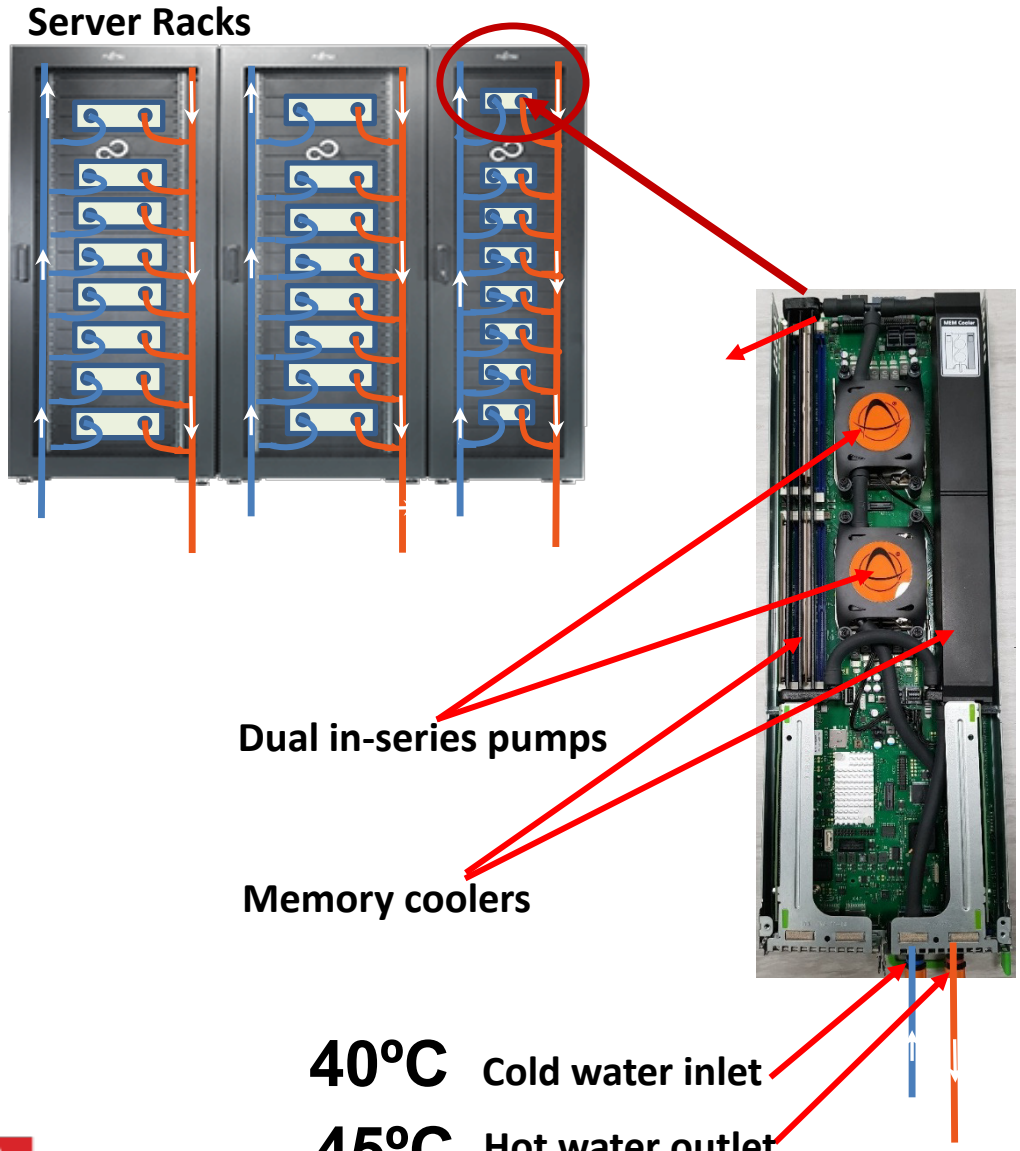
Warm Water Cooling System



Direct-to-chip hot water based Cool-central Liquid cooling

- Captures between 60-80% of the servers heat ,which reduces Data Centre cooling cost by over 50%

Free Cooling

- The free cooling solution removes heat from CPUs, GPUs, and memory
- Modules using water as hot as 45ºC which exits via the Red outlet. The water goes up
- To level 18S where fans have been constructed
- To cool the water down to 40ºC and re-enters the server via blue inlet

Dense Server

- These are dense servers which allows for 2.5 – 5x higher data centre density.

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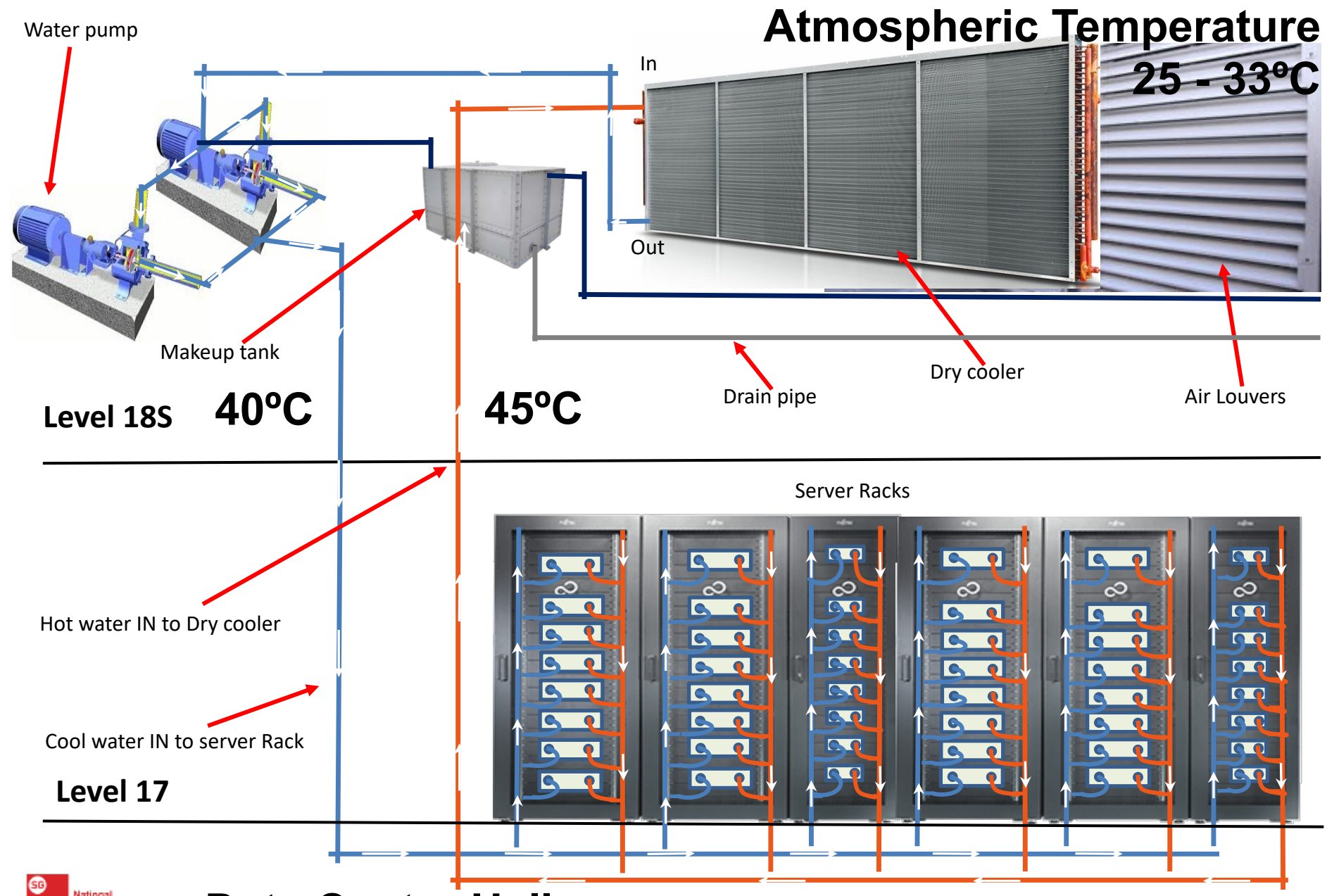
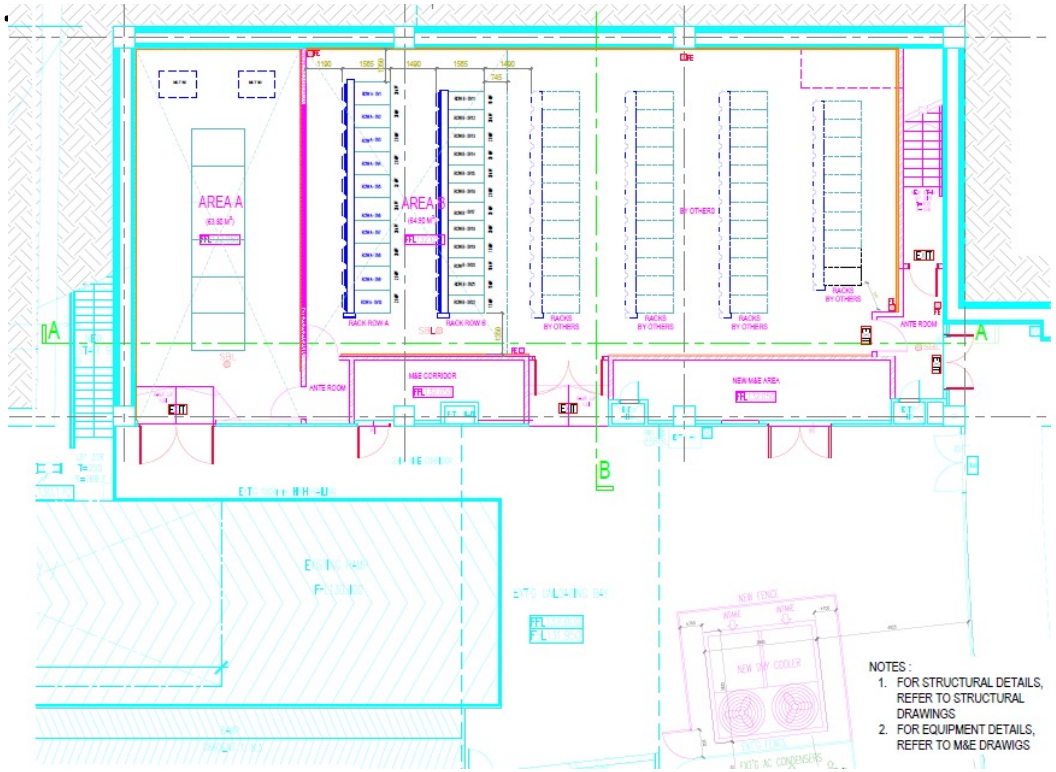
18S Dry Cooler Operation



New NSCC Data Centre @NUS i4.0 for ASPIRE2a

- The New Data Center is designed into 2 separate areas.
  - Area A: Compute System (HPC Cray EX) of the Supercomputer.
    - Warm water cooling with dry coolers for heat dissipation.
    - Ambient temperature - natural air to dissipate radiant heat. (Singapore tropical temperature environment 24°C to 35°C)
  - Area B: Other servers, hard disk for storage, network equipment, etc.
    - The area is maintained at 26°C.
    - KoolLogix Rear Door cooling
    - Thermosiphon method using gas instead of liquid
- The Data Center has been awarded the **BCA Green Mark Platinum award (2021)**



Building and Construction Authority

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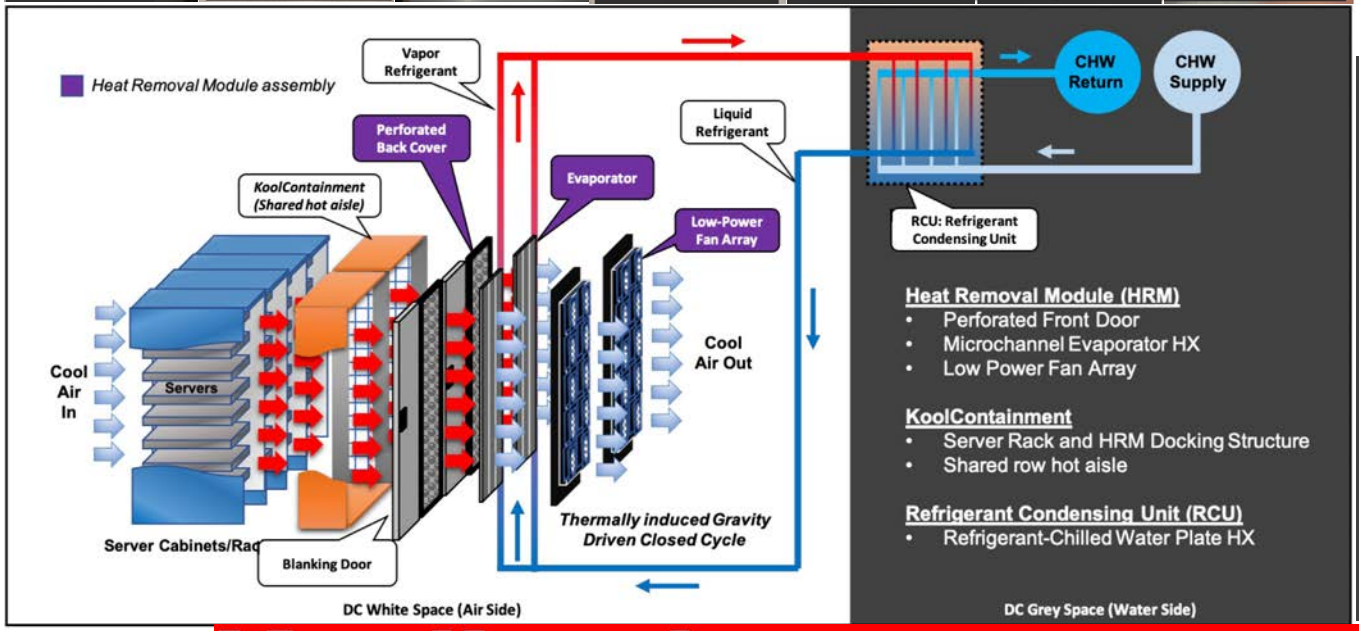
NSCC Data Centre @NUS Innovation 4.0

Area B:
- NSCC servers
- AI Singapore DC



KoolLogix™ System

It's simply kool and logical!

Some of the Benefits Include ...
- Improves PUE
- Lower Cooling Energy Cost
- Economizes Chilled Water Use
- Increases Productivity
- Water-free DC White Space

Some of the Features Include ...
- High Power Rack Density Handling
- Thermosiphon Concept
- Refrigerant-Based System
- Heat Removal before Cooling
- Recycles Server Waste Heat

KoolLogix — Passive Thermal Management Solution for High Performance Data Centers

KoolLogix from ERS Industries Pte Ltd is a Singapore-based engineering company specializing in data centre solutions. For more information, visit **www.ERS.com.sg**

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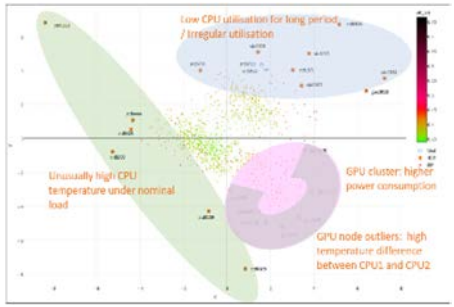
Intelligent Data Centre

Intelligent Sensing of 6540 IoT Sensors

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

INFOCOMM MEDIA DEVELOPMENT AUTHORITY

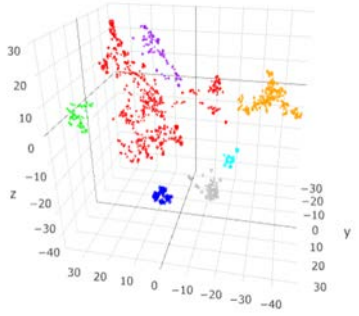
Outlier Analysis of Server Nodes



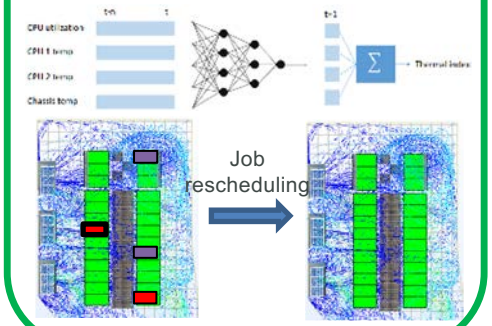
Example of outliers detected:

1. High temperature difference between CPU1 and CPU2 for GPU nodes
2. Unusually high CPU temp under nominal load
3. Low CPU utilisation for long period

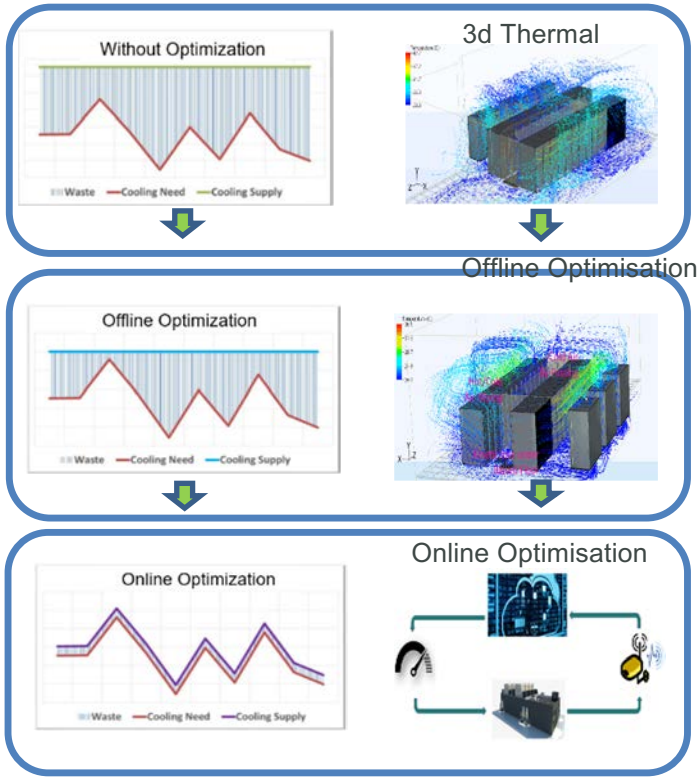
Cluster Analysis of Server Nodes



Thermal-Aware Job Scheduling



Intelligent Energy Optimisation



PUE dropped from 1.36 to 1.08 after optimization and retrofitting

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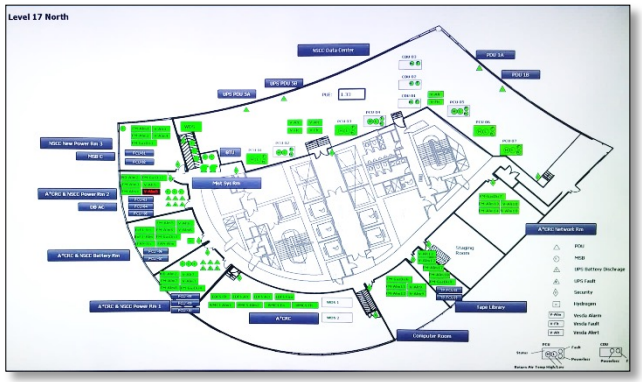
Smart Network Operations Centre

- 24x7 NOC Health Monitoring
- Parameters monitored include:
  - ❖ CPU Utilisation
  - ❖ Power Consumption
  - ❖ Relative Humidity
  - ❖ Temperature
  - ❖ Chilled Water pressure

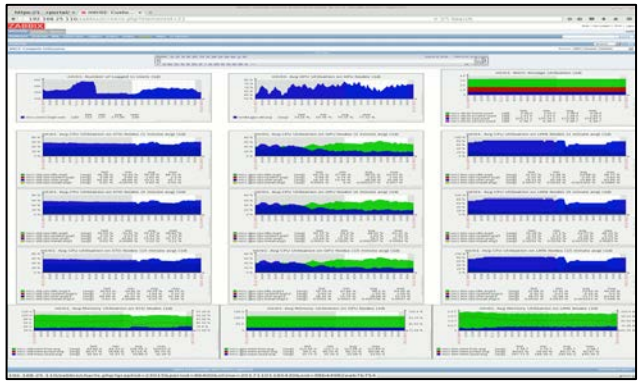
- Integrated DCIM-BMS, HPC
- IoT sensor system (6,540 sensors)

- Fire Suppression System
  - ❖ Water Mister (1 tonne water storage pressurised system)

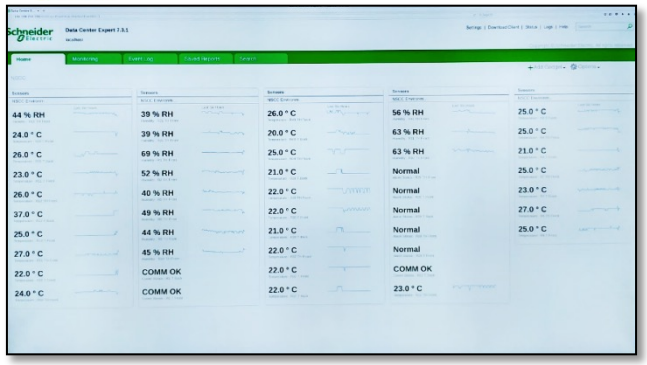
- Fujitsu Managed Services
  - ❖ 5 onsite staff
  - ❖ Service Delivery Manager, Service Desk, Call Centre team
  - ❖ Facility Management team



ZABBIX



Schneider Electric StruxureWare



Exploring Novel Green DC Architectures

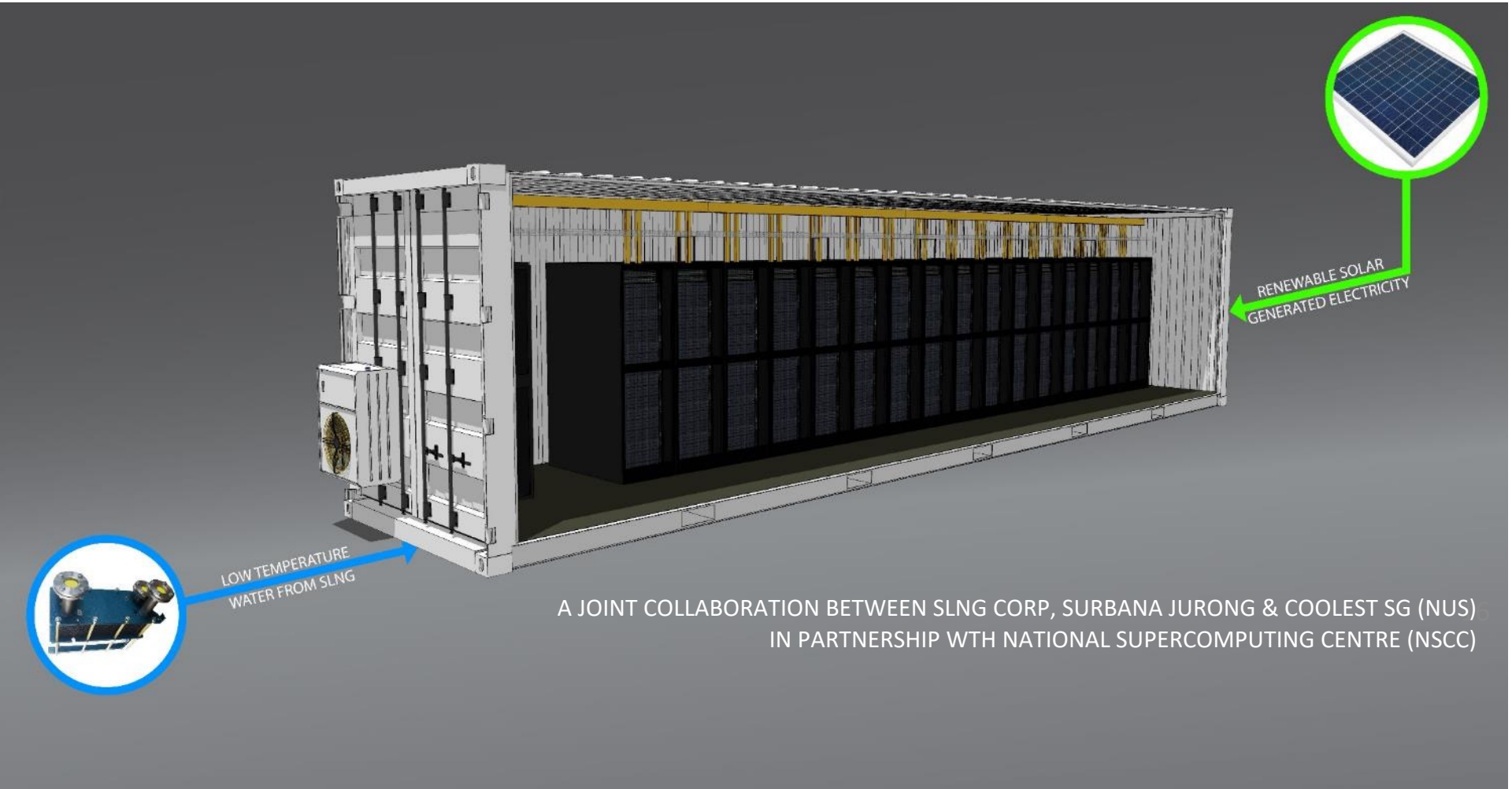
National Supercomputing Centre SINGAPORE

COOLEST SG

NUS National University of Singapore

SLNG SINGAPORE LNG

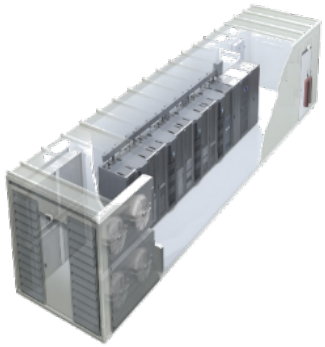
SJ SURBANA JURONG

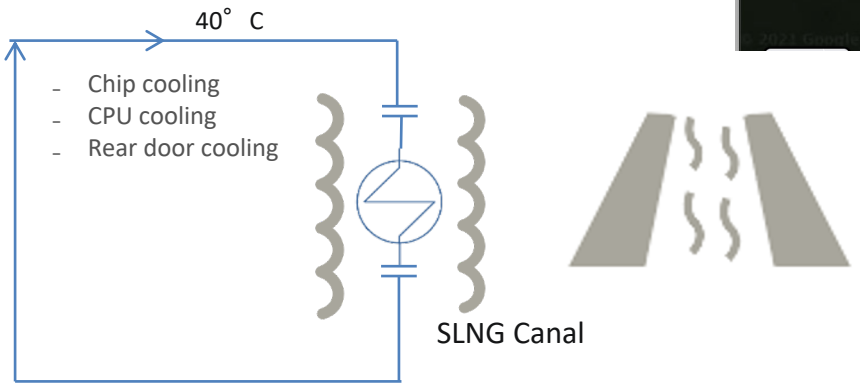


A JOINT COLLABORATION BETWEEN SLNG CORP, SURBANA JURONG & COOLEST SG (NUS)
IN PARTNERSHIP WTH NATIONAL SUPERCOMPUTING CENTRE (NSCC)

INDUSTRIAL SYMBIOSIS

1 petaflop Containerized Supercomputer





LNG -162°C

1kg LNG – 230Wh Cold Energy

Harnessing 300MW of cold

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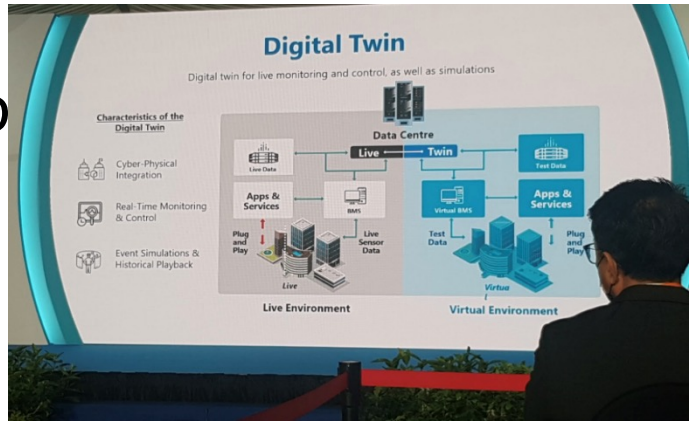
National Supercomputing Centre COOLEST SG NUS SLNG SINGAPORE LNG SURBANA JURONG

USE GREEN ENERGY

- Use greener energy
  - Solar power
  - Explore LNG
  - Investigate Hydrogen

Proposing **a hybrid Land-Water DC** interconnected by InfiniBand at the Punggol Digital District (PDD)

PDD is next to Serangoon Reservoir and Johor Straits



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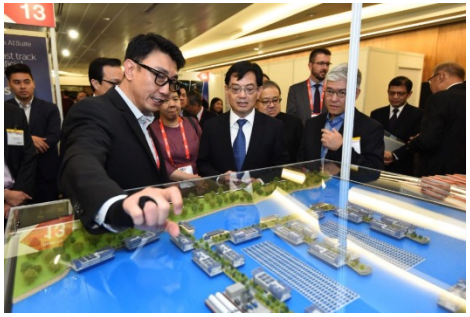


Keppel Data Centres

Singapore

Construction begins on Tengeh Reservoir floating solar farm, touted as one of world's largest

Artist impression of the upcoming 60MWp floating solar system on Tengeh Reservoir. (Photo: PUB/Sembcorp)

Accelerating Solar Adoption through Innovation and New Business Models

SolarNova

Demand aggregation on government rooftops using solar leasing model

Floating PV

World's largest floating PV testbed with 10 different systems at Tengeh Reservoir. Addresses Singapore's land shortage challenge.

Goh Chee Kiong
Executive Director, Cleantech & Cities, Infrastructure & Industrial Solutions

Singapore plans to have 1GW solar after 2020

ACHIEVING NET-ZERO CARBON

FLOATING DATA CENTRE

A holistic approach of harnessing solar power as on-site power source and LNG " Waste Cold" for energy-efficient cooling

Floating PV

SOLAR ENERGY
Harnessing solar energy from Floating PV which also addresses land shortages

Power

Floating DC Prototype

Floating LNG Tank

COLD ENERGY ECONOMY FOR ENERGY EFFICIENCY

Extraction of cold energy from LNG while regasification, to supplement DC cooling load

Hydrogen Fuel Cell

GREEN ENERGY

Replacing diesel generators with hydrogen-powered fuel cells.

COMPUTE ELSEWHERE

- Compute somewhere else more efficient
  - Global range InfiniBand
  - Interlinked Supercomputing Centres

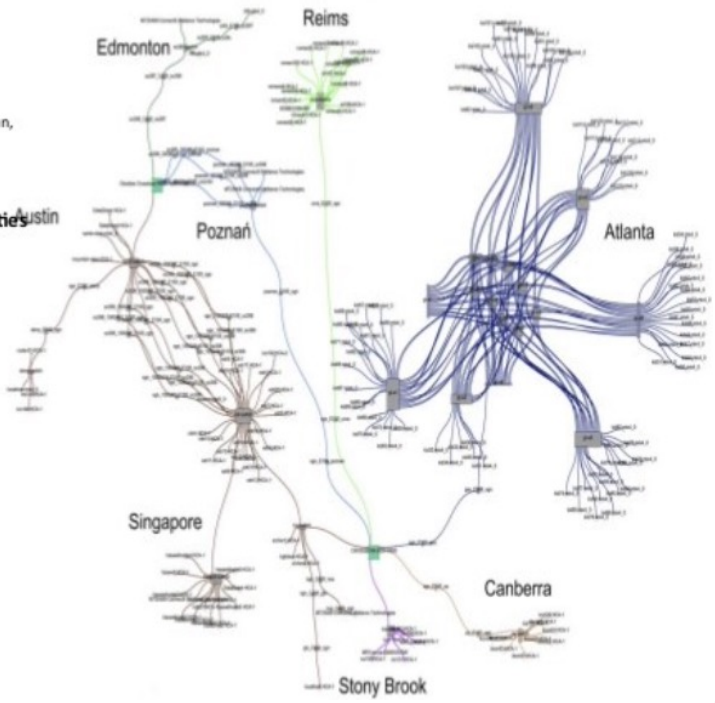
InfiniCortex:

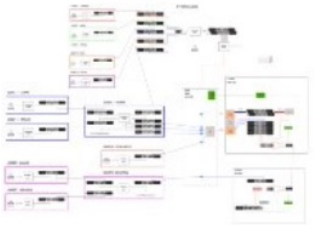
concurrent supercomputing across the globe utilising trans-continental InfiniBand and Galaxy of Supercomputers

Marek T. Michalewicz
A*CRC

InfiniCortex demo, SC15, Austin, TX, USA

7 InfiniBand sub-–nets
7 countries: Singapore, USA, Australia, Japan, Poland, France, Canada
100Gbps Singapore-–Austin
10-–30Gbps rest of network
~15 Universities and Research entities
~40 partners and growing
HPC InfiniCloud over 4 continents





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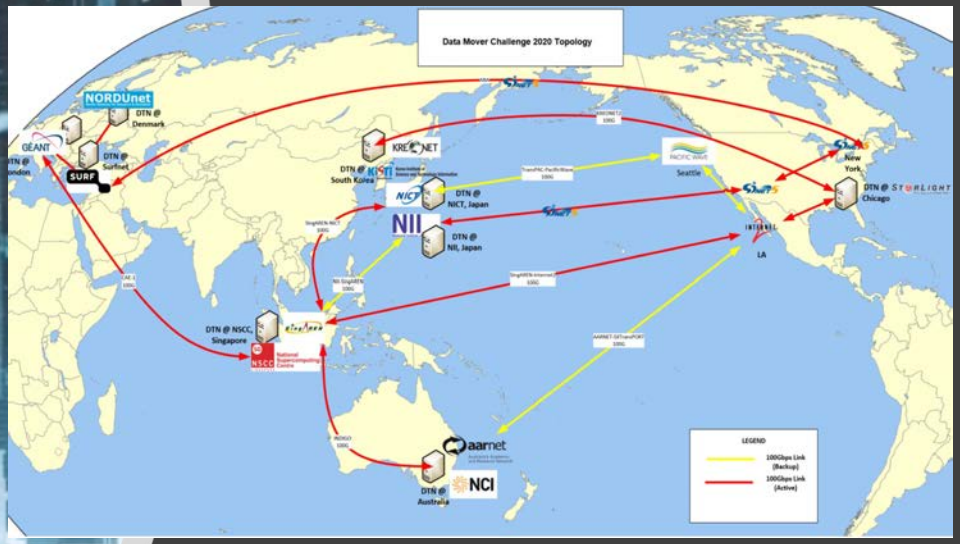
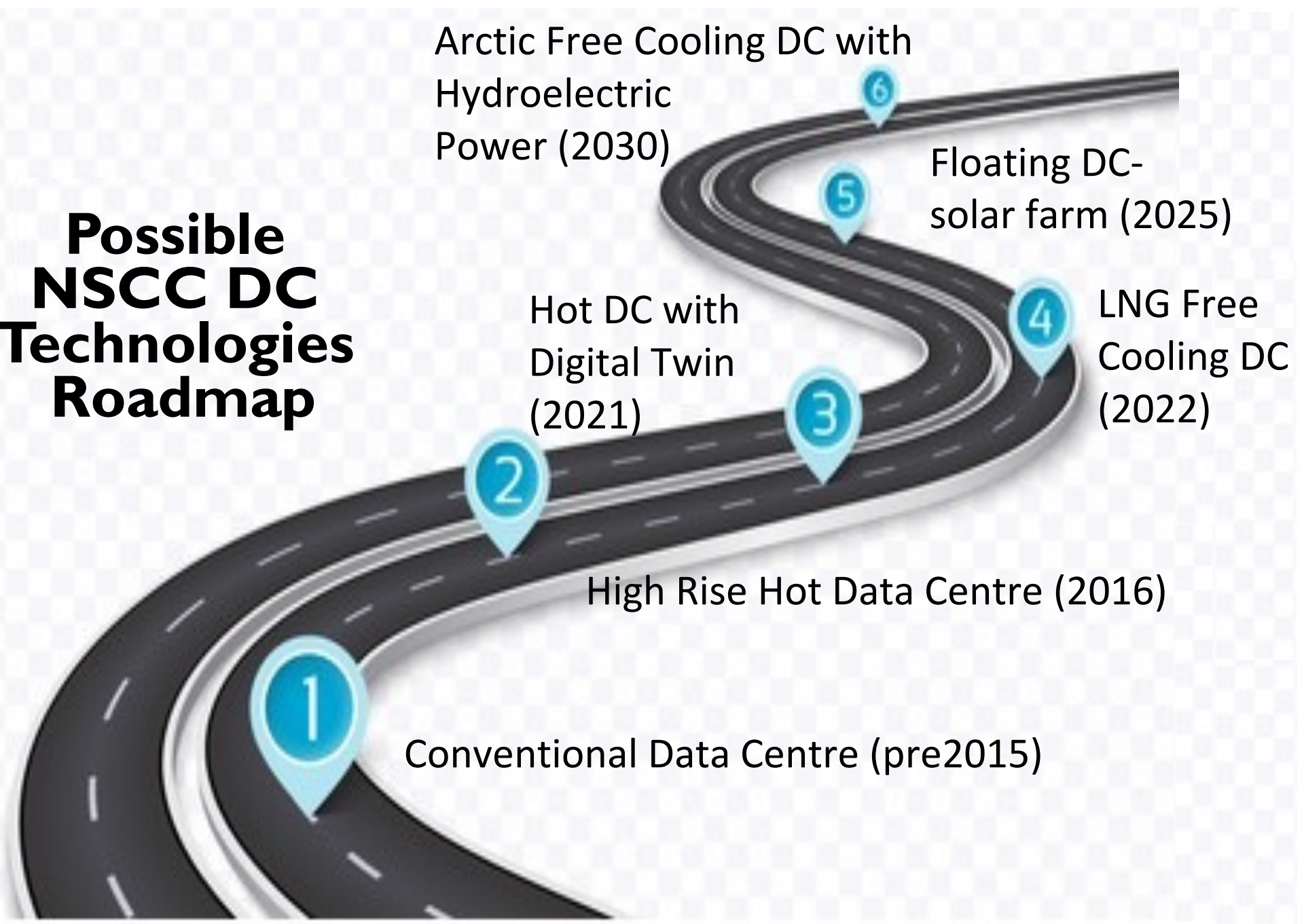


From Singapore to

Finland's CSC-IT LUMI Supercomputer

Possible NSCC DC Technologies Roadmap



USE LESS ENERGY

USE GREEN ENERGY

COMPUTE ELSEWHERE