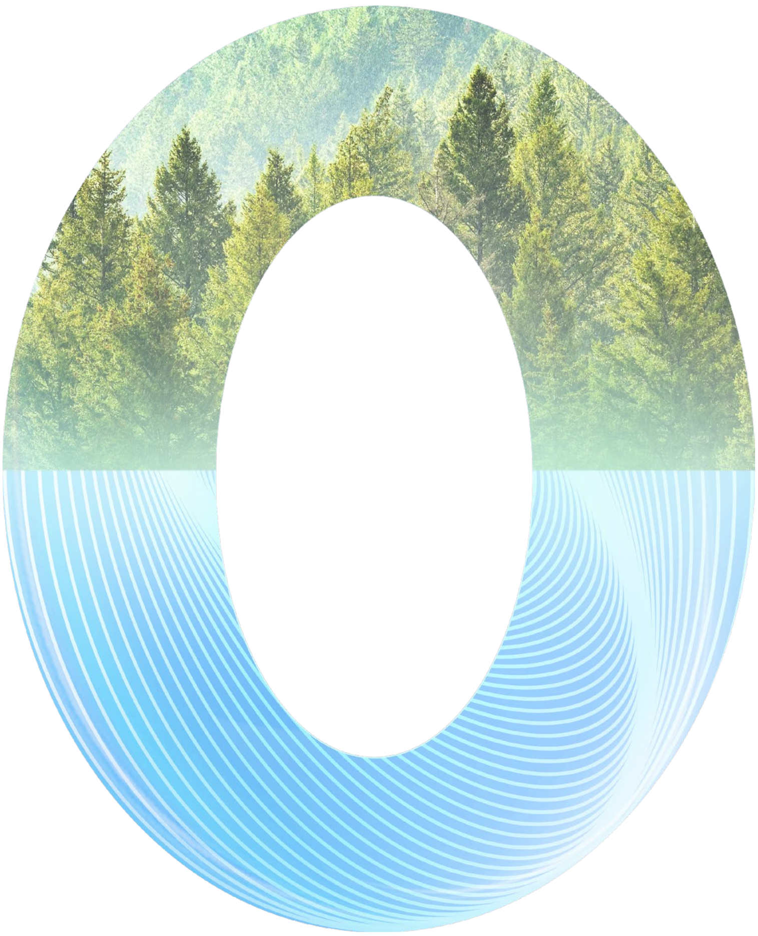
AIDC Facility Reference Design

White Paper



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Contents

1. Executive Summary

With the rapid development of the artificial intelligence (AI) industry in recent years, AI loads have gradually become a critical component of data centers (DCs). To meet the explosive demand for computing power driven by AI applications, intelligent computing equipment is evolving rapidly toward higher density, liquid cooling, and clustering. The increasing power density of racks and the expanding scale of clusters are posing disruptive challenges to the planning, design, and rapid deployment of physical infrastructure in DCs, covering power supply, distribution systems, and cooling equipment. To address these challenges, it is necessary to re-evaluate the system-level planning and design of DCs from intelligent computing equipment to physical infrastructure in an effort to build AIDCs that can adapt to the evolution and development of future AI business.

This white paper analyzes the future development trends of AI racks, super-nodes, and clusters, as well as the key challenges facing DC physical infrastructure. It provides future-oriented recommendations on planning strategies and deployment models for AIDCs, with the goal of fostering collaboration across the industry chain to jointly establish an AIDC standard system and build a thriving AIDC ecosystem.

This white paper provides a technical analysis of Li-ion battery applications in data centers, emphasizing:

- **Development Trend:** High density, Liquid cooling, Clustering
- **AIDC Design Challenge:** Reliability, Architecture Design, High Power Demand, Flexible Heat Design, Fast Delivery
- **Recommended Design:** cooling system, power system, building structure, network cabling
- **Initiatives:** Standard Specifications, Ecosystem Development

2. Development Trend of AI Loads and Computing Devices

2.1. Development Trend of AI Loads and Applications

Currently, AI models are rapidly evolving toward ultra-large scale and multi-modal convergence. The model size has grown dramatically—from 117 million parameters in GPT-1 to several trillion in GPT-5. Meanwhile, model architectures have progressed from dense large language models (LLMs) to sparse mixture of experts (MoE) models and increasingly multimodal models[1][2]. The development of large LLMs is unfolding along two distinct paths. The first focuses on pushing the boundaries of model performance through ultra-hyper-scale parameters combined with new algorithms, gradually improving model effectiveness by scaling up model size and training data[3]. The second emphasizes optimizing model architectures to lower the barrier to AI adoption, enabling broader participation across industries and accelerating the availability of AI[4].

In terms of industry applications, the shift toward intelligent transformation is accelerating, with AI technologies deeply empowering a wide range of business scenarios. In autonomous driving, AI technologies are used to process massive sensor data to enable real-time assisted driving decision-making. In the financial sector, AI supports high-frequency transaction analysis and risk prediction. In healthcare, AI is applied to assist with diagnosis and drug development. In intelligent manufacturing, AI helps optimize production processes. In the future, as multi-modal LLMs and embodied intelligence continue to advance, AI will become more deeply integrated into both industrial production and life.

AI Diagnosis AI Quantitative Trading

Figure 1 Typical AI Applications

Both the increasing AI loads and the evolving application landscape are driving an explosive growth in computing power demand, which paves the way for AI's continued evolution and development

2.2. Development Trend of AI Computing Devices

To support the rapidly growing demand for hyper-scale computing power in the AI era, developing AI computing power cannot be achieved simply by traditional servers stacking [5]. High-density deployment, liquid cooling, and hyper-scale clustering have become the mainstream development direction [6].

High density: To support hyper-scale computing power supply, the computing density and power density of AI chips are rapidly increasing. In rack design, the number of chips in the electrical interconnection domain of a single rack continues to grow in order to maximize computing efficiency through low-latency communication. As a result, rack power consumption will be growing from 50 kW to minimum 300 kW in the future[6]. The development trend of AI rack power consumption is predicted as follows:

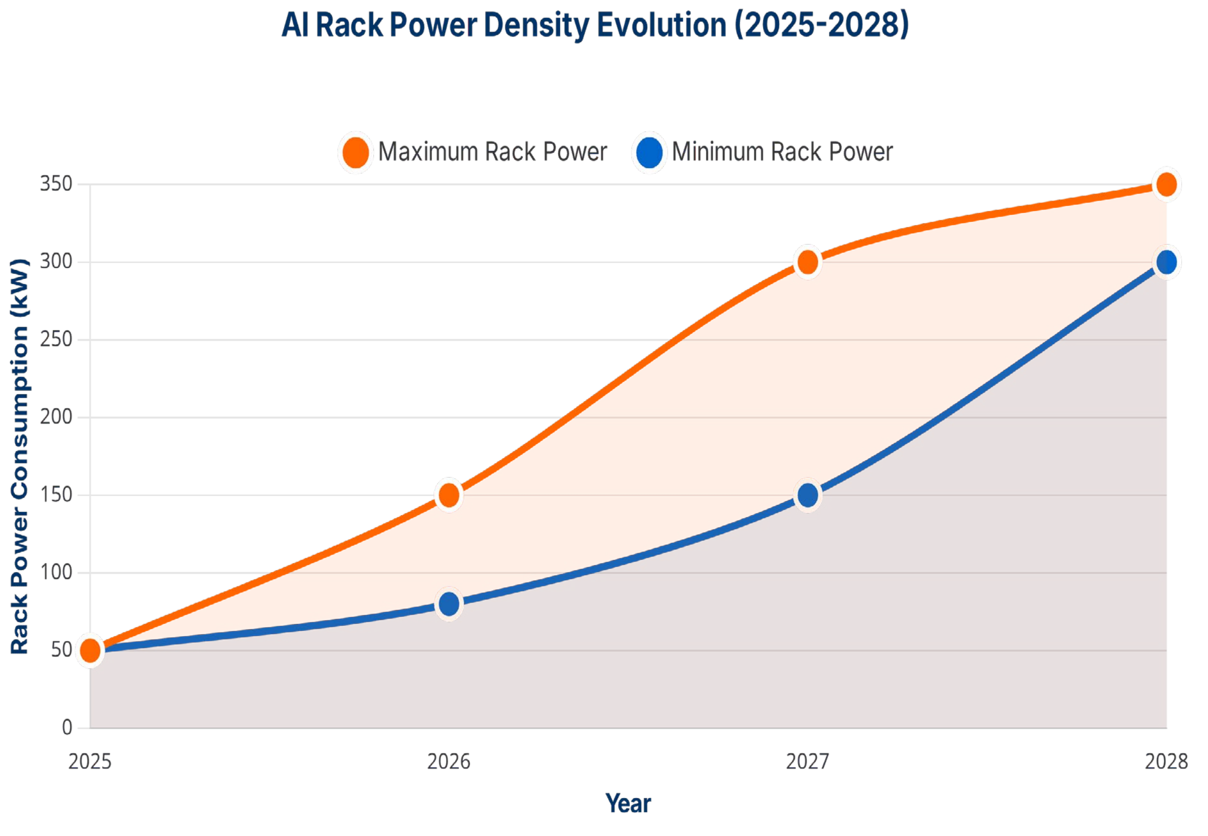

Figure 2 The development trend of AI Rack Power Density

Liquid cooling: As the power consumption of a single chip and racks continues to rise rapidly, the traditional air cooling mode cannot meet the cooling requirements of AI high-density racks. Liquid cooling, with its superior cooling performance and energy efficiency, has become the mainstream deployment mode for AI computing infrastructure[7].

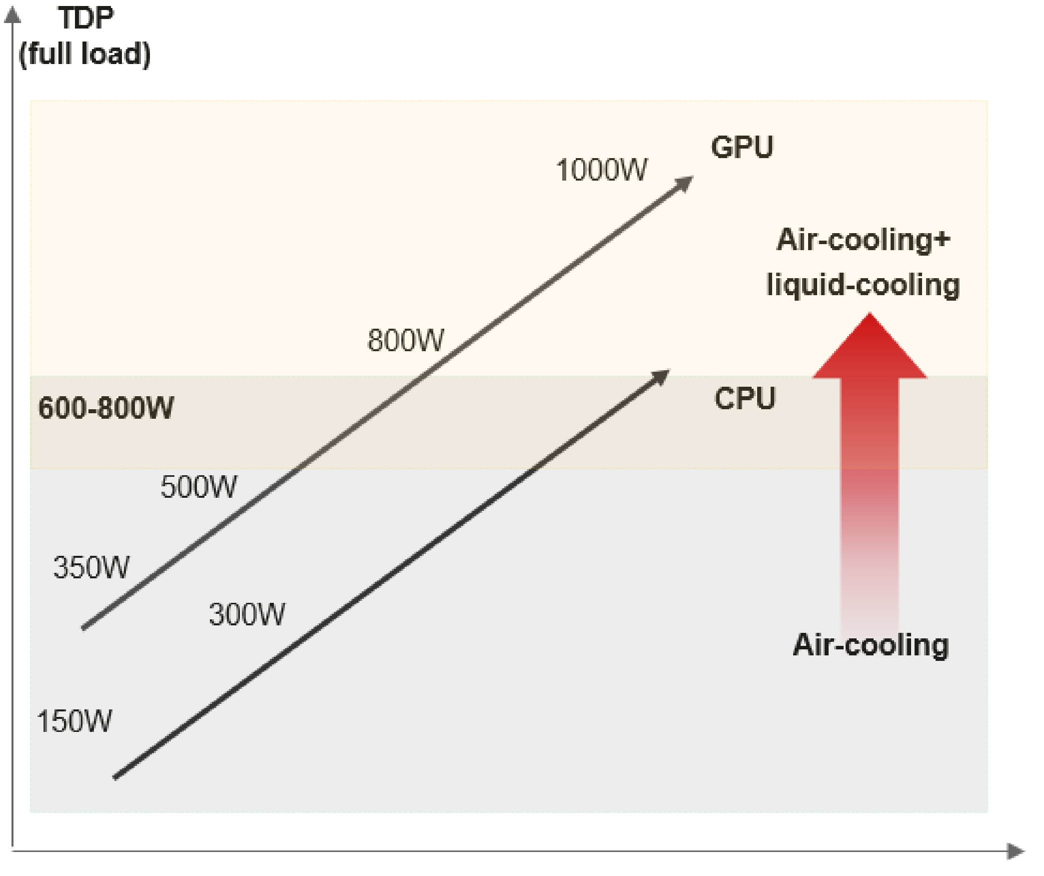

Figure 3 Relationship between chip power and cooling methods

Clustering: The traditional server stacking mode lacks high-bandwidth and low-latency interconnection between servers. This results in inefficient communication for hyper-scale distributed hybrid parallel algorithms such as tensor parallelism (TP), expert parallelism (EP), sequence parallelism (SP), pipeline parallelism (PP), and data parallelism (DP), which are essential for training LLMs [8]. The low communication efficiency makes it difficult to meet the time to accuracy (TTA) requirements of LLM training. AI Super node clusters are emerging as the mainstream industry solution[9], leveraging scale-up networks with high-bandwidth, low-latency bus interconnects. The interconnect domain has expanded from 8 cards on a single server to hundreds or even thousands of cards on a Super node, significantly reducing communication overhead for parallel strategies like TP and EP, and dramatically improving training and inference performance.

3. Challenges in AIDC Facility Planning and Design

With the advancement of AI racks, super nodes, and clusters, significant changes are being brought to cooling, power supply, architectural structure, and integrated network cabling of DCs. This chapter will analyze the challenges in planning and design of liquid-cooled equipment rooms from four perspectives.

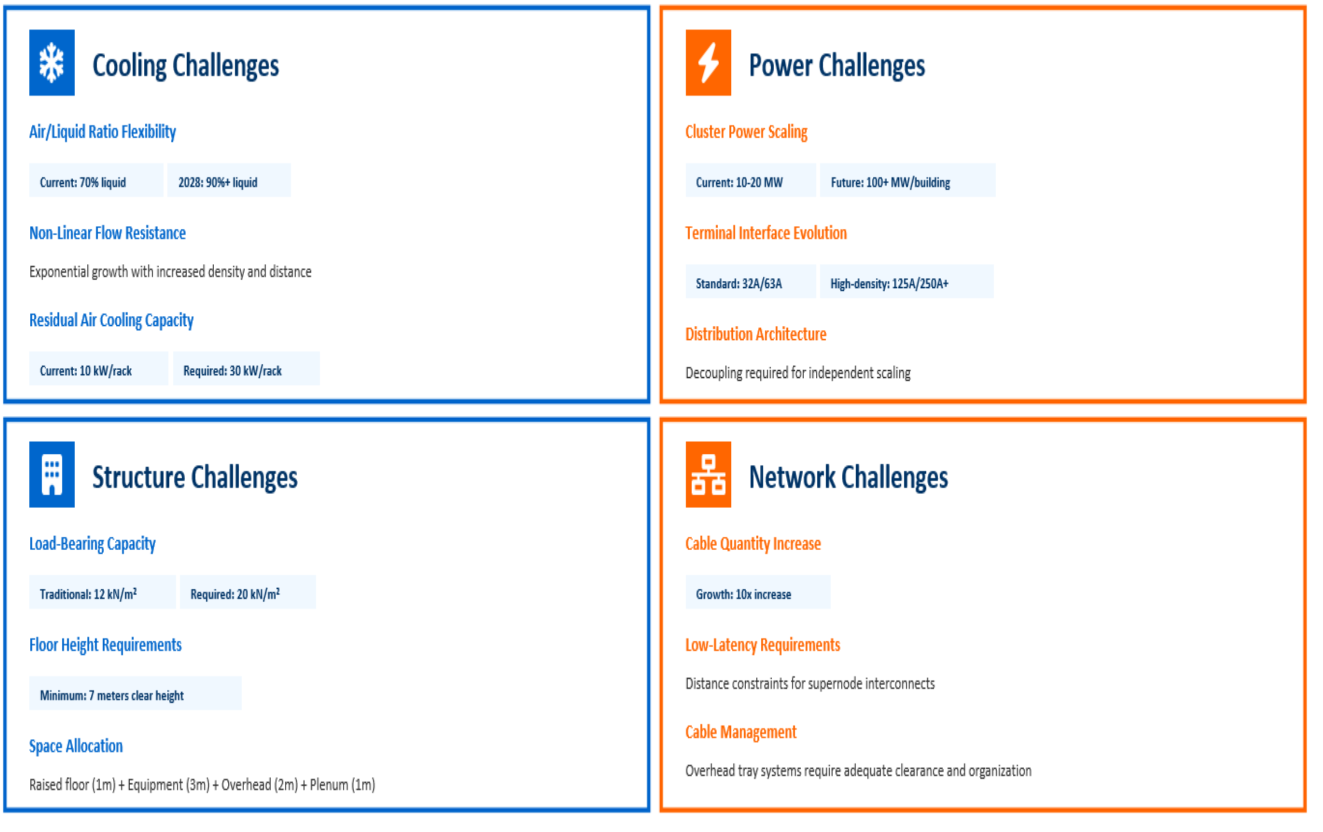

Figure 4 Four Infrastructure Dimensions Face Disruptive Pressure

3.1. Challenges in Cooling System Design

Challenges brought by the change in the air/liquid ratio in AI racks: As the power density evolves from 50 kW to minimum 300 kW, the proportion of liquid cooling within each rack will increase from the current 70% to over 90%. This trend requires DCs to maintain sufficient flexibility in balancing air and liquid cooling capabilities.

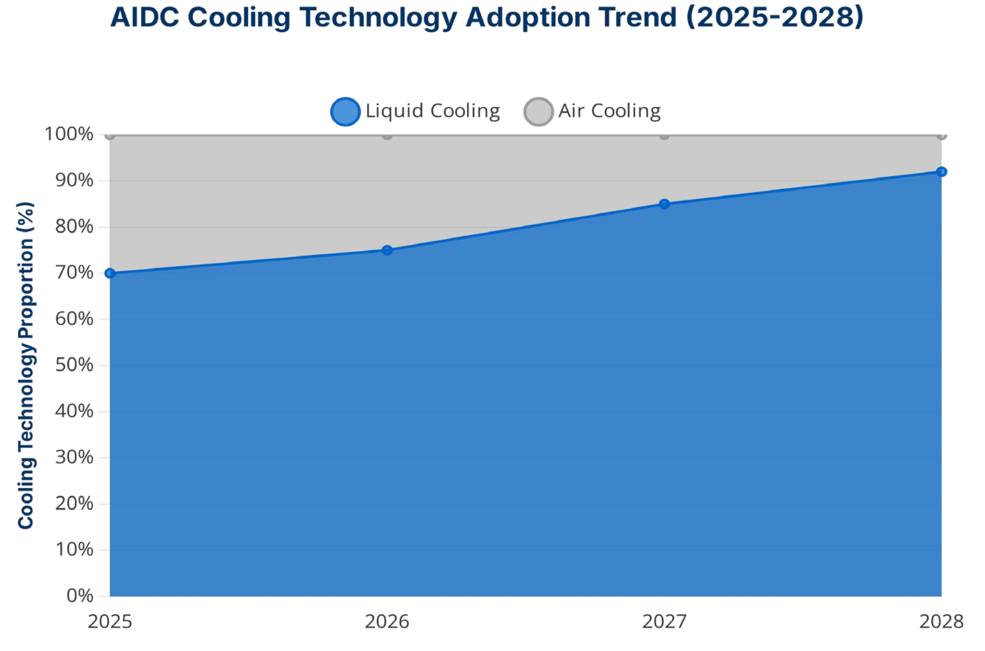

Figure 5 AIDC Cooling Technology Adoption Trend

Challenges brought by non-linear growth of liquid cooling flow and flow resistance in AIDC facility: As power density increases, the flow rate and flow resistance on technology cooling side（TCS) grow nonlinearly. This places higher requirements on the planning, design, and component selection of secondary-side heat exchange systems including thermal management unit (TMU) and liquid cooling main and branch pipelines. To accommodate these changes, the technology cooling side（TCS) must be designed with sufficient flexibility.

Challenges brought by the increasing air-cooling requirements in AIDC facility: Although the proportion of air cooling in AI servers will decrease from 30% to nearly 10%, with the increase in power density of AI server cabinets, the power consumption of the air-cooled cooling system for AI cabinets will also evolve from the current level of about 10 kW/R to 30 kW/R or higher. The current air-cooling capacity of end devices is insufficient to meet the cooling requirements of the air-cooled devices in a high-power rack. Enhanced, more efficient, and reliable air cooling solutions are required to address this challenge.

3.2. Challenges in Power Supply and Distribution System Design

Challenges in power supply for hyper-scale clusters: As intelligent computing clusters continue to evolve, the power supply requirements of a single Super node is expected to scale from 1 MW to 10 MW. Consequently, the total power supply requirements for a single cluster could reach to hundreds of MWs. Currently, the power of a datacenter POD is 1–2 MW, and that of a single building is 10–20 MW, which is insufficient to meet the evolving power supply requirements of intelligent computing clusters.

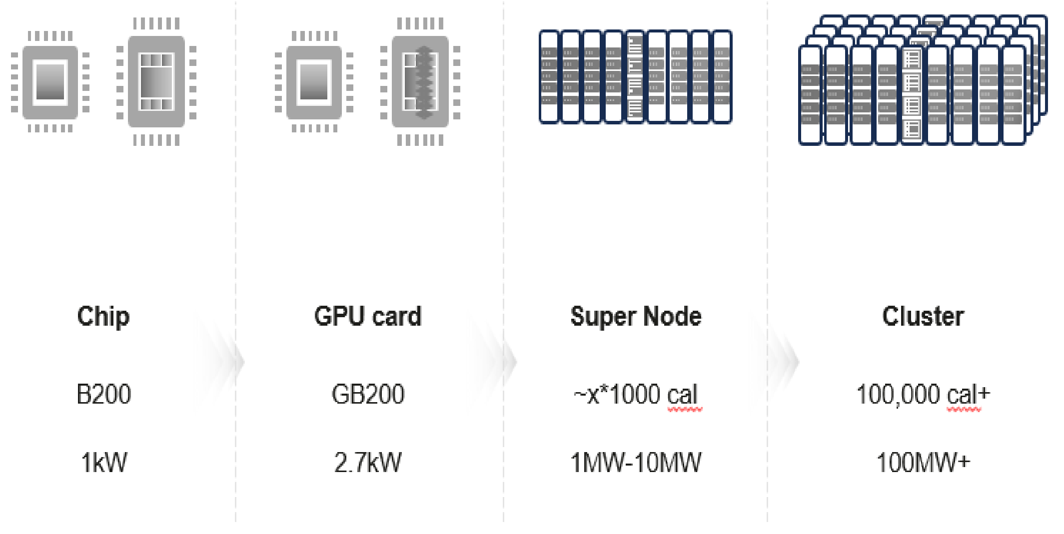

Figure 6 Power supply trend of AIDC

Challenges in high-density power supply of the terminal power distribution system: Currently, DCs primarily use 32 A/3P and 63 A/1P power distribution units for individual racks. As power density continues to rise, these existing power distribution units will no longer be sufficient to meet the future high-density power supply requirements of AI racks. For example, in a 300 kW power rack, a 2N power distribution architecture system requires minimum 18 inputs of 63 A/3P power distribution units. This creates significant challenges for the cabling space at the top of the rack. To reduce the number of power inputs, it is necessary to increase the capacity of each individual input. As a result, the terminal power distribution system at the rack level faces cross-generation evolution pressure.

3.3. Challenges in Building Structure Design

Challenges in the floor height of the AIDC white space: As the power density of AI racks increases, larger-diameter liquid cooling pipelines are required to support effective cooling. This necessitates higher raised floors to accommodate the expanded piping infrastructure. At the same time, the air cooling power consumption per rack is expected to reach 30 kW or more, demanding greater return air ceiling space. Additionally, high-power racks require intelligent busbars with larger cross-sectional areas for connecting cables. Supernode interconnection demands a tenfold increase in the number of optical fibers. These trends place greater demands on rack-top space for both power supply and interconnect cabling. In conclusion, to support cooling, power supply, and interconnection of high-power-density racks, the equipment room must have larger vertical space and higher floor height.

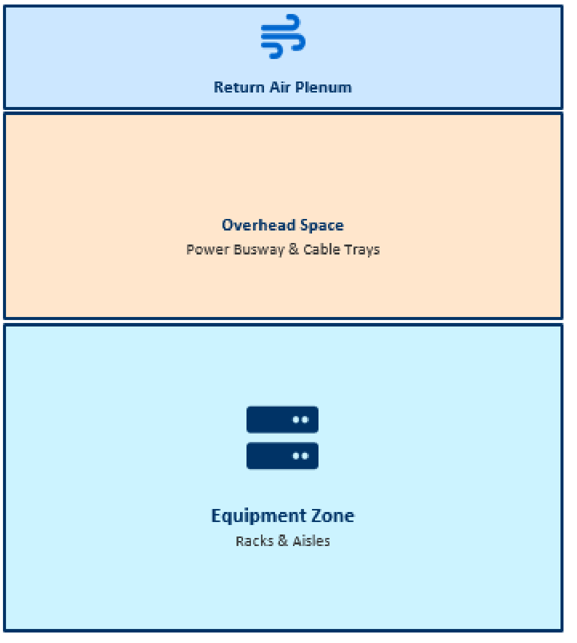

Figure 7 AIDC white space Vertical Layout Section

Challenge in the bearing capacity of the white space: An AI rack is typically delivered as a whole unit. As compute density increases, the overall weight of each AI rack continues to rise. Currently, the weight of an AI rack is about 1300kg, and the bearing capacity of the white space floor is about 1600kg/m^2. It is estimated that the weight of a 300 kW rack will exceed 2000kg in the future, and the bearing capacity of the equipment room will reach 2000kg/m^2. As rack weight continues to rise, it introduces new challenges for the loading capability design of the equipment room structure. The bearing capacity of the white space will be a factor to consider in future AI rack deployment.

3.4. Challenges in Network Cabling Design

Network cabling challenges: Compared to traditional general-purpose computing centers, AIDCs requires a ten-fold increase in the number of network cables due to the massive scale and ultra-high bandwidth requirements of AIDCs. As supernode scale expands from today's hundreds of cards to thousands of cards in the future, the low-latency requirements for intra-domain interconnection impose strict constraints on the interconnect distance between nodes. This evolution presents new challenges for DC network cabling and floor layout design.

3.5. Challenges in AIDC Facility Construction

In addition to the preceding challenges in planning and designing the AIDC facility solutions, the rapidly evolving nature of AI services drives DCs to be delivered quickly and flexibly adapted to future intelligent computing equipment. This introduces new challenges for the construction of liquid cooling datacenter.

Challenges in AIDC Facility delivery: In the field of AI, the speed at which a business goes live can directly determine its survival. How AIDC construction can support rapid service deployment has become a key concern across the industry. In China, some customers have proposed a four-month construction time for AIDC (from service requirement confirmation to completion of physical infrastructure commissioning and readiness for intelligent computing equipment installation). A few customers even expect a two-month construction time. In Middle East, most customers have proposed a eight to ten-month construction time for AIDC. However, the current construction model for DC facility typically follows a sequential approach: Civil work framework is built first, and the construction of major and minor electromechanical equipment systems begin only after the intelligent computing equipment is finalized. This results in a delivery period of 18 to 24 months, which often fails to meet service requirements. Moreover, It is highly uneconomical to let AI servers waiting for the DC facility，as the depreciation expenses of AI servers in a few months is equivalent to the capital expenditure (CAPEX) of the AIDC facility itself. Therefore, AIDC facility must be pre-ready to support rapid AI service deployment and maximize the utilization of intelligent computing equipment throughout its lifecycle.

Challenges in adapting DCs to rapid evolution of intelligent computing equipment: To meet the requirements of evolving AI loads for computing power, intelligent computing hardware is now upgraded at a pace of one generation per year. This accelerated pace requires DCs to be designed with sufficient flexibility and scalability and the planning and construction models of equipment rooms must adopt a forward-looking approach.

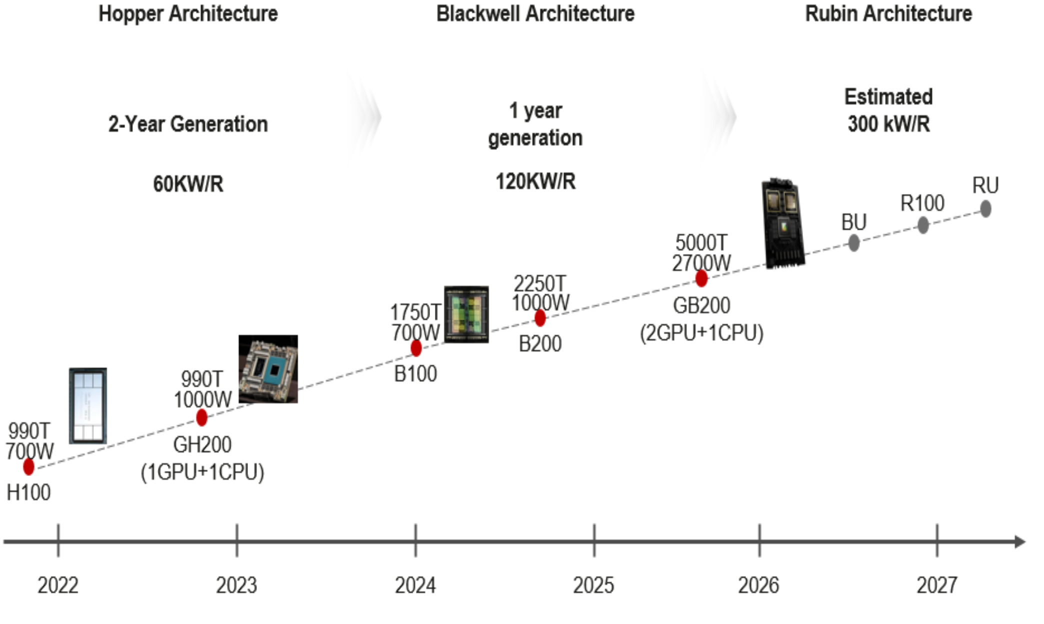

Figure 8 AI Cabinet and Chip Power Development Trends[10]

4. Recommended Design Guidelines and Deployment Mode for AIDC

4.1. Recommended Design Guidelines

The rapid evolution of AI racks presents significant challenges to architectural structure, power supply and distribution and cooling systems, and integrated network cabling, impacting design and planning from the campuses down to buildings and floors. In terms of overall architecture, AIDC recommends adopting a distributed architecture and decoupled layout. This approach allows for flexible expansion of the entire AIDC system, enabling capacity to be increased as needed. It also simplifies maintenance, clearly defines the boundaries between cooling/power and DH (Data Hall), and supports multi-vendor solutions.

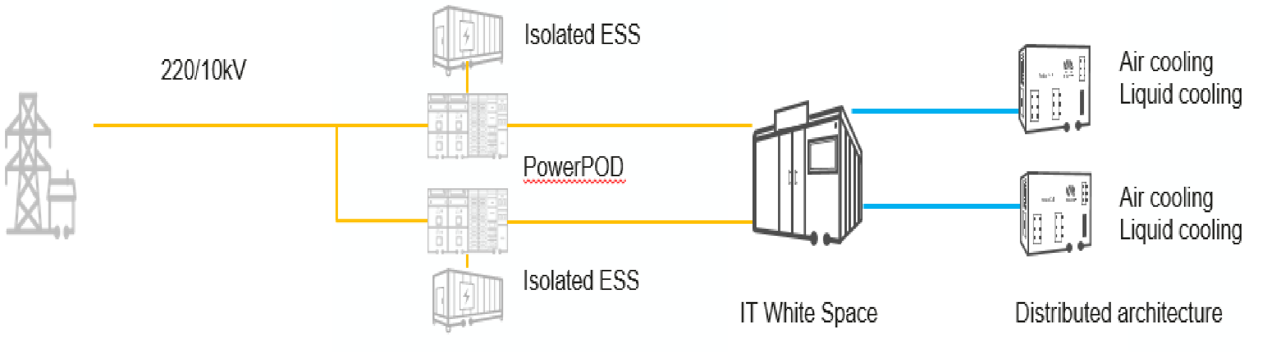

Figure 9 AIDC Architecture

This chapter provides detail recommendations on design guidelines across four key dimensions: cooling, power supply and distribution, architectural structure, and network cabling.

4.1.1. Cooling System

A unified source for air cooling and liquid cooling and compatibility with different air-to-liquid ratios: This involves using a common cooling solution for the facility cooling side（FCS）, while designing the terminal infrastructure based on specific air-liquid requirements. This enables flexible deployment to support different air/liquid ratios.

Liquid cooling flexibility and reliability design: The capacity of the liquid-cooled thermal management unit（TMU）and the diameter of the main pipe on the secondary side can be designed based on the cooling requirements of the rack with the highest power density. Secondary branches can be adapted to AI racks with different power levels through terminal pipe reduction or dual-interface integration. The liquid cooling system can integrate the real-time monitoring function of key parameters (such as conductivity and pH value) of the coolant to predict the coolant health and implement proactive maintenance, ensuring reliable running of intelligent computing equipment.

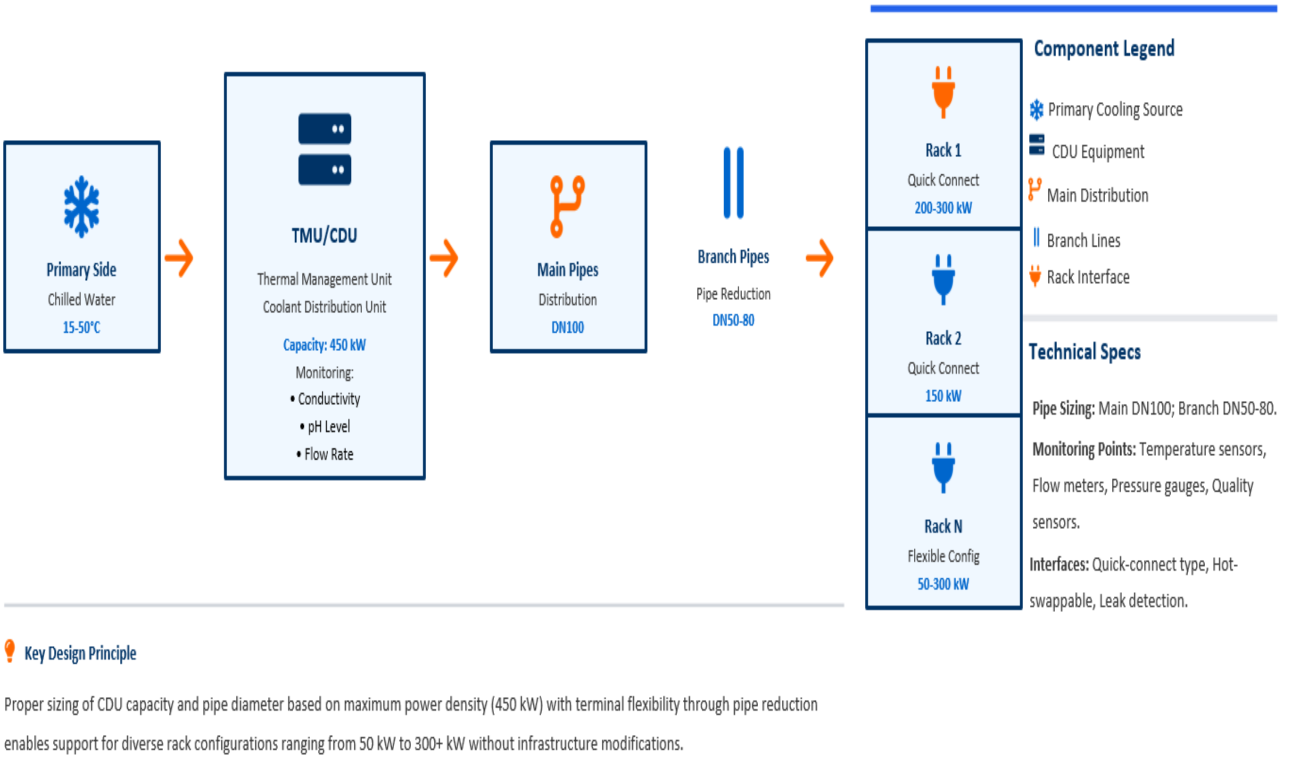

Figure 10 TMU Flexibility And Reliability Design

Figure 11 HW TMU Key Features and Technical Specifications

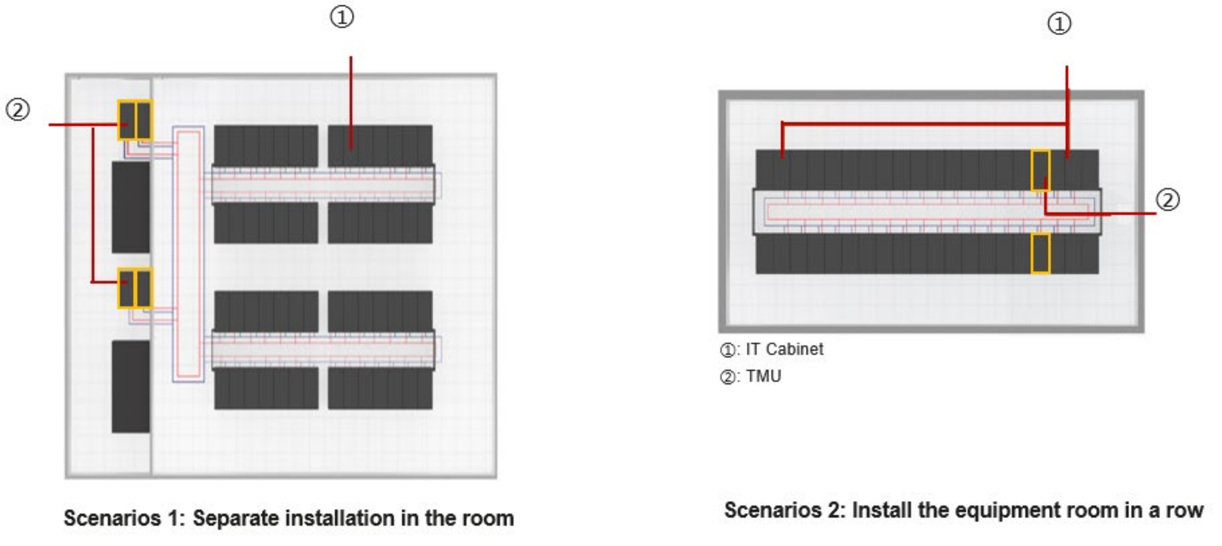

Figure 12 HW TMU installation recommendation

High-density air cooling solution design: To meet the air cooling requirements of a single rack up to 30-40 kW in future intelligent computing scenarios, the following two solutions are recommended:

Solution 1: **Dual-side Fan Wall deployment solution.** Deploy large fan walls units (in-room air conditioners) on both sides of the room to increase the number of cooling terminals to improve the cooling capability. Compared to a single-side in-room air conditioner solution, this approach could increase rack power density， reduces the width of hot and cold aisles, lowers the return air height of the ceiling, and increase the number of single-row cabinets.

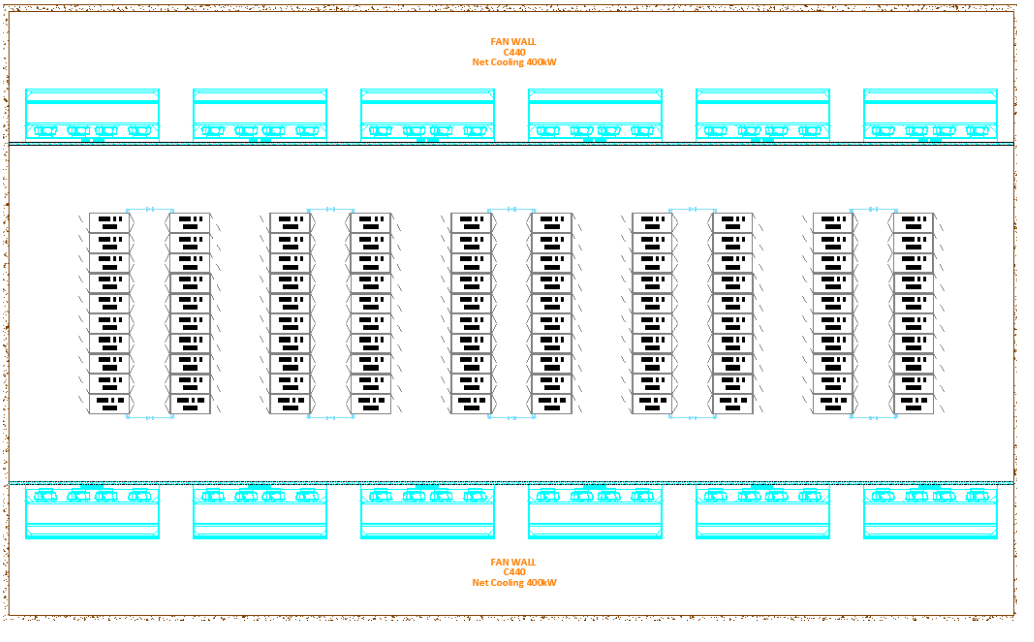

Figure 13 Fan Wall Solution Typical Layout（4MW，40kw/R，100Rack）

Solution 2: In-row cooling Solution. In-row cooling air conditioners are deployed in close proximity to the intelligent computing equipment cabinets. Hot aisles are enclosed, and cold zones are pooled, eliminating the need for return air ceilings and thereby increasing power density. Compared to solution 1, this solution has lower requirements on the equipment room height. However, intelligent computing equipment and cooling equipment are deployed in a hybrid manner and O&M zones tend to overlap, resulting in higher O&M requirements.

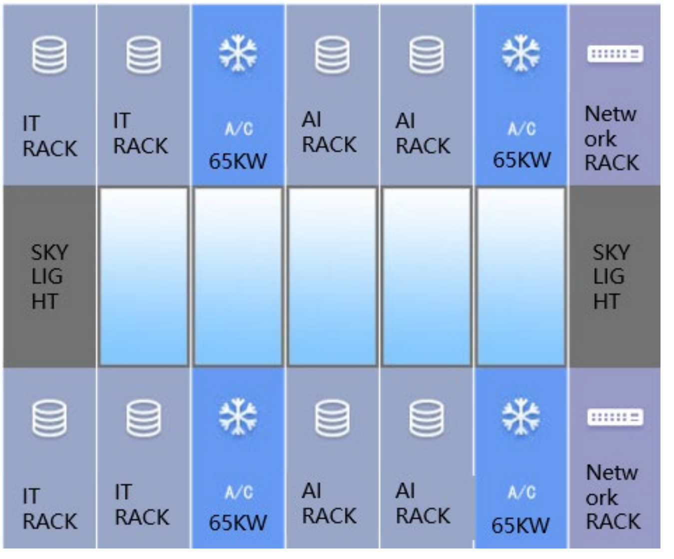

Figure 14 In-row Cooling Solution Typical Layout (200kW，up to 50kw/R，10Rack / module)

4.1.2. Power Supply and Distribution System

Decoupled design of medium- and low-voltage power distribution systems and intelligent computing equipment: To adapt to the development trend of individual super nodes reaching 1-10 megawatts (MW) and individual clusters reaching hundreds of megawatts (MW), it is necessary to build an efficient power supply system across the entire chain to achieve optimal system energy efficiency.

It is recommended that the medium- and low-voltage power distribution systems adopt a pooled designed based on the maximum capacity. Power distribution and supply equipment and intelligent computing equipment shall be decoupled or loosely coupled to support flexible power supply requirements for supernodes of varying scales.

The medium- and low-voltage power distribution system can be designed in a standardized, modular, and productized manner to support early deployment of electromechanical equipment or prefabricated delivery, ensuring that the physical infrastructure of the equipment room is ready in advance.

To ensure safe operation, the key lies in fault domain isolation and control. It is recommended that battery systems be deployed away from IT equipment and housed in dedicated physical compartments equipped with fire protection and ventilation measures, effectively mitigating the risk of thermal runaway.

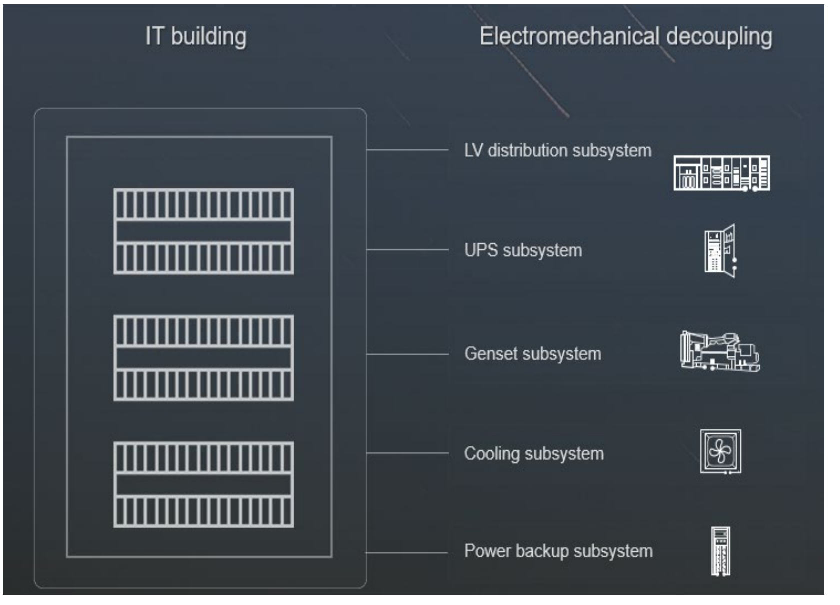

Figure 15 Electromechanical Decoupling Design

Flexible design of the terminal power distribution interface: To keep up with the high-density development trend of AI racks, it is recommended to adopt an integrated and flexible power distribution approach at the racks' terminal interface (load side). If intelligent busways are used for rack-level power distribution at the terminal side, the general input unit of smart busbar and main bus can be designed based on future equipment. Power distribution units can be configured in changeable capacity specifications, enabling flexible deployment of AI racks with different power levels.

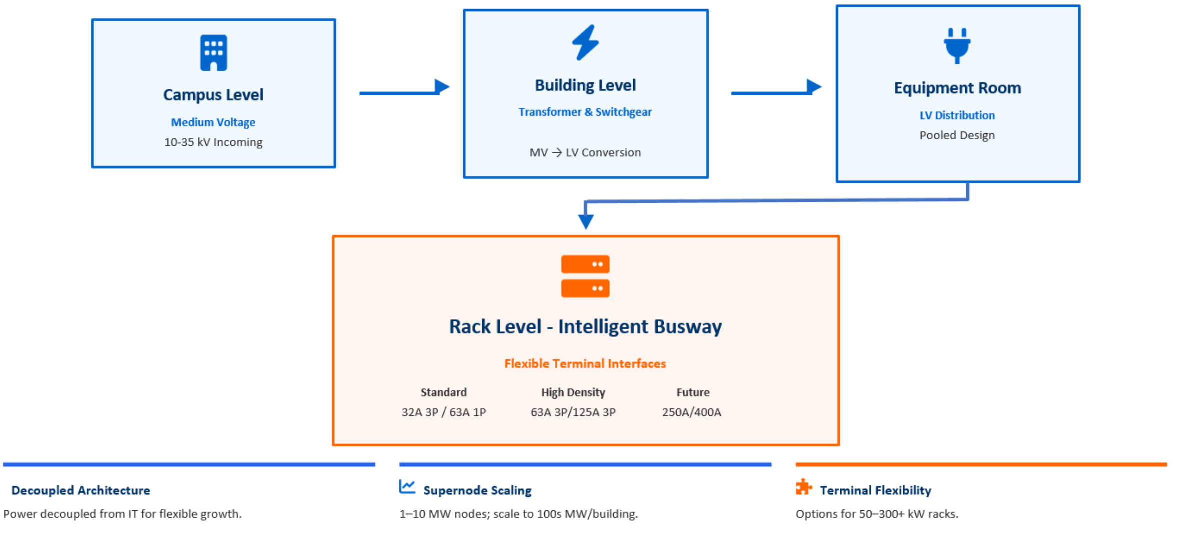

Figure 16 Flexible design of the Intelligent Busway

4.1.3. Building Structure

White Space load-bearing design: The civil engineering facilities of an equipment room typically have a lifecycle of 40 to 50 years, while the civil work cost accounts for only around 10% of the overall CAPEX. During the initial design phase, it is important to consider the increased structural load capacity required due to the higher density of intelligent computing devices in the future. This approach avoids the need for subsequent costly structural reinforcement and modifications, making it a more economical solution. It is recommended to incorporate load-bearing margin in equipment room design. For newly AIDC facility, the load-bearing capacity should be designed at 2000kg/m2 or higher.

White space height design: As power density scales up to 300 kW, the requirements for vertical space increases due to cooling, power supply, and networking requirements. At the equipment zone and overhead space, approximately 5 meters of vertical space is needed. An additional 1 meter shall be allocated for return air plenum, along with another 1 meter for liquid cooling pipes under the raised floor. Therefore, the total ceiling height for the equipment room is approximately 7 meters. It is recommended to design new liquid cooling equipment rooms with a ceiling height no less than 7 meters.

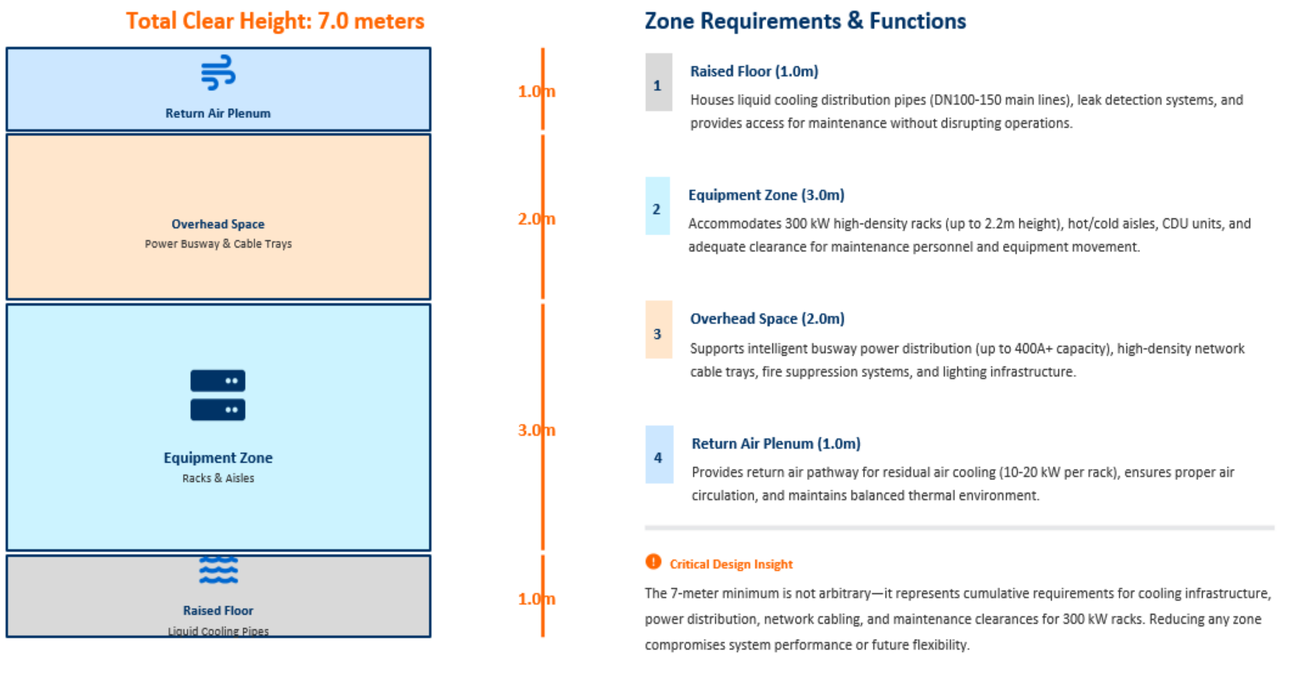

Figure 17 White Space Height Design

4.1.4. Network Cabling

For hyper-scale cluster datacenter, it is recommended to plan network cabling by layer from the campus to the data hall based on the maximum cluster deployment capacity while fully considering cabling space requirements and distance constraints.

1. The capacity of the optical fiber routing across the campus shall be planned based on the maximum cluster scale. A dual-route design is used without cross-connections to facilitate capacity expansion. The pipe trench or pipeline corridor solution is adopted, with sealed cable boxes installed within the pipe trench or pipeline corridor.
2. The dual-route design is used for the datacenter building, and the dual routing architecture must remain isolated without any crossover between paths. The capacity is designed based on the maximum number of cables, optical fiber bending radius, phased deployment plans, and reserved space for future maintenance.
3. A dual-layer mesh cable tray is installed on the top of all racks in the data hall. The lower layer is used for routing optical fibers in supernodes and optical fibers

for interconnection on the parameter planes between supernodes, while the upper layer is designated for routing optical fibers on other network planes.

4. It is recommended to plan the interconnect cabling within the supernodes based on the shortest routing distance to minimize latency within the supernodes.

4.2. Recommended Deployment Mode

The current approach of "civil work construction first" where major and minor electromechanical equipment systems are built only after service requirements are finalized struggles to meet the rapid delivery demands of AI services. Shortening the data center construction time has become a common goal for the industry.

To shorten the data center construction time, two approaches are recommended: First, advance construction procedure by prioritizing early deployment of major electromechanical equipment systems that have weak coupling with intelligent computing equipment, as shown in mode 1 in the following figure. Second, standardize, modularize, and preconfigure major and minor electromechanical equipment systems. AI computing capacity and equipment room infrastructure shall be planned in a fully integrated, end-to-end manner. Design validation for each module shall be conducted in advance and resources are reserved through framework bidding to shorten the construction cycle of both major and minor electromechanical equipment systems, as shown in mode 2 in the following figure.

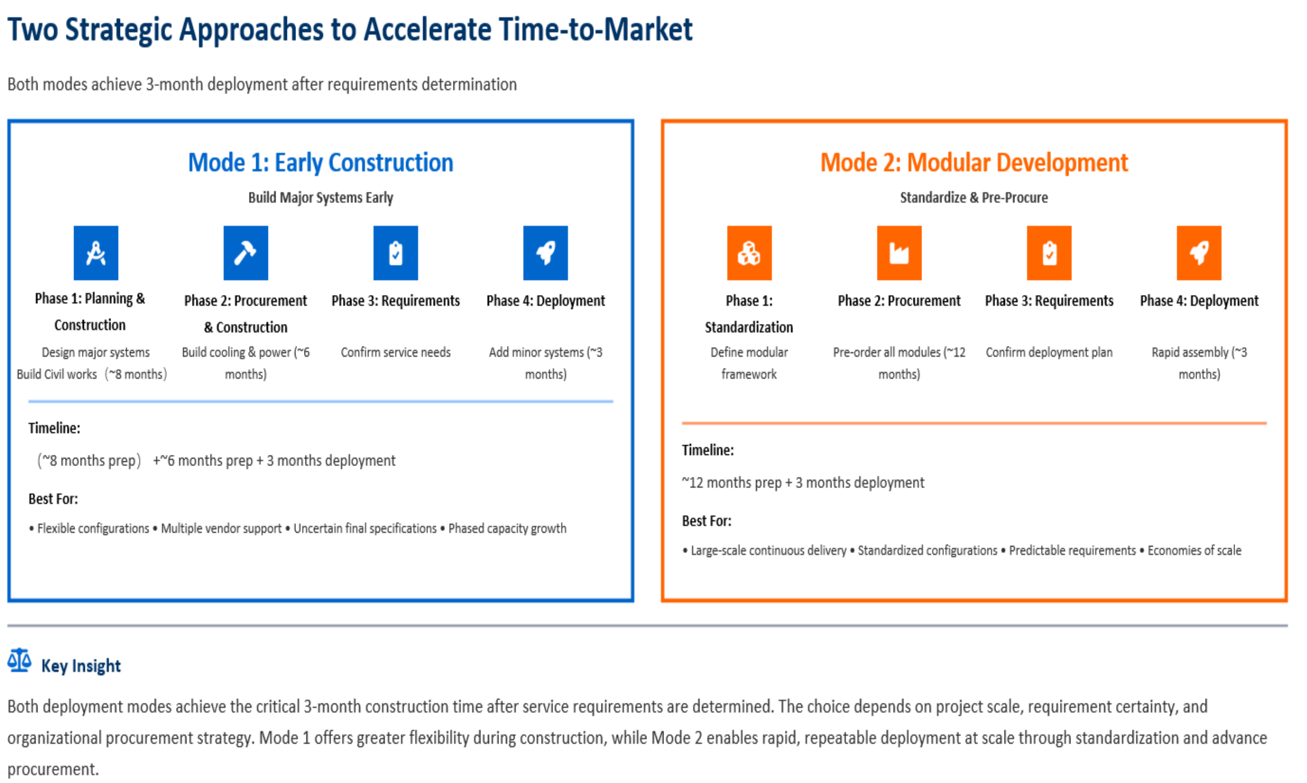

Figure 18 Recommended Deployment Mode

Mode 1: **Early construction of civil work and major electromechanical equipment systems**. Before services and intelligent computing equipment requirements are finalized, **major electromechanical equipment systems can be decoupled and constructed in advance** based on the estimated air-to-liquid ratio and power ranges of racks. Once the services and intelligent computing equipment requirements are confirmed, quickly start the construction of minor electromechanical equipment systems that are strongly coupled with intelligent computing equipment, such as the low-voltage power distribution system, liquid cooling secondary system, rack system, terminal cooling system, and terminal power distribution system. This approach can reduce the datacenter deployment time to approximately three months.

Mode 1: Early construction of civil work and major electromechanical equipment systems (Perform certain process steps in advance)		
Civil work	Frame (civil work)	~8 months (rational reserves)
Determine the approximate specifications of specifications of racks (power and air-to-liquid ratio).		
Major electromechanical equipment systems	Decoration and fire extinguishing system Cold source system Genset system Medium-voltage power distribution system	~6 months (rational reserves)
T = Determining services requirements		
Minor electromechanical equipment systems	Low-voltage power distribution system Liquid cooling secondary-side system Rack system Terminal cooling system Terminal power distribution system	~3 months

Figure 19 Early construction Mode

Mode 2: **Early civil work, development of major and minor electromechanical modules, and framework procurement**. By standardizing, modularizing, and productizing the major and minor electromechanical equipment systems based on the target intelligent computing equipment, start the design and development as well as framework procurement for major and minor electromechanical modules, and drive periodical goods preparation by suppliers and rolling construction of civil work and decoration one year in advance. After the services requirements are determined, the delivery of major and minor electromechanical equipment systems can be completed within three months based on Huawei's practical experience.

Mode 2: Early civil work, development of major and minor electromechanical modules, and framework procurement (Shortened project duration of major and minor electromechanical equipment systems through prefabricated modular delivery)		
Determine the precise specifications of the equipment room where the IT devices are installed		
Module design and development	Genset and medium-voltage modules Cooling module IT module Power distribution module ELV module	~6 months (rational reserves)
Major and minor electromechanical equipment systems (framework procurement and periodical goods preparation)	Module-based framework procurement for electromechanics and periodical goods preparation by suppliers	~1 year (rational reserves)
Civil work and decoration	Frame (civil work) Decoration and fire extinguishing system (Civil construction must be coordinated with the design of electromechanical modules to avoid on-site modifications.)	
T = Determining services requirements		
Minor electromechanical equipment systems	Genset and medium-voltage modules Power distribution module Cooling module ELV module IT module	~3 months (Early framework procurement for major and minor electromechanical equipment systems and periodical goods preparation. shortened goods preparation and production periods)

Figure 20 Modular Deployment Mode

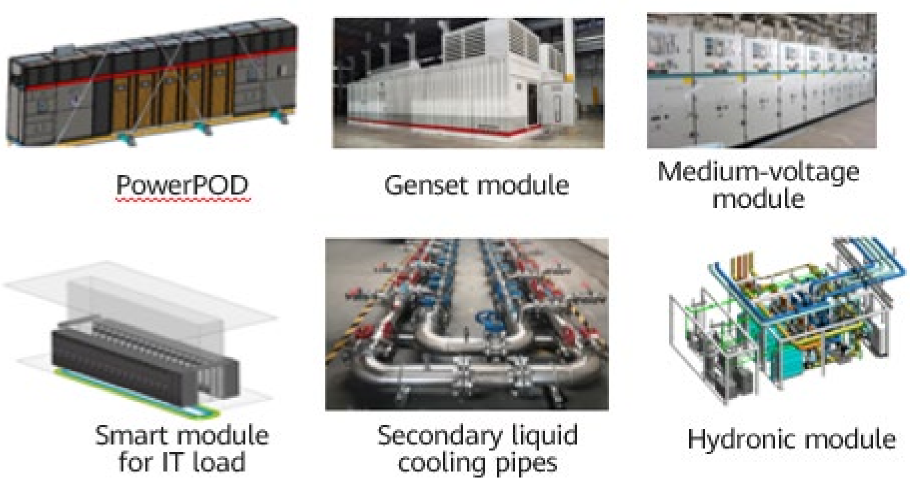

Figure 21 Product-based standard Modules

A comparative analysis of the two modes is summarized in the table below. Select an equipment room construction mode based on the specific scenario and business requirements.

Item	Mode 1	Mode 2
Construction Mode	Early construction of civil work and major electromechanical equipment systems	Early civil work, development of major and minor electromechanical modules, and framework procurement
		Productization and modularization of major and minor electromechanical equipment systems
	Construction of minor electromechanical equipment systems after services requirement determination	Delivery of major and minor electromechanical equipment systems after services requirement determination
Application Scenario	• Non-hyper-scale continuous delivery scenario • Equipment rooms flexibly designed to accommodate diverse customer requirements for electromechanical configurations, such as equipment brands and redundancy coefficients	• Hyper-scale continuous delivery scenario • Standardization of electromechanical configuration solutions
IT Equipment Compatibility	Flexibly compatible with IT equipment from multiple vendors (similar power and air-to-liquid ratio)	Specific IT equipment supported (Minor electromechanical equipment systems needs to be customized based on specific IT equipment.)
Content to Be Determined in Advance	Approximate specifications of intelligent computing equipment (power and air-to-liquid ratio)	Detailed specifications of intelligent computing equipment and equipment rooms
Preparation Period	~14 months	~1 year
DC construction Period	~3 months	~3 months

4.3 Recommendations for Existing Scenarios

Existing datacenters are primarily low-density air-cooled facilities. To meet the requirements of high-density liquid cooling racks for AIDCs, these facilities need to be reconstructed. Key challenges include air-to-liquid cooling conversions, insufficient power distribution capacity, limited floor height and load-bearing capacity. Meanwhile, considering the rapid evolution of AI chips, it is recommended to prioritize new construction for AIDC projects, and only consider upgrades when new construction is not feasible.

Due to the varying conditions of existing equipment rooms and the diversity of electromechanical solutions, it is essential to thoroughly assess the status of the equipment room. In alignment with AIDC construction requirements, select a proper site and reconstruction solution based on a comprehensive evaluation of reconstruction difficulty, period, safety, and cost-effectiveness. Considering different system requirements, the following recommendations are provided.

Liquid cooling system reconstruction:

1. Liquid cooling end devices:

   a. Reconstruction of liquid cooling AIDCs: The solution can be flexibly implemented based on the number of cabinets and the on-site conditions of the data center, such as using distributed TMUs or TMU + liquid cooling secondary piping systems. If the existing chilled water system meets the necessary conditions, it can be utilized as the primary cooling source for the EHU or TMU. The prefabricated modules also can be used to integrate the TMU and technology cooling system to support integrated prefabrication and fast delivery.

   b. Reuse or build new air cooling terminals based on on-site conditions. Select the in-row air conditioner or fan wall solution based on site requirements. A comprehensive evaluation should be conducted, taking into account the current solution, power density, space, and management requirements.

2. Cold source system:

   a. If the capacity of the existing chilled water system is sufficient, it can be reconstructed as the primary side cold source of the liquid cooling system by adding new branches. If the original system uses open cooling towers, it is recommended to add plate heat exchangers for isolation to ensure the cleanliness of the primary-side water quality.

   b. If the existing chilled water system does not meet the requirements, it is recommended to add liquid cooling sources.

      (a) The open cooling tower(based on the climate condition) + plate heat exchanger solution is preferred for the liquid cooling primary side. In water-scarce regions or areas with high anti-freezing requirements, closed cooling towers can be used. For extremely water-deficient regions, dry coolers are recommended as an alternative solution.

      (b) In existing scenarios requiring additional cooling sources, a prefabricated and integrated chiller plant can be adopted to ensure rapid delivery.

c. Auxiliary cooling can be implemented based on the original data center design, using either a chilled water system or an air-cooled refrigerant pump as the cooling source.

Power supply and distribution system reconstruction:

1. Terminal circuit reconstruction: For a small number of newly added liquid cooling racks, the power distribution circuits can be reconstructed by leveraging the existing UPSs and the end cabinet or small busway system.

3. Power system building or reconstruction: A prefabricated PowerPOD solution can be considered as it requires less power distribution space and enhances the flexibility of the power supply system. Select a solution based on project duration and available equipment room space.

4. Terminal power distribution shall be planned with comprehensive consideration of flexibility and safety requirements. Intelligent busway systems or smart end cabinet systems can be adopted.

Others:

1. Intelligent computing racks are relatively heavy, and the floor load-bearing capacity must be thoroughly evaluated. To meet the load-bearing capacity requirements of server racks, reinforcement measures or sparse rack deployment strategies can be adopted.

5. For equipment rooms with limited ceiling height, it is recommended to perform scanning and modeling for the equipment rooms. High-precision BIM modeling shall be applied to computing equipment, infrastructure, and pipelines to thoroughly assess potential risks of collisions and insufficient maintenance clearance.

6. For airflow organization and temperature field, it is recommended to conduct modeling and simulation to ensure proper airflow organization and avoid local hot spots.

7. It is recommended to evaluate the height of transportation channels, cargo lifts, and equipment room doors in advance. Generally, the height is greater than or equal to 2.5 m to meet the equipment transportation requirements.

5. Standard Specifications and Ecosystem Development Initiatives

To address the multiple challenges posed by the trends of high power, high density, liquid cooling, and clustering in AIDCs, it is imperative to establish an open and collaborative standard system and industry ecosystem to promote healthy and sustainable development. This chapter is centered around the overall vision of "Jointly building an AIDC standard system with the industry chain — Jointly building an AIDC ecosystem — Achieving sustainable industry development through shared success." It outlines the implementation roadmap and key initiatives for AIDC infrastructure in terms of standards & specifications and ecosystem development.

1. Jointly Building an AIDC Standard System

   Given the rapid power increase of AIDC equipment, inevitable trend of liquid cooling, and increasing complexity of supernode networking, it is necessary to accelerate the establishment of a standard system that aligns with national conditions and guides the industry's advancement.

   - Developing group/community technical specifications and reference designs

     Industry organizations related to AIDC are focusing on key links such as liquid cooling racks, technology cooling system, and working fluid characteristics. It is recommended that a series of technical specifications and reference designs be developed to provide clear basis for the design, compatibility, and interoperability of equipment rooms, equipment, and related infrastructure.

   - Promoting the formulation of industry standards and aligning with requirements

     Key industry users from sectors such as Internet, carriers, finance, electric power, and governments and enterprises take the lead in formulating standards. The aim is to establish baseline performance and safety benchmarks for AIDC in terms of power supply, cooling, load-bearing capacity, and networking as well as to align industry requirements with technical solutions.

   - Supporting national standard development and forward-looking layout

     Against the backdrop of rapid evolution of AI computing equipment and technology routes, it is recommended to timely incorporate key technologies such as liquid cooling systems of high-power racks, flexible power supply architectures, and supernodes into the national standard system. This aims to provide more systematic and forward-looking technical guidance and support for the development of new infrastructure.

2. Jointly Building an AIDC Ecosystem

   AIDC represents not only a technological upgrade, but also a transformation in the way the industry chain collaborates. It is essential to broadly integrate resources from government, industry, academia, research institutions, and users to build a healthy and sustainable industrial ecosystem.

   - Bringing together key players across the industry value chain

Internet enterprises, telecom carriers, third-party DCs (colocations), financial institutions, server manufacturers, and component suppliers with ambitions for hyper-scale AIDC development are joining forces to establish a full-cycle closed-loop process from requirement proposal and solution validation to hyper-scale deployment, driving industry collaboration and ecosystem co-development.

- Carrying out industry activities and promoting achievements

  Work with related industry organizations to regularly hold forums and technical seminars, release best practice white papers and ecosystem case studies, and promote successful implementation experiences to strengthen industry consensus and influence.

3. Achieving Sustainable Industry Development Through Shared Success

   The sustainable development of AIDCs rely on clear division of work and collaborative innovation among all parties of the industry chain, enabling joint efforts to address the challenges of rapid technological iteration and hyper-scale delivery and operations.

   - Promoting technological collaboration and supply chain upgrade

     To address common requirements such as liquid cooling for high-power racks, flexible decoupled architectures, and rapid deployment, efforts shall be made to advance the technological maturity and production capacity of key components like TMUs and working fluids. This will help reduce overall construction and operational costs.

   - Matching future AIDC deployment requirements

     In line with the evolving trends of AI equipment power and rack density, it is essential to jointly develop AIDC infrastructure deployment solutions that support scientific planning and phased construction. By doing so, rapid rollout of AI services and efficient operations throughout the lifecycle can be ensured.

   - Jointly creating a continuous evolution mechanism

     Establish a regular mechanism for technical exchange and industry standards updates, encouraging continuous innovation across the supply chain in areas such as liquid cooling, power delivery, monitoring, and management. This will enable the coordinated evolution of AIDC infrastructure and AI technologies.

     Standards, specifications, and ecosystem initiatives are critical enablers for transforming AIDCs from concept to hyper-scale implementation. By jointly developing standards and ecosystems, and pursuing win-win development, industry stakeholders can effectively consolidate resources, reduce construction and innovation costs, and accelerate the formation of an efficient, green, and sustainable AIDC infrastructure system.

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7. Appendix- HW TMU Technical Specifications

Specifications	Unit	FusionCol600-L450MA
Cooling capacity	kW	450(dual-pump)/ 360(single-pump)
Power supply	V/Ph/Hz	380-415/ 3 / 50/60
Number of water pumps	PCS	2 (simultaneous start/stop for dual pumps, primary/standby (active-backup), and automatic load modulation)
Water flow on the secondary side	L/min	650(dual-pump)/ /520(single-pump)
Available lift on the secondary side	kPa	250(dual-pump)/ /180(single-pump)
Primary side inlet and outlet liquid rated temperature	°C	37/45
Secondary side supply and return liquid rated temperature	°C	40/50
Primary side inlet and outlet liquid pipeline interface	in	3，Quick-connect chuck interface (Chuck outer diameter: 91 mm；Welded pipe outer diameter : 76 mm)
Secondary side supply and return liquid pipeline interface	in	3，Quick-connect chuck interface (Chuck outer diameter: 91 mm；Welded pipe outer diameter : 76 mm)
Primary side working medium	-	Chilled water / Ethylene glycol aqueous solution / Propylene glycol aqueous solution
Secondary side working medium	-	Deionized water / Ethylene glycol aqueous solution / Propylene glycol aqueous solution
Precision of the filter on the primary side	mesh	50
Precision of the filter on the secondary side	mesh	270
Pipe routing mode	-	Bottom piping
W x D x H	mm	600×1200×2250 (with casters) / 600×1200×2200 (without casters)
Net weight	kg	≤700
Communication interface	-	RS485、FE and USB with security protection mechanism
Communication protocol	-	Modbus-RTU、Modbus-TCP、SNMP

8. Acronyms and Abbreviations

A

AIDC	AI Data Center—facility for high-density AI compute.

B

BIM	Building Information Modeling—Digital model of a facility's design and operation.
BMS	Central system to monitor and control facilities.

C

CDU	Coolant Distribution Unit—feeds liquid cooling to racks.

D

DP	Data Parallelism—replicate model and split data.
DN	Nominal pipe size (e.g., DN100 = 100 mm).
DCIM	Software to monitor and manage data-center resources.

E

EP	Expert Parallelism—place experts on separate devices.

F

FCS	Facility cooling Side

M

MoE	Mixture of Experts—multiple experts with routing

P

PP	Pipeline Parallelism—split model layers into stages
PUE	Total facility power / IT power (lower is better).
P&ID	Schematic of process flow and instrumentation.
POD	Point of Delivery—modular unit with built-in power and cooling.

S

SP	Sequence Parallelism—split sequences across devices

T

TTA	Time from project start to operational readiness.
TCS	Technology Cooling Side
TP	Tensor Parallelism—split tensor ops across devices.
TMU	Thermal Management Unit—same as TMU,feeds liquid cooling to racks.

U

UPS	Uninterruptible Power Supply—backup power for outages.

W

WUE	Metric of water-use effectiveness in data centers.