T H E E L E C T R O N

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UNINTERRUPTIBLE POWER SUPPLY SYSTEMS FOR DATA CENTRES

Uninterruptible power supply (UPS) systems form the foundation of the data centre's electrical infrastructure and provide 'insurance policies' that protect the safe operation of the computing layer.

The highest level of protection is provided by conventional UPS systems operating in true online double conversation mode or VFI, but efficiency is often compromised, particularly when multiple UPS units are used in parallel for resilience and redundancy, taking the maximum loading to 50 per cent of total capacity.

In order to combat these poor efficiency levels many UPS systems now come with an ECO option, or a direct mode of operation (typically VI or VFD), which bypasses the online double conversion technology and allows power to flow directly from input to output. This configuration significantly increases efficiency levels, but also reduces the protective capability of the UPS.

Where once this function was used for non-sensitive loads such as emergency lighting systems, which are not really affected by a short power break, some data centres have now, misguidedly, begun to use the ECO mode as a standard setting in order to save power.

Taking efficiency even further, many of these ECO functions have resulted in increased intelligence of UPS solutions, enabling them to automatically select which mode of operation to choose, subject to mains voltage conditions, historical data and even the weather.

Some manufacturers now employ these ECO modes as the standard operation to increase UPS efficiency with a minority even removing the ability for data centre managers to manually change the settings for a planned power cut.

The problem is that any modern UPS that operates as a default with VI or VFD operation has to react to any issue with the mains supply. IT may well react within a few milliseconds, but those few milliseconds can compromise the safe operation of the computing layer supported by the UPS, the very reason the original investment in the UPS was made.

Conventional online double conversion UPS solutions, by contrast, are unable to achieve the same 95 to 98 per cent efficiency levels, but they do provide a constant output to the load that is isolated from mains input, so protecting the connected equipment from all mains borne disturbances.

As a result of this trade-off the question now being asked is 'should data centre managers be forced to choose between high efficiency with compromised protection and complete protection with compromised efficiency?'

At Data Centre World a new range of technologies was presented to help resolve this dilemma.

Available from 60 kVA upwards, Borri UPS units are of traditional design and incorporate online double conversion topology. They also include an output isolation transformer as standard to provide ultimate protection through galvanic isolation of the critical load from input spikes, surges, inverter switching devices and DC voltages. Borri state:

'Investing at component level ensures that users gain maximum power protection by operating in online double conversion mode but can also achieve high efficiency levels. These sophisticated UPS solutions can operate at efficiencies of 95 per cent at full load, and even over 93 per cent at half load and below, ensuring users deploying the units in redundancy can still achieve impressive efficiency gains,'

Following an FXS upgrade in 2011 SmartOnline (SOL) mode has been added giving users the option to allow the UPS to switch between conditioned line and direct line mode of operation.

The B9000FXS and B9600FXS series of units incorporate SOL, which monitors the quality of power supplied and selects the most efficient operating mode based on the environmental conditions at the time and achieve efficiency levels of up to 99 per cent. Borri state:

'Unlike other UPS systems, SOL allows the user to select how and when it is to operate in a high-efficiency, direct line mode. The system will always revert to a conditioned line mode as default until an operator defines the characteristics to run in high-efficiency direct mode.

Most importantly, data centre operators can take full control. Consideration can now be given to the power output, day-to-day energy consumption and environmental impact, as the FXS upgrade gives data centre operators the flexibility as to whether they operate in Online Double Conversion (VFI) for complete protection or run in SmartOnline mode for even higher efficiency. The flexibility of the system allows for this decision to be constantly reviewed and changed as required by the data centre.'

A further development is load-based shutdown (LBS), which maximises the efficiency of parallel redundant installations.

Historically, clients who wanted or needed a high level of resilience (N+1, 2N architecture) from their UPS solutions had to make sacrifices with respect to

increasing the power consumption as the UPS efficiency drops as the load per cent decreases. The LBS technology, however, intelligently monitors the connected load on the UPS and maximises the capacity of each UPS within a parallel redundant solution. Any 'spare' UPS modules will then become dormant with their static switch output blocked. In the event of failure of other UPS modules or an increase to connected load these 'spare' modules will return to normal operation within 2ms.

The SOL technology allows the UPS system to automatically switch between the two operating modes depending on the quality of the mains supply and in line with the characteristics specified by the user.

International Certification

The B9000FXS and B9600FXS units have received international certification to EN 62040-3, having achieved over 95 per cent efficiency even at part load when operating in Online Double Conversion (VFI) mode.

This highly sought after certification, which was established by the Internationat Electro-technical Commission in 1999 to help end users better ubderstand UPS capabilities, was awarded to Borri by the global certification body TUV NORD Cert. Borri state:

'The cost and energy savings of even 1 per cent increase in overall efficiency can amount to thousands of pounds. While it is common for some UPS manufacturers to test their equipment in-house and declare the efficiency figures, there is some scope to be optimistic with the results. With this independent certification, users can be rest assured that the specifications we quote are what they will actually realise on-site, guaranteeing a lower TCO and ultimate efficiency.'

Further Information

Borri Limited is an independent business, which works closely with Borri S.p.A. who have been manufacturing in Italy for over 75 years. They currently offer full turnkey UPS solutions, electrical infrastructures, delivery, positioning and SLA driven maintenance contracts to over 2000 customer sites in a variety of sectors from academia to manufacturing.

Contact: Borri, Systems House, Rotherside Road, Eckington, Sheffield S21 4HL.
Telephone: 01246 431431. www.borri.co.uk

CASE STUDY: OXFORD UNIVERSITY

Oxford University provides an example of an organisation that has chosen to install the Borri B9600.

Two of these units have been installed to support an additional data centre located in the basement of the Oxford Molecular Pathology Institute. They are now being used to provide power back-up to a new shared data centre for members of Collegiate University, which is also playing a critical role in hosting the University's administration system and servicing over 50,000 active email accounts.

The B9600 ECO-UPS has an operating efficiency of 95 per cent in true online mode, potentially saving the University significant operating costs relative to comparable non-eco-friendly equipment.

The configuration used at the University involves two Borri B9600 400 kVA systems installed in an N+1 parallel configuration to ensure that one system always remains operative in the unlikely event of a UPS failure.

Two chilled water handling units provide resilient forced air cooling to ensure that the UPS and batteries operate in a suitable temperate environment to prolong operation and usage.

With two further B9600 400kVA UPS systems the critical IT electrical capacity will be increased to 1.2 MVA N+1. An extra bonus will be the ability to add additional capacity quickly without the need for shutdown with Borri's straightforward connectivity solution.

Contact: Borri as above.

CASE STUDY: CORPORATE INFORMATION TECHNOLOGIES

Corporate Information Technologies™ (CIT) helps small and medium sized enterprises in and around Charlotte, North Carolina, USA, and the Central Piedmont Carolinas, with their IT needs. As a VMWare® Enterprise Partner CIT puts virtualisation to use for its clients, educating them as to how this solution can greatly reduce IT costs.

Serving in the role of technology business advisor for its clients, CIT tailors services to the client, whether it is a needs analyst or a complete IT department working on-site or remotely. Key areas of competency include infrastructure virtualisation; enterprise data storage; disaster recovery and business continuity; network infrastructure and information security. CIT provides advanced technology knowledge; hands-on product experience; and hardware, software and project management options. The company seeks to ensure that both itself and its clients use technological solutions that maximise efficiency and budgets.

The company has been using UPS systems for many years, but until recently compatibility with virtualised environments has not been considered. Now, however, software is available that enables seamless integration with the VMWare virtualisation platform.

The innovation is the Eaton Intelligent Power manager, which allows multiple power devices, such as UPS systems, ePDUs and environmental sensors, to be monitored and managed on one computer screen. This program offers users a global view across the network from any PC with a web browser or VMWare's vCenter™ dashboard.

For a company such as CIT that manages its own power devices as well as those of its clients this innovation was clearly of interest, providing the ability to have an all-in-one management window that offers an efficient solution to on-site and off-site management.

Lawrence Cruciana, President and Chief Systems Engineer for CIT, stated:

"We don't have to ask 'What's going on with the power?' We can see it all. We can manage it remotely and control it remotely."

The engineering team at CIT tested the new software in-house, searching beyond mere viewing of the power systems that protect the servers that are hosting all of the virtual machines.

A key attribute of the Intelligent Power Manager is its ability to trigger VMWare's vMotion® during a power outage to transparently move virtual machines onto other, available, servers on the network.

When CIT invited customers to observe the new UPS and Intelligent Power Manager solution there was, according to Cruciana, "immediate interest". He says:

"We saw that there was customer interest to such a level that we should probably replace some of the UPS systems or strongly consider Eaton for the replacement of the UPS systems because of this one differentiator – the technology."

With Intelligent Power Manager in place CIT is now able to:

- Monitor and manage all units connected to the system without ever leaving their facility.
- Maintain continuous uptime and availability
- Transfer virtual machines from one power unit to another without powering anything down
- Keep all devices online until they can safely power down during extended power outages.

Further information is available from The Eaton Corporation, 221 Dover Road, Slough, Berkshire SL1 4RF. Telephone: 01753 608700. www.eaton.com/uk

NEXT-GENERATION POWER MONITORING SOLUTIONS

At Data Centre World innovators in data centre technology 2bm showcased their iMeter, the first product to provide an intelligent, reliable and accurate method of monitoring power consumption without requiring any system downtime.

This revolutionary device can be used at rack level, providing an unprecedented insight into the energy requirement s of servers and Storage Area Networks and switches, as well as the attendant supporting equipment such as lighting and air conditioning, that will enable the controlled reduction of a data centre's Power Usage Effectiveness (PUE) rating.

The 2bm iMeter continuously monitors power consumption allowing reporting that compares every hour, day, week and month to both show clear trends in energy consumption and allow for the setting of alarms based on predetermined thresholds. Real-time alerts can be raised if consumption exceeds the specified threshold, improving day-to-day management, whilst the information can also be integrated with existing systems management tools to provide a complete data centre overview.

The iMeter is supported with iMeter Management Software, a powerful data collection, analytical and reporting software suite designed to enable IT and facilities personnel to manage power consumption in the data centre more efficiently. The software monitors the 2bm iMeter and its attached sensors in order to collect sensor data including power usage, temperature and humidity, so as to enable a better understanding of where power savings can be made within the data centre. This gives organisations the ability to effectively manage and analyse data centre power usage so that decisions aimed at reducing power costs and improving operational efficiency can be easily made.

The power of the iMeter lies in its intelligent sensor, intelliAmp, which has been designed to monitor the current draw of racks via 16A and 32A cables. Unlike other data centre power monitoring solutions that require downtime for implementation, the intelliAmp can be installed in 'live' environments as it simply clips around the cable that needs to be monitored. The unique calibration system ensures that the sensor can be positioned correctly to achieve optimum levels of accuracy, which is ideal for legacy data centres where a re-build is either prohibitively expensive or not possible.

Director of 2bm, Mark King, comments:

"With growing demand for capacity and energy efficiency in the data centre the 2bm iMeter provides a revolutionary power monitoring tool because it can be implemented in a 'live' environment without a complete re-fit, allowing normal uninterrupted operation. Indeed, within just three days, the average medium-sized data centre can be set up with the 2bm iMeter solution, providing managers with real-time access to continuous, in-depth and accurate energy consumption information."

More information is available from 2bm, Eldon Business Park, Eldon Road, Chilwell, Nottingham NG9 6DZ. Telephone:0115 9256000.

CASE STUDY: UNIVERSITY OF WARWICK

The University of Warwick has two main data centres at its Coventry campus. Following an electrical upgrade in one of the main data centre halls the University saw the need to monitor the power supply to each individual rack within the data centre. The 2bm iMeter was considered because it guaranteed accurate meter readings as it is fixed onto each rack's power supply.

Following a period of testing 200 such sensors were installed across three rooms.

The 2bm iMeter provides reports that allow the University to analyse energy usage every hour, day, week and month at rack level. This displays clear trends in energy consumption so that the University can effectively manage power usage by setting alarms based on predetermined thresholds. Power consumption can also be evaluated at departmental level so the University can allocate energy costs against departmental budgets if necessary depending on how much power is being consumed.

Steve Silver, Service Owner at the University of Warwick, states:

"The 2bm iMeter provides an intelligent, reliable and accurate method of monitoring power consumption and critically it can be installed without requiring any system downtime. Before the 2bm iMeter was installed we had no means of measuring the load on each Power Distribution Unit, which meant we could overload any one PDU at any time. Now we are able to monitor the power consumption at individual cabinet level by securely fixing the 2bm iMeter on to the power supply and receiving reliable and accurate energy readings.

Having set up the thresholds on the 2bm iMeter just below the maximum capacity, we are able to highlight any potential problems on a piece of equipment in the data centre before they happen. The ability to have this information sent to us via email alerts is extremely useful, and engineers also receive alerts on their pagers meaning that any issues can be dealt with immediately without causing any disruption to the business."

CASE STUDY: UNIVERSITY OF HERTFORDSHIRE

In the highly competitive world of higher education, state-of-the-art ICT infrastructure has become an imperative and the University of Hertfordshire has responded to this challenge with a major redesign and redevelopment of its data centre and communications infrastructure.

In 1997 the University built a computer room that combined comms equipment with the data centre. This sufficed until 2008 when a decision was taken to move the IT equipment to a new purpose built data centre with the computer room functioning as a major comms room housing all of the networking equipment.

Stephen Bowes-Phipps, Data Centre Manager for the University of Hertfordshire, states:

"This is the main communications room for the University, hosting all the external Internet connections, many internal campus connections, as well as the link to the JANET further education network. Furthermore, at this time, the University was a regional JANET hub, handling connections from other local colleges, making it a critical resource for a large number of organisations."

Unfortunately the migration to the new data centre and reconfiguration of equipment had made the management of the room difficult. The room had office cooling systems rather than tailored data centre technology and the UPS was located in a high voltage room, which meant that any inspection had to be undertaken by an HV trained engineer, adding to the cost. The flooring was also carpet-based, which could potentially cause fibre and dust to get into the equipment.

The University was granted funds to improve the comms room, with the prime focus being to introduce power, fire and flood protection to minimise risk to this critical network equipment. It also provided an opportunity, however, to undertake a more energy efficient refurbishment.

One of the most challenging aspects of the project was the need to ensure zero downtime for students and staff during the three-month time-span of the project. The JANET rack, for example, had to be moved to enable the flooring to be replaced, but it had never been moved since its installation in 1997 and the sheer number of under floor cables meant that this was going to be a complex task. Several other vendor cabinets also had to be retained and also had to be shifted in position without being taken off-line.

It was a challenge to find an organisation that had the capability to do this on a fixed cost basis without a demand for contingency fees. The ensuing tender process led to the selection of 2bm with a brief to upgrade the major comms room, including alterations to and removal of the existing electrical and mechanical infrastructure, replacement of the existing suspended ceiling, replacement of the flooring with a raised access floor with an ESD panel finish, and moving existing comms cabinets, including the JANET cabinet, to allow a phased refurbishment and upgrade of the room.

The facility was fully re-cabled to provide inter-cabinet links within the comms room with links to remote areas of the campus. The cabling has been designed with exposed components to ensure that maintenance can be carried out without the need for intrusion and that additional circuits can be deployed without interruption to IT services.

In order to improve the power supply the team installed a completely new electrical supply infrastructure and mains connections, providing a maximum total 100kW data centre power with 54kW of net technical load. The existing generator and ATS was used to provide 24-hour run time power failure resilience while two high efficiency UPS systems with eight minute autonomy were deployed in parallel to support 'A' supplies, with TVSS filtered mains 'B' supplies providing redundancy in the event of

failure of the ‘A’ supply path. This solution provided 98 per cent efficiency when running in ‘Smart’ mode.

Fire risk was addressed with a double knock fire detection system coupled to an FM200 gas fire suppression system together with a VESPA aspirating smoke detection system for very early smoke detection and warning. This was interfaced with the building’s main fire alarm system.

The University opted for 14 bespoke designed racks, with allocated space and infrastructure for a later deployment of a further six racks. Blanking panels were installed to maximise the efficiency of the solution by maintaining high return air temperatures and each cabinet includes power distribution units (PDUs) with integrated Ammeters.

This power consumption information is combined with the IP metering fitted to the new power distribution boards to monitor the room’s performance and Power Usage Effectiveness (PUE) calculation. Temperature and humidity monitoring is also provided to the front and rear of the IT cabinets.

Energy efficiency was addressed by introducing low energy lighting to all areas fully controlled by proximity switching and an innovative cooling system was developed to compensate for the low ceiling (2.35m) and floor void (125mm). The solution was the installation of 40kW of N+1 inverter controlled ducted cooling (expandable to 60kW) coupled to a 2bm bespoke designed air delivery canopy, which provides a high efficiency open cold aisle solution for the low density cabinet requirement.

Stephen Bowes-Phipps concluded:

“2bm’s refurbishment has made a massive improvement. University of Hertfordshire now has a modern comms facility that is fit for purpose. Now we can leverage that innovative design to gain further energy efficiencies.”

CASE STUDY: BIRKBECK, UNIVERSITY OF LONDON

Birkbeck, University of London has a history that dates back to 1823. It specialises in providing some 20,000 mature students each year with part-time face-to-face evening tuition.

In common with many educational establishments its IT development has tended to be driven by academic departments which ultimately resulted in its having four separate small equipment rooms each with its own cooling and UPS, providing services to specific departments.

In 2008 it transpired that one of these rooms had to be vacated for forthcoming electrical work to be undertaken. This was seen as an opportunity to consolidate the IT infrastructure, particularly as one of the other rooms was also no longer fit for purpose. In addition to this there was also pressure to improve data centre efficiency and drive down energy consumption.

In order to fund the project Birkbeck was granted a £500,000 interest free loan from Salx, an organisation that has been set up specifically to accelerate investment in energy efficiency technologies across the UK public sector.

The project was constrained by the fact that the new space available was relatively small for the number of racks required and was located in the centre of the building, surrounded by other space that was undergoing redevelopment. In addition there was a time constraint for vacation of the old equipment room, so there was a deadline for commencement of the first phase.

Following the tendering process it emerged that 2bm was the only company willing and able to address the specific challenges that this project presented.

David Willcox, IT Infrastructure Manager for Birkbeck's IT Services, explains:

"It was not simply a question of handing over a room and saying 'there you go' to a supplier. This project required a lot of interaction with the other building work that was going on and therefore required a supplier capable of being extremely flexible as well as totally committed to meeting this deadline"

The primary challenge for 2bm was the delivery of 56 cabinets with a design of 240kW technical load, together with all of the facilities support infrastructure required with a miniscule 180 square metres of floor space, and a low floor to ceiling height of just 3.1 metres. This was achieved by the use of 2bm's innovative 'overhead conditioned air delivery system', which forms a major component of the contained cold aisle pods.

The conditioned air is supplied to the pods using high efficiency perimeter chilled water fan coil units. This overcame the need for a raised access floor, which would have been impossible to install without further space. New free cooling chillers were installed on the roof of Birkbeck and maximum free cooling is achieved by high design water flow and return temperatures.

The new data centre needed an innovative design to deliver the power infrastructure because on-site restrictions precluded the use of a generator to deliver back up. Full resilience was therefore provided by Riello high efficiency MP HIP models that are positioned in a separate switch room together with new metered electrical panel boards and PDUs.

Energy saving technology incorporated into the data centre design include reflective wall surfaces, white powder coated racks with compliant contrasting hinges, hinges and door leading edges, low energy luminaries with proximity switching, and blanking panels to seal unused 'U' space in the cabinets.

A key consideration of the design is that while the data centre resources were being consolidated the space was still being shared by four different management entities. This meant that the equipment was being managed by four separate teams, requiring that there be full flexibility about where the equipment can be located and managed.

It was also important to put in place a way of measuring the resources used by each management team. For this 2bm applied their Sensorium metering solution, which keeps track of the performance of the equipment and ancillary plant, including the cooling unit, UPS and PDUs. It will also raise an alert if there is a problem with any part of the equipment, enabling early intervention.

David Willcox states:

"Insight into power consumption is key to ensure the data centre is operating as efficiently as possible. At the moment there is no requirement to apportion costs on the basis of power consumption – it is currently done on the basis of space occupied. But that may change in the future and the 2bm metering solution would enable Birkbeck to rapidly make that shift to charging power usage on a per cabinet basis."

The new data centre design has led to a reduction in power consumption that has led to a PUE of around 1.3 as opposed to the more typical 2.5.

Birkbeck is now looking to adopt desktop virtualisation, which will demand additional data centre equipment.

David Willcox concludes:

"The reliance on IT within Birkbeck cannot be understated. We have to be as flexible and reactive in terms of the IT requirements of our teaching staff and researchers as possible and anything that provides better protection and an improvement in performance and availability is incredibly valuable. The new data centre also provides a platform on which we can build and develop future services, including desktop virtualisation. Without the new facility it is difficult to see how we could have considered it."

ENVIRONMENTAL TARGETS COMPROMISE DATA CENTRE OPERATIONS

CRC Energy Efficiency Scheme targets "are nothing more than a distraction" according to Mike King, Director of 2bm.

In his opinion article entitled 'Environmental Targets compromise Data Centre Operations' Mr. King is critical of what he describes as "random carbon targets", pointing out that the primary focus for data centre managers should be on understanding costs, operational performance and risk. Data centre monitoring tools should, he says, be used to identify the servers in a data centre that are redundant, to automatically and remotely switch equipment into sleep mode at weekends and to eliminate expensive downtime arising from equipment failure. He says:

"A shift in focus is required. Organisations need to exploit real time data centre monitoring to improve operational efficiency, reduce energy consumption and minimise the risk of downtime to reduce costs. CRC compliance will be achieved by default."

The text of the article is reproduced below.

Business relevance

Given the fast declining global power resources, a commitment to carbon reduction was a compelling policy for a government presiding over a booming economy several years ago. Now, with companies fighting to stay in business, the Carbon Reduction Commitment (CRC) requirement, which came into force in 2011, is actually distracting companies from key issues, such as improving data centre operational performance and minimising expensive downtime.

Today, organisations with power consumption in excess of £500,000 per annum must comply with the CRC Energy Efficiency Scheme requirements and the vast majority (95 per cent) of organisations are now on board.

The 2011 league table shows that over 60 per cent of organisations have taken action by installing smart meters and obtaining a certificate for 'good energy management' from the Carbon Trust or other accreditation scheme. But what does this mean in practice? In reality, some believe this has offered the temptation to avoid making changes to improve energy efficiency prior to the regulation coming into effect to ensure, for the first year at least, that simple, quick changes can be made to meet reduction targets.

Flawed Model

This attitude flies in the face of any real commitment to carbon reduction. But it also raises a huge issue surrounding the relevance of environmental targets when companies should be focusing on operational performance and efficiency. It is great news that organisations are improving metering, especially in the data centre, which is a significant area of energy consumption. But are these organisations leveraging this insight to gain real, operational benefit?

By emphasising the importance of carbon reduction and forcing organisations to prioritise this area, the government has distracted these businesses from addressing the key issues of the day – namely improving performance, reducing costs and minimising the risk of downtime that can damage reputation, lose customers and compromise business viability.

The Confederation of British Industry (CBI) has slammed CRC as adding to business cost; and the reasons are clear. CRC is too narrow; it fails to take into account all the other contributions to carbon, such as business travel and its objectives do not reflect the current business climate.

Data Centre Focus

Of course, data centres are a massive contributor to carbon creation. But they are also the hub of any business operation. Surely efficiency, good performance and minimal downtime should be the focus – not making ad hoc attempts to reduce energy consumption by plugging up holes between cabinets or switching off fans without understanding the implications?

And yet this is the situation facing the majority of organisations. Without understanding energy consumption across the data centre, companies cannot make good decisions. For example, how many data centre managers recognise that turning down the air conditioning within the data centre to increase the temperature from 22 degrees Centigrade to 26.5 degrees Centigrade will result in some servers automatically turning on all three fans on each server – as opposed to the single fan required at 22 degrees Centigrade?

The result is that whilst turning off the air conditioning reduces consumption by 400 Amps in a 1000 server data centre, the additional fans demand an extra 1000 Amps. The net result of increasing the data centre temperature is an additional 600 Amps. The strategy, in this case, is flawed.

There are clearly huge opportunities for reducing energy consumption and, hence, cost within a power hungry environment such as the data centre. However, without accurate insight into energy consumption at rack/cabinet level, data centre managers cannot manage power consumption effectively: they cannot track spikes in demand; identify the least efficient devices; identify the servers that are redundant yet still consuming power; or reliably assess the potential value of new, theoretically more efficient technologies.

Nor can the business exploit technology that can centrally manage energy consumption, remotely turning off lights in empty rooms, for example, or reducing the CPU usage or fan speed on a server that is not being used. Leveraging such tools in combination with real time monitoring will dramatically reduce an organisation's energy consumption. Critically, with such monitoring in place, organisations have early warning of potential problems – such as an air conditioning leak – that could cause downtime.

Conclusion

The world is running out of power at the same time as demand is spiralling. Of course, something has to give. But is CRC really the answer? Some of the world's largest companies are exploiting in depth real time understanding of their operational fabric – from data centre equipment to building facilities – to achieve fantastic reductions in energy consumption. But for the rest, the sheer pressure to meet CRC requirements is clouding the issue, distracting data centre managers from the key practical and operational concerns that are central to effective data centre operations.

Organisations need to focus on saving money and improving performance – with the right approach, carbon reduction commitments will be met by default.

The Institution is grateful to 2bm for permission to reproduce this opinion article.

CASE STUDY: eBAY

As one of the world's largest Internet commerce platforms eBay requires total data centre reliability. Any downtime would impact on transactions that are worth in excess of $2,000 a second. Consequently its global data centre team has to excel simultaneously in delivering uptime and flexibility as well as keeping costs down, which is challenging, requiring a strong ability to be innovative.

Since its inception in 1995 eBay expanded to the point where it had 12 data centre sites in order to manage its ever-increasing compute load. Data centre operating costs increased every year and in order to manage this a four-year data centre plan was devised with the overall goal of halving power costs and doubling compute performance. For this a new infrastructure design was needed offering greater operational agility and improved reliability.

Under the new plan eBay looked to consolidate its assets so that there would be fewer data centres, which would be energy-efficient without compromising uptime.

In May 2010 eBay opened Project Topaz, the largest single capital investment in its history, located in South Jordan, Utah, to house more than a third of its worldwide server infrastructure. This facility deploys all of the necessary redundancies that are required for a Tier IV data centre, yet has a PUE of just 1.4.

By employing innovative energy-efficient mechanisms in its infrastructure – such as optimised building design, water-side economisers, rainwater collection and dynamic controls throughout the cooling and electrical subsystems – Topaz was able to provide power and cooling to the raised floor with remarkably minimal overhead. It also implements many best practices on its raised floor space, working in tandem with the cooling plant to contribute to the site's Leadership in Energy and Environmental Design (LEED) Gold ranking from the US Green Building Council.

Hot Aisle Containment

In order to achieve maximum cooling efficiencies eBay's data centre architecture team outfitted full-scale mock-ups of multiple containment designs, experimenting with different strategies (hot aisle versus cold aisle containment), materials (containment doors versus plastic sheathing) and dimensions. This enabled an optimal balance of cost, flexibility and reliability to be ascertained prior to mass deployment:

'eBay found that hot aisle containment provided more generous buffer times than cold aisle containment in the event of a CRAC failure. The team deployed containment aisles comprising rows of 45U cabinets and partnered with their cabinet and containment vendor to ensure a modular design while still minimising leakage.'

400V Distribution to each Cabinet

With multiple blade servers deployed in certain cabinets eBay wanted any given rack to be capable of provisioning loads of up to 17kW. While this is achievable with traditional 208V distribution, Topaz achieves higher cost efficiencies by extending higher voltage distribution all the way to each cabinet:

'By supplying 400V power to each rack eBay minimises step-down transformation and line transmission loss while simultaneously reducing copper utilisation.'

Specifically, eBay provides 400V three-phase power to two Raritan intelligent rack power distribution units or 'rack PDUs' in each cabinet. The rack PDU, with internal line-to-neutral (3-phase WYE) wiring, supplies each server with 240V, single-phase power – well within the operating range of the power supplies of virtually any IT equipment:

'By eliminating unnecessary voltage transformations, 400V power reduces energy costs by approximately 2 to 3 per cent versus 208V distribution and approximately 4 to 5 per cent versus 120 V distribution.'

Detailed Server Power Instrumentation

Arguably the most important economic metric for eBay's data centre operations team is aggregate cost per search. With CPU capabilities growing with each product generation, eBay replaces its servers in two-year refresh cycles as performance-per-Watt gains outweigh the capital costs of new assets. With each server procured, however, eBay can only truly minimise its cost per search by factoring in all of the costs of running the server, not just the capital expense, it being noted that energy costs are the single largest operational expense for any given asset.

In order to maximise savings eBay deployed rack PDUs that provide precise energy consumption data for every single power supply of every single server:

'Accurate to IEC/ANSI "billing grade" standards, Raritan's Dominion PX family of rack PDUs provides continuous plus or minus 1 per cent accurate kilowatt-hour information for each individual asset in the data centre. Built with both IT and facility standards in mind, Dominion PX can pass this information upstream to eBay's building management and asset tracking systems in real time, achieving what Green Grid terms PUE Category 3 (or PUE 3) monitoring.'

Granular Temperature Instrumentation

The cooling infrastructure of Topaz is revolutionary in concept, with cooling efficiencies that are enhanced both in cost savings and reliability with a real time understanding of every server's operating environment:

'While most data centres monitor set point and return temperatures, this data only approximates to the actual server environment at the rack. And approximations require operators to build in safety margins and cooling headroom that are, by definition, wasteful. By contrast, eBay knows the exact inlet and outlet temperature for every single cabinet in the Topaz data centre.'

Specifically, Topaz adheres to ASHRAE recommendations for server environmental monitoring, measuring the cold aisle at the top, middle and bottom in addition to the hot aisle. As this information can be monitored constantly, eBay can fine-tune its cooling parameters to optimise efficiency while ensuring instant alerts for any fault condition at the server level.

This level of environmental monitoring would ordinarily be prohibitively expensive to deploy in every cabinet, but with the intelligent rack PDUs deployed granular temperature instrumentation can be provided with no additional infrastructure costs other than the 'plug-and-play' temperature sensors themselves.

Overhead Power Distribution Busway

Most data centres deploy a maze of underfloor power cabling from PDU panel-boards to each cabinet, which significantly impedes airflow supply and so compromises cooling efficiency. This often occurs under the raised floor resulting in the inefficiency being easily overlooked. Furthermore, a standard design that provides dedicated underfloor power "whips" for each breaker also consumes a significant amount of unnecessary and underutilised copper as well as simultaneously limiting flexibility in commissioning new cabinets.

In order to solve this problem Topaz uses an overhead power distribution busway to allow any cabinet to easily tap into a 400A source of power:

'Two busses run alongside each row of cabinets, each supplying redundant power, thereby completely eliminating the need for underfloor whips. Receptacles can be added at any location along the row of cabinets in a matter of minutes by provisioning a breaker-protected junction box, instead of waiting several days for an electrician to provision additional drops.'

Dean Nelson, Senior Director of Data Centre Strategy and Operations for eBay comments:

"A successful data centre strategy assumes that computing demand will grow every year, yet enables this growth without proportionate increases in operational expense. We have to break the linear relationship between compute load and operational cost. This requires regular, disruptive leaps in our energy efficiency, computational power and server utilisation profiles."

More information on this case study is available from Raritan, 4th. Floor, 25-26 Lime Street, London, EC3M 7HR. Telephone: 020 7090 1390. www.raritan.co.uk

CASE STUDY: INTERXION

Interxion is a leading provider of carrier-neutral collocation data centre services in Europe, serving over 1,200 customers through 28 data centres in 11 European countries. Uniformly designed, energy efficient data centres offer customers extensive security and uptime for their mission-critical applications. With connectivity provided by more than 400 carriers and ISPs and 18 European Internet exchanges across its footprint, Interxion has created content and connectivity hubs that foster growing customer communities of interest.

When Alex Mason, Customer Implementation Manager for Interxion saw the hot air escaping around the sides of the server rack cabinets and being sucked back into the servers he recognised an instant need to improve energy efficiency. Thermal analysis at the Brick Lane data centre later reinforced this necessity, prompting an upgrade in line with the latest EU Best Practice recommendations for improving data centre efficiency:

'The thermal analysis conducted by Dataracks revealed short-circuiting , hot spots in the aisles, cold and hot air mixing and places where cooled air escapes rather than moving through the IT load.'

With the help of Dataracks, Interxion opted for cold aisle containment, which involved fitting blanking panels within the rack cabinets so as to ensure that cooled air passes through the servers:

'All gaps are blocked between the cabinets and brush grommets fitted where cables enter and exit the cabinets. Aisle roof closing panels keep the air from escaping upwards and doors or curtains are fitted at the end of each aisle.'

For a new build it is possible to standardise on the cabinets, selecting models that are designed in line with best practice standards, but for older data centres there is often a legacy of cabinets all of different sizes made by different manufacturers. Mr. Mason explains:

"Every aisle had a different mix of manufacturers' cabinets and we were working in a live environment."

The Dataracks team worked on the development of self-closing aisle doors that would work without any energy input. Dataracks designed and built the closure and tested it on the aisles at Interxion.

Following the introduction of cold aisle containment there was an improvement in PUE, but Interxion are keen to point out that this metric is often misunderstood and cannot be applied effectively to mixed-use buildings where there is office space as well as datahosting. Mr. Mason states:

"Our Service Level Agreement says we must maintain a temperature range of between 18 and 24 degrees Centigrade for up to a metre from the bottom of the cabinet. Now, with the cold aisle containment, we can meet that right to the very top. So we have no worries in meeting our SLA.

The theory of containment is that in time the CRAC units won't have to work so hard and this will allow us to slow or throttle down some of the units. Although it varies from one manufacturer to another, there is a discussion that CRAC units perform better if the temperature of the return air increases. In our system, where the cold air is controlled, there is no mixing with the hot air and the temperature of the room beyond the containment goes up by 2 degrees Centigrade. I think that we have seen an efficiency improvement from this and as a result we are getting a greater return on our energy usage. Although we haven't gone so far as to make any units redundant we have been able to turn off the units in some rooms and still maintain our SLA."

Jeremy Hartley, Managing Director of Dataracks and of its sister company eCool Solutions, believes that companies that are interested in investigating the benefits of cold and hot aisle containment should set up a pilot study and see for themselves:

"Interxion started in a small way and when they could see the benefits for themselves they extended the scheme across the data centre. We can create a temporary rig, which is often all that a client needs to become evangelical about the solution. Some data centre managers have commented that they can feel the drop in temperature themselves within an hour."

More details about this feature may be obtained from Interxion, 5th. Floor, 91-95 Brick Lane, London E! 6QL. Telephone: 020 7375 7000. www.interxion.com

REDUCED LATENCY BOTTLENECKS FOR SERVER-BASED HDD VOLUMES

Today's work-intensive business applications are often constrained by the performance limitations of their existing hard disk drives (HDDs). With this type of storage infrastructure already in place, it can be cost prohibitive to switch to a new array based purely on solid state devices (SSDs).

SSDs are capable of many more transactions per second than HDDs, but they have a very high cost per gigabyte and are not suited to heavy, large file workloads. This

makes it desirable to accelerate the performance of existing HDD arrays without making substantial investments in new hardware.

In order to provide the desired improvements semiconductor and software designers LSI have developed MegaRAID CacheCade Pro 2.0 read/write software to leverage SSDs in front of HDD volumes so as to create high-capacity, high performance controller cache pools.

The new software eliminates the need for manually configured hybrid arrays by intelligently and dynamically managing frequently accessed data and copying it from HDD volumes to a higher performance layer of SSD cache:

'Copying the most accessed data "hot spot" to flash cache relieves the primary HDD array from time-consuming transactions, which allows for more efficient hard disk operation, reduced latency, and accelerated read and write speeds. This provides significant improvements to overall system performance – two to twelve times that of HDD only configurations – for a wide variety of server applications including web, file, online transaction processing database, data mining and other transaction-intensive applications.'

The new software offers the ideal combination of HDD capacity and SSD speed and is designed to improve the performance of a server's existing drive volume(s) by dynamically utilising SSDs as a dedicated pool of RAID controller cache to maximise read and write performance:

'Manual storage management and in-house application tuning costs can be avoided with CacheCade Pro 2.0 software, lowering the total cost of storage ownership for data centres and small-to-medium businesses.'

The software is the first to offer both read and write controller-based caching on SSDs, dramatically enhancing the performance gains achieved by the previous generation of CacheCade software. With the addition of write caching support, read/write-intensive workloads such as Exchange server, high performance computing applications, Web 2.0 and other IO-intensive online transaction processing database system workloads are said to experience dramatic performance improvements.

The benefits obtainable from the new software may be summarised as follows:

- Accelerated performance of existing HDD arrays with small up-front investment.
- Read and write caching of hot spot data for significant reduction in I/O latency.
- Optimisation for real-world workloads of transaction-intensive applications.
- Lower use of space and power relative to adding short-stroked drive spindles and unrequired capacity.
- Better cost-effectiveness than using all SSD storage volumes in storage arrays.

- Cached write data protected by non-volatile CacheCade cache pools (RAID 0, 1, 10) and data availability protected by RAID data redundancy.

- Simple intuitive management tools to assign and manage the CacheCade SSD pool.

- Industry's first read and write controller-based caching on SSDs that dramatically enhances performance.

More details may be obtained from LSI, One Station Square, Bracknell, Berkshire RG12 1QB. www.lsi.com

CASE STUDY: TOPTABLE

Founded in 2000, toptable is Europe's largest online dining community and restaurant booking service featuring thousands of bookable restaurants across the UK and Europe, and providing users with a free easy-to-use service for searching for and booking restaurants.

Data traffic was passed across a shared VPN leased line, which was a 10Mb/s managed service between the Barbican and the city-based data centre. This line was prone to outages and was too small for the bandwidth-intensive requirements of toptable. Andy Chakraborty, Head of IT Operations explained:

"We found ourselves having to taxi portable hard drives over to the data centre to transfer back-ups because we couldn't physically fit the data down our 10 Mb/s line. But when we looked at upgrading to a 30 Mb/s managed service the costs were outrageous, plus it wouldn't have eliminated the problem of downtime."

When toptable were informed that their building lay on the proposed 2017 Crossrail route, they were given just three months to relocate to new premises, adding to the already difficult situation.

In January 2010 a new location was found in the form of an old warehouse in Moorgate. This had no existing telecoms infrastructure, and the lease on the property was not available until late February.

A move was planned for March, creating pressure to find a network provider that could install within 60 days and without the standard legal lease documents.

Fortunately, toptable's new landlord, The Corporation of London, was able to recommend Geo Networks Limited. The legal teams worked together to obtain a waiver for the wayleave so that the work could commence immediately and a target date of 60 days was set for the installation of a 1 Gb/s dedicated fibre for the building:

'By virtue of the fact that Geo's network exploits London's sewers, it was a relatively easy project to deliver despite the tight timescales. The dig was 100m from the network to toptable's new premises, but seamless project management and dedication meant that Geo delivered the project in just five weeks, giving toptable an extra week for testing before its office move.'

Mr. Chakraborty commented:

"We ran all of the standard tests which were phenomenal, with low latency and no packet loss. Using our old leased line back-ups could take up to a week to transfer. We were now seeing transfer times of under two hours.

It's crazy to think that we were previously investigating scaling up our existing 10 Mb/s to a 30 Mb/s shared fibre line when a dedicated 1 Gb/s managed service from Geo costs a quarter of the price. Every vendor was offering a shared 100 Mb/s line, but even those were on double the cost of a Geo private network.

The downtime, had we opted for a major player with double Geo's lead times, could have cost us £1 million in missed bookings."

With the network being buried deep in London's sewers reliability is likely to remain good over a long period and less likely to suffer as a result of disruption. This is seen as being critical to Internet-based businesses such as toptable.

With an aggressive growth strategy, toptable is already looking at its next connectivity project to a new data centre. Business continuity objectives will involve linking to a number of data centres around the country.

Geo is the only company in the UK that is focused solely on the design and build of bespoke dedicated fibre network solutions for electronic applications. For the first time organisations can own and control their networks ensuring that security, high bandwidth and resilience are guaranteed.

Geo's network is the newest legacy-free, high capacity telecoms network in the UK. With over 3,000 km of fibre footprint Geo can provide large-scale access to over 100 public and private data centres and exchanges.

The latest project is a resilient subsea network to Ireland that will provide dedicated fibre connectivity to Dublin and access to most of the key commercial hubs and data centres in Ireland.

More information is available from Geo Networks Limited, 4th. Floor, Harmsworth House, 13-15 Bouverie Street, London EC4Y 8DP. Telephone: 020 3326 9500. www.geo-uk.net

THE 6SIGMA DC SOFTWARE SUITE

At Data Centre World Future Facilities were showcasing their unique software suite 6SigmaDC, aimed specifically at data centre operators, data centre designers, facilities managers, field engineers, equipment designers and others with an interest in designing and/or maintaining a model data centre.

It is a comprehensive toolset that allows for the building and testing of an entire Virtual Facility (VF), that is a holistic three-dimensional mathematical representation of a data centre in the past, present or future. Modules enable analysis of the configuration at almost any level right down to the design of a specific item of IT equipment:

'The VF provides a standard way for any stakeholders to share their ideas, plans and proposals with each other, so not only does it allow one to one design or evaluate space, power, cooling and network decisions but the VF provides a great communication methodology between interested parties. In fact it can be used to coordinate design, planning and implementation throughout the data centre lifecycle.'

The VF may be used to:

(i) Design, plan and configure the new facility, extension or upgrade including consideration of the architectural form (such as floor void height room shape), location and general methodology (such as cooling in-service corridors, perimeter cooling or in-row cooling), layout cooling and power and network infrastructure to meet the needs of the building plan and IT requirements.

(ii) Manage IT deployment in the room to maximise cooling and energy efficiency, balance power configurations, improve cable routing, maximise space utilisation, maintain inventory and test changes prior to going live.

(iii) Design and plan equipment configuration at room and cabinet level.

Primary applications include:

- 6SigmaRoom for building the VF, considering alternative configurations and inspecting the likely thermal environmental conditions without taking risks with real equipment.

- 6SigmaFM allowing drag-and-drop of new equipment into cabinets, filling of cabinets to capacity, adding or changing cabinets in the model, movement of floor grilles, and modelling of everyday operations.

- 6SigmaRack allowing creation and testing of virtual racks.

- 6SigmaET for equipment design allowing for its configuration right down to component level with a multitude of features such as PCBs, chips, heat sinks, cold plates, angled dims, thermal vias, power supplies and disk drives.

Additional applications and plug-in modules include:

- 6SigmaPower for recording and managing the power system connections in the VF, and analysis of the consequences of a single point of failure of a PDU or UPS.

- 6SigmaNetwork for recording and managing the IP network connections in the VF.

- 6SigmaWeight to check that the weight loading of equipment standing on a raised floor does not exceed the design tile loading, and for ongoing installation management accounting without exceeding weight limitations.

- 6SigmaITM for management of Change Requests with full analysis of the impact of the change, in particular the thermal impact on other equipment and consequences for long-term energy efficiency and capacity.

- 6SigmaCAD for import and export of CAD data from DWG, DXF, XML, and STL files as line drawings that can be used as guides (including snapping to lines) when creating 6SigmaDC models.

- 6SigmaDatAq to program and subsequently download measured temperature time histories from Maxim/Dallas Semiconductor I-Button data loggers for display in the VF and comparison with predicted temperatures – often used in the VF calibration process.

- 6SigmaCooling and 6SigmaDC CFD Solver for evaluation of airflow and heat transfer in a virtual model and of the risk of poor airflow or overheating.

- 6SigmaExchange allowing seamless integration for data exchange of any data that can be associated with an object that exists in the VF.

- 6SigmaChangeRecord allowing seamless integration of Asset Plans between other asset management tools and 6SigmaFM.

Details may be obtained from Future Facilities, 1 Salamanca Street, London SE1 7HX. Telephone: 020 7840 9540. www.futurefacilities.com

CASE STUDY: DELL COMPUTER

The most efficient cooling path in a data centre is direct and well defined. Unfortunately, cooling path considerations made during initial data centre design often involve overly simplistic assumptions because IT equipment layout and composition are usually unknown at design time. Upon implementation, cooling paths will differ from design intent. Consequently it is a challenge to manage the unintended consequences of changing thermal dynamics as IT equipment and load evolve.

Dell's management was hoping to add a new high-density computing zone to Dell's 15,480 square-foot data centre in Austin, Texas. The data centre housed 577 two-post cabinets containing nearly 5,000 networking and storage equipment elements. It had non-uniform distribution of IT loading with high-density equipment concentrated on one side. Despite the presence of 25 Leibert 740C scooped CRAC units (capable of cooling 2.7 MW of waste heat), a handful of servers were overheating as determined by their manufacturer's specifications.

The site's PUE was 1.86, which is described as 'reasonable', but still higher than the commonly accepted ideal value of 1.6.

In order to address the challenges Dell decided to use the 6SigmaDC Software Suite to model the thermal properties of the data centre under three different conditions:

(i) The current 'Baseline' configuration.

(ii) The baseline configuration with proposed low risk/ low cost 'tactical' modifications.

(iii) The tactical configuration with cold aisle containment.

For each simulation all aspects of the data centre were modelled, including the nature and configuration of internal cabinets, floor tiles, structured cabling, and water-plumbing troughs below the slab:

'The detailed modelling produced a consistent and impressive 85 to 90 per cent accuracy level across the entire data centre space. The performance of the baseline configuration was found to have deteriorated over time due to cooling path breakdowns that resulted from prior IT equipment adds, moves and changes. 56 per cent of the cold air from the CRACs by-passed the equipment inlets, and 54 per cent of waste heat re-entered equipment inlets.'

A number of tactical improvements were proposed and modelled, including adding skirts to the power distribution units, sealing holes behind the CRACs, and installing high-capacity floor grilles.

The containment simulation revealed that reducing gaps between cabinets and installing strip curtains around the cold aisles would reduce harmful recirculation:

'The simulations indicated that tactical modifications would reduce recirculation from 54 per cent to 51 per cent, increase cabinet capacity from 2.7 kW to 3.2 kW and increase airflow by 17 per cent. Cold aisle containment would reduce bypass from 56 per cent to 46 per cent and reduce recirculation to 40 per cent. The combined tactical and containment changes would improve PUE from 1.86 to 1.77, reducing overall power consumption by 5 per cent. Furthermore the simulation indicated that greater improvements could be possible if airflow capacity were increased.'

The practical results that followed from the exercise were:

- Chiller power consumption reduction of 12 per cent and total data centre power consumption reduction of 5 per cent providing a potential annual saving of $100,000.

- Capacity per cabinet increase from 2.7 kW to 3.2 kW, facilitating expansion.

- Conclusions based on simulation that would pave the way for the introduction of a new high-density computing zone in the data centre.

Details from Future Facilities as above.

THE FUTURE OF THE DATA CENTRE

Data centres represent a powerful growth area within the electronics industry. Demand for space is high and the advent of cloud computing has accelerated the migration of data and services from customer premises to service provider data centres.

In the journal *Data Centre Solutions*, February 2012, John Soames, Head of Architecture for Adapt, states in his article 'The Future of the Data Centre':

'As large amounts of data are held for longer, the importance placed on the data centre and the ability to connect to its peers and the Internet also increases. What we are seeing in our data centres is a dramatic increase in the density of computer, network and storage provision as power costs continue to spiral.'

Data centres are increasingly capitalising on the higher density of infrastructure and the flexibility of service providers, who deliver a wide variety of infrastructure management and business processing services. Demand is also becoming more service-provider led as they take the lead in the adoption and wholesale use of the data centre with cloud and virtualisation platforms. He states:

'The changing profile of data centre tenancy is altering the nature of the equipment that is powered and cooled, and is also increasing the importance of connectivity. Equipment operates at higher utilisation than ever before, with subsequent increases in power consumption and cooling requirements – making the skills required to manage this equipment within the data centre more important than ever.'

Resilient Internet connectivity via multiple carriers is now being blended with managed firewall and security services and for more stringent end-user requirements a range of extreme resilience services across multiple sites is becoming available:

'The highest calibre of these will include the use of very low latency dark fibre in order to deliver services such as synchronous storage replication and IP failover between sites.'

Service providers are increasingly acting as the wholesale purchasers of space and power, with space resold in smaller, more flexible and more innovative ways, bringing to an end the era of five-year contracts with fixed commitment.

The ascendancy of the Virtual Data Centre has provided access to a potential 20-fold increase in the capacity of every physical data centre, equating to as many as 1,000 production-grade virtual servers in a single cabinet:

'The strategic importance of the physical data centre and the way infrastructure is manages correlates exactly with the increased dependence on the capabilities of single cabinets to support multiple Virtual Data Centre environments.

Virtual environments often have much more inherent resilience where services can migrate seamlessly between physical hardware without human intervention. The most progressive service providers have extended the concept to provide Virtual Data Centres that literally span multiple physical sites. In this type of solution, a virtual server can be migrated between locations in real time with no loss of service for the end users accessing that system.'