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Dynamic Phase-change Cooling For Moving to AI Load

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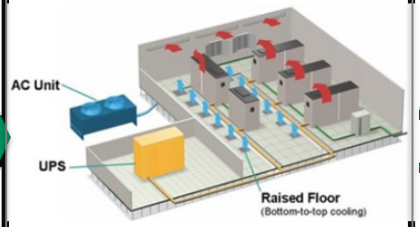
00 Self-Introduction

HVAC system

Refrigeration System

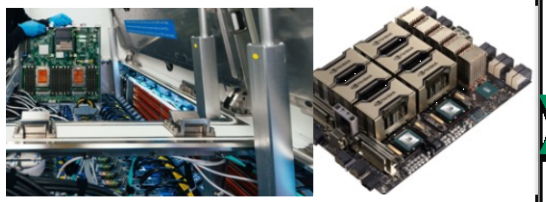
residential motorcar

HVAC System



data center

Thermal System



server

Server
Network
Rack

Computility Resource
算力资源

Dual Pump Phase-change Cooling (2017~)

Dynamic Phase-change Cooling

Compressor → Gas Pump

Liquid accumulator → Liquid Pump

Oil → Oil free

Evaporating Condenser

Liquid Cooling（ 2016~）

Cold plate / CDU / negative pressure

ROI / TCO / T-case / T-junction

Immersion / Main Frequency / FLOPS

Computility Center

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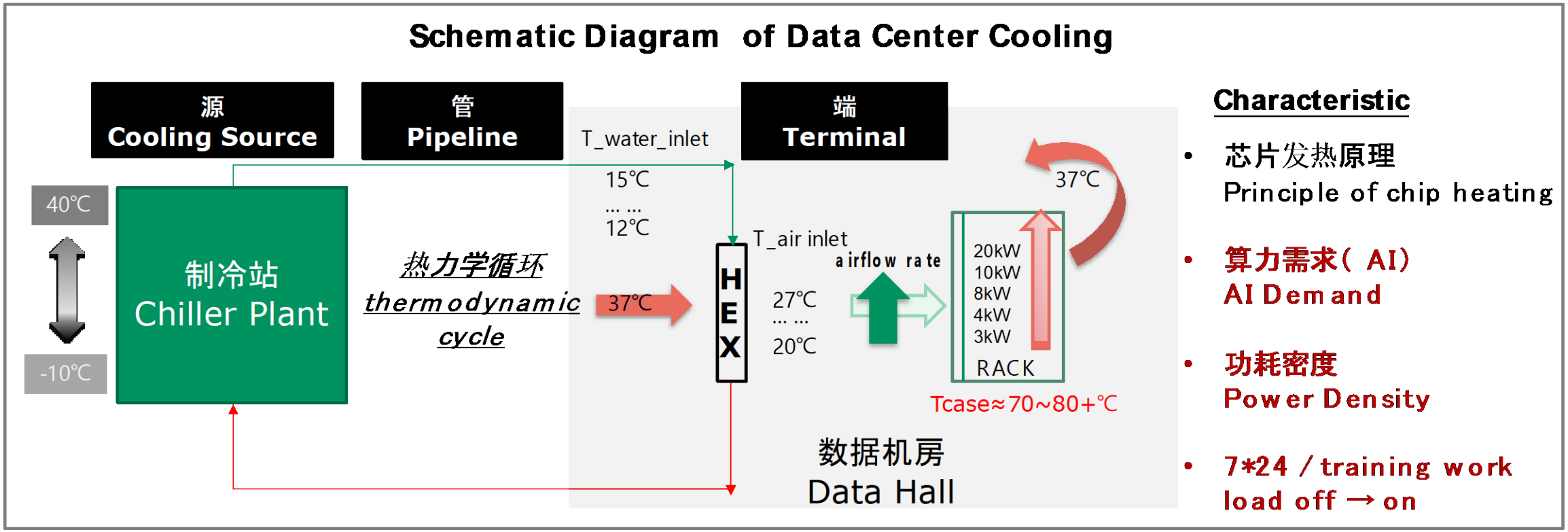
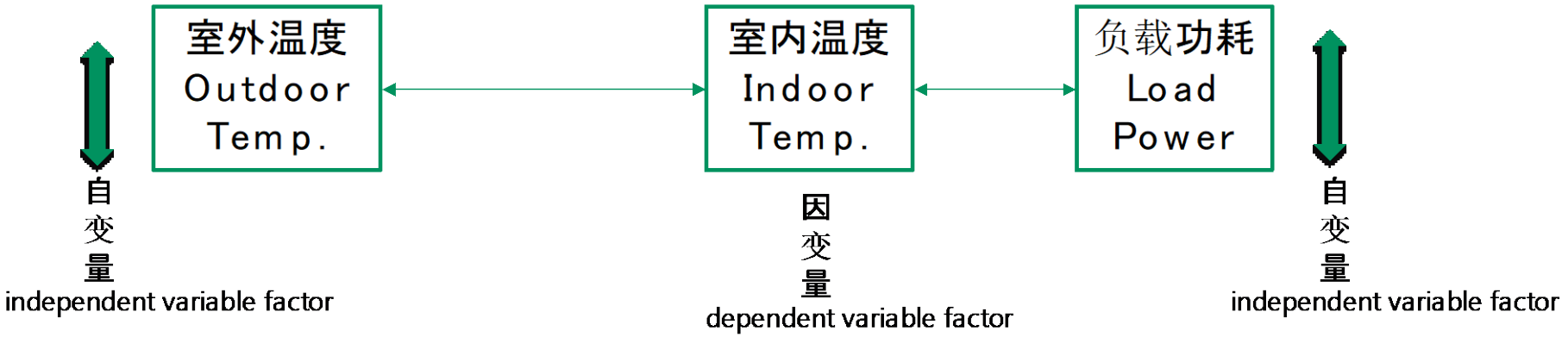
01 What?

- What's core principle of data center cooling?

01 What?

What's core principle of data center cooling?





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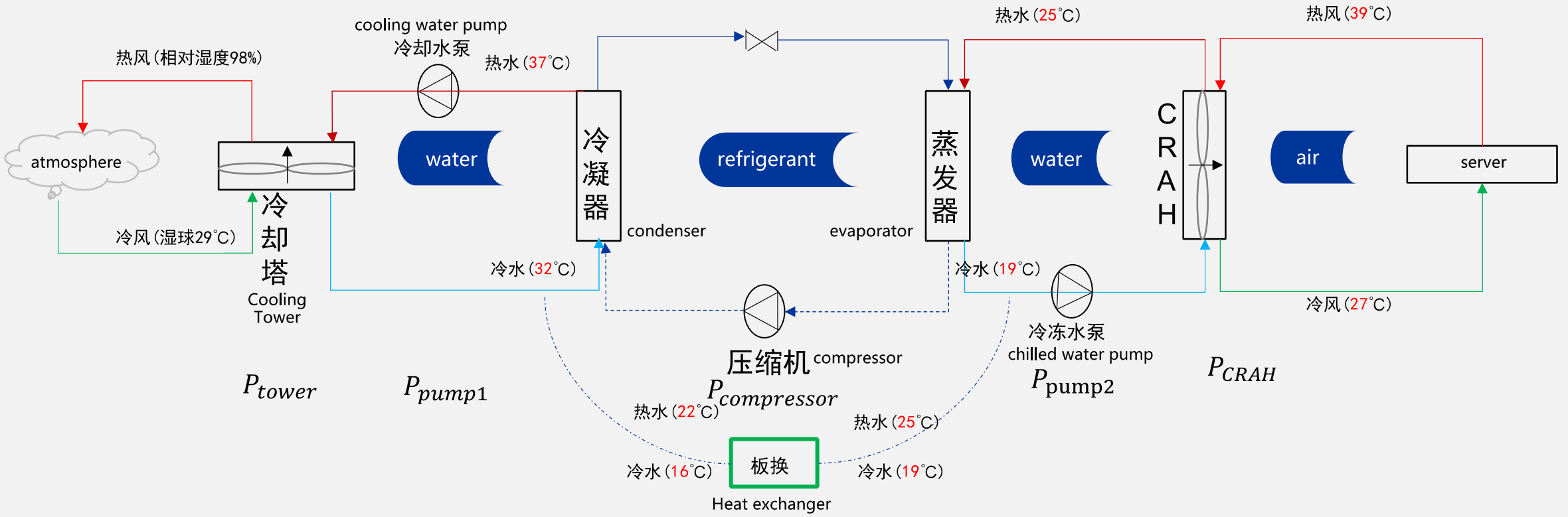
02 How?

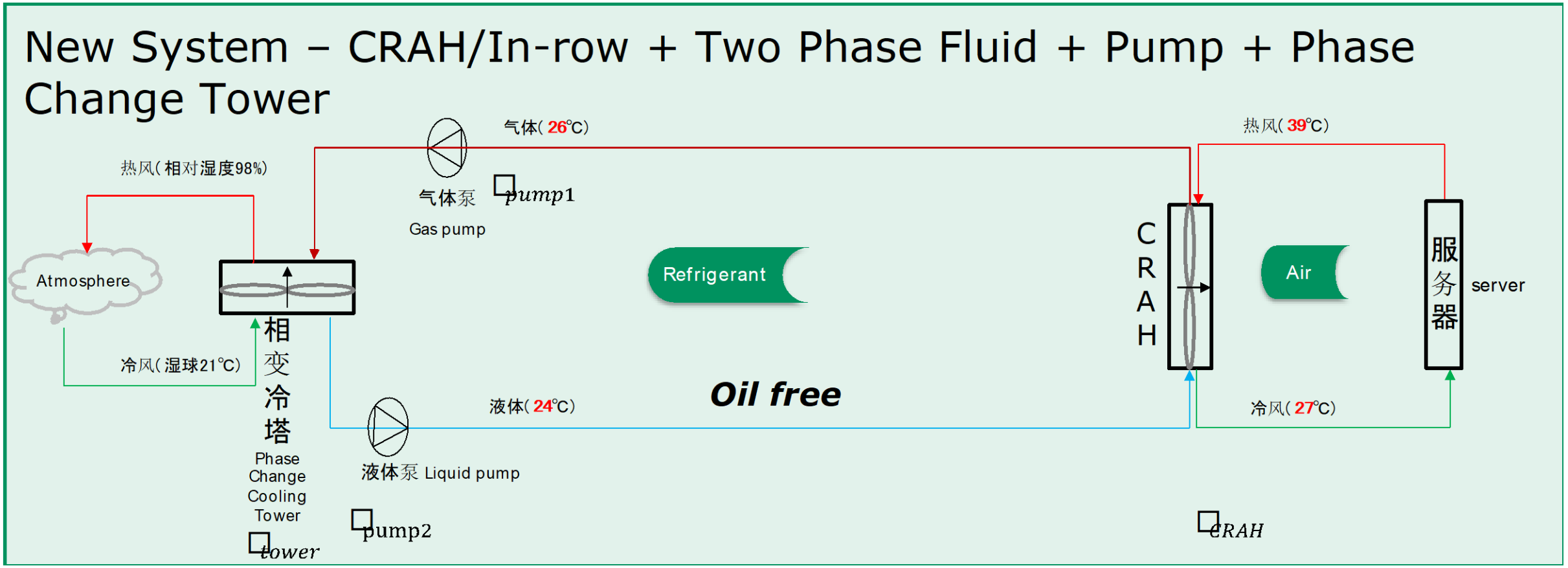
- Current cooling solution vs Dynamic Phase-change Cooling

Current solution of data center cooling

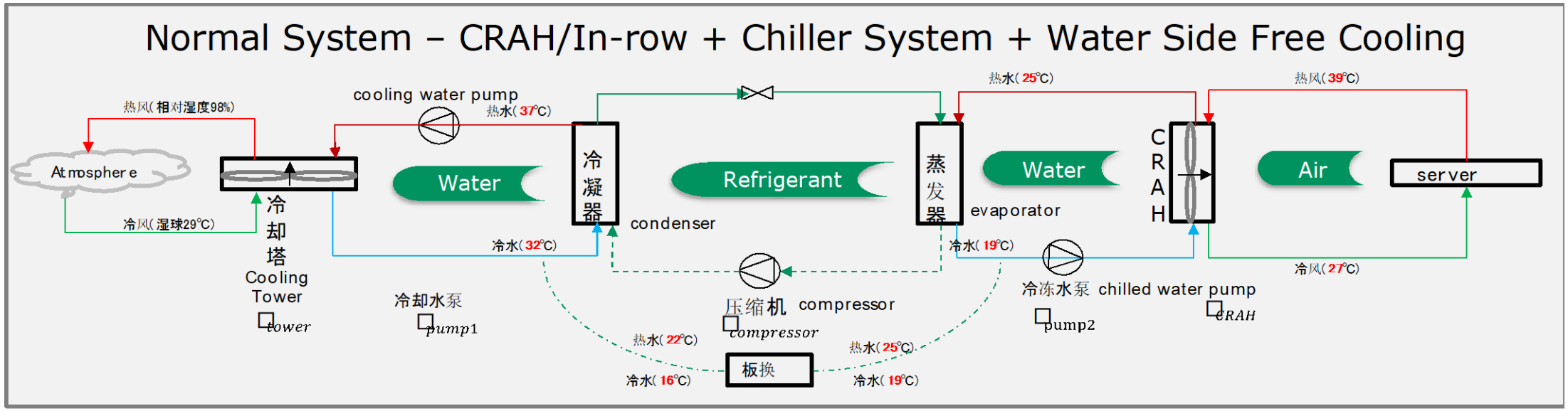
Normal System – CRAH/In-row + Chiller System + Water Side Free Cooling

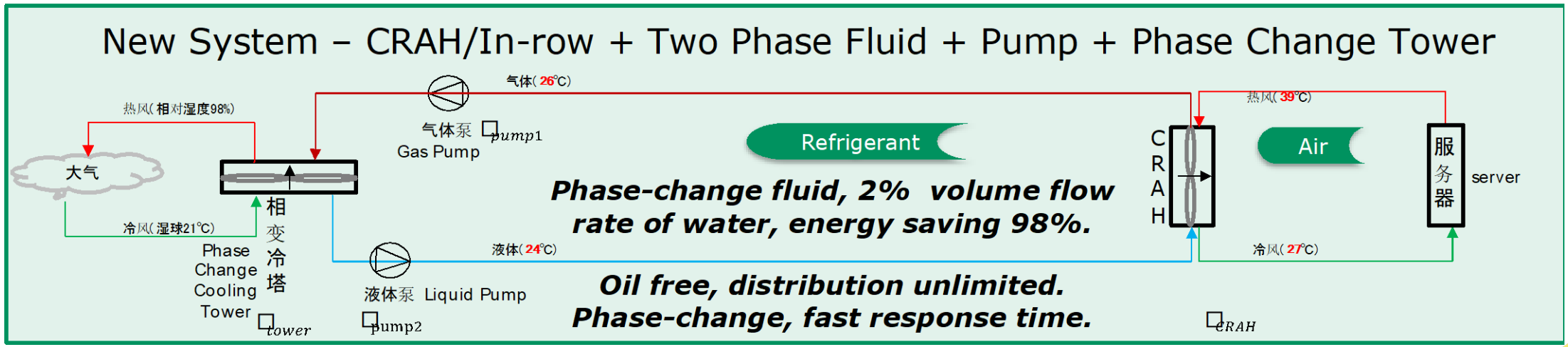


Dynamic Phase-change Cooling Technology



Dynamic Phase-change Cooling Technology - efficiency





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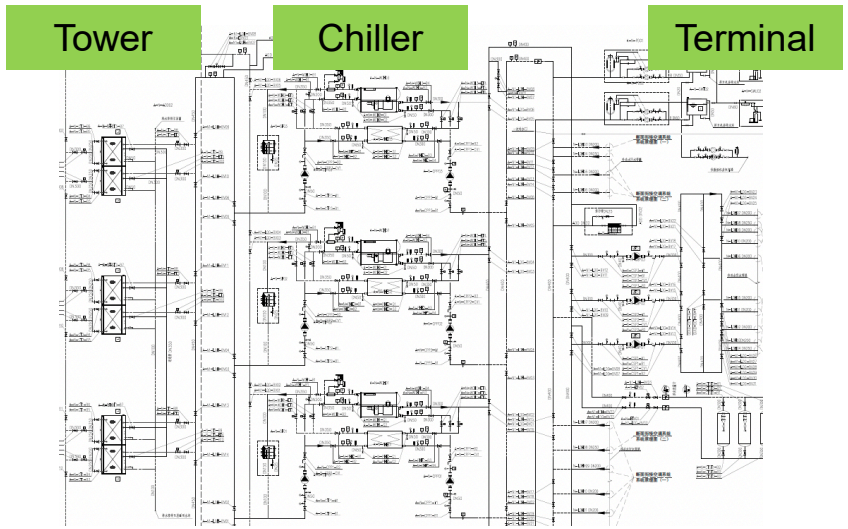
Dynamic Phase-change Cooling Technology - Efficiency

		Dencity	Specific Heat Capacity	
		kg/m3	kj/(kg.℃)	kj/(m3.℃)
Single Phase	**Air**	1.29	1	1.29
	Water	1000	4.2	4200
Two Phase	**Water**	1000	2,500kj/kg	2.5x10E6kj/m3
	R1233zd	1129.9	161.6kj/kg	1.83x10E5kj/m3
	HFO-1336	/	164kj/kg	/
	Novec 7000	1400	142kj/kg	2x10E5kj/m3

Dynamic Phase-change Cooling Technology - Architecture

Centralized Chilled Water System



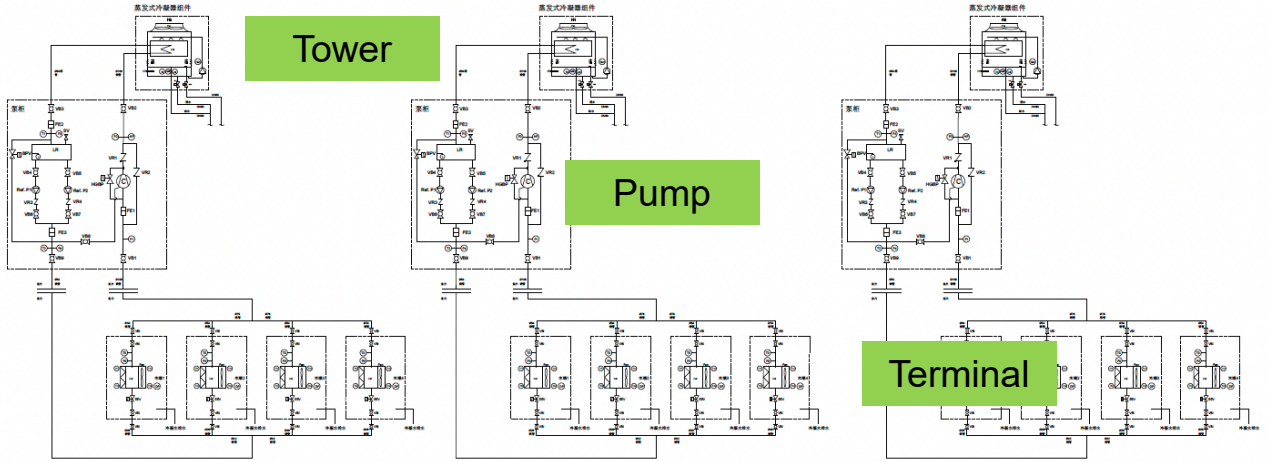
Centralized, Integrated

Fialure Domain, Big

End to end efficiency, low

Cooling Pull down time, slow

Dynamic Phase-change cooling System



Distributed, Modularization

Fialure Domain, Small

End to end efficiency, High

Cooling Pull down time, quick

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Dynamic Phase-change Cooling Technology - Delivery

Centralized Chilled Water System

Tower

Chiller Plant

Pipeline

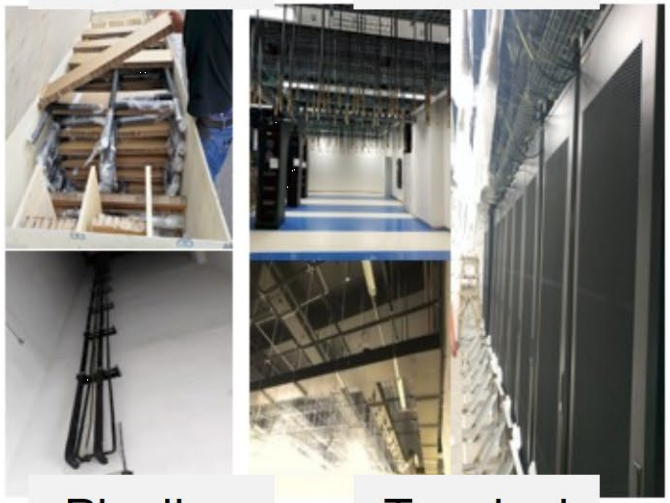
Terminal

Dynamic Phase-change cooling System

Tower

×

“Chiller Plant”



Pipeline

Terminal

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03 How much?

- Real Operation Data of DPC

Why phase change cooling system?

1. Oil free centrifugal compressor has very high efficiency especially at low pressure ratio operation and capacity modulation, can gain lower PUE
2. Modular design and Distributed system, faster delivery and higher reliability
3. Oil free system, also no friction ,compressor has no performance degradation, and easier maintenance
4. Oil free system, easier to do piping between indoor and outdoor unit, in general just need to consider the convenient path to do the piping

One of the most difficult issue we were encountered at beginning :

The system cannot operate at very low load due to it will be easy to cause compressor surge.
Surge is one characteristic of centrifugal compressor. Usually, will require the operating load not lower then 20% of full load. But in many case for IT room at the beginning do not have enough load for the Unit. Considering this situation, we improve the refrigeration system design details and control logic many times, according to mass testing in R&D testing room, finally the unit is able to operate at the load lower then 10%(5%-10%) of full load.

Project Operation Case:

Case 1
Location: North of China
Cooling type: phase change cooling system
Condition:40/30(return and supply air temp.)
Unit type: air cooled type outdoor + small fall wall indoor
Efficiency: **annual CLF<0.08**

Case 2
Location: Malaysia
Cooling type: phase change cooling system
Condition:38/25(return and supply air temp.)
Unit type: evaporative type outdoor +
small fall wall indoor
Efficiency: **annual CLF<0.15**
testing CLF=0.166@27℃ wet bulb

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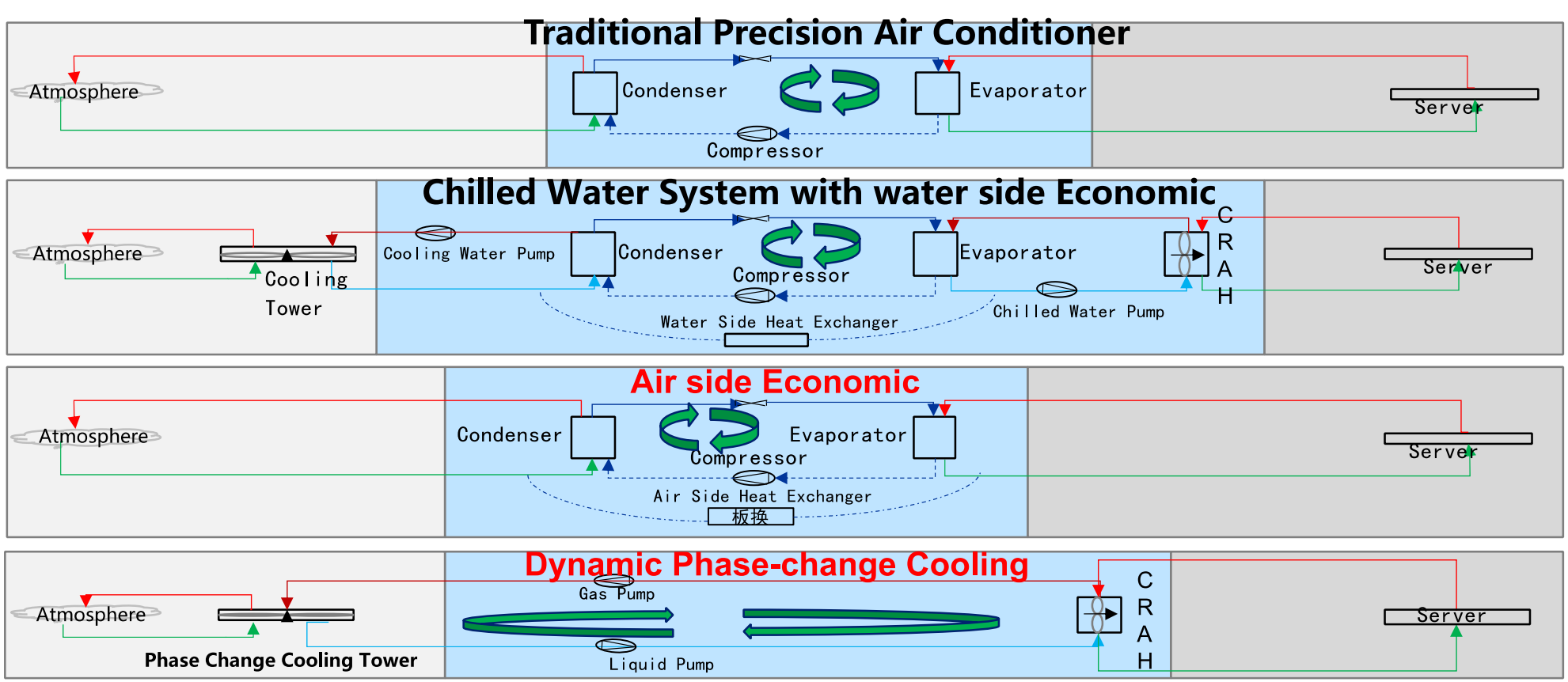
04 Journey

- The story of the invention

Why we start to do it?

PUE=1+PLF+CLF=1+Ppower/Pit + Pcooling/Pit
PLF≈0.06~0.08;
CLF≈1/COP → get more free cooling, get better end to end COP. What about **the hot region**?



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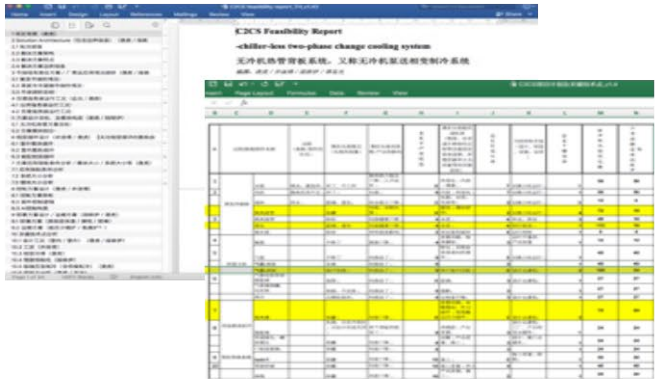
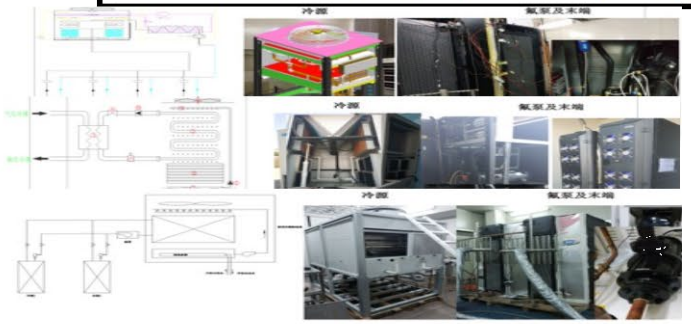
How we do it?

1 Idea and patent submit firstly

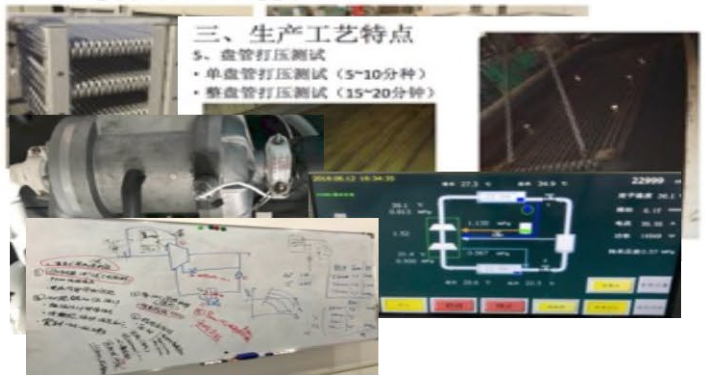
2 Feasibility & FMEA, Risk analysis



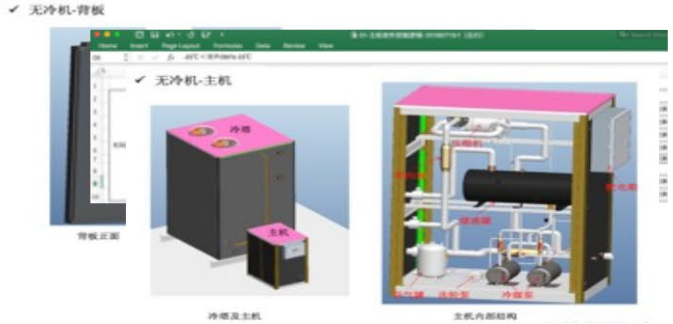
3 DEMO verification, updated quickly



4 Core components, quality control



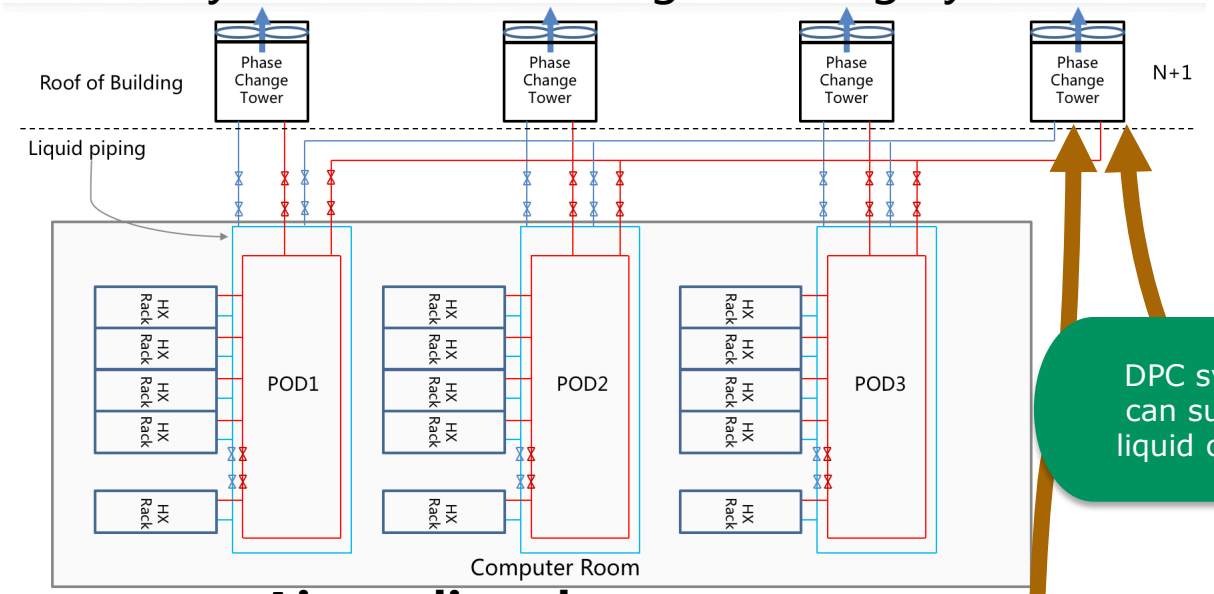
5 Design updated, process control



6 100% dummy load testing, Full verification

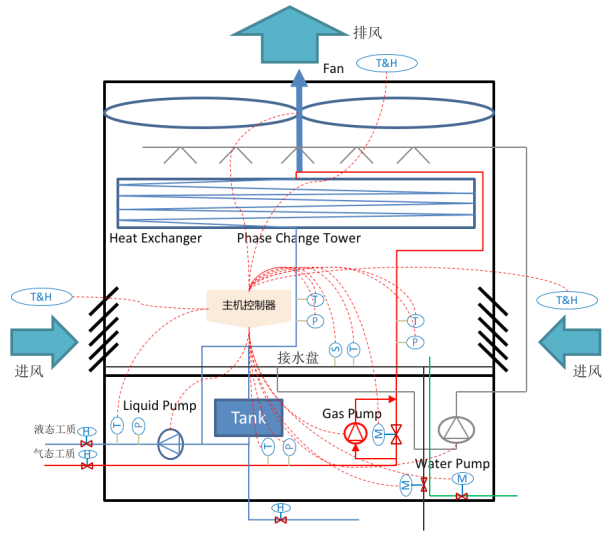
Further More

Dynamic Phase-change Cooling System

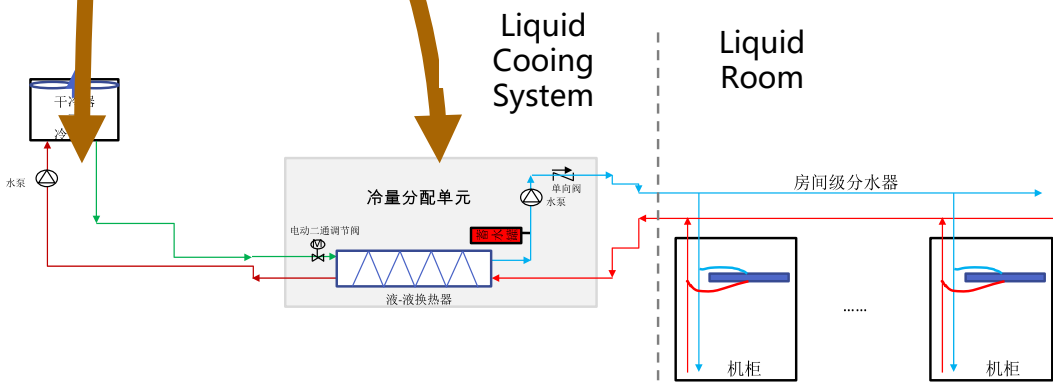


Air cooling data center

DPC system can support liquid cooling



Combined Phase-change Tower



Liquid cooling data center

① Increase liquid cooling data center's cooling part efficiency.
② Better for heat recovery, Gas pump can become heat pump.

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谢谢观看！
Thanks!

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