WHITE PAPER

400V DC Microgrid Small Scale Demo System for Telecom and Datacom Applications

Presented at INTELEC 2012

1. Objective

This live demonstration of a 400V DC powered eco-system, validates the feasibility of what has been previously discussed in concept. The demo operates at 380V DC and makes use of existing technologies and components provided by several major vendors. The solution shown features high end-to-end efficiency and can result in significant savings in the site wiring costs versus 48V DC. This tabletop demo was put together by using standard, off-the-shelf components. Figures 1 and 2 offer an overview of the demo installation.

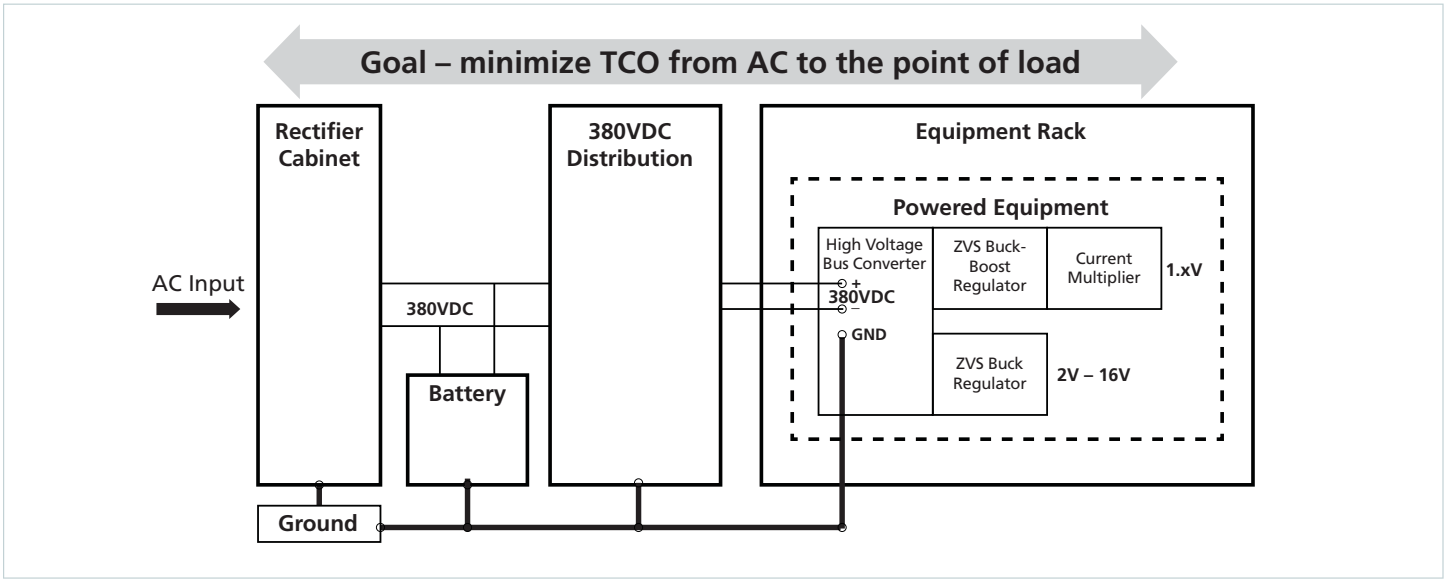

Figure 1: 380V DC power system configuration for telecom applications

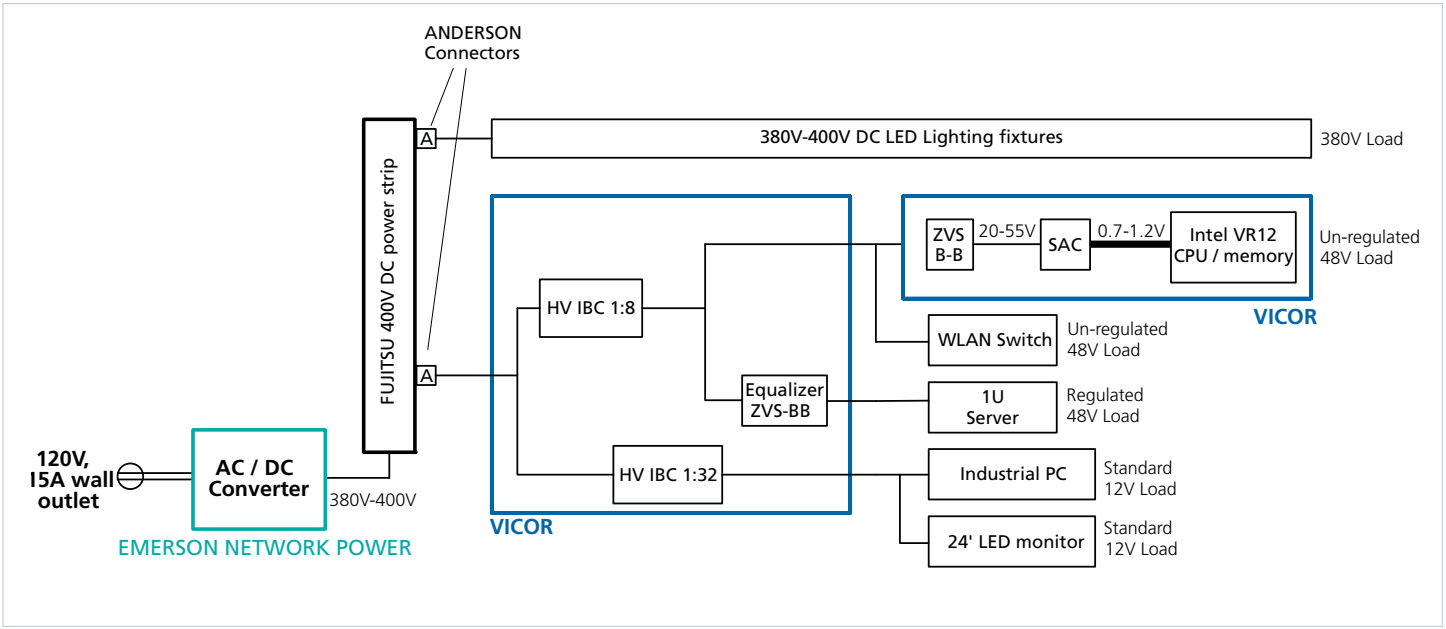

Figure 2: Block diagram of the 380V DC table-top demonstration

2. System Aspects

By using Vicor's Equalizer concept in the powered equipment power supply, there is no efficiency penalty in supporting the ETSI EN 300 132-3-1 normal service voltage range of 260V - 400V DC. The "Equalizer" block enables the use of a high-voltage bus converter as equipment front-end element, with minimal impact on conversion efficiency. During normal operation with source voltage greater than 350V DC the equalizer is bypassed and does not impose any losses in the power transfer. The equalizer is activated only when the source voltage drops below the 350V DC level (typically during battery discharge).

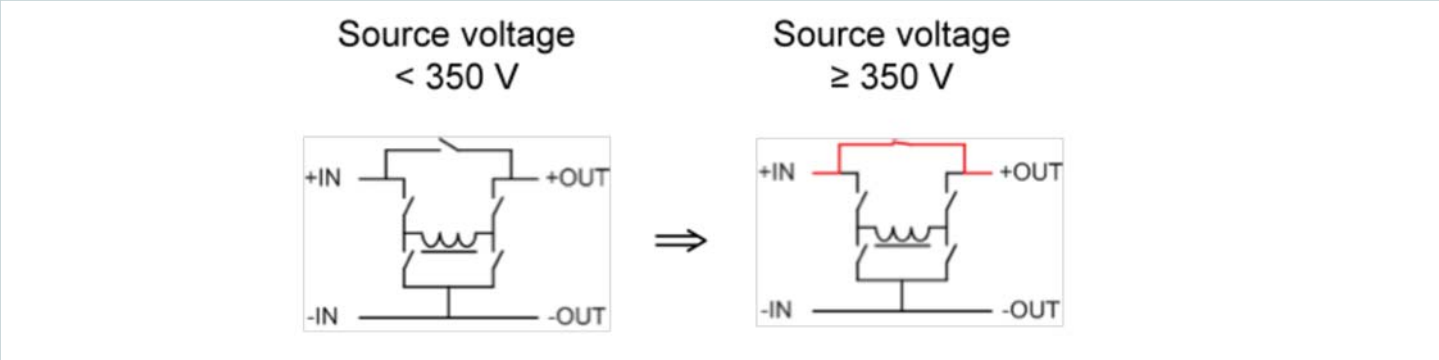

Figure 3: Vicor equalizer concept to address different DC system voltages

Safety concerns for 400V DC distribution have been systematically addressed with a high resistance mid-point ground (HRMG) implementation:

a. On the bulk power source by midpoint resistive grounding with fault detection
b. On the distribution system by using ±190V instead of 0V-380V
c. On the equipment front end conversion, with fully isolated, safety extra low voltage (SELV)-output high voltage bus converters

Midpoint resistive grounding with fault monitor provides for a safe and reliable distribution line; fully isolated, SELV output high voltage bus converters used as equipment front-end provide for an extra layer of safety for the operators.

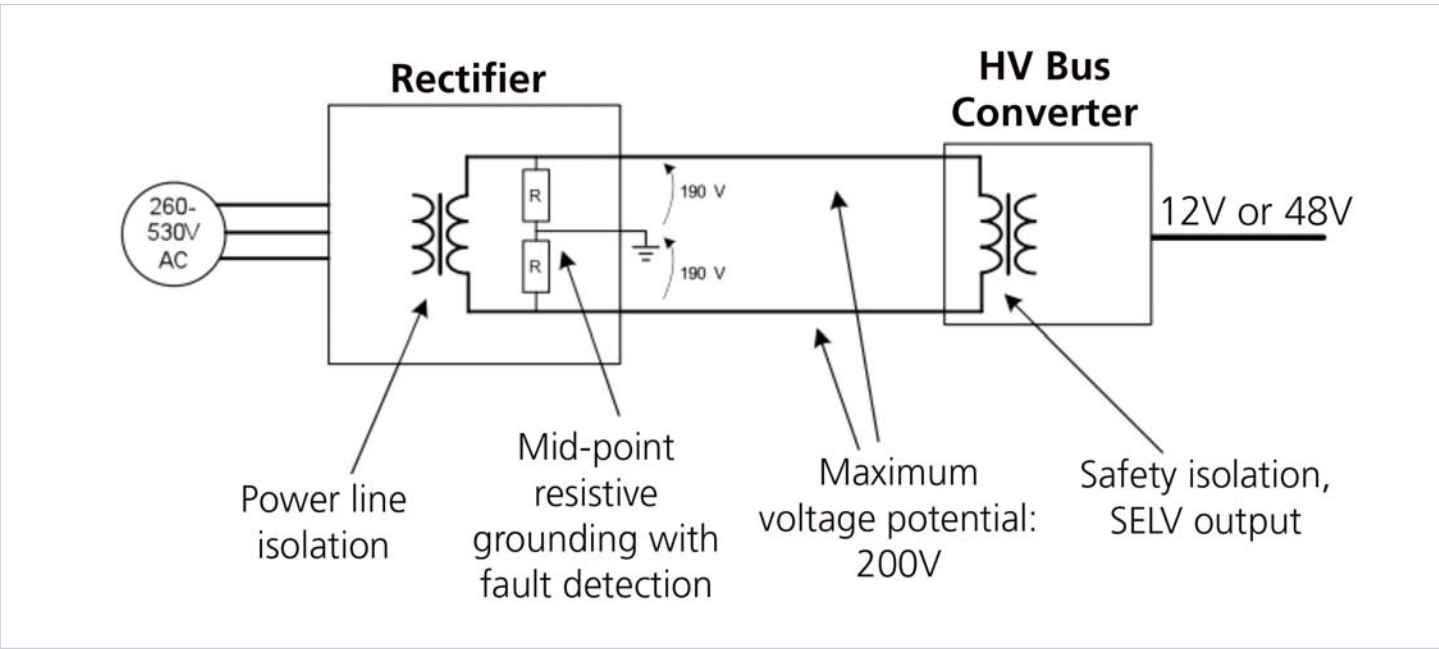

Figure 4: 380V DC power grid IT mid-point resistive grounding

2.1 Transition path from existing 12V or 48V to 400V DC powered equipment

Existing 48V DC loads can be transitioned to 400V DC distribution by implementing simple, minimally invasive adapters.

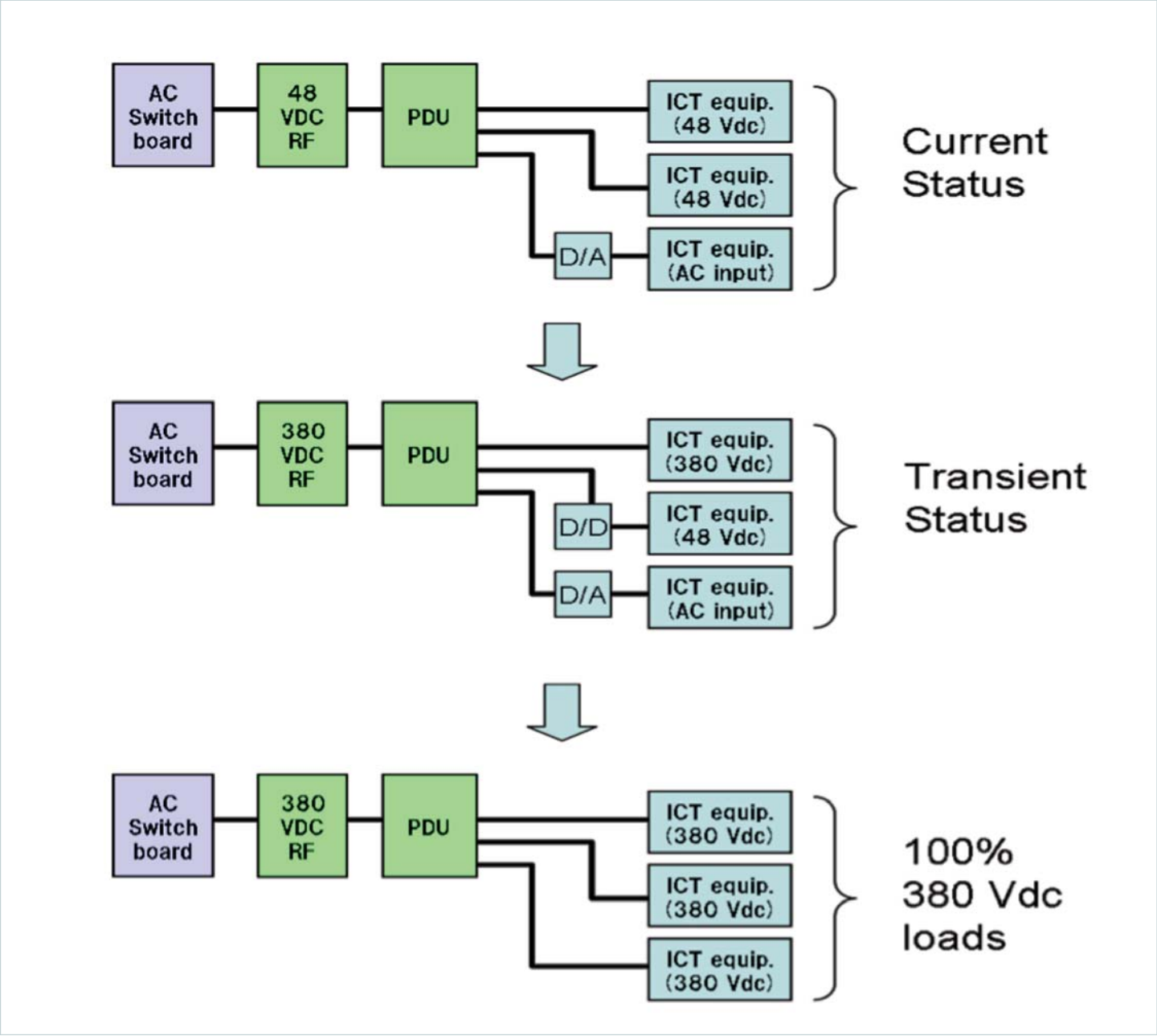

Figure 5: Transition path from 48V DC to 400V DC grid systems (Source: Didier Marquet, France Telecom - Orange Labs)

2.2 Proposed power system architectures

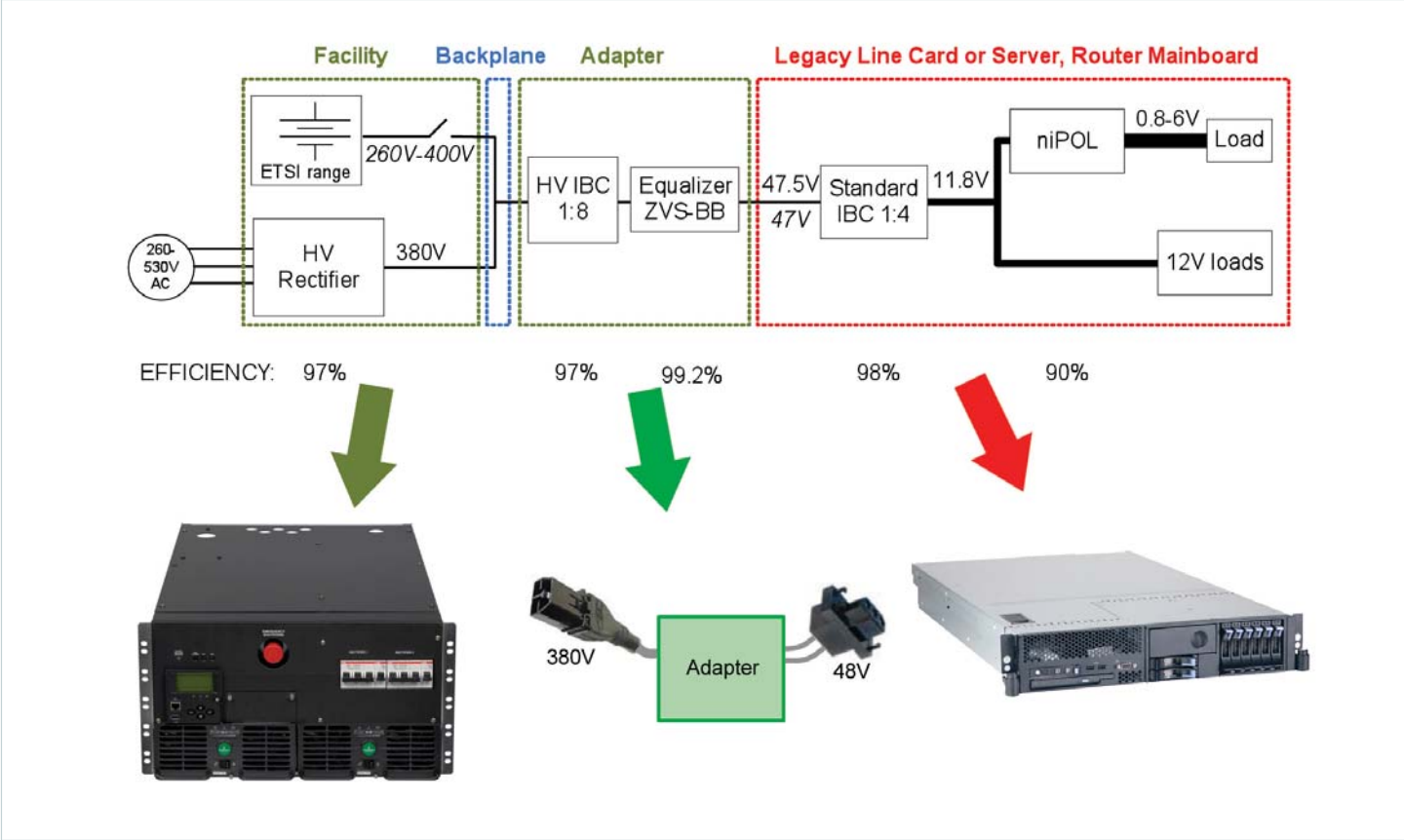

Figure 6: External adapters can easily interface existing 48V powered equipment

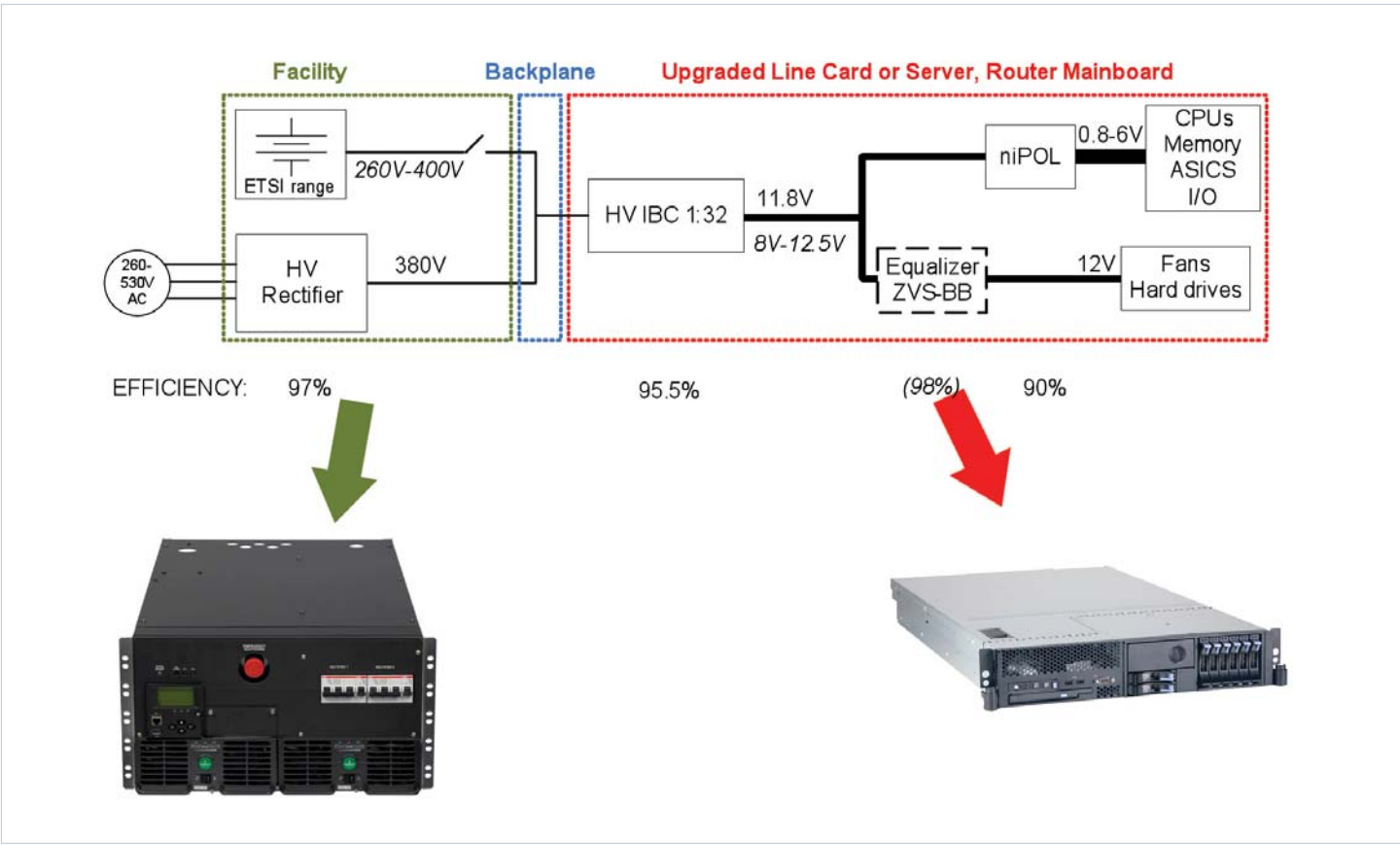

Figure 7: Existing equipment can be retrofitted with 400V bus converters that feed intermediate 12V buses

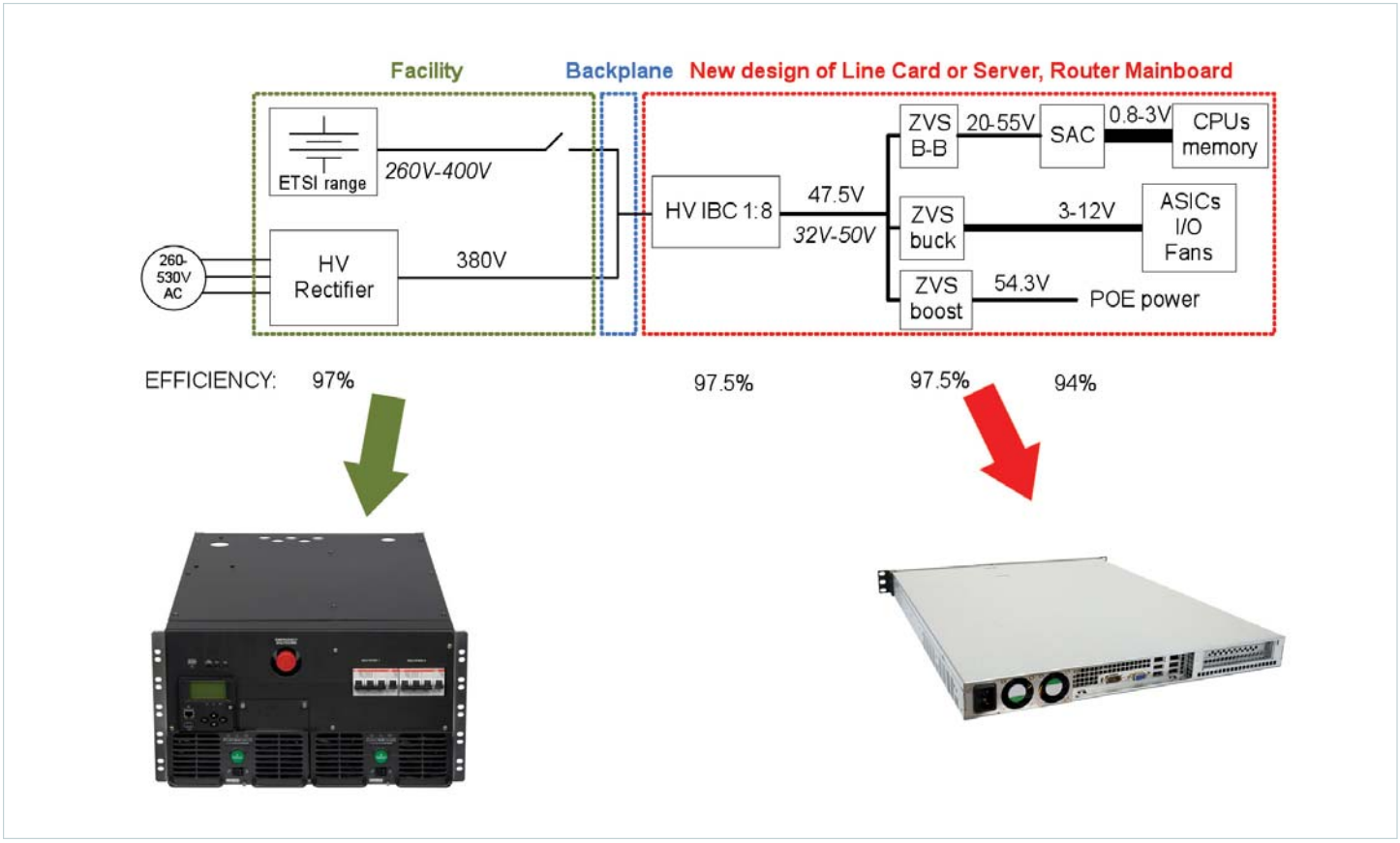

Figure 8: New rack equipment can be natively designed to accept 400V DC, by implementing Factorized Power Architecture.

3. Vendor Contributions

3.1 Emerson Network Power: AC to DC Power Conversion

The NetSure™ 4015 is the latest AC to DC power system from Emerson Network Power designed for telecom and datacom facilities operating up to 400V DC, with a 3-phase AC input. The foundation of the system is our patented, next generation 15kW eSure™ rectifier, featuring high frequency switching technology in a compact package at 97% efficiency. It is designed for easy deployment in lab evaluation or field installations, all three major components of this system fit into standard 19" racks.

For the purposes of this portable demonstration, Emerson has provided a modified single phase rectifier to provide the 380V DC supply.

For more information, please visit: http://www.Emerson Network Power.com/400VDC

3.2 Vicor: 400V DC to Point-of-Load Conversion

Vicor enables customers to efficiently convert and manage power from DC distribution to point-of-load.

We address the entire power chain with a comprehensive portfolio of high efficiency, high-density, power architectures aimed at performance-critical applications. Vicor's holistic approach gives power system architects the flexibility to choose from modular, plug-and-play components ranging from bricks to semiconductor-centric solutions.

For the purposes of this portable system, Vicor has provided two demonstration boards:

a. Interface card featuring 400V DC bus converters, with ratios of 1:8 and 1:32 in order to power 48V and 12V loads respectively, as well as energy storage and Zero Voltage Switching Buck-boost converters in equalizer configuration in order to provide compliance to ETSI EN 300 132-3-1 standard.

b. 48V reference design compliant to Intel VR12 server processors

For more information, please visit: http://www.vicorpower.com/promotions/2012/Compliance/VR12/dc.php or http://www.vicorpower.com

3.3 Anderson Power Products: 400V DC Connectors

Anderson Power Products (APP) is the world's leading developer of DC power connectors with sixty years of experience producing connectors from 10 to 700 Amperes and from 12 to 1,000 Volts. APP is a leader in the development of DC product safety standards working within EMerge, IEC, NEMA, and in cooperation with UL. In January 2009, APP introduced the UL recognized Saf-D-Grid connector, developed for 400V DC IT equipment up to 8KW.

3.4 Fujitsu Components: 400V DC Rack PDU

Fujitsu Component Limited and NTT Facilities co-developed a safe, user friendly arc extinguishing 10A, 400V DC power connector that insures user safety and equipment safety when installing or disconnecting a high voltage (10A, 400V DC) power port. The interconnect system was considered a key element in providing safe and reliable usage or ability to implement high current DC. Development started in 2007, to support 380V DC power grids in the data center applications. Fujitsu has adopted the power connector design into our Power Distribution Units (5 port and 10 port), and is currently installed in several data centers, both in Japan and in North America/Europe.

Fujitsu Component also developed a key relay with arc extinguishing characteristics, to support the circuit protection requirements of the power supply manufacturers, supporting 450V DC (Fujitsu's FTR-J2 series), which is UL/CSA/VDE approved to support 450V DC (along with 277V AC).

For product information, contact FCAI via telephone at 1-800-380-0059 or by email at components@us.fujitsu.com

For more information, please visit: http://us.fujitsu.com/components

3.5 GVA Lighting: 400V DC LED Lighting

GVA Lighting is a Canadian design and manufacturing company specializing in architectural and special application lighting. As a pioneer of LED lighting with 12 years of experience in large scale and high reliability projects, GVA Lighting thrives on solving great engineering challenges. GVA is the first company to offer a 380VDC lighting solution by using proprietary INFINITY™ technology. GVA Lighting provides unique and cost effective solutions for long lighting circuits including delineation of bridges, skyscrapers or illumination of data centers.

For more information, please contact us: support@gvalighting.com

3.6 Philips: 400V DC LED Lighting

Philips Green Flagship LED luminary LuxSpace Compact High Efficacy offers 2490 Lumen light output with an outstanding efficacy of 90 Lumen/Watt. This efficacy number includes LED driver with 400V DC input, the Philips Fortimo LED light engine and the reflector of the LuxSpace luminary.

For the purposes of this portable demonstration, Philips Research has realized LED luminaires with 400V DC supply.
For information on commercial available products of the LuxSpace Compact High Efficacy luminaire, please visit
http://www.ecat.lighting.philips.com/l/indoor-luminaires/downlights/luxspace-compact-high-efficacy/52878/cat/# .