High-Performance Liquid Cooled Server

Real-Time Digital Twinning and AI Modelling



Captec delivered a customised high-performance direct liquid cooled server for a UK Digital Twin R&D Centre. The optimised 4U system integrates top-tier CPUs and GPUs, and is engineered for maximum reliability and efficiency. This advanced system supports AI-driven digital twinning simulations, AI modelling, real-time analytics, and scalable HPC workloads.

The client is a government-backed research consortium advancing next-generation Digital Twin technologies across sectors including maritime, aerospace, defence, and healthcare. Their expertise lies in modelling complex real-world systems through the integration of AI and high-fidelity data, enabling more informed decision-making, improved performance, and accelerated innovation.



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The Challenge

To enable a UK-led R&D programme in Digital Twin technologies spanning sectors such as defence, maritime, aerospace, and healthcare, the customer required a highly specialised computing platform. This system needed to be capable of real-time modelling and analytics, demanding exceptional performance and reliability to support the requirements of the complex AI workloads and simulations being delivered. Due to the performance requirements, the solution needed to deliver superior thermal management while fitting within a 4U rackmount chassis, a compact design for the level of performance required. Energy efficiency and low acoustic emissions were also critical, particularly for prolonged usage in sensitive environments.

In addition to performance and thermal constraints, the platform would need to be maintainable and durable under challenging operational conditions. Rapid deployment was another essential factor, with a firm delivery window of six months. The customer was unable to find any standard commercial system able to meet these stringent demands, lacking the necessary customisation, thermal capabilities, scalability, and adaptability required for high-performance Digital Twin operations.





The Solution

Drawing on deep expertise in hybrid cooling systems and HPC design and engineering, Captec configured a custom solution ideally aligned to these advanced requirements. Each server node was equipped with dual AMD EPYC™ processors and dual NVIDIA L40S GPUs, delivering top-tier performance specifically optimised for AI and Digital Twin applications. The thermal demands of such a configuration were addressed through the integration of Direct Liquid Cooling (DLC), supported by a rack-mounted chiller unit. This setup enabled sustained high-power operation of up to 2.2kW per node without thermal throttling, ensuring peak processing performance.

Crucially, the solution also enabled the system to support sustained periods of turbo or boosted operation. By maintaining consistent and optimal operating temperatures, the CPUs and GPUs were able to perform at optimal frequencies, unlocking their full performance potential and accommodating a wide variety of high-complexity computational scenarios.

The ability to avoid throttling not only extended component longevity, but also ensured that maximum processing capacity was continuously available, even under prolonged, intensive workloads; providing flexibility for future workload scalability and demanding use cases.

A comprehensive cost-benefit analysis, including mean time between failure (MTBF) comparisons, demonstrated that DLC would provide significant long-term return on investment. Benefits included a substantial reduction in heat-induced component degradation, lower overall power consumption, and decreased system downtime.

Acoustic performance was also significantly enhanced, with operating noise levels reduced from approximately 75dB with traditional fan-based options to safe and comfortable thresholds due to minimal reliance on traditional fan-based cooling.

The system architecture was designed to adhere to industry-standard form factors, simplifying serviceability and future upgrades. Its modular design supports evolving computational needs, ensuring adaptability to future AI and simulation demands. All components were seamlessly harmonised into a single integrated system, maximising reliability, operational lifespan, and compliance with stringent environmental and defence-grade standards.

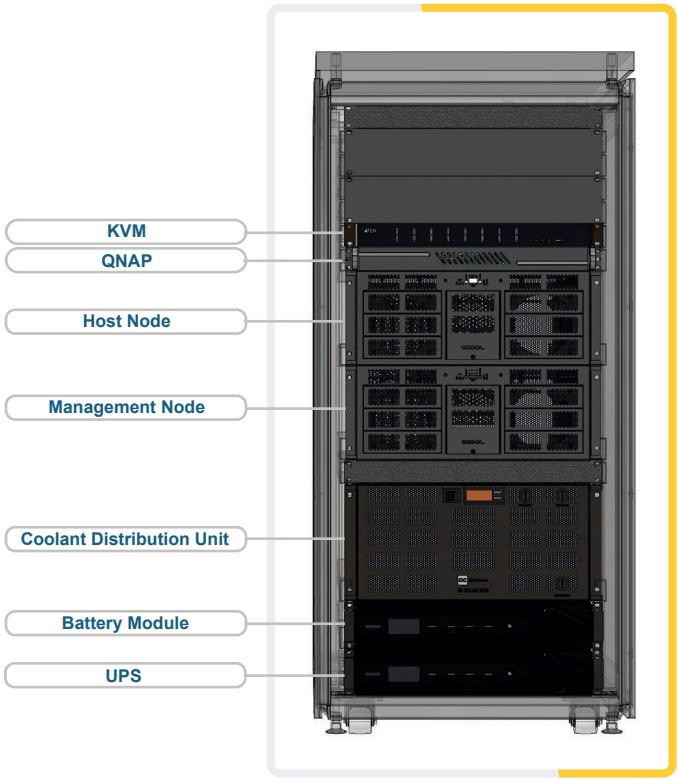
Why Captec?

The customer engaged Captec due to its proven track record in delivering complex, highly specialised computing platforms and integrated systems, particularly for simulation and military training applications. Captec's engineering and compliance teams collaborated closely with the customer to translate their broad and technically challenging requirements into a practical, high-performance design. This partnership enabled the delivery of a fully integrated, end-to-end solution that balanced technical excellence with flexibility.

Captec's design approach was focused on optimising rack-space efficiency and application-specific functionality. Captec's UK-based technical support and production facilities made it straightforward to collaborate and align with the customer's need for a fast-track programme. Ultimately, Captec's agility, engineering knowledge, proficiency, and capacity to innovate beyond conventional limitations proved pivotal in successfully delivering the project.

The Host Node Configuration Included

- Dual AMD EPYC 9575F, 64 Cores, 128 Threads, 3.3GHz. 5.0GHz Boost
- 2048GB DDR5, 6400Mhz (16x 128GB)
- 4x Removable 2.5" 1.92TB U.2 Drives
- 2x NVIDIA L40S CPU Computung Processor Cards
- Dual 100 GB QSFP28 Fibre Card
- 2200w Fully Modular PSU
- Uprated Chassis Cooling
- Caibinet Managment, NAS, Thermal Managment Switch, UPS



The Outcome

Captec delivered a high-performance, direct liquid cooled server that aligns with the customer's long-term Digital Twin R&D strategy. The system significantly enhances processing capabilities, enabling real-time Digital Twin modelling with greater speed and precision. It offers a quieter, energy-efficient, and more reliable performance profile, translating into reduced maintenance requirements and a lower total cost of ownership over its lifecycle.

The system now forms a foundational component within the UK's advancement of virtual modelling technologies, reinforcing its leadership in the global Digital Twin ecosystem. The platforms modular design also provides the customer with an ideal foundation for further scalability and integration into broader infrastructure as the research programme evolves.





CAPTEC

Delivering end-to-end, like no one else.
Bring us your challenge & experience the difference.

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