Direct Current as a Standard

By Gunter Pauli

This article introduces a creative approach to electricity standards as one of the 100 innovations that shape “The Blue Economy”. This article is part of a broad effort to stimulate entrepreneurship, competitiveness and employment.

The Market

The world market for computer servers is estimated to reach in 2011 nearly $48 billion increasing from a 2009 base of $42.2. This is good for 7.6 million servers. The first quarter of 2011 already confirmed a growth of 8.7% in volume, whereas the high end segment increased with 14.2%. This is good news after the business suffered in 2009 from a sharp downturn of the economy with a drop of 18 percent in demand over 2008. The cloud computing concept, which is an on demand provision of data and services using networks of computers instead of a local server, is expected to stimulate further stimuli to the demand for servers. One of the big new shifts in the ever evolving internet system is that an increasing number of servers is solely dedicated to video. This market segment is expected to leap from nearly nothing two years ago to $2.3 billion in 2012.

The growth of data centers is explosive. A company like Dell is doubling its data service centers in China from one to two thousand in just one year, claiming that 60 percent of all cloud service centers in China are based on Dell. The market leader in servers (all types combined) is Hewlett Packard, commanding 31.5 percent of the market, closely followed by IBM with 29.2 percent. Oracle, a newcomer in the field has acquired 6.5 percent. The arrival of server parks comes at a price: 1.2 percent of all electric power in the United States is consumed by servers, which represents 0.5 percent of all greenhouse gas emissions. Intel is with 100,000 servers the largest declared server user in the world. Facebook had by 2010 over 60,000 servers, but Google leaves the world guessing how many servers it employs, with some claiming that is has now surpassed the one million mark. Microsoft could have as many as 225,000, with Yahoo and eBay each running more than 50,000 units. The telecommunication companies are minor users with 20 to 25,000 servers only (!) for giant operators like Verizon and AT&T.

The Innovation

The core innovation drive for servers has been a combination of increased computer power and miniaturization. The pre-configuration of bundles of servers has also become a key component in the drive towards efficiency. Energy efficiency has received attention, especially through component design. The world of mobile electronics realized that the Bluetooth technology is technically very performant, however it could be considered the Hummer of Communications since it excessively draws on energy supply. The lower thermal design power (TDP) has become a key focal area pushing the requirements per processor
from 35 to 40 W down to 15 W at present, to even under 10 W by 2012. However the major challenge is that the grid is providing electricity in alternate current (AC) while all consumption is in direct current (DC). The conversion of AC to DC implies a loss of efficiency, and while this has created a huge business for AC to DC converters, this not only adds to cost, it also make energy efficiency a difficult target since at least 10 percent of the AC energy is converted to heat and is thus wasted. Worse, the excess heat must be removed requiring all server parks to be excessively air conditioned.

Prof. Umesh Mishra is a Professor at the University of California at Santa Barbara and an expert in physics. He has made major scientific contributions to the design of high speed transistors. Prof. Mishra built up an expertise in power amplification and concluded that he could design computer chips to convert AC to DC. Instead of losing 10 percent of the energy in the form of waste heat, he could now get +99 percent, and have nearly no heat loss. Such highly efficient converters could reduce demand for air conditioners humming their way at data centers solely to get rid of waste heat generated by light and servers. He calculated that if his solution be applied throughout the industry, his innovation could save hundreds of terawatt hours of electricity. Las Vegas - Prof. Mishra points out - only consumes 33 terawatt hours!

The First Cash Flow
Prof. Umesh and his colleagues went on to create Transphorm, a company that aims to produce chips that will convert AC to DC, thus eliminating the need for chargers that are also rectifiers. Transphorm has received a $38 million backing from investors including Google, a company that has already decided to create for each server a 12 V DC back-up battery. Google has gone further and created its data centers inside standard 40 ft. shipping containers, each with 1,160 servers with a power consumption of 250 kW, all based on DC. Data centers typically rely on uninterruptible power supplies (UPS), which are giant batteries that kick in when the main supply fails. UPS kicks in much faster than the traditional diesel generators which lead to disruption. However, building power supply into the server is cheaper, matching the cost directly to the server, eliminating wasted capacity, tailoring to local needs.

The Opportunity
Whereas Umesh Mishra is planning to have their prototype factory up and running in 2012, the real shift that should occur is not to have to worry about the conversion at all. The substitution of something with "nothing" is one of the core principles of the Blue Economy. The target should be to substitute the AC to DC converters by no converters at all. This is only viable when the whole grid, including the base load is operating in DC. After all, servers, notebooks, LED lights, cell phones, electric motors and vehicles, even refrigerators operate on DC. Solar panels, piezo-electricity, and many of the renewable energies are all based on DC as well. So why would we look for expensive inverters (which are often called chargers - but their main function is to rectify 110 or 220 AC into 6 -12 or 24 DC), when we could bypass this inefficiency of the grid?
The revolution on hand is that innovations in AC to DC converters are simply not needed since renewable energy could be locally produced and locally consumed, eliminating the need for macro smart grids. The core power in buildings could be powered through multiple sources as has been described in Case 12 (flutters), Case 40 (electricity from osmosis), Case 42 (electricity from the tap), Case 53 (innovative solar), and piezo-electric electricity, generated thanks to the compression strength of the building that could produce for each ton of compression up to 6 V DC. Whereas the assembly of compression panels are still at a conceptual stage, it is clear that the manufacturing technique of photovoltaic solar cells is very similar to the production of compression cells, where silicium is replaced by quartz, crystalline silk or even sugar and salt. The only condition for success is that the building slightly moves - at the molecular level - and that can be quite easily achieved provided we rethink the roof. The superstructure of a building will rather look like a tree with a broad canopy protecting the base from rain and sun, but providing the flexibility to move with the rhythm of the wind and the earth in order to harness the power embedded in the Earth's rotation, that Kepler has already proven centuries ago. Solutions inspired by natural systems.

This new standard would unleash a tremendous wave of entrepreneurship, driven by energy efficiency, rendering renewable more competitive since it is not forced to undergo the cycle of DC to AC and then AC to DC. Most important is that all electronics can be designed to leapfrog in energy efficiency. A multiple of minute electrical currents - often at a rate of 70 millivolts - which were never considered commercially viable since to invert these to 110 or 220 V would be too costly and too inefficient, are now turning economically viable since the inversion is only required up to 6 - 12 or 24 V. This is comparable to what is required to put energy from solar cells into the grid. The great advantage is that these currents can be used locally, without the need for a grid, turning the buildings' weight and structural design into the base load that will supply all that is needed locally, and provide power through a micro smart grid. That is in the end what the Blue Economy is all about: use what you have, see the connections and then make it happen!