



**Sustainably Supporting Science**  
through committed community action

# Emerging Realities and New Protocols for Power Distribution: High Voltage and DC

Panel Session  
November 17, 2016



# Panel Members

- Anna Maria Bailey, Lawrence Livermore National Laboratory
- Keichi Hirose, NTT Facilities
- Gary New, National Center for Atmospheric Research
- Michael Patterson, Intel
- Dan Stanzione, Texas Advanced Computing Center



# Is there room for DC Distribution in the HPC Data Center?

- Power requirements for HPC systems can draw 40 to 100KW per rack.
- More and more HPC racks are being supplied with 480V up from 208V allowing manageable wire sizes and improved efficiency.
- Is it time to explore DC distribution in lieu of AC in the HPC data center just as we migrate to liquid cooling solutions away from air cooling for many applications?



TEXAS ADVANCED COMPUTING CENTER

WWW.TACC.UTEXAS.EDU



# Emerging Realities and New Protocols for Power Distribution: High Voltage and DC TACC Case Study

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PRESENTED BY:

Dan Stanzione

# History of Systems (and Power) at TACC *(Probably similar to your experiences...)*

2004 – Lonestar, 512 nodes, 6.3Tflops, 400kW

2006 – Lonestar 2, 650 nodes, 8.3Tflops, 500kW

2007 – Lonestar 3, 1462 nodes, 62 Tflops, 850kW

2008 – Ranger, 3936 nodes, 579 Tflops, 2.3MW

2011 – Lonestar 4, 1888 nodes, 302 Tflops, 1MW

2013 – Stampede, 6400 nodes, 9.7 Pflops, 4.5MW

More than 1000x improvement in performance for only 10x more power

*BUT IT IS STILL 10 TIMES MORE POWER!*

*This can't continue indefinitely!*

# The Power Landscape

As everyone here likely knows:

Large scale datacenters are 1-3% of all US fixed power

“The Cloud” datacenters will soon draw more power than all of Japan

A typical datacenter power scenario:

Draw power from the AC power grid.

Pass through a UPS (with DC batteries)

Distribute from an AC PDU to the rack

Run electronics on DC

# The Landscape May Change

Lots and lots of loads on the power grid are DC

- All electronics

- The batteries in all those electronics

- Your new Tesla

- Home battery systems?

- UPS and storage nodes

Some of the sources on the power grid are DC:

- Renewables, particularly solar

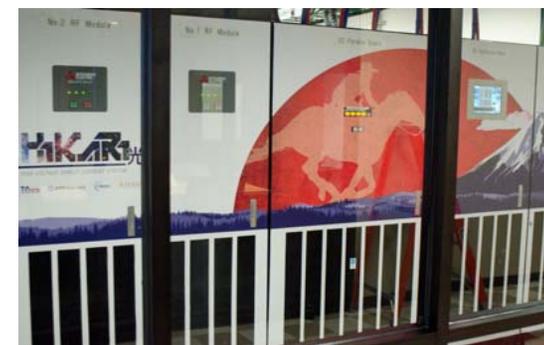
Maybe it's time to think about DC end to end

(and standards are emerging to make this happen)

# The Hikari Project



- A new 10,000 processor supercomputer that runs on High Voltage DC power
- A solar farm to provide a renewable DC input
- An entire power grid, in miniature, replicated in our datacenter to demonstrate an all DC infrastructure
  - Removing AC-DC conversions will boost our overall efficiency

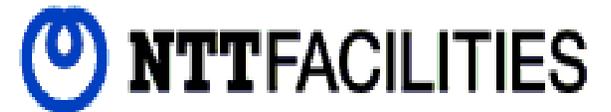


# Hikari Status

- HVDC Operations started in August
- ~25% of power for the cluster has come from solar since then.
- Actual DC conversion comparison data coming in March



**Hewlett Packard**  
Enterprise



# A Greener Datacenter Future



- HVDC will give us a higher efficiency datacenter.
- Our renewable energy source reduces our power further.
- Our Apollo 8000 servers from HP-Enterprise have water cooling and a variety of other efficiency features.
- Through the Hikari project, we hope to take a step towards responsible stewardship of our own datacenter assets – and maybe show a greener path!



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# DC Distribution in the HPC Data Center Pros

- Eliminates double conversion in data center UPS design
- Eliminates additional electrical distribution equipment
- Increases available space - a commodity in data centers
- Generally improves the reliability of systems
- Reduces both capital and operating expenses
- Reduces cable losses



# DC Distribution in the HPC Data Center Cons

- Limited availability of suppliers of DC electrical equipment compared to AC
- Limited product features and designs available in electrical distribution for circuit protection, metering, monitoring, etc.
- Safety, with some opponents suggests that high-voltage DC poses a greater risk to data center personnel compared with high-voltage AC
- NFPA 70E is silent with regards to arc-flash requirements for DC where AC requirements are widely studied and published
- Size and weight of cabling for DC relative to AC may also be a concern
- Solid operations reputation is what really hampers DC