

## **Power Technology Helps Mitigate Impact of Power Outages on Wireless Networks**

By Al Cioffi, Valere Power

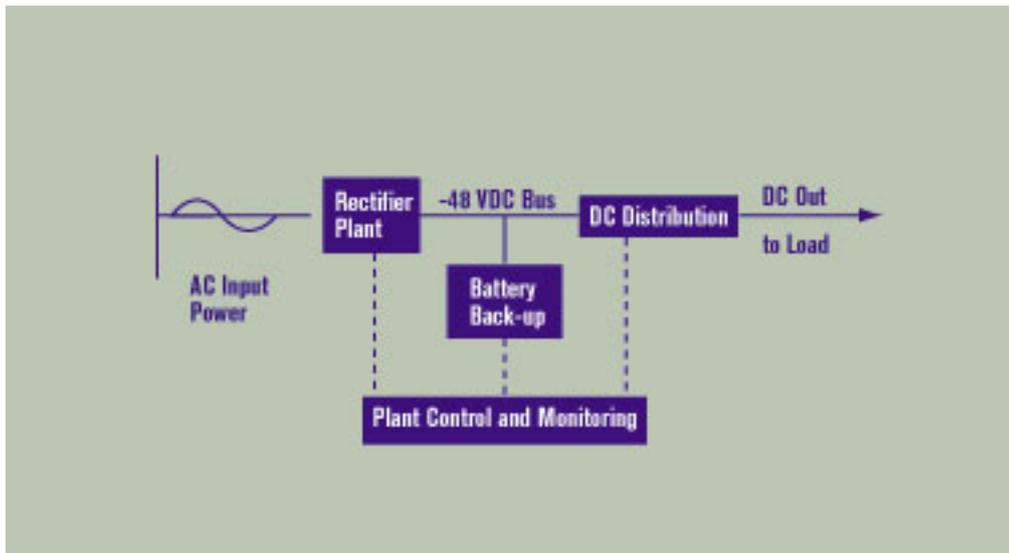
One of the indelible images of August's "Blackout of 2003," a massive power outage that affected more than 50 million people in the Northeast, Midwest and Canada, was the lines of customers at pay phones trying to make calls. People couldn't use their cell phones because in many cases the cell sites and base stations were overloaded or, worse yet, had run out of back-up power.

This clearly illustrates the back up power issues facing the wireless industry. Although this power outage was catastrophic, the problem of power outages is constant &#151; estimated to be the source of about 25% of the industry's service outages.

The wireless industry has generally under-engineered its power systems. This is due in part to the industry's rapid growth in recent years and to the high-power nature of its equipment, which makes back up power expensive. Part of it is also attributable to the way the industry grew up. Unlike its wireline counterparts, wireless carriers don't have to engineer their power systems to provide lifeline services.

### **Power Management**

In many cases, the answer to the lack of power outage protection is to upgrade the power and battery back up system &#151; an unappealing solution for cash-strapped carriers. But the savvy wireless carrier will spend its preciously small capital budgets to invest in technology advances, in both AC/DC power systems and in remote monitoring and management, that can lower ongoing operating expenses while at the same time making power systems more effective.



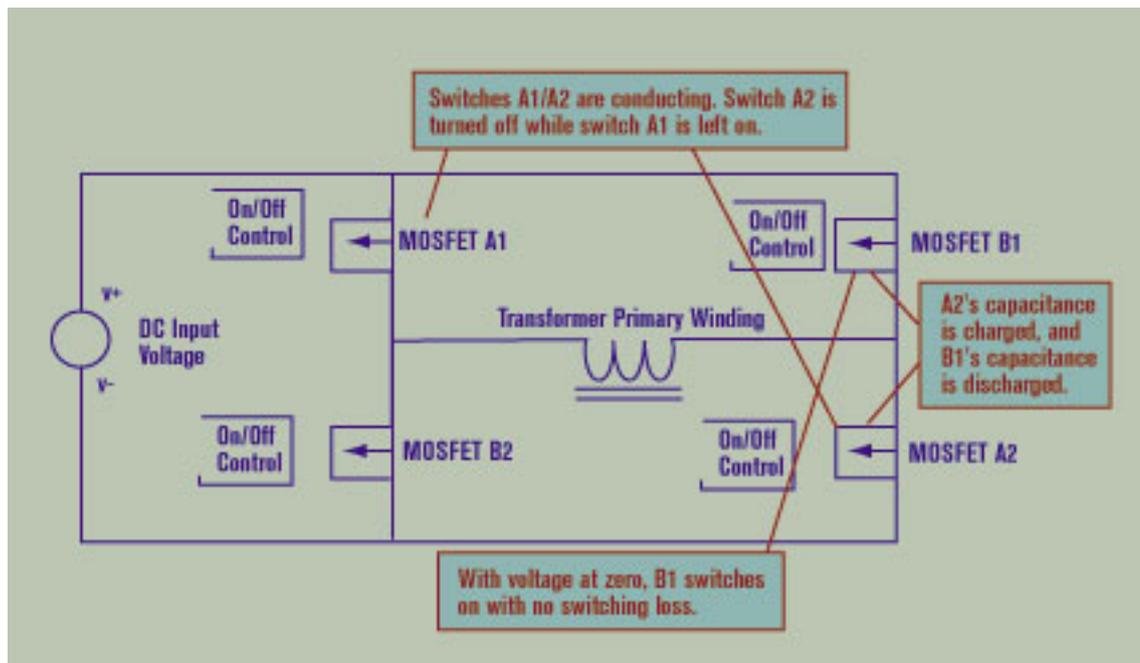
**Figure 1. Heart of the Power System: The AC/DC power system converts an AC power from the utility into 48 VDC power and then distributes that voltage to wireless equipment. Changes in technology and improved management systems make it more cost-effective to provision adequate back up power.**

At the heart of the power system is the AC/DC power system. It takes a source feed of AC power from the local utility and converts it into DC power that is distributed to the various pieces of equipment. It also charges the battery back up system and monitors its health and performance.

A key technology trend in power systems is the adoption of zero-voltage switch mode (ZVSM) technology. Current generation switch-mode systems &#151 the bulk of today's installed base &#151 have an efficiency rating between 85 to 88%. For a 1000 W system, that results in roughly 150 W of heat generated by the power system.

A switch-mode power converter operates by chopping the input voltage at very high frequencies and modulating the relative amount of time that the switch is on to vary the output voltage. An analogy would be flipping a light switch on and off at very high speeds to give the appearance of a dimmer, yet constant, intensity.

The primary benefit of this approach is that the high frequency allows magnetic elements and energy storage elements to be minimized, reducing size and weight. The primary drawback of this approach in traditional switching power conversion is loss during the transition of the switch, when there is an overlap of voltage and current in the switch at the same time, resulting in a slight energy loss. Each switch transition results in this loss, and as the switching frequency is increased the power associated with switching loss increases. Typically half of the power loss internal to the rectifier is associated with switching losses.



**Figure 2. Synchronized switching**

Zero voltage switching uses a modified approach to transition the switches such that the overlap of voltage and current during the switching transition is minimized. This is accomplished by taking advantage of circuit parasitic elements and by careful timing of the switching cycles.

The illustration above shows how the switching is transitioned in a synchronized manner. With switches A1/A2 conducting, switch A2 is turned off while switch A1 is left on. This places the capacitance of A2 in series with the energy stored in the parasitic inductance. Since current in an inductor cannot change instantaneously, this current charges the capacitance of switch A2 and discharges the capacitance of switch B1. The voltage decreases to zero across switch B1, at which time the switch is turned on with no switching loss. Switch A1 is turned off and a similar process occurs, charging the capacitance of A1 and decreasing the voltage across switch B2. When this voltage reaches zero, switch B2 is turned on with no switching loss.

With this technology, power conversion efficiency jumps to 92% in ZVSM-based rectifiers, and cuts the heat output of a system by 30%.

Switch-mode power systems are large and bulky because they are based on components that are optimized for high heat levels. In a ZVSM system, the lowered heat output means smaller components can be used and the overall system can be made up to 60% smaller. In a typical wireless application, a 1,200-amp ZVSM system can fit in a half-telecom rack, compared to an equivalent switch-mode system that requires two telecom racks. When battery back-up systems are relocated under that rack, the space savings can be even more dramatic.

ZVSM systems are a solution to the need to pack more equipment in a remote cabinet structure and avoid high costs related to new facility construction. The issue is most acute in remote terminals and base stations that are being upgraded for 2.5G and 3G network equipment which increases the power requirements while decreasing the floor space for the power systems to provide this power.

## Cutting Power-Related OPEX

ZVSM systems provide more room for battery back-up, but this exacerbates the cost of managing and replacing these batteries - the largest power-related operating cost in the network. Remotely located batteries are subject to temperatures that can degrade their life dramatically. And there are few visual indicators of the health of the battery. This leads some carriers to adopt very conservative replacement policies, sometimes as extreme as replacing 10-year-life batteries every two years.

New battery management systems are available today to help lower this cost by allowing the carrier to remotely test and evaluate battery strings and get a better indication of the health of the battery. These systems can leverage the Internet and remote access technologies to allow technicians to get a view of the health of their systems without a truck roll.

They also feature new tests to gauge the health of the battery. A key test is the ability to force the battery to discharge power and then to monitor the voltage, current and temperature changes. The results of this test can be compared to a profile, either manually determined from experience or based on a manufacturer's specifications.

With this information, a service provider can determine the current capacity of the battery and know exactly how many hours of back up power is available in a remote equipment center.

## Conclusion

As the nation becomes more dependent upon mobile communications, service disruptions related to power outages will increasingly have an impact on customer relations and may even draw regulatory scrutiny. PUCs in several states will undoubtedly begin looking at the issue with the possibility of setting a minimum power back up standard. But with power system technology developments and new power back-up management capabilities, carriers can more effectively manage their power systems to minimize both the cost and the impact on customers.

Al Cioffi is VP of Business Development and Product Management at Valere Power. He has more than 23 years of experience in DC power systems and products for networking, data processing, and industrial applications. He spent sixteen at AT&T Bell Laboratories, starting as a power engineer, and progressed through management, international, manufacturing, and marketing positions. He joined Lorain Products (now Marconi) in 1996 as VP of Engineering and was responsible for bringing to market the highly successful Vortex DC Power portfolio of products. While at Marconi he also held positions VP of Marketing and VP of Operations.

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