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Memorandum

To: DC Demonstration Participants
From: My Ton, Ecos Consulting; Brian Fortenbery, EPRI Solutions
Re: Notes from Monday 3 April 06 "Kick-Off" Meeting at Sun Microsystems
Cc: Bill Tschudi
Date: Friday, April 5, 2006

This meeting was intended to finalize the equipment list and scheduling for the DC Powering Architecture for Data Centers Demonstration to be held at the Sun Microsystems facility in Newark, CA. A list of the attendees is attached.

A. TECHNICAL DISCUSSION POINTS

Demonstration Configurations: There was general agreement that both rack-level and facility-level demonstrations can be accomplished, and are needed for completeness and credibility. Both can take place at the current Sun location if needed equipment can be found. For an "apples to apples" comparison, three different configurations are needed (one is needed as reference):

1. Configuration 1: Current data center typical set-up delivering 208/120V AC input to AC-powered servers.
2. Configuration 2: DC conversion/distribution at the rack level (Rack-Level Demo), using a rectifier unit to convert 208/120V AC at the rack, and delivering high-voltage DC to DC-powered servers.
3. Configuration 3: DC conversion/distribution at the building/data center level (Facility-Level Demo), converting 408V AC to high-voltage DC and delivering this directly to the DC-powered server units in the rack.

Equipment Set: Configurations 1 and 2 require additional equipment (UPS back up, PDU for power delivery) to accurately reflect the conditions at a typical data center, all three may also require additional loads to simulate operating conditions. The agreed upon equipment set for the three configurations are as follows:

1. Configuration 1: The AC data center set up will comprise of a 75 kVA UPS, a 75 kVA PDU, and a load bank, in addition to the rack of AC servers.
2. Configuration 2: The rack-level set up will utilize the AC output of the UPS from Configuration 1, convert this to high-voltage DC with a TBD rectifier, and deliver it to a rack of DC servers and load bank.
3. Configuration 3:The facility-level set up will have a flywheel UPS, a 75 kW rectifier, a load bank, and a rack of DC servers and load bank.

The AC servers will be matched to equivalent DC models and the same applications will run on both sets. Configurations 1 and 2 will share an AC buss way, while Configuration 3 will have its own DC buss way. The test DC voltage will be set at 380 ± 5%, with 3% peak to peak for the ripple, which includes high frequency and line frequency ripple components.

The distribution method of high-voltage DC into the rack has not yet been finalized. A safe method will need to be determined as 400 Volts DC is not typical. An interim solution is proposed, but a standardized, agreed upon connector will need to be identified for commercial use.

Not all needed equipment are available, and follow up by some participants is needed to complete the equipment set by 1 May 2006. Follow up items are highlighted in the matrix enclosed at the end of this document.

Testing and Measurements: The group agreed on test points and metrics, with emphasis on measuring the efficiency of the configurations – there will be no comparison of server equipment performance.

- For Configurations 1 and 2, the efficiency test points will be the measured watts at the load and the measured watts at either the UPS input or the step down transformer input.
- The efficiency test points for the DC facility-level system will be the measured watts at the load and the measured watts at the input to the rectifier.
- The test duration shall be made over several hours to assure steady state conditions.

Standardizing DC input voltage: Due to the lack of any other points of view, the group again settled on 380 VDC for the high voltage DC input, as HP and IBM were not available to present alternatives (Intel noted that IBM currently uses 380 VDC in their high-end servers). However, the group agreed that this demonstration is about measurements rather than standard-setting, and any level below 600VDC can be accommodated. Other related points on DC input voltage that were brought up by participants:

- Input DC voltage should be maintained between 300 volts and 400 volts for use with batteries and +/- 5% for use with flywheels.
- Input DC ripple voltage should be +/- 1.5%.
- When using batteries, additional DC to DC conversion may be required.

DC Power Supply Efficiencies: Manufacturers noted that gains in the efficiencies of DC power supplies will probably be in the order of 1% to 3%. The server manufacturers already make efficient DC power supplies at around 90%, but end users can buy the less efficient (80%) and less expensive power supplies (~10% less in cost). Thus for DC servers, the increase in on-board power supply efficiencies will come from the elimination of the computer on board power factor correction circuits and rectifiers. (Most of the efficiency gains is expected to come from the elimination of the many AC to DC stages of the rack- or facility-level conversion).

Safety: The issue of high-voltage DC safety was brought up again. The group agreed that for the time being, this is adequately addressed by the buss way set up, and all safety precautions will be taken. For the future, we will research DC safety standards in use for other applications, including standards in use for the EU.

Other Related Technical Issues: The group also brought up various other issues, some of which were deferred, or will be discussed as part of the project report follow up discussions, as they are not directly or immediately connected to the demonstration tasks. They included:

- Construction Costs
- Reliability
- Equipment costs
- Grounding
- Environment
- Final Project Report

B. PROJECT COORDINATION, TIMING AND OUTREACH DISCUSSION POINTS

Coordination: Participants requested that a regular conference call be set up to enable communications among the team, especially critical in the next few weeks. All agreed that a conference call every 2 weeks is needed, the consensus is every other Tuesday at 10 AM Pacific/1 PM Eastern, starting on 4/18/06. My Ton will set up the call and provide the agenda to all participants prior to the calls.

Timing: All participants agreed that the month of April should be used for equipment configuration, definition, acquisition testing, and shipping, with the target date for to finalize all equipment and transportation to Sun's Newark, CA site is 1 May 2006. On-site equipment assembly and verification will take place in the first 2 weeks of May (1 May to 12 May), and testing/measurements will take place on the 3rd week (15 May to 19 May).

No decision has been made on how long the demonstration configurations will be maintained after the data has been gathered. The CEC project contract officially closes on 31 August 2006, but participants can agree on an end date before or after this date.

Outreach: Bill Tschudi has requested that information on the demonstration project provided to the press and public be consistent, especially on projected savings, as no data is yet available. Ecos Consulting has prepared two project "one-pagers" for the group to review and use to discuss the projects to ensure consistency. Draft versions are being circulated for review with this memo.

LBNL will investigate news releases and other public outreach/technology transfer venues to generate on-going interest and support. Other public venues include:

- Sun has suggested that an "Open House" be held on 24 May 2006, with regular occurrences after that (weekly, bi-weekly, or monthly).
- Data and information about the Demonstration will also be made available on-line as part of the CEC's public education and outreach efforts. This will include real-time monitoring via web tools.

Suggestions and contacts for additional publicity should be forwarded to My Ton, Brian Fortenbery, or Bill Tschudi.

C. MISCELLANEOUS NOTES FROM 4 APRIL 06

A smaller group of participants met on the morning of 4 April 06 to discuss additional details and integration needs prior to equipment unpacking and assembly in the afternoon. Some of the discussions details were captured above. Other discussion/meeting points of note include:

- There is general agreement of the need to track international standards and practice, as well as any applicable national codes and standards on high-voltage DC. David Geary of Baldwin currently has the repository of HVDC materials. Once we have decided on a portal/dashboard venue for information exchange, My Ton and Brian Fortenbery will work to determine the materials that can be posted for general use.
- A number of participants have been invited to present at the EPRI DC Power Production, Delivery, and Use Conference, June 1-2, 2006 in Washington, DC. We used this time to coordinate the presentation agendas.

- My Ton, Brian Fortenbery and Kevin Fellhoelter meet with representatives of NTT Facilities (a division of NTT Docomo in Japan). NTT currently has DC facilities operating in Japan, and has significant data on Japanese data center composition and consumption. The NTT representatives that we met with were very interested in the demonstration, and is willing to participate as well as locating some needed equipment for the demonstration. Brian Fortenbery and My Ton will follow up to secure the equipment loan.

D. NEXT STEPS

The immediate next steps include:

- Distribution of contacts information, meeting notes, and relevant documents by the project coordination team by 10 April.
- Scheduling of follow up conference calls – the next one will be on 18 April 06 at 10 AM Pacific/1 PM Eastern. My Ton to provide call information, schedule and agenda by 13 April.
- NexTek and Baldwin Tech will work together to define connection points for their units to the buss bar, as well as to define monitoring points for Dranetz-BMI.
- BTI and D-BMI to provide Sun with information needed to set up on-line monitoring.
- General follow up on equipment availability, including Intel server delivery dates, and rack-level DC rectifier.
- Confirm 24 May 06 as the first “Open House” date and begin publicity efforts.

DC Architecture Demonstration Study

Status as of 4/3/06

Category	Item/Component	Facility Level DC (Config. 3) Supplier	Facility Level AC (Config. 1) Supplier	Rack Level DC (Config. 2) Supplier	Notes/Availability
Data Center					
	Equipment Hosting Location	Sun's Newark, CA Location			Now - 3 to 6 month facility loan
	On-Line/Remote Link	Dranetz-BMI equipment, LBNL weblink			LBNL to investigate
Equipment					
	UPS	Pentadyne	Mitsubishi AC UPS unit from Chatsworth is available	Can use output of Mitsubishi AC UPS unit, need a step-down/PS unit	Pentadyne unit now at Satcon - 4/20 ship to Sun. Mitsu unit available for AC, need stepdown. Mark B & Kevin C Tasked with locating AC UPS and xformer
	Rectifier	SatCon	NA	Shaefer	Shaefer unit available in 5 weeks, need alternatives
	DC Busway & Support Rack	Universal Busway	Universal Busway	Universal Busway	1 in place, need one more to be shipped
	Server Units	Intel, Sun, TBD	Intel, Sun, TBD	Intel, Sun, TBD	Others (TBD) may add to current list
	Dummy loads	Need load banks	Need load banks	Load banks - Lease	2 DC loadbank needed, 1 AC load needed, Kevin C to check
	Racks	Sun (APC)	Sun (APC)	Sun (APC)	Will use standard APC rack for DC distribution - Square D to provide connectors
	Rack level PDUs	NA	TBD	TBD	in-line fuse needed for DC
	NexTek Unit	For use on the other end of the 380 VDC Buss			Available by end of April
Measurement					
	Meter & Sensors	Dranetz-BMI	Dranez-BMI	Dranetz-BMI	Dranetz-BMI to agree to new equipment requirements
	Metering Design & Installation	Baldwin Technologies	BTI	BTI	NexTek to work out details with BTI on installation needs
Installation/Tech Support					
	Engineering Support/Supervision	Baldwin Technologies, EPRI Solutions, Sun, TBD			BTI, EPRI Solutions, and Sun to provide technical assistance
	Installation Labor	Data Power Design	EPRI Solutions to investigate		Contracted labor
	Installation Supplies	Misc	Misc	Misc	CEC budget
	Startup and Operation	Sun, Intel, TBD	Sun, Intel, TBD	Sun, Intel, TBD	Sun, Intel and others TBD will be responsible for the installation & operation of their units