A White Paper from the Experts
in Business-Critical Continuity

DC Power Systems for Convergent Networks

A joint White Paper between Emerson Network Power and MTS Allstream

Communication is evolving. The distinction between telecom networks and data centers is blurring, with facilities being built housing equipment for both. Amidst the changes, there are new concerns, new challenges, and some tough decisions that need to be made – including choosing how to power those convergent networks.

This paper probes the differences between telecom and data center power, examines the difficulties in powering equipment for convergent networks, and offers insights into the advantages of using DC power for both telecom and data center equipment.

For decades, equipment for datacom and telecom networks has resided in different locations. As more and more telecom networks carry datacom traffic and equipment, the need for coexistence strategies has become imminent – beginning with the challenges in powering these converged networks.

As voice, video, and data services continue to drive the growth of telecommunications, the evolving networks that bring these offerings to market face new opportunities, new challenges, and new dynamics.

The Messaging Industry Association (TMIA) reports that from 2003 to 2006, US residents 35 years and under have been showing declining use of wireline phones[1]. Roughly ninety percent of them had home telephones in 2003; by 2006, the TMIA survey indicates that those numbers were ranging between sixty-eight and seventy-five percent.

Other independent studies[2] estimate fixed line penetration to decline from ninety-six percent in 2005 to seventy-four percent by 2010. The forecast predicts the decline of fixed lines as it faces increasing competition from alternative, convergent technologies.

Meanwhile, video, voice, and data services over the telecom infrastructure and Internet Protocol (IP) are on the rise. Amidst the changes, companies like MTS Allstream are observing a significant market movement: telecommunications networks are rapidly evolving into systems carrying Internet, IP telephony, and other data traffic in addition to traditional voice telephony. The need to adjust to the evolving market dynamics is fueling a change in offerings and business models. Just as the business models are changing, the equipment requirements are transforming with them.

Datacom industry equipment is typically powered by AC mains with uninterruptible power supplies (UPSs). Telecom facility equipment is powered by DC power plants with battery reserve power. As more telecom operators house datacom equipment, the separation of power solutions for telecom and datacom raises concerns. Different power systems, service requirements, and grounding schemes results in power backup, maintenance, and installation challenges.

Challenges with Powering Convergent Telecom Networks

With telecom operators housing datacom equipment, issues about reliability and reserve time, distribution, grounding, safety, installation, and maintenance come into play.

Reliability and Reserve Time

During mains outages, AC backup power for datacom and DC backup power for telecom offer different reserve times, and both directly affect a network's reliability. For series-connected elements, the lower reserve time sets the cap for reserve power, this results in decreased service availability. In a mixed power environment, more batteries are used; and this potentially leads to more points of failure and more parts to maintain.

While UPS technology has improved significantly over the past ten years, DC power plants continue to be simpler as a system, with fewer points that can fail.

1 Use of Home Phones in the US, 2003-2006, ***The Messaging Industry Association***

2 US Fixed Telecoms Market Statistics, 2001-2010, ***Businesswire***

In a typical telecom central office with a permanent engine generator set (1,000kW -2,000kW) and -48-volt DC power plant (4,000A-10,000A) with three to four hours battery autonomy, the system has comparatively few components (Figure 1.1).

A similar configuration for AC power, with a permanent generator set (1,000kW-2,000kW), AC UPS (100KVA-500KVA), and switching equipment, would have a few more components and a slightly more complex configuration (Figure 1.2).

Depending on tier requirements and budgets, hours of reserve time can be set up for both AC and DC power systems. With DC power plants, this means acquiring additional batteries. For AC power, this requires purchasing additional UPSs.

Installation, Maintenance, and Safety

AC and DC are grounded differently. Implementation to meet safety standards in a mixed power environment can be a challenge. Different standards affect the complexity of the process of grounding equipment.

Installation in mixed power environments is more difficult. Preventive maintenance can be more tedious and more costly with two power systems installed. Mean-time-between-failures (MTBF) is reduced as the surface area for faults and accidents rises with complexity. Mean-time-to-repair (MTTR) can be lengthened as the intricacies of the installation can make the source of the problem harder to identify. Having different power systems typically means dealing with different suppliers, which may add to the costs of maintenance contracts.

Figure 1.1

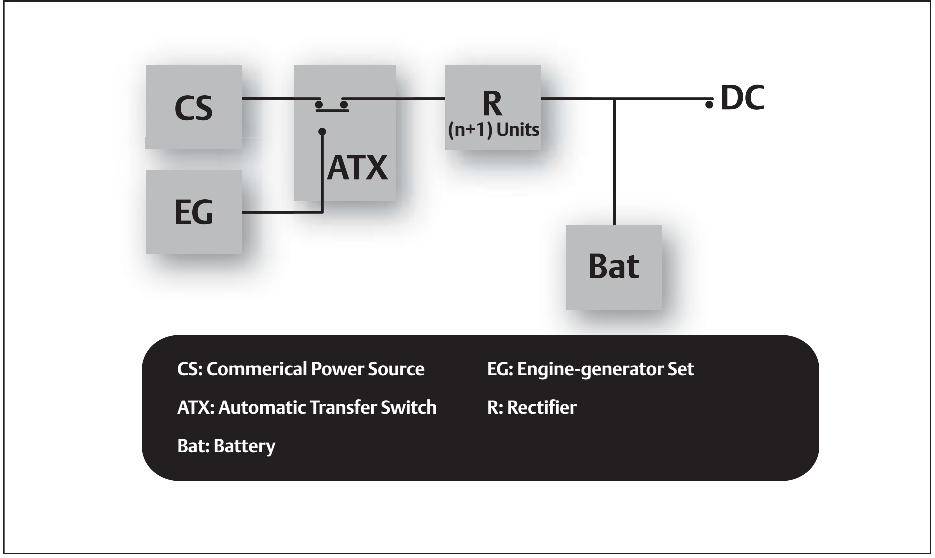
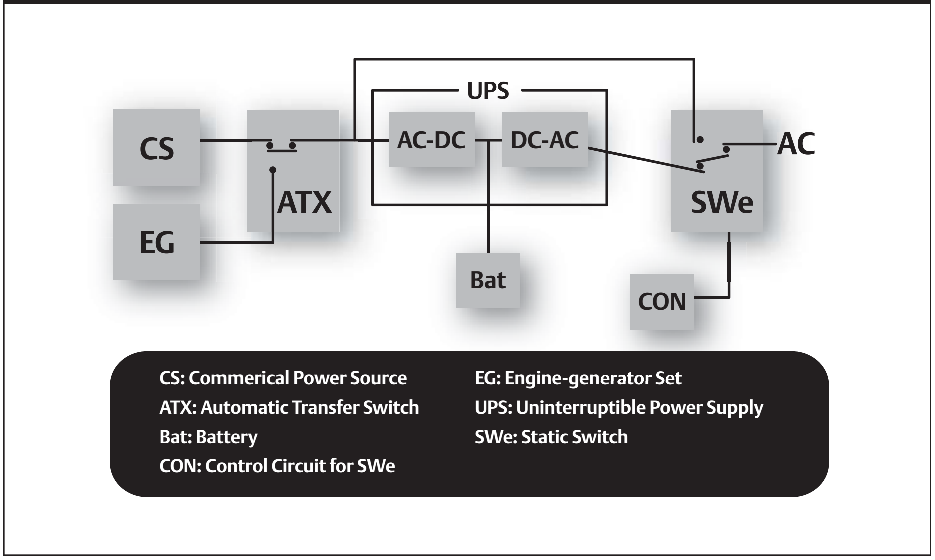


Figure 1.2



Efficiency and Distribution

The capability to protect equipment from disturbances on the commercial power source, like transients, harmonic distortion, and high switching voltages, fundamentally vary for AC and DC power.

DC

DC power distribution entails that the commercial power source currents are isolated from the equipment load – this is something inherent to the system's architecture. The commercial power source goes through rectifiers and power is stored in the batteries. When commercial power fails, there are no switching processes involved, and fewer points of failure – the equipment load is carried by battery output.

Another advantage of DC distribution is that DC power plants do not undergo as many conversions as currents under AC systems do, influencing power efficiency. DC distribution, though, requires more copper than does AC, and this has an impact on cost.

AC

AC systems carry a considerable number of challenges for distribution, perhaps the most important being when the UPS is bypassed, the system relies on protection fitted to the bypass line, as current from the commercial power source directly goes to the equipment. This could mean high-switch voltages, transients, and harmonics are not filtered properly before they reach the equipment.

AC distribution requires more conversions than does DC. Power efficiency is something that has improved with UPS systems tremendously over the last few years, but the conversions still reduce the efficiency of AC systems. However, AC-powered systems carry less copper wire per rack.

DC Power Systems for Converged Networks

Text: For new telecom sites with both telecom and datacom equipment, setting up a mixed power environment can be more costly, less efficient, and significantly more complex than just having one type of power for the entire network. With mixed power, safety becomes more difficult to ensure, maintenance and installation are that much more tedious, and more points of failure are added to the system.

Choosing DC power for converged networks gives networks an array of benefits over both mixed power environments and AC power systems.

Cost-efficiency

MTS Allstream conducted a study showing costs associated with similar power requirements for a new UPS system and a -48-volt DC power plant upgrade supporting datacom and IP telephony growth (refer to Table 1.1, page 6).

Data from the comparison shows that provisioning a new UPS system cost more than upgrading a -48V DC power plant. On top of this, the typical scenario for MTS Allstream DC power plants is that it is maintained by in-house staff, while AC is maintained by electrical contractors. The latter has a significant impact on cost, and adding UPSs cost significantly more than adding batteries.

Reliability and Efficiency

MTS Allstream also conducted a separate case study for AC and DC power for a recently quoted central office (see Table 1.2, page 6).

Both solutions are for new dedicated DC or AC power systems within a segregated space in a central office, with the same type of utilities and a single generator backup.

The DC solution costs less, but the key numbers to note are in the reserve time. The DC option offers four times more backup power than AC, for slightly less than what it would cost to set up an AC system. The reserve-time figures for DC under the case study helps enable tier four uptime, or 0.35 hour of downtime in five years.

Reserve time aside, DC systems utilize power more efficiently than does AC. Another company, NTT Facilities Inc., conducted studies in Japan on data center efficiency using AC and DC systems. Their analysis indicated that data centers achieve a 20 percent improvement in efficiency and a 10 percent reduction in cooling costs when DC systems are used[3]. DC power plants can also utilize power management to switch rectifiers on and off as the load changes, so system operation is at optimum all the time.

DC power is also exposed to less downtime risks. The currents from the commercial power source always get filtered; the equipment is always galvanically isolated from the mains. With AC, bypass operations can sometimes subject the equipment to transients and harmonics, in addition to the risks of switching failures when the commercial power goes out.

3 Use of DC power for data centers in Japan Keiichi Hirose, NTT Facilities, Inc.

Table 1.1 – Cost comparison between AC and DC from MTS Allstream study							
Telecom/ Data Center	**Power Capacity (80% loading)**		**Present Load**		**Unit Cost of AC vs. DC** (Canadian dollars)		**Comments**
	AC	**DC**	**AC**	**DC**	**AC**	**DC**	
Facility 1	325/(260) kVA	6400/(5120) A	201 kVA	3605 A	$186 k / 1000 A*	$80 k /1000 A**	* This system is for a new 65 kVA UPS system, or 48 V 10000A DC plant. ** Existing DC plants have some spare capacity, cost is shown for distribution of 1000 A only.
Facility 2	30/(24) kVA	2200/(1760) A	23 kVA	1327 A	$143 k / 30 kVA*	$95 k / 500AA**	* Cost shown is for 30 kVA UPS. ** Cost shown are for upgrading DC plants including distribution to cover additional 500 A requirement.

Table 1.2 – AC and DC comparison from a case study on a central office				
Power	**Specifications**	**Cost** (Canadian dollars)	**Reserve Time**	**Space**
AC	2x200 kVA UPS 2xSTS 2xPDU Total max load – 160 kVA or 128 KW	$705,000	1 Hour	Approx. 800 -1000 sq ft
DC	-48 V 3000 Amp frame 15x48/200 A Rectifiers Distribution 7xBattery strings Total max load – 2124 A	$600,000	4 Hours	Approx. 540 sq ft

Simplicity

DC power plants are comparatively simpler than AC power systems. As DC power plants only consist of paralleled rectifiers connected to two or more battery strings, there are fewer components and points of failure. The plants do not require plans for phasing. With DC, distribution originates at the point where batteries are paralleled, with only fuses or circuit breakers interposed. If the commercial power source fails, the load gets its power from batteries, no switching takes place.

There are also fewer points of power conversion in a DC system – this helps ensure high power efficiency.

Footprint

Servers that use DC power do not require power supplies for the extra conversion needed in AC systems, and DC systems require fewer batteries than AC. As the number of equipment supported by the power systems pile up, the space saved, because DC systems require less components, amount to considerable footprint savings. These can be used to house revenue-generating equipment.

Scalability

While both AC and DC systems can scale to different power needs, DC systems can do so with more control, and fewer considerations. Large AC UPSs scale at the module level; if the existing modules are 200kW, then 200kW increments have to be used for expansions. DC systems use smaller building blocks and can more closely match the actual load requirement. This result to better efficiency and lower initial capital spent. Also, DC systems can be maintained by personnel with limited power training; as more components get added to scale to the organization's power requirements, the maintenance cost does not increase significantly.

Safety

AC mains with UPSs use higher voltage DC power when converted, so more controls need to be put in place. This has a bearing on the overall safety of the system. On top of this, AC has fourteen different voltages across the world, while the battery voltage for most telecom switching equipment is -48 volts, as defined by bodies such as ETSI and ANSI. The -48-volt DC standard allows technicians to work on the conductor without special safety measures and minimum risks.

Summary

With voice, video, and data services driving the growth of telecommunications, the need to reliably and efficiently power convergent networks becomes a chief concern. DC systems empower network operators to provide just that – greater cost-efficiency and higher reliability in powering mixed equipment facilities.

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