Open Compute Solutions Guide

Delivering density, performance and serviceability for demanding and extraordinary customers

www.penguincomputing.com | 1-888-PENGUIN (736-4846) | twitter: @Penguin HPC

Tundra Rack and Power Infrastructure

- Open Compute Open Bridge Rack contribution from Fidelity
- Convertible from 19in EIA to 21in OCP and back as needed
- Optimized serviceability with cold aisle maintenance
- Up to 36 KW (N+1) power by Emerson
- Available in 40 OU/42 RU and 44 OU/48 RU heights
- Front and rear doors

Cost reduction in delivering power to the racks

- Power shelves fed with 120/208V, 230/400V or 277/480V circuits
- High voltages mean lower current, smaller wires, fewer breakers

Distributing power to all equipment in the rack at 12V

- Voltage conversion steps eliminated, improving power efficiency
- Servers, network and storage equipment can be powered from 12V

Power infrastructure can be re-used

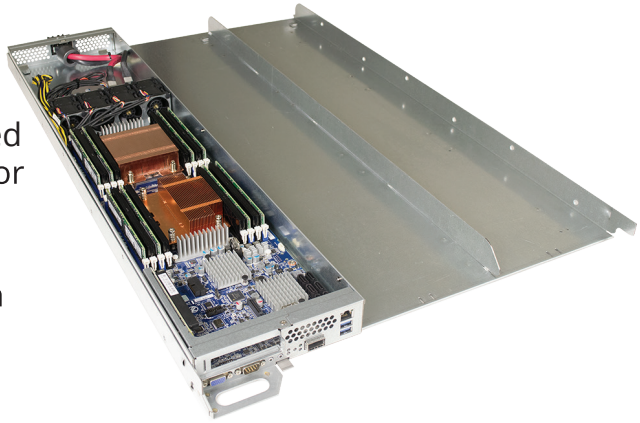
- Dramatic ROI improvements over multiple generations of hardware

All nodes in the rack benefit from shared power redundancy features

- Phase currents balanced by design of load sharing modules
- Optional A/B redundant feeds, and/or N+1 redundant power supplies

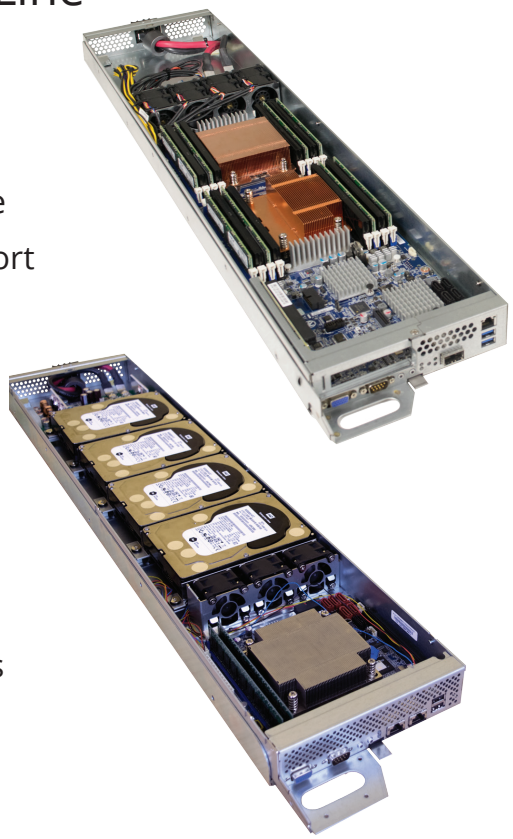
Tundra Server Shelf

Forward looking shelf design to fit next generation half-width boards, up to 173mm wide.



- Tundra OpenHPC™ Compute Server Shelf supports mixed Tundra sled configurations: compute/storage/accelerator
- Tundra OpenHPC™ Shelf is 1 OU height (Open U)
- Designed in accordance to OCP Open Rack Specification
- Compatible with third party motherboards

Current and Future Tundra Product Line



Tundra Compute:

- Dual Intel E5-2600 v3 Processors
- Up to 512GB DDR4-2133MHz (16x DIMMs) per node
- NVDIMM options based on Grantley platform support
- 1x Fixed 2.5” HDD

Tundra Storage:

- Single Intel E5-2600 v3 Processor
- Up to 64GB DDR3-1600MHz (2x DIMMs) per node
- Up to 4x 3.5” or 4x 2.5” HDDs

Other nodes feature support for:

- Knights Landing: Bootable Xeon Phi compute nodes
- Atom/ARM based sled
- ARM 64-bit CPUs based sled

TUNDRA SERVER SHELF AND NODE HIGHLIGHTS

Total Cost of Ownership

Leverage the TCO savings Facebook reported

- Cost reduction in delivering power to the racks
- High voltages mean lower current, smaller wires, fewer breakers
- Cost reduction in delivering power to the racks
- Distributing power to all equipment in the rack 12V
  - Voltage conversion steps eliminated, improving power efficiency
- Power infrastructure can be re-used
  - Dramatic ROI improvements over multiple generations of hardware
- Fewer power supplies mean fewer failures

Reduced infrastructure cost during technology generation transition

Facebook Statement

"Facebook's first generation Open Compute 1.0 hardware had world-classTCO and ROI. As we looked to improve on that with Open Rack, we foundthat it wasn't giving us the reductions in TCO and improvements in ROIthat we were looking for.... Until we factored in the savings overtwo generations of hardware in the same Open Rack. Then the TCO andROI became obvious and undeniable."

—Frank Frankovsky, Facebook

	Standard 1U Rackmount/yr	Tundra OCP Solution/yr	Savings / yr	Saving w/ 2x Server Refresh in 4yrs
	13920 nodes / 348 Racks	14256 nodes / 132 Racks		
Opex	$775,000	$130,000	$645,000	$2,580,000
Capex	$33,060,000	$31,810,000	$1,250,000	$3,360,000
Totals	**$33,835,000**	**$31,940,000**	**$1,895,000**	**$5,940,000**

Network and Interconnect

Network shelves support standard 19in EIA 1U switches

- 1G Ethernet, 10G Ethernet, 40G Ethernet Arctica switches
- Infiniband QDR, FDR and future

Allow for in-rack cabling of nodes to Leaf and TOR using short copper cables

- In rack leaf switches are preferred
- Active Optical Cable (AOC) preferred for leaf to spine links

Arctica Ethernet switches from Penguin Computing

- Open source Cumulus Linux software option
- Can be managed like any other node using standard provisioning tools
- High speed uplinks to avoid bottlenecks and oversubscription

ARCTICA NETWORKING

Cooling Options

Tundra designed to use air/liquid cooling

Optional rear chilled water radiator can support local cooling

- Access to hot aisle side of rack not required for service
- Simplified mounting of radiator
- Can be coupled with:
  - Free Cooling Chiller Systems
  - Chilled Water Systems
  - Ground Source Water Systems
  - River or other natural water sources

- CoolIT/Asetek direct-to-chip central pump/distributed cooling

CoolIT SYSTEMS™

ASETEK DATA CENTER LIQUID COOLING

motivair™ Engineered cooling solutions for all applications.™

NETWORKING/INTERCONNECT AND COOLING FEATURES

For any questions regarding these systems and their configurations, please contact Penguin Computing.

email: sales@penguincomputing.com
phone: 1-888-PENGUIN (477-2206)
www.penguincomputing.com