

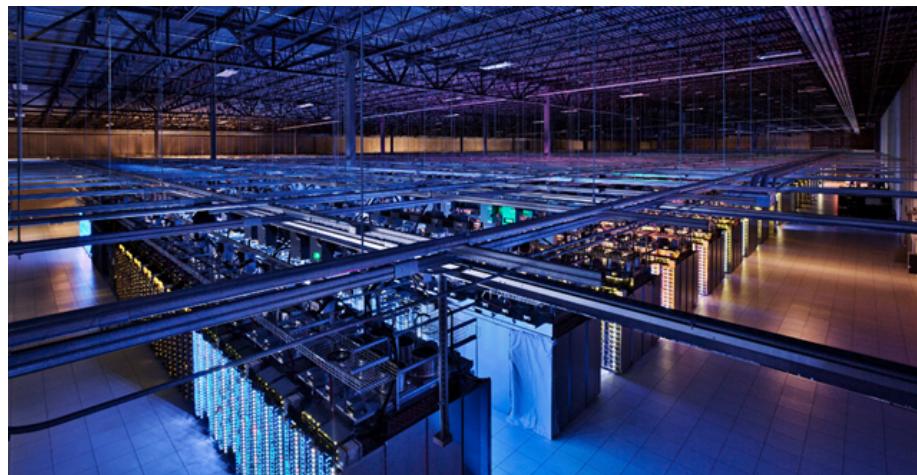
# AI Datacenter behind 0.55 AI-EFLOPS Infrastructure

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CENTRA3 Post-workshop, May 17, 2018

# Commoditizing Supercomputing Cooling Density and Efficiency for Cloud Datacenter



Traditional DC  
~10kW/rack PUE 1.5~2  
15~20 1U Xeon Servers  
2 Tera AI-FLOPS(SFP) / server  
30~40 Tera AI-FLOP / rack



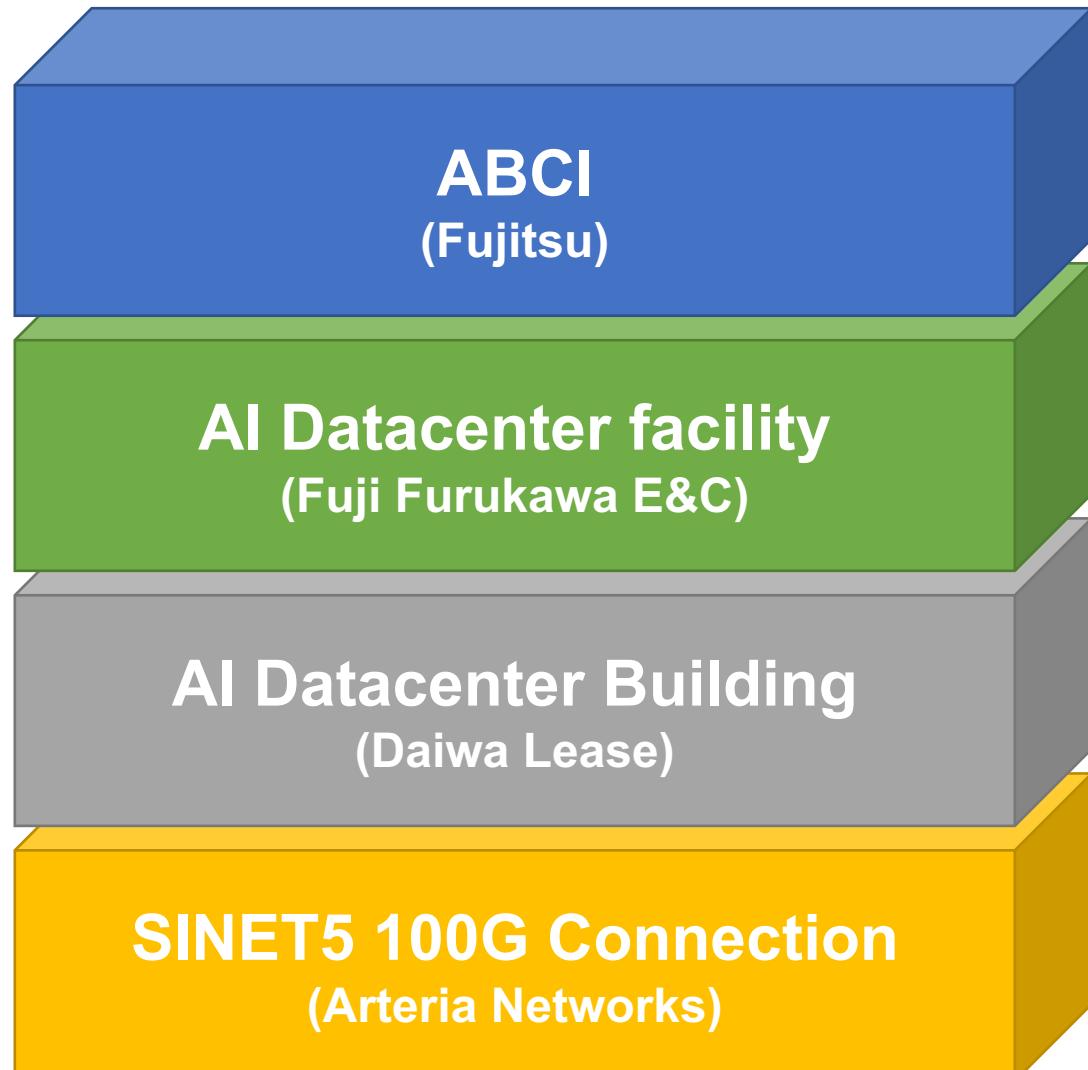
TSUBAME 3.0  
State-of-the-art  
Supercomputer

Perf > 400~600  
Power Eff > 200~300



ABCI DC  
70kW/rack PUE ~1.1  
32 Xeon + Tesla V100 servers  
~500 Tera AI-FLOPS(HFP) / server  
~17 Peta AI-FLOPs / rack

# ABCi-related Procurements



The world's first large-scale open AI infrastructure

Cooling and electric equipment for AI cloud infrastructure

Lightweight “warehouse” building

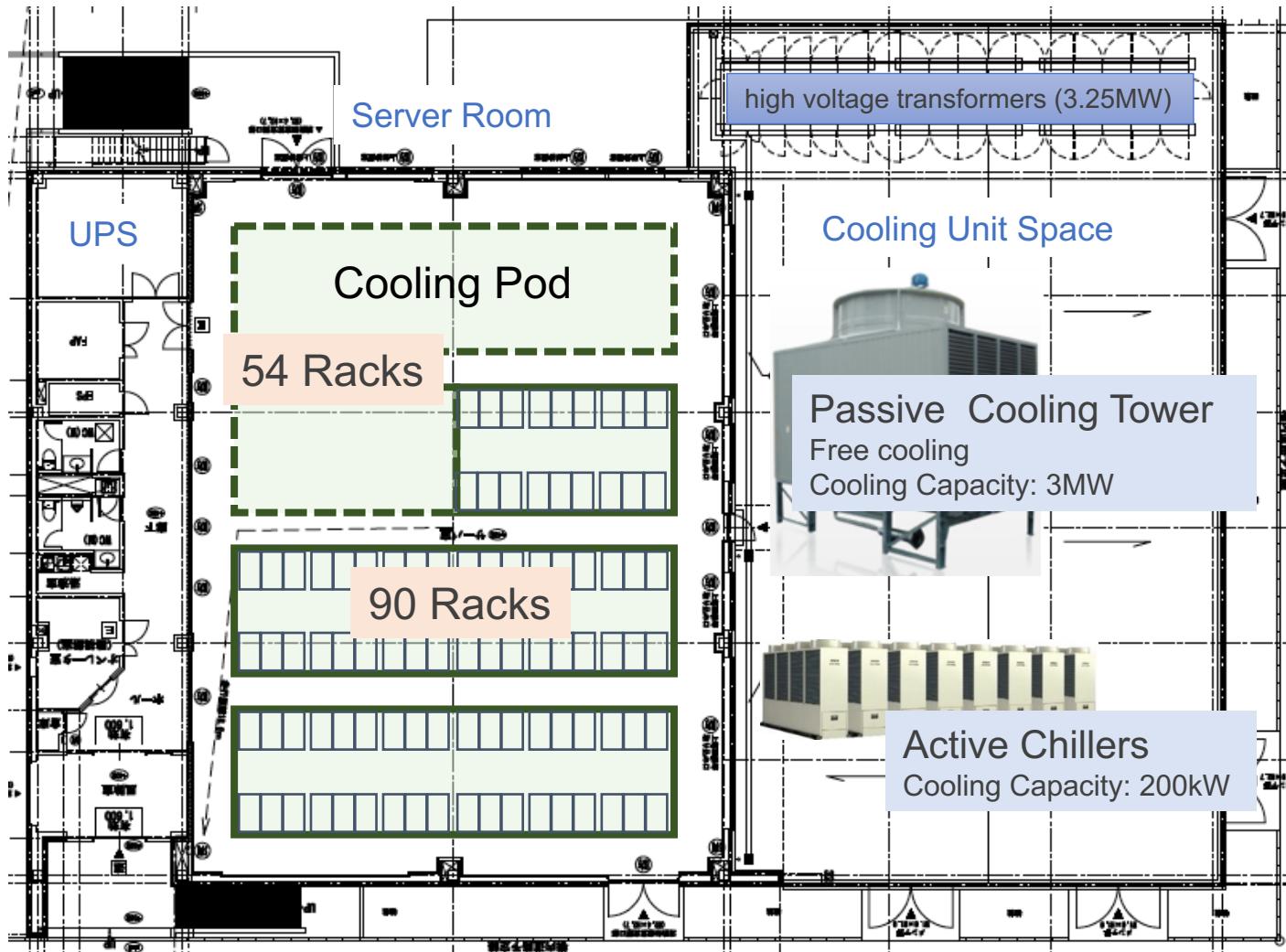
High-speed research and education backbone network

# ABCI and AI datacenter

	<i>system-specific</i>	<i>system-agnostic</i>
	<b>ABCI</b>	<b>AI Datacenter facility</b>
Basic component	Compute/multi-platform/management node, storage, network switch	Cooling pods and 48U 19-inch racks
Electric equipment	Power Distribution Unit (PDU)	Bus bar
Water cooling equipment	Rack Cooling Distribution Unit (CDU) – cold plate	Cooling tower/chiller - pipe
Air cooling equipment		Fan coil unit (FCU) and Front door cooler

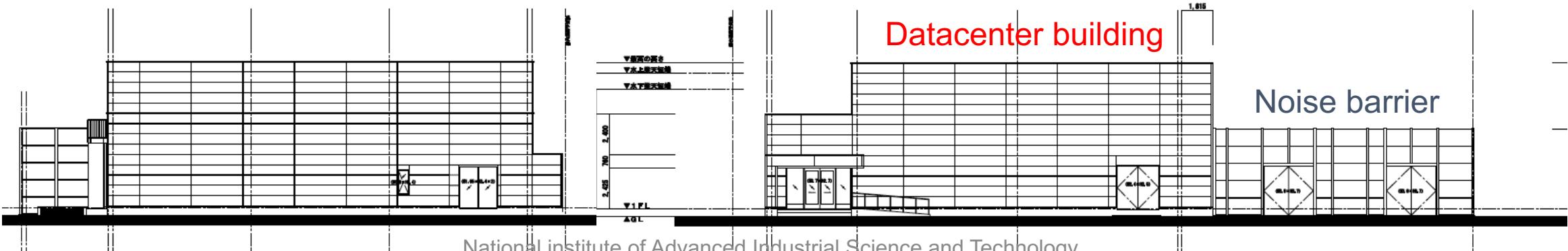
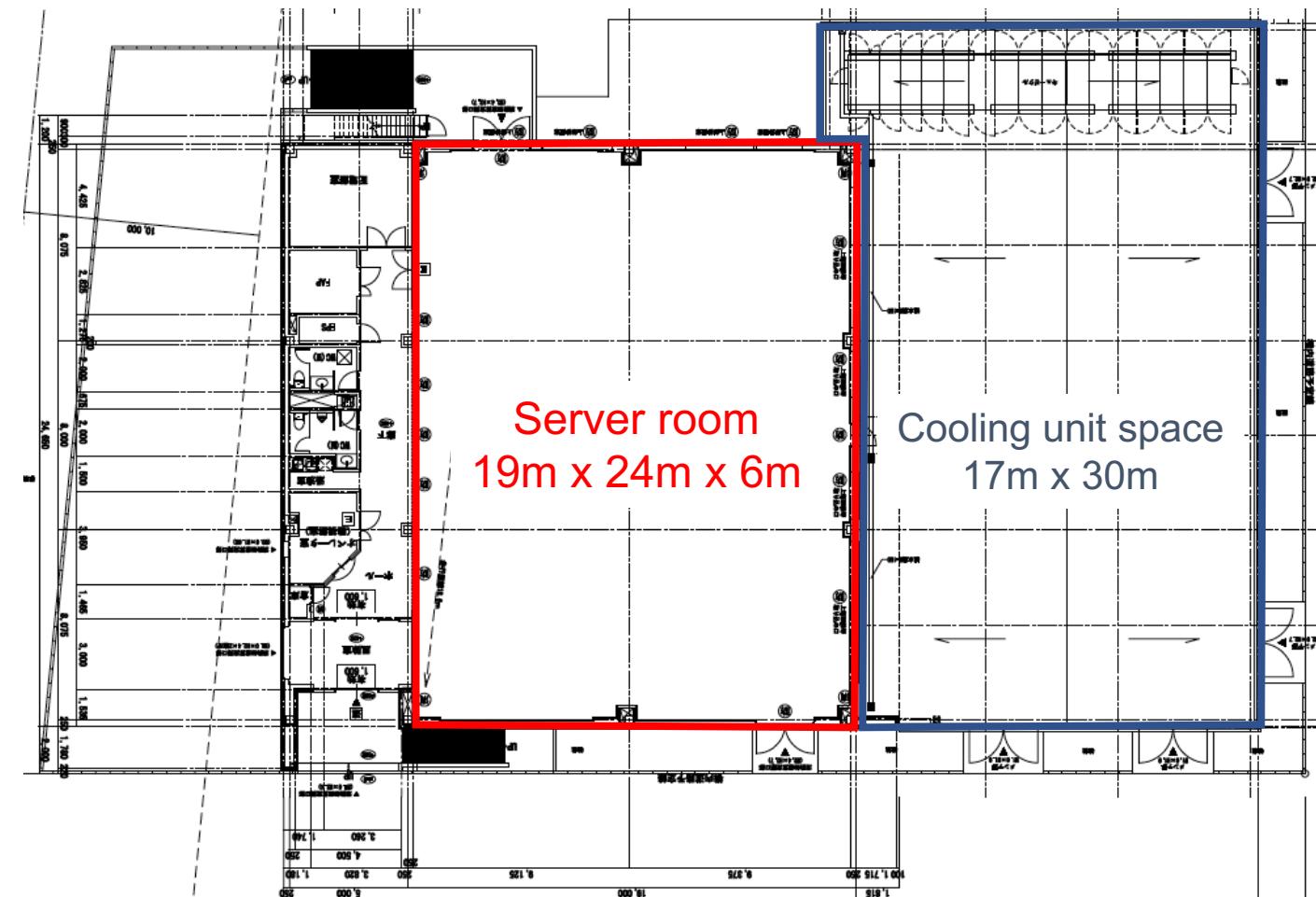
# AI Datacenter Overview

Commoditizing supercomputer cooling technologies to Cloud (70kW/rack)



- Single Floor, inexpensive build
- Hard concrete floor 2 tons/m<sup>2</sup> weight tolerance for racks and cooling pods
- Power/Cooling Capacity
  - Power: 3.25 MW (Max, incl. research building), *ABCi uses 2.3 MW max.*
  - Cooling: 3.2 MW (Min in Summer)
- Number of Racks
  - Max: 144
  - Initial: 90
  - *ABCi uses 41 racks*

# AI Datacenter Building



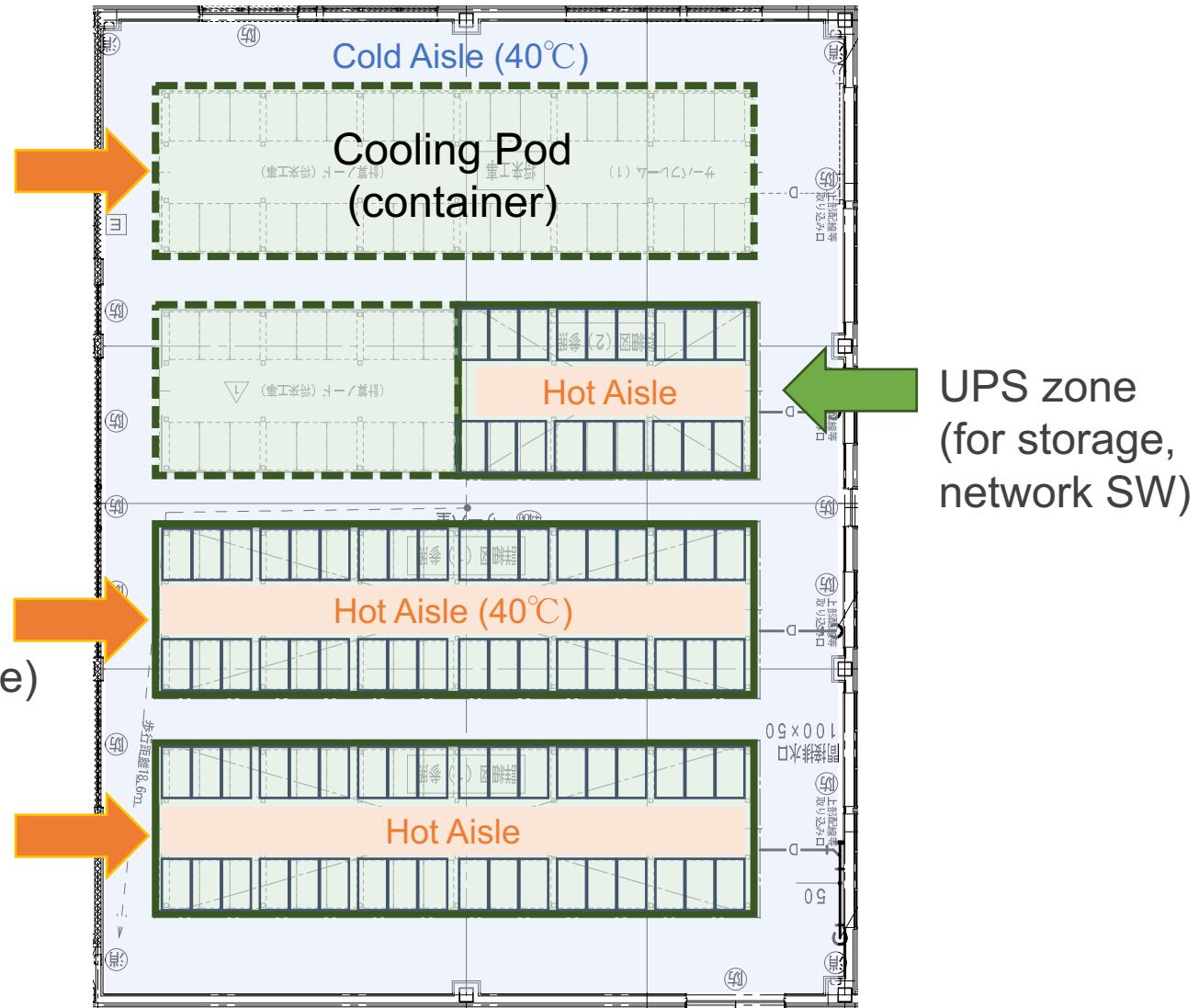
# Server Room



Non-UPS zone  
(for compute node)

- Number of Racks
  - Max: 144
  - Initial: 90
  - *ABCI initially uses 41 racks*

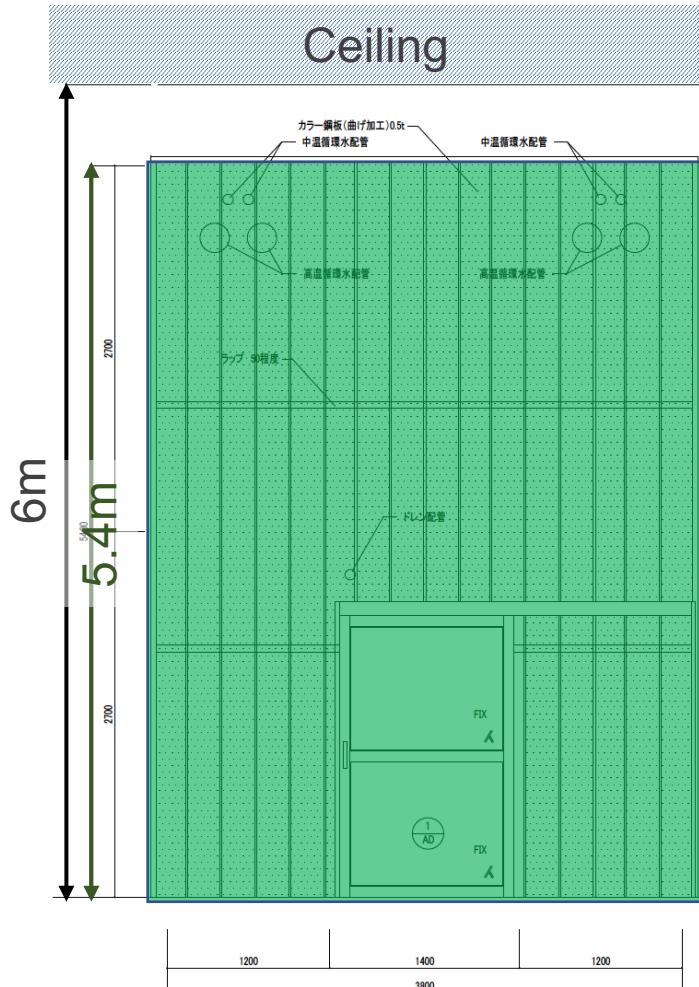
Floor Plan



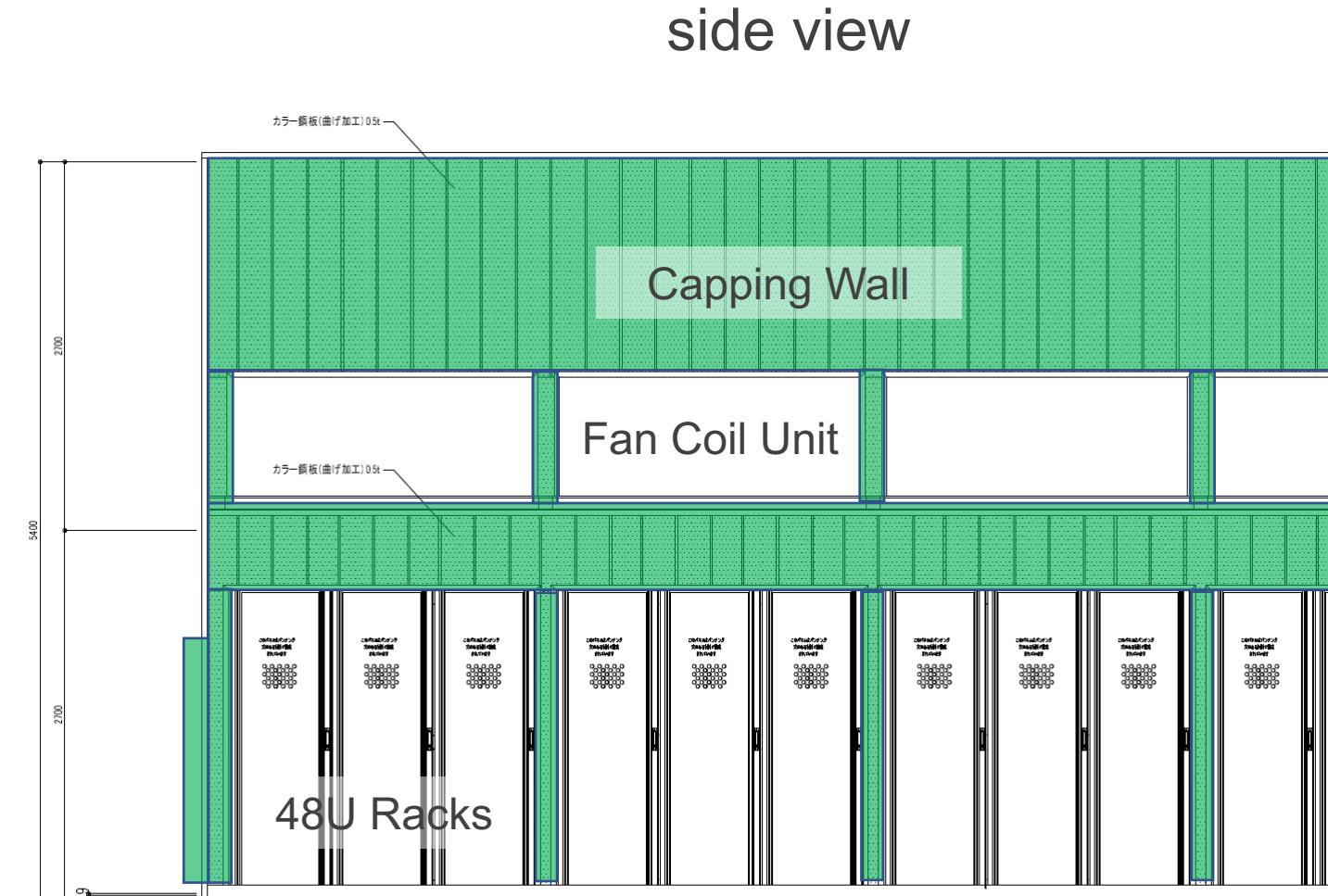
# Cooling Pod

Implementing 70kW/Rack in AI Cloud Datacenter

front view



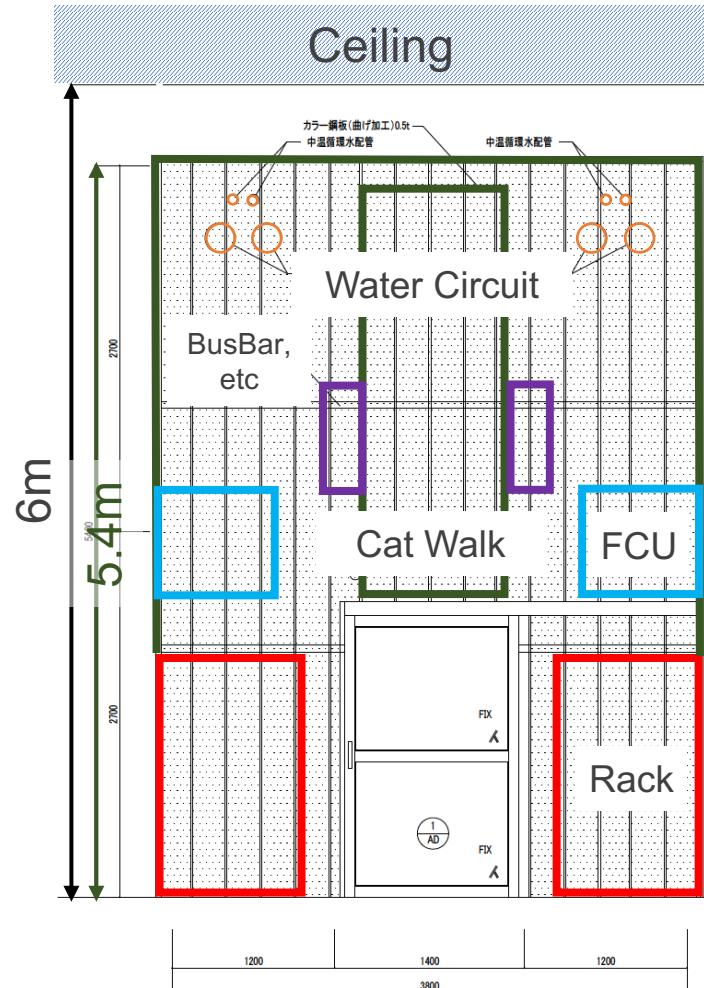
side view



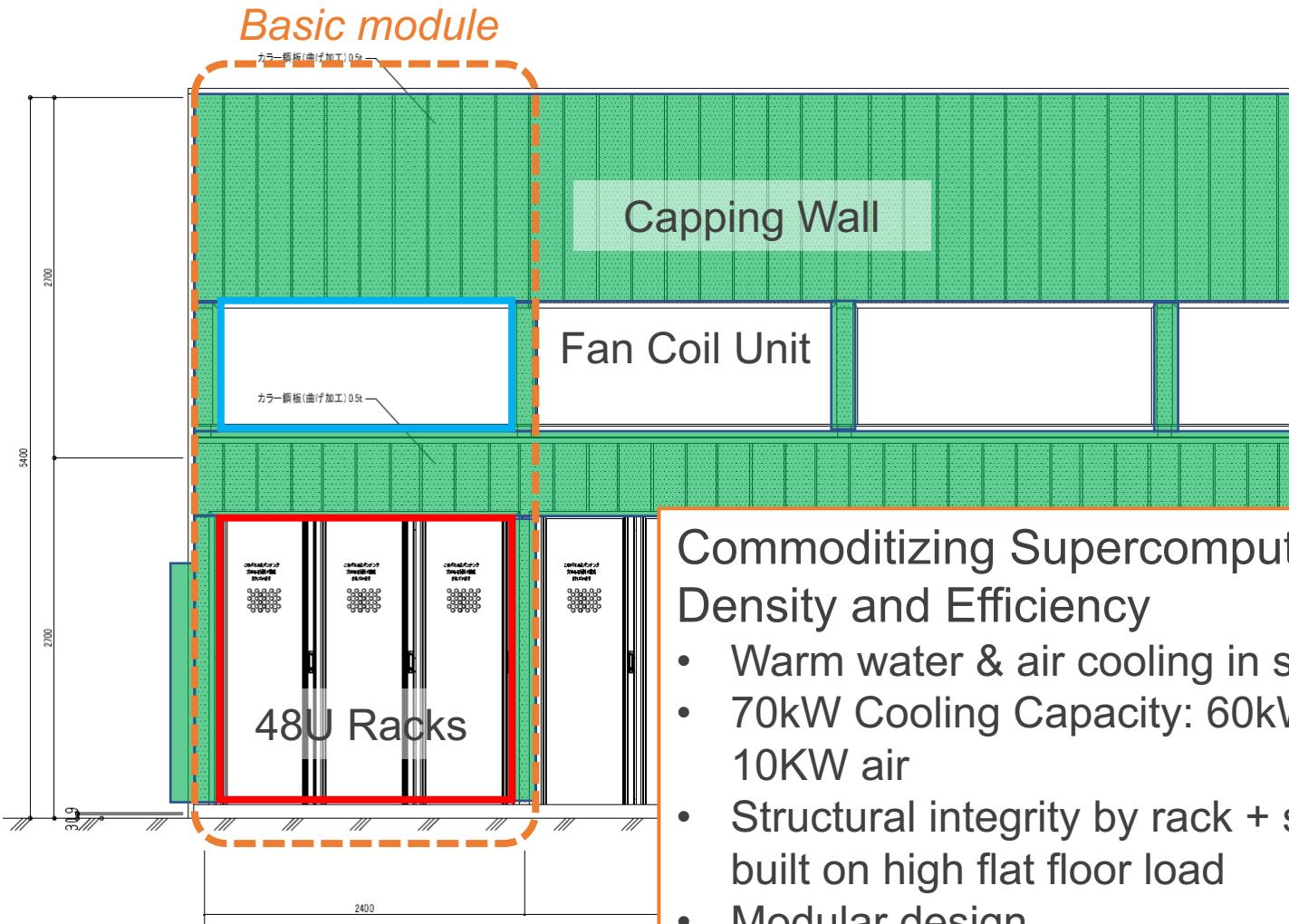
# Cooling Pod

## Implementing 70kW/Rack in AI Cloud Datacenter

front view



side view



- Warm water & air cooling in same rack
- 70kW Cooling Capacity: 60kW liquid + 10kW air
- Structural integrity by rack + skeleton frame built on high flat floor load
- Modular design

# Cooling Pod

Implementing 70kW/Rack in AI Cloud Datacenter



February 6, 2018



March 21, 2018

# Cooling Pod

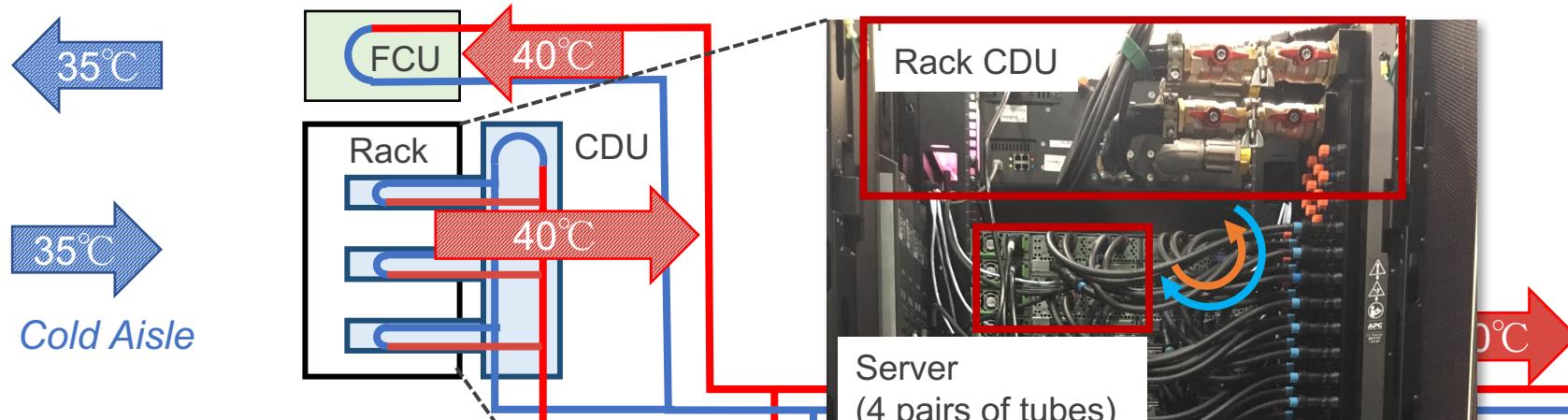
Implementing 70kW/Rack in AI Cloud Datacenter



April 18, 2018

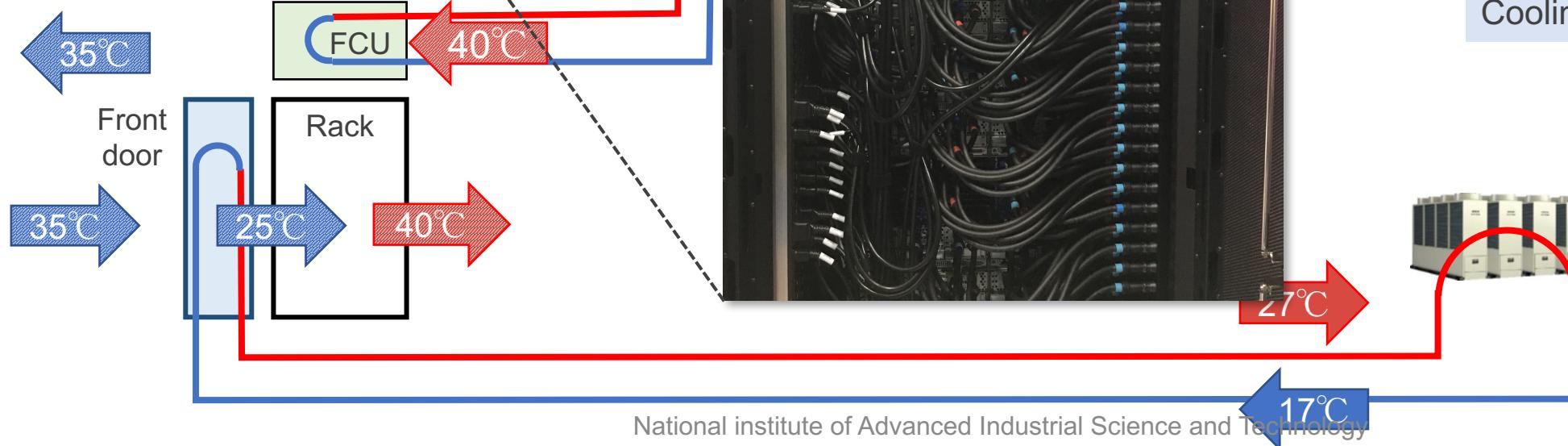
# Air/Water Hybrid Cooling

Compute node rack



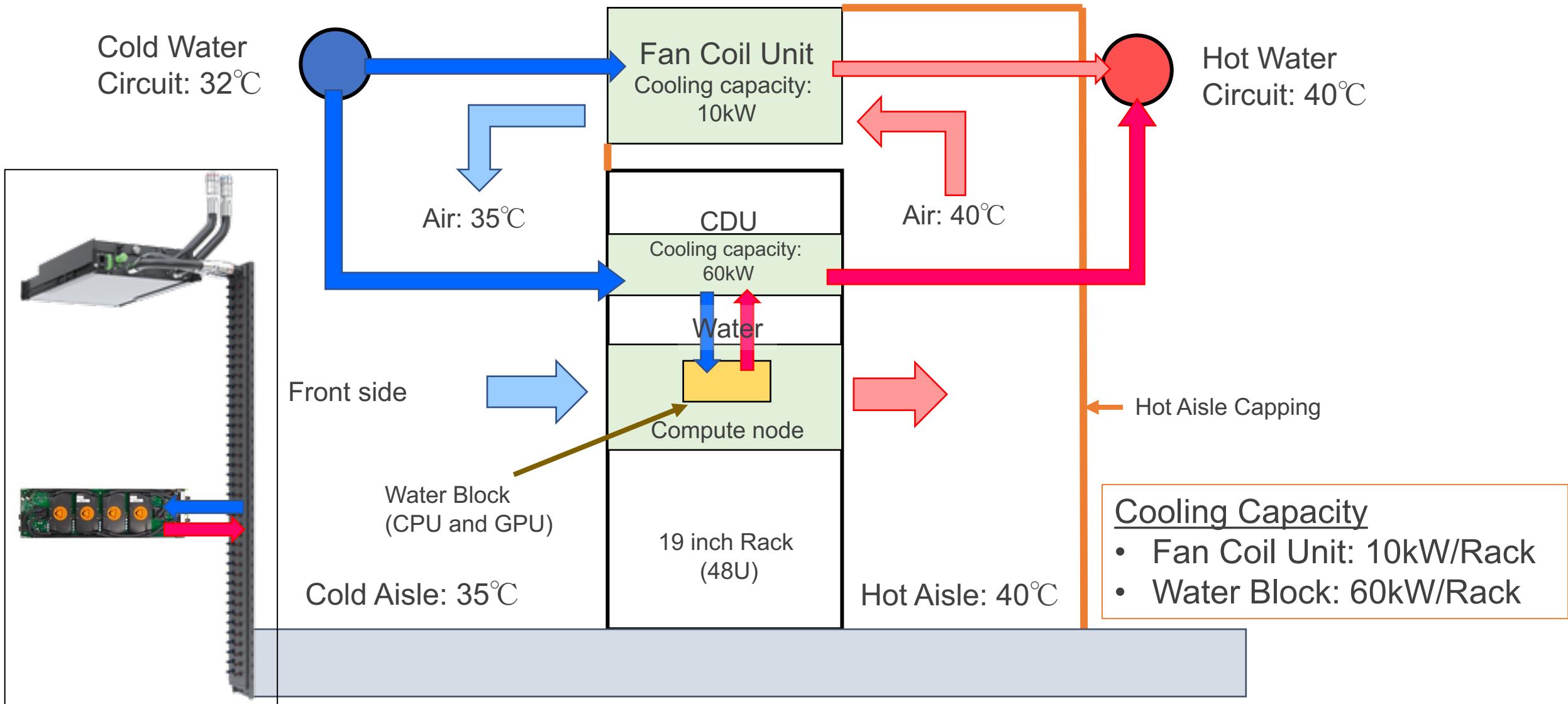
Passive Cooling Tower  
Free cooling  
Cooling Capacity: 3MW

Storage rack

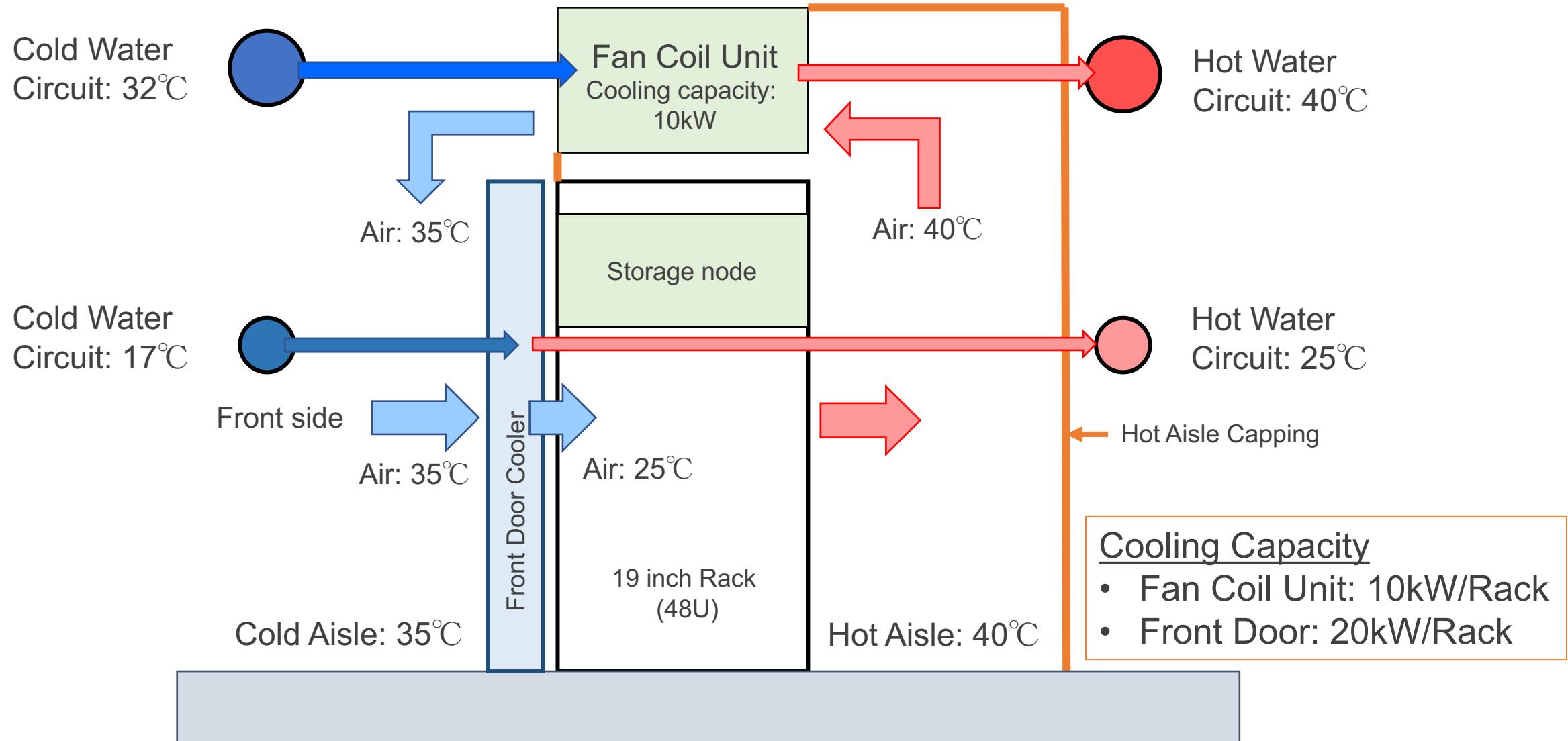


Active Chillers  
Cooling Capacity:  
200kW

# Cooling Block Diagram (for compute node)



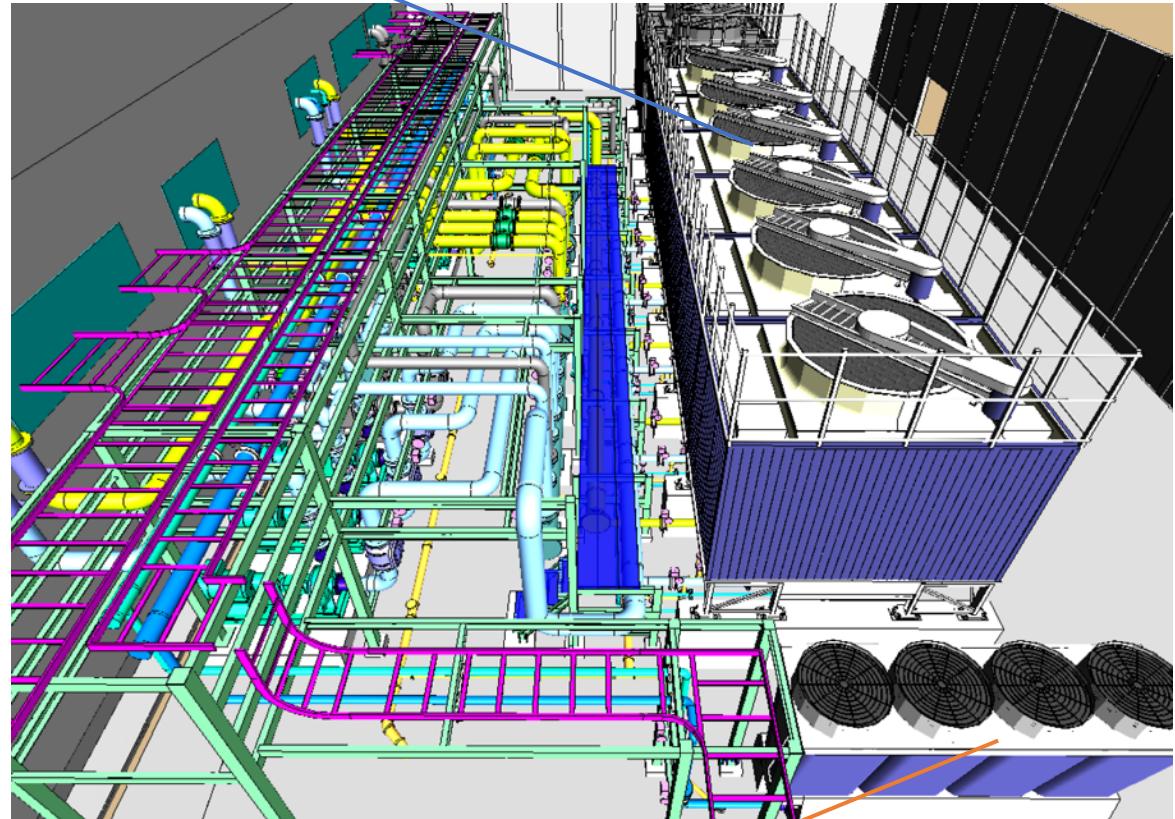
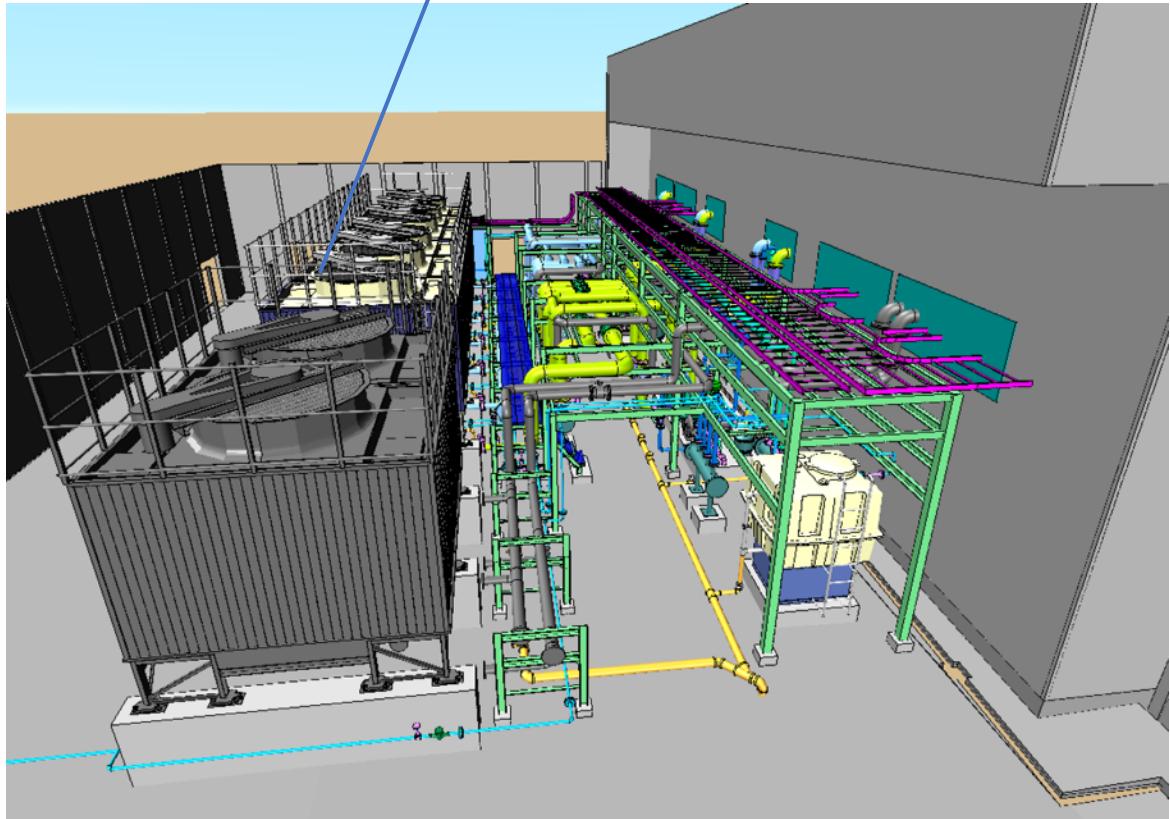
# Cooling Block Diagram (for storage node)



# Outdoor Cooling Unit Space

**Passive Cooling Tower**

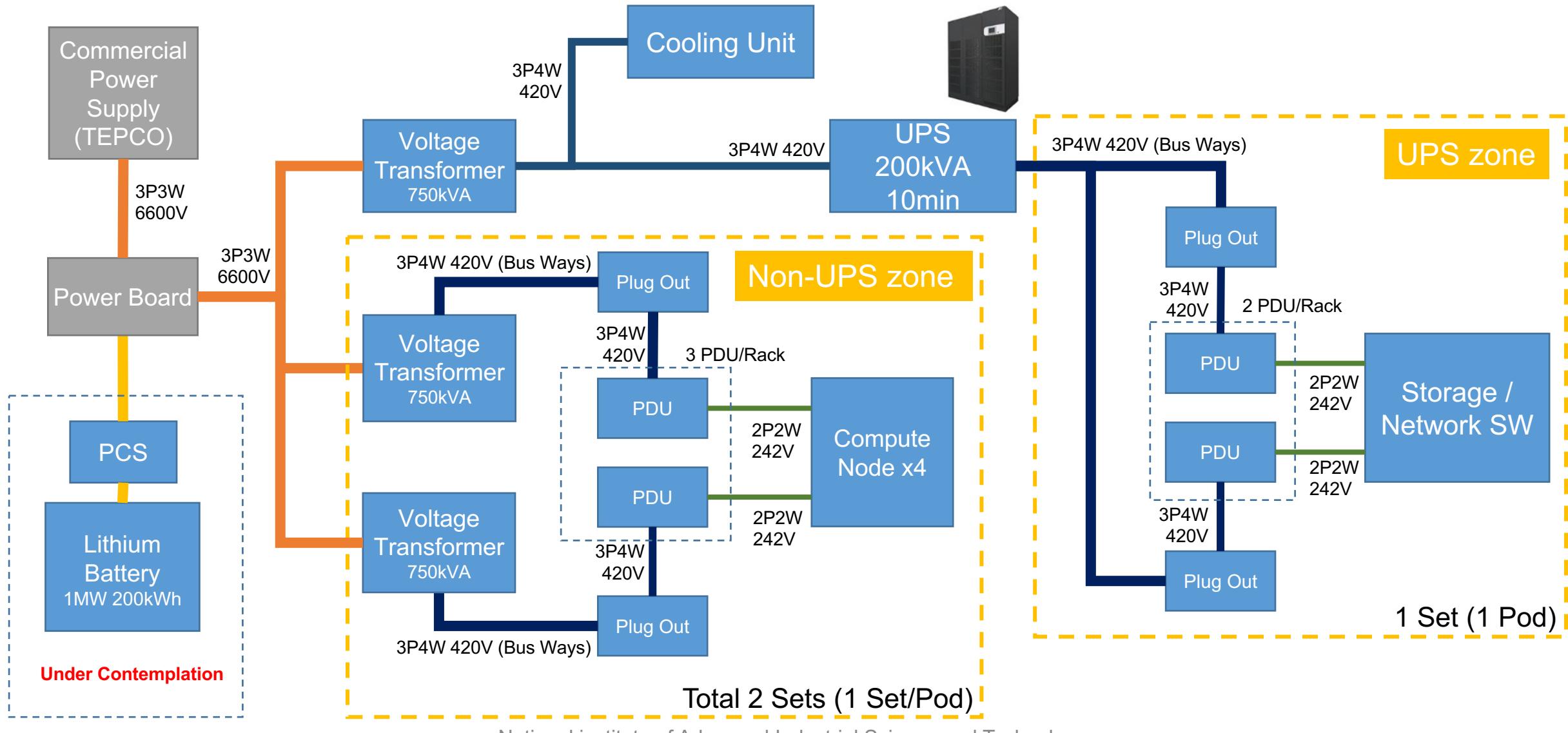
(Cooling capacity:  $500\text{kW} \times 6 = 3000\text{kW}$ )



**Active Chiller**

(Cooling capacity:  $100\text{kW} \times 2 = 200\text{kW}$ )

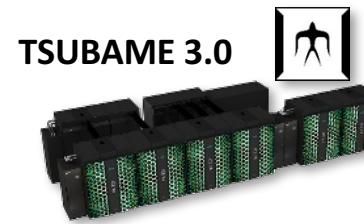
# Power Circuit



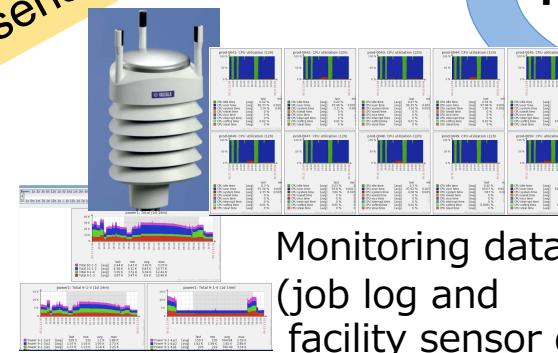
# Optimizing data center operation using ML

Develop a framework for optimizing the operation of AI data centers by self-adapting ML/DL technologies

World leading supercomputing systems for big data / AI

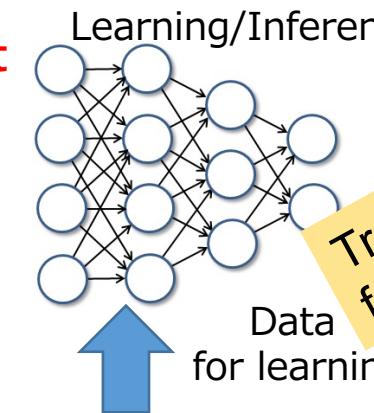


Data center generates  
huge amount of sensor data



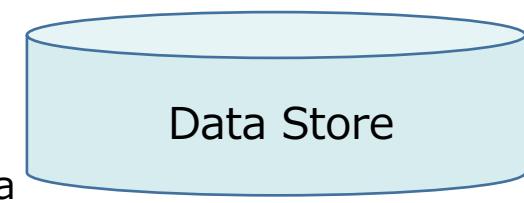
Improve data center  
operation using feedback loop  
of sensor data analysis

- Reduce Operation cost
- Reduce power consumption
  - Improve resource usage
  - Reduce HW maintenance fee using failure prediction



Train and apply parameters  
for improving the operation

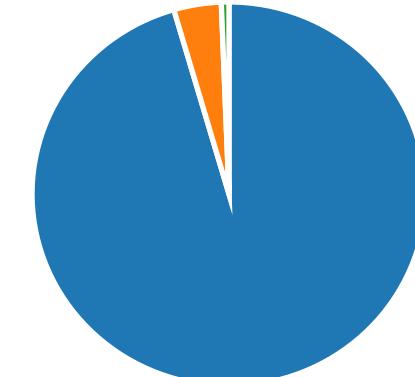
Time series data



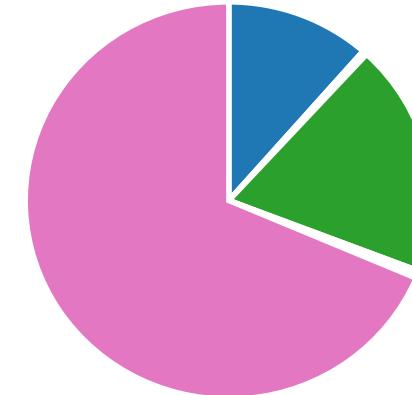
# Preliminary data analysis for efficient deep learning job scheduling

- Analyze **55,127** jobs submitted on AAIC from 07/14/2017 to 12/31/2017
- 95%** jobs are Single GPU jobs and WRA is too low, **0.103** on average.

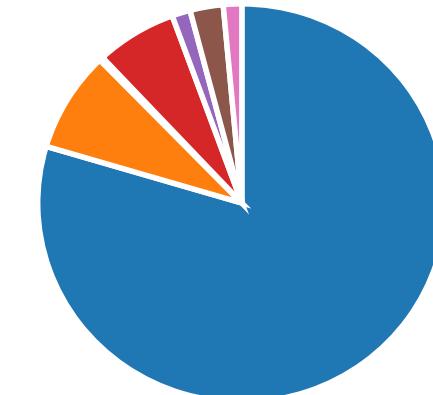
1 GPU/ Multi GPU /  
Multi Node Jobs



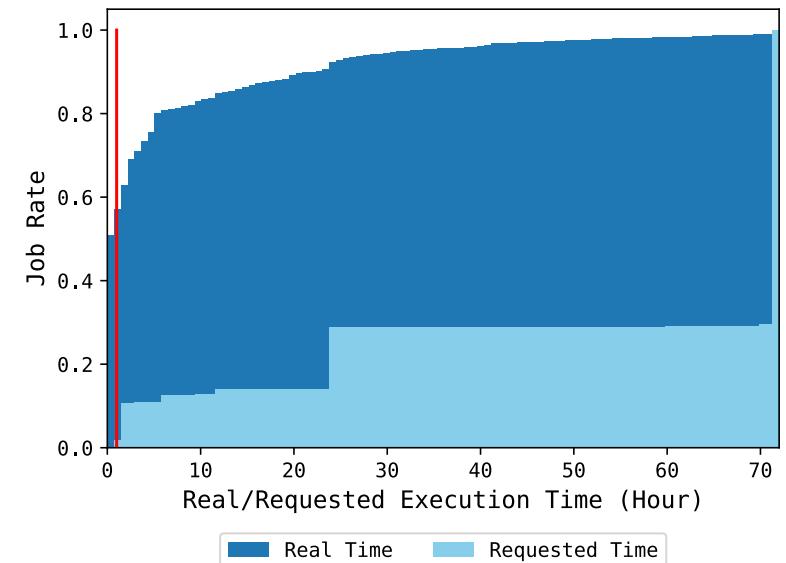
1 Node,  
Multi GPU Jobs



Multi Node Jobs



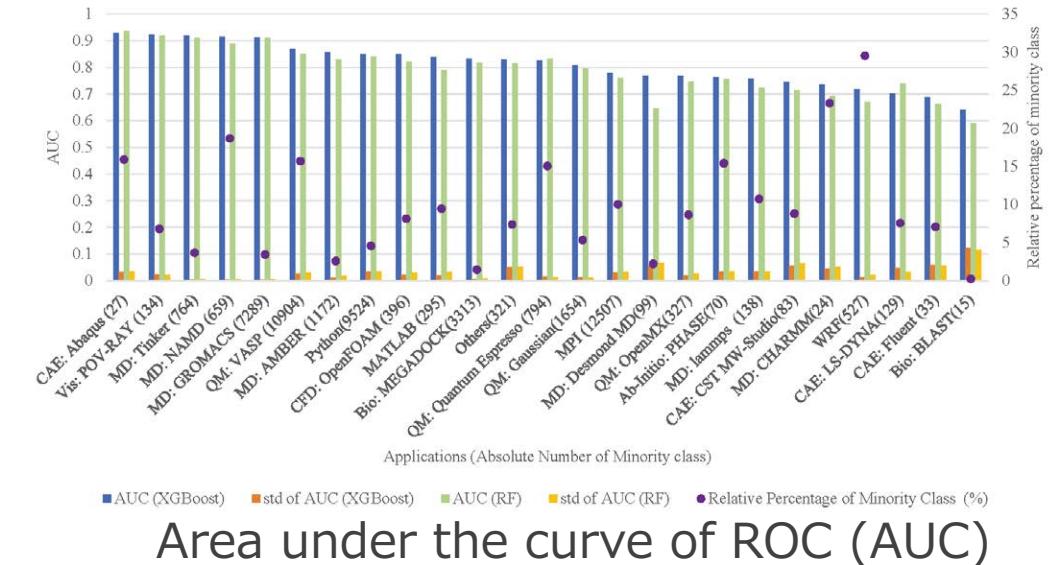
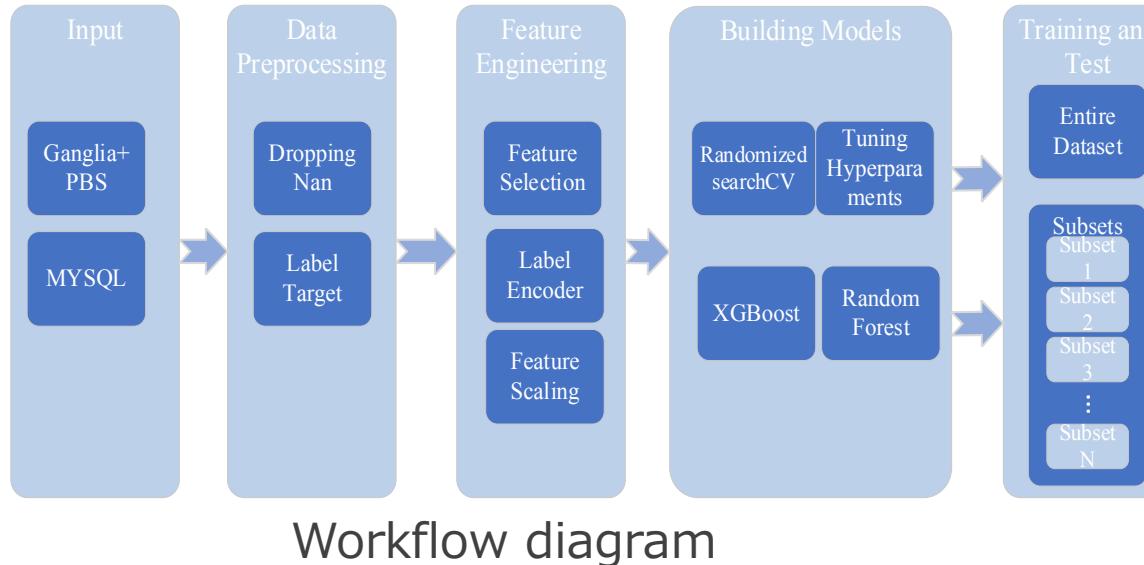
Walltime Request Accuracy (WRA)



$$WRA_i = \frac{Walltime_i}{Walltime\_Request_i}$$

# Machine Learning Predictions for Underestimation of Job Runtime on HPC System

- Job runtime-underestimation prediction from HPC job logs by applying Random Forest and XGBoost algorithms.
- The best precision, recall, and F1-score of subsets on prediction achieved 90%, 95%, and 92%, respectively.



*Thank you for your attention.*

*Enjoy the ABCI site visit this afternoon!*

