Starline DC Solutions

380vdc Revolution or Evolution?

380Vdc Data Center Architecture Advancements

Timothy E. Martinson

Universal Electric – Director StarLine DC Solutions Division
Emerge Alliance Chair for Data Center Telecom Marketing Committee
EMerge Liaison to the EMerge Alliance - Green Grid
Society of Cable & Telecommunications Engineers 380vdc Standards Committee

Abstract

Thomas A. Edison truly started a revolution when he proposed using electricity instead of natural gas to light up a home. In the terms of politics we might define revolution as the overthrow of a ruler of political system. In industry we might consider it a dramatic change in ideas or practice. Evolution on the other hand could be considered a gradual development of something into better form. With the primary objective of data centers as being reliability and the secondary objectives are that of managing the cost , one should look at the macro trends in power, compute and reliability. The 380V dc data center power topology is one of those macro trends!

StarLine DC Solutions and the EMerge Alliance are at the center of the initiative of bringing 380V dc to data centers and commercial buildings. This presentation will identify milestone progress made and review industry trends which are providing the fuel to change from what some consider the standard for power distribution.

The relevance of positioning this movement as revolutionary or evolutionary will become apparent.

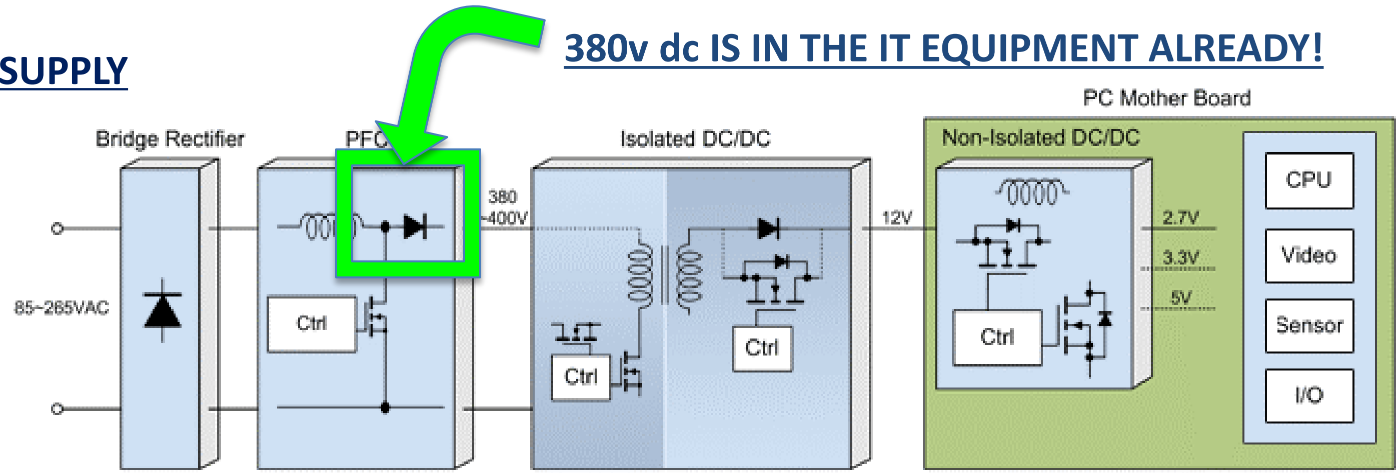
Dr. Roger Schmidt, IBM Fellow - Chief Engineer for Data Center Energy Efficiency - Systems & Technology Group @ Syracuse University

Why 380V dc?

STARLINE®

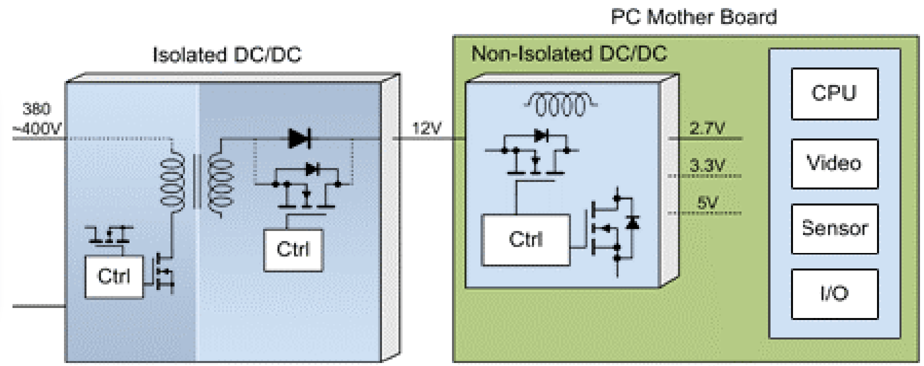
AC POWER SUPPLY

380v dc IS IN THE IT EQUIPMENT ALREADY!



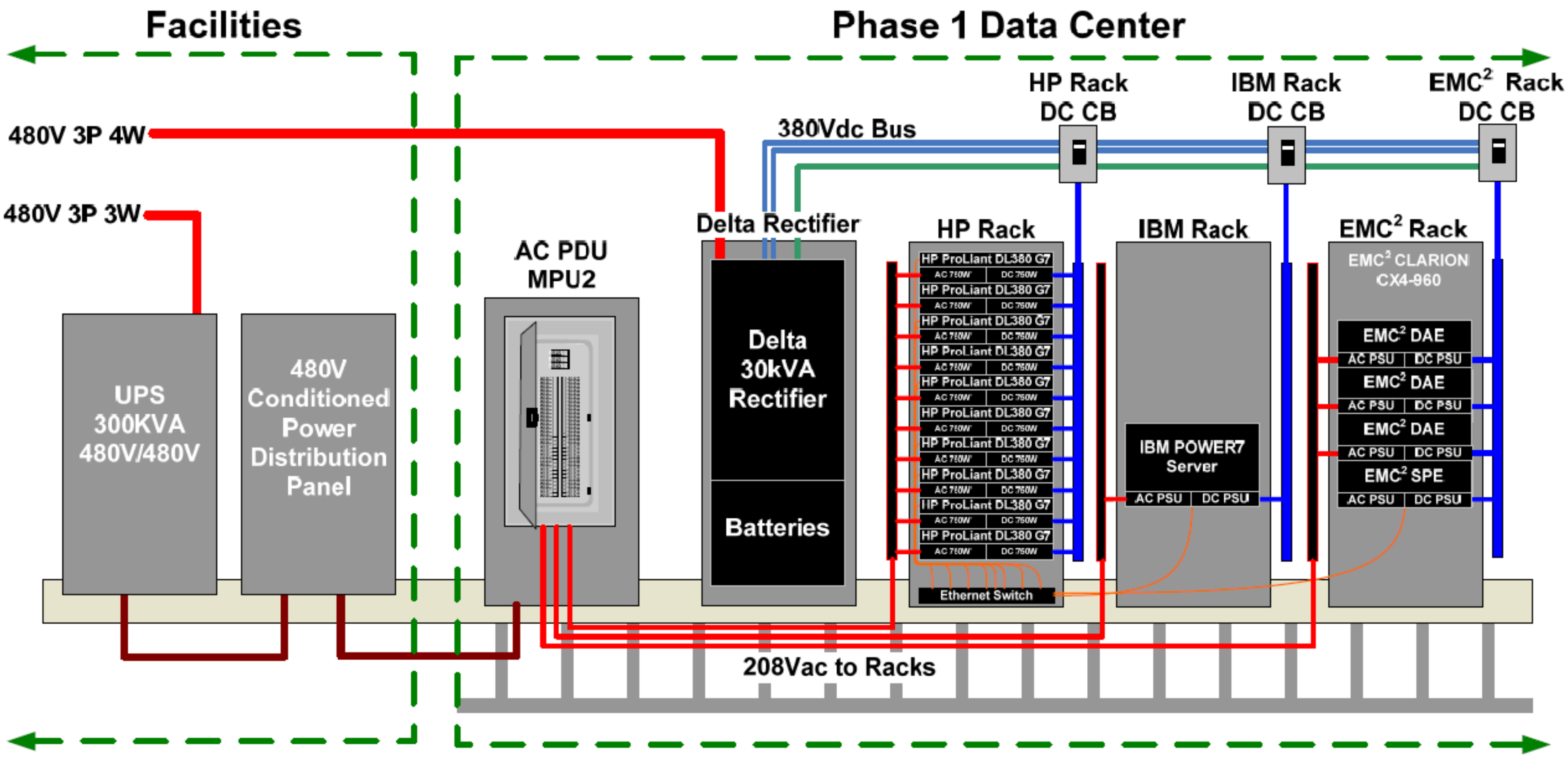
380V DC POWER SUPPLY

Few Parts = Less cost and higher reliability



Duke Energy Beta Site Configuration Yielded 15% Improvement

EPRI Lead Team included: HP, IBM, EMC, Delta, Starline – Dave Geary, PE Engineer of record



EPRI Executive Summary

STARLINE®

DUKE ENERGY / EPRI DEMONSTRATION

- **EPRI brought in experts to accurately measure the performance of both methods**
- **"EPRI Finds Direct Current Power Uses 15% Less Electricity Than Alternating Current System at Duke Energy Data Center"**
- **Best in class AC double conversion UPS**
- **Still in service today**
- **Due to changes in their business the power consumption on the UPS is less = even less efficient**

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Duke Energy - EPRI DC Powered Data Center Demonstration
Executive Summary

What: Duke Energy and EPRI Sponsored DC Powered Data Center Demonstration Using 380V DC Power
When: 2010-2011
Where: Duke Energy Data Center, Charlotte, North Carolina

Overview

Typical data center power delivery designs use alternating current (AC) power, typically distributed within the facility at 480V AC. Direct current (DC) power distribution is an alternative approach to a conventional data center AC power scheme. Duke Energy and the Electric Power Research Institute (EPRI) are working together in a demonstration project that focuses on DC conversion at the data center (or facility) level. The approach will convert the facility's 480V AC into 380V DC and deliver it to the equipment racks via a 380V DC bus. The very best AC equipment can be deployed to improve power distribution efficiency, but that approach only squeezes some of the losses out of each component. The DC approach eliminates those losses completely, through the removal of the less efficient AC components.

Through this demonstration, it is expected that the Duke Energy data center should yield anywhere from 7 to 20 percent energy savings, depending on the vintage of the equipment compared. These figures could be doubled if you take into account the added energy savings realized by the decrease in cooling load.

Preliminary Results Synopsis

Testing of a direct current power system at a Duke Energy data center in Charlotte, North Carolina has revealed preliminary results that the system uses 15 percent less energy than a typical double conversion UPS alternating current power system.

Background

Typical data center power delivery designs use alternating current (AC) power, typically distributed within the facility at 480V AC. This power goes through several conversions from AC to DC and back again. The power losses due to the use of inefficient power conversion devices from both outside and within equipment result in a large loss of useful electrical power, as well as directly increasing the energy required to remove the heat produced. While estimates and actual measurements vary, the actual power utilization by IT loads can sometimes be as low as 50 percent of the total input power consumption, or worse.

DC power distribution is an alternative approach to a conventional data center AC power scheme. Most data center server racks are not currently powered using DC, but the servers and storage arrays can operate with either AC or DC. Typical servers and storage arrays inherently convert an AC power source to DC within each power supply which adds an additional power conversion loss within the typical data center power chain. Using the DC powering approach, extra power conversion steps are eliminated creating several benefits, mainly:

- Lowering losses,
- Increasing reliability,

Together . . . Shaping the Future of Electricity

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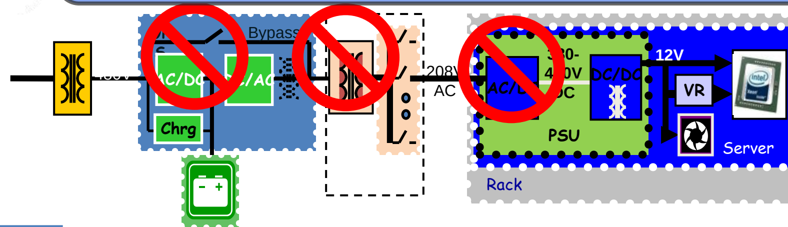
380Vdc Business Case

Direct-Current Micro Grid: 380Vdc the New Standard

“380VDC is the highest efficiency, cost effective solution”

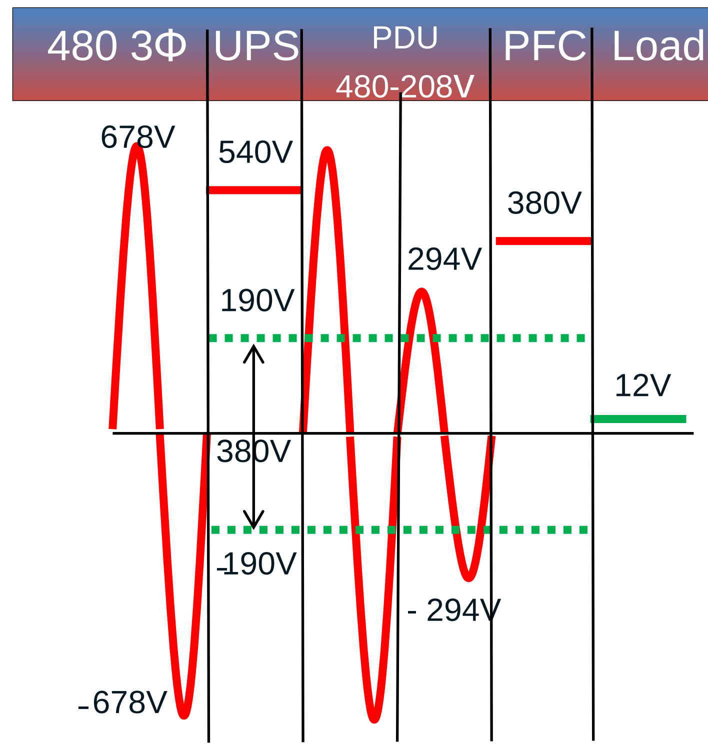


- ETSI 300132-3-1 v2.1.13 (1) (2011)
- EMerge Alliance ➔ NEC 2014
  - ➢ 200%-1000% more reliable[2]
  - ➢ 15% less up-front capital cost in volume[2]
  - ➢ 33% less floor space[2]
  - ➢ 36% lower lifetime cost[3]
  - ➢ Efficiency
    - ➢ Up to 28% more efficient than 208VAC[1]
    - ➢ 7% more efficient than 415VAC[2]
  - ➢ No Harmonics, and is Safer [4]

Efficiency↑ Voltage↑ Conversions↓

UCSD, Duke Energy, Intel IT (2011)

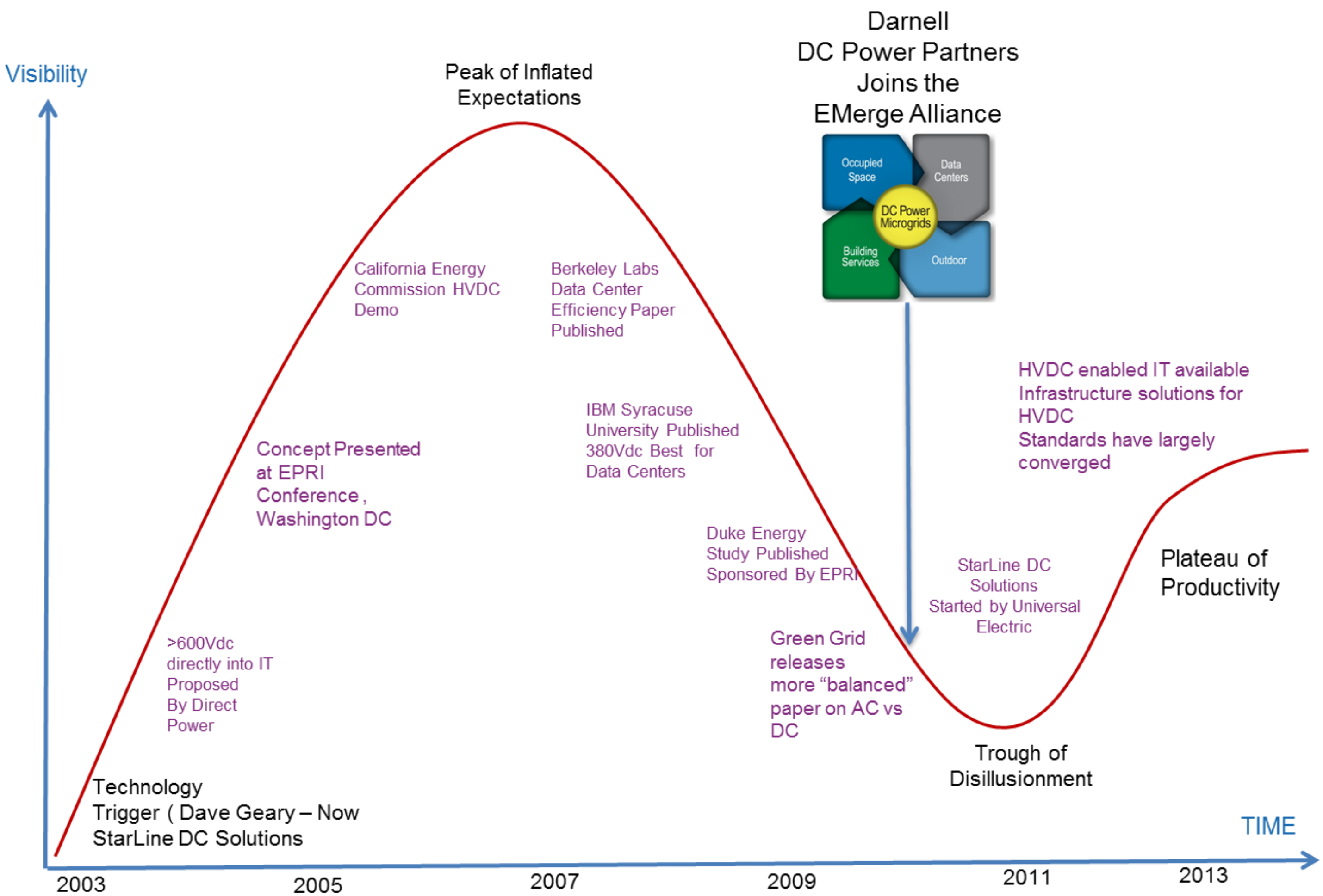
- Other Industries adopting 380Vdc
  - – PV, Wind, Lighting, EV Charging, VFD Motors



[1] Intel, Intelec Paper, 2007 [2] Intel, HP/EYP, Emerson, Whitepaper, 2009, [3] Validus/ / GE Study, 2010 [4]IEC 23E/WG2

Industry Update

HVDC Adoption Cycle



DC – The Power to Change Buildings

A Non-profit Alliance Driving Open Standards to Direct Current Power Distribution in Buildings

380vdc - Revolution or Evolution?

Tim Martinson
EMerge Alliance – Marketing Chair for DC Telecom Committee
Liaison to the Green Grid
SCTE 380vdc Standards Committee
Universal Electric – Director StarLine DC Solutions

Brian Patterson
President – EMerge Alliance

Global collaboration

STARLINE®

Dennis Symanski
Chairman
EPRI

EMerge® ALLIANCE

DC-The Power to Change Buildings

What is the EMerge Alliance?

- Not-for-profit 501c -Part 6
- Open application standards - DC platform
- Eco-system development and promotion
- 100+ Member organizations and growing!

Who is the EMerge Alliance?

- Architects, Engineers
- Contractors/Builders/ Integrators
- Manufacturers - Service Providers
- Building Owners – Facility Managers
- National & Independent Labs
- Academic Institutions
- Codes & Standards Groups

What is an EMerge Standard?

- Commercial Applications Standards
- Subordinate to safety, equipment standards
- Physical, electrical, operational interfaces
- Application definition - listing requirements of other standards (incl. IEC)

Vision: DC Microgrids in Buidings

Members as of 9/15/2011

CHIP2GRID

STARLINE DC SOLUTIONS

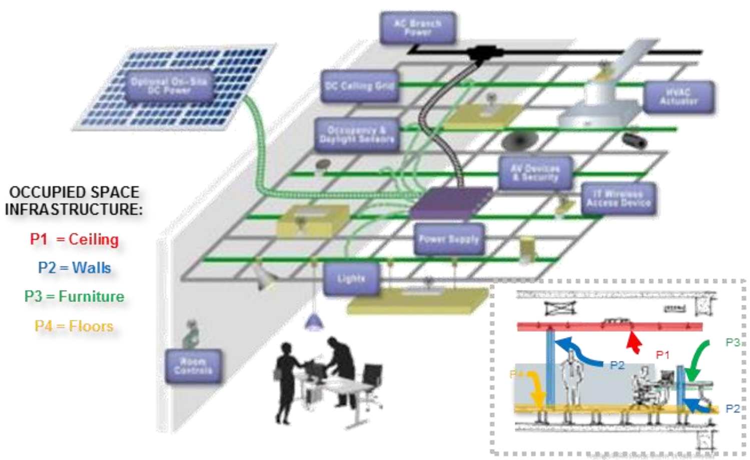
Addressing Codes and Standards

Standards Organizations We Work with to Advance DC Microgrid Technology / Use

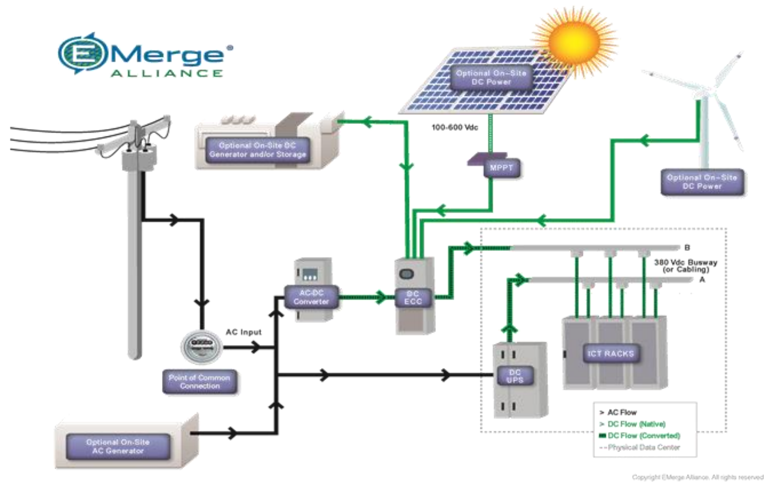
Industry Update

EMerge Hybrid AC/DC Buildings Standards

Occupied Space Ver. 1.1 | **Data Center Ver. 1.0**



http://www.emergealliance.org/Standards/OccupiedSpace/RequestStandard.aspx



http://www.emergealliance.org/Standards/DataTelecom/RequestStandard.aspx

Future Standards

Furniture/Desktop Direct DC (Active)

*Outdoor DC / Electric Vehicle Charging**

*Building Services (HVAC)**

Building/Campus Level DC Microgrid (Active)

*Residential DC Microgrid***

CHIP2GRID Patent No: US 7,492,057

STARLINE DC SOLUTIONS

Reliability – It's in the Architecture

STARLINE

EMerge ALLIANCE

380 Vdc Architectures for the Modern Data Center

2013

Abstract

The public mandate to develop and operate more efficient, lower cost, more reliable, more sustainable infrastructure clearly includes data center design and operation. Ideally, these concepts are addressed at the concept and design stage and implemented from the foundation to daily operations. Practically, new and different approaches (evolving thinking and technologies) are implemented in all facilities. This paper presents an overview of the case for the application of 380 Vdc as a vehicle for optimization and simplification of the critical electrical system in the modern data center. Specifically, this paper presents currently available architectures consistent with ANSI/BICSI 002-2011 and the EMerge Alliance Data/Telecom Center Standard Version 1.0. Additional EMerge Alliance white papers will explore the specific elements including economics, reliability, safety and efficiency.

BICSI Class F3 – Concurrently Maintainable and Operable

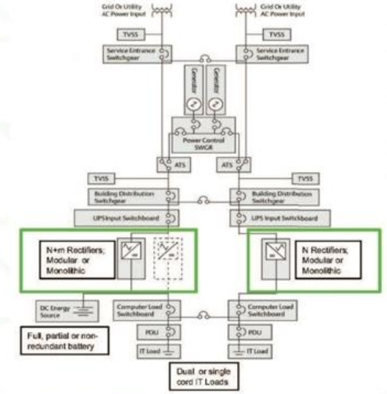


Figure 4: 380 Vdc System Equivalent to BICSI Class F3 (Source TGG)

Class F4 – Dual Path; Fault tolerant

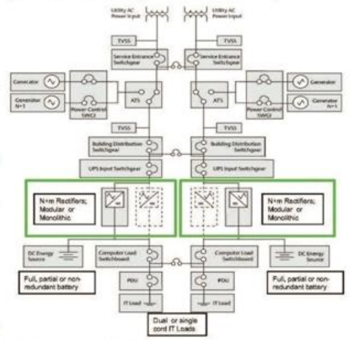


Figure 5: 380 Vdc System Equivalent to BICSI Class F4 (Source TGG)

CHIP2GRID Patent No: US 7,492,057

STARLINE DC SOLUTIONS

Industry Update

STARLINE®

IT Technology …is driving density
Power Density = Lower KW per Compute

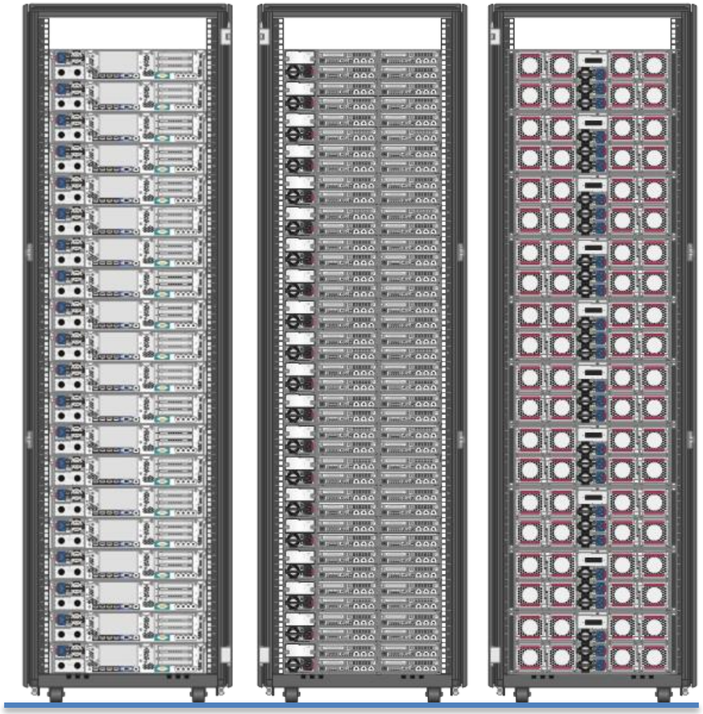
	DL380P	SL2500	SL6500
Current Data Center Costs			
Current System Wattage total	4487.07	10155.65	14612.95
Your cost per kW/hr	0.11	0.11	0.11
Wattage x cost per kW/h	0.4935777	1.1171215	1.461295
Server Lifecycle	3	3	3
Hardware driven cost of ownership (Hardware Wattage x Cost per kW/h x number of years)	12971.22	29357.95	38402.83
# of cooling watts required for each watt generated	1	1	1

Total Cost of Ownership			
Total Wattage Estimate (Hardware + Cooling)	8974.14	20311.3	29225.9
Total Cost of ownership (Hardware Wattage and Cooling Wattage x cost per kWh x number of years)	$ 25,942.44	$ 58,715.91	$ 76,805.67

Data Center Summary			
Line Voltage	-380 VDC	-380 VDC	-380 VDC
BTU HR	15301.21 BTU	34630.87 BTU	49830.11 BTU
System Current	11.73 A	26.68 A	38.5 A
Total Wattage	4487.07 W	10155.65 W	14612.95 W
VA Rating	4487.07 VA	10155.65 VA	14612.95 VA
Total Idle	1755.36 W	2714.69 W	8802.53 W
Total Circuit Sizing	4487.07 W	10155.65 W	14612.95 W

47 - BW911A - HP 647 1075mm Pallet Intelligent Series Rack			
Rack Level Summary			
Line Voltage	-380 VDC	-380 VDC	-380 VDC
VA Rating	4487.07 VA	10155.65 VA	14612.95 VA
BTU HR	15301.21 BTU	34630.87 BTU	49830.11 BTU
System Current	11.73 A	26.68 A	38.5 A
System Wattage	4487.07 W	10155.65 W	14612.95 W
Idle	1755.36 W	2714.69 W	8802.53 W
Circuit Sizing	4487.07 W	10155.65 W	14612.95 W
System weight (Kg)	747.21 Kg	923.39 Kg	1217.8 Kg
System weight (lbs)	1647.3 lbs	2035.71 lbs	2684.76 lbs

DL380P 20 Servers | SL2500 40 Servers | SL6500 80 Servers



380Vdc with Cloud Implications

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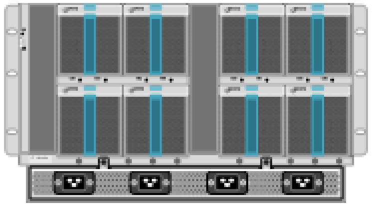
[Comcast launches cloud DVR in San Francisco, lays foundation for a set-top box-free future]

Janko Roettgers

Sep. 30, 2014 - 9:00 PM PST

Comcast customers in the San Francisco Bay Area can now stream their DVR recordings to their iOS or Android devices, no matter where they are. The Sling-like feature requires one of the company's newer X1 set-top boxes — for now. Under the hood, it's already powered by Comcast's cloud DVR, which could eventually make set-top boxes obsolete altogether.

https://gigaom.com/2014/09/30/comcast-launches-cloud-dvr-in-san-francisco-lays-foundation-for-a-set-top-box-free-future/



CISCO UCS 5100 – Also the heart of the V Block
CISCO Claims this application used to run on 160 Servers

Also claims that this product ideal for BIG DATA

Shipping globally with 380Vdc input and now available in the US with 380Vdc

380Vdc Ready

STARLINE

UNICOM Engineering, Inc.
A Division of UNICOM Global

650W Power – Available now

Reliability	Supporting up to 12 3.5" Hot-swap SAS or SATA drives
Redundant fans & power supplies
Efficiency	650W 380VDC, 80+ Platinum
Performance
2 x Intel 8 Core Xeon Sandy Bridge CPUs
24 x DIMMs

1200 & 2400 W Power

HP Common Slot Platinum Power Supply

HP 1st Half 2013
1200W
This PS is designed to support:
- DL/ML/SL with exception of entry SMB
- C3000
- Several storage platforms (~20 models)
- Some Networking products

HP 2nd Half 2013
2400W
This PS is designed to support:
- C7000 Blade System Enclosure
- Superdome platforms

Main frame

IBM

Z10
Z196
Power7 795 – Jeopardy Watson

lenovo 联想
Flex Blade System /

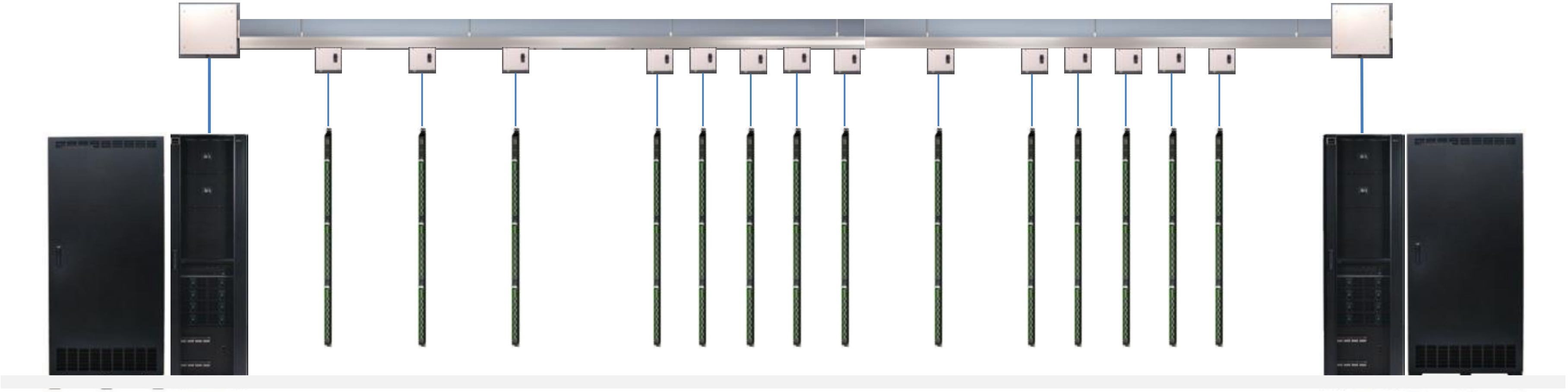
Cisco Systems
UCS Converged Technology

Architectural Benefit $$$

Selective Redundancy –
The Steel ORCA Solution

- 105KW N+1 with Battery
- Second Controller Cabinet
- 400AMP Busway with 2 End Feeds (Redundant)
- Commissioned and tested with 3 40KW Loadbanks

- Plug In Units are added as customers are added
- Customer does not have to purchase redundancy
- Back up redundancy is added as customer wants / needs it



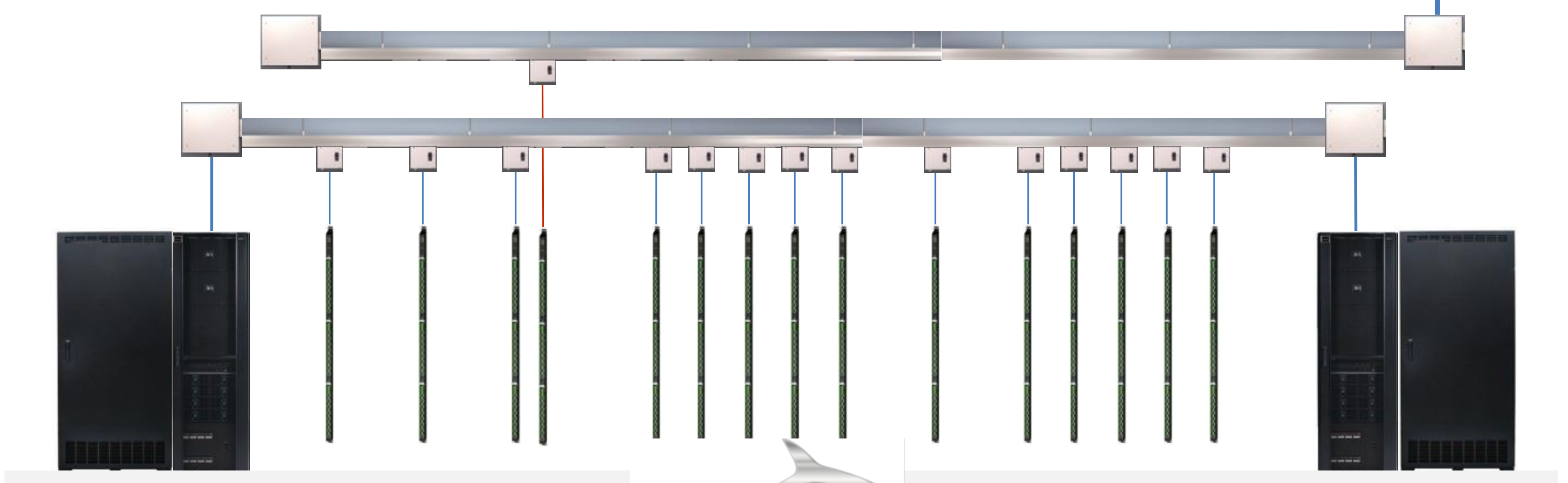
Hybrid Solution – Truly Evolutionary

STARLINE®

The Steel ORCA Solution
Flexibility used to be expensive – now it increases Reliability and Saves $$$

- Bring your current (PUN) technology to Steel ORCA (ac)
- As you upgrade to new technology select based on what is best for your budget ac or dc (Get a quote from SO on both currents)
- StarLine DC and Steel ORCA prepared to support dual current in a single row or single rack
- Auto discovery plug and play metering utilizing Norlinx Software tested and proven with StarLine's meters.
- Add more power to a rack (up to 20KW) without shutting down the line **(Exclusive to StarLine ac or dc)**
- Add Stulz In-Row cooling when and where you need it directly off the busway.

120/208 Vac



Why @ Steel ORCA?

- The trend is to drive applications to the Cloud
- Steel ORCA’s Digital Burst will be a step beyond the Cloud creating the opportunity for a Digital Utility
- Like an Energy Utility the Utility has to respond to instant changes in demand.
- 380V dc provides the most flexible and cost effective system to meet the fluctuating energy demands that will capitalize on all of the engineering benefits of direct current.
- Steel ORCA recognizes that similar to Cloud Deployment the world is evolving to direct current and that eventually even the utilities will be embracing direct current (as China, Russia and Japan are today.
- VSORC – NSF – Villanova Steel ORCA Research Center

Steel ORCA

STARLINE®

Steel ORCA Princeton, Digital Utility Center

Available Now!

Exclusive Wholesale Colocation and Managed Services

- Delivered within 6 months of signing
- From individual racks to 100,000 sf suites
- 350,000 sf of white space
- Custom autonomous suites available
- Up to 60 MW of Critical Power
- Variable density
- Multiple UPS output voltages (AC & DC)
- Tier III design with tier IV options
- On site security and complete video surveillance
- Biometric ingress and egress portals

- Digital Burst Environment
- < 1 millisecond to New York City
- Multiple fiber carriers
- Design/Migration/Management services
- Comprehensive managed service options
- In the heart of the Princeton Technology Corridor
- 200 seat disaster recovery offices
- Conveniently located off Route 1
- 45 miles from NYC

For more information and to arrange a tour
Contact
info@steelorca.com
Office - 215-789-6260 or 1-855-SteelORCA

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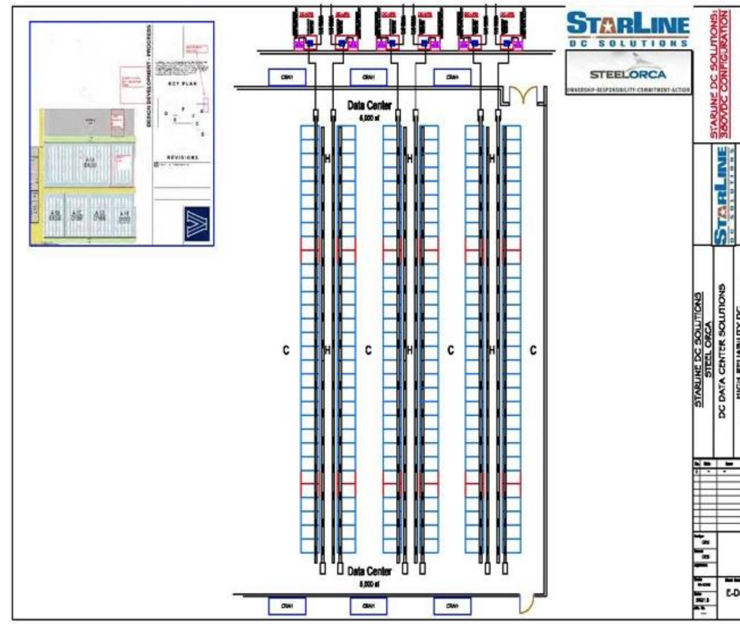

Steel ORCA

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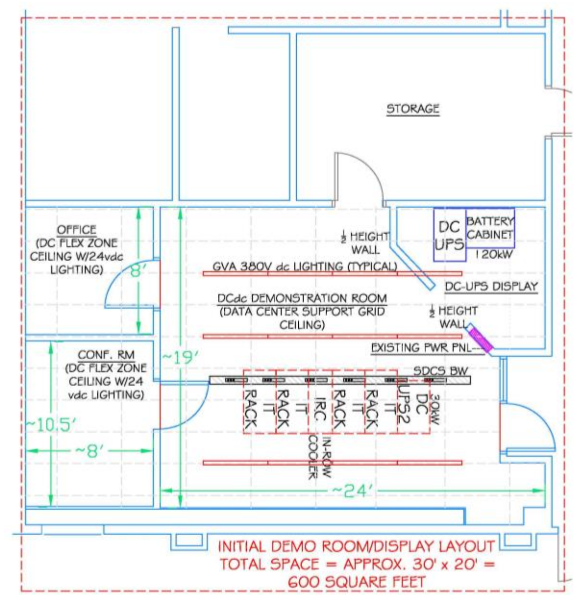
STEELORCA

National Science Foundation I/UCRC ES2 Villanova
Steel ORCA Research Center (VSORC) is focused on data center and digital utility center efficiencies in several areas.



Steel ORCA offers the first commercially available 380Vdc power distribution environment with StarLine DC Solutions commercially available colocation space based upon the 380Vdc power topology.

A dcDC Demonstration is being created to show how an EMerge Microgrid is executed

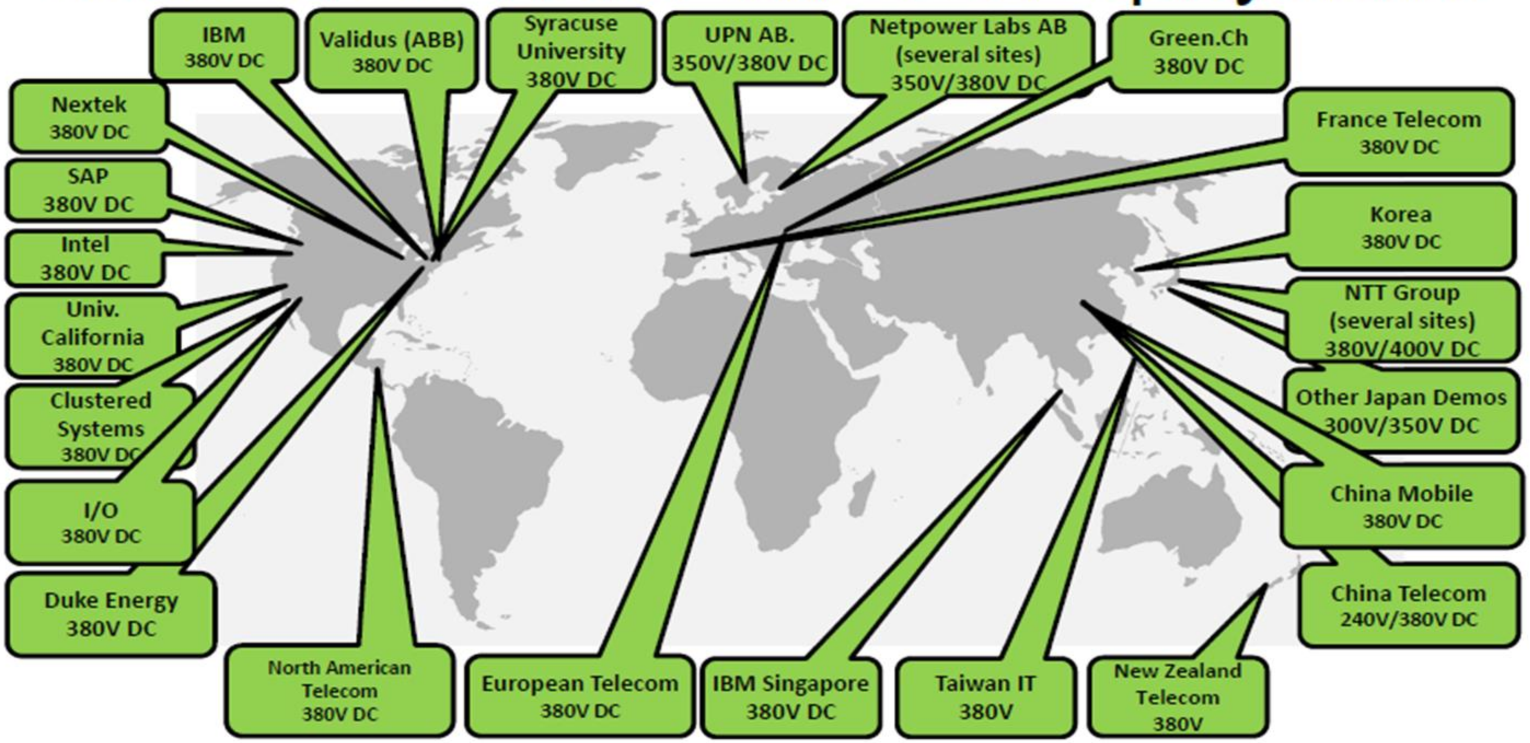
www.SteelORCA.com

Global Data Center Projects

STARLINE®

Review of selected deployments to date:

Some of the World-wide DC Deployments



Sizes vary from 15 kW to 1MW

North America
- Proof of concept - 9
- Production - 4

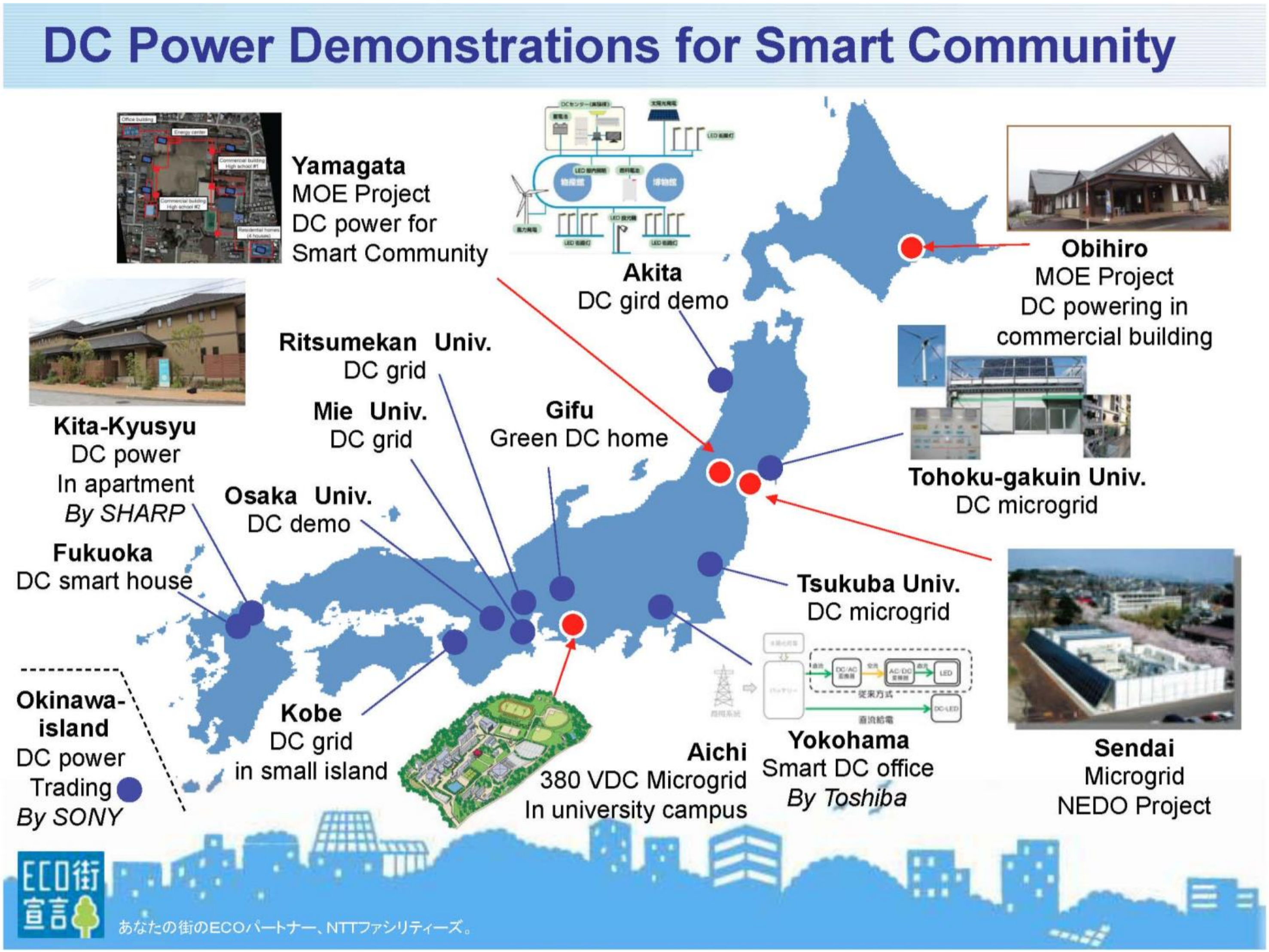
Europe
- Proof of concept - 2
- Production >20

Asia
- Proof of concept – 11+
- Production - >350 (majority 240VDC in China)

Update
More than 800 operational in China

Micro Grid Projects in Japan

STARLINE



Power Electronics is Evolving to Direct Current

Thank you

Timothy E. Martinson

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814-899-5245