June/July 2017
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The lifecycle of a data center

The king under the mountain

We head to Norway to evaluate what could be Europe's largest data center - Lefdal Mine

Top 10 extreme data centers

From frontline duty on the battlefield to the far reaches of space, we chart the most extreme data centers

The second coming of Mark Shuttleworth

We talk to the returning CEO of Canonical about the future of Ubuntu and what's wrong with OpenStack

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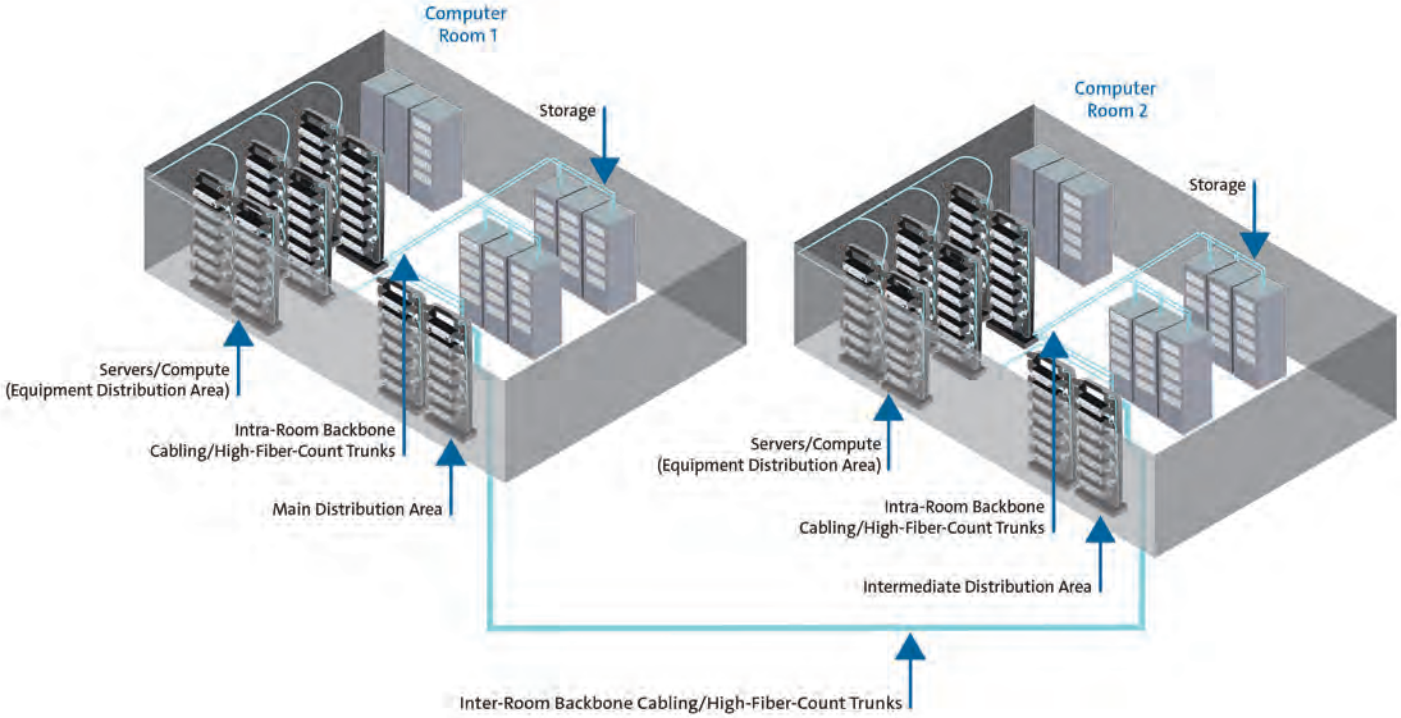

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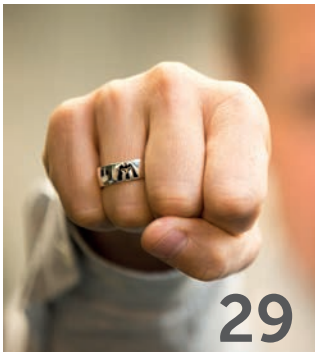

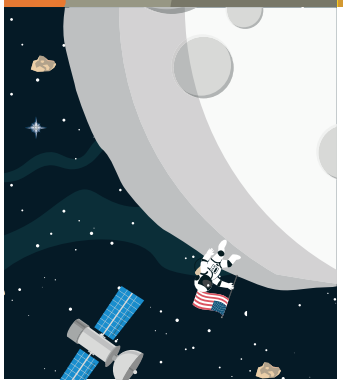

From the Editor

Data center life: going to extremes

Life is 10 percent what happens to you, and 90 percent how you react to it, according to US preacher Chuck Swindoll. I think that's true for data centers, as well as for people.

A data center starts life as a planning application. Whether it gets built, and how it delivers services, will depend on how it responds to the obstacles and opportunities in its path.

A facility will probably last for about 25 years: a short life compared to a human being, but one with many phases (p18). Our cover feature looks at how a data center progresses from concept to actuality, through upgrades and business changes, and eventually to the end of its life.

We can all learn from data centers which deal with conditions beyond the normal range

Extreme data centers live life to the full, thriving in heat or cold, or delivering services from a location that no one would have thought possible - deep underground, or on the edge of space, in orbit in the International Space Station.

We can all learn a lot from these data centers that deal with conditions beyond the normal range. Our roundup (p31) explains why we rate each of these sites, and provides a link to find out more.

Lefdal Mine is a special case, even amongst the most extreme data center designs. Built inside a Norwegian mountain honeycombed with broad tunnels, it could become the biggest data center in Europe.

Before that happens, it needs to gather lots of customers, and this will be a big test for current trends in the data center industry. Are customers ready to trust a remote facility, and use pre-configured kit delivered in containers? We sent reporter Sebastian Moss to find out (p24).

Webscale sites are where these new approaches are being developed, and we're expecting major news stories and radical views from our Webscale event in San Francisco.

One key topic will be the use of increasing intelligence to drive efficiency and flexibility in software defined data centers. Expect to hear machine learning and AI at Webscale. But there's also steady progress in automation through the OpenStack cloud platform - so we sent Max Smolaks to find out more (p40).

Data center performance will also be explored at Webscale. Measuring how sites perform is important and Infrastructure Masons' Data Center Performance Index (DCPI) looks like a promising way to do this (p29).

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47.0°C

Average August temperature in Kuwait City. Could your data center survive?

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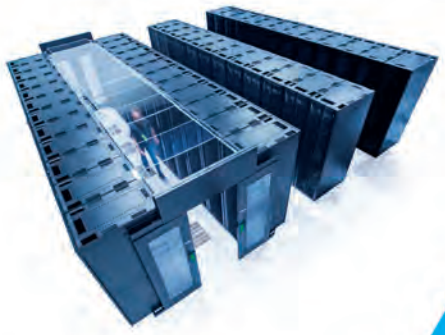

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CenturyLink completes sale of data center business Cyxtera

CenturyLink has completed the $2.3 billion sale of its data center and colocation business to a consortium led by BC Partners. Combined with several cybersecurity companies, it is known as Cyxtera Technologies.

Investor group acquires 365 Data Centers, appoints new CEO

An investor group led by Chirisa Investments has acquired US colocation provider 365 Data Centers for an undisclosed sum and appointed Xand's Bob DeSantis as CEO.

LinkedIn launches OpenFabric webscale standards effort

At DCD>Middle East, LinkedIn launched a standards effort to support webscale data centers. The proposed OpenFabric standard emerged from the company's efforts to develop networks for its own needs.

AMD's Naples server chip becomes Epyc

Previously codenamed Naples, AMD's server chip based on its Zen microarchitecture will be called Epyc.

CyrusOne to build massive data center campus in North Texas

Data center and colocation provider CyrusOne is planning to build a 1.4 million square foot (130,064 sq m) data center complex in Allen, Texas.

The construction will take place in three phases: the first facility will deliver 350,950 sq ft (32,600 sq m), and the following two will add another 619,100 sq ft (57,500 sq m) and 412,800 sq ft (38,300 sq m) respectively.

The campus was designed by Dallas-based architect firm Corgan, which oversaw the design of Cisco's TXDC data centers, also in Allen.

Allen is a popular location for data center providers; TierPoint, Compass Data Centers and AT&T all house their servers there, due to the city's convenient location within the Dallas-Fort Worth metro.

According to a study by Synergy of the metropolitan wholesale and retail colocation market in 2016, Dallas experienced the highest colo revenue growth year-on-year of all US cities and became the seventh largest colocation hub in the world.

When completed, the CyrusOne campus will be the third largest in the area.

The company runs a total of 35 data centers, 32 of which are located in the US, including two in the Dallas suburbs of Carrollton and Lewisville.

Earlier this year, the company also opened a 184,000 sq ft (17,094 sq m) facility in San Antonio.

At the time, CyrusOne's CEO Gary Wojtaszek said: "While one of our Texas customers likes to tell us that we build data centers as tough as a $2 steak, I like to tell folks that they are just as big as the state of Texas."

2017 has also seen the company move into a new headquarters in Uptown, Dallas.

The $4 billion company said that it hopes to double its value in the next five years.

bit.ly/DCDtbone

Vox Box

Yuval Bachar
Principal engineer, global infrastructure architecture
LinkedIn

What's the difference between Open19 and OCP?

They share the approach of creating open hardware technology. The main difference between the two is that Open19 does not define the server itself; it only defines the form factor and the connectivity. It fits any 19in rack and will be available for anyone to consume. It will be available in production from Q3 this year. We defined a form factor so all existing motherboards can fit into it.

bit.ly/DCDopen19

David Liggitt
CEO and founder,
datacenterHawk

How are things changing for colocation operators in the US?

One of the changes we've seen in the last few months is for colocation operators to offer a more complete line of services. As data center users have required more, service providers have worked to deliver additional services. One of the challenges that colocation operators have today is to really understand the ever-changing environment of data center users.

bit.ly/DCDcolovid

Apple...

...close to finishing second phase of Mesa command center

Apple's Mesa command center expansion is "well underway," sources told *AppleInsider*, in the second phase of three planned at the site of a former manufacturing plant.

Contractors are reportedly installing new equipment in the facility, and construction workers are building new roads and infrastructure to support the expansion.

The company's massive global command center was once leased by GT Advanced Technologies, who manufactured sapphire screens for the iPhone 6 under a $578 million contract; but when it failed to meet production expectations and filed for bankruptcy, Apple bought the facility.

Two years later, in 2015, Apple decided to invest $2bn over 10 years into making it a 1.3 million sq ft data center powered by its own on-site solar farm.

bit.ly/DCDcommandandconquer

...will invest $1 billion in Reno data center

Apple has announced a $1 billion expansion of its data center campus in Reno.

"We're excited to be increasing our contributions to the local economy with an additional $1 billion investment to expand our data center and supporting facilities," said spokesman John Rosenstock in an email to *WISN 12 News*.

"As part of our growth, we plan to hire 100 employees and expect construction will support an additional 300 jobs," he added. The company currently employs 700 people in the state.

The state governor Brian Sandoval credits Apple with creating a technology boom in Nevada, saying in a statement that the data center "helped place this region on the technology and innovation map."

But, at the same time as the $1 billion expansion was announced, the Reno City Council approved the technology company's application to build a 30,000 sq ft (2,787 sq m) warehouse in a dilapidated area of the city after several years of delays.

This move will give the company a huge tax break on data center gear used in its Reno facility. See below for more.

bit.ly/DCDRenojackpot

...cuts Reno tax with data center equipment warehouse

Apple will be able to bring down the sales tax rate on hundreds of millions of dollars worth of computer equipment used at its Reno Technology Park data center to just 0.5 percent.

It already had a lower tax rate than most, at 2 percent, achieved through negotiations over the location of its data center, but its purchase of a warehouse will effectively cut it by another 1.5 percent due to the site being located in a tourism improvement district which allows developers to be reimbursed a portion of the sales tax in that area.

Washoe County's sales tax rate is 8.265 percent. Apple has been given $88m in state and local tax breaks (the largest corporate tax exemption in Nevadan history) on its still-growing Reno Technology Park data center, and has used the state to lower taxes across the US.

bit.ly/DCD1morething

Peter's random factoid

The European Commission has asked Apple to pay €13 billion in back taxes it says are owed

Facebook...

...opens Fort Worth data center; large expansion underway

Facebook has officially opened the first phase of its data center in Fort Worth, Texas, as it took steps to follow through on expansion plans revealed last year.

The social network started construction on the site in July 2015, originally conceiving a campus consisting of three buildings totaling 750,000 sq ft (70,000 sq m).

Then, at the end of last year, Facebook increased its investment in the project to roughly $1 billion, promising to build five buildings totaling 2.5 million sq ft (230,000 sq m). With two data centers operational, it has now filed for permits to spend nearly $267 million on a third facility.

The early plans for the second phase, originally spotted by the *Dallas Business Journal*, include 25,406 sq ft (2,360 sq m) of office space, a conferencing center and break room, space for mechanical equipment and a 219,989 sq ft (20,438 sq m) data hall.

Thomas Furlong, VP of infrastructure at Facebook, told the publication: "Three buildings has always been our original concept, but we saw ourselves growing. We went ahead and grabbed enough adjacent land to build five buildings when we saw the additional need."

bit.ly/DCDFortworthsworth

...to go to court over BladeRoom allegations

Californian district court judge Edward Davila has revealed the timeline for the lawsuit between UK-based data center specialist BladeRoom and Facebook.

The British company claims that it shared some of its modular data center ideas with the social networking giant, believing it would enter into a business partnership, but instead Facebook allegedly used the designs for its data center in Luleå, Sweden, and then published them on the Open Compute Project blog.

Facebook denies the allegations, and earlier this year unsuccessfully attempted to get the case dismissed.

In a pretrial order, Judge Davila set the deadline to complete fact discovery on May 18, with an extension until July 28 for some depositions. In August, the parties will meet for a pretrial conference, and in March next year jury selection will begin. The trial itself is expected to begin on April 3, 2018, with a scheduled ending of May 7-11, 2018.

There is still time for the two parties to settle out of court, but the original lawsuit was brought by BladeRoom Group in 2015, and there is yet to be any sign of agreement.

bit.ly/DCDtocourtwego

...to build 200 mile underground fiber cable

Facebook is to lay a new high-capacity fiber cable for its upcoming Los Lunas, New Mexico data center, giving the facility 'three diverse paths to move data' when it comes online next year.

"With state-of-the-art optical fiber being deployed, it will be 50 percent more efficient when moving information compared to most high-capacity cables previously built," the company said.

"Specifically, we can move information 50 percent farther without needing additional equipment to regenerate the signal — helping our bandwidth demands scale."

The cable will stretch 200 miles, which is not enough to reach any of Facebook's other data centers or its headquarters in California, so it presumably links up with another cable or third party facility at that point.

Facebook said: "With this new cable, we're one step closer to the Los Lunas Data Center becoming a cornerstone of our global infrastructure, and we're doing so while supporting and investing in the local economy.

"We expect the construction of this new cable will lead to more than 50 jobs over the next year, which is in addition to the hundreds of jobs created by the building of our Los Lunas Data Center."

bit.ly/Facebooksfiber

Switch plans massive Atlanta data center campus

Cloud and colocation provider Switch has set its sights on the south-eastern region of the United States, where it is planning to build yet another gigantic campus of over one million square feet (92,900 sq m) in Atlanta.

'The Keep' will also become Switch's fourth availability zone in North America, after Las Vegas, Tahoe Reno in Nevada, and the Grand Rapids in Michigan, all of which are up and running but at different stages of deployment.

Outside of the US, Switch runs a SuperNAP facility in Milan, based on its Vegas campus design and built in partnership with the ACDC Fund.

There is another facility underway in Thailand, this time developed with partners CPB Equity Kasikorn Bank, Siam Commercial Bank and True IDC. The 120,000 sq m (1,291,669 sq ft) data center is expected to have capacity for more than 6,000 server racks.

The Atlanta facility will run on 100 percent renewable energy, following on the company's promise to do so for all of its data centers after joining the American Business Act on Climate pledge in 2015.

Details of the development and its anchor clients of the Atlanta data center campus are to be announced at a later date.

bit.ly/DCDplayingforkeeps

China Telecom, Global Switch and Daily-Tech in data center partnership

Telecommunications giant China Telecom Global (CTG) has announced partnerships with data center operators Global Switch and Daily-Tech.

Global Switch runs an extensive network of facilities in Europe and Asia Pacific, while Daily-Tech maintains infrastructure in China.

CTG and Daily-Tech will get access to Global Switch's 10 existing data centers, with plans for expansion worldwide.

Global Switch currently operates in Amsterdam, Frankfurt, London, Madrid, Paris, Hong Kong, Singapore and Sydney, with a combined technical space of 300,000 square meters (3,229,173 sq ft).

"The signing of this agreement is a testament to Global Switch's considerable strength, experience and reliability as an international, large-scale, carrier and cloud neutral data center owner, developer and operator," John Corcoran, Global Switch CEO, said.

"It represents another core building block in our future growth strategy, and is a further demonstration of the springboard and connectivity we can offer to companies seeking to expand within a secure, professionally managed and world class environment."

Late last year, Li Qiang, Daily-Tech's CEO and a major shareholder in the company, led the Elegant Jubilee consortium to acquire a 49 percent stake in Global Switch, despite security concerns raised by the UK's foreign secretary and former head of Parliament's intelligence and security committee, Sir Malcolm Rifkind.

At the time, the two companies announced that they would collaborate on a data center in Shanghai, and since then, Global Switch has closed a $530 million revolving credit facility.

bit.ly/DCDdoesdailytech

Oracle announces a data center in India

Oracle has announced plans for a dedicated data center in India as it looks to expand its cloud services in the subcontinent over the next six to nine months.

The data center will allow customers to "build and move workloads to an India-based cloud," said Oracle co-CEO Safra Catz during a three-day visit to the country, according to a report by *The Economic Times*.

Catz said that businesses should move to the cloud to benefit from its economies of scale, and deploy resources faster and cheaper. Oracle will review proposals from the government and business partners for the eventual facility.

"Our customers and partners in India have trusted their businesses and mission-critical workloads to the Oracle Cloud for years," said Thomas Kurian, the president of product development at Oracle.

The announcement by Oracle comes almost a year after rivals such as Amazon Web Services built multiple data centers to launch two availability zones in Mumbai and three edge locations. Microsoft came in even earlier, opening three data centers in India for its Azure cloud in October 2015.

India is currently in the spotlight as a potential fast-growth market, with hundreds of millions of Internet users and rapidly-increasing online sales.

Gartner has estimated that the public cloud services market in India will grow from US$423 million in 2013 to $1.3 billion this year, putting India as the fastest growing cloud market in the world.

bit.ly/orcalecloudandproud

European colo market sees 27 percent growth, London dominates

Europe has seen the size of its colocation market increase by a quarter in the past year, according to research by property consultancy firm CBRE, based on data centers in Frankfurt, London, Amsterdam and Paris.

In the first quarter of 2017, the four major data center hubs saw a 38MW rise in supply, and existing data centers added 26.6MW of IT capacity.

London accounted for 60 percent of take-up in the past quarter, whereas that of Amsterdam, Frankfurt and Paris put together only amounted to 9MW.

The growth in demand has been mainly attributed to the rise of cloud computing, but CBRE expects that an increase in enterprise activity over the course of the year will contribute to further growth.

London's return to the top stands in contrast with the figures from last year, when Amsterdam became the first market ever to see more than 50MW of take-up in one year, having outperformed London for three consecutive years.

CBRE recently published another report stating that a combination of Britain's exit from the European Union and the new data compliance rules, which will come into force with the General Data Protection Regulation in 2018, would in fact boost the London market, which is already the largest in Europe by total supply.

As for Paris, 451 Research found that - despite slow growth - not only does it remain the third largest colocation market in Europe, but new demand for cloud services from within the country is increasing rapidly.

Overall, last year, take-up in Europe reached a record high of 155MW.

bit.ly/DCDwillprevail

Karnataka state has no disaster recovery

Government departments of the Indian state of Karnataka have reportedly been storing information for over a decade with no backup systems in place.

Information was sent to a data center in Bengaluru, with no copies made to ensure recovery in case of an earthquake, power failure, or any other unexpected event leading to data loss, according to a report in *The Hindu*.

Although the local government has two facilities to its name, both of these are located within a mile of each other and store different types of data. Officials are "considering options" for a disaster recovery site, but concrete plans are yet to be announced.

All Karnataka government records post 2004-2005 - when the first data center was opened - are stored in these facilities, meaning there is no physical back-up either.

"Several communications have taken place at the government level, but no concrete action has been taken. In early 2000, Karnataka took the lead in IT applications in public spaces, but has been slack in the last decade," a government source told *The Hindu*.

"Not having a disaster recovery, a primary necessity in storage space of such a large magnitude, also mirrors the State's interest in IT applications."

According to a 2017 Internet and Mobile Association of India report, the country's data center infrastructure market is set to become the second largest in the Asia Pacific region, expected to reach $4.5 billion in 2018.

bit.ly/DCDnoMaxno

$9,000 /second

The average cost to a business due to data center downtime (Ponemon Institute)

Data center fire knocks out UniSuper

Customers of Australian superannuation provider UniSuper were left unable to access their accounts after a fire at a Port Melbourne data center.

No data was lost or compromised during the fire, which happened at an unspecified facility.

"Early Wednesday morning, an incident at one of our data centers triggered a partial system shutdown. A number of our systems and services were impacted," UniSuper spokesperson Catherine Dohrmann told *iTnews*.

"The direct impact on our members was limited to the outage of our telephony system and MemberOnline portal."

UniSuper, which provides superannuation services to more than 400,000 employees of Australia's higher education and research sector and has more than AU$56.8 billion in assets, was able to come back online on the next day.

The company declined to name the data center provider, but the facility is located in an area home to Vocus, NextDC and Equinix. UniSuper is an investor in both Vocus and NextDC.

This is far from the first time a data center has caught on fire - earlier this year Australia's largest telecoms company, Telstra, suffered a major outage after a core exchange near Sydney went up in flames.

bit.ly/DCDMaxdidit

UK data center outage impacts Australian airports

The passenger processing system used in airports across Australia and New Zealand stopped working on May 22nd, following an outage at an unidentified third party data center in the UK.

The issue with the Society International Telecommunications Aeronautiques (SITA)-run system is believed to have affected airports around the world, but due to the timing of the outage, those in Oceania were the worst hit.

"We experienced a network connectivity issue which resulted in systems provided for border control being disrupted between 21:19 GMT and 00:09 GMT," a SITA spokesperson told *The Register*.

"This was caused by a major telecom failure in the UK of a top provider to our data center. In response, we implemented an alternative communications link and resumed services."

With staff unable to process passports electronically, airports including those in Brisbane, Melbourne, Sydney and Auckland suffered long passenger processing delays and a noticeable backlog, causing the Australian Border Force to deploy extra officers.

This year alone has seen Delta, United Airlines and British Airways ground or delay flights after sudden issues with their digital infrastructure.

bit.ly/DCDStopitMax

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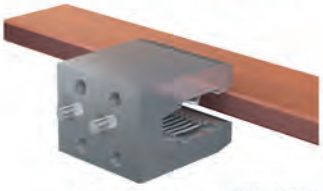

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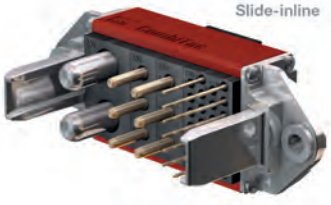

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The Connected University

To become a smart establishment, the Central University of Ecuador has built a new highly reliable data center. *Celia Villarrubia* reports

Growth in Ecuador

One reason the new data center was needed is a growing interest in Internet of Things (IoT) in Ecuador, which required a hybrid cloud solution, said Romero.

While there are some barriers, everything points to unstoppable data center expansion in the region, he said, due to the constant growth of data. "The only limitation is the economic crisis that Latin American countries are going through," he said.

Celia Villarrubia
Assistant Editor LATAM

When the Central University of Ecuador began a project to become a connected, intelligent institution, it needed to carry out a full redesign of the data center within its Department of Information Technology and Communication (DTIC).

Built over 40 years ago, the old data center did not support efficient management of its infrastructure or information. The air conditioning system had constant failures, the UPS and batteries could only support the facility for two minutes, the floor could not hold the weight of the new equipment needed, the data room was dependent on certain electrical equipment, and the security systems were too basic.

Aware of the technical and physical constraints, the University built a new data center based on the principles of redundancy, energy efficiency and modular growth, which overcame all the above problems. The design and building of the facility was carried out by engineering and construction company Constecoin.

"The requirement was for a data center with high availability and cutting edge technology, holding computer equipment with more processing power and storage," said Pedro Tulcán, technical manager of Constecoin. The country needed a connected university, where society's youth could work on securely stored information, he said.

The DTIC wanted a data center which was also an "integrated technology center," said Carlos Romero, general manager of Constecoin - one which could also provide infrastructure to allow students and teachers to "develop projects that involve processing large volumes of information."

The new data center is located in the basement of the Department's building, which in turn is situated in a campus of 92 hectares. It provides reliable information services for a population of 45,000 students and staff.

The old data center occupied 222 sq m (2,400 sq ft), and more than half of this space was not in use. The new infrastructure enables a more optimal use of space, with equipment distributed in several areas. The IT room supports up to ten racks in a space of 30 sq m (320 sq ft), although there are currently more than 7,000 virtual machines linked to the data center and this is expected to reach 10,000 VMs.

As well as the white space, there is a separate 21 sq m (230 sq ft) power area, which holds the UPS, the power distribution panels and battery banks. The space is completed with a monitoring room, a research room and a room for exhibitions.

The University and Constecoin carried out an electrical and architectural survey and decided on a Tier II+ architecture with a maximum downtime of 22 hours per year for maintenance.

The electrical system has two power sources: one from the utility Electric Company Quito (EEQ); the other from an electric generator.

"All connections and electrical panels are designed for a capacity of up to 125kVA," said Tulcán. This gives room for future growth.

The old data center had a 20kVA uninterruptible power system (UPS). The new one has two new 60kVA modular UPSs, with a bank of 40 external batteries per UPS. Each one can be increased with 20kVA modules.

The air conditioning system now has three modules, each delivering 45,000 BTUs, with a cyclic and alternating operation, allowing a permanent cooling capacity of 90,000 BTUs - double the previous capacity.

"Condensing units are installed between the racks to dissipate heat," said Tulcán. "This technology greatly improves air conduction; the cold air is sent in two directions through lateral outlets, distributed evenly throughout the data center.

Major changes to security and infrastructure were made to ensure availability. First, the new data center has a comprehensive fire detection system, which provides early detection through photoelectric sensors located in three areas of the room, and which puts out fires automatically using the clean agent Ecaro 25. The data center has a control panel to monitor any alarm, as well as an access control and CCTV system.

> *The country needed a connected university, where society's youth could work securely*

In the IT racks, the data center uses Vblock systems from Dell EMC, including blade servers, storage and LAN and SAN network, with software management.

The team expects to expand the capacity soon to develop the Smart University project, which will use the new data center as a hub for processing and storage of information, says Romero.

Constecoin will continue on the project with the University for another three years for maintenance and support.

"During this time we will support the development of new projects, such as the Intelligent University," he concludes.

Stretched by the rules for financial data

Indonesian operators are having to adjust to a series of data rules - but the end result could be to their benefit, says *Paul Mah*

Paul Mah
SEA Correspondent

Data centers and cloud providers in Indonesia have had quite a learning curve in the last ten years, as the government has ramped up regulations on the use of data by financial institutions.

A series of rules have been issued since 2007, with ever more impact on the cloud, starting with initial guidelines first introduced in 2007 in the form of Regulation Number PBI 9/15/2007, Alvin Siagian, vice president and director of NTT Indonesia explained at the DCD>Indonesia conference held earlier this year in Jakarta.

After the 2007 guidelines, many data centers and service providers were caught off guard by the implementation of Government Regulation 82 in 2012 (PP82/2012), which ruled that Indonesians' financial data should be housed within Indonesia.

PP82/2012 prohibits financial data from being kept outside the country without prior approval. "There are exceptions... but with strict requirements," said Siagian.

But it hasn't stopped there. Commercial banks should now be getting ready for a new hurdle, more complex than PP82 - Regulation 38/POJK.03/2016 on Risk Management in Information Technology Usage by Commercial Banks, has been introduced by Otoritas Jasa Keuangan (OJK), or the Financial Services Authority of Indonesia. "[The rules] used to be very brief, now it's very detailed. It covers everything, from customer care all the way down to service level management. From your process, your technology, your resources, they will check that," he said.

And this has implications for outsourced providers, Siagian explained. For one, outsourced or cloud providers serving commercial banks must be ready for independent audits by the Financial Services Authority. This means banks can only work with service providers that are willing to – and capable of - cooperating if they want to achieve compliance.

Banks are expected to keep the Financial Services Authority appraised of their providers and the services they are furnishing – effectively allowing the government agency to audit the service providers directly. And this requirement is no longer negotiable, Siagian asserted, including for banks using providers outside of the country.

There are implications should service providers perform below par, either by breaching their service level agreements (SLAs), violating guidelines stipulated in 38/POJK.03/2016, or being unable to provide pertinent data during an official audit. When that happens, banks will need to prepare an action plan to rectify the situation, or could even be asked to terminate the contract midstream for particularly egregious violations.

The clincher? The indications are that these regulations will eventually be expanded to cover the entire financial services industry, and not just commercial banks, he said.

It's no longer "business as usual" for providers in Indonesia, says Siagian. He noted that the days where providers can hide behind empty promises or proclamations of Tier compliance are numbered, as genuine improvement to standards is forced upon the industry.

To underscore the strictness of the Financial Services Authority's approach, Siagian explained that when NTT decided to swap a bank's disaster recovery site with a production site at another location, NTT employees had to accompany the customer to the agency to explain their decision. Ultimately, raising standards

> *It is not about the IT. That is an enabler. It's about the commitment of the business unit*

consists of multiple components such as risk management, managing privacy risks, and securing the physical sites. Customers should have a say if a service provider wants to use a certain subcontractor, and must agree to a chain of business trust.

"It is not about the IT; IT is an enabler. It's about the commitment of the business unit. What is your customer satisfaction?" said Siagian. It is more than just choosing the right outsourced provider. Siagian warned of common mistakes and misconceptions, and said analysts must translate business requirements into IT.

"If you don't have a business analyst in your team, please [hire them]. I see a lot of disconnects between IT and business units," he said. "When people come to us to outsource, they will ask about power, and cost per square meter of a data center," said Siagian, alluding to the mentality that outsourced providers are charging too much.

So how does one go about choosing the right provider? Siagian suggested stakeholders step up and engage with outsourced providers. He said: "Get a feel on the process, on the attitudes. [Learn about their] process governance, their best practices," he said.

And while the onus is on customers to figure out what they need, outsourced providers must be forthright, too. He said: "If you want to outsource, make sure you are clear what your requirements are. Make sure you know what your providers are providing. I always try to be brutally honest, it is a 3, 5 or 10-year contract [after all]." ●

DCD will convene the SE Asia community in Singapore with workshops, data center tours and the DCD>Zettastructure expo during SE Asia Data Center Week (15-21 September).

Indonesia's financial data rules in brief

Regulation Number PBI 9/15/2007 - 2007

Guidelines for cloud use

Government Regulation 82 (PP82/2012) - 2012

Indonesians' financial data should be housed within Indonesia.

Regulation 38/ POJK.03/2016 - 2016

Tightens risk management in IT used by commercial banks.

The data center life story

Data centers are born, they get old, and some day they die, says *Peter Judge*

Peter Judge
Global Editor

Data centers, like people, have a lifetime, and different things mark each stage of their existence. They have an extended and sometimes painful gestation, they can have a difficult birth, but then look forward to a long and useful life.

Like people, they may pass through multiple relationships during their lifetime, forming lasting partnerships with owners and with clients installed within their space. They may become part of a larger family, or spin-off offspring of their own.

During their lifetime, they will have health crises, when their vital signs crash to zero and remedies are needed. At the end of their life, data centers may be more or less decrepit, and ready to retire, eventually to be cleared or demolished.

And beyond their life, data centers are part of an evolutionary cycle contributing to changes in the next generation.

Planning permission is the normal start of the data center's story. A location is found and the prospective parents go through the actions which they hope will eventually produce a healthy, bouncing baby data center that will delight them and enrich their lives.

We needn't go into those activities in too much detail. The early stages of a data center pregnancy are normally kept very private. This isn't coyness: it's merely that the companies involved don't want to alert the competition.

"There's a lot of sensitivity around these exercises," says Malcolm Howe, critical systems partner at engineering consultancy

Cundall. "If word gets out that someone is looking at a particular site, it complicates things no end."

Engineers will start to have some involvement now, says Howe: "We get some involvement in site selection, but normally the client has its own site selection team. We often get drawn into discussions with utilities on power supply and things like that."

The site will have been chosen for numerous factors. It must have energy available - and preferably renewable energy. It must be easy to hook up to networks. The local market for data centers should indicate there will be customers. For instance, the site may have to be close to a population center, like London or New York, so prospective clients can visit easily.

Even after the planning is underway, the actual conception can take a long while. A data center can find it hard to get planning permission, as residents may object to the noise or the looks of their potential neighbor. Even if planning permission is granted, the other elements may prove difficult.

Some data center projects languish for years. For instance, Lockerbie Data Centres sought permission to build a $1 billion facility at Lockerbie in South West Scotland in 2008. Nearly ten years later, the project is still on the drawing board, and has had its planning permission extended three times.

Conception can be tricky, but construction may take about as long as a human pregnancy

An anchor tenant has to be found, unless the facility is being built for one specific customer, be it a cloud provider or a large enterprise.

Once all that is in place, it's time to design and build the facility. This can take some time, but once capital is committed, there's an incentive to get it built quickly.

The building time is normally measured in months. There have been some extremely fast builds - CyrusOne claims a record for building a 30MW facility in only 180 days - but most sites will take about a year, meaning data center gestation takes longer than a human pregnancy.

One thing that speeds up the planning and build process is a pre-existing design, particularly if the data center is being built for a service provider with multiple facilities.

"There is no blank sheet of paper," says Howe. "With a few exceptions, you are working to a reference design." The design may need to be localized or adapted however, for instance selecting a cooling system suitable to the location: "These things are never completely static."

For instance, Telehouse TM2 in London was a one-off, because the price of land and the demand for space mandated a multi-story building. "The fact that it needed to be a tower was preordained, but the shape and size was something unique to that project."

Another shortcut will be the use of pre-selected equipment. "The client may have pre-existing framework agreements with vendors, so when they order up generators, they can get them quicker," adds Howe.

As with any birth, the completion of a data center is a time for celebration. There's a grand opening, people drink champagne, they make speeches, and look forward to the bright prospects of this new arrival.

The data center may be built in phases, and take some time to fill up. When it does, we could see this as the facility reaching adulthood. "It's rare to build out a site in one hit," says Howe. "There's a master plan, with successive phases turned out quite quickly. The designs get polished with each phase. There's always a bit of evolution going on, say moving from a direct cooling scheme, to an indirect air scheme."

Standards help the facility to have a safe and predictable life. "Data center owners have internal standards they adhere to, so lessons learnt in one place are shared across the whole team. Also, if you have a facilities team maintaining these sites, they don't want to be confronted with completely different equipment at each site."

Finally, building and operating a data center can be streamlined with a good asset management system, which can give builders and operators information on where something should be and how it should be configured.

"This can increase the speed of deployment, as installers and operators get feedback in real time," says Peter Kazmir, director of product management at RF Code. "If someone takes down the wrong network switch, this could take down hundreds of customers and have an service level agreement (SLA) penalty."

For the data center, big life experiences will follow, among which will be relationships with new partners. These backers are like a spouse, supporting them through the good and bad times, but sometimes abandoning them, forcing them to find another partner.

The tenants in the data center, meanwhile, can be like children, needing nurture and attention, sometimes being demanding, and sometimes causing trouble. ▶

Health crises

Like humans, data centers suffer from illness and sudden accidents. They need continuous power and cooling, just as humans require air and blood circulation. Any interruption can knock a facility out. It will then require emergency aid, surgery, and possibly extended time off from work.

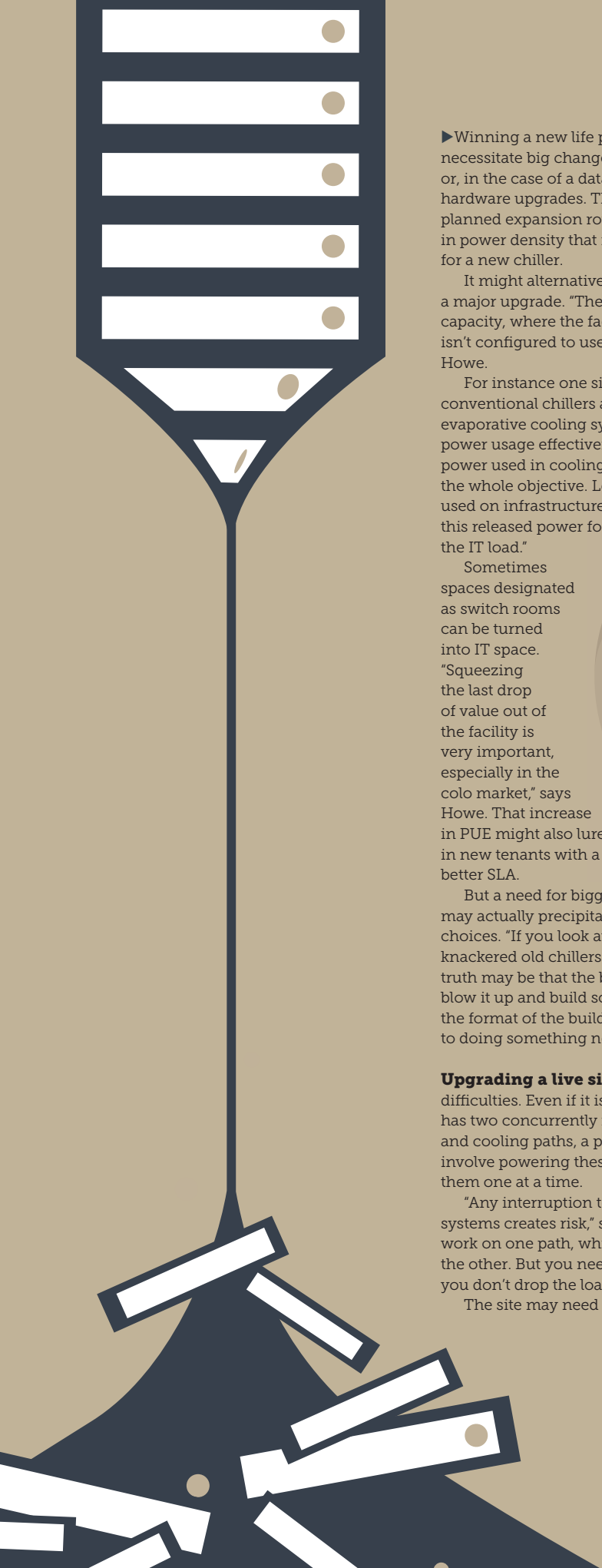
For this reason, operators continuously monitor the vital signs of their charges, and invest in equipment and exercises that keep them in prime condition. They also ensure they are not operating under a load which puts them at a constant risk of failure.

There are emergency drills designed to save the life of a stricken site, to resuscitate it safely if it shuts down, and to minimize any long-term damage to the site, as well as reduce the distress caused to its dependents.

As with people, any illness may be surrounded by secrecy or embarassment. British Airways, for instance, is reluctant to give any details of a failure which grounded thousands of planes in May.

There is an extensive industry catering to the health of data centers; investigating the causes of any sudden illness and applying preventive medicine to other operating data centers.

Healthcare for data centers can be expensive but, as BA and many others have found, the alternative is far more costly.



▶Winning a new life partner might necessitate big changes, like a makeover or, in the case of a data center, some major hardware upgrades. This might be part of a planned expansion route, such as an increase in power density that makes use of room left for a new chiller.

It might alternatively be a redesign and a major upgrade. "There may be trapped capacity, where the facility has power, but isn't configured to use it effectively," says Howe.

For instance one site changed from conventional chillers and CRAH to an evaporative cooling system. This cut the power usage effectiveness (PUE), with less power used in cooling: "That was the whole objective. Less was used on infrastructure and this released power for the IT load."

Sometimes spaces designated as switch rooms can be turned into IT space. "Squeezing the last drop of value out of the facility is very important, especially in the colo market," says Howe. That increase in PUE might also lure in new tenants with a better SLA.

But a need for bigger changes may actually precipitate some tough choices. "If you look at what's there, and it's knackered old chillers and CRAHs, the brutal truth may be that the best thing would be to blow it up and build something else. Often the format of the building doesn't lend itself to doing something new."

Upgrading a live site is fraught with difficulties. Even if it is Tier III certified and has two concurrently maintainable power and cooling paths, a planned upgrade will involve powering these down and replacing them one at a time.

"Any interruption to power and cooling systems creates risk," says Howe. "You can work on one path, while the facility hangs off the other. But you need to choreograph it so you don't drop the load."

The site may need temporary power and cooling during an upgrade, but even then, the upgrade may be too risky for the tenants, who might decide to migrate elsewhere.

Migration is not done lightly, and is likely to be a one-way journey, Howe says: "If you have to move the IT load, why not just move it into somewhere better, and keep it there?"

Migration has also become big business, says Tom Forbes of specialist firm Technimove. "It used to be down to the client, and left to the last minute, but now it is early in the project plan."

Migration services have become part of the colocation vendors' armory: "If the client is coming to the end of the contract, they may want to save money," says Forbes. A new colo provider may win the business by including the migration service: "That minimizes the risks and makes the costs predictable. If the new provider doesn't include migration, the customer is averse to taking the risk."

180 days

time taken for CyrusOne to build a 30MW data center in Northern Virginia

What happens when all the clients move out, leaving the data center with an empty nest? For a person whose children leave home, that could lead to a new lease of life. But the analogy with a human life finally breaks down here. Data centers normally have a much shorter lifespan than humans. The buildings are typically on 25 year leases or less.

"A hyperscale facility could last 15 to 20 years," says Howe. "The steel frame and paneling may last 60 years, but the IT will be updated every three to four years, recycling the servers and crushing the drives."

At this point they are re-occupied by the landlord and someone has to deal with the high tech equipment, and any continuing tenants. By this stage, the mechanical and electrical hardware may be out of date, and the only sensible thing is to decommission the facility.

"The lifespan of data centers is short compared to other buildings," says Howe. ●

Sebastian says

There is such a thing as life after death

Death can be a terrifying concept - a dark, unyielding force inevitably coming for us all. And yet, there is hope.

Buildings which have come to the end of their natural life have been brought back from the dead and turned into data centers, rejuvenating sites that were heading towards the light at the end of the tunnel.

Structures designed for bygone eras have been modernized and made part of the world's digital infrastructure. With print media's tragic decline, printing presses have fallen into disuse - but luckily, data centers are here to save the day.

Both QTS and DuPont Fabros have set up inside now-silent newspaper facilities, perhaps to host modern news publications.

Elsewhere, Apple has reused a factory that once hoped to make iPhone screens, Welsh data center NGD is in a former electronics fab and a Motorola CRT television plant is due to become a Digital Realty data center. Abandoned since 1976, the 63-year old facility could now live to 100. Google, meanwhile, is adapting a power station in Alabama.

But what about data centers when they die? It is too soon to tell what the next wave of architects and builders will make with the remnants of the early Information Age, but we can predict which ones will survive extinction by noting what it took for older structures to survive their own industry's cull.

Robust, adaptable and intelligently located buildings have persevered. But so too have those whose beauty repels the blunt trauma of a sledgehammer.

As we found in our last issue, some data centers are indeed beautiful. Maybe these buildings will live to fight another day.

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The king under the mountain

Sebastian Moss heads to Norway to visit what could become Europe's largest data center

Sebastian Moss
Reporter

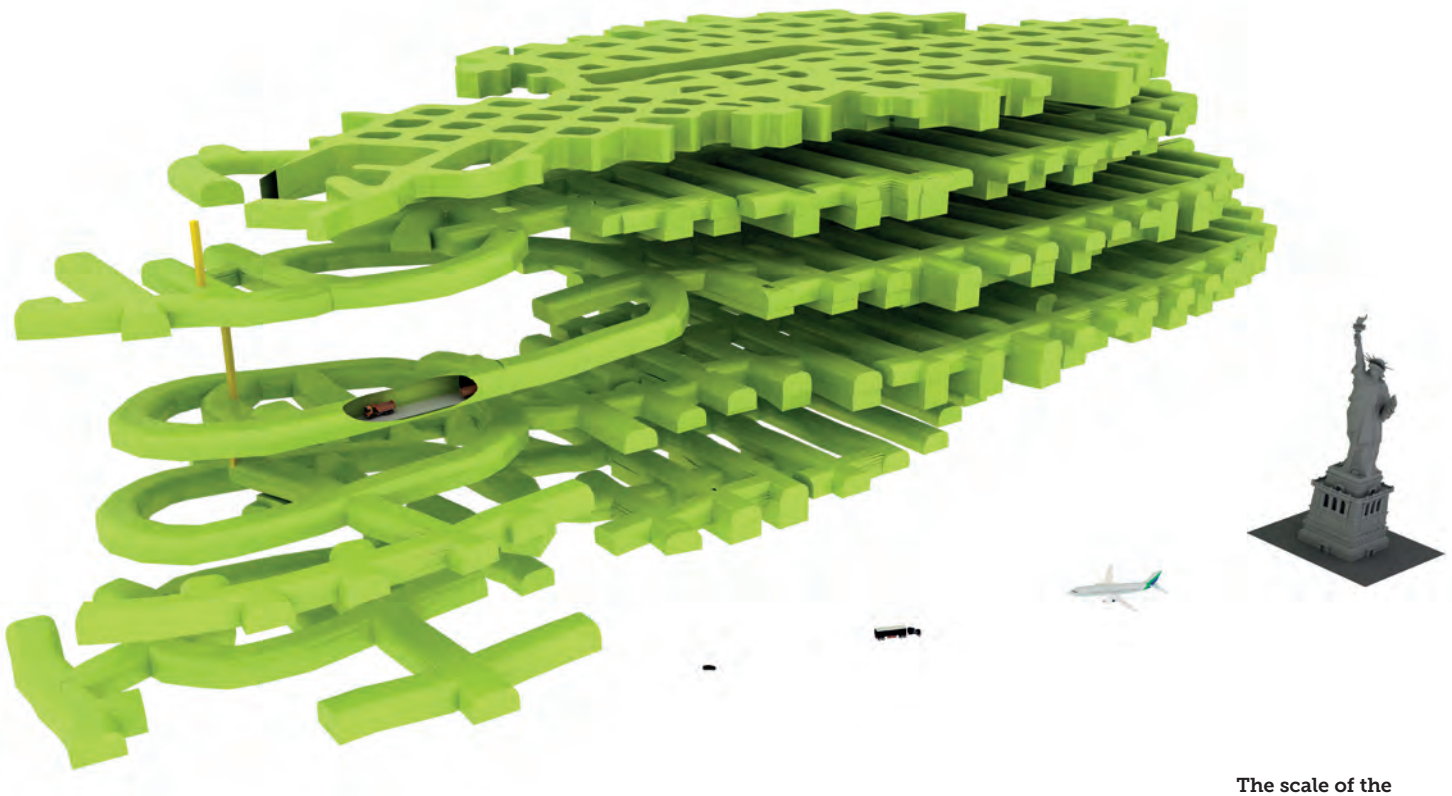
In 1988, while working for the steel and mining company Hoesch, Dr Karl-Ulrich Köhler visited a mine in Norway to discuss olivine, also known as the gemstone peridot. There he met works director Steinar Kvalheim and watched as hundreds of thousands of tons of the green mineral, used to tap blast furnaces in the steel industry, was excavated from the inside of a mountain.

Little did he know that twenty nine years later he would once again stand in that mine, this time with Kvalheim's son, Sindre, and announce that Lefdal has a new use - as a data center.

Now CEO of German IT manufacturing giant Rittal, Köhler has big hopes for Lefdal, telling an assembled crowd at the facility's launch: "We will be by far the largest data center in Europe once fully utilized."

With Lefdal Mine Datacenter now open, the difficult, perhaps impossible, journey to full utilization of some 120,000 square meters (1,291,669 sq ft) of white space has begun.

But the desire to transform the mountain into a data center predates Köhler, whose company is the largest single shareholder in the project.



The scale of the Lefdal labyrinth

Nine years ago, after the mine was abandoned when surface-level olivine was discovered just 10km away, regional hosting company LocalHost realized there could be another use for the empty mountain.

Heidi Grande Røys was Minister of Government Administration and Reform at the time, campaigning in the final months of her term. When in Måløy, she met LocalHost CEO Sindre Kvalheim and investors Gunnar Carlson and Egil Skibenes, who told her about their fledgling plan for Lefdal.

"They needed some money, but most of all they needed a government official to sign on and say that this is okay," Røys told *DCD*.

Røys said she struggled with departmental red tape, but eventually was able to give the new venture half a million kroner ($75,000). "Then IBM said 'okay the government is behind this.'"

"We worked with them on the project itself, on the business plan and design," Laurence Guihard-Joly, GM of IBM's resiliency services division, said.

The data center progressed slowly, with a delay when the company became "entangled with a large data center project outside of Oslo for two years, which was sold to DigiPlex," Lefdal Mine Datacenter CMO Mats Andersson explained.

"Then we came back to Lefdal two and a half years ago and said 'now we're doing it.' We raised the equity, we got the banks on board, and then we announced in August 2015 that we're starting the build out."

For the phase one opening, tenants have access to Level 3 of the mine "which will start to gradually fill up. When that gets to a certain limit, we will start on Level 4 and then Level 2," Andersson said.

The mine goes deeper, but CTO Vidar Saltkjel said that the plan is to use just those three levels: "Below it, space is limited and there are even pressure challenges when you put something 120m down."

Level 6 is occupied by pumping stations that remove the groundwater that seeps into the mine. "We're trying to do it as effectively as possible with the right set of pumps, but it's a facility issue and is part of the PUE," Saltkjel said.

PUE (power usage effectiveness) is the leading measure of data center efficiency, and Andersson told *DCD*: "The PUE will never be more than 1.15, guaranteed."

One of the reasons for that low PUE is an adjacent fjord, which provides a constant supply of cold water: the facility takes seawater from as deep as 80m down and pumps it out at sea level. On Level 3, the fjord gives the facility a cooling capacity of two times 45MW, "meaning a Tier III 45MW data center, or a 90MW Tier 0," Andersson said.

He was unsure when the other levels will be needed, but said they can be "built out rather quick when we decide it's the right moment, hopefully in a couple of years."

Any data center developer can buy space in Lefdal, but Rittal's container-based solutions were most visible at the launch. ▶

17ms
round trip
to London

▶ The tunnels, which some in the company describe as "streets," are wide enough to accommodate data halls built inside the mine, or else shipping containers stacked up to three high along each side of the tunnel. "Data halls are regular white space, delivered by Rittal and built in weeks," Andersson said. "Always 4m high rooms, 12m wide and varying in length, built in two stories."

With Rittal's large equity stake and close involvement, it is perhaps not surprising that one of the first customers of Lefdal is another business with close ties to the company - German-based Innovo Cloud, part-owned by Rittal.

Innovo operates in two standard colocation data centers in Frankfurt, as well as in an edge data center facility. "Rittal asked us to see if we could leverage Lefdal, and the answer for us was immediately yes because we want an ecosystem of data centers that are a bit different," Innovo CEO Dr Sebastian Ritz said. "At first we were very skeptical about the network connectivity, but it turned out not to be an issue."

Lefdal claims round trip time to London of about 17 milliseconds, 20ms to Frankfurt and 22ms to Amsterdam.

That said, Innovo appeared to be conscious of latency, initially targeting high performance computing "because HPC customers are not worried about latency." It will also use its single starting container as a disaster recovery site for its cloud service.

Ritz said: "My hope is that we don't have to sell Lefdal as a disaster recovery [site], because I feel you don't serve them best as 'oh it's just a backup data center.' We can use it as a full, active data center."

IBM is also treating Lefdal as a backup facility at first: "We will start with backup and disaster recovery. We will not start with a container fully utilized from day one, but we can grow inside the [single] container," Sebastian Epple, director of resiliency services in Europe at IBM, said.

Epple, like those at Innovo, believes that Lefdal works both for backup and for HPC customers, with flexibility making the site particularly attractive for the latter.

"There's no need to rent a full hall like in an old traditional data center. You can grow as you need it. The density in those containers is quite high - you can have 30-50kW per rack, so you don't need as many containers and racks as you might in a traditional data center."

It was this flexibility that helped attract Lefdal's latest customer, Fortuitus AG, which describes itself as "a Swiss technical infrastructure projects-financing consultancy, currently engaged in over a billion euro's worth of projects stretching from Scandinavia to South Africa."

"We have a very, very small footprint," CFO Neil Collins told *DCD*. "Most operators said that 'if you want 10MW, you're going to have to rent 120,000 sq m.'

"Why? We only need 200 sq m, and forget all of your fancy services, we don't want any of it. We just want a locked room where people leave our stuff alone."

Fortuitus was at Lefdal's launch to announce a 4MW HPC installation arriving this year, followed by another 4MW next year, and potentially 2MW more after that. It would not reveal the backers of the project, other than to describe the group as "financial." A source who requested anonymity told

DCD the company would be mining cryptocurrencies.

Whatever the system will be working on, Fortuitus' first IT hardware iteration would not have been suitable for Lefdal due to the intense air cooling requirements.

"Genuinely you wouldn't have been able to stand in here, it would have been a wind tunnel," CEO Mark Collins told *DCD*, staring at the 'street' his HPC rig would soon be installed in, dubbed 'Penny Lane.'

Lefdal looked at putting the air cooling infrastructure outside of the mine - "and then we told them how much noise it would cause. They had a sound engineer saying 'no,' this would have been heard all over, and this beautiful Norwegian landscape would have been ruined," Neil Collins said.

Fortuitus settled on liquid immersion cooling using 3M Novec solution instead, cooled by cold water in Lefdal, which is in turn cooled by the fjord's salt water:

"So we have three separate circuits. Our IT guys said that this is fantastic because we didn't need all this extra stuff. It enabled us to save money and buy a lot more computing power."

Lefdal edged out Iceland for Fortuitus, which wanted to use 100 percent renewable energy. "As for the US," Mark Collins added, "we were less trusting of the regulatory environment. And with the [Trump] administration, it's unpredictable and you've got to minimize risks."

Norway's Minister of Petroleum and Energy Terje Søviknes told *DCD* that he "hopes data centers will represent a new green industry for Norway.

"The most important thing is that we have a surplus of renewable energy. We have green energy, we have enough energy, and we have affordable energy."

Egil Skibenes, chairman of the board at Lefdal Mine Datacenter, agreed: "Developing Norway as a data center country is at the core of the government's new strategy," he said.

But before Norway as a whole can even begin to pitch itself to the world as a data center hub, Lefdal itself has much to prove. If you need to visit your data center space regularly, this reporter - who took two planes, a ferry and a coach to get there - can attest that this facility is not for you. Nor is it for those requiring the lowest of latencies.

Perhaps it may not achieve its aim of becoming Europe's largest facility, but it has certainly carved out a niche that could grow.

And, no matter what the mountain's eventual fate, there may be a poetic quality to its rebirth. Rittal's Dr Köhler said: "A loop has closed between this green mineral, olivine, which we were digging out of this ground for industrial purposes to make steel, and this green mine. All of a sudden that steel - as racks, containers, cooling units, hardware and so forth - is coming back."

Cool contenders

Norway is not alone in its push to become a northern data center hub. In fact, compared to some Nordic nations, it has a certain amount of catching up to do.

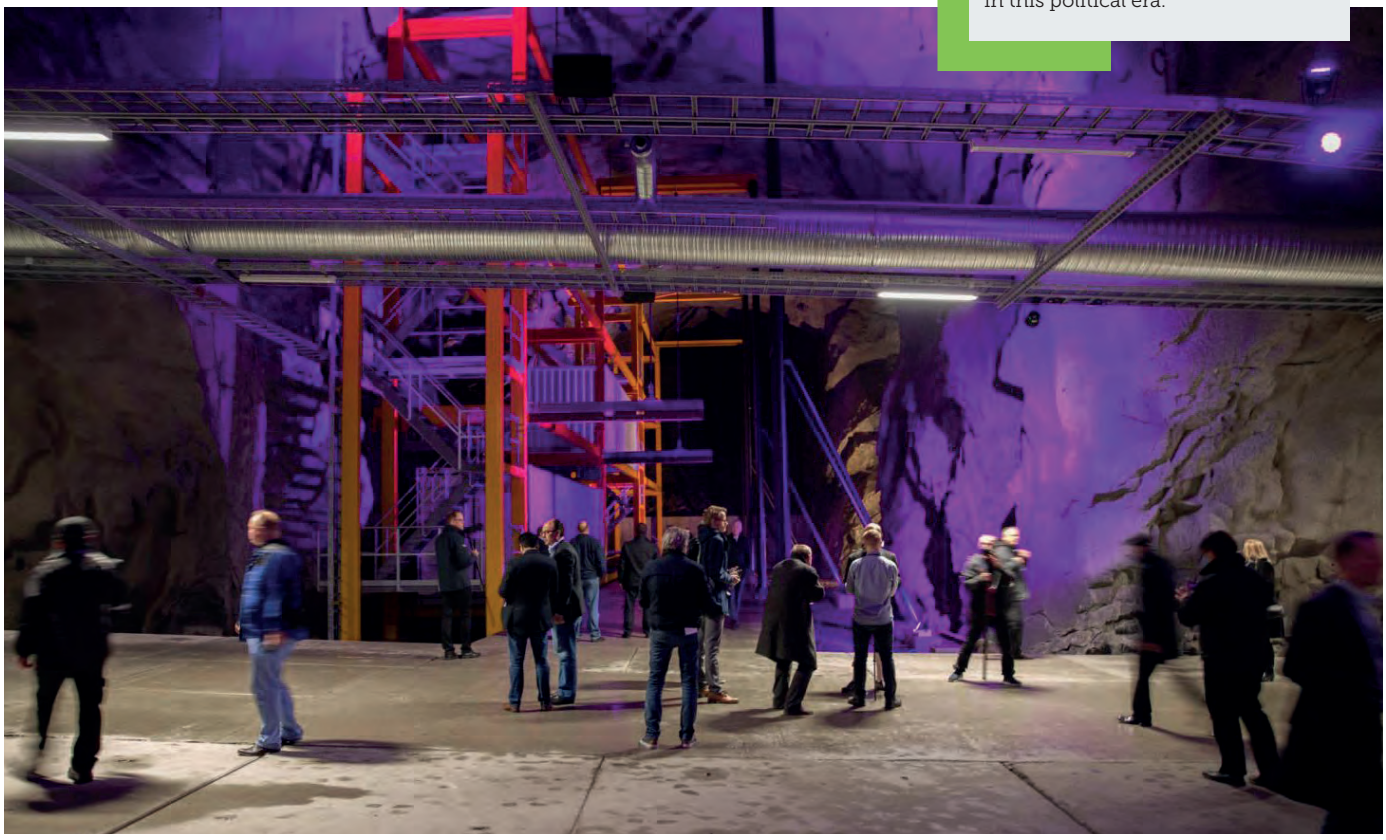
Iceland, which is generally colder than its neighbors and has unrivaled access to geothermal energy, has become a hub of HPC activity and is home to companies such as Verne Global, which runs a data center on a 45-acre campus on a former naval air base just west of Reykjavik.

Finland used low energy taxes to lure data centers until nearby Sweden retaliated with a data center tax break of its own.

Sweden's low tax and energy prices have enticed companies to the area known as 'The Node Pole' near Luleå, notably attracting social media giant Facebook, which runs its own data center there.

As for Norway: "Few politicians know ICT, so it's very difficult to tell them how important this could be for Norway," ex-minister Heidi Grande Røys told *DCD*.

"Norwegians are conservative and old fashioned, perhaps, so it's a difficult project to sell and talk about in this political era."

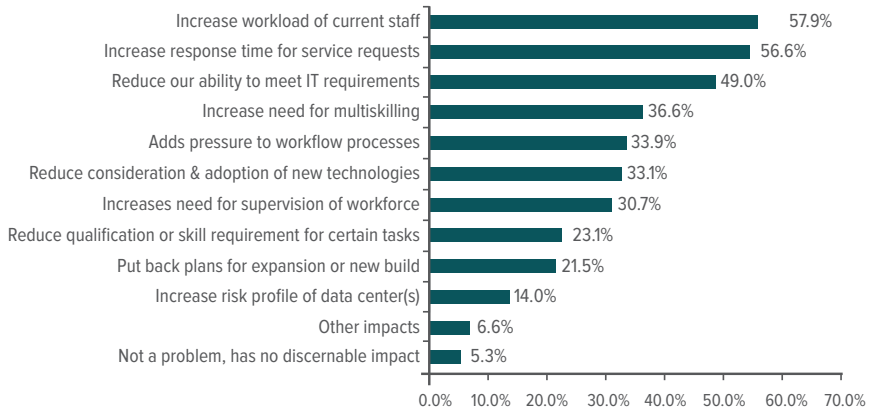


Photography: Sebastian Moss, Lefdal Mine Datacenter

Skills – The Data Center's Ever-Changing Need

Data centers rely on national investment into skills.

Expected problems arising from the skills shortage



Companies that invest in data centers or data center services outside their home country are changing their search requirements. Facility based requirements – power, water, land, low disruption profile – are now standards, like power steering or ABS on cars. The search is taking on new perspectives as issues of governance, sovereignty and the business culture move center stage.

Among the drivers attracting increasing scrutiny, the data center industry's much-reported 'skills shortage' is the most intractable. The shortage of skills is more difficult to measure or monitor directly than threats to the supply of power, water, connectivity or money. It exists partly within the minds of the market but that in itself is enough to negatively impact investment confidence.

That the skills shortage is a matter of strong industry concern is evidenced by the key problems experienced as a result of it. Responses to DCD research indicate that a skills shortage in and around the data center leads to increased workloads for staff, an increase also to the response time for service requests and reduction in the capability to meet IT requirements. Other consequences include the increased need to multi-skill staff, added pressures on workflow, reduced consideration and adoption of new technologies and the increased need for supervision.

Dealing with the skills shortage will mean compromise – maintaining service levels or creating lower service expectations, better organising the skills resource, and/or putting plans for expansion or transformation on hold.

The skills shortage is elusive for a number of reasons. By its localized nature no two areas or companies have a similar skills profile. Also, it is linked more strongly with transformation and change rather than just growth – the numbers of people working in and around data centers has more than kept pace with growth in white space, power or racks. The technological changes disrupting the data center and driving the trend towards the wider concept of data infrastructure will further impact the skills shortage. That's because the evolution of data infrastructure increases the range of skills required to the design and management of cloud, converged systems, programming, outsourced footprint, analytics, networks as well as coordinating these with corporate requirements. While growth in staff numbers is now led almost entirely by IT skills, the pace of technological change will mean the industry skills base continues to lag the requirement.

The challenge to the data center industry is also that it will need to depend in part on external providers to meet it. As a small segment of an industry wedged between far larger IT, telecommunications and engineering industries, it will need to rely on national education systems to generate people with the level of raw skill that can then be shaped by data center employers to meet their needs. While training provided by data center industry players helps maintain skill levels, this is usually directed at people already working in the industry.

There is no 'silver bullet' for the skills shortage; most organisations will use a variety of methods to solve the problem including investment in training, monitoring, automation and AI, colocation, outsourcing, paying higher wages or importing skills. Some may develop links with training partners, or establish their own training entities.

Regardless, the skills supply vs demand pendulum will continue to swing.

Malaysia's location at the center of the ASEAN market provides outstanding opportunities within the digital economy. MDEC is committed to empowering people by enhancing their digital skills in order to meet growing and more sophisticated industry demands. Programs run from the levels of primary and secondary education through tertiary studies to people already in the workforce. Incentives and investments are available to enhance the workforce and to grow and maintain a pool of labor that is suited to working in the digital era. The diversity of the courses covers the digital spectrum, from accreditations relating to ICT infrastructure and data centre professionals to incubating talent and start up companies. MDEC regards this as an integral part in its growth and development towards the digital future.

MDEC
Driving Transformation

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Check your provider's data center rating

The Data Center Performance Index from Infrastructure Masons could help customers choose a facility, says *Mark Monroe*

If you don't consider the cleanliness of a restaurant when choosing where to eat, it will cost you. Eating at an unsanitary restaurant can impact your health, make you sick and, in some cases, kill you.

Health departments in most cities and countries are required to inspect establishments serving food, posting the results using a simple grading system which reports how the facility is actually performing. Most places use an A-D grade. A means the restaurant has performed well. D or "No Rating" means you should probably look for another place to eat.

There is a standard way to measure restaurant cleanliness; why not data center performance?

DCPI grades are based on actual performance of the data center over the last 12 months, so customers can balance risks against cost

Infrastructure Masons' founder Dean Nelson proposed the Data Center Performance Index. DCPI uses simple performance grades in three categories: Availability, Efficiency and Environmental. More than 200 iMasons members contributed to the latest version.

Every "availability zone" in a data center - each building or section served by common power, cooling, and physical connectivity infrastructure, will get ratings in the three categories, (A-A-B, A-C-A etc).

The grades are based on actual performance of the data center over the last 12 months versus the expected design performance. This enables customers to quantify risks and balance them against cost.

The Availability category uses two measures: total downtime in seconds and the number of incidents over the last 12 months. Both are important to IT operations.

Any data center outage could have disastrous implications to a business, but is a single outage lasting 30 seconds better than three outages lasting 10 seconds each? Is an outage acceptable to your business at all? Knowing how a data center performed over time enables you to understand that risk and decide what level is acceptable.

The Efficiency category is based on work done by The Green Grid and ASHRAE's 90.4 committee. To earn an "A" rating in efficiency, a facility should have a Mechanical Load Component (MLC) and Electrical Loss Component (ELC) 60 percent better than the ASHRAE 90.4 standard in each climate zone. In the US, 50 percent-loaded data centers with a PUE between 1.26 and 1.31 could get A ratings.

The Environmental category rates the annual greenhouse gas emission value of the facility. In the US most facilities will be unable to achieve an "A" grade (zero GHG emissions) by depending on the utility power since it is a mixture of sources. The provider must supplement or offset their consumption with high-quality credits or net new energy projects.

New iMasons members are welcome to help review these proposals. Once formalized, DCPI could be used in response to RFPs.

Mark Monroe is executive director at Infrastructure Masons. www.imasons.org/join

Mark Monroe
Infrastructure Masons

DCD > Webinars | 2017

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Tuesday 13 June | 14:00 BST

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Bernd Hanstein, Vice President Product Management IT, Rittal
George Rockett, CEO & Co-Founder, DCD

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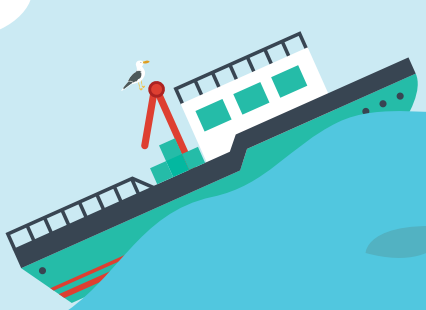
TOP 10 EXTREME DATA CENTERS

Data centers are not all created equal: some of them serve and survive in the world's most hostile environments. Here are a selection of facilities which have made extreme adaptations for locations which are above and beyond the everyday.

If your site beats any of these, let us know at extreme@datacenterdynamics.com!

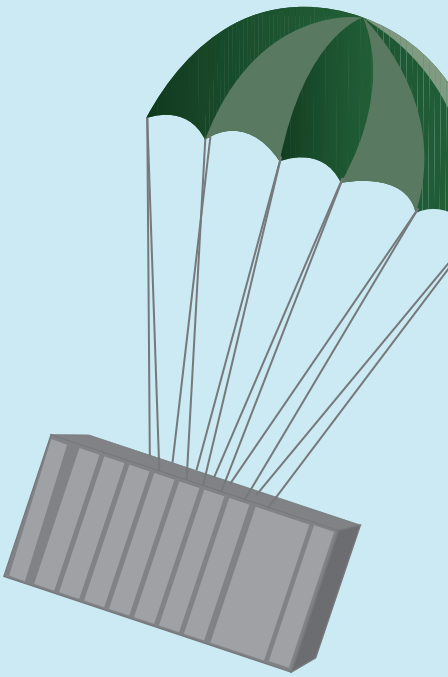


#1 SUNKEN TREASURE

Microsoft servers on the ocean floor

In early 2016, Microsoft made a splash with Project Natick, a prototype data center which served Azure cloud from a pressure vessel full of nitrogen off the US Pacific coast. The sea is cool, and off-shore land is cheap and close to population centers. The next step? A patent suggests a large artificial reef.

bit.ly/DCDnatick



#2 RACK ATTACK

Parachuting containers into a war zone

Modern warfare needs "edge" data centers. UK-based Cannon Technologies' rugged sheet metal boxes were flown into Afghanistan and quickly set up to support Army operations, with custom cooling systems to handle dust and heat. Not all of the containers made it back; some of them returned with bullet holes.

bit.ly/DCDcannon

#3
BLAST FROM THE PAST

Florida data center in nuclear bunker

Data Shelter's colocation facility in Fort Pierce, Florida, due to open in spring 2018, was originally an AT&T-built Cold War era nuclear bomb shelter. First opened in 1964, it was part of the AUTOVON network - a worldwide American military telephone system designed in case of all-out war.

It was built with double layer steel-reinforced concrete, on a nine foot thick blast slab. It has two exterior entrances with armored steel blast doors. Features include chemical, biological, radiological, nuclear (CBRN) emergency air filtration, FEMA P320 safe room standards for Category 5 hurricane and EF5 tornado resiliency... and a Tier IV Design certification from the Uptime Institute.

bit.ly/DCDbunker

#4
THE FINAL FRONTIER

Like a data center in the sky

Once the thrill of orbiting our planet at some 400km wears off, astronauts on the International Space Station need access to the Internet.

The ISS has up to 80 laptops, mostly Lenovo ThinkPad T61p devices, one of which acts as a server. The US segment and the Russian segment each have around seven laptops running Linux, the Japanese have eight and the Europeans have two, while 12 manage payloads. The remainder are Windows-based support computers on the operations LAN.
The ISS also has special EXPRESS racks for experiments, including for cutting-edge computing research.

bit.ly/DCDforbesspace

#5
SOME LIKE IT HOT

Free cooling in the Middle East

Kuwait and Dubai contain the world's hottest cities, with summer temperatures regularly over 44°C (111°F). They are also affluent, with a demand for data. So far data centers there use mechanical cooling, but engineer Noriel Ong of Syska urges "free" cooling with outside air.

A 1MW data center in Riyadh can be cooled with outside air for 82 percent of the year according to Ong. The vast majority of the outside air cooling is with adiabatic evaporative cooling, which consumes water. Despite the cost of water in the region, this would still represent a cost saving of $148,000 per year over full-time mechanical cooling, says Ong.

bit.ly/DCDsyska

#6
THE NUCLEAR OPTION

Russia's largest data center will be colocated with a nuclear power station

Russia's nuclear power firm Rosenergoatom is building a data center at its 4GW power station in Udomlya. The data facility will have up to 10,000 racks, and could draw as much as 80MW from the on-site reactor.

Rosenergoatom will use about 10 percent of the data center's capacity, while the rest will be available to commercial customers. Among its benefits: The data center will provide a market for surplus electricity, and could enable foreign companies to meet Russia's stringent data residency laws.

bit.ly/DCDnuclear

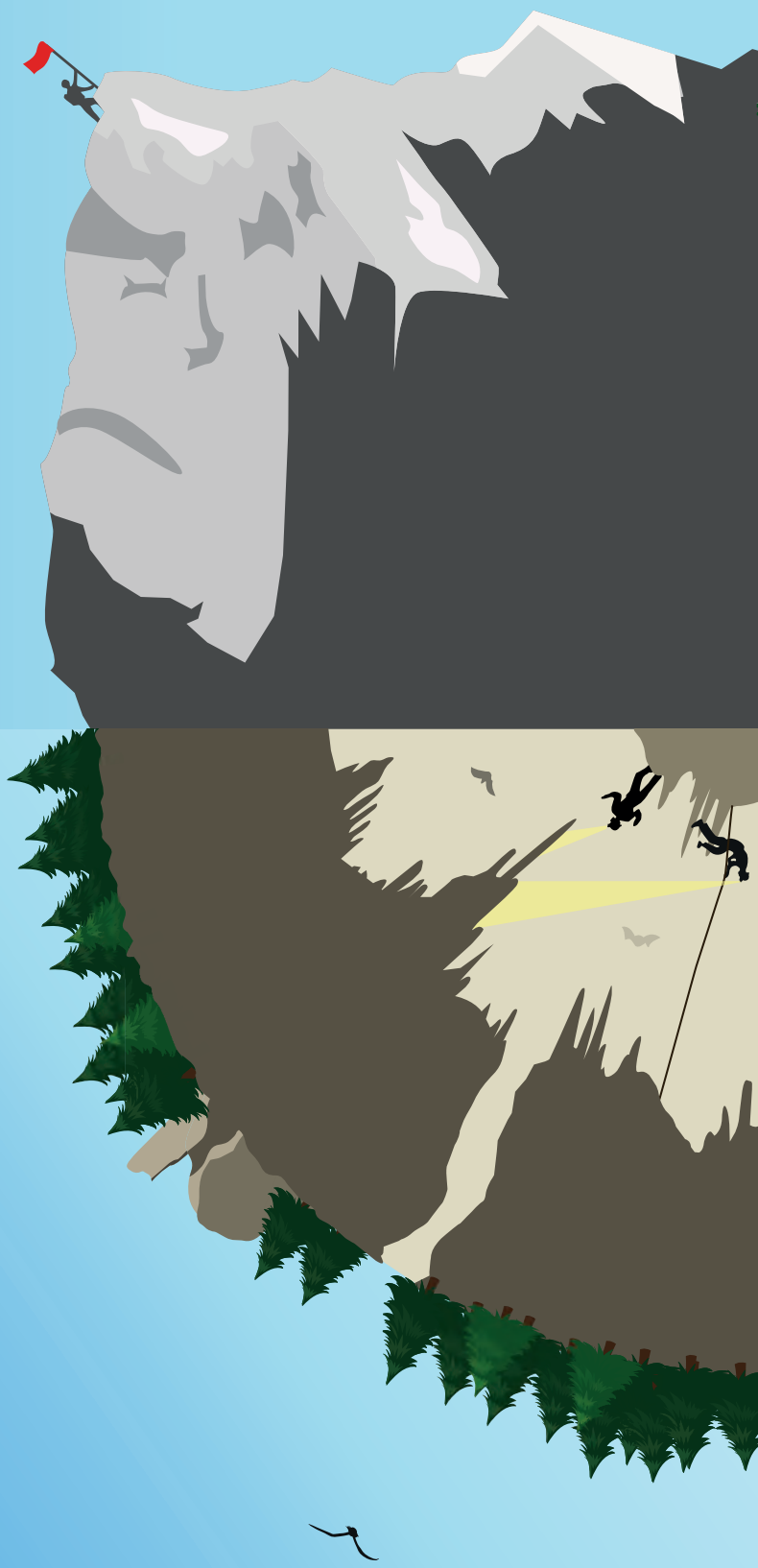
#7
PEAK PERFORMANCE

Three-mile high supercomputer

The Atacama Large Millimeter Array (ALMA) radio telescope, 16,500 feet above sea level on the Chajnantor Plateau in the Chilean Andes, combines signals from multiple antennas up to 16km apart. The signals are processed on site by the world's highest-altitude data center: the ALMA Correlator.

The 140kW facility performs up to 17 quadrillion specialized image processing operations per second. It needs twice the normal cooling airflow for an equivalent facility, as the atmosphere is thin. The thin air and risk of earthquakes also ruled out hard drives, so the Correlator is diskless. Finally, in that air, it took the engineers 20 weeks to unpack and install the machine.

bit.ly/ALMAcorrelator



#8
BURIED ALIVE

125ft deep data center

There are plenty of underground data centers (see Lefdal Mine, p24) but the deepest online facility we know of is Cavern Technologies, 125ft below the ground in Lenexa, Kansas.

The Lenexa caves are natural limestone formations, which hold a 3 million sq ft business park and significant parts of the US National Archive - including President Kennedy's autopsy data.

Cavern has expanded multiple times, and now has 300,000 sq ft of data center space, and up to 50MW of power.

bit.ly/DCDcavern

#9
TIME CAPSULE

- **Store your data for the end times**

Svalbard, the northernmost settlement in the world with a permanent civilian population, has long appealed to those wishing to store precious objects in case of disaster.

Already home to the famous Global Seed Vault, the Norwegian archipelago is now the site of a unique data center.

Developed by data storage company Piql and mine operator SNSK, The Arctic World Archive stores data on film for 500-1,000 years. Piql essentially converts data into QR-like codes on 35mm film that simply represents binary code.

As it's film, it can also include images and written text to explain how to access that code, in case the technology becomes obsolete or those that know how to use it die.

bit.ly/DCDsdoom

#10
BEYOND THE WALL

So cold it would kill hard drives

With air temperatures of -40°C (-40°F), the IceCube Lab at the Amundsen-Scott South Pole Station has to warm the air it uses in the data center. If suddenly cooled to the outside air temperature, its hard drives would die. The lab serves the IceCube Observatory, a neutrino detector with strings of optical sensors buried a kilometer deep in the Antarctic ice, searching for the fallout of cataclysmic astronomical events.

The Lab has 1,200 computing cores and three petabytes of storage. IT staff make brief visits in the Southern summer; for the rest of the year they must work remotely with the help of the year-round scientific staff, and a store of spare parts. Communication is via the 2.4kbps Iridium satellite network, with 10 hours a day of 1Mbps broadband from NASA satellites.

bit.ly/DCDicecube

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IoT in the industrial arena – an engineer's best friend?

When the Internet of Things strays into industry, you may need to clean up after it, says *Chris MacKinnon*

To a technology enthusiast the Internet of Things (IoT) is like a pet - it's been around for a while, we're all used to it, and it's here to stay. But what happens when you walk that pet into the industrial world? You'll get devices that are much better than humans at capturing and communicating big data in a manufacturing setting; that is, the Industrial Internet of Things (IIoT).

If you then take your IIoT pet to a neighboring data center, the changes are vast. And depending on who you talk to, IIoT could mean the difference between the data center becoming less relevant, or more useful - with a little help from its friends.

Over the past couple of years we've seen a growing understanding of the value in connecting operations technology (OT) assets with information technology assets. It's an educational process, but engineers on both sides of the OT/IT divide are beginning to identify business opportunities in combining these two traditionally disconnected disciplines.

Matt Newton attests to this. As director of technical marketing for industrial automation developer and

Chris MacKinnon
North America

manufacturer Opto 22, he's aware of industry expectations. "The biggest expectation," Newton said, "is better interoperability between OT and IT technology. Traditionally, OT and IT systems have used different protocols and programming languages. But as Internet technologies are increasingly adopted in the manufacturing, process control and industrial automation markets, engineers are looking for parity in OT and IT technology." That means traditional automation controllers, like PLCs and PACs, are starting to add programming language capabilities like JavaScript and C++, Newton said. "It's part of an overall encompassing trend towards embracing open standards and Internet technologies."

The biggest change Newton sees coming - that data centers in particular need to be aware of - is how to handle the massive amounts of data that operations technology devices are going to start generating: "Our existing infrastructure wasn't designed to cope with that much data. All engineers need to be aware of the concept of edge computing, where we push some intelligence down to the network edge to help process data before it's passed up to cloud-based applications that reside in data centers."

It would help if data center managers got a basic understanding of OT protocols and languages such as Modbus and Ethernet/IP, and an understanding of how automation controllers and industrial I/O are used.

IIoT connectivity is well understood, compared to even a couple of years ago. The Industrial Internet Consortium (IIC) has produced an Industrial Internet Connectivity Framework (IICF) which analyzes the various standards, provides practical guidance on selection and clarifies how they can work together. This includes networking from the "things," through the data center, to the cloud.

"Industrial Internet of Things (IIoT) systems need practical AI and high-speed networking in the field," said Dr Stan Schneider, CEO at IIoT firm Real-Time Innovations. "Autonomous cars are great examples: The intelligence has to be on the vehicle. Connectivity back to the data center is also important, of course."

Deployments like intelligent hydro and wind power, smart hospital systems and autonomous cars could change industries across the economy, Dr Schneider says.

His perspective on IIoT's impact on the data center is slightly different in tone. He said data centers are quickly becoming less relevant: "Cheap, capable processors in the field, when combined with much more functional software, are reducing the need to send everything to the cloud." He often hears Peter Levine's prediction of the demise of the cloud (*The End of Cloud Computing*, Andreessen Horowitz) cited.

What should data center managers do? Schneider says: "They should be considering a world where the cloud has seen its best days. It's still five to 10 years out, but the trend is already clear."

The 'only' compelling role for cloud computing in IIoT, is optimizing existing applications. "But, the IIoT's biggest economic impact," Schneider says, "comes from enabling new things." The main goal for data center managers should be understanding this new paradigm, from a non-IT perspective.

There's no doubt - interoperability, scalability and security are going to be key as more and more systems and applications are deployed. These topics have been discussed over the past couple of years, but Dr Schneider believes now is the time when companies are looking for real solutions. He said it is crucial that these technical elements are built into the IIoT systems, rather than plugged in as an afterthought. "In the next few years, the industry must (finally) get serious about making real change. Many companies have been in 'wait and see' mode to avoid risk. Avoiding that risk and being left behind is becoming riskier than moving."

The increasing clarity on options, however, offered by initiatives like the IICF, reduces the risk of choosing incorrectly.

Dr Schneider concluded: "The likelihood of a new technology coming along in enough time to matter is declining as well. In short, the industry is expecting to see both sufficient technology and guidance to let them realize all the potential."

The security side of IIoT

The Industrial Internet covers machine-to-machine networks and cyber-physical systems that interact with the physical world.

It stretches from command and control networks (ICS or SCADA) in energy, oil and gas, transportation and infrastructure to the emerging IoT. It has become a critical aspect of buildings and data centers with modern building management systems (BMS).

Industrial control systems (ICS) used to be closed and proprietary, but are now more open, becoming integrated with IT and external business partners, while relying more and more on IT standards, making them highly vulnerable to cyber risks. Present IT cybersecurity solutions do not fit in with ICS constraints and standards.

Meanwhile security incidents are skyrocketing. Malware strains like Havex, Blackenergy and Dragonfly now specifically target ICS. Less than a year ago, the control system in a large German steel mill was compromised, causing the destruction of a blast furnace. Authorities have responded with regulations demanding critical infrastructure operators implement cybersecurity best practices. Pushed by their shareholders, industrial asset owners are trying to figure out how to protect them.

Data center managers must consider a new rising threat to their business continuity: the cybersecurity of the building itself, including energy management systems, HVAC and access control.

Laurent Hausermann is co-founder of the Industrial Internet of Things cybersecurity company Sentryo

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The Second Coming

Returning to the helm of Canonical, Mark Shuttleworth tells *Max Smolaks* why he doomed some Ubuntu projects, and why OpenStack is headed for a crisis

Max Smolaks
News Editor

Talkative, energetic and wearing permanent stubble, Mark Shuttleworth is worth in excess of $200 million according to the latest *Sunday Times Rich List*, and yet you will often find him running around the show floor at open source events, breaking into impromptu feature demos and briefing journalists.

Shuttleworth established Canonical in 2004 to bring Linux to the masses, and in this respect, he has already won - Canonical's Ubuntu is everywhere. It is the most popular supported Linux distribution in the world, riding high on the increasing adoption of OpenStack, the open source cloud platform.

In 2010 Shuttleworth stepped down as the CEO, making way for Jane Silber while still remaining the public face of Ubuntu. This month (June 2017) he has resumed his duties as the chief executive – and this time he is wielding an ax.

In April, Canonical announced that the Unity interface, meant to create a seamless bridge across smartphones, tablets and PCs, was being removed from Ubuntu and replaced by the GNOME shell. The Ubuntu Phone project, intended to take on iOS and Android, was also terminated. In both cases, people lost their jobs.

Shuttleworth looks visibly hurt when he talks about criticism leveled at Unity, and we saw him enthusiastically launch Ubuntu Phone in London just four years ago. He takes personal responsibility for both failed projects, and still believes in the eventual convergence of platforms. But he plans to refocus the company around cloud computing and the Internet of Things (IoT) with a long-term goal of going public, and that means tough decisions.

> *"OpenStack has suffered from trying to be everything"*

"Clearly, the cloud business is a real business – it's growing very quickly," Shuttleworth told *DCD*. "We grew 90 percent in public cloud, 70 percent in private cloud. That's much faster than our competitor Red Hat. Large companies who are users of Red Hat are opening up to become multi-OS, and buying support from Canonical.

"And then IoT looks like it will do exactly the same thing for us that cloud did, so we will maybe run on two thirds of the IoT devices out there. Already, 20 percent of smart displays are on Ubuntu."

A few years ago, it was thought that IoT devices would require specialized versions of Linux designed to operate with very limited resources. Turns out this assumption was false. Thanks to advances in chip design and competitive pressure from companies like ARM, even the feeblest IoT boards can now run a full-fat operating system. For Shuttleworth, that means more platforms that could benefit from Ubuntu.

"The cost of running full Ubuntu is now less than $10, and it will be less than $2 by 2020. At $2, why would you spend lots of extra money to have embedded developers doing complicated things? Embedded development is intrinsically expensive, and when you've finished doing it you have something that you can't change very easily.

"Our core thesis is that IoT development, embedded development becomes standard Linux development and that's how we are positioning Ubuntu."

The new direction doesn't mean Canonical will sideline desktop Linux – even if there's less money in it. "The desktop continues to be important to us because developers use the desktop," Shuttleworth said. "So I want to make sure that there is a secure, fully supported, fully maintained, free desktop."

The data center, meanwhile, is "all business," a lot of which is linked to OpenStack. Ubuntu is the most popular OS in open source cloud environments, especially those in production. Shuttleworth thinks all of the major technical challenges facing OpenStack have been solved, but he has been speaking out against the concept of the 'big tent,' the name given to OpenStack's project structure and governance model.

"I think the challenge is in shaping the community's mission. OpenStack has suffered, I think, from trying to be everything. And it doesn't need to be. This is VMs, virtual networks and virtual disks on demand. Just that, done really well, at a predictable price. And that's a fantastic mission.

"We do well because we are very clear about that mission. There are lots of other communities where you can go and talk about machine learning or containers or big data or real-time monitoring. This is a community where you can get virtual machines, virtual networks and virtual disks."

Shuttleworth thinks that the collapse of the big tent is inevitable, but that OpenStack itself will survive. As for the managed private cloud business model, announced at this year's OpenStack Summit? Canonical has been doing just that for the past two years.

"What that really means is that the institution can consume both public and private cloud as a service. They can price it, they know exactly what it is going cost them. If they want to buy the racks, then the racks will cost them $15 per server per day for OpenStack that's provided by Canonical. If they buy public cloud then they get a price per VM per hour – that's easy to work with."

Another big play for Canonical is data center automation. Rather than adopting third party tools, the company created its own with Juju charms and Metal-as-a-Service, or MAAS, dealing with software provisioning and with physical servers.

"If you want a data center that runs itself, MAAS is the right place to start. It doesn't do everything yet, but it really is bringing those pieces together," Shuttleworth said.

MAAS is relatively new, but it clearly shows where Canonical sees its future. It doesn't really need to appeal to consumers, not when there are billions of enterprise devices that require an operating system.

EVENT PREVIEWS

> Colo + Cloud | Dallas

THE FUTURE OF DIGITAL INFRASTRUCTURE FOR HOSTING, COLO, TELCO, CLOUD AND MSP

September 26 2017 // **Fairmont**, Dallas

DCD>Colo + Cloud is the global IT business and technology leadership forum on the rapidly-growing, 3rd-party hosting, colo, telco, cloud data center, and managed services provision ecosystem

This conference is a fully integrated marketplace of ideas, products and services for those who design, build, buy, sell and service outsourced digital infrastructure for the "factory of the future."

"Data Center 4.0" is now materializing right before our eyes. Every enterprise is now engaged at some level with business-critical, digital-first applications in colocation and cloud services data center environments. And that will only increase in volume and speed.

The conference is split into two zones: on one side the event covers how and what to build; on the other side, a dedicated hall chaired by datacenterHawk's David Liggitt covers the where and why.

How is demand changing and evolving, where should new colo/cloud facilities be sited, and what are clever investors putting their cash into? Money, analysts, contractors, and commissioning executives are all gathered under one roof to provide answers to your most pressing questions.

The IT colo and cloud services data center of the future, the digital infrastructure of global economic transformation, is likely purpose-built, open-sourced, smart, software-defined, data-driven, agile, DevOps and workload-centric, optimized, efficient, clean, secure and resilient.

In all of this, it is rivaled only by the cloud hyperscale mega data center owners. Now they are bringing their technology advances to the world of colo providers and vice-versa.

An important all-pervasive theme running throughout the conference will be all things open source. Standardization and commoditization of infrastructure components and software are likely to provide impetus to improve bottom-line performance of IT service providers as technology and equipment costs tumble and drive more reliable and massive scale service provision into end users. The pre-conference day on September 25 includes a workshop on the OCP Telco Project.

This forum's 30+ hours of pre-conference tutorials and workshops, high-level briefings and 'Big Discussons' and thought-leadership conference content are curated for senior business and technology leaders and professional teams charged with the responsibility for delivering on the demands of business in the Zettabyte era of digital transformation.

On the IT cloud capacity buy-side, few other industrial sourcing areas are as sophisticated as that for the brokerage and procurement of IT, network and cloud capacity and services. The change is driven by the evolving technological and economic pressures of modern digital infrastructure supporting changes such as IoT.

Registration is complementary exclusively to pre-qualified infrastructure technology and business management executives and operational professionals who apply before July 28, 2017.

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DCD>Zettastructure Singapore is the meeting place for Asia's major data center hub. With tours, training and an Awards ceremony, this will be a week that builds the strength of an already-vibrant community

As part of the prestigious SE Asia Data Center Week, DCD's 11th annual Conference and Expo in Singapore will welcome over 1,500 senior IT and data center professionals from across Asia Pacific at Marina Bay Sands from 20-21 September 2017. This year's theme – "Zettastructure" – will focus on the catalytic impact of IoT, Smart Cities, Big Data and Cloud Computing which will generate and drive zettabytes of data traffic across networks.

The event has established itself as a highlight of the regional industry calendar.

For one week a year the whole SEA data center market comes together with international industry thought leaders, trendsetters and trailblazers debating the state of the current marketplace, and forging the future; networking, making new connections and celebrating the latest innovations.

The week will feature:

- Conference & expo DCD>Zettastructure | Singapore
- DCD's CXO Leaders Summit
- Partner networking events
- DCD Cybersecurity Summit
- Data Center Tours
- DCPRO Training Workshops
- Datacenter Week Awards Finalists Ceremony

According to DCD's 2016 research, Singapore's data centers account for over half of the footprint in South East Asia.

"It is currently the fourth largest data center market in the Asia Pacific, and has amazing potential to see an increase in investment of 65 percent by the year 2020. Singapore's investment direction has capitalized well on the trend to shared facilities (colocation, outsourcing, cloud)," commented Nick Parfitt, senior global analyst at DCD Group.

"We are thrilled to headline DCD>Zettastructure in Singapore and be part of the SE Asia Data Center Week," said Bruno Lopez, CEO of ST Telemedia Global Data Centres (STT GDC), a fast-growing data center provider headquartered in Singapore. "Singapore is our home base and an important hub within our global data centre platform."

To maintain Singapore's competitive position, the Ministry of Communications and Information (MCI) has launched initiatives that will aid companies in building digital capabilities, including a Data Innovation Programme Office (DIPO) and a Data Sandbox. Minister of State for Communications and Information Janil Puthucheary said: "The DIPO will address industry concerns by facilitating data-driven innovation projects, and the Data Sandbox will provide a neutral and trusted platform."

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Data Center Cooling Professional: Bogotá, Colombia
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Events

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Data Center Cooling Professional: Sao Paulo, Brazil
June 26-28 2017, Venue TBC

Data Center Power Professional: Sao Paulo, Brazil
June 26-28 2017, Venue TBC

Energy and Cost Management: Brasilia, Brazil
June 26-28 2017, Venue TBC

Data Center Design Awareness: Bogotá, Colombia
June 28-30 2017 at Hotel Atton 93

It is a great opportunity for attendees to learn from their peers and gain knowledge around industry trends. It deep dives into the choice of selections of data centers which is very useful

Jenny Gui | Royal Bank of Scotland

DCD is a very good communication platform as it attracts the participation of many parties including product and service providers, clients and research institutions. We can share technical expertise on this platform and promote the development of the whole industry, hence creating a good ecological environment

Zhu Hua | Tencent

Events

> **Australia** | Sydney
June 27 2017
Optimising Hybrid IT (and other Data Center challenges)

> **Webscale** | Bangalore
July 19-20 2017
The annual summit for webscale infrastructure builders

Training

Data Center Cooling Professional
Shanghai, China, June 12-14
Singapore, July 24-26

Energy Efficiency Best Practice
Tokyo, Japan June 22-23
Sydney, Australia, June 29-30
Singapore, July 20-21

Data Center Power Professional
Melbourne, Australia, July 3-5
Singapore, July 17-19

Data Center Technician
Singapore, July 12-14

Data Center Design Awareness
Singapore, July 17-19

Critical Operations Professional
Singapore, July 17-19

Event Highlight

> **China Data Center Week**
12-15 June 2017

This year, DCD holds its first-ever China Data Center Week, including the 8th DCD>Enterprise China in Shanghai Tower Conference Center – the tallest building in Greater China's commercial center. The four-day initiative includes a major conference and expo, business and networking events with partners, training sessions, data center tours, and the launch of our new Asian awards.

For more details, head to **www.DCD.events**

It's a week-long gathering of infrastructure technology executives coming from across the nation, and foreign technology companies seeking to build or invest in China.

Vincent Liew | DCD

I'm probably too old for this

I'm getting older, my joints are creaking and I can't stay up all night anymore. More importantly, I stopped understanding young people. Kids these days are glued to their smartphones, they are driving around with Ubers while sexting on Snapchat. They keep asking for cloud computing - haven't they heard what happens beyond the firewall? There are drive-by downloads, malicious advertising, and even ransomware. If anyone brings an infection back here, I'm kicking them out – none of that crap under my roof.

The world was slower when I was young. We had landline phones, grainy VHS footage and we didn't care about data protection because there was no one to harvest personal data. Servers were bigger, networks were slower and cyber crime wasn't an actual career choice. They say my network is not fast enough – I say they don't read enough books, and Jay-Z is not a real musician.

My health is getting worse. Last month they found a foreign object in one of my ventilation ducts. I won't bore you with details – it's a bit embarrassing, really – but the experience was painful, and I'm not doing that again. They say there's a high risk of reoccurrence with older systems like mine, but they also said mainframes were dying out.

If only they had replaced my filters, but no, there's no budget for that. If that's the case, how did they find the money for that pile of hyperconverged garbage in the corner?

I have an occasional power issue, but it's nothing serious. Yes, the hardware goes out, and yes, it takes a few seconds to start the generator. But it all works out in the end - we were built tough in the eighties, with pre-cast concrete floors and steel framed walls.

Jeff is coming around tomorrow. He's bringing a bunch of consultants with him to look at the old piping. They keep talking about 'doing something new' but I'm not worried –they know my contents are mission-critical.

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[We're afraid that's all we'll be hearing from good old Max. He was a trooper to the end, but we finally had to let him go. When we've cleared out that hardware, we'll have some space available in the facility for rent, suitable for any startups that aren't going straight for the cloud. Also, some vintage electrical and mechanical plant suitable for enthusiasts. - Jeffrey S. Rackman, CTO]

> *"They say my network is not fast enough – I say Jay-Z is not a real musician"*

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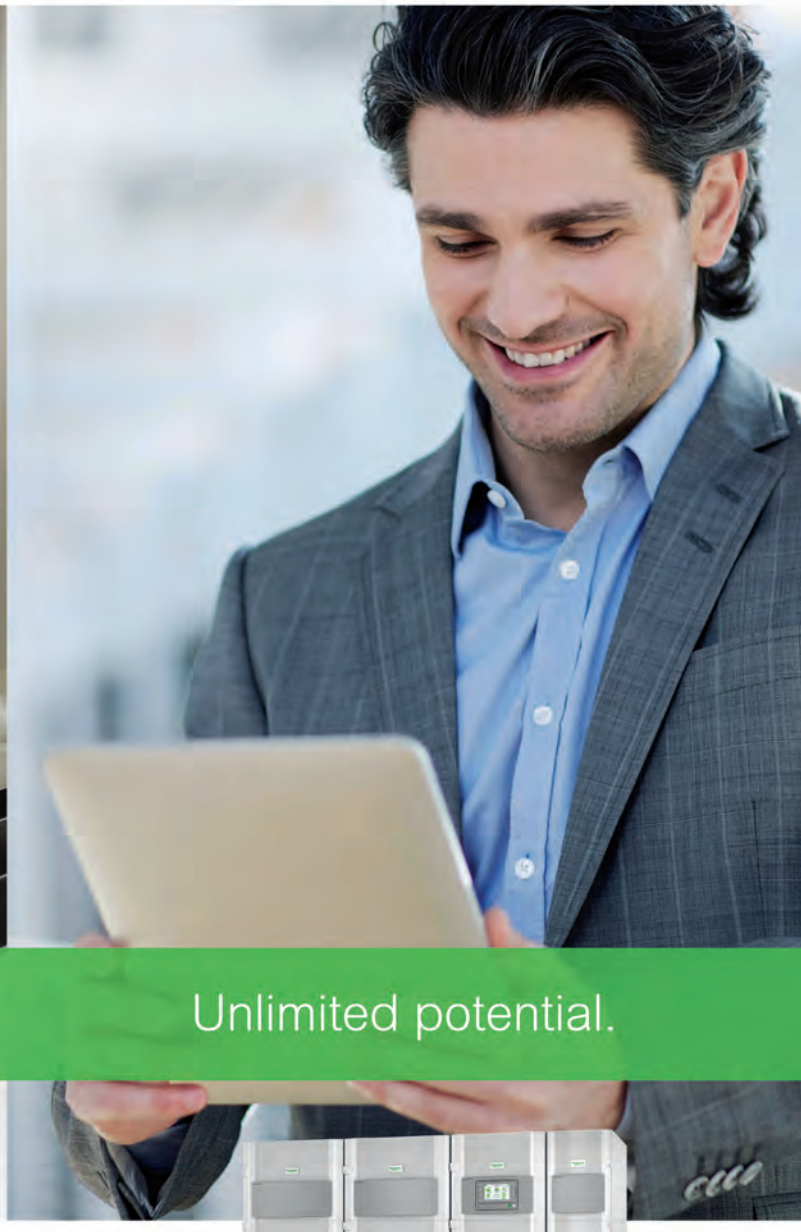

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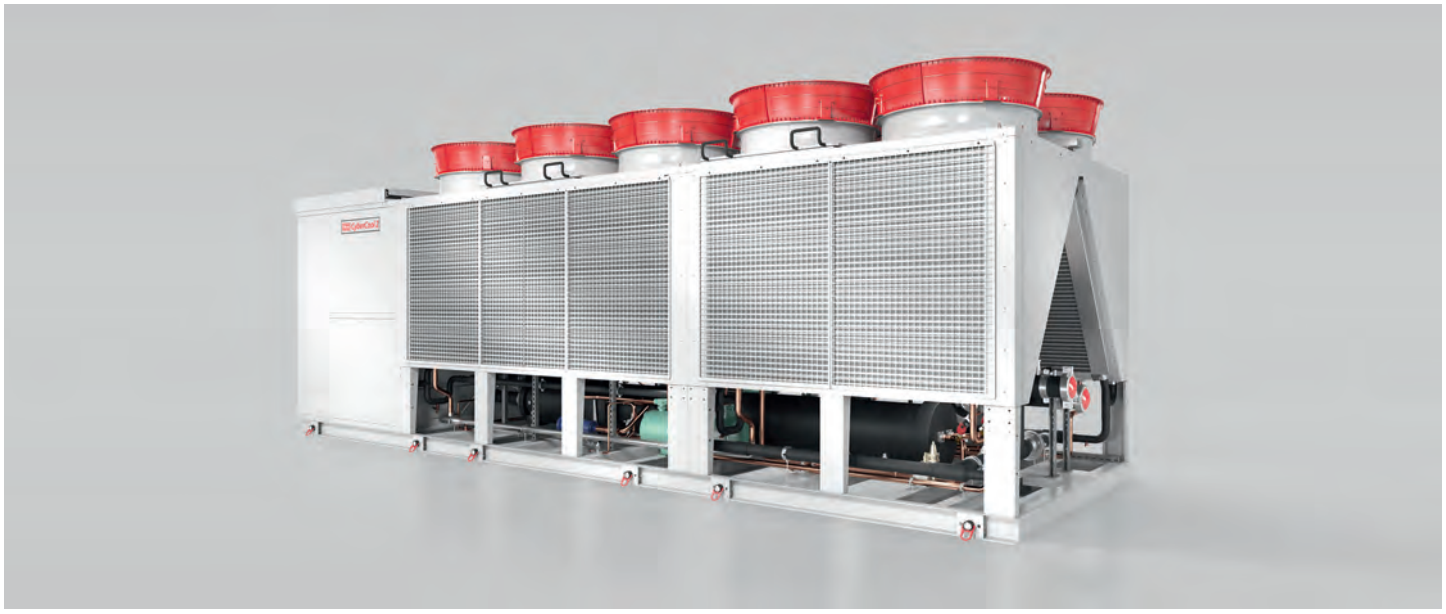

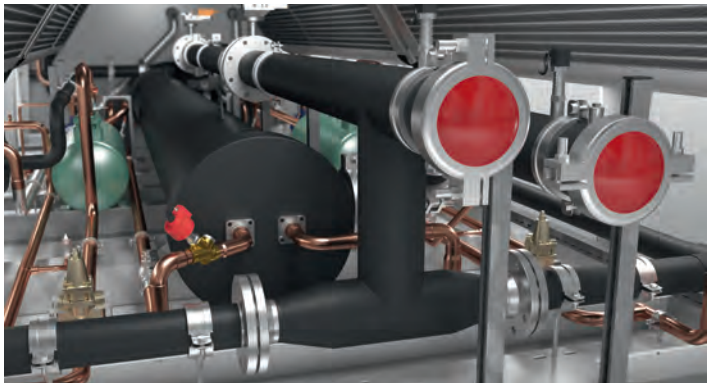

CyberCool 2
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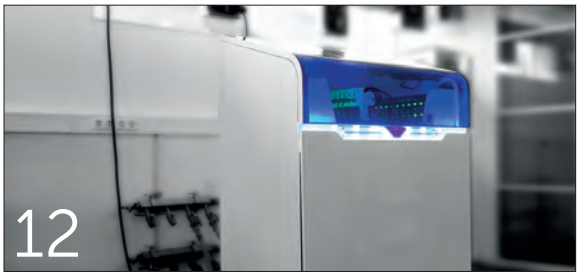
Our CyberCool 2 chillers are optimized for continuous operation 24/7. They cool industrial facilities and data centers to the optimum operating temperature, extremely reliably and with maximum efficiency. Flexibility included: with a cooling capacity from 50 to 1,400 kW and 11 different sizes, the CyberCool 2 is capable of satisfying most industry-specific requirements and individual customer requests. **www.stulz.com**

Contents



Birth of the cool

The people who remove heat from our data centers certainly count as some of the coolest around. They have a very specific engineering problem, and to solve it, they evolve the best options allowed by physical laws.

Over recent years, data center cooling has evolved from a simplistic model of top-down control, to demand-led systems where the cooling is provided where and when it is needed.

There are various flavors of cooling, from traditional CRAC air conditioning units to heat exchangers and evaporative systems (p4).

Being a cooling engineer is a matter of keeping on top of these tools, tracking the steady movement from old, dumb and wasteful methods towards new, smart and efficient techniques.

In preparing this supplement, we had the benefit of some great input from vendors across the industry, as well as specific cooling training from DCD's professional development wing, DCPRO.

Thermodynamics is an unforgiving science, but knowledge can turn it to your advantage. We suggest you absorb as much as you can.

Outside the data center, you have many choices for the ultimate disposal of your waste heat.

In theory, much of this heat could be useful - piped to buildings and offices where it warms water and living space.

In practice, most heat output is too low-grade and too distant from potential customers, so the best option is to find a good way to vent it without requiring more energy, or distorting the local environment.

One of the more promising destinations for waste heat is in lakes and rivers, where a large body of water can absorb a lot of energy without a big change of temperature (p10).

Inside the facility, liquid also has a place, as it has better heat transfer abilities and can carry heat more effectively.

Despite the obvious benefits - (and some others not so obvious) it has been difficult to adopt liquid cooling on a large scale, because of the large scale engineering changes it requires.

There are some encouraging movements from specialized vendors in the liquid cooling field. Systems which circulate fluid in the racks and more radical ones which simply immerse the server in fluid, are getting a growing trickle of support from the industry (p12).

Still need convincing? Julius Neudorfer has some persuasive arguments for liquid cooling. A long time expert in the field, he has taught DCPRO courses, and most recently wrote a paper on liquid cooling for The Green Grid.

The full paper is available from The Green Grid, but Julius condenses some important knowledge in a special piece for us, designed to combat the hydrophobia that is still rampant in data centers.

Peter Judge
DCD Global Editor

The flavors of cooling

Peter Judge
Global Editor

Data centers have to beat the heat. *Peter Judge* gets into the swing of cooling

The second law of thermodynamics is the most unbreakable of physical laws, and it is the second law of thermodynamics which requires all data centers to get rid of their heat. Luckily, data center engineers have kept their cool.

Every Joule of energy, pretty much, that goes into a data center is turned eventually into heat. The IT equipment burns electrical energy to do its symbolic work, and the heat it gives off has to go somewhere, or the equipment will overheat.

The aim of data center cooling is to do this job, without using more than a bare minimum of energy, on top of the IT equipment's power. Ideally, all the electricity goes to the racks. But in practice, plenty of other energy is required, pumping air or other coolants, operating refrigeration systems and more.

At its worst, powering and cooling a data center has been described as running a room full of electric heaters, and a roomful of hairdryers using just as much energy to cool them down. However, as cooling has evolved, the field has developed, with a subtler application of the science of psychrometrics (see box "cooling hits the charts").

There are metrics designed to grade and improve efficiency (see Box "PUE and metrics"), and a panoply of cooling kit including CRAC, CRAH and economizers (see box "The elements of cool").

Most of this sort of equipment dates from the era when data centers were kept too cool, because builders were not prepared to take risks with the tolerance of IT systems. Vast amounts of energy was spent getting the air temperature in a data center down well below the level that was actually required.

Recently, more focused systems have limited the cooling with in-row systems, and also introduced systems which cool using chillers, instead of refrigeration equipment. The tolerance of IT equipment is better understood, and the TC 9.9 guidance from ASHRAE (the American Society of Heating Refrigeration and Airconditioning Engineers) has resulted in a trend of increasing temperatures in data centers, so less energy is wasted.

The details are complex. Trainers like DCPRO's Barry Shambrook can spend a three day course outlining the basics of cooling and how to improve it.

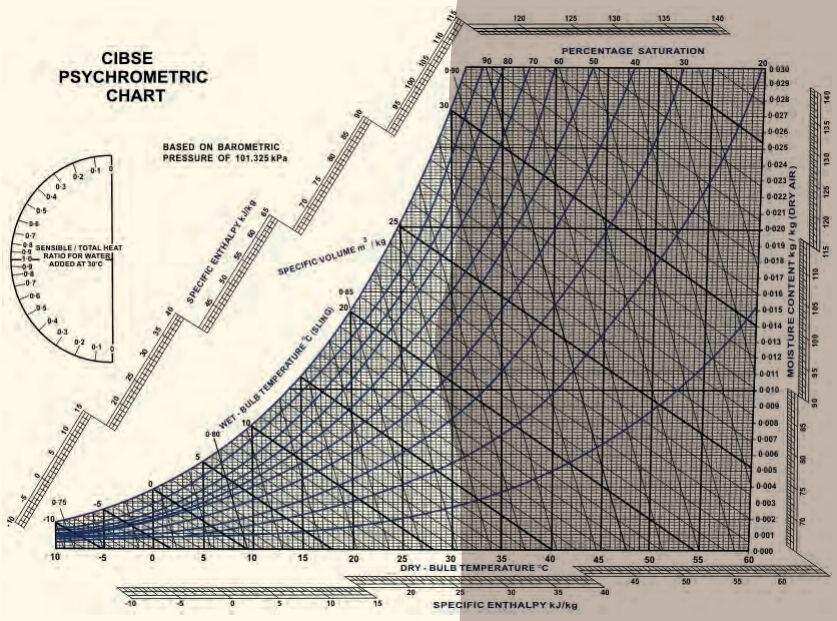
"It might seems simple because hot air rises," he says. "But at the speeds we move air around in a data center, the buoyancy of air has very little effect, so hot air can actually go down." ▶

Cooling hits the charts

To use air in cooling, you have to understand its thermodynamic properties. At the start of the 20th century, US inventor Willis Carrier created electric air conditioning and, in the process, invented the science of psychrometry.

Carrier understood the connection between the pressure, volume and temperature of a gas, as well as its relative humidity, and found a way to illustrate these in an understandable form, inventing the science of psychrometrics.

Gases have a wet-bulb temperature, which expresses the ability of air to cool things by evaporation, as well as the dry-bulb temperature measured by a thermometer. With psychrometric charts, cooling engineers can adjust the moisture, pressure and volume of a gas, in order to navigate along isobars and other lines, from one temperature to the one they want, making the gas absorb heat and reject it at will.



What this means is that data center engineers have to pay attention to the air flow through a data center. A lot of the great improvements have come from simply making this better. Cold air should be directed to the equipment which needs cooling, and the warm air should go to where it will give up its heat.

Openings in raised floors can create recirculation paths, leading to warm air returning past the IT kit, or cold air may move too fast, and bypass the cabinets, or pass through so quickly it doesn't pick up any heat.

The overall system will have a greater tendency to recirculate air, if the heat change across the server is too small (a small delta-T) and air will tend to bypass the servers if there is a high delta-T.

Electronically commutated (EC) fans have been adopted, which can have their speed adjusted, so only the right amount of cooling is applied, saving masses of energy.

Distributed cooling systems take the cooling to the racks, using active rear-door heat exchangers (ARDHs) attached to the cabinets themselves. This can work with server cooling systems, according to Rich Whitmore, CEO of ARDH-maker Motivair: "The addition of an ARDH actually reduces fan power consumption of the computers inside that rack, more than offsetting the minimal power consumption of the ARDH fan array."

Other major improvements added recently include the use of economizers - these use water evaporation to cool air in a heat exchanger, so circulating air can be cooled below the outside air temperature.

This is "adiabatic cooling," and Shambrook points out that can't add an unlimited amount of cooling, because air can only carry a certain amount of moisture. Using it effectively "uses up" a certain amount of water which is expelled in moist air.

Using these techniques, says Shambrook, "the whole of Europe can use free outside-air cooling all year round."

Malcolm Howe of engineering consultant Cundall, winner of DCD's Business Leader 2016 award for his work in data center design, agrees: "You don't have to go to Luleå in Sweden to cool your data center. You can achieve refrigerant-free cooling all year round in London."

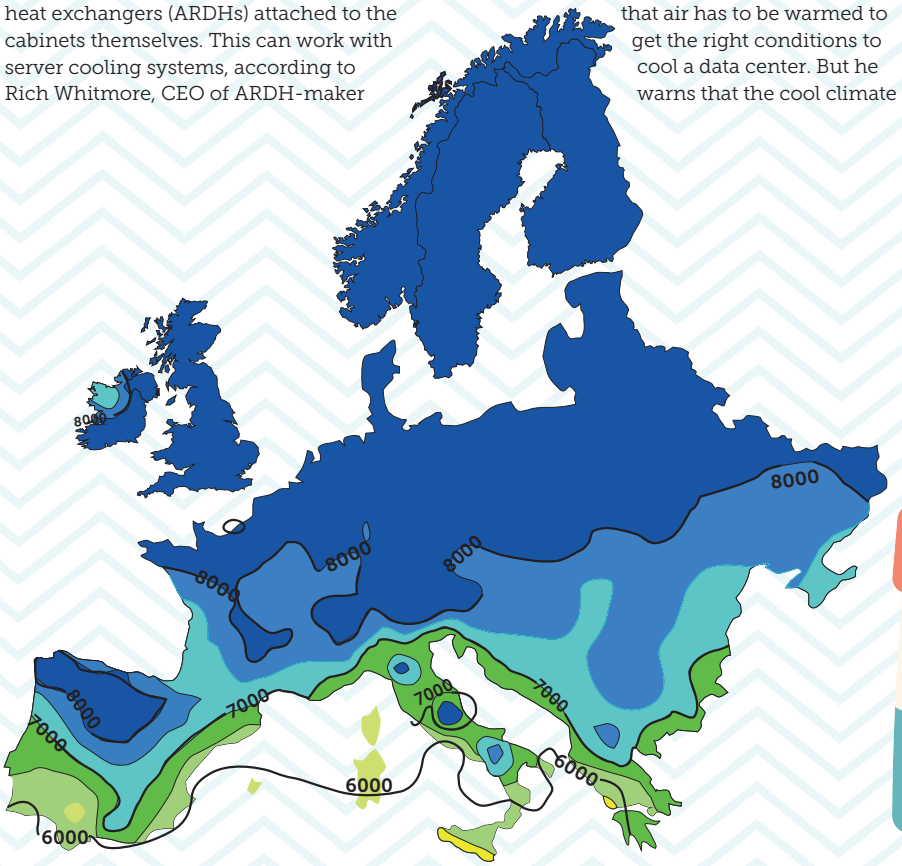
At present in large parts of the world, winter temperatures are so cold that air has to be warmed to get the right conditions to cool a data center. But he warns that the cool climate of Europe may change in the future, due to climate change.

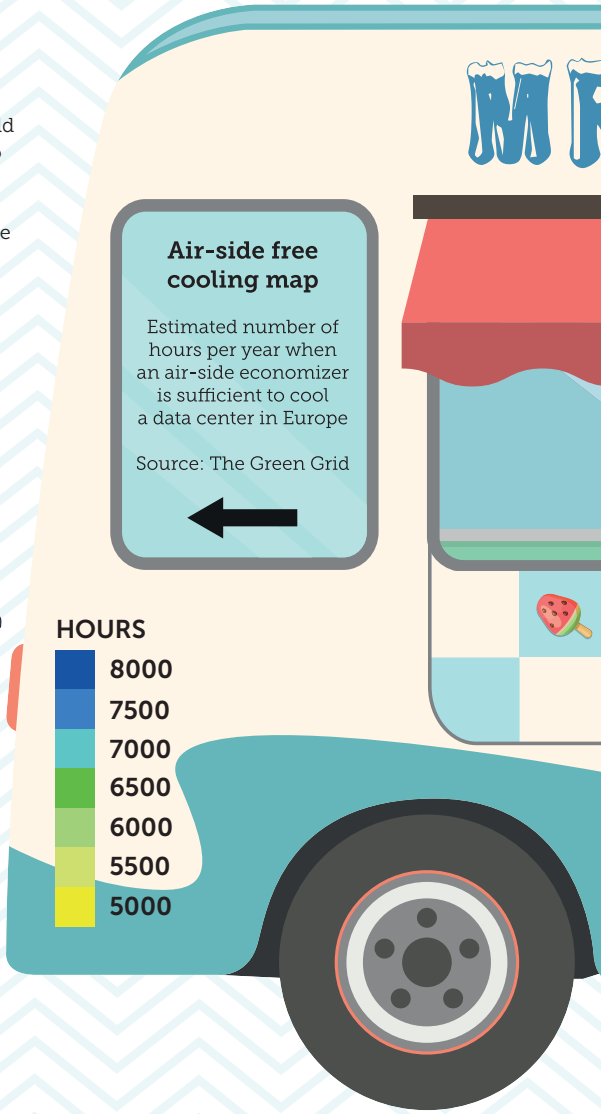
"We might have to add chillers to data centers in borderline areas," he says. "There will be some locations, maybe in France or Spain, where it's the difference between not needing heat-lopping equipment now, to needing it in 15 years' time."

In other words, data centers, and the world, may get warmer. But data center engineers will always be indisputably cool.

This article was produced with the help of a course from DCPRO presented by the remarkably chill Barry Shambrook.

626 billion
liters of water consumed by US data centers in 2014 (US Gov)





The elements of cool

Data center designers have an armory of cooling equipment at their disposal, starting with traditional computer room air conditioning equipment (CRAC) systems which apply conventional air conditioning, using "direct expansion" of a refrigerant such as a fluorocarbon, to remove the heat from the racks.

There are also computer room air handlers (CRAHs) which apply a less-demanding cooling system based on chilled water. And beyond that, newer cooling systems attempt to do with as little equipment as they can, using the outside air where possible to remove heat.

Liquid cooling is more efficient, because liquid is denser than air, and has a higher heat capacity. But there are overheads in getting liquid closer to the equipment.

Meanwhile, use of outside air as the eventual heat sink reduces the amount of plant and energy required.

The total system has to include four major elements:

- A heat exchange system where a medium (liquid or air) will absorb the heat at the IT equipment.
- Some cooling plant which then removes the heat from the cooling medium. This is where CRACs and chillers are found.
- Heat rejection systems, such as condensers and cooling towers which expel that heat to the outside world.
- And finally, quite a lot of equipment dedicated to moving air around the building and making sure that heat is carried in one direction - away from the IT kit.

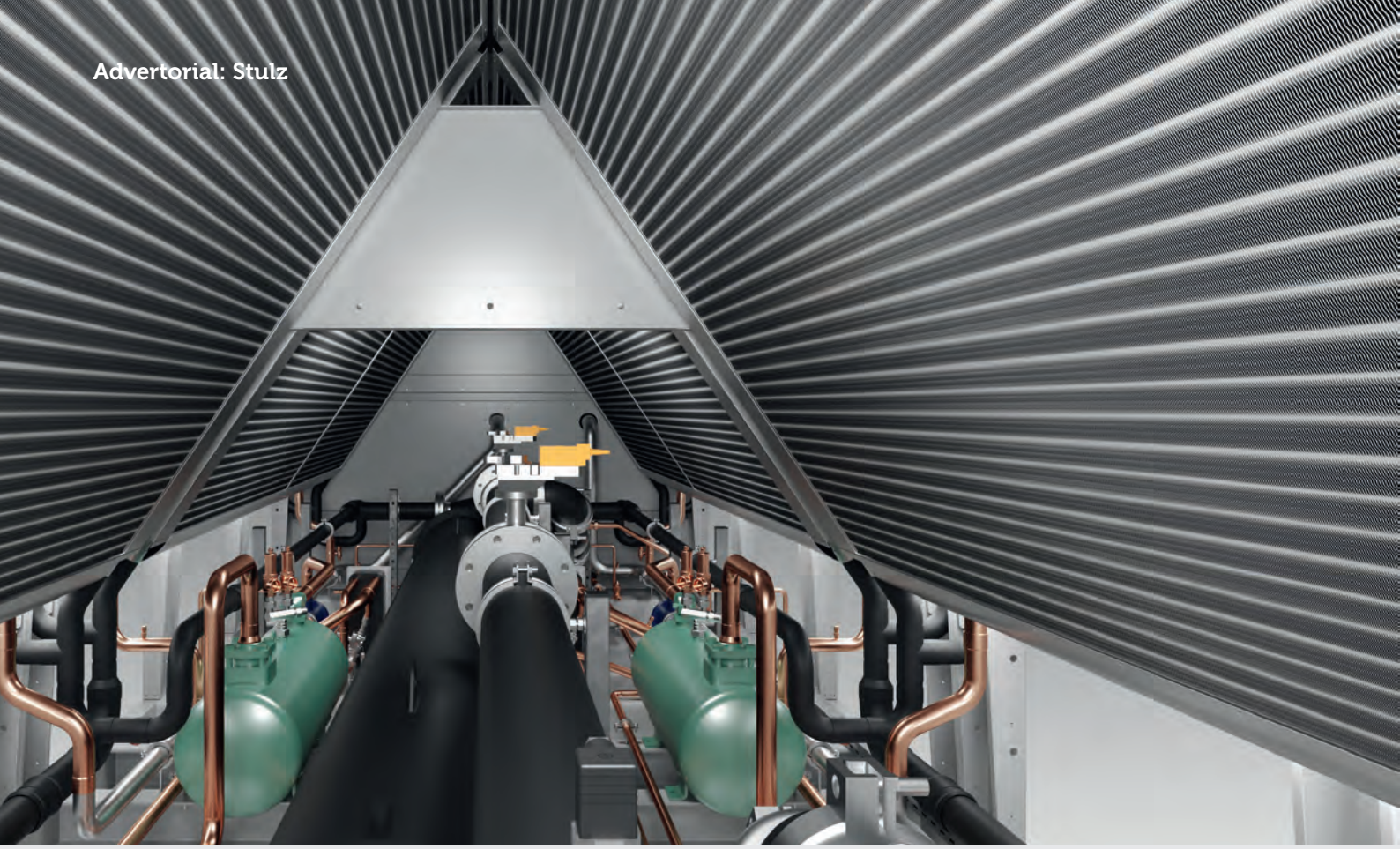
PUE and metrics

When the data center community realized that most data centers spend as much energy removing heat from the racks as they do in powering the equipment there, a measurement was proposed called Power Usage Effectiveness (PUE), which is just the ratio of total power to IT power in a data center.

Old school data centers had a PUE of 2.0 or more. The most efficient will approach 1.0. This simple expression, along with the rising awareness of electricity costs, means that new data centers now are expected to have a PUE of 1.2 or less.

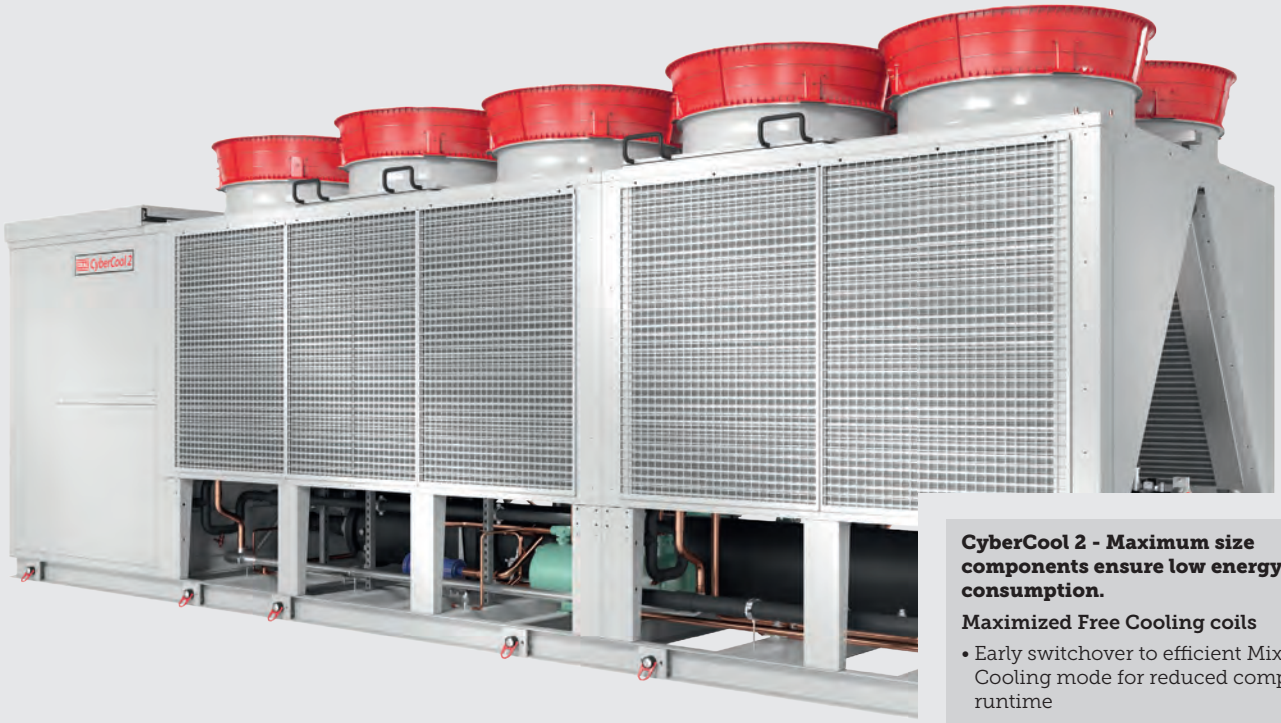
PUE was created by industry group The Green Grid and was not intended for marketing comparisons, but has inevitably been used in that way. It's also been enshrined as a draft international standard by ISO, and is referenced in national energy efficiency policies, such as the UK's data center Climate Change Agreement.

In practice in the data center, engineers need to work with detailed metrics such as the coefficient of performance (COP) which is the amount of cooling power, divided by the input power.



Project-specific customization is the key

In many cases, all-in-one volume production chillers are still the solution of choice for data center cooling. But it is often worth taking a look at specific customization options such as piping, the frame and electrical parts. Under its “Climate. Customized.” motto, STULZ factors in project specifics upfront at the design stage for its CyberCool 2 chiller, to optimize energy efficiency and operational reliability.



It is all about intrinsic values
When we design STULZ CyberCool 2 chillers for a project, our fundamental objective is always maximum energy efficiency and operational reliability. Making the heat exchangers as large as possible is a decisive factor in meeting that goal. It is the only way to achieve early switching to Free Cooling, to reduce compressor running times and hydraulic pressure drops. We use ebm-papst EC fans with a large surface area and precision air conduction to ensure lower noise emissions.

Climate.Customized in practice – same footprint, more cooling capacity
A leading colocation operator redesigned its entire server architecture in an existing data center to provide more computing power going forward. At the same time, they wanted to replace their old chillers with a more efficient and powerful solution. From a structural and financial point of view, modifying the existing chiller lines in the building wasn't an option. What's more, for technical reasons, the company needed to keep to the exact footprints of the old chillers. After lengthy discussion with various chiller manufacturers, there was still no ideal solution on the horizon. STULZ's "Climate. Customized." approach was the only one to deliver, thanks to a wider range of options, especially in the form of a tailor-made CyberCool-2 chiller which met all the project requirements perfectly.

Conversion in the tightest of spaces
Customization of the STULZ CyberCool 2 started with the base frame, as it had to fit into in the existing steel structure. On account of the increased requirement for cooling capacity, the compressors had to be enlarged, and accordingly – because of the need for a more powerful pump – the evaporator was made more compact. As the installation location was a given and the base frame had to be modified, this meant the pipe routing and the positioning of internal components also had to be adjusted.

The modified CyberCool 2 meets the project specifications and allows the customer to run an efficient, reliable data center.

Tailored advice for planners and customers
Chillers are complex technical installations with a whole range of factors that play a key role in adjustment and optimization. Size, cooling capacity, compressors and electrics are some of the deciding criteria. What matters here is finding the perfect balance within the boundaries of technical feasibility, without compromising efficiency and operational availability. STULZ experts advise planners and data center operators at the preliminary project stage to ensure that customer integration requirements are met precisely.

CyberCool 2 - Maximum size components ensure low energy consumption.

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- Designed with copper and aluminum coils

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Evaporators with large surface area for high evaporation temperatures

- Low pressure drops and an optimized heat transfer ensure particularly high evaporation temperatures

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Back to nature

Data center operators are dipping their toes into a new cooling opportunity, says *Tanwen Dawn-Hiscox*

Tanwen Dawn-Hiscox
Reporter

Water makes up about 70 percent of the Earth's surface. Most of it is contained in the oceans, but there's still about 11 million cubic kilometers of water in lakes and rivers, all of which has the capacity to absorb heat.

The data center industry is generally pretty conservative, but some operators have seen an opportunity to cool their servers more efficiently, and dived right in.

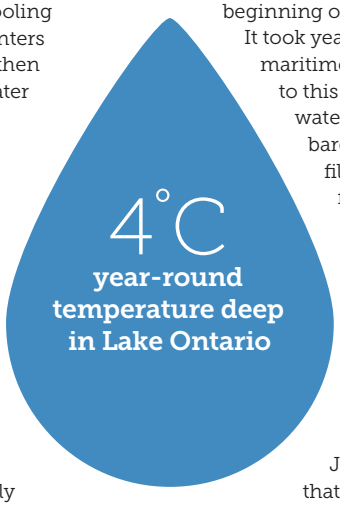
Green Mountain's two data centers in Norway use natural water sources to cool their IT loads. DC1, in a former NATO ammunition store in Stavanger, uses gravity to draw water from a fjord, from the depth of 75m, up through the pipes and into the pumps of a cooling station, releasing it back out 30m below the surface. DC2 in Telemark takes its water from a source which was initially used for hydro electric power generation.

In Toronto, both Cologix and Equinix have attached their facilities to the Deep Lake Water Cooling system, which draws on the chilly waters of Lake Ontario. Melting ice from surrounding mountains keeps the lake

at a constant temperature level throughout the year. Whilst the upper layer is drawn and used as potable water, the water underneath, which remains at 4°C (39.2°F) all year round, is drawn via three 5km polyethylene intake pipes and channeled to a filtration plant.

Then, it is pumped through heat exchangers into an energy-transfer station. The cold air then enters a closed circuit, reaches cooling towers, and finally the buildings connected to the cooling system, including the data centers mentioned above. The water then goes into the city's potable water system.

Other data centers are cooled by water simply taken from the ground. TierPoint's facility in Washington is built on an aquifer, from which it draws water via a 200 foot well, shifting 750 gallons a minute through heat exchangers; the cold air enters a closed loop before being blown onto the servers. As the water circulates at high speed, the heat dissipates almost instantly as it is returned to its source.



The B'eeau Lac project goes one better: a French technology hub near the Swiss border, Technolac, is planning a similar setup, using water from the Lac du Bourget to cool offices and a data center.

There are plans to take the waste heat it collects, and use it for central heating in newly built homes. That's an idea which is also being applied in district heat systems, widely used in Scandinavian countries, but there are practical considerations (see right).

These are success stories. They have cut energy consumption, and reduced the chemicals in the public water supply. The data centers are using less chlorofluorocarbon for air conditioning, and water isn't wasted.

However, all of these projects, much like the free air cooled data centers of the Nordic countries and those in the windy plains of Iowa, depend on a set of very specific circumstances, says Barry Shambrook of TCL data, a teacher of DCPRO's Data Center Cooling Professional course. "I wouldn't totally discount it, but it is very dependent on the local environment and what's available."

Data centers boast that lake and river cooling systems have little to no impact on the environment, but Shambrook says the bigger picture won't be affected. "It might be a little bit more efficient discharging heat to water than to air, but you're still discharging the heat to the environment. So I wouldn't pretend that it was environmentally friendly."

But those using lake and river cooling point out that warming water and returning it doesn't consume natural resources, and puts less pressure on public water supplies.

This is important for Nautilus, a company that emerged during the California drought with a proposal to put data centers on reconditioned navy and shipping barges. The idea is to bring data centers close to where they are needed, and Nautilus hopes to give its floating data centers a launch party at the beginning of 2018.

It took years of hard graft and applied maritime engineering to get Nautilus to this point, but the idea is simple: water is drawn from wherever the barge is moored, sifted through filters and a heat exchanger, feeding the cold to a closed loop of fresh water in a rear-door cooling system. And then the warmed water is released into the source.

So what of the environmental impact of releasing warm water into seas, rivers and lakes? Nautilus president and CEO James Connaughton says that the barge design releases water at a temperature "below the most stringent regulatory standards" in the US, promising a maximum temperature rise of 4°F (2°C). "So our discharge does not cross regulatory thresholds. We are a fraction of the discharge of power plants or large industrial process units. And we're on par with the heat discharge of all the ships in the ports where many of our data centers will be located."

Even if it raises temperatures, he says there are "so many places on earth where a little bit of warmer discharge will have no, or a beneficial, environmental impact that you can very readily avoid places where it might [be harmful]. And, if you're thinking creatively, because we are actually producing warmer water as a bi-product, we have some additional future capabilities to interact with desalination systems, with water treatment; you know, public water treatment systems where a little warm water is actually a good thing. That's an additional upside depending on where we put our facilities."

Connaughton has a track record in energy policy. He was an environmental adviser to George W. Bush, serving as a chairman for the White House Council on Environmental Quality. He now represents ClearPath Foundation, a lobbying group that supports "conservative clean energy," such as natural gas, hydropower and "new technology for clean coal."

Green Mountain backs him up, saying that the warm water it releases from its data center "helps fish procreate."

Shambrook reserves judgment: "It's stuff that's beyond my understanding to be honest, because you're affecting the local environment. I suppose you could argue that you're affecting it in a positive way."

Whether or not it is eco-friendly, Connaughton is convinced that water cooling will take the center stage: "In the next twenty years, every new data center is going to be water cooled. Twenty years from now, there will not be air cooled data centers, because water is a much more efficient heat transfer agent. Air cooling will be the niche application of the future, water will be ubiquitous. And we know this because that's what's happening in every other sector."

And if the sea is a bit warmer by then, maybe we can all go for a swim.

Can we use the heat?

Water can absorb and transport heat, so why not reuse that heat? Plans to do this may sound good on paper, but are difficult to implement in practice. "If you're taking water from a source, warming it up and then you're using that heat, that's a very good way of using wasted energy," says Barry Shambrook. "My only skepticism would be how many homes you could feed with hot water from a reasonable sized data center."

Shambrook estimates one rack could warm two homes, so a data center could heat hundreds of homes: "I can see it working if you had an apartment complex close to a lake or a big source of water and a smallish data center."

By contrast, a hyperscale data center might generate too much: "The amount of hot water you're dealing with is just huge. You could use a bit of it, but you're not going to use anywhere near enough. A hyperscale data center with hundreds of racks at 5kW would produce megawatts of heat."

The problem is that data centers generate heat continuously, and demand for heat is not steady. "Data center loads are there all the time, 24x7, 365 days a year, but people don't use hot water 24x7 365 days a year," says Shambrook. "They use it a lot in the evening, when they come home, first thing in the morning, and not much in between. You have to balance the capacity with the need."

Dunk or dip

Water cooling is a good thing, but the benefits of liquid cooling really start to add up when you switch from water to dielectric, take the coolant inside the IT equipment, and apply it directly to the electronics. We look at two different approaches

Taking a bath

Sebastian Moss
Reporter

Dutch startup Asperitas wants you to dunk your servers into its specialized module, the AIC24, submerging up to 24 servers in a water-cooled oil-immersion system that uses natural convection to circulate the dielectric fluid.

Within those modules, the AIC can support any type of server mainboard up to a maximum size of E-ATX (12x13") for a 1U chassis. It can also accommodate two cassettes that hold switches.

The data center in-a-box supports up to 22kW of pure IT power with a footprint of 600x1200 mm.

"So far we have had a very positive response," CEO Markus Mandemaker told *DCD*. "People we talk to are less cautious than expected."

But, with that said, the company has struggled to overcome fixed mindsets, Mandemaker said: "The biggest hurdle is people's perception. We're a new company, presenting a new technology which changes your way of working.

"If you are a data center company wanting to expand, you call a consultant, and everybody starts going by the existing framework because that's how you build a data center."

> *It uses a cheap medicinal quality oil, like Vaseline but with a different viscosity*

Asperitas hopes it can reach beyond the high performance computing market where most liquid cooling systems are deployed, eying a much larger prize. "We've designed this for cloud providers," Maikel Bouricius, Asperitas marketing manager, said.

"Liquid cooling is an old idea, but what we did was focus on usability to make it easy for cloud providers to use it and make it fit to their business."

Ease of use is an area which Asperitas was keen to tout, highlighting the AIC's automatic opening and closing cover and specialized arm which pulls servers out of the oil. "We thought about how to deal with it not just when things are running, but also when something happens," Bouricius said.

Another focal point is the price, Mandemaker stressed. "Floor space can be smaller. You don't need the raised floors. You don't need the aisle separation. You don't need the cooling installation."

When compared to other liquid cooling systems, the company said AIC24 was cheaper because "any direct liquid cooled system still needs some airflow," whereas its system relies exclusively on natural convection.

The medium is a cheap medicinal quality oil, like Vaseline but with a different viscosity, bringing more savings.

"If you compare it to the 3M Novec-type solutions where you need very expensive liquids for the multiphase cooling, I only actually see those kinds of solutions in smaller environments," Mandemaker said. "I haven't seen huge data floors with 3M or Iceotope solutions because it's too expensive."

But before the company can start to see huge data floors of its own, filled with AICs chained together, it still has a way to go.

Asperitas is now shifting into production mode, after running a prototype version at The University of Leeds for a year and a half. It has had several discussions described as promising, including with the Dutch Army, but its dream of supplying the booming cloud market remains elusive, for now.

Boosting the circulation

Max Smolaks
News Editor

When British liquid cooling company Iceotope started out more than a decade ago, it was pitching to research projects and high performance computing environments. It was an obvious match – supercomputers produce more heat than your average stacks of servers, and liquid cooling solutions remove heat more efficiently than those based on shifting large volumes of air.

"Why? It is a space that tends to invest in new technologies, it's a space where you can test stuff out, and it's a space that has a lot of problems that can be solved with liquid cooling," David Craig, CEO of Iceotope, told *DCD*.

Today, after years of testing, the company has found a new, possibly more lucrative target market: edge computing.

45°C
inlet water temperature

Iceotope's Petagen system wraps each server blade in a metal case filled with dielectric coolant – namely Galden, made by Belgian chemical company Solvay. The blades are installed in a rack-sized chassis that circulates water to remove the heat.

The system can considerably increase the density of compute, since cooling capacity is pretty much the only factor that limits how many servers you can install in a square meter of space. As a consequence, it can also reduce the overall footprint of servers. And hot water produced by the system can be collected and re-used for other purposes, like central heating.

"There's a whole set of technologies where compute cannot be done in the cloud – because of data sovereignty, latency or some other critical issue," Craig said.

"As we get more interconnected devices and more people move to cities, there will be a huge demand for close and local processing – and it will be part of our ability to compete in the future. Global competition will be based on proximity and speed."

What makes Petagen a perfect fit for edge computing is its ability to turn any enclosed space into a data center. The system doesn't require computer room air conditioning units, humidity control systems or air purification. There are no fans, so it doesn't produce any noise and can be placed in the middle of the office, or even a library.

"If you are going to be running your data center from an old brownfield site, from a warehouse, you can drastically reduce your cost of operation. You can then drastically improve the pricing of the service you are offering to your customer," Craig said.

And it's also good for some of the more extreme environments: "We recently looked at the example of a 300kW containerized data center that was going to be deployed in Australia. In that instance, we would be reducing the container size from 40-foot to 20-foot, and there would still be space left for a desk and a chair for somebody to work inside it. We would be having external temperatures of 50°C (122°F), creating huge amounts of stress on the internal environment.

"That containerized space we are perfect for – because we can deal with 45°C (113°F) inlet water. So get hot, feel free. We can handle it."

It doesn't require computer room air conditioning units, so it can be in an office, or even a library

Peter's final Judgement
Getting liquid closer to the electronics allows ever greater densities. Good luck to Iceotope, Asperitas, and all the other liquid cooling experts!

Get over your hydrophobia

Liquid cooling has come a long way. Data center operators need to get over their fears, says *Julius Neudorfer*

Julius Neudorfer / North American Access

It seems history is repeating itself. Even in the age of the cloud, virtual data center and virtual everything, somewhere there still needs to be IT hardware that draws power and needs to be cooled. While liquid cooling has been used since the early mainframe days and is still used to cool some supercomputers, for the last few decades, air cooling became the predominant form of cooling for most IT systems as a matter of convenience.

As power demands continue to increase in the Zettabyte era, the use of liquid cooling has re-emerged, by offering effective thermal solutions for rack power densities of 25kW to 100kW per cabinet, which effectively addresses the cooling and energy challenges of high performance and hyperscale compute, as well as higher density mainstream applications.

The thermal transfer effectiveness and energy efficiency of liquid cooling compared to air are well-known, but for most people liquid cooling may still seem like an antiquated concept. To some, there is actual fear of water, which I refer to as data center hydrophobia.

Nonetheless, more recently, many new liquid cooling technical developments and systems have entered the market which were originally aimed at hyperscale applications and are now available for conventional data center servers. Some of these systems are offered by major OEMs, such as Dell's Triton server, while others are options for systems by HP, IBM and Lenovo.

In other cases, there are systems made by smaller manufacturers, as well as liquid cooling systems built into "standard" style IT cabinets, which can accommodate both air and liquid cooled servers in the same cabinet.

Some vendors offer hot-plug liquid cooling servers, which plug into a cabinet, making them as convenient as blade servers to swap-out server blades. This type of liquid cooled IT equipment is easier to implement for traditional facilities, and has increased interest in liquid cooling.

Moreover, while the industry is well aware of the ASHRAE Thermal Guidelines for air cooled IT, fewer are aware that the ASHRAE has had Liquid Cooling guidelines since 2006. In fact, the 2011 and 2015 Thermal Guidelines also includes Liquid Cooling categories W1 to W5. This should help guide facility designers and engineers, and equipment vendors and also help to reassure data center owners, operators and IT departments about utilizing liquid cooled systems.

There are many myths and misconceptions about liquid cooling in the industry. To address this, The Green Grid (TGG) published the Liquid Cooling Technology Update whitepaper #70. This whitepaper provides a high-level overview of IT and facility benefits, as well as a guide to state-of-the-art liquid cooling technology. The paper defines and clarifies liquid cooling terms, system boundaries, topologies and heat transfer technologies. It is intended for chief technology officers and IT systems architects, as well as data center designers, owners and operators, which should help drive understanding and accelerate adoption.

The magnitude of demands from the expected flood of data from IoT devices, compounded by the massive bandwidth of 5G connectivity on edge data centers, will require HPC performance levels at an "industrial scale," which will make it more difficult for air cooled IT equipment to meet density and performance requirements.

This will drive hyperscalers towards liquid cooling, which will demonstrate its effectiveness and establish its feasibility. This will validate and refine its operational practicality, as well as making it more cost effective, as volume manufacturing will lower costs to match air cooled systems.

Free cooling was first used by Google, Facebook and other "at scale" facilities, and is now commonly considered for mainstream sites. I believe that liquid cooled systems will similarly see far more widespread adoption in the not too distant future.

bit.ly/GreenGridliquid

The thermal transfer effectiveness and energy efficiency of liquid cooling is well known, but some suffer from actual fear of water

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