

Redefining the Data Center: How IO Used the Open Compute Platform to Create a Unique Cloud Solution

Background

When IO set out to design its Enterprise Cloud solution, there were four principles upon which we would not compromise. The product would be:

1. **Open**
2. **Scalable**
3. **Essentially engineered and dense**
4. **Based on a strong hardware solutions provider partnership**

Open

As a company that lives in the intersection between hardware and software, and as a global leader in software-defined data centers, IO was not willing to compromise in the hardware design of our converged infrastructure product. We knew we had to find the right platform that would enable us to develop and evolve the hardware components over time, and not one that would render us dependent upon a vanity-rich commercial hardware supplier.

Another facet of open that was remarkably important to us was to insure our ability to participate in a vibrant community of engineers, sharing a common vision of the future of IT capacity.

Scalable

As a company that services some of the world's most demanding businesses, it was crucial for us to rely upon hardware and software components that were capable of delivering the uptime and performance expected by our customers. It was equally important that uptime and availability claims were verifiable, and backed by a production track record. ▶

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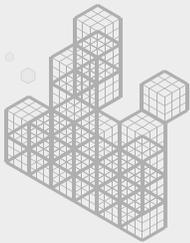
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Essentially Engineered and Uniquely Dense

The converged infrastructure market has evolved rapidly over the last five years, and it is expected to change drastically in the near future, with a renewed focus upon delivering value, not frills. In line with the IO engineering philosophy of designing purposeful and essentially-engineered products, we knew we had to look outside of conventional IT capacity suppliers to achieve our targets for both density (to meet our customers drive for value), and purpose (in order to meet our target for operational efficiency).

A Strong Hardware Solutions Provider Partnership

From early on, we knew that one of the most important factors in the overall success of this project would involve finding a uniquely capable hardware partner that recognized our exceptional goals, that had the right scale to support us as we ramped up production, and most significantly, would be capable of providing deep technical expertise.

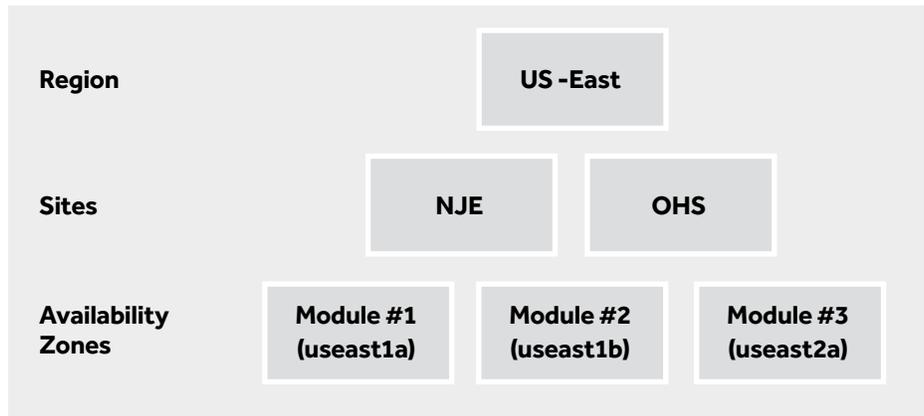
As we will elaborate below, the Open Compute platform perfectly matched our hardware needs, and AMAX was the perfect partner.

Solution Overview:

IO's Enterprise Cloud solution, IO.Cloud™, is specifically engineered to address the demands of large, sophisticated consumers of data center capacity. IO.Cloud is built on a secure and open foundation that delivers the intelligence Enterprises require.

High-Level Module Architecture:

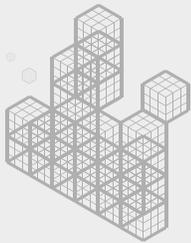
IO manufactures modular data center infrastructure, IO.Anywhere®, which is capable of providing a wide range of IT capacity. For this product, we chose to aggregate "blocks" of Open Compute capacity in "zones" built upon our IO.Anywhere CORE product line. The goal was to leverage the built-in resilience and redundancy of our modules in order to achieve reasonable failure domains (availability zones); whereas in a conventional data center this would require a significant facility investment. We grouped capacity hierarchically, into Availability Zones, Sites, and Regions, as shown below. ▶



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Rack Configuration:

The overall OCP rack configuration required IO and AMAX to spend a sizable amount of engineering time. Because we were building a product to be consumed in a low-friction and self-service way, we had to solve how to assemble fairly specialized hardware in a general-purpose way, while still retaining all the benefits brought by Open Compute hardware.

Ultimately, we opted for a balanced hardware mix of Compute (Winterfell v3 processors) and storage (Open Vault v0.5 (Knox) drives), using dual "innovation zones".

Open Compute Open Rack provided us great flexibility. For each rack we allocated:

- General purpose compute nodes - 26
- Storage nodes - 4
(Each Winterfell is attached to 2 Knox using a quad port HBA)
- Total Knox - 8 (240 total drives @4TB each)

We pooled all storage into a few "storage nodes" per rack. These provide storage to all the general-purpose compute nodes. This setup not only allowed better overall storage utilization, but also allowed us to keep the number of specialized nodes at a reasonable level (four per rack).

Total density at the above specs:

	STORAGE	MEMORY	CORES
Per Open Rack	960TB	3.75TB	480 (960 threads)
Per 18 rack Module	16.875PB	67.5TB	8,640 (17,280 threads)

Networking Configuration:

IO engineers opted to deploy a two-tier spine/leaf network architecture, with a 10GB, 48-port "middle of the rack" data switch inside the open rack, along with a 1GB, 48-port switch for "lights out" management using DCMI. All racks in a module are aggregated to our carrier spine and backbone, and compute nodes are connected to both DCMI and data switches via 10Gb and 1Gb network interfaces. We are also working closely with the Open Compute Project networking group and AMAX to assess the feasibility of utilizing their Open Switch specification in our next product revision.

The full performance potential of this hardware could not be achieved without equally impressive software. IO relied on its data center operating system, IO.OS®, coupled with our specialized version of OpenStack (another project in which we are involved) to productize and deliver the full IT capacity of the OCP hardware.

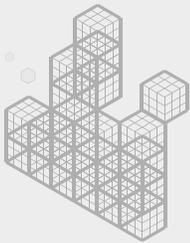
IO also developed its own storage subsystem, and methodically tuned our hardware (Knox and Winterfell) to operate very close to its theoretical limits, while still providing multi-layer data redundancy. ▶

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Summary:

Today, IO.Cloud is an enterprise-ready converged infrastructure product built on Open Compute hardware, and is capable of providing Infrastructure as a Service (IaaS) to our customers. And this is just the beginning. We look forward to working with the community to continue to evolve the specifications, and to drive deeper and smarter integration between the hardware components and the data center.

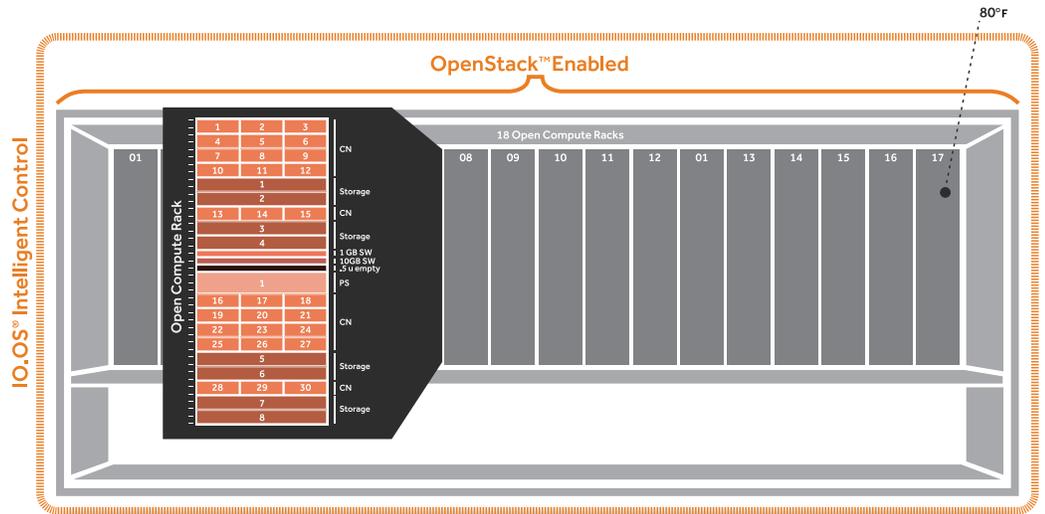
Achieving all of our goals for this new product: open, scalable, elegantly built and uniquely dense, would not have been possible without the deep engineering knowledge, manufacturing capability, and tenacity that AMAX brought to this project, along with countless hours of hard work provided by Open Compute community members and Facebook.

If you are interested in finding out more about our product and to learn more about our use of Open Compute hardware, please visit: io.com

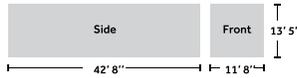
Appendix:

IO.Cloud™ Reference Architecture

IO.Anywhere®
D400 Modular Data Center



D400 Module Dimensions



Factory tested, UL-Listed, software-defined securely and efficiently deploy at any scale, on any premises, anywhere in the world.

Open Compute + OpenStack™ + IO.A®+IO.OS® = IO.Cloud™

Compute:	8,640 cores/ 17,280 threads
Storage:	16.875 Petabytes
Memory:	67.5 Terabytes
VM's:	34,560@4VM's per core

Key

IO.OS	IO Operating System
CN	WinterFell Compute Node
Storage Node	Knox
PS	Power Supply
1GB SW	48-port switch
10GB SW	48-port switch

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As a member of the OCP Foundation and Platinum sponsor of the OCP Summit, IO supports the OCP vision and principles and intends to make contributions to the community. However, this paper is not, and should not be construed to be, a Contribution by IO to the OCP Foundation.