

# OCP Engineering Workshop 25 September 2017| Dallas, TX



OCP Engineering Workshop – 25 September 2015 – Dallas, TX

# Best Practice of Alibaba Datacenter

## Immersion Cooling Escorts Cloud Computing

**Hedy, Ren**



# Datacenter Growing with IT



**YUNOS**  
CLOUD COMPUTING



**Alibaba Cloud**  
aliyun.com  
OPERATING SYSTEM

**Datacenter has become into Production Center From Auxiliary Facility .**



# Key Points of Alibaba Green Datacenter



**1、Forward-Thinking on IT Strategy**



**2、Site Selection and Critical Facility Design**

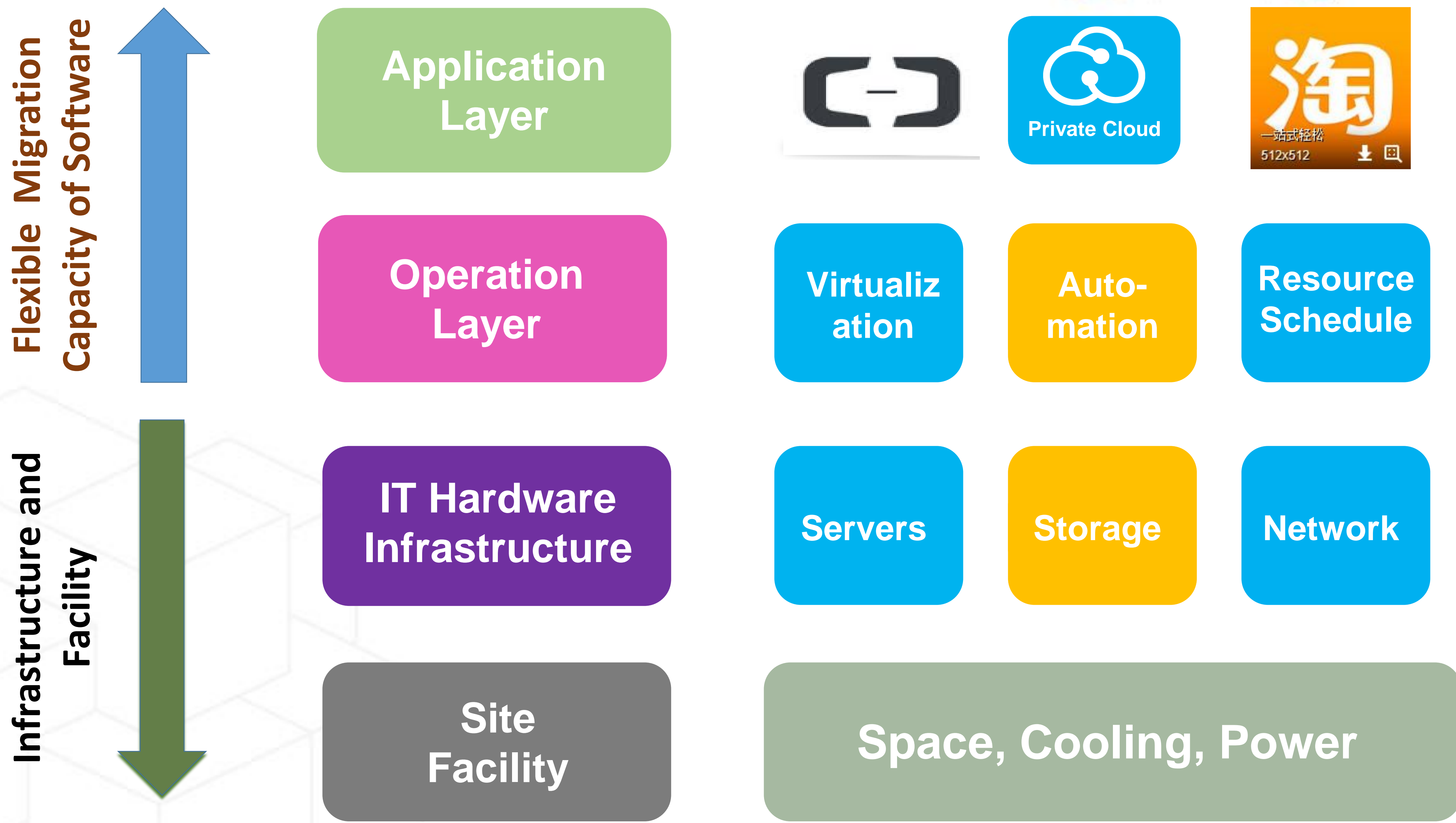


**3、Immersion-Cooling Combined with Datacenter**



**4、Intelligent Operation**

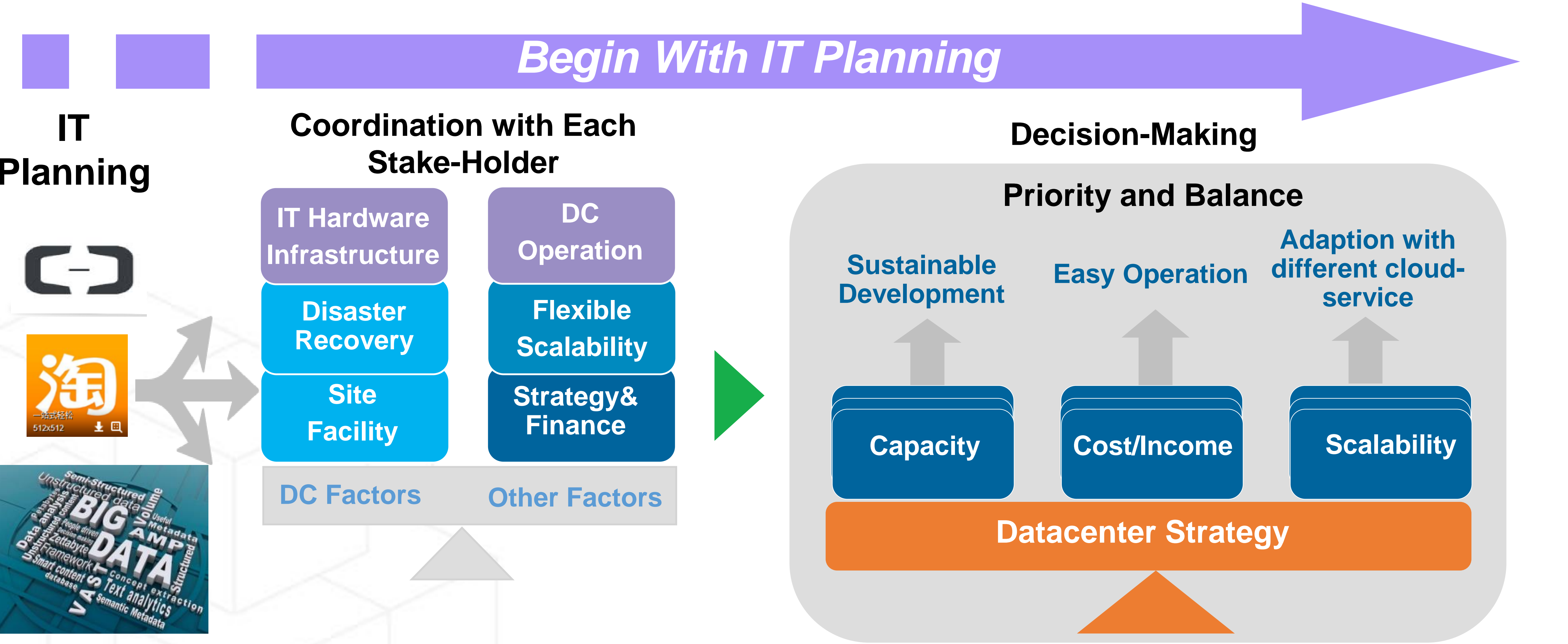
# Datacenter As Multi-Layer System



# Forward-Thinking on IT Strategy



Datacenters serve for IT, so forward-thinking on IT planning is very important.



# Key Points of Alibaba Green Datacenter



1、Forward-Thinking on IT Planning

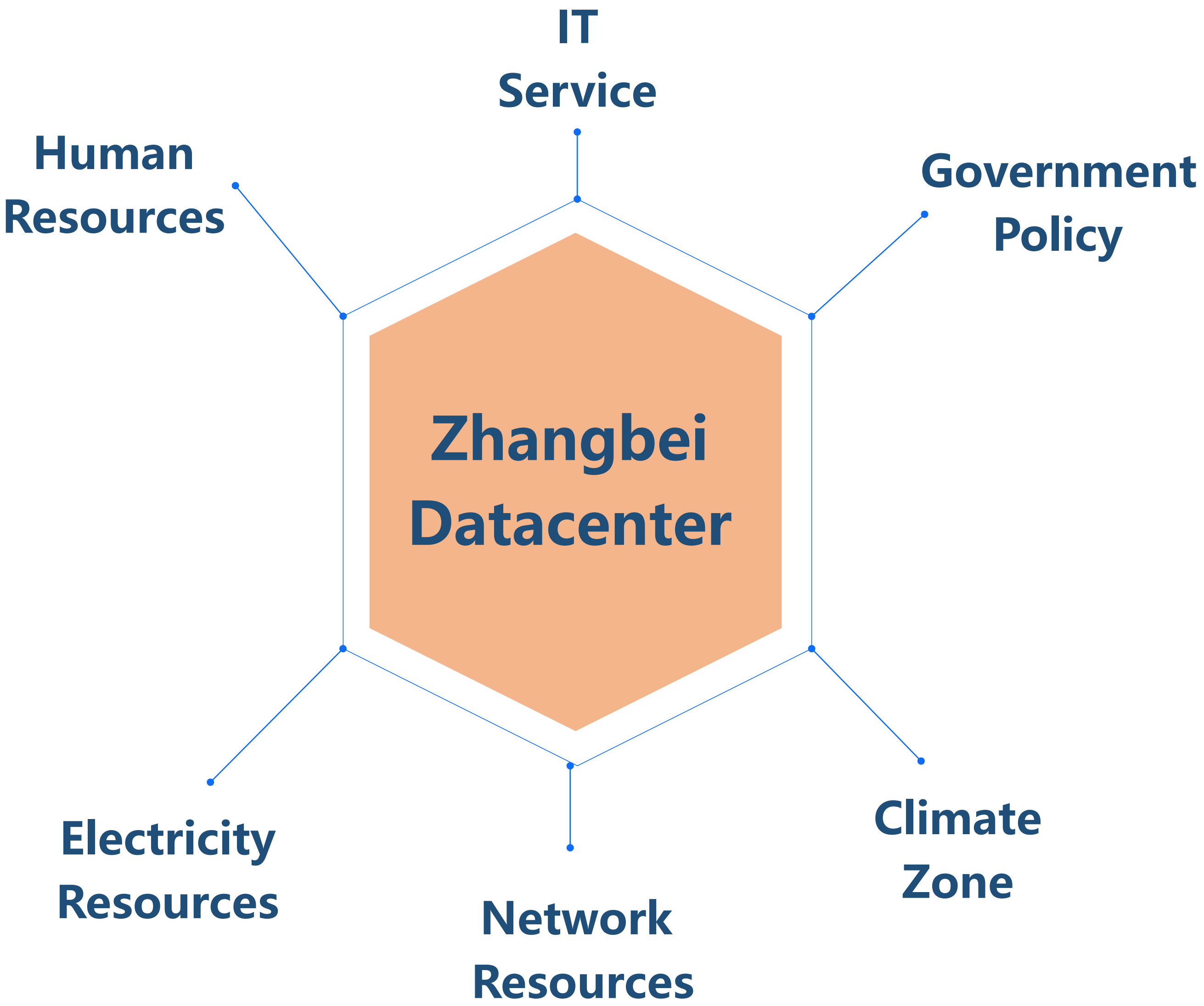
**2、Site Selection, Critical Facility Design**

3、Cooling Combination with IT Equipments

4、Intelligent Operation

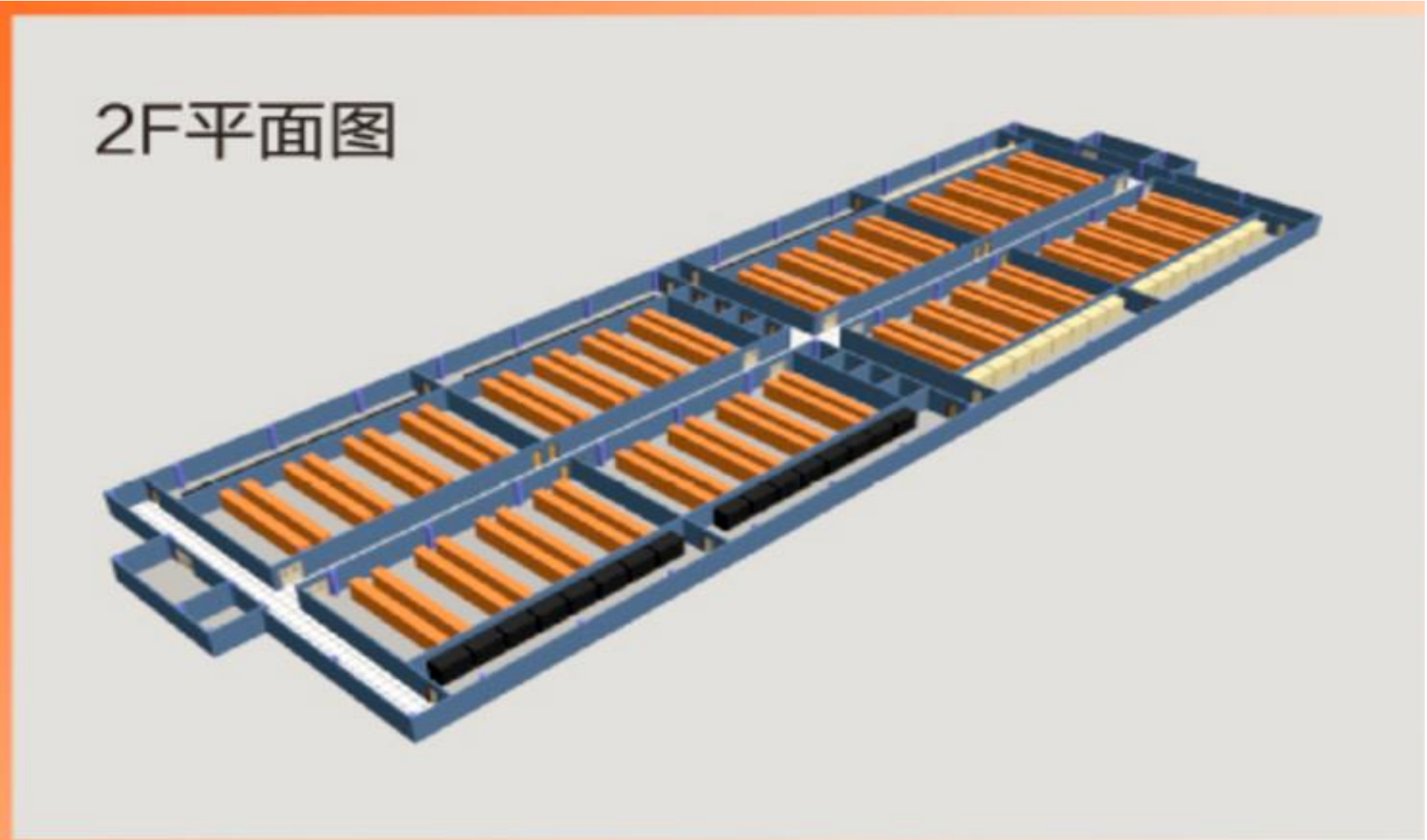


# Site Selection—Why Zhangbei?





# Critical Facility Design—Space and Architecture



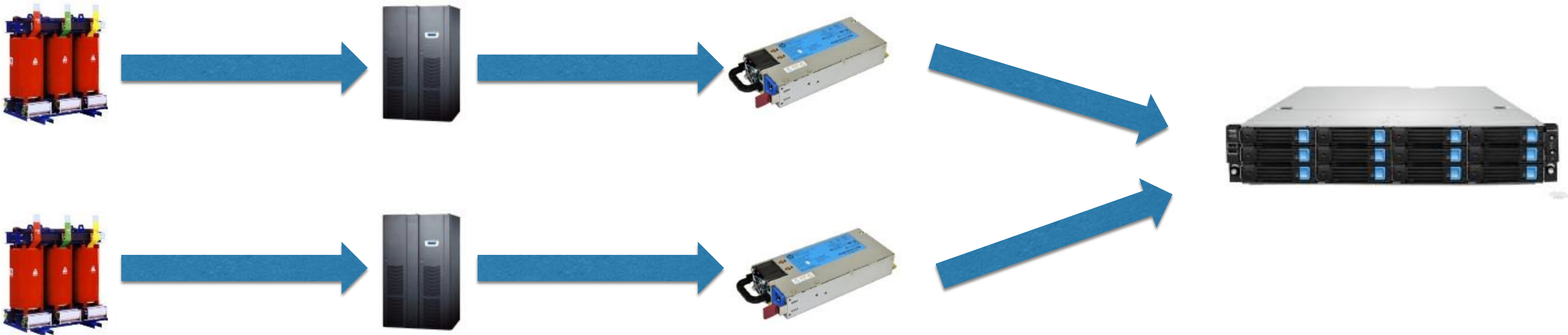


# Critical Facility Design—Power Supply System



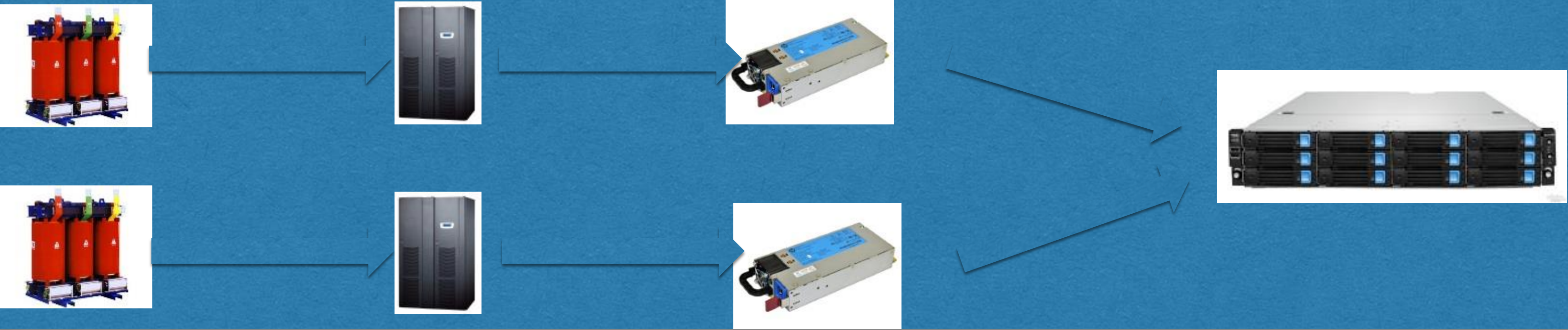
## Dual UPS

Efficiency :  
 $88\% \times 94\% = 83\%$



## AC direct supply &HVDC

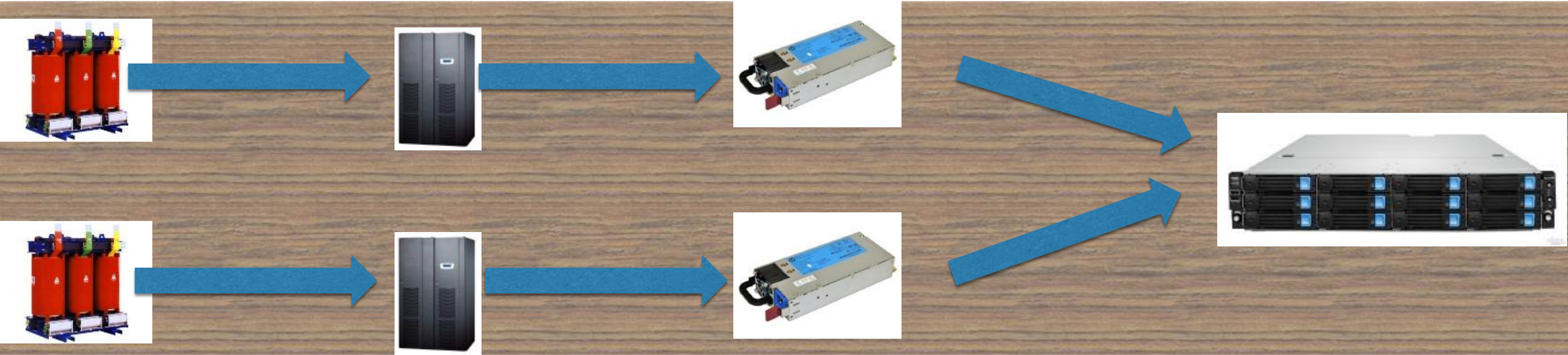
Efficiency :  
 $(94\% + 94\% \times 94\%) / 2 = 91\%$



Widely  
used

## Dual AC direct supply

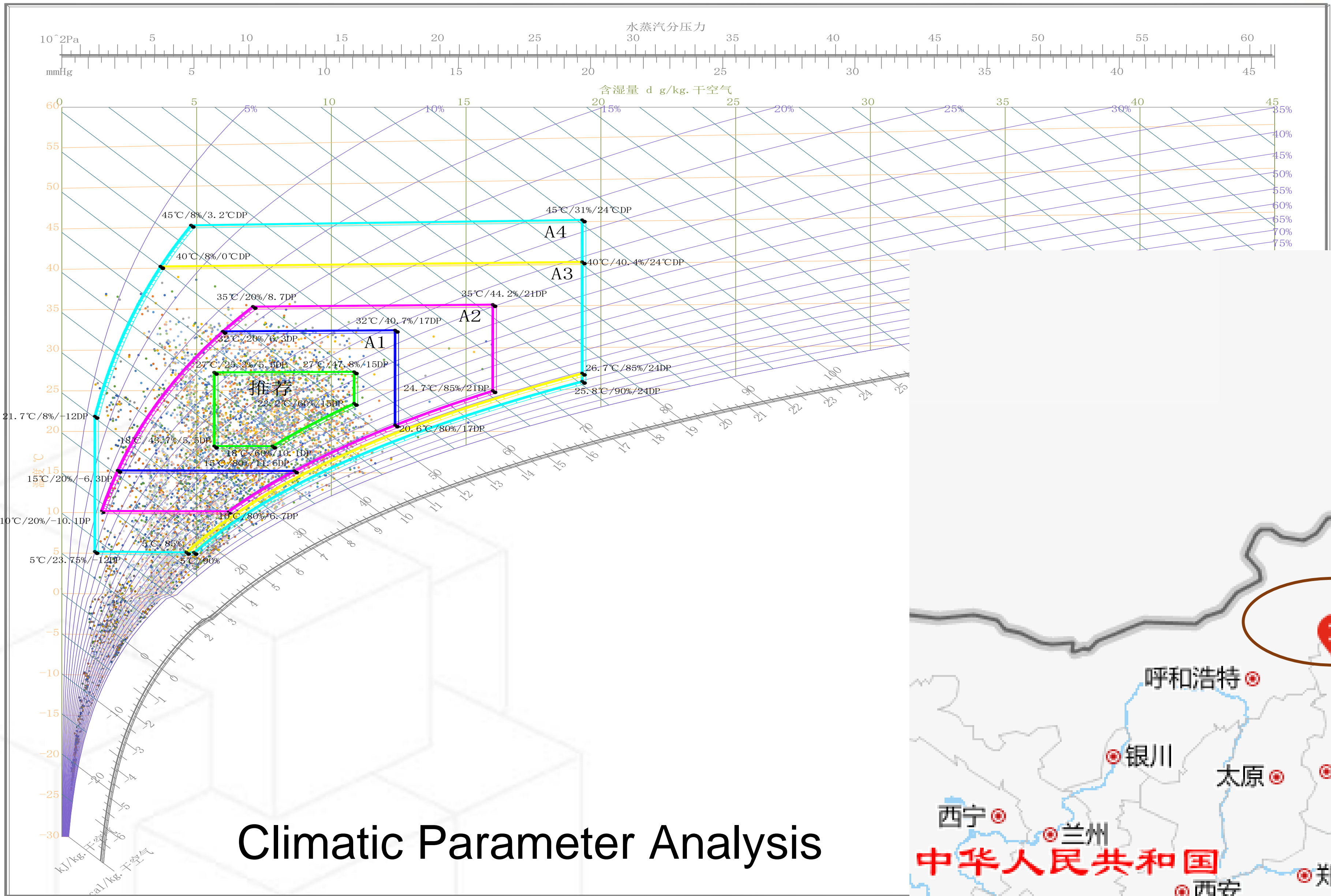
Efficiency :  
94%



Small-scaled  
used



# Critical Facility Design—Cooling System



Climatic Parameter Analysis



## Air Corrosion Levels

Level	Copper/Silver Corrosion Rate	Description
G1	300 Å/month	Corrosion is controlled not to affect the reliability of equipments。
G2	300-1000 Å/month	Corrosion can be measured, and it possibly affects the reliability of equipment.
G3	1000-2000 Å/month	High Possibility of corrosion.
GX	>2000 Å/month	Only special designed and packaged equipments can be installed.

**ASHRAE “Gaseous and Particulate Contamination Guidelines for Data Centers” defines four levels of corrosion.**



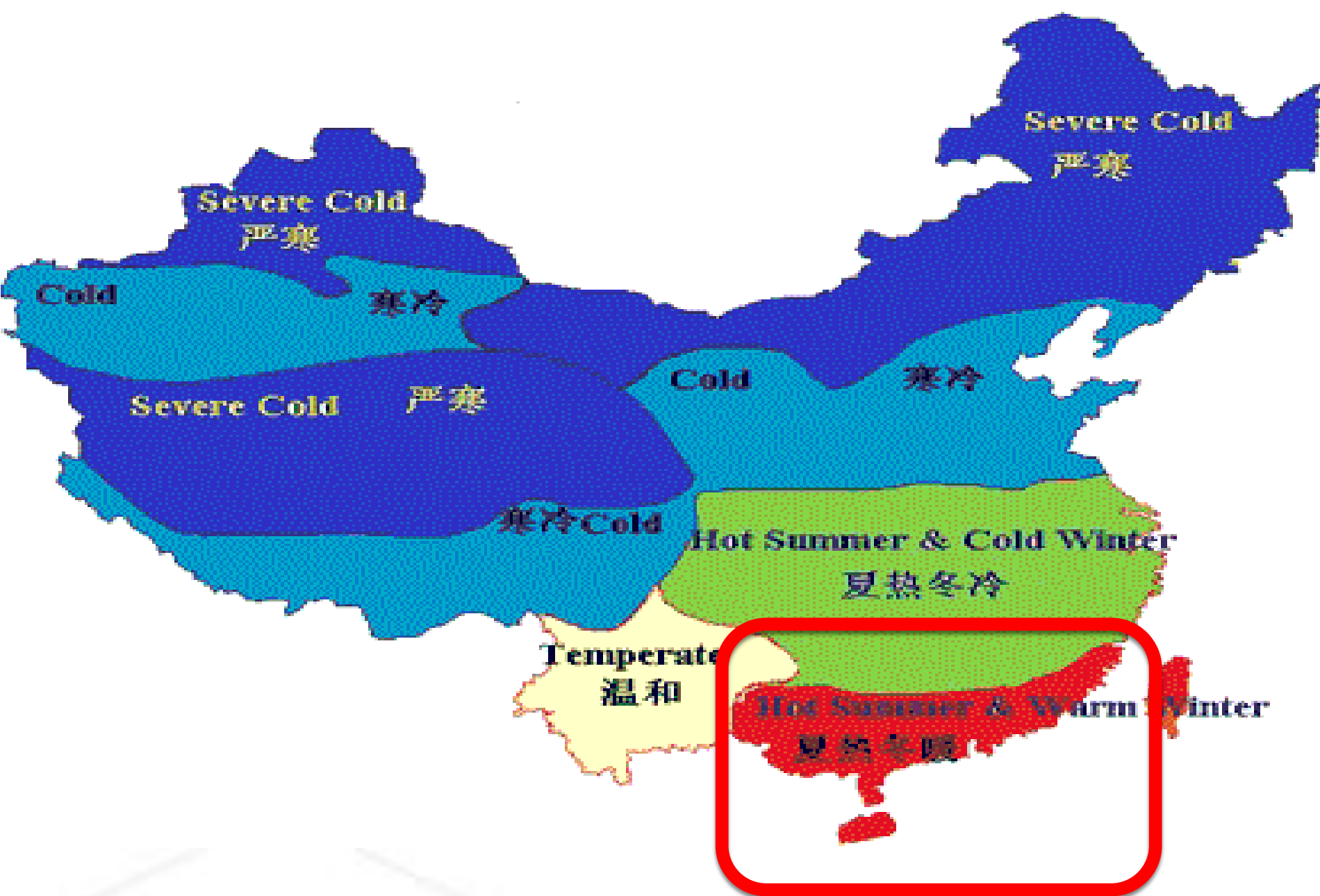
# Critical Facility Design—Cooling System



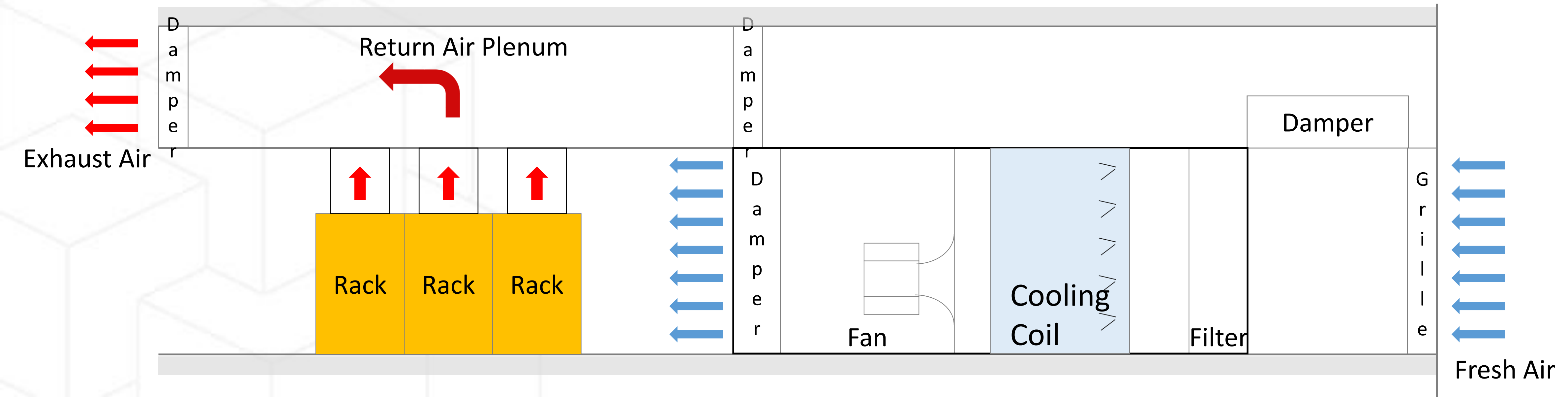
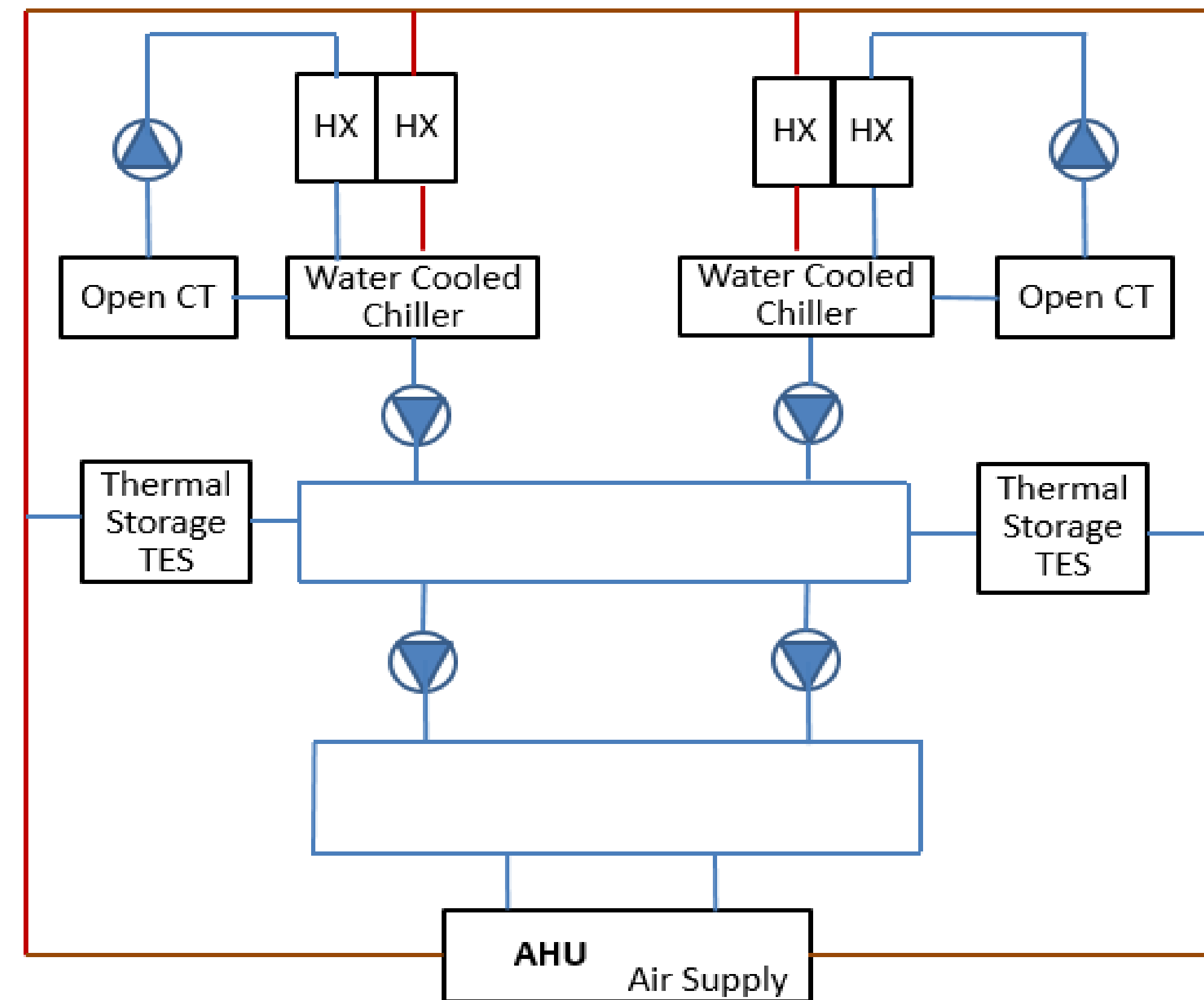
- Average dry bulb temperature is 3.7°C in latest 5 years.
- Air is clean enough for direct cooling in 320 days a year.
- Water-side free cooling time is about 96%, air-side free cooling time is about 88%.
- Water resources are not rich.
- PUE is 1.25.
- Direct air-side economizer is fit for Zhangbei area.
- Considering special weather such as sand storm, water-side economizer is also furnished.



# Free-Cooling Depends on Climate



**Free Cooling**—When outdoor temperature and humidity is appropriate, no need for running mechanical refrigeration.





# Key Points of Alibaba Green Datacenter



1、 Forward-Thinking on IT Planning

2、 Site Selection, Critical Facility Design,

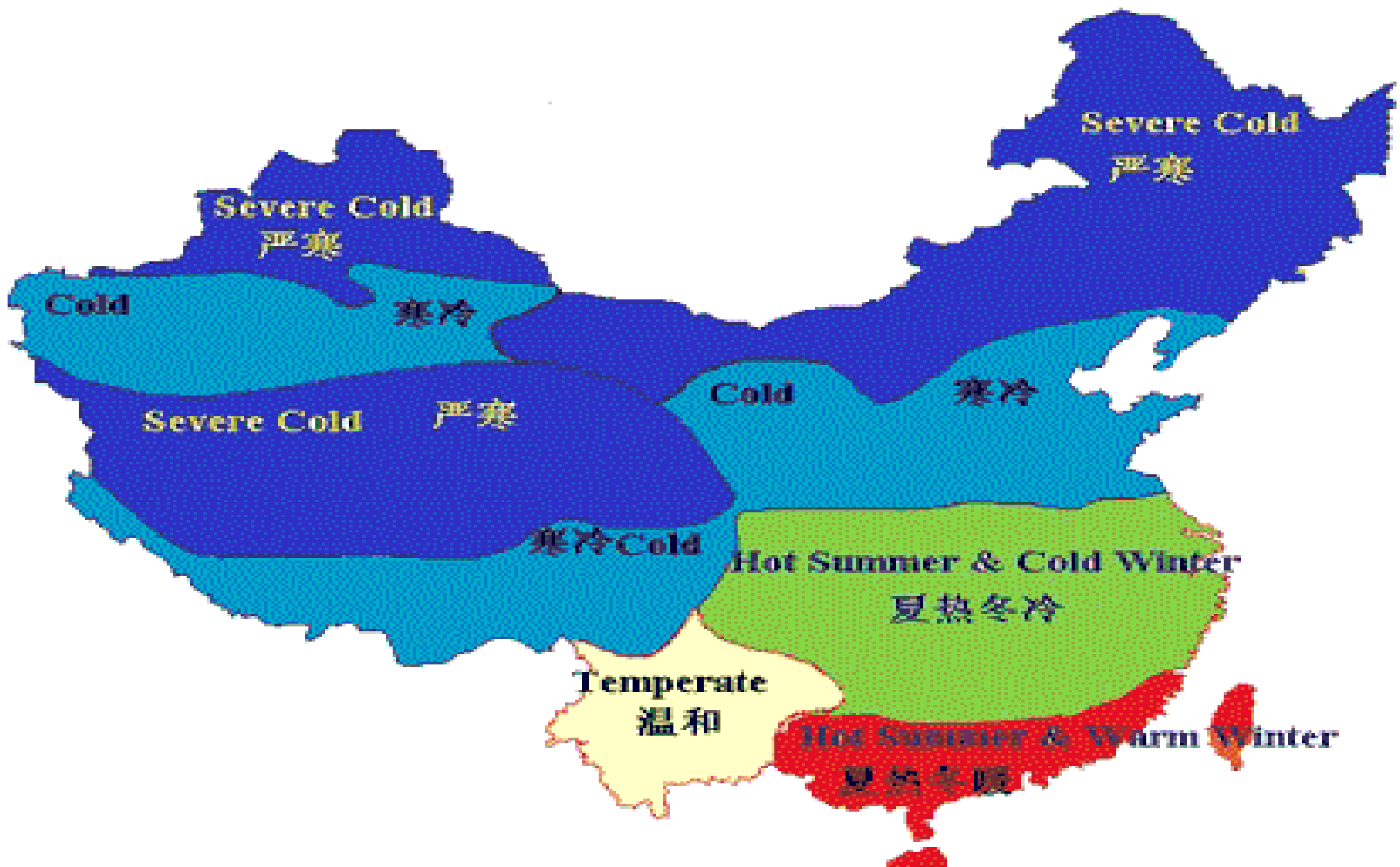
**3、 Immersion-Cooling Combined with Datacenter**

4、 Intelligent Operation

# New Challenges on Datacenter Cooling Solution

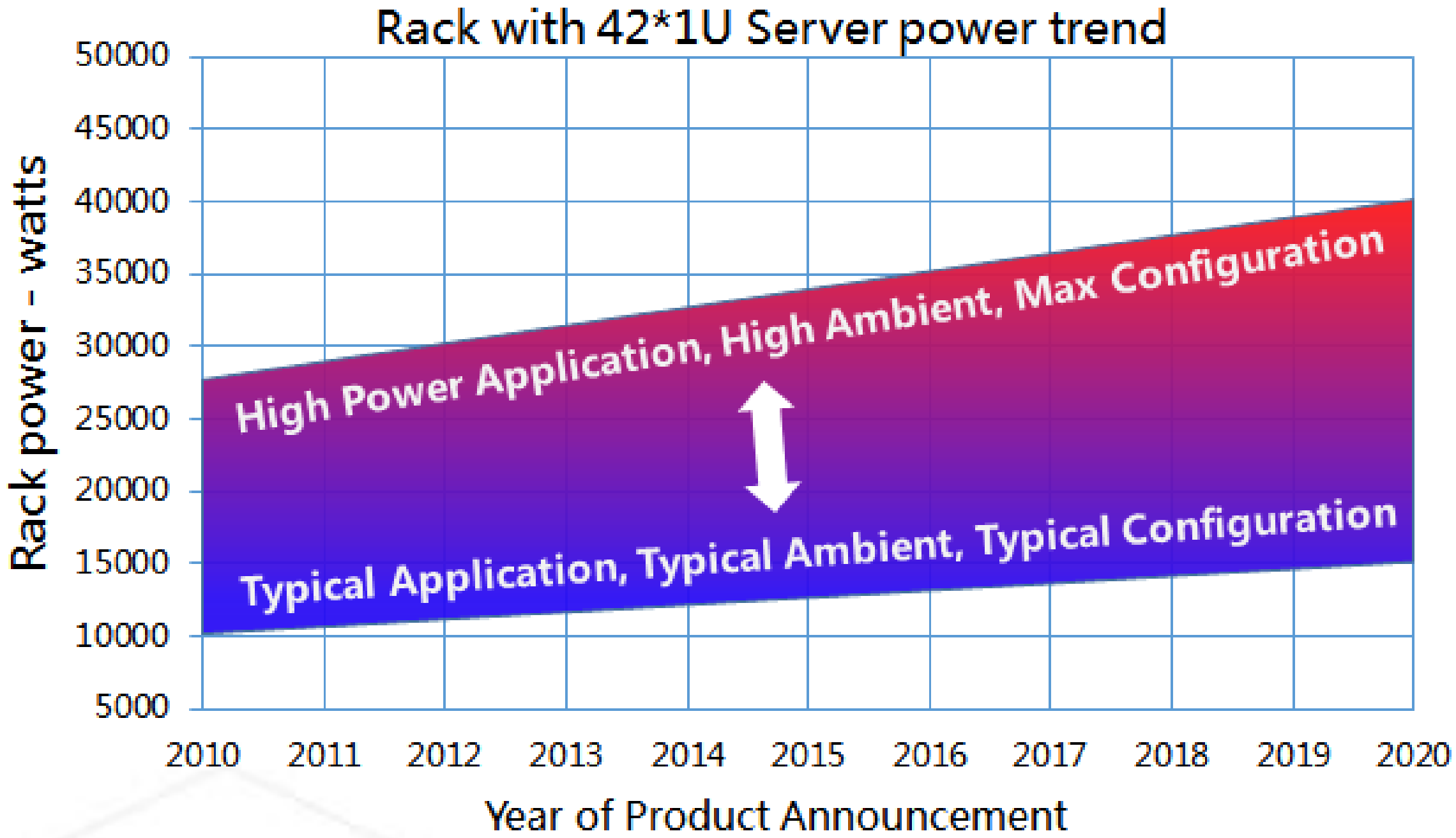
Power Consumption	35W	40W	80W	95W	135W	155W	165W	165W	255W	?
Case Temperature	Tc=72	Tc=72	Tc=76	Tc=74	Tc=72	Tc=77	Tc=79	Tc=52	Tc=70	
	Merom	Penryn	Nehalem	Westmere	Sandy Bridge	Ivy Bridge	Haswell	Broadwell	Skylake	Future
	65nm	45nm	45nm	32nm	32nm	22nm	22nm	14nm	14nm	
	Core Platform		Thruley Platform		Romley Platform		Grantley Platform		Purley Platform	
	Tock	Tick	Tock	Tick	Tock	Tick	Tock	Tick	Tock	Tick

- 1. Computing drives CPU into higher power consumption.
- 2. Air-Cooling cannot meet the heat dissipation demand any more.
- 3. Datacenters in all climate zones need to lower PUE and optimize TCO.

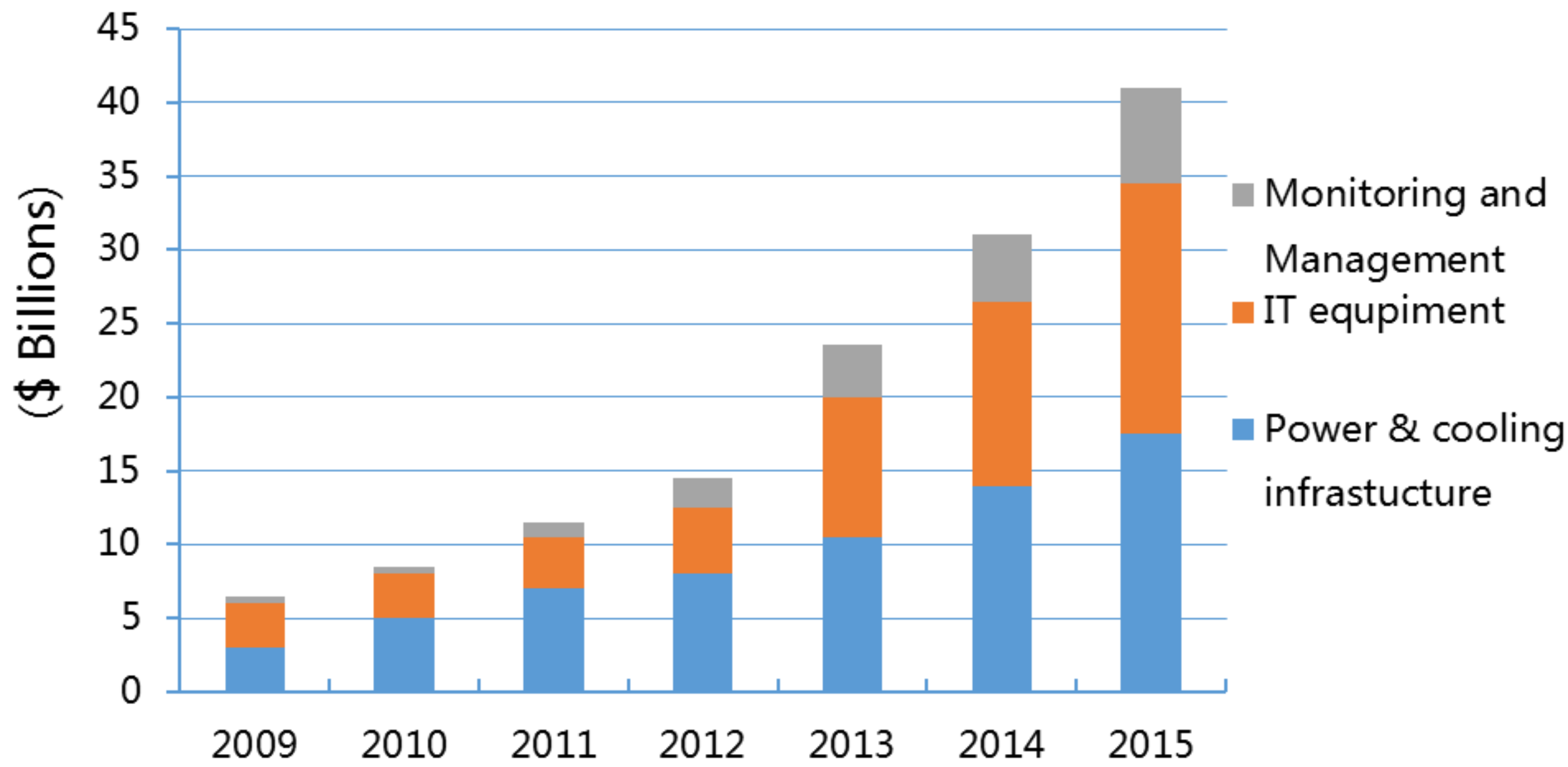




# New Challenges on Datacenter Cooling Solution



Green Data Center Revenue by Technology Sector, World Markets:2009-2015



Datacom Equipment Power Trends and Cooling Applications --ASHRAE

**Rack power density is growing rapidly**



◆Issues:

- How to resolve high density racks' cooling?
- How to lower cooling cost and TCO?
- How to achieve low PUE in every climate zone?

**Power and cooling cost is increasing rapidly**

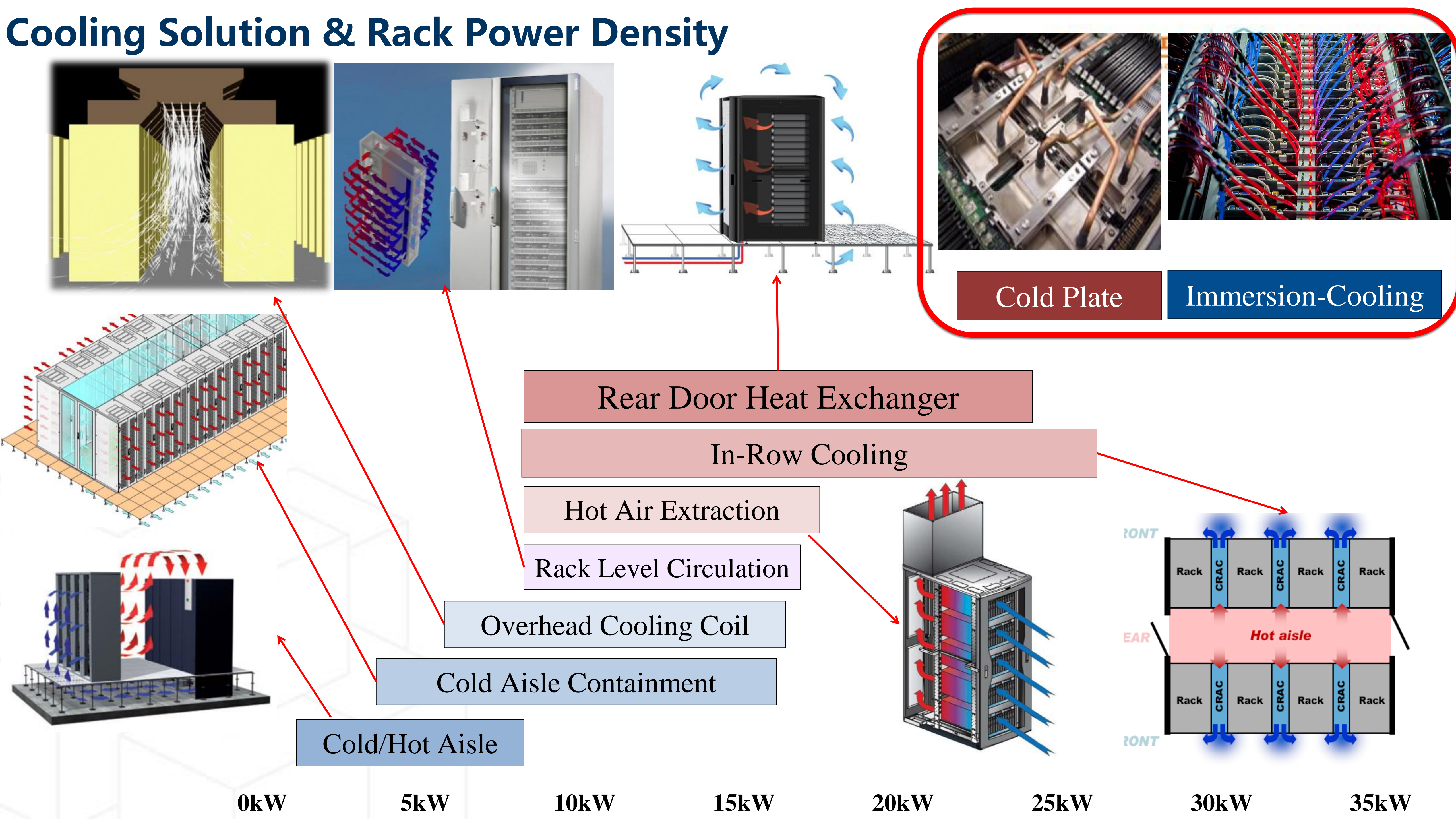


**Alibaba Rack Density**

Alibaba DC Situation	Past	Now	Future
Power Density	3-5 kw/rack	7~19 kw/rack	20~90kw/rack (partial)

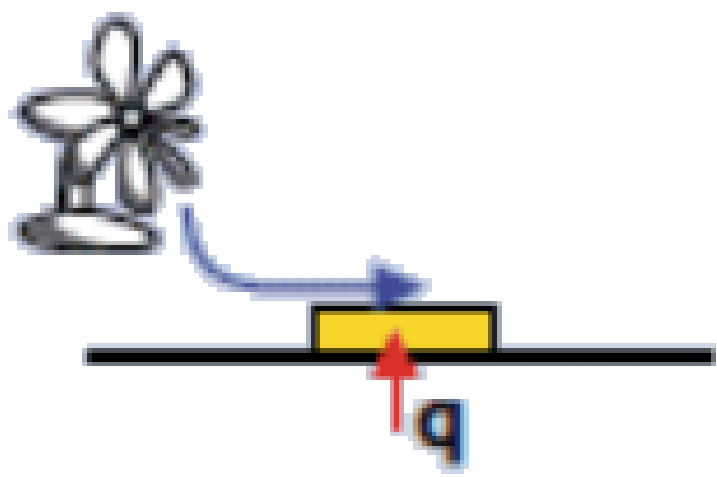

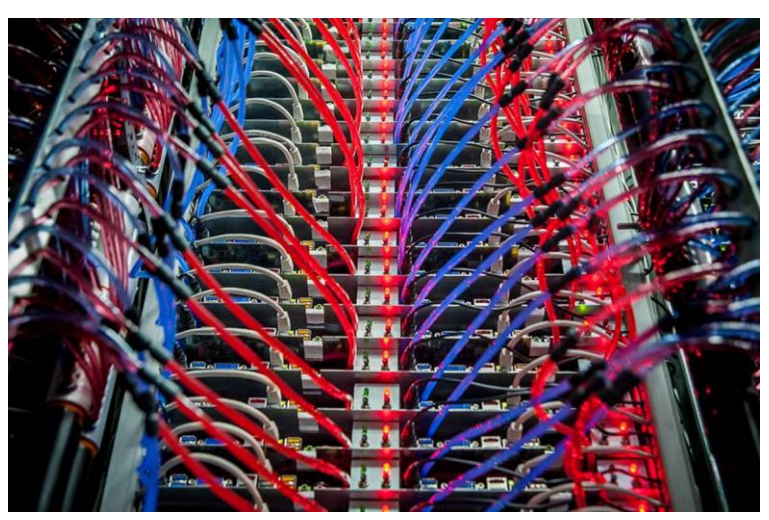


# Cooling Solution & Rack Power Density



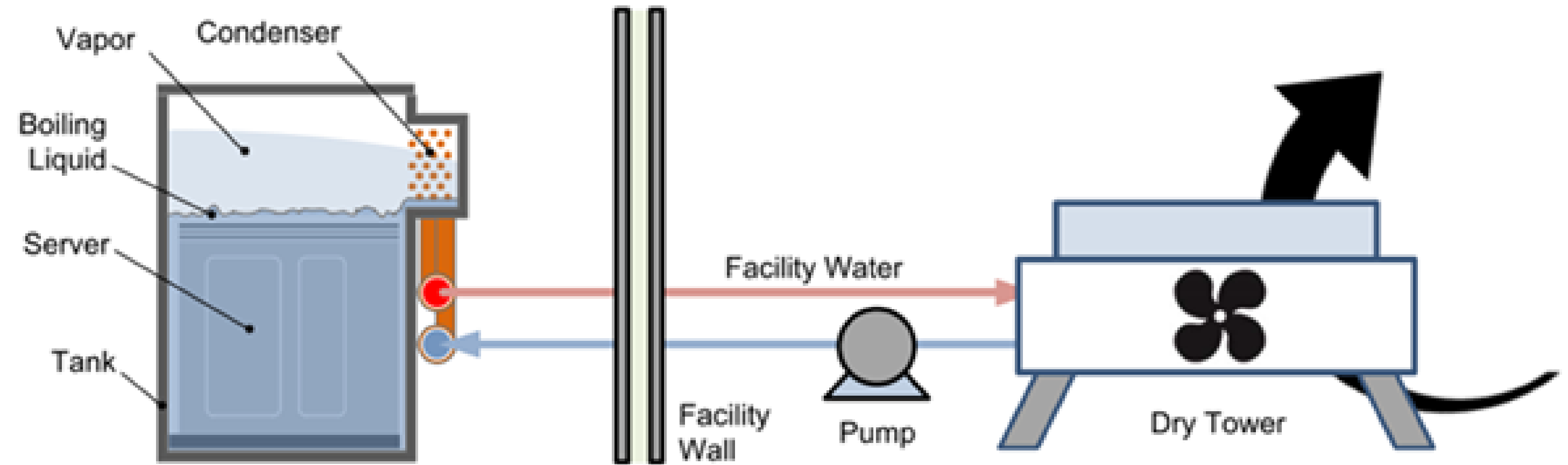
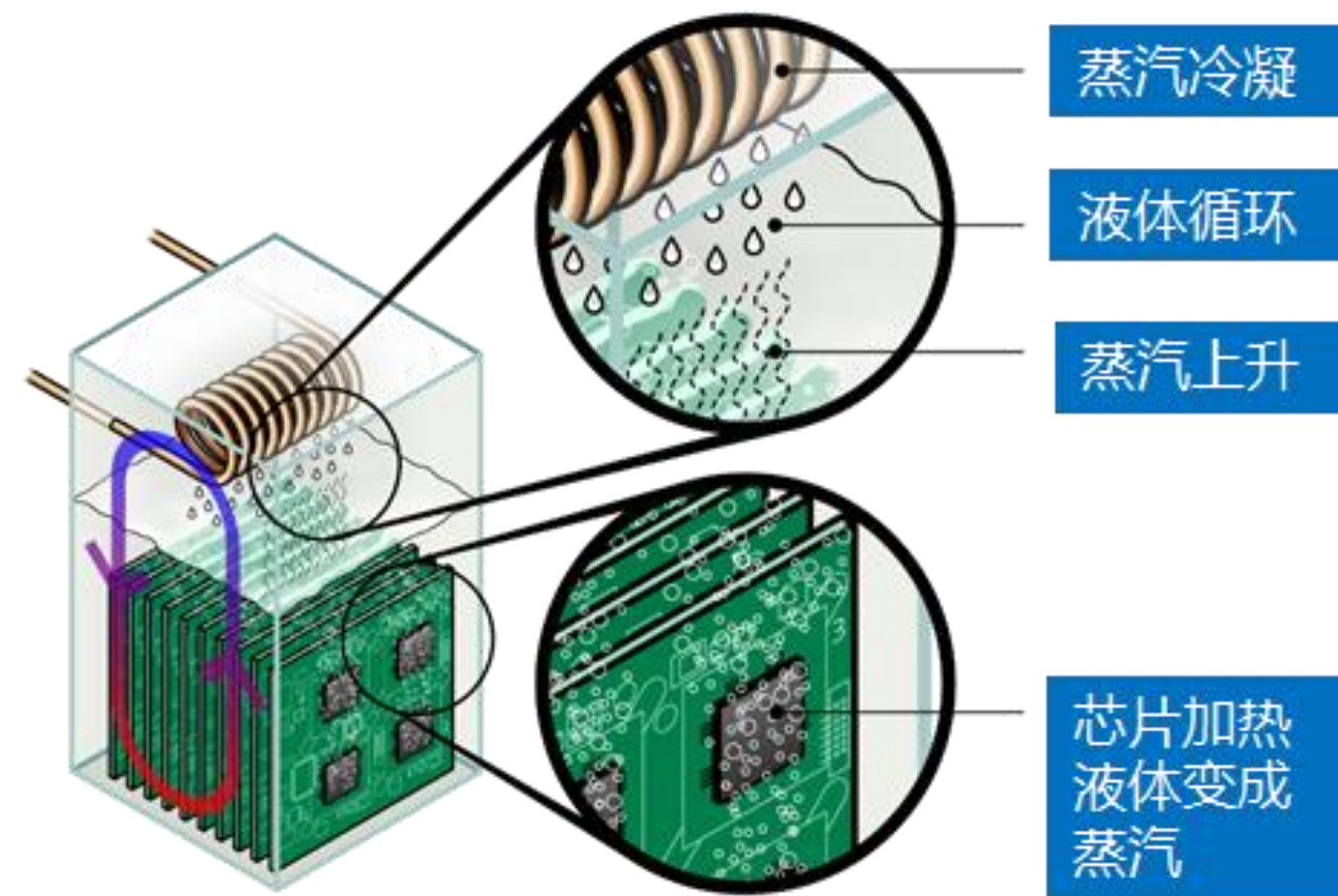


# Why immersion-cooling?

	Air Cooling 	Cold Plate 	Immersion Cooling 	<b>0 means “Base Line” + means “Better” - means “Worse”</b>
Cooling Capacity	0	+	++	Immersion Cooling is the best.
Hardware Integration	0	+	++	No fans in immersion Cooling.
Maintenance	0	--	-	New design of hardware.
Hardware Reliability	0	-	+	Unaffected by dust, humidity and vibration.
Hardware Performance	0	+	++	Cooling helps improving performance.
Energy Efficiency	0	+	++	No fans, chillers, CRAHs.
Heat Recovery	0	+	++	Easy to be recovered from liquid.
Noise	0	+	++	No fans, no noise.
Corrosion	0	+	++	Isolation from air, no corrosion.
Material Compatibility	0	0	?	Material compatibility needs to be tested.
Initial Capex	0	-	--	Liquid cost is temporarily high.
Opex	0	+	++	No fans, chillers, CRAHs. Low PUE.
Weight	0	-	--	Liquid is heavy.

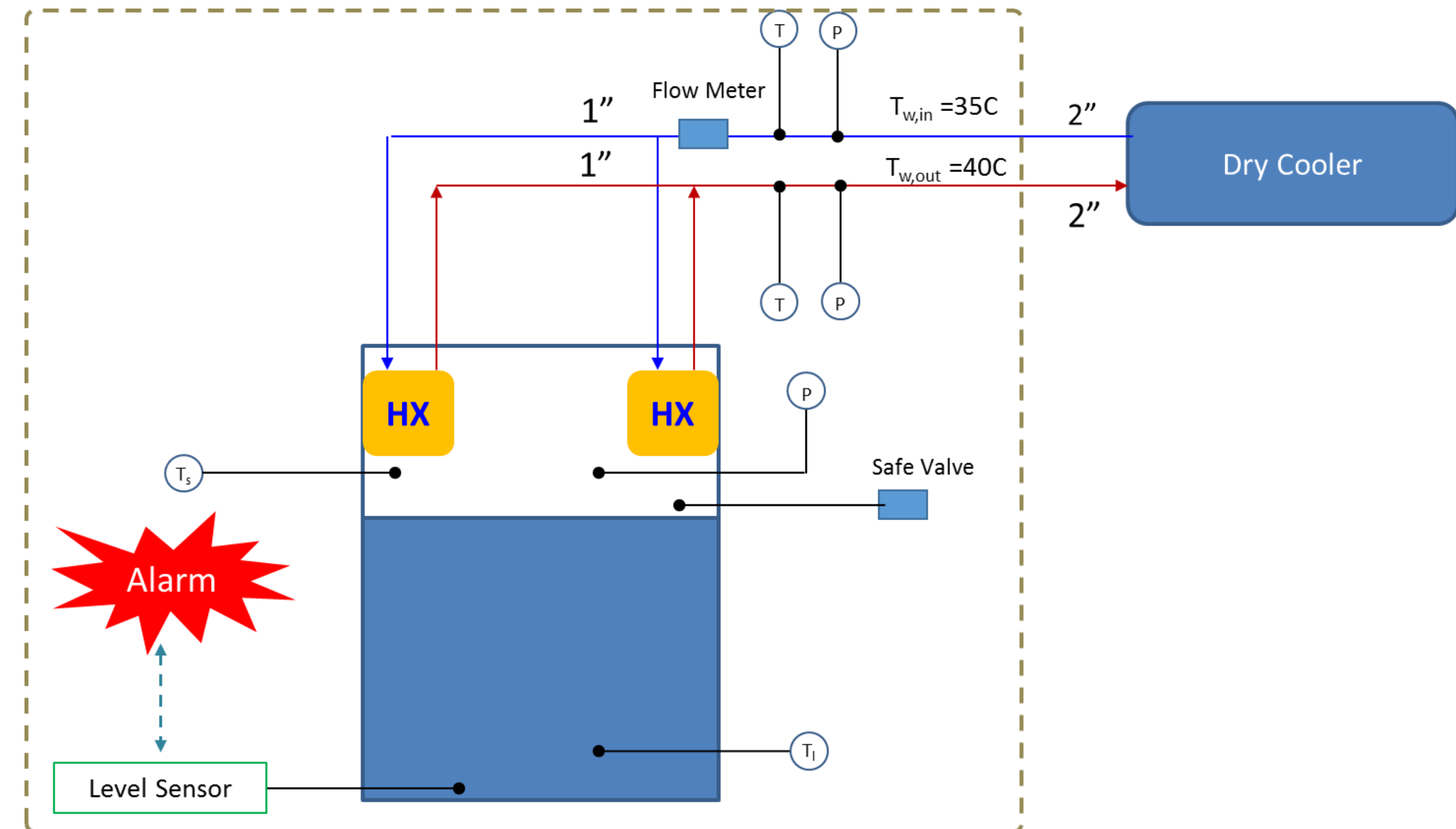
We have to solve material compatibility, maintenance, hardware re-design& cost for immersion-cooling.

# Immersion-Cooling Combined with Datacenter



## Immersion Cooling&Datacenter

- **Simple Cooling System** : No chillers , no CRAHs, no server fans, zero WUE.
- **Low PUE** in any climate zone.
- **New monitor and control system.**





# Benefits From Immersion-Cooling



## Density

- No limitation for rack power density .
- No need to worry about heat dissipation when designing hardware.

## Efficiency

- Low PUE in every place even in hot climate zone.
- Lower chip temperature , faster data-processing.

## Simplicity

- No server fans, no screws, no CRAHs, no chillers.
- No need for special thermal design of high performance hardware and easy hardware update.
- Quite.
- Unaffected by vibration , air dust and air humidity.

## Scalability

- Easy to expand rack density from 20 kW to about 120kW by replacing the server.
- Modular construction is easier for immersion-cooling solution.

# Key Points of Alibaba Green Datacenter



1、 Forward-Thinking on IT Planning

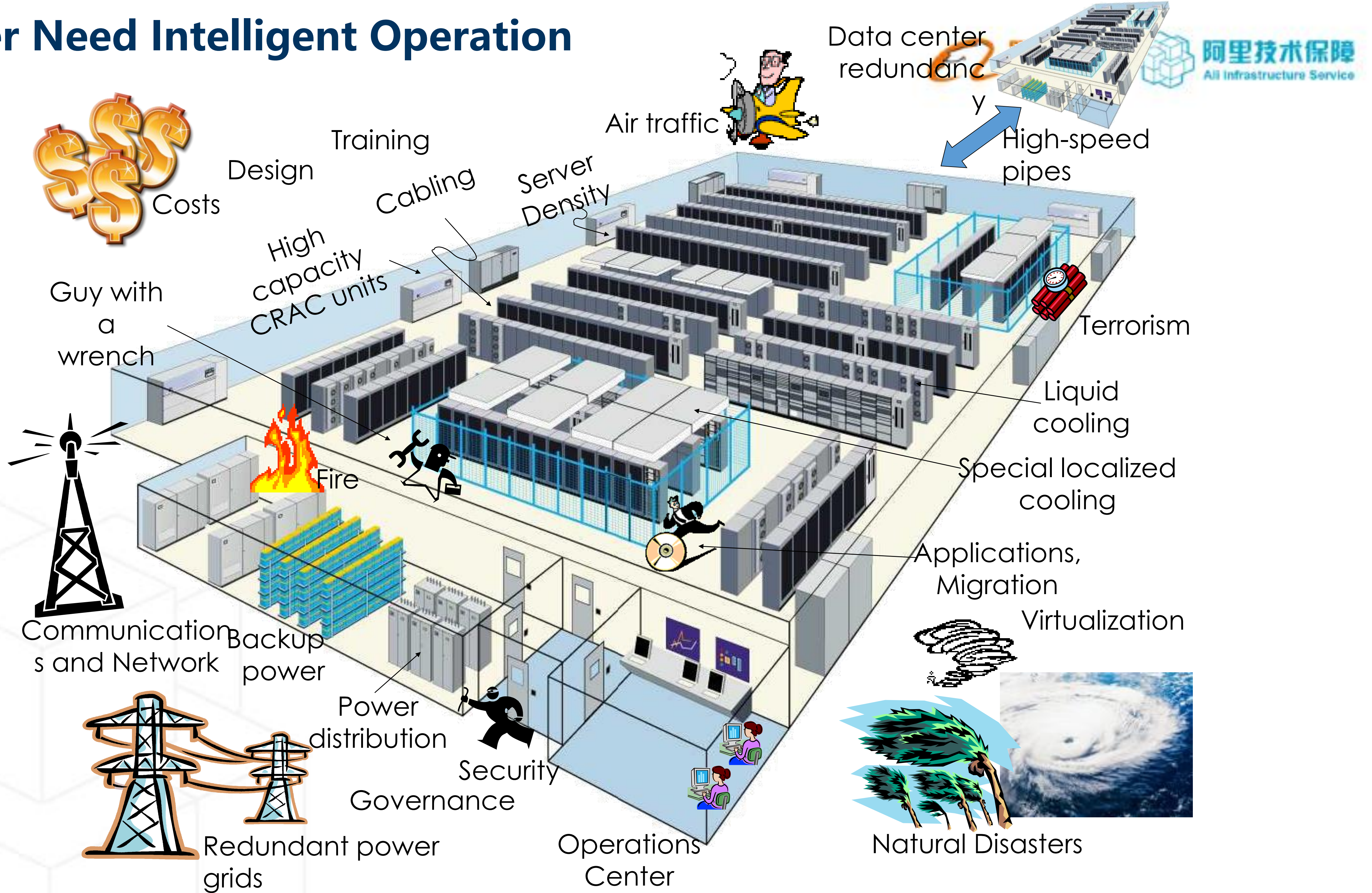
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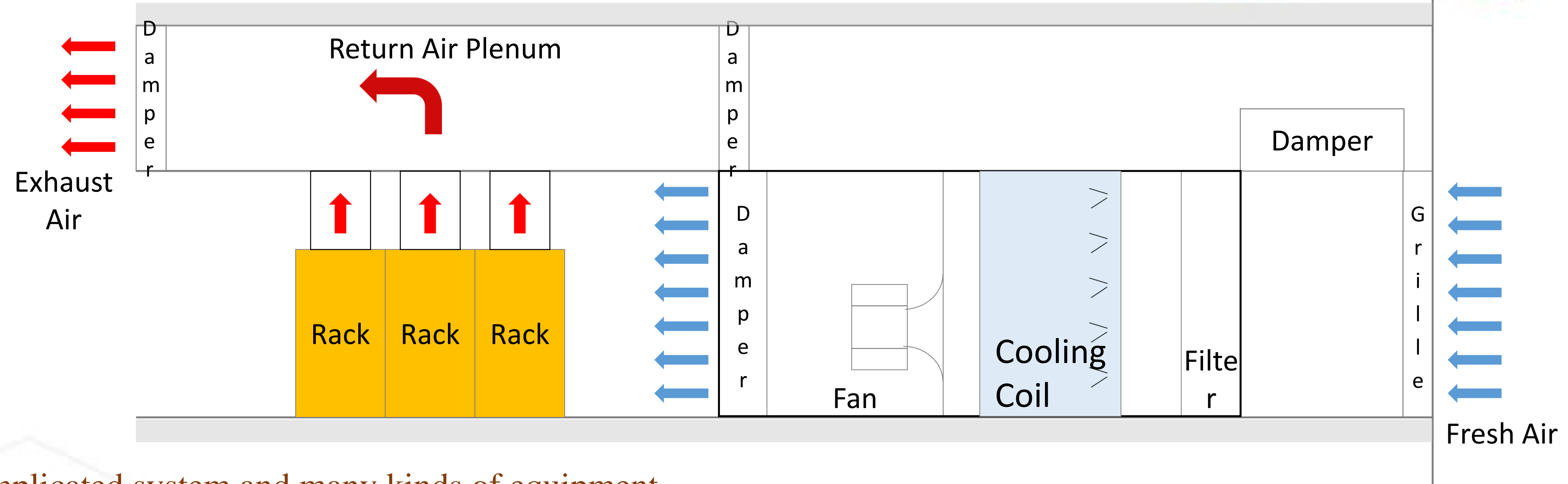


# Datacenter Need Intelligent Operation





# Cooling System & Intelligent Operation

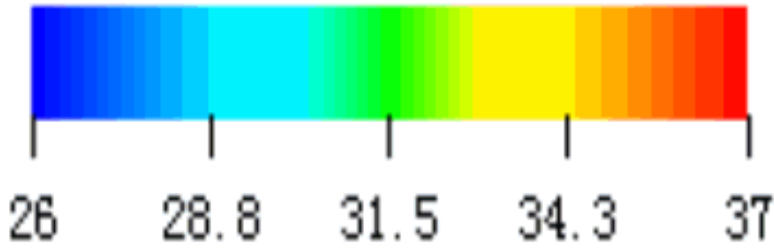


- ✓ Complicated system and many kinds of equipment
- ✓ 7×24X365 uninterruptible running
- ✓ Continuous Cooling is usually must to have
- ✓ On-demand cooling capacity
- ✓ Seamless transition between economizer and mechanical cooling

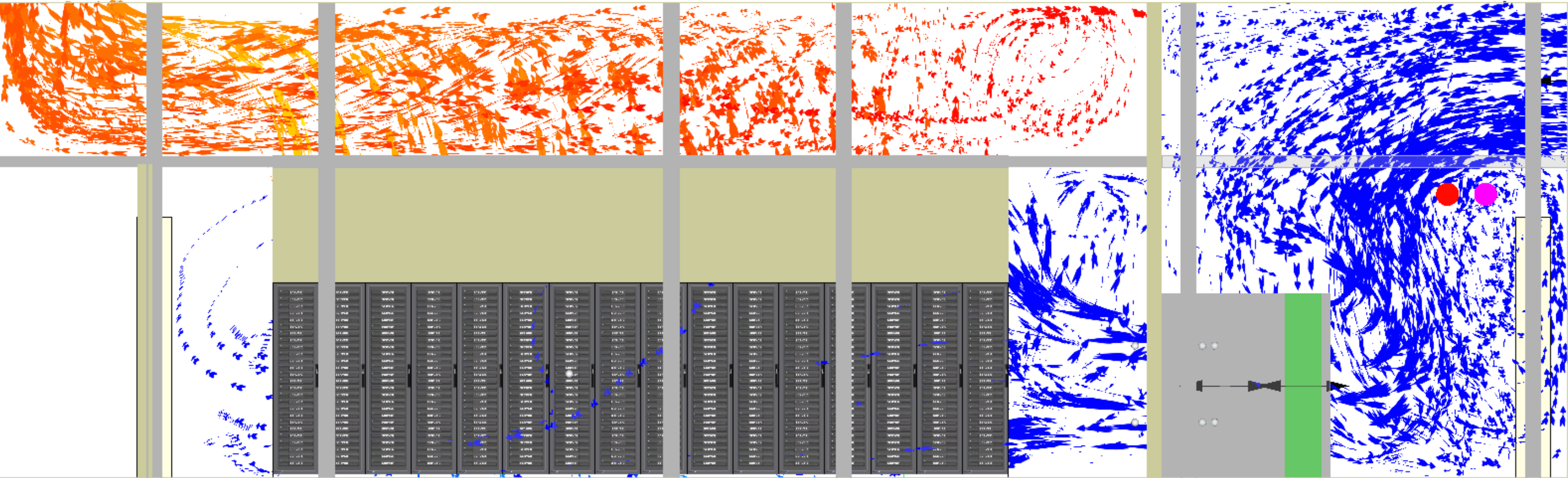




# Full Air-Side Free Cooling



Temperature (C)

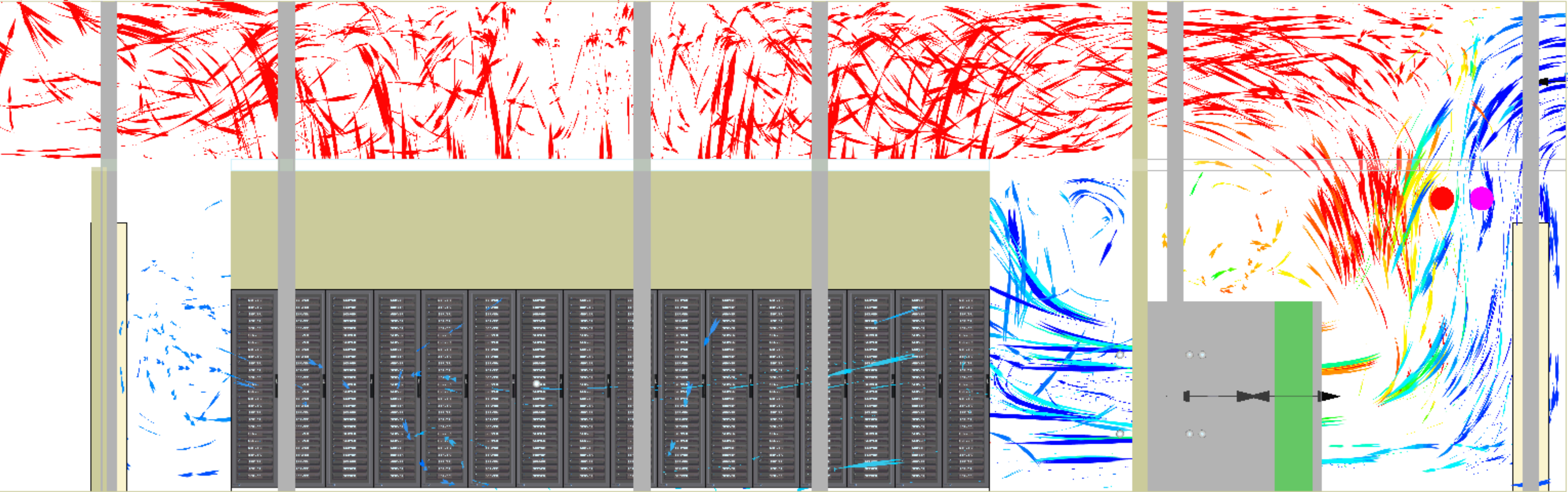
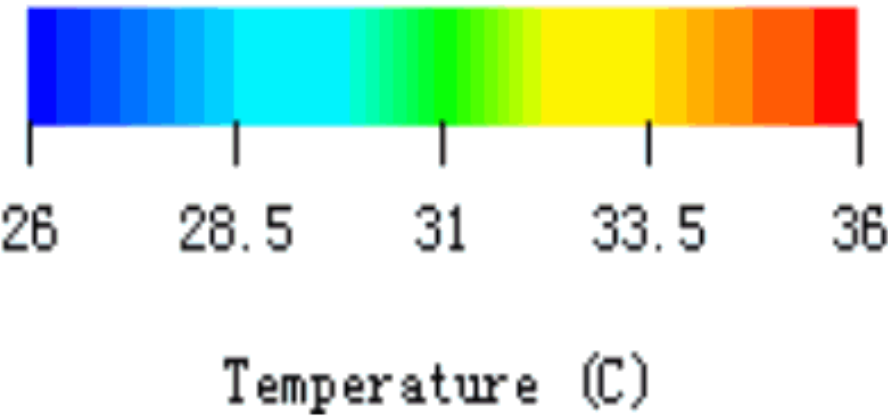


- Open Fresh Air Dampers
- Close Return Air Dampers
- Open Exhaust Air Dampers

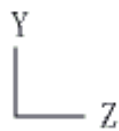
Y  
Z



# Partial Air-Side Free Cooling

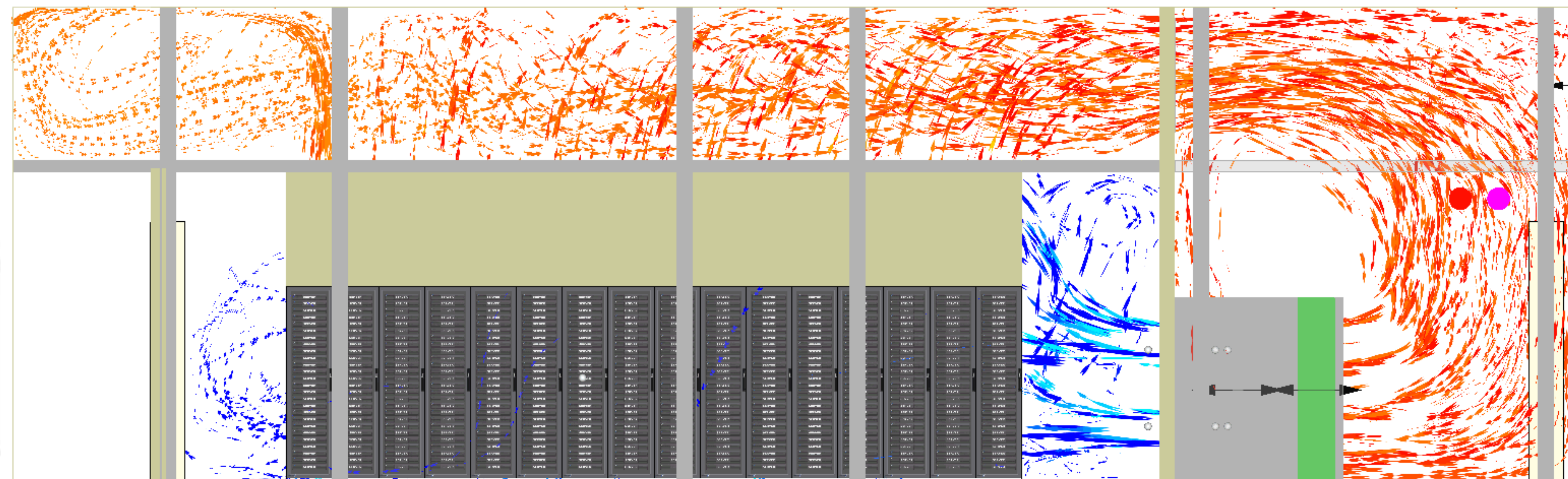
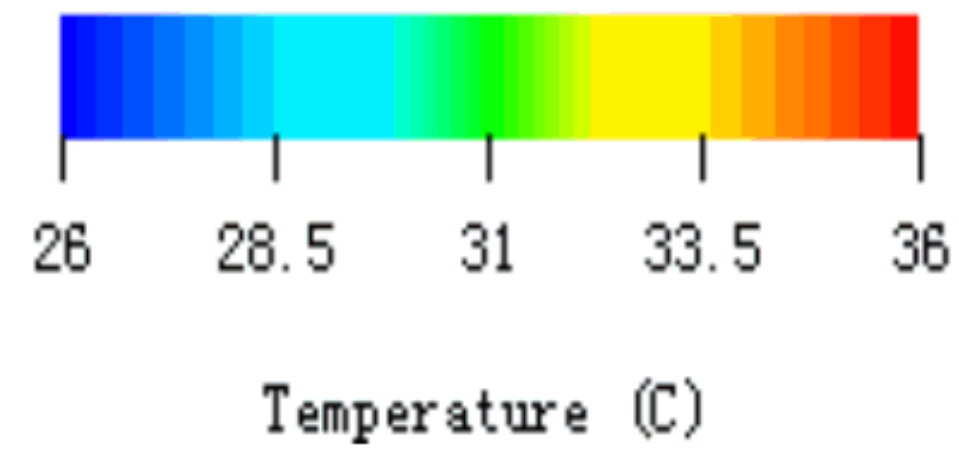


- **Modulate Fresh Air Damper**
- **Modulate Return Air Damper**
- **Modulate Exhaust Air Damper**





# No Air-Side Free Cooling



- Close Fresh Air Damper
- Open Return Air Damper
- Close Exhaust Air Damper



## Datacenter Facility Management Platform

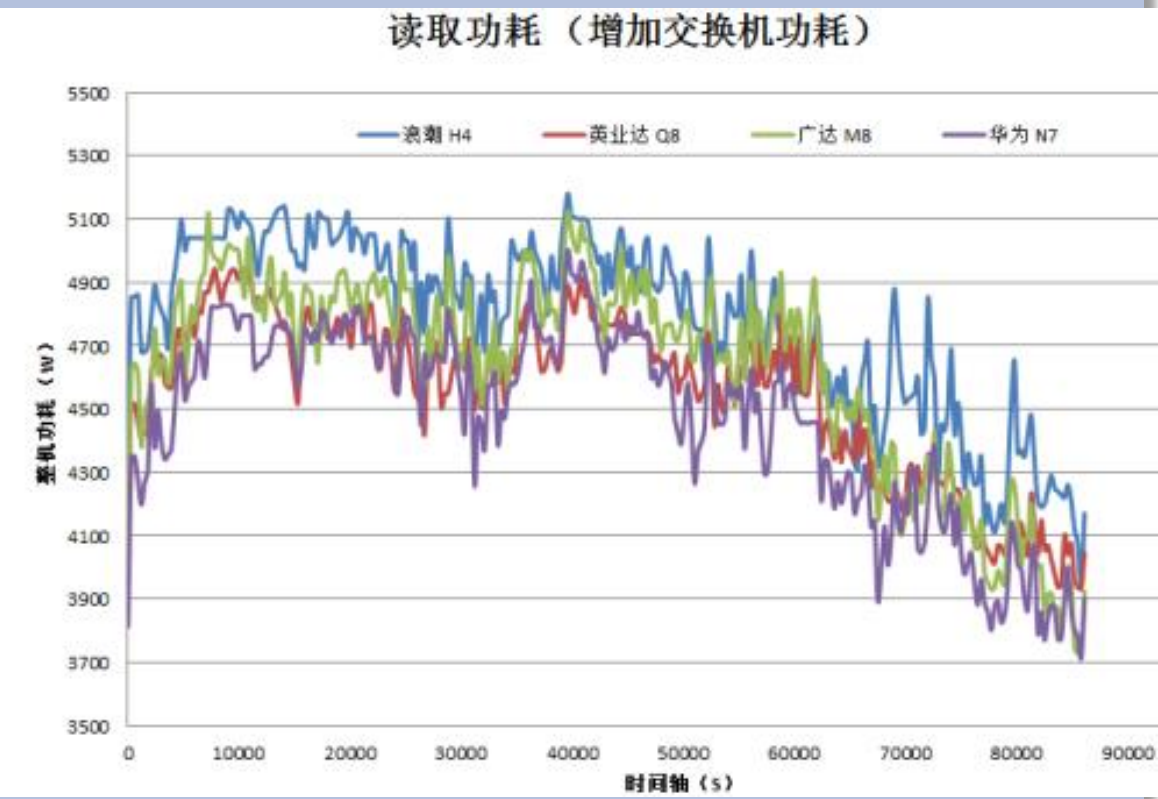
EPMS

BMS

Fire and Security  
Control

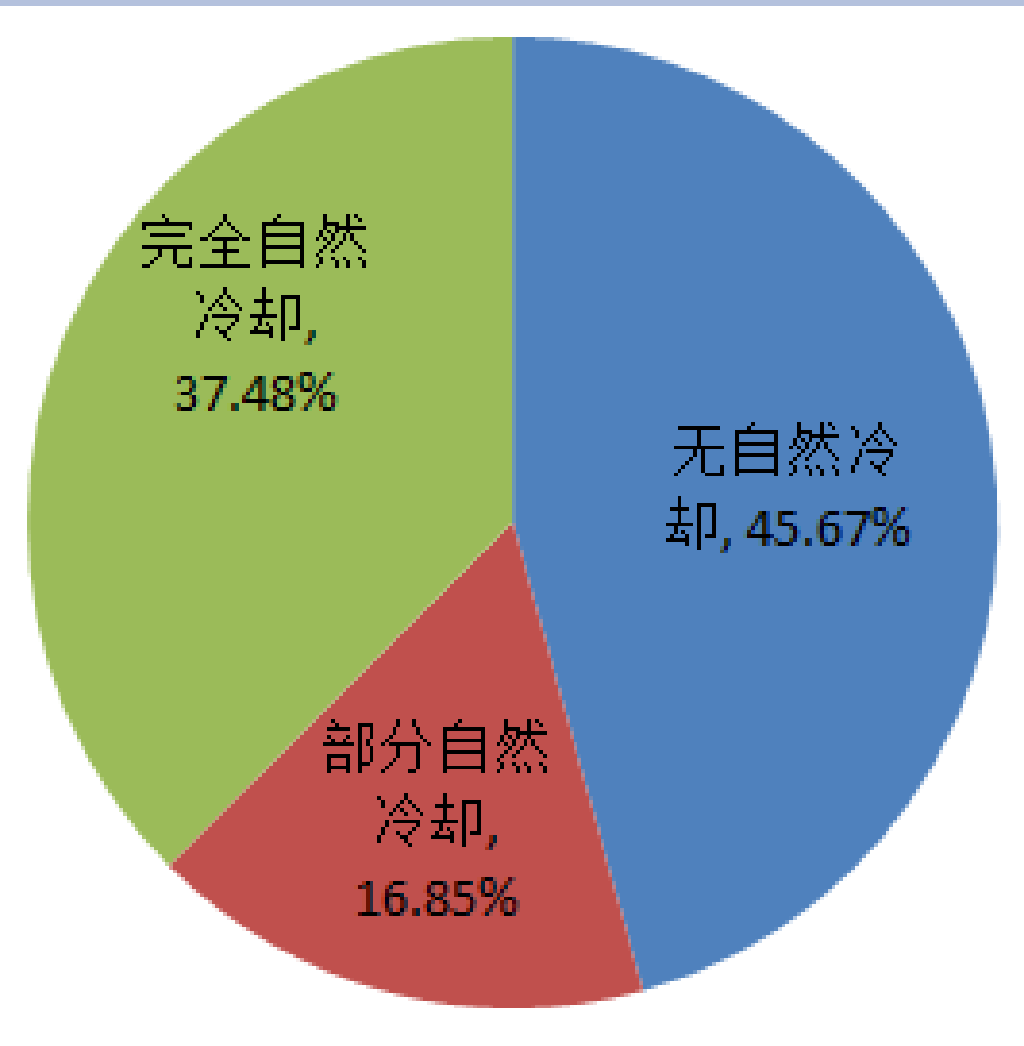
ITSM

Data Acquisition & Visualization

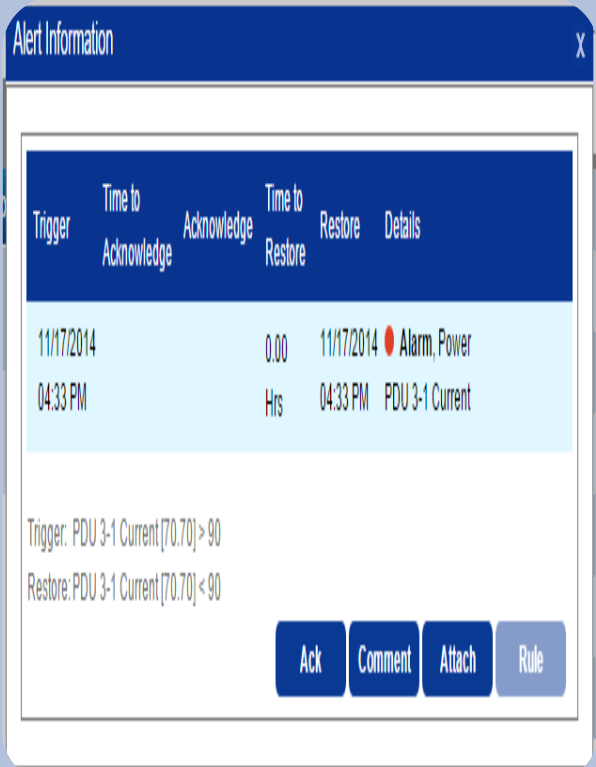


Generators, fuel supply system, city electricity, Battery, UPS, PDU&PUE.

Data Acquisition & Visualization

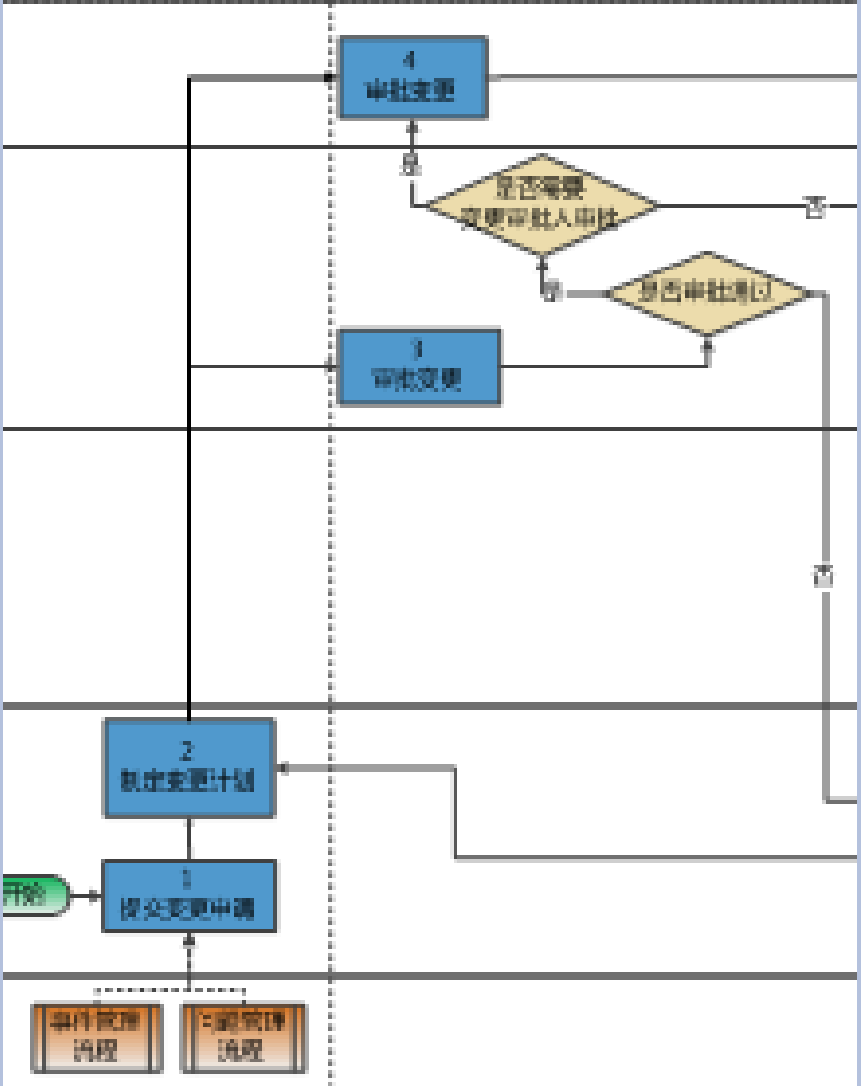


Chillers, CRAHs, Temperature and Humidity Monitor of cold aisles, Free Cooling Status, PUE&WUE.



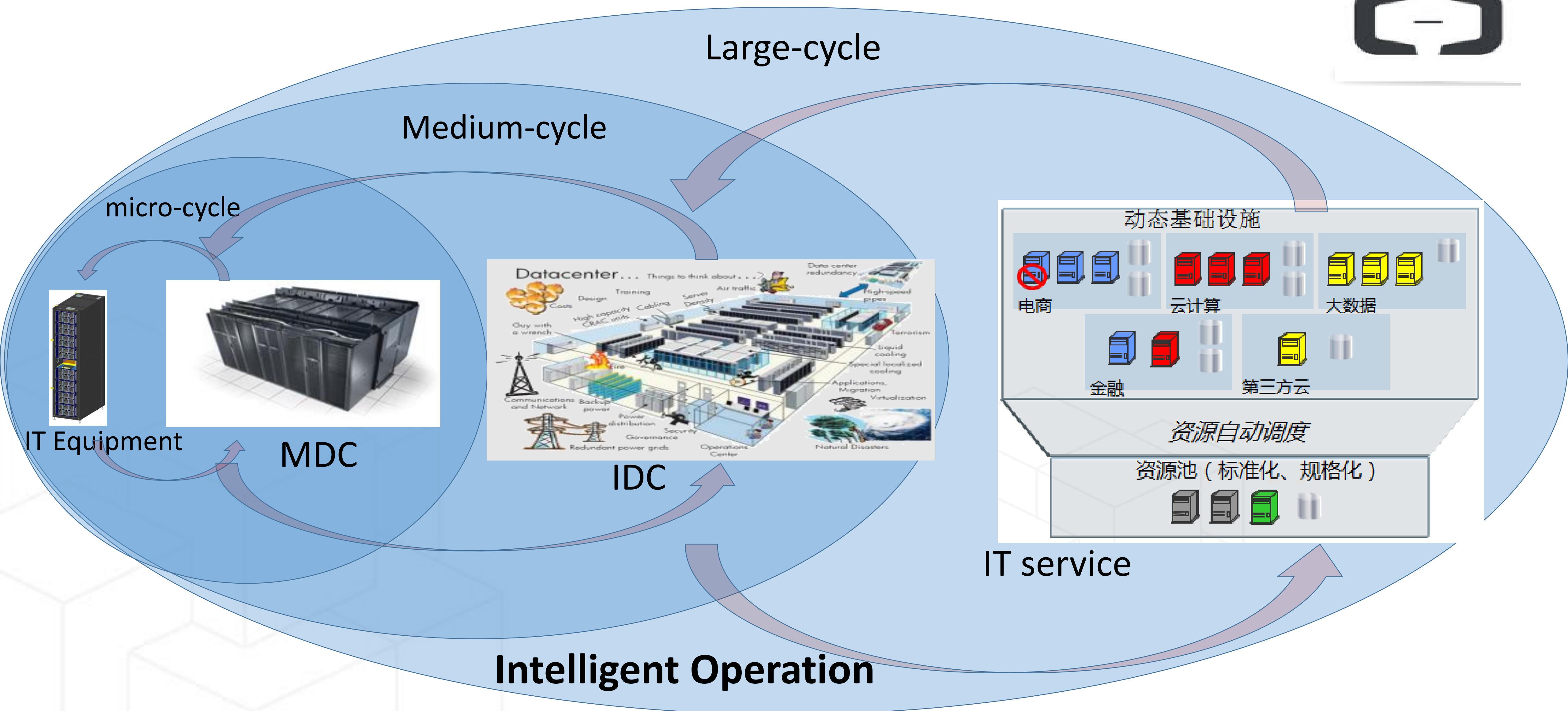
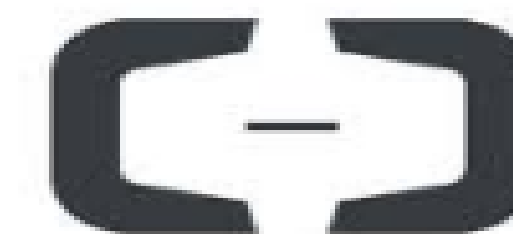
Fire and Security Alarm

Configuration, Event Change, Process, Problem, knowledge, Service Management

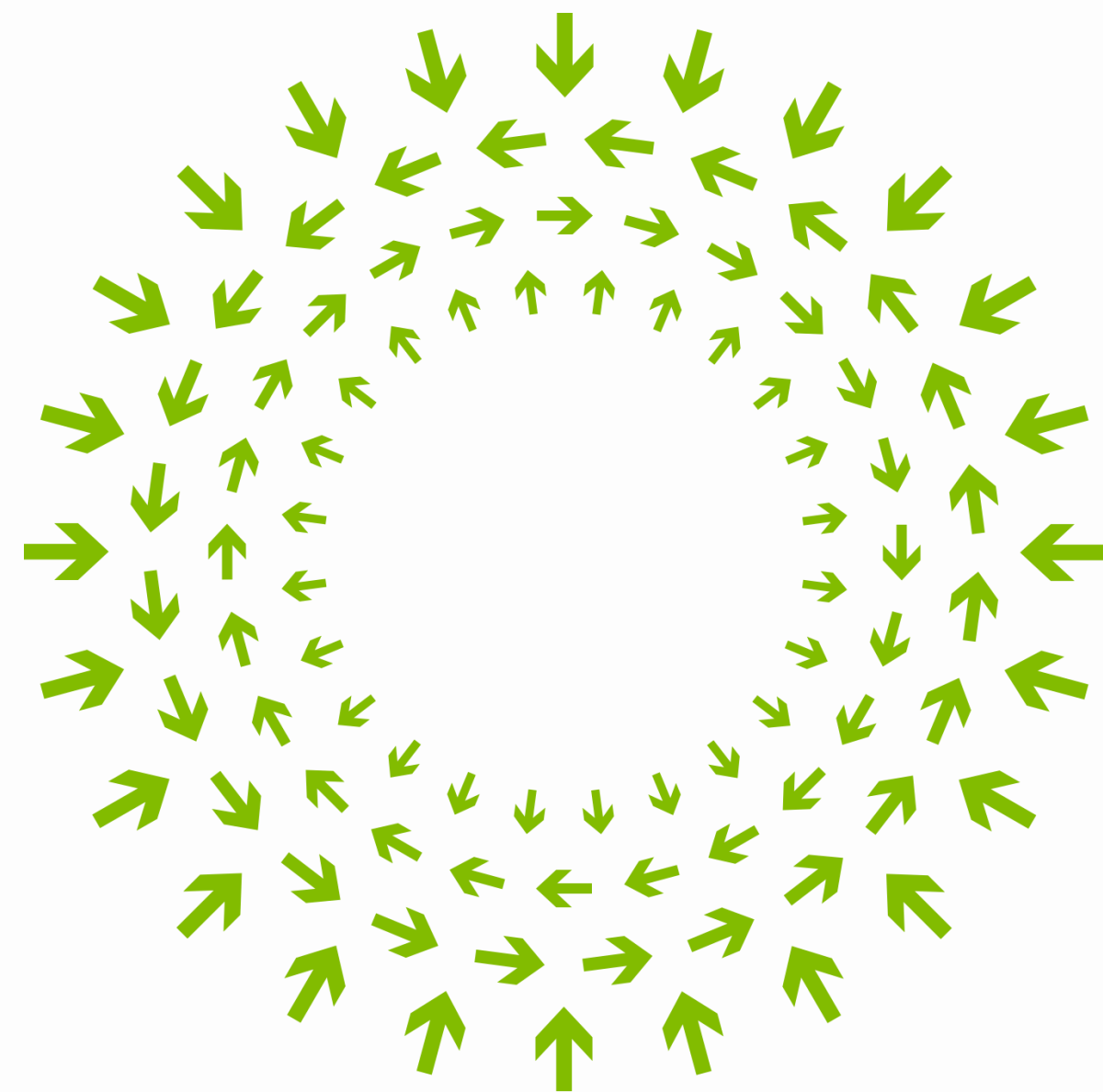




# Datacenter— Base of Cloud Computing







# OPEN

Compute Project

