HVDC Innovation,
XECHNO® Power & Fresh HVDC®
Energy Saving Technology for the Data Center

Green Consulting Business Unit
Solution Business Division

NTT DATA INTELLILINK Corp.
Problems facing data centers: Energy efficiency

There are so many AC/DC and DC/AC converts in a data center. Conversion causes power loss and dissipates heat, and requires more power to cool.

<table>
<thead>
<tr>
<th>Power Grid</th>
<th>Transformer</th>
<th>UPS</th>
<th>PDU</th>
<th>ITE (e.g. Server)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
</tbody>
</table>

![Diagram](image6.png)

Energy (Power) Loss
More heat, more cooling
IT equipment are fundamentally DC powered

Most electric appliances have an internal power supply converting AC to DC. Why not directly feed them DC power?
Trend: from UPS to DC+Battery

Google
- 3φ AC480V
- 1φ AC200V
- 3φ AC480V

Microsoft
- 3φ AC480V
- 3φ AC480V/1φ AC277V

Facebook
- 3φ AC480V/1φ AC277V
- Open Compute project
- Open Rack Hardware v1.0 V1 Power shelf
- Open Compute project
- Open Rack Hardware v1.0 V2 Power shelf
Our proposition: HVDC and DC 12V ITEs

Our HVDC power system reduces AC/DC conversions between Grid and ITE. Power loss is reduced approximately by 10-20%.

<table>
<thead>
<tr>
<th>Fresh HVDC</th>
<th>XECHNO Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Grid</td>
<td>Transformer</td>
</tr>
<tr>
<td>PS Rack</td>
<td>PDU</td>
</tr>
<tr>
<td>Server Rack</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of HVDC system](image)

**Fresh HVDC**

- **AC**: Input voltage
- **DC 340V**: Intermediate DC voltage
- **DC 12V**: Output voltage
- **Central Redundant Power Supply**
- **Efficiency 90% typ.**

**XECHNO Power**

- **CPU / メモリ / HDD**
- **DC12v SERVER**

**Notes**

- **Our HVDC power system** reduces AC/DC conversions between Grid and ITE.
- Power loss is reduced approximately by 10-20%.
Traditional HVDC pain points have been removed

Key Technology: Middle Point Ground

Current is limited within safety limit for human through high resistors of 47KΩ.

Key Technology: Bus Bar

Key Technology: Arc Suppression Circuit

Resolved the arc discharge issue at the time of switch-on/off and disconnection.

Less chance of fire
Reliability: redundancy

Non-stop maintenance and expansion through N+1,2 redundancy

<table>
<thead>
<tr>
<th>Rectifier Rack</th>
<th>Server Rack 4kW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RF Unit 20kVA</strong></td>
<td><strong>ITE (DC Server)</strong></td>
</tr>
<tr>
<td><strong>RF Unit 20kVA</strong></td>
<td><strong>ITE (DC Server)</strong></td>
</tr>
<tr>
<td><strong>RF Unit 20kVA</strong></td>
<td><strong>ITE (DC Server)</strong></td>
</tr>
<tr>
<td><strong>RF Unit 20kVA</strong></td>
<td><strong>ITE (DC Server)</strong></td>
</tr>
<tr>
<td><strong>RF Unit 20kVA</strong></td>
<td><strong>ITE (DC Server)</strong></td>
</tr>
<tr>
<td><strong>RF Unit 20kVA</strong></td>
<td><strong>ITE (DC Server)</strong></td>
</tr>
<tr>
<td><strong>RF Unit 20kVA</strong></td>
<td><strong>ITE (DC Server)</strong></td>
</tr>
</tbody>
</table>

**Input**

- **Failure**
- **Backup**

**PDU**

**Central Redundant Power Supply**

- **DC12V**
- **DC/DC 2kW**
- **DC/DC 2kW**

**Backup**
Reliability: fewer failure points

Simpler architecture = less component count and failure points.

- **Failure Point**: Points of potential failure in the system.
- **AC In**: Input from the AC power source.
- **DC**: Direct Current, used for internal operations.
- **UPS**: Uninterruptible Power Supply.
- **Battery**: Energy storage device.
- **Switch**: Device used to control the flow of electrical power.
- **HVDC**: High Voltage Direct Current.
- **DC12V**: 12 Volts DC, used for server power.
- **Mother Board**: The main circuit board of a computer.
- **AC ITE (Server)**: AC Input Transformer Equipment for the server.
- **Non-Voltage Flicker, Non-Stop, Non-Interruptible Power through N+1 Redundant Operation**: Description of a reliable power system.

The diagram shows the flow of electrical power from AC to DC, through HVDC and DC12V, with failure points marked along the way. The system is designed to be simple and reliable, with natural flows like a river, ensuring non-voltage flicker, non-stop, and non-interruptible power through redundant operation.
Pass-through box

A drop-in replacement for AC/DC power supply of conventional ITEs

- Only some protection circuitry
- No fan
- No liquid capacitor
- No need for certification
- Lots of space to add value
  - Battery
  - Sensors
  - ... and more
Combining DC sources: HVDC + Solar + Battery

No need for power conditioner (no MPPT)

Locally generate & consume

Our testbed
In service, March 2013
19 racks, 160 kW
For greater ecosystem of HVDC

We support conventional equipment by “evangelizing” pass-through box.

What can we do to support Open Compute compliant equipment?
Discussion Points

AC/DC

Any plan for experimenting with “up-front” AC-DC conversion for Facebook data centers (or Colo sites adopting OC servers)? Can we collaborate?

(Any issues?)

DC/DC

Bus Bar

ITE

Input voltage fluctuation tolerance: Can we standardize on it?
  Open Compute mobo: 12.5 Vdc within 10.8 – 13.2 range
  Conventional mobo: 12.0 Vdc within 11.4 – 13.2 range (±5%)

Protection circuitry: Is there an Open Compute spec? Can we eliminate redundancy if any?
Global IT Innovator