White Paper

SGI™ UPSafe Solutions™

Enabling Effective Power Management Solutions for Today's Changing Power Environment

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Introduction

Almost every organization in the world today benefits from the coming of the Digital Age. Computers help us share knowledge, operate businesses, perform important research, communicate around the globe, and generally improve our way of life. The spread of the Internet especially has made many changes in how we do business.

But the benefits of this computerized society are quite literally being dimmed by the growing failure of the infrastructure most of us take for granted: our electric power grids. Today's demand has far overtaken supply, and current delivery systems are increasingly inadequate for our power-hungry society. Yet demand will only continue to grow: it is predicted that by 2050 the world will need 50–100% more electricity than it does today. At the same time, organizations continue to suffer the same power problems they have always had: poor power quality, disruption from weather, and damage to plants and transmission lines.

Confronted by increasing power delivery failures and insufficient power quality, businesses, institutions, and government agencies around the globe are seeking more effective ways to manage their options in order to prevent the Digital Age from becoming the Dark Ages. New power plants are being planned and new and cleaner transmission solutions sought. But while we wait for these projects to come to fruition—and as companies come to grips with skyrocketing power bills—organizations need to find effective solutions that provide:

- Backup for mission-critical systems such as Web servers and data storage appliances
- General equipment protection from power surges, sags, and spikes
- Short-term power during outages
- Protection during switchover to backup power sources
- Power that is clean enough for use by digital systems
- Intelligent management options to maximize corporate resources and minimize equipment maintenance
- A cost-effective, easy-to-use response to current power emergencies

The power infrastructure we have relied upon for so many years is vanishing. This paper discusses the challenges faced by organizations as they try to adapt to changing power conditions. It also examines the future of companies doing business around the world and some of their likely options.

This paper also demonstrates how SGI UPSafe solutions provide users of SGI systems with a flexible, easy-to-use solution to meet their current power management needs during this chaotic time. UPSafe offers a series of options—ranging from single-unit towers to large-scale, online uninterruptible power supply solutions—to protect computer equipment, whether it be workstations or major research or defense systems. Combined with Global Services, three-year support contracts, and customization for specific needs, SGI UPSafe solutions help users to protect business data and continue operating under adverse power conditions.

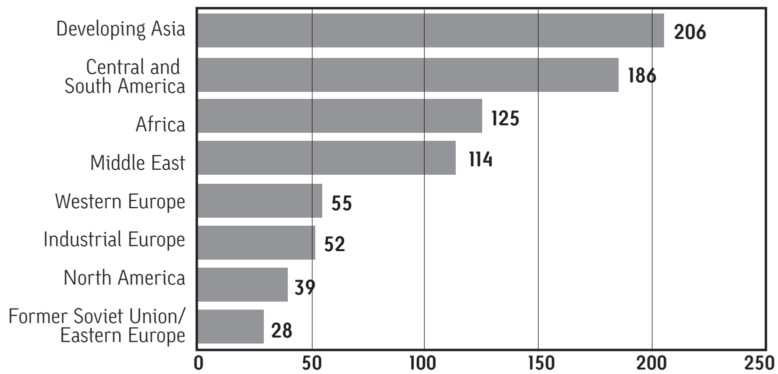
The Unforeseen Consequences of the Computer Age

Demand vs. Supply: How We've Fallen Behind

One of the most unforeseen results of computerization has been its impact on the world's power infrastructures. Digitization has increased power demand around the globe—in the past decade, more than 80% of energy demand growth in the U.S. alone has been met by electric power and within 25 years electricity is expected to account for more than half of the energy consumed by most industrial nations.[1]

As too many businesses learned, the resulting power losses can be devastating. Computers are especially sensitive to changes in or loss of electrical power. As critical systems go down, companies risk corrupted data, damaged hardware, and lowered business productivity. That, in turn, leads to diminished confidence on the part of customers and ultimately impacts the competitive position of organizations. In early 2000, Frost & Sullivan estimated that the overall impact of power-related problems was costing U.S. companies more than $26 billion per year.[3]

Growth in Net Electricity Consumption by Region



Source: Energy Information Administration/international Energy Outlook, from the EPRI Electricity Technology Roadmap (1999).

Unfortunately, power generation has not kept up in many areas of the globe. Third-world countries are struggling to get plants built, due to lack of funding and social unrest. In first-world countries, limitations have been put on building power plants due to growing concern about emissions and safety; while at the same time, utilities and other entities have made a policy of persuading governments to drop incentives for developing and investing in alternative power resources. As a result, almost half of all electricity in the U.S. today comes from only about 100 plants, according to the Utility Data Institute. The situation is even worse in other countries: some produce as much as 90% of their power at a single facility.

This places a huge burden on power transmission and distribution systems designed more than half a century ago, when reliability requirements were much less rigorous and countries were still recovering from World War II. For the most part, needed improvements in both capacity and reliability have not been made since then. During the past decade, for example, total electricity demand in the U.S. rose by nearly 30%, but the nation's transmission network grew by only 15%. Over the same period, expenditures by investor-owned utilities for distribution system construction fell by about 10% in real terms. The outlook for the next decade is even worse: demand is expected to grow by 20%, but planned transmission system growth is only 3.5%.[2]

The situation has only worsened as the result of the 1990s e-commerce boom, which has made the world's economy increasingly dependent on reliable electricity supplies. The Internet cannot exist at all without electric power. Yet in the Asia-Pacific region alone, sales of Web server applications have surged by 112.8% over the past year; in the U.S., they have grown by 61.4%.[4] Internet companies experiencing server downtime for any reason are seeing substantial financial losses. One of the more notorious examples is that of e-auction house eBay, whose dramatic 22-hour crash in June 1999 cost the company more than $5 million just in returned auction fees.[5] In the same year, numbers from Intel indicated that the company takes in about $275,000 per hour over the Web—meaning that the site wouldn't have to be down even for four hours to forfeit $1 million dollars in sales.[6]

According to Resource Data International, in five years the electricity consumed just by e-commerce computer and networking systems has risen from a tiny fraction of the overall electricity pool to close to 13%. This could increase to as much as 25% by 2010.[7] While not all agree on these exact figures, it is apparent that our society's power use has greatly increased due to digitization.

Other Power-Related Problems
Of course, not all power problems are to be blamed on increases in demand. One of the most basic problems with power delivery is the weather. Ice storms bring down power lines. Tornadoes and hurricanes flood plants and destroy transmission systems. Politicians' protestations notwithstanding, global warming is in fact a direct cause of increasing numbers of natural disasters each year around the world, with often-catastrophic results for power production. A 2001 report to the United Nations highlights the fact that emerging nations, many just beginning to participate in worldwide computerization, will suffer the most from these temperature increases and the resulting disastrous storms.

"Even when the distribution system reaches a very high standard, it cannot be completely protected against failure," says Gerd Zieroth of Germany's *Power Quality International Product News*. "Workers digging holes in roads may damage cables; storms, trees or aircraft may bring down overhead lines; lightning may cause short circuits; and switching operations in the distribution system may briefly interrupt the energy flow." At the same time, Zieroth affirms, "industrial applications of electricity are more and more complex and sensitive. Downtime has an immediate adverse effect, and some cases of energy loss may have serious consequences."

Despite what many still believe, one of the most basic, ongoing problems is that electricity coming even from a first-world utility has never been pure—it includes a multitude of ongoing problems such as sags, spikes, brownouts, and surges. Each year, according to the National Power Laboratory, the typical computer location in the U.S. experiences 36 spikes, 392 voltage fluctuations, 128 voltage surges, and 15 blackouts. Approximately half of all service calls and downtime experiences on computers and networks can eventually be traced back to utility power or the mains. Just using the elevators or photocopiers in an office setting can impact voltage flow, gradually building up a series of fluctuations that erodes data flow and integrity.

Today, with poorly planned deregulation wreaking havoc in the U.S. and many countries suffering from decreased power reliability, up to tens of millions of dollars can be lost per day during rolling blackouts. U.S. deregulation is not just confined to California; more than half of the 50 American states and several countries in Europe are currently deregulating their power industries.

Countries are also increasingly buying power across national boundaries. The United States has been purchasing energy from Canada and Mexico for years and is expanding those relationships in response to deregulated demand. Countries such as Indonesia, Singapore, Taiwan, and Thailand buy power from each other on a regular basis, as do the countries of the Vietnam peninsula and Europe.

However, buying internationally introduces new problems with reliability and synchronism, requiring alignment of sometimes widely divergent power systems to insulate equipment on both sides of the border. Especially in the Pacific Rim, emerging nations suffer from supply constraints (inadequate generation and transmission capabilities) as they introduce new technology industries to help boost their economies. Central and South America's fragile power systems also suffer from this problem, as older, weaker systems are asked to carry larger loads with the onset of industrialization.

The Long-Term Effect on Organizations
The conclusion from all this is clear: our dated power infrastructures are becoming increasingly unreliable, during a time when a computerized world economy depends almost entirely on stable power production. The situation will only get worse for the next several years.

Yet, with so many reasons to carefully consider their power options, most organizations still provide little or no power management planning or protection for IT systems. According to the Federal Emergency Management Association (FEMA), in the United States one in four local area networks is completely vulnerable to disaster or disruption; 64% of all organizations do not have an effective plan to protect their wide area networks.[8] And network downtime, says Infonetics Research, is costly. If each segment of a corporation's 30-node local area network is down for just 1.5 hours per year, losses can total $7.5 million in revenue and productivity.

Karl Stahlkopf, vice president of power delivery at the Electric Power Research Institute (EPRI) based in Palo Alto, California, sums it up clearly and succinctly: "Obviously, we've got a train wreck coming."

Constant Change Is Here to Stay

The power landscape has changed forever. Perhaps the impact will be felt the least in Europe's power-rich environment; certainly it will be felt the most in the emerging third-world nations. However, companies in the U.S. and other countries are feeling an increasingly severe financial impact as they absorb growing costs passed on by local utilities and suffer from blackouts, outages, and other previously unknown problems. Even though troubled areas such as California are now buying new power contracts, generation will still fall short of supply by 40% or more for some time to come.[9] Over the next few years, the question of who generates, buys, transmits, sells, and uses power—and how much they pay for the privilege—will significantly impact our worldwide economy.

A common terminology appearing today is the number of nines: the percentage of time that organizations spend out of contact with the power gird. For example, even before the current power crisis, the U.S. grid was

The Number of Nines: The Cost in Time of Power Outages

Reliability Percentage	Number of Nines	Yearly Downtime in Hours*	Equal To
99%	2	87.6 hours	3 days, 15 hours, 36 minutes
99.9%	3	8.76 hours	8 hours, 45 minutes, 36 seconds
99.99%	4	.876 hours	52 minutes, 34 seconds
99.999%	5	.0876 hours	5 minutes, 15 seconds
99.9999%	6	.00876 hours	31.54 seconds
99.99999%	7	.000876 hours	5.26 seconds
99.999999%	8	.0000876 hours	.53 seconds

*Based on 8,760 hours in a calendar year
Source: "Power and Pain: Dollars & Sense," by Chris DeVoney, *Sm@rt Partner* (September 18, 2000).

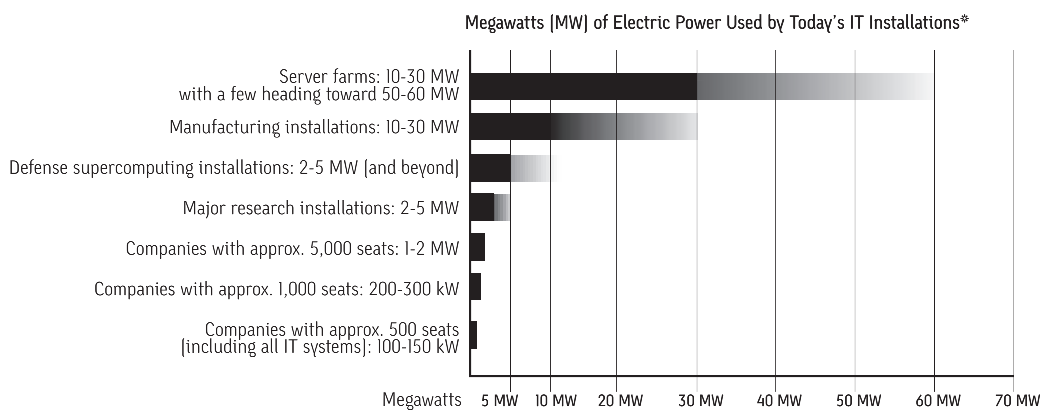
only about 99.9% (three nines) reliable, meaning that on average in any location, power was down for almost nine hours per year. This may not seem like much until one considers the ensuing downtime resulting from damage control. Just a three-minute outage may cost a company hours of downtime, resulting in up to millions of dollars in lost revenues, data, and customers.

In the longer term, hope is offered by the development of new technologies, such as the Flexible AC Transmission System, a family of high-voltage electronic controllers that promise to boost capacity over existing power lines by as much as 40%. New superconductor technologies being developed in Japan may make power generation and transmission far more efficient,although not for some years yet. A few companies are participating in premium power parks, experimental industrial park projects designed to rely on a guaranteed electrical service using new custom power devices.

Short-term solutions for companies include conservation, engaging in real-time pricing, and brokering their own power contracts; it is frequently predicted that in the near future the Internet will serve as a basis for extensive self-service power buying. However, the difficulty with brokering is that the chief problem still remains: Organizations can buy their own power, but not the transmission lines. Inadequate distribution capabilities will help to stifle such initiatives for some time to come.

A Growing Power Delivery Option: Self-Generation
To ensure that companies stay operational, the answer for a growing number of organizations is self-generation—installing backup systems to handle utility power outages or to engage in peak shaving to reduce power costs during the most expensive operation hours or even building their own power plants. These distributed resource developments (known as DRs) range from the most common diesel-powered backup generators to newer natural gas microturbines and

Power Draws for IT Installations



*Including cooling systems
Source: SGI, 2001.

small on-site power plants. Such independent installations have been increasing at a rate of about 35% per year around the world, according to Stahlkopf. DR technologies are in various stages of development and include:

- Microturbines: A rapidly developing technology in the DR arena. Small gas turbine systems in the 300 KW to 2 MW range are being designed by a number of firms for interconnecting distributed generation to electric utility systems. However, it should be pointed out that natural gas prices are rising sharply in the U.S. (now about four times more expensive than coal) and may well impact adoption of these technologies.
- Wind power: With its fiberglass technologies, advanced electronics, and aerodynamics, wind power is the world's fastest growing energy source, increasing 24% annually worldwide throughout the 1990s. Germany currently supplies 2% of its own total energy needs with wind power, and Denmark supplies 7%. Wind turbines are now directly competitive with new gas-fired plants in some regions of the United States, according to the U.S. Department of Energy.
- Photovoltaic/solar: Solar energy is the world's second-fastest growing energy source. Advances in technology have made rooftop solar collectors and photovoltaic generators more economical: in early 2001, solar power cost about 18 cents per kilowatt-hour (U.S.). Two years before, this was a high price; these days, it is an increasingly viable alternative. In California especially, interest in photovoltaic installations has increased dramatically since the power crisis began; both the state and the utilities are offering incentives for making this investment.
- Fuel cells: These electromagnetic devices, combining hydrogen and oxygen to produce electricity and water, offer many promising generation features. However, suitable products are not yet commercially available. A group of municipal utilities in collaboration with the American Public Power Association and EPRI are working to develop a plan to make fuel cells commercially available in the near future.[10]
- Hybrid fuel cell/microturbine technologies are also being tested in Germany.

Additionally, as of 2001, the national Consortium for Electric Infrastructure to Support a Digital Society was launched in the U.S. with a mandate to improve utility power delivery systems and also to figure out how to integrate DRs into the power grid. "Unless the needs of diverse market segments are met through such a combination of power delivery and end-use technologies, U.S. productivity growth and prosperity will increasingly be constrained," Stahlkopf says.

Putting Corporations into the Power Business

Even given such activity in the DR industry, however, some energy experts were surprised by networking leader Cisco Systems' announcement in January 2001 that it was soliciting bids for a 48- to 60-MW plant on its new California campus. This substantial plant would essentially send Cisco into the power business, selling extra energy back to the local grid and perhaps distributing power to other company sites.

However, setting up buy-back deals with today's utilities is easier said than done. Utilities have proven extremely reluctant to buy power from their customers and have so far fought any policy that might make it easier for companies to operate largely off-grid. However, with the State of California now trying to buy transmission lines, for example, such policies may be easier to get off the ground and will provide a model for other states. One of the goals of the Silicon Valley Manufacturing Group, a California advocacy group, is to provide new financial incentives for utilities to buy power back from corporations, changing interconnection standards to enable a free flow of energy in both directions. The Silicon Valley is an especially major area of concern in the midst of the deregulation debacle—it contributes more than $100 billion to the California economy every year, but to do so, it imports 80% of its electric power.[11]

Another challenge is environmental issues. In the long term, the NIMBY (not in my back yard) syndrome is one of the greatest bars to new power generation almost anywhere. While there are increasing numbers of clean power technologies on the market today, companies may have to endure many struggles to create a power source that is acceptable to their neighbors and employees.

Changes in the Global Corporate Culture

Even with these obstacles in the path, however, a movement toward DRs is growing in industrialized nations and is increasingly being seen in third-world countries that lack the resources to build large-scale plants. As a result, we may witness a number of changes to our business culture, including:

- New policies and changes in interconnection standards and technologies that enable corporations and utilities to regularly buy and sell power to each other across the same grid
- Corporate alliances to build and share in the maintenance costs of small to medium-size power plants; with some company losses estimated at millions of dollars per day during each power outage, the cost of building an on-site plant (ranging from $300 to $800 per kilowatt, depending on location and emissions requirements) promises a fairly rapid return on investment
- International investment partnerships that include the creation of on-site power plants as part of funding
- Expansion of the subcontracting power development industry; currently a few firms do operate in this arena, like today's large property management firms, representatives would go to a corporate campus and be paid to permit, build, and maintain a power plant for corporate use
- A rise in the growth of telecommuting, as companies trying to manage their power down to the minute

send more workers home to utilize power from another grid (presumably reimbursing them for power usage)

- Increasing costs of litigation with environmental groups as companies try to strike a balance between power needs and a descent into the smoke-filled days of the Industrial Revolution

Meanwhile—as policies are discussed, plants built, and technologies developed—companies continue to try to negotiate the rugged new landscape of power management. For the next several years, organizations must find a way to protect their IT systems, plan effectively for failures, handle switchover between a variety of power sources, and manage power needs efficiently and inexpensively.

Unfortunately, very few technologies have been developed for this arena, as a worldwide power crisis was never anticipated by the computer industry. Current power protection options range from basic surge strips to generators and DC power supplies, but generally system administrators are looking for an AC power source to provide backup to utility or DR-produced power. Only one existing technology accomplishes this: the uninterruptible power supply, commonly known as a UPS.

The Uninterruptible Power Supply

An uninterruptible power supply is a battery backup system for electronic equipment, positioned between the raw mains and the computer system. It conditions and filters incoming power, eliminating any electrical spikes or surges that may cause damage to computer drives, servers, and networks and their data. It also protects the system in case of a power outage, giving the user time to seamlessly switch over to another power source or to properly shut down the system. Since most power disturbances are very brief and last from a few milliseconds to a couple of minutes, servers and systems usually simply run off the power contained in the uninterruptible power supply.

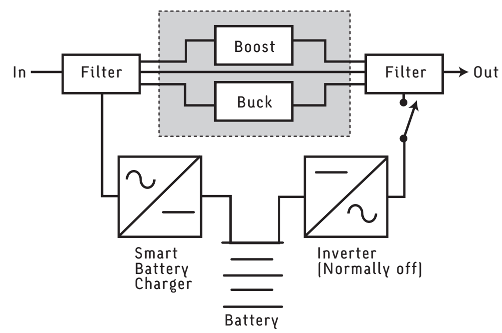
Uninterruptible power supplies can range from the size of a lunchbox to a room and are available at seven different power ratings: from less than 1 kVA to more than 100 kVA. The level of protection a company needs varies with the size of the organization and the critical nature of the systems. Some enterprises have one large system in the basement that protects the power supply for the entire building. These sizable systems can be backed up by a diesel-powered generator or microturbine that serves as an alternative source of power for the duration of the blackout. Other companies may use uninterruptible power supplies to protect specific network servers, storage appliances, or individual workstations containing data that is vital to their business.

Uninterruptible Power Supply Technologies Available Today

A variety of uninterruptible power supply technologies is available at several levels of complexity. The simplest solution is a basic standby or offline design that does not regulate utility voltage or frequency changes. Its inverter converts DC battery power to AC power to run the equipment when voltage or frequency changes become too severe.

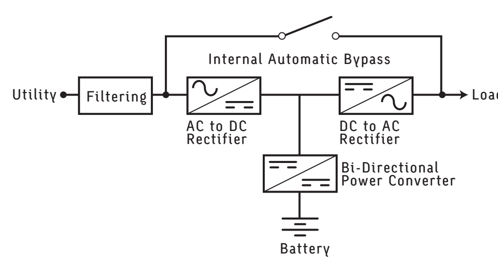
Increasingly sophisticated and robust systems offer more complete protection at a midrange cost. Line interactive technologies protect systems against power failures, power sags and surges, brownouts, and electrical line noise. This design offers active voltage regulation, even in the standby mode, before passing the power through to the IT device. It may run from 5 to 30 minutes during a power outage, allowing administrators to manage a correctly executed shutdown or switch over to an alternative energy supply.

Power Conditioner



Source: Powerware (2000).

The most advanced online power protection devices, or double conversion uninterruptible power supplies, continuously use the inverter (or rectifier, as it is sometimes called) to create 100% clean, regulated AC power for protected computer systems. The equipment is thus isolated from all types of power problems, protecting critical applications that must meet the 5% maximum harmonic requirement stated in major computer manufacturer specifications and installation guides. Such devices use the battery less than other technologies, increasing its life cycle.



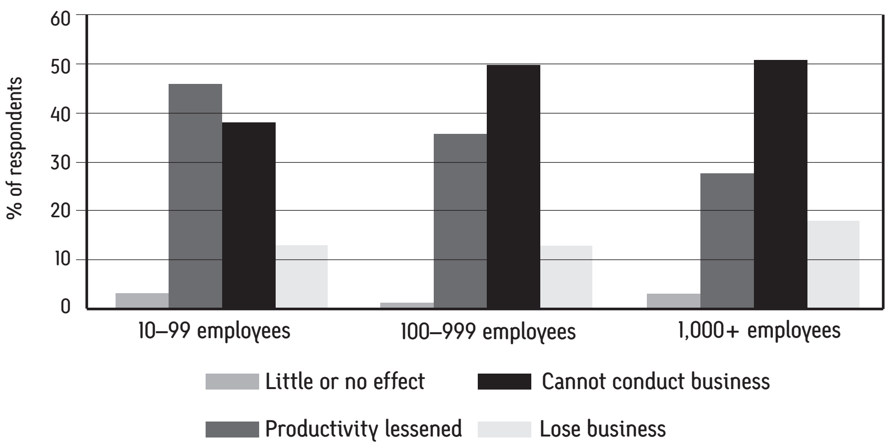
Source: Powerware (2000)

In today's uncertain power environment, businesses are investing in uninterruptible power supply solutions that provide a full range of power management capabilities—allowing users to monitor, transfer, and manage power to the best interests of their operation. Protection during extended blackouts also enables a user-defined, planned shutdown for even the most complex environments. And, by providing conditioned power at all times, companies keep their homogeneous and heterogeneous IT infrastructures productive. Even before the 2001 power crisis, the global uninterruptible power supply market was growing almost 20% annually.[12] For some vendors, sales have now quadrupled since the beginning of the California power crisis, making it clear that companies are becoming more aware of the need to protect their data and equipment.

Power Management Solution Requirements

The right power management technology protects today's distributed environments from the short-term effects of power variation, helps to manage power during a power failure, and supports long-term strategies for power management and corporate growth. The most cost-effective solution is one that integrates fully with current systems, keeps overall complexity to a minimum, and maintains critical systems online as required. Following are the key issues that companies should consider as they select a power management system.

Effect of System Network Downtime by Company Size



Unweighted N – 850
Source: IDC's Technology Integration Panel Study, 1998.

Determining the Number of Systems Needed

How many uninterruptible power supply devices does an enterprise require—a large, single system or multiple small ones? The answer depends on a number of factors:

- Are power loads spread throughout the building or centrally located? If there are a number of smaller loads that need to be protected spread out over the facility, it may be easier to buy a number of smaller devices.
- How quickly does the solution need to be installed? Advanced planning usually isn't required when using smaller uninterruptible power supplies, and such a solution can be installed more quickly.
- Does the company have a large, central location that houses its critical functions (Web and network servers, storage appliances, etc.)? A larger uninterruptible power supply may be the answer. But is there physical space for it, including battery cabinets if required? Will it fit through doorways? Will the floor support the device? Is there an adequate electrical supply?
- What voltage is needed? In North America, for example, companies wishing to install an uninterruptible power supply above 1,500 VA may need to call in an electrician in order to provide the appropriate wall socket. Additional electrical work may also be needed to support a large installation.
- What sort of corporate growth is anticipated? It is best to plan to load each uninterruptible power supply to approximately 70-80% of its total capacity to take future expansion into account. Users generally plug more systems into an uninterruptible power supply over time, not less.

In other words, companies often need to take advantage of a variety of configurations, and these may change over time due to corporate expansion, moves, merges, and reorganizations. It is therefore important to select a power management solution that provides a range of options and can be smoothly integrated and transitioned over time to meet new power demands.

This selection of options is also important to multisite operations. In many cases, large corporations spread out over a number of sites currently silo their power management, with each facility manager making individual decisions about how to deal with a power outage. Such an arrangement can lead to unfortunate results, as some divisions of a company go offline during an outage while others continue to try to function without them. It is advisable for companies to have a solution in place in conjunction with an overall power outage policy, even if the strategy is carried out by disparate units and takes on a number of different forms.

Generator Applications

Increasing numbers of organizations rely on backup generators to support mission-critical systems. A single online or multiple uninterruptible power supplies are needed to help protect IT systems from the inevitable connection delay during switchover, as well as to transform power from DC to AC. Otherwise, critical data could be lost and equipment damaged.

Adhering to Industry Standards

Uninterruptible power supply devices must adhere to strict engineering standards, as with any computer hardware. The Institute of Electric and Electronic Engineers has defined requirements for design applications, equipment and component designs, service conditions, and testing. The solution should also guarantee user safety through compliance with standards such as the European CE standard and UL Listing 1778.

Extended Battery Life

Uninterruptible power supply systems are based on sealed, lead-acid batteries, but how long these batteries last depends on their working environment. All batteries are rated at an annual average temperature of 25°C (77°F), and the longer they can be kept at this steady temperature, the longer their service life. However, each time batteries are discharged and recharged, they lose a small amount of the finite material they contain. Eventually, batteries lose enough of this material that they are unable to support the device. This means that batteries in environments with rolling blackouts or frequent storms are likely to have a shorter service life. For example, a battery in Phoenix, Arizona, is likely to last longer than one in California or Yugoslavia, due to those uncertain power delivery environments.

Therefore, the key to any power management policy is a solution that includes battery management techniques. While all vendors use the same batteries, it is important to insist on technologies providing advanced monitoring and testing capabilities, which can as much as double the length of battery service.

Administration and Monitoring Software

Any uninterruptible power supply solution should also include software that allows administrators to monitor power conditions and establish a user-defined shutdown sequence in the event of an extended power failure. If the power outage lasts longer than the battery time provided by the device and no shutdown has taken place, administrators have simply delayed the impact of the power outage and may lose priceless data or damage valuable equipment.

Extended Run-Time Options

To execute a proper shutdown in the event of a long power outage, some applications may need longer run times. It is important to select an uninterruptible power supply with features designed to protect such applications, including multiple battery pack capabilities.

Load Segment Management

For increased power management and greater cost-effectiveness, companies should have the ability to control separate segments of output receptacles from a single uninterruptible power supply. By shutting down a load segment, administrators can increase run time for the remaining group(s). This maximizes battery usage for critical devices without requiring additional devices or power sources.

SGI UPSafe Solution: Complete Power Management for SGI Systems

As can be seen, a complete power management solution to help companies get through the next few years must provide an array of flexible uninterruptible power supply options, maximum protection from power disturbances, and powerful administrative and management capabilities. In addition, it needs to be easy to install, easy to use, and cost-effective to preserve company resources.

Most of the solutions available today meet only some of these requirements. SGI UPSafe solutions stand alone as complete solutions for protecting SGI systems, even in distributed environments—providing scalable and redundant solutions to match the SGI scalable server product line and protecting Web servers, databases, and large-scale manufacturing and scientific systems from damage, lost data, and loss of productivity.

Key features of the UPSafe solution include:

- A solution approved and tested by SGI that covers all uninterruptible power supply, power monitoring, and support requirements
- A range of options from compact 500 VA models to large three-phase systems
- Rack-mount and tower configurations
- Advanced battery management that doubles battery life
- IRIX® and Linux® OS–compatible network or direct administration and monitoring
- Extended run-time options
- Load segment management
- User-installable (plug-and-play) for most single-phase models
- Global support contracts

The UPSafe Solution Set

SGI's approach to power protection revolves around the nine most common power problems present in most work environments: power failure, sags, surges, brownouts, line noise, high-voltage spikes, frequency variation, switching transients, and harmonic distortion. Working with Powerware, an industry-leading provider, SGI offers a series of standards-based uninterruptible power supply solutions designed to match user needs with the appropriate level of power protection.

The SGI™ 5115 and 5119 provide both tower (stand-alone) and rack-mount versions of the UPSafe solution. These are effective against five of the nine common power problems—power failure, sags, surges, brownouts, and line noise—and offer a degree of protection against the others. Some of the damage they prevent includes premature hardware failure, data loss and corruption, data error, keyboard lockup, storage loss, and system lockup. These two uninterruptible power supply series are recommended for small and large networking environments. Features include advanced battery management, hot-swappable battery, and a start-on battery.

The high-performance SGI™ 9170 online solution protects large-scale systems against all nine power problems, as well as helps prevent CPU lockup errors, overheating and premature failure of electrical components, component stress, burned circuit boards, data crash, and program failures. The 9170 offers the highest level of power protection and 100% clean power and thus is recommended for mission-critical applications such as server farms, manufacturing environments, and hospitals. It also adds features, including redundancy, a double-conversion topology, a hot-swappable power module, and internal bypass.

By deploying these SGI power management solutions, managers can control critical power resources while adding functionality and protection to their system. The UPSafe solution offers easy installation, scalable architecture, remote monitoring, shutdown and control, and other capabilities that increase total system availability while decreasing maintenance costs for protected equipment.

Flexible Options for Physical and Electrical Configurations

The UPSafe solution provides a flexible array of tower and rack-mount options to suit business needs. Racks are increasingly being used in a variety of sizes to save on storage space: ISPs, for example, often have up to dozens of racks of equipment. Instead of taking up floor space for uninterruptible power supplies as well as servers, routers, hubs, etc., administrators may consolidate all this equipment into racks. Companies planning to migrate to a rack environment should purchase a device along with the rest of their SGI equipment; installing an uninterruptible power supply at a later date mandates shutting down the system and possibly rearranging rack equipment already installed. The more power-dense the uninterruptible power supply, the more rack space saved; because of this, SGI offers rack-mount devices that are unsurpassed in their power density.

Generator Applications for Backup Power

SGI 9170 provides the specialized online uninterruptible power supply solution necessary to protect and power computer equipment during switchover to backup power sources. Such systems are also capable of seamlessly handling input from a small on-site plant, as well as switchover to utility-produced power as required.

Superior Battery Service Life

Both SGI and other manufacturers utilize equivalent sealed, lead-acid batteries. However, only the SGI UPSafe solution offers advanced monitoring circuits, voltage regulation capabilities, and intelligent self-testing to extend service life longer than in competitive models. SGI users yield a lower cost of ownership as a result of reduced battery replacement and installation costs. UPSafe also offers battery monitoring devices capable of predicting battery failures before they become a problem.

Software for Effective Power Management

The software bundled with SGI UPSafe solutions includes LanSafe III, CheckUPS II, NetWatch, and OnliNet—well-known third-party software packages compatible with all standard operating systems. These products also support cross-platform functionality for networks using multiple operating systems.

When an uninterruptible power supply is operating with an intelligent device such as a server, it links to the server via a cable connected to a communications port. During an extended power outage, this communications link enables the software to respond to the power failure trigger message provided by the UPS. The software then follows an automatic shutdown sequence that properly turns off the equipment, as opposed to permitting a power failure-related system crash. Network administrators are made aware of the impending shutdown through configurable network alerts, paging, and e-mail features. If power returns to normal, the shutdown is disengaged.

In addition, the network manager can use software to prioritize the use of backup battery resources and preset automatic shutdowns based on the unique needs of each network device and the business as a whole. These advanced software packages also now incorporate regression analysis models that track power events and predict future occurrences, giving managers the opportunity to respond to issues before they become problems.

Multiple Battery Packs to Extend Run Times

SGI also provides devices that feature extended runtime capabilities for applications that need longer to complete and shut down. SGI hot-swappable multiple battery packs are easily connected or swapped out without danger of bringing down the system.

Effective Load Segment Management

SGI UPSafe provides the ability to configure separate segments of power receivers from a single UPS via the bundled SGI software. For example, if administrators have two load segments, they may assign less-critical devices to Load Segment 2. Then, when the system goes to battery during a power outage, Load Segment 2 can be shut down a minute or so into the failure. This enables more efficient battery management, reserving power for the critical equipment on Load Segment 1.

Proven SGI Managed Services

SGI UPSafe solutions are part of SGI Global Services, providing power protection for SGI IRIX and Linux OS–based systems. Organizations may enable a UPS solution and other productivity enhancing solutions using SGI Deployment Services for hardware installation and system relocation, Implementation Services for product-focused system software installation and configuration, and System Management Services, including remote and on-site system administration and system tuning.

Preparing Organizations for a Power Outage

Until recently, many businesses around the world never had to confront the potentially catastrophic effects of power loss. Today, it has become imperative for businesses of every size, in every location, to determine a power management policy to protect their data and operations.

Administrators and managers should consider the following steps:

1. Ensure that all critical and stand-alone systems and network components are properly protected by an uninterruptible power supply.

2. Understand the capabilities and limitations of each uninterruptible power supply before the purchase. Select the one that meets business needs both now and in the future.

3. Select a device that can tolerate wide undervoltage and overvoltage variances without going to battery.

4. If a company has an auxiliary generator or microturbine as a backup to utility power, make sure the uninterruptible power supply is compatible with the alternate energy source.

5. Properly evaluate total power capabilities. However difficult, it is vital for IT administrators to keep track of all the equipment their company owns and operates.

If companies already have a uninterruptible power supply solution in place, they should:

1. Regularly check backup batteries to ensure they are fully charged. This step may not be necessary if, like UPSafe, their solution has self-test diagnostic capabilities and battery monitoring devices capable of predicting battery failures.

2. Check to see if battery maintenance is part of the uninterruptible power supply service contract. If not, ask the supplier what battery maintenance services are provided.

3. When computers or other electronic devices connected to an uninterruptible power supply are not in use, shut them off during periods of inclement weather. This will prevent unnecessary battery drain on the system, which would eventually leave computers defenseless against normal power fluctuations.

Conclusion

Our worldwide power situation will continue to change for some time to come. Over the next several years, organizations large and small will find themselves confronted with a plethora of potential power options: individual power deals, power partnerships, alternative energy sources, and new policies. In the meantime, the one certainty is that organizations need to be prepared for anything.

To survive and thrive, it is vital that corporations, institutions, and agencies institute effective power management initiatives to protect their data and equipment. For SGI users, the UPSafe solution provides an integrated, efficient answer to today's immediate problems, while building the infrastructure to protect systems as they transition to tomorrow's power environments.

References

1. “Power for a Digital Society,” by John Douglas,

The EPRI Journal, Winter 2000.

2. Ibid.

3. *Power Conditioner Market* (U.S.), Frost & Sullivan, February 2000.

4. *Global UPS Markets*, Frost & Sullivan, 2000.

5. “The Cost of Downtime” by Tim Wilson, PlanetIT.com, August 5, 1999.

6. Ibid.

7. Resource Data International, 2000, quoted in “E-comm Short on Juice—Looming Electricity Shortages Threaten Internet Economy,” *InternetWeek*, June 26, 2000.

8. FEMA Disaster Statistics Fact Sheet, March 2000.

9. “State Agrees to Long-Term Electricity Deals,” San Francisco Chronicle, March 6, 2001.

10. “Micro Power Sources,” *San Francisco Chronicle*, February 25, 2001.

11. Association of Bay Area Governments, 2001.

12. *Uninterruptible Power Supplies* Market (WD), Frost & Sullivan, May 2000.

Glossary of Commonly Used Terms

Advanced Battery Management: A three-stage charging system designed to prolong the service life of uninterruptible power supply batteries. By charging the batteries only when necessary, battery life is significantly improved.
Charging stage one: quickly recharges battery to approximately 90% of capacity.
Charging stage two: fully charges the battery to 100%.
Charging stage three: rest mode prevents overcharging.
Charging stage one is initiated after a power outage or periodic self-test.

AC Utility: The electric power furnished by an electric power utility company.

Alternating Current (AC): Current that changes (or alternates) direction at regular intervals. Since the current flows in one direction for the same amount of time that it flows in the opposite direction, the average value of the current flow is zero.

Ampere (Amp or A): The unit of measure for current. One ampere is the amount of electricity per second that flows through a conductor such as a wire.

Battery Backup: A battery or a set of batteries in an uninterruptible power supply system. Its purpose is to provide an alternate source of power if the main source is interrupted.

Bidirectional Converter: A device that changes (or converts) alternating-current power to direct-current power and vice versa.

Brownout: A reduction in the voltage of the AC utility without complete loss of power.

Buck and Boost: A proprietary voltage regulation process used when an overvoltage or undervoltage situation occurs in the uninterruptible power supply. Undervoltage is boosted to make the voltage greater, and overvoltage is bucked to reduce it. The result is less reliance on the battery, extending overall battery life.

Bypass: A circuit used to change the path of the electrical power so that it goes around (or bypasses) its normal path. In the uninterruptible power supply, the bypass circuit is used to route the power around the major electronics so they can be serviced without power interruption.

Converter: A device that changes electrical energy from one form to another, such as from alternating current to direct current.

Direct Current (DC): A type of current that never reverses its direction. Since the current flows in only one direction, the average value of the current cannot be zero unless the current has stopped flowing.

Double Conversion: An uninterruptible power supply design in which the primary power path consists of a rectifier and an inverter. Double conversion isolates the output power from all input anomalies such as low voltage surges and frequency variations by converting AC to DC to AC.

Emergency Shutdown: Used to instantly or quickly shutdown all of the electrical power available to the UPS and the load. An emergency shutdown device is usually used during a crisis to prevent damage to the uninterruptible power supply and the load. Some computer-room installations require a Remote Emergency Power Off capability as part of their security/safety system.

Filtering: A method of removing noise from the output of an uninterruptible power supply, preventing dirty power from reaching connected equipment.

Frequency: The number of times per second to complete one cycle. Defined as Hertz (Hz). In North America, utility power completes 60 cycles per second (60 Hz).

Full Load: The greatest load that a circuit is designed to carry under specific conditions; any additional load is considered an overload.

Harmonic Distortion: The presence of harmonics that change the AC voltage waveform from a simple sinusoidal to complex waveform. Harmonic distortion can be generated by a load and back to the AC utility line, causing power problems to other equipment on the same circuit.

Hot-Swappable Batteries or Power Modules: A feature that enables the user to change uninterruptible power supply batteries or power modules without powering down the connected load.

Internal Bypass: Uninterruptible power supply circuitry that provides a redundant power path. If there is an internal uninterruptible power supply fault, the connected load will still be supplied with unconditioned utility power.

Inverter: A machine, device, or system that changes direct-current power into alternating-current power.

Load Shedding: The ability to selectively shut off a set of uninterruptible power supply outlets, extending the capacity of the battery. Certain models support load shedding with separate outlets for each set on their rear panels.

Overload: A condition in which the load wants more from the power source (such as an uninterruptible power supply) than the power source has been designed to supply.

Raw Power: Electrical power that may or may not contain unwanted electrical signals.

Receptacle: A contact device installed at an outlet designed to accept a single plug. Receptacles on the rear of an uninterruptible power supply accept plugs from supported system equipment such as computers or monitors.

Redundancy: Duplication of elements in a system or installation to enhance the reliability or continuity of operation.

Scalable UPS: An uninterruptible power supply that allows for expandability; for example, enables the device to accommodate a larger load by purchasing additional power modules.

Start-on-Battery: Enables user to power up the uninterruptible power supply in the absence of utility power.

Transfer Switch: A switch that will transfer current from one circuit path to another without interrupting the flow of the current.

Trickle Charge: With the trickle charging process, the battery receives a constant voltage feeding a low current. Constant use of this method dries the electrolyte and corrodes the plate, reducing potential battery service life by up to 50%.

User-Replaceable Batteries: User-replaceable batteries allow the user to easily exchange uninterruptible power supply batteries once the unit has been turned off.

Volt (V): The unit of measure for voltage. Voltage is the electrical pressure that forces the current to flow in a conductor such as a wire.

Volt-Ampere (VA): Voltage (V) multiplied by the current (ampere); apparent power. For instance, a device rated at 10 amps and 120 V has a VA rating of 1200 or 1.2 kVA.

Watt (W): The unit of measure for true power.
Watts = VA/power factor.

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