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Game on

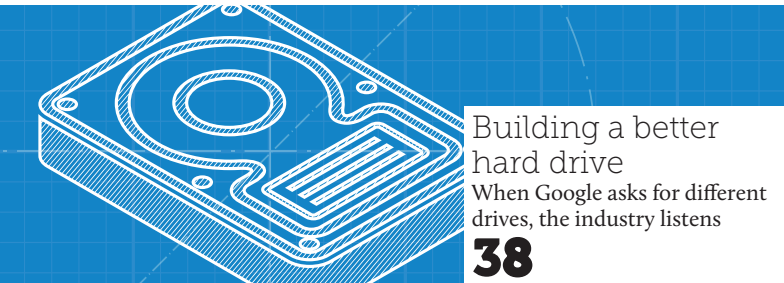


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Meet the team



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DCD
MEDIA

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Game-changer for the world

Video gaming is a \$100bn market and it's entirely digital. The content, the delivery, the billing, even the contracts that deliver the customers' immortal souls to the gaming companies; it all happens in virtual space. That means, whatever is happening on your screen, the real action is all happening in data centers.

In recent months a data center failure interrupted the flow of in-game purchase revenue for a heavily marketed (but reportedly dull and cynical) little thing called *Game of War*. The result was a court battle and bankruptcy for the data center provider.

Pokémon Go has been huge (but may be past its play-by date and nearly forgotten by the time you read this). In its launch and hype phases, it has been seen as a test for the Google Cloud which hosts it.

Delivering this cost-effectively and efficiently is a challenge (p20). With its emphasis on fast reactions and edge computing, the games market is preparing us for the eventual rollout of the Internet of Things.

Ten years ago, DCD held its first Awards, and I don't think many people would have predicted the meteoric rise of interactive video games in a world of Windows XP and Sony PS2s, with no iPhones.


A couple of the first winners of those awards (p25) have told us how their world has changed in the past decade and what they expect to happen next.

We also examine the state of data centers in Europe, as the ripples from the UK's Brexit vote continue to disturb the waters (p29).

Storage and servers might be something data center people overlook as merely the stuff you put in the racks. But the move to hyperconvergence is enabling tiny data centers, and at the same time commoditizing the hardware in some larger ones (p34).

Also in our storage and servers focus, we see how data centers are driving the way storage is developed. With a vast quantity of the world's zettabytes inside data centers, we are seeing the providers start to talk terms with the hardware makers – with mind-blowing results. That's yet another game-changer!

• **Peter Judge** – Global Editor

 @PeterJudgeDCD

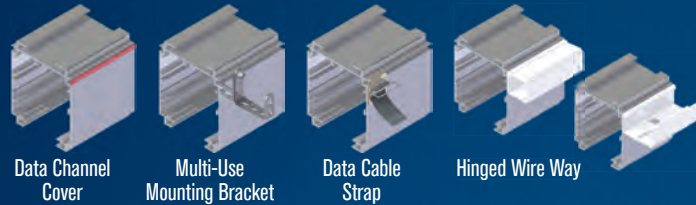


190K

largest number of users on one server (*World of Tanks*) Guinness World Records

The games market is preparing us for the rollout of the Internet of Things

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One of the main goals of STARLINE Track Busway is to supply a safe, reliable connection to power while also making your life a little easier. That's why now, in addition to our customisable plug-in units and multiple feed options, we offer a variety of accessories that allow you to conveniently route cabling while still leaving it accessible and identifiable. These innovative accessories are just another reason why we are the industry standard for power distribution in mission critical environments. To learn more about the simple and versatile STARLINE Track Busway, visit StarlinePower.com.

*Accessories are only compatible with new systems of 250, 400 & 800 amp STARLINE Track Busway.

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New Mexico leads in competition for Facebook site

In a competition between Utah and New Mexico for a sizeable Facebook data center, Utah has fallen behind after a vote against a controversially large tax incentive.

Salt Lake County, SLC's Mayor and The State School Board balked at tax breaks that could have reached as high as \$260 million.

"Effective immediately, all negotiations between the company known as Discus and the City of West Jordan are hereby terminated. Any and all incentives and inducements preliminarily offered the company to locate in West Jordan are hereby rescinded in whole without prejudice," West Jordan City said in a press release.

Project Discus was the name Facebook used to remain secret during the early phase of negotiations.

"This was the largest tax incentive ever offered in Utah history, and the skids were greased, and I felt it was important that the public have a chance to look at it," Salt Lake County Mayor Ben McAdams told *The Salt Lake Tribune*.

But West Jordan City continues to hold out hope that it can stay in the race.

"The players are very much interested in keeping it alive," West Jordan spokeswoman Kim Wells said the day after the vote. Now, officials are optimistic that they can find a compromise that offers

Facebook some tax relief, just not \$260 million.

The incentive was originally proposed to try to compete with New Mexico, which West Jordan said "has opened its doors" to Facebook.

New Mexico's Los Lunas Village Council authorized up to \$30 billion in industrial revenue bonds for the data center, in a series of six IRBs worth up to \$5 billion each. To get the tax deal, all Facebook has to do is make annual payments beginning at \$50,000, eventually increasing to \$100,000.

After Utah's vote, New Mexico has tried to sweeten the pot even further, and could be set to pay for Facebook's water rights - with the Los Lunas village council approving the agreement in a unanimous vote, despite not being involved in negotiations over how much money might be offered.

As the fight for Facebook enters its final lap, it seems that New Mexico has taken the lead.

<http://bit.ly/2bKjQie>

HPE buys SGI

Hewlett Packard Enterprise is buying HPC firm SGI, for \$275 million. As Silicon Graphics, SGI pioneered desktop workstations and was worth \$7bn in 1995.

Oracle buys NetSuite

For \$9.3bn, Oracle is swallowing NetSuite, the cloud business software firm, half-owned by Oracle founder Larry Ellison, and once known as Oracle Small Business Suite.

DR buys in Chicago

Digital Realty has bought 800,000 sq ft of land in Chicago's Franklin Park, to build a second data center that could be as big as its existing campus there.

Seagate's monster SSD

Seagate has demonstrated a mammoth 60TB solid state drive, which will be available to the public in 2017, multiplying capacity by four in the traditional 3.5in format.

VOX BOX / DCD VIDEO



Jim Connaughton
CEO
Nautilus Data Technologies

Why has Nautilus put a data center on a barge?

We take the best of military nautical technology for electronics cooling, and apply it to the data center environment. We can significantly reduce the footprint, reduce the energy, and improve the sustainability of data center operations. It's just like any other data center, but with the advantage of being able to rapidly construct it and move it to where it is needed.

<http://bit.ly/2boOA9g>



Yuval Bachar
Principal Engineer
LinkedIn

Why did LinkedIn design its own rack?

Open19 came about because we wanted to find a solution which would enable us to build any rack in any location - to have a cookie-cutter environment for our data centers. We tried different open technologies which were out there, and they did not work for us, so we had to develop something which is simple and open and works for any 19 inch equipment.

<http://bit.ly/2bARXrA>



Microsoft's €2bn Amsterdam data center revealed

Microsoft is expanding a secretive data center project near Amsterdam, reckoned to cost around €2 billion. The project, on farmland, has faced resistance according to Dutch media, but two halls are already built, with more to come.

With two buildings complete, Microsoft has built 11 hectares of data center space on a 37 acre property, located on the Agriport A7 zone, 50km from Amsterdam, according to reports in the *Financieele Dagblad* and *Dutch News*. The site has cheap land, with good power and fiber optic networking, reports say, but all parties have refused to talk to the media.

Microsoft's plans for a cloud data center park were first reported in 2013, and work apparently started in 2014. The land is zoned for agricultural use - mostly greenhouses - and *Boeren Business* reports that the municipality has changed its status to allow Microsoft to build.

The municipality expects the site to become an Internet hub, with many jobs, but *Boeren Business* describes it as "a thorn in the eye of farms around

it," pointing out that many of the Microsoft jobs will go to Irish, British and American incomers.

Based on occasional news reports, and signs visible on the Agriport fence in Google Street View, the overall contractor for the project is UK-based Mace Group. An electricity substation is being built for the project by Netherlands-based Joulz, also visible in Street View.

Reports say that 70 hectares have been made available for data centers and other tech businesses. The change in zoning appears to be temporary, with the land reverting to agricultural use if it is not developed by tech firms within ten years.

Reports also suggest that Microsoft and its partners may have a plan to mollify local farmers. The data center's waste heat is apparently being offered to warm nearby greenhouses.

The Netherlands is a major hub for European data centers. Other new data centers there include a four-story Equinix facility in Amsterdam itself.

<http://bit.ly/2bnA9jq>

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Apple gets approval for Galway site

Apple has been given the green light to build its €850 million (\$947m) data center in Galway, Ireland, following delays caused by concerns about power supply and environmental impact.

An Bord Pleanála gave permission to the massive development, which will begin as one data center, with plans to build eight 25,000 square meter facilities by 2031.

"The proposed development would not seriously injure the amenities of the area or of property in the vicinity, would not have an unacceptable visual impact, would not exacerbate risk of flooding in the vicinity, would not result in a risk of pollution, would not be prejudicial to public health, would be acceptable in terms of traffic safety and convenience, and would not have detrimental environmental impacts," the board concluded. "The proposed development would, therefore, be in accordance with the proper planning and sustainable development of the area."

The decision includes 20 conditions Apple must meet, such as reducing the number of car parking spaces to 100 for staff, seven for visitors and eight for disabled access.

The news comes after a protracted approval process that saw concerns raised over issues such as whether it would cause harm to the local wildlife, whether it could flood the nearby golf course, or if construction would cause undue noise and traffic.

Meanwhile, Chinese giant Alibaba has sent a delegation to look at possible brownfield sites near Dublin for a data center.

<http://bit.ly/2b1szMX>



Korea wants Google data center in Maps dispute

South Korea is apparently using a dispute with Google over access to detailed mapping data in a bid to persuade the search giant to build a data center in the country.

Google applied for data from the National Geographic Information Institute (NGII) six years ago, but the application was rejected. Now, as the application is resubmitted, the company has become embroiled in a dispute over data sovereignty, national security, taxes and local competition that has seen some ask Google to build a Korean data center.

Google is requesting 1:5,000 scale map data, which would be the most detailed among all location datasets currently available in Korea. As Google has no data centers in the country, and it generally stores its map data on its cross-border cloud, the information would be stored outside Korea, although a law states that any maps or photographs for survey cannot be manufactured and transported out of the Republic of Korea.

Korean civic group the Green Consumer Network said: "Google can put an end to the issue by establishing a data center here," adding that this would also lead to Google paying tax.

Korea is technically still one nation gripped by a civil war that has been in the state of 'cease fire' since 1953, with North and South both claiming sovereignty over the whole peninsula.

<http://bit.ly/2bit3TF>

Zellabox announces 'world's smallest' micro data center

Australian modular micro data center company Zellabox has revealed its smallest box yet - a 12U micro data center.

The company says the box on wheels will be of particular interest to companies concerned about storing data in the cloud, and those who wish to have data kept locally or moved easily to temporary sites.

"We have spent the effort researching and designing this new 12U micro data center in response to extensive customer demand for a more agile, deployable, unit. We look forward to helping our customers get their servers where they're really needed in this micro data center solution," Zellabox CTO Clinton Keeler said.

As expected of a micro data center, the 12U Cubb controls power, air quality and temperature. The box also provides security, with the installation monitored 24/7 even if the network is unavailable. As a modular product, multiple micro data centers can be deployed together.

The product announcement comes after Zellabox began to expand abroad in the UK and Europe, hiring the head of Cambridge Cleantech, Hugh Parnell, as chairman of the board.

The 12U micro data center is described as the world's smallest, and does beat out the 23U Schneider SmartBunker and the Rittal 15-usable U 'The System'.

<http://bit.ly/2bKFBPa>

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Telehouse opens London North Two

Telehouse Europe has opened a new 258,000 sq ft (24,000 sq m) data center in London's Docklands, growing its capacity at a site where it already has 785,800 sq ft (73,000 sq m) of space. The £135 million (\$177 million) investment adds to existing connectivity at the Docklands campus.

North Two will provide direct connections to service providers, carriers and content providers, enterprises and financial services companies, the company says.

Telehouse believes this is the world's first multi-floor data center to contain a vertical indirect adiabatic and evaporative cooling system, and promises it will have a power usage effectiveness (PUE) of 1.16.

London Internet Exchange (LINX) is a partner for the Telehouse North Two data center, and a number of other customers have registered interest in the premises.

LINX is a long-standing partner, having been a tenant in Telehouse data centers since it pioneered Internet peering in 1994, when Mbps speeds were considered fast. LINX is now a leading neutral Internet exchange point,



and it will use 100 Gbps Ethernet routers in London North Two.

Telehouse's central role in the UK's Internet was underscored in July, when a power failure on the third floor of its existing Telehouse North site created a "major outage" for customers of BT broadband, and ISPs reliant on BT's wholesale arm Openreach.

A critical circuit breaker had tripped and only a limited range of customers within the building were affected, Telehouse told *DCD*.

That outage came in a bad week for the British Internet. The previous day, Equinix subsidiary Telecity lost service at an entire London data center due to a faulty uninterruptible power supply (UPS) leading to Internet outages across the UK. The UPS power supply was interrupted, and it failed to respond, which in turn took out a LINX peering node.

<http://bit.ly/2bKfrMg> ●

An advertisement for AMCO Enclosures. The main visual is a white server rack floating in a vast, white, fluffy cloud against a blue sky. The text "We're taking our racks to new heights" is written in a large, bold, sans-serif font at the top left. Below the main image, there is a black banner with white text. On the left, it says "DatacenterDynamics COLO+CLOUD THE BUSINESS OF DATA CENTERS. Booth #41". In the center, it lists the website "www.amcoenclosures.com", email "sales@amcoenclosures.com", phone "(847) 391-8100", and "Made in the USA". On the right, there is the AMCO Enclosures logo, which consists of a stylized white 'E' shape above the text "AMCO ENCLOSURES" and "an MS Engineered Products Brand".

Amazon to build in retired Italian power plants - report

Cloud computing giant Amazon plans to build two Italian data centers on the sites of retired power plants in the next 12 months, according to sources quoted by *Reuters*.

The sites, owned by state utility Enel, will use new fiber-optic infrastructure running along Enel's existing electrical transmission lines. This tactic to improve broadband connectivity in the country was announced by Italian Prime Minister Matteo Renzi in April.

In total, the rumored investment is expected to cost about €500 million (\$550 million). It would also see the development of a 645,000 sq ft storage and logistics center in Lazio, outside Rome, for a figure of €150 million (\$165 million).

An additional center to support Amazon's artificial intelligent

virtual personal assistant, Alexa, will be constructed in Turin, Italian media outlet *Unita* reports.

Francesco Starace, Enel's chief executive, has previously said that Amazon is one of several companies interested in purchasing three of its old power stations, as reported in the *Corriere della Sera* newspaper.

Renzi (left) met Amazon founder and chief executive Jeff Bezos (right) in Florence on Friday, July 22.

Diego Piacentini, formerly Amazon's vice president of worldwide sales has been appointed to a position working pro-bono at the government's digital technology office. Piacentini said he wanted to "give back to the country" where he was born and lived for 40 years, according to reports.



Amazon was recently placed under investigation for tax evasion in Italy, but the company's chief for Italy Francois Nuyts said Amazon pays all applicable taxes and is cooperating fully with the Italian authorities.

Amazon is second only to eBay in its retail market share in Italy, according to research company Euromonitor International, with a 14 percent share to eBay's 24 percent.

<http://bit.ly/2bpK8o8>

Citibank tech wiped routers

A technician who deliberately damaged 10 core routers at Citibank has been punished with a near-two-year jail term and a \$77,000 fine. After a poor performance review in December 2013, 38-year-old Lennon Ray Brown, from Dallas, sent commands to erase the configuration files on 10 core routers within Citibank's internal network. This affected network and phone access in 110 Citibank branches.

Emerson sells Network Power division for \$4bn

Emerson is selling its Network Power division to Platinum Equity and co-investors for \$4 billion in cash.

Network Power, which owns popular data center brands such as Liebert, Trellis, Chloride Group and NetSure, had revenues of around \$4.4 billion in 2015. After sales fell, Emerson announced plans in 2015 to spin it off as an independent body, owned by Emerson shareholders.

In April 2016, it was revealed that the new company would be called Vertiv. In July, the sale to Platinum was announced, with the rebrand still going ahead, *DCD* understands. Other potential purchasers apparently included Siemens.

"This agreement marks a major milestone in the strategic portfolio repositioning we announced last June," said Emerson CEO David Farr. "By selling Network Power to Platinum Equity, we have achieved a successful result for our shareholders as part of our plan to streamline Emerson to create a more focused company with significant opportunities for growth and profitability in our core served markets."

The equity group previously bought a 51 percent controlling stake in Emerson's embedded computing and power business, renaming the company Artesyn Embedded Technologies.

The sale is expected to close by December 31, subject to customary regulatory approvals.

Emerson is also set to sell its motors and electric power division to Japan's Nidec Corp for \$1.2 billion.

<http://bit.ly/2ax3cMR>

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Russia builds data center in Crimea

The Republic of Crimea, recently established and not recognized by the international community, is building a government data center to assist with the 'digitization' of the country. The facility will be built by state-owned Krymtehnologii (Crimea Technologies), an organization that reports to the Ministry of Communications.

The hardware alone is expected to cost at least 148.2

million rubles (\$2.2m), according to *Cnews.ru*, but the project might be complicated by Western economic sanctions imposed over Russia's annexation of Crimea in 2014.

In March 2014, following popular unrest across Ukraine and dissolution of the elected government, the Crimean peninsula was taken over by local separatists and units of the Russian Armed Forces, and then annexed to become part of the Russian Federation.

To help incorporate the peninsula into the Federation, the new Crimean government has launched numerous infrastructure projects, including one that calls for a state-owned

data center. The facility is meant to process citizen information and improve the technological capabilities of the government as a whole.

The report in *Cnews.ru* notes that the related government tenders are very specific about the risks involved, and the conditions for cancellation of contracts – likely due to economic sanctions that prevent some of the world's largest IT suppliers from doing business with Russian companies.

As for hardware, the tenders reveal that the data center will initially host around 100 servers that have to be compatible with various distributions of Linux.

Krymtehnologii is no



stranger to data center design, and already runs a commercial colocation facility in Crimea that offers managed hosting, virtual servers, security services and DDoS protection.

<http://bit.ly/2b36zP4>

DARPA builds pop-up data center for AI security contest

The US Defense Advanced Research Projects Agency (DARPA) knocked up a small, liquid cooled data center in just 29 hours ahead of the Cyber Grand Challenge (CGC), an event which pitted AI security systems against each other.

The US military body, which commissions advanced research for the Department of Defense, built the temporary facility to support the creations of seven teams of cyber security experts, and then tweeted "is that not the handsomest liquid-cooled data center you've ever seen?"

The seven supercomputers, made of seven racks of servers, were each loaded with an autonomous security bot from one of the teams. The bots then ran software from DARPA that none of the bots had seen before, and had to patch holes in their own system while exploiting the holes in other systems, all without any help from humans.

The top-scoring machine, Mayhem, earned the chance to be the first AI to compete in the DEF CON Capture the Flag contest, and won \$2 million for its creators, ForAllSecure of Pittsburgh. The \$1 million second place went to Xandra, developed by TECHx, and the \$750,000 third prize was taken by Mechanical Phish, developed by Shellphish.

Autonomous security bots are an area of intense research, with the promise of AI systems that can defend (and potentially attack) of obvious merit to technology firms in a world increasingly connected.

But all of the systems are still in their very early stages and are unable to compete with a talented individual hacker, let alone a large team, for example in the case of nation-state cyber warfare.

<http://bit.ly/2brvAXx>

CenturyLink expects to sell data centers by year's end



After publicly debating the idea of selling off its data center business in 2015, communications company CenturyLink has said that it hopes to complete a sale by the end of 2016.

The company says it has narrowed down the group of final potential buyers and believes it will be successful in getting a sale, but will continue to sell colocation services by working with partners.

In an earnings call, CEO Glen Post said: "Regarding the data center business, we expect that it will be a sale; however, the colo business is going to continue to be an important part of our future."

He added: "We think there are opportunities to approach it differently if we don't have a sale. We have a couple of partnership opportunities we think are legitimate, real that could be beneficial for shareholders if we don't get the valuation from a sale that we expect that we require."

Telecoms firms have been altering their stance on data centers, with several indicating a readiness to sell their assets to partners, while still selling the services. Post would not discuss the valuation the company hopes to get, and he cautiously noted that CenturyLink is still deciding what to do with any money raised.

"We'll obviously consider a number of alternatives, stock buybacks, debt reduction, investment and strategic services, and other possible areas," he said.

<http://bit.ly/2aYKdzo>



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Businesses built on blockchain

Best known as the basis of bitcoin, blockchain is ready to help build security in enterprises, reports *Paul Mah*. But, first we have to make it scale



Paul Mah
SEA Correspondent
@paulmah

Known as the technology that underpins the bitcoin cryptocurrency, blockchain is slowly gaining attention in business circles.

But what does it actually do, and how can blockchain technology be applied to benefit enterprise IT and security systems?

Blockchain is a system that establishes trust between people, and between machines, says Joaquin Moreno, the blockchain practice lead at software development company Globant and founder of bitcoin academy BTCenEspañol. Speaking at the Singapore Datacenter Week conference this month, he will explain to attendees how blockchain can be used as the basis for finance and company security.

At its heart, blockchain is the linchpin of a real-world solution to a tricky computer science problem.

The Byzantine Generals' Problem

envisions five armies poised to launch a coordinated attack on a stronghold, and with a need to exchange messages on an agreed time to commence. However, the spanner in the works is that one army is commanded by an unidentified traitor who can be counted on to pass on the wrong information. How does each commander ensure that the details he receives have not been tampered with, and that the other commanders are in agreement?

Satoshi Nakamoto, the mysterious creator of blockchain, updated the trust problem, imagining the Byzantine generals attacking a Wi-Fi network.

“Fundamentally, blockchain technology is a database system where information cannot be changed, so the system could be used as a source of trust,” explained Moreno. “So by having a system where every participant on it can trust, we have a tool that can help us with the communication – either

Blockchain stats (August 2016)

- 15.8 million bitcoins in circulation
- 78MB – the size of bitcoin blockchain
- 400,000 – the number of unique IP addresses on the blockchain

between humans, between a human and a machine, or between machines,” he said.

The distributed nature of blockchain eliminates the problem of double spending in financial systems – a crucial feature given the ease with which digital bits can be flipped. This is because a consensus with other nodes is required to validate new transactions, and in turn ensure that all nodes are updated with the same version of the blockchain.

For most organizations, blockchain is definitely in the experimental phase, but what practical applications might it bring? For starters, it could facilitate secure communication between devices, said Moreno, an especially pertinent application given the growing momentum behind the Internet of Things. Filament, for example, is a company already using blockchain for wireless networked devices.

IT professionals will be well aware of the ease with which network addresses can be spoofed by cyber attackers. To offer a decentralized and robust resolution of endpoint addresses so that secure communication can be established, Filament relies on blockchain and public notaries to verify the authenticity of name and address bindings.

On the security front, blockchain could be used to detect certain types of unauthorized changes to the traditional database, said Moreno. A long-time favorite attack is to inject SQL commands into traditional database systems through insecure web pages, which can either modify existing values in the database or insert unsanctioned records.

To combat this, Moreno proposed writing all changes into two databases: a traditional one and another one based on blockchain. “We create an interface where we compare the information from each one of the databases. We simulate a hack on the traditional database. We know the information in the blockchain is a source of trust, and we use it as a reference,” he explained.

Another possible application is the use of blockchain to craft “smart contracts” with the use of code that is stored, verified and executed on a blockchain. The program can control blockchain assets, which can either be cryptocurrency or access permissions.

Moreno is working towards the creation of a supporting app that can be downloaded by a guest visiting a workplace. The idea is that entry to the general area of the office compound can be granted by any employee, while a manager is required for access to the

secure part of the facility. The code and the corresponding permissions are all recorded and executed on a blockchain, guaranteeing its incorruptibility. “That is something which I think is real: we are working on that, we are doing that,” he said of this project.

“A database could be changed, information could be changed, logic [of normal apps] could be changed; with a smart contract, the logic cannot be changed,” he explained.

While blockchain has been the beneficiary of immense hype, there is at least one area where additional consideration may be necessary. The irony is that while blockchain ensures that all transactions are duly verified and recorded by other nodes, Moreno pointed to how it actually moves the issue of trustworthiness of transactions outside the system. “You can trust the information itself due to its use of blockchain, but who wrote the information to it? In a traditional database, the person writing the data in is understood to be trusted,” he said. “Different tiers of security mechanisms need to be engineered [for the blockchain], so you have to be careful about who has access to the blockchain.”

If there is one area of criticism about blockchain, then it would surely be over the amount of computational processing that it requires. Bitcoin’s blockchain system currently uses processing power equivalent to 154,000 times that of the world’s fastest supercomputer – currently the Sunway TaihuLight in China – when measured in petaflops. “There are people who say: ‘Hey, we are wasting energy here,’” acknowledged Moreno. This requirement also raises questions about the scalability of a system that has been proposed as the basis for digital currency systems, or even to replace

real-world currencies. Blockchain is still in its infancy, said Moreno, cautioning against attempts to treat it as a panacea and trying to “blockchain everything.”

“Blockchain is not a solution for everything,” said Moreno. “We first need to think about the problem – and then we must be clever enough to identify if it can be solved with blockchain, with traditional IT, or with a new technology,” he explained. “There is a key for everything. How does blockchain add value?” ●

Joaquin Moreno is speaking at this year’s DCD Converged SE Asia, held during Singapore Datacenter Week, from 13-16 September

Blockchain could secure links between devices – an especially pertinent application for the Internet of Things

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- It has more than 300 tech companies
- Carbon tax has been in place since 1995

Costa Rica's green data ambitions

José María Figueres, former president of Costa Rica, tells *Celia Villarrubia* he wants the Central American nation to lead the world's green infrastructure

Costa Rica has a strong tradition in technology that dates back to the 1990s, when Intel established its first factory in the Central American republic. Today it has an ever-growing data center industry, with abundant renewable energy and a skilled workforce to meet the sophisticated and complex needs of the data center industry.

Former president José María Figueres, who was commander in chief of Costa Rica from 1994-98, made it possible for Intel to establish a foothold in the Central American nation. The company now has the largest research and development center in Costa Rica, which employs 1,900 people.

Before entering politics, Figueres was an engineer working in agribusiness. After a decade, he became Minister of Foreign Trade



Celia Villarrubia
Assistant Editor
LATAM

 @DCDNoticias

and then Minister of Agriculture. In 1994, he was elected President of Costa Rica, as the nation's youngest elected president of the 20th century.

After leaving office, he founded the Digital Nations Consortium at MIT, and then chaired the United Nations' ICT taskforce.

From 2000 to 2004, the former leader was head of the World Economic Forum, organizing its annual meeting in Davos, Switzerland. He later chaired the Carbon War Room, a non-profit organization whose aim is to encourage a global low-carbon economy.

Now Figueres has returned to politics as chair of the National Liberation Party, having been elected by delegates to lead the party for four years. He has a plan that, if successful, will boost Costa Rica's tech prospects and potentially position it as leader in the global data center arena.

There are three principle reasons why the National Liberation Party's 2021 roadmap centers on turning Costa Rica into the world capital of green data centers, explains Figueres. "Firstly, Costa Rica is an open country – it's very interconnected with the world and has a strong technological economy. Twenty years ago, we brought Intel to Costa Rica; as a result of that investment, there are now more than 300 companies operating in the field of technology," he says.

"The second is that Costa Rica is not only a technological country, it is also green. Thirty-two percent of our territory is in national parks, 98 percent of our energy is renewable, and since 1995 we have had a carbon tax to pay for environmental services," he explains.

"The third is that in today's world, data centers and global industry are growing at about 30 percent annually, driven by the convergence of smartphones, cloud services, the Internet of Things and Big Data."

The initiative will affect both public and private sector data centers, and Figueres believes Costa Rica has the capability to build the most high-spec data centers.

"We can build the most modern data centers, with four-nines of availability and redundancy, and all they need in connectivity,



cooling and energy," he says. "We are also very capable and very ready to operate the related services," he says.

Today, Costa Rica has an energy supply of 2,700MW. The demand is approximately 2,000MW and last year 98 percent of demand was generated with green energy, mainly hydropower, geothermal and wind. "We are also expanding our supply. This year the Reventazón hydroelectric project will begin to generate power and will eventually provide 300MW," he says. "The country has received a loan of more than \$400m from the Inter-American Development Bank for new geothermal plants, which have the advantage of generating renewable electricity 24/7."

Costa Rica is also aiming to generate at least 250MW of solar energy within five years, taking advantage of the falling cost and increased efficiency of solar panels.

"Geographically, the country is located just 10 degrees north of the equator, so we can generate solar energy, both centrally and distributed onto the roofs of homes, buildings and factories," explains Figueres.

The country has the right attitude to compete on the world stage and establish itself as an international hub, says Figueres: "Costa Rica wants to compete, to deliver the best services, and meet all the necessary international standards. We want to ensure we have a high-skilled workforce and renewable energy that is economical enough to attract data center investment."

Despite this, global businesses may require some persuasion to trust Costa Rica as a global data center hub. Figueres believes that certification can help here. He intends to support the Certified Energy-Efficient Datacenter Award (CEEDA).

"I am absolutely convinced we need to go through a rigorous process of international certification. Only in this way can we attract market-leading companies."

Costa Rica is an open country – it's very interconnected with the world

The goal is realistic, he believes: "It makes all the sense in the world and Costa Rica can meet the demands of a global data center market which is growing at impressive rates."

Many bodies should be involved, says Figueres: "It is important to build a public-private partnership between global companies, the government of Costa Rica and specialized agencies in promoting foreign investment, so that together we can look for suitable solutions to each of the small challenges of creating a cluster in this type of activity."

Talks are already beginning with companies that want to know more about the initiative: "We are taking advantage of these talks to get to know their requirements better. And Costa Rica itself has national companies specializing in data centers."

He concludes: "There is a lot of interest in this initiative, founded on Costa Rica's status as a green, well-connected country with a wide range of renewable energy." ●

• This article first appeared in *DatacenterDynamics.es*. This extract was translated from Spanish and edited by Peter Judge and Donatella Montrone.

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Game on

The industry that changed the world

From GPUs to cloud computing, *Sebastian Moss* looks at the impact of video games on the data center



Sebastian Moss
Reporter
@SebMoss



While thousands of data center and infrastructure professionals are toiling away to keep the world online, teams of developers, engineers and security experts are working hard to support other virtual worlds, some over a decade old, which are aging in lockstep with ours.

Video games have changed reality, helping push computing and infrastructure forward.

Games created a huge revenue stream for chipmakers eager to provide hardware to those chasing the best visuals. They gave millions of families a reason to demand faster Internet, forcing companies and countries alike to build out networks, and they pioneered the technology behind large scale distributed applications.

Now, gaming is set to impact us once again, with technology developed for play potentially controlling our cities and transport, as virtual worlds and reality collide to help form the oft-promised smart societies of the future.

To truly understand the importance of games, we must go back to the early days of consumer computing. As demands for better graphics and more ambitious levels for 2D and later 3D titles grew, it quickly became apparent that CPUs were not up to the task. From the Sharp X68000 for Capcom arcade machines, to Silicon Graphics' Reality Coprocessor for the Nintendo 64, to Nvidia's Geforce 256 for PCs, a market for gaming-oriented chips grew rapidly, with large gaming audiences allowing for heavy R&D

investment in hardware which is now finding its way into the very heart of the data center.

Graphics processing units (GPUs) were originally specialized devices, but now General Purpose GPUs (GPGPUs) have been used for jobs including machine learning, scientific image processing and stock options pricing determination. Google is preparing to remake itself as a "machine learning first" company, with much of its progress led by DeepMind, a deep learning group founded by an ex-games developer.

Speaking at an earnings call that saw profits rise on the back of increased GPU sales for data centers, Nvidia's CEO Jen-Hsun Huang said: "In terms of how big that is going to be, my sense is that almost no transaction with the Internet will be without deep learning or some machine learning inference in the future. I just can't imagine that."

This future will have been made possible by decades of investment in the backbone of the Internet.

"What's moving the Internet from an infrastructure perspective? Video, porn and games," said Andre Reitenbach, MD at G-Core Labs, a provider catering specifically to video games developers.

G-Core Labs was spun out of Wargaming, the developer responsible for the smash-hit title *World of Tanks*, a game with over 100 million active online users.

"Each player sends their information to each other player every 100ms," said Reitenbach. "Everybody is connected and knows what the other guys do. This was a big challenge for us to solve with infrastructure."

"Five years ago, the infrastructure wasn't there, so we had to take the best available hardware, the best available network equipment, to manage it."



The company has built its own content delivery network to enable the huge game and patch downloads players have to endure. "You have to download the client, and games clients are big, and they have huge patches, and even the whole Internet backbone is congested for some time."

"At the beginning, we used Level 3 and other big players, and then we had the biggest audience of customers ever in Eastern Europe, but there was no Level 3 there, and they just pushed it from Frankfurt, so it was totally congested. So we had to build our own just in order so the player can play as soon as possible after the patches."

Now, G-Core links 15 facilities, many in regions not served by hyperscale cloud providers.

"We're opening right now in Uzbekistan. It's a complex environment, but we managed to find a way to build something. Especially for shooter games, or games where latency is important, it's always good to be next to your player."

Reitenbach fears a future where "companies like Google, Baidu etc will just put billions into it and say 'OK now we want to have this niche,' and blow everybody out of the market. This can happen for sure," he said.

Already, hyperscale cloud providers have begun to appeal to developers. Amazon has tried to woo the industry by releasing its own games engine, Amazon Lumberyard, for free - with the caveat that online components should be served through AWS.

"Amazon has a good support for us as a games developer, I have seen them growing on their game support," CCP's IT manager and producer for Virtual Worlds, Jóhannes Jóhannesson, said. "We see that AWS is constantly adding in new features."

Iceland-based CCP Games, famous for developing the *Eve Online* MMO, sees its ►



► future in the cloud and is using Amazon for its latest title, the VR space flight shooter *Eve Valkyrie*. Indeed, its AWS account manager “is an avid gamer,” Jóhannesson said. “He has a really good passion for it, a really good connection with *Eve Valkyrie*. It’s literally like he’s a CCP employee, you ask him one thing and he’s right on it.”

Google Cloud is less popular, however Jóhannesson said that it is being tested “for other projects we have going on here.”

But CCP’s oldest, and most beloved, game may never be able to join the cloud.

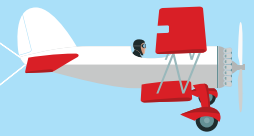
On a single floor of a data center in London sits the cumulative creation of hundreds of thousands of people that has been in the making for 13 years. On these racks, empires and corporations have risen and fallen, wars have broken out, alliances formed and economic theories have been tested. Within the confines of the *Eve Online* servers, a galaxy exists where man finally lives among the stars.

When the game launched, “clouds were just white spots on the sky,” Jóhannesson said. “The core of the *Eve* code is 15/20 years old. But it’s not like a broken ship that leaks or something like that. The code is maintained, updated and all that. But some of the fundamentals, that’s hard to change when you have a product in production for so long.

“It’s the core monolith. Some aspects of it are not that happy with virtualization, but some parts of *Eve* can function in the cloud, so we are taking bits and pieces and moving it to the cloud where we can scale up and down more, but it’s a long trip until *Eve*, if ever, will be fully run by a cloud provider. I would love to see it, but I have a hard time seeing it.”

Instead, *Eve* is hosted in London, and

“On these racks, empires and corporations have risen and fallen”



recently saw its server tech upgraded to a third generation, dubbed Tranquility III - “we upgraded the hardware massively three times. That was one of the most challenging tasks the operations department has taken on.” A team of 25 keeps the game online.

Despite its age, the game is still growing its player base and even suffers from repeated DDoS attacks. “We’ve seen massive hits, there was one occasion where we got hit so badly in London that we compared the pipes we have to Iceland in general and the network guys were saying ‘this would have probably taken out one of the subsea cables to Iceland.’”

But as CCP strives to keep its galaxy connected, and pushes forward with plans to host future games in the cloud, there are those with an eye to an even more ambitious use of the data center.

Some wonder why one needs a powerful, expensive computer at home. The dream of a ‘Netflix of games,’ where titles can be streamed from the data center, is alive and well. “We experimented with cloud gaming in 2013,” said Reitenbach. “You have to build huge data centers full of GPUs, because you have to emulate each client in the cloud.”

He views this future as still some way off, with latency having to be exceptionally low, and costs rather high. These challenges led to the bankruptcy of cloud gaming company OnLive, but others are still pushing ahead. Sony bought Gaikai for \$380 million in 2012, relaunching it as PlayStation Now - a way to play PS3 titles directly from a data center,

while Nvidia GeForce Now allows players to stream titles from Nvidia’s “cloud-based supercomputers.”

Going forward, games may begin to influence our lives in more fundamental ways, whether we play them or not. Beyond just seeing hordes of *Pokémon Go* players congregating in parks, you may notice that our smart cities could be run on software first trialled in games.

Machine Zone shot to fame with its mobile title *Game of War*, a many-to-many massive environment where millions of people interact with each other at once. Availability is so critical, a two-hour outage pushed its provider, Peak Hosting, into bankruptcy in June.

But the tech behind *Game of War* has seeped into reality - Machine Zone CEO Gabe Leydon told *CNBC*: “We’re taking that technology and applying it to New Zealand’s public transportation system... soon entire cities will be networked in one real-time environment which will create a level of efficiency that the world hasn’t seen yet.”

In a separate interview, Leydon told *VentureBeat*: “Our unparalleled cloud technology is what has enabled millions of people to concurrently play our games in a many-to-many environment — in real time, without limitation, in a single virtual universe.

“No other cloud platform has the real-time capability, capacity, or efficiency that we’ve developed.” ●



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Global trends are transforming Internet usage in industry, entertainment, trade and health care, bringing data centers ever closer to the customer and driving a requirement for small, autonomous data centers. Edge computing has become the byword for a data center market undergoing radical change. Film streaming and online gaming are generating large volumes of data from a great many users, increasing latency and resulting in more and more frequent buffering of live content. Not to mention the high cost of transmission tariffs for transporting data from different networks right across the country or across continents. To avoid compromising their in-house flexibility and to maintain a rapid response to customer needs, companies and data center operators need increasingly compact, flexible, modular solutions. Edge and MDCs are the product of this trend. As a manufacturer of data center air conditioners, chillers and air handling units, we've been supplying customized cooling solutions to a range of micro data center producers for years. One of these customers is Technology Space Integration (TSI). We've set up a joint venture with TSI, and together we'll be developing solutions for this fast-growing market.

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A whole lot can change in ten years



Efficiency is a given, and everything is turning into software. Two of the first DCD Award winners tell *Peter Judge* what has changed in the last decade



Peter Judge
Global Editor

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Ten years ago, data centers were well established, but change was in the air. As *DCD's* Awards mark their tenth year, some early winners tell us how things have changed, and what is going to change in future.

"There is one thing that is predictable," says Don Beaty, "and that is that your predictions are going to be off." He's in a good position to say that. In 2002, Beaty founded the influential ASHRAE TC9.9 committee which defines recommendations for efficient power and cooling in data centers, and has continued to work with it. In 2007, his work was recognized with an Outstanding Contribution Award from *DatacenterDynamics*.

For 30 years, Beaty has tracked the changes in the data center industry, and he says the big change in the last ten years has been the move towards virtualization, and the growing tension where the software mentality is winning out over the hardware viewpoint.

Sophia Flucker agrees that prediction is difficult. But for her, the big change over the last ten years has been the acceptance of sustainability as a goal for data centers. She won *DCD's* first Young Mission Critical Engineer Award. Since then, she's seen growing interest in sustainability, and a developing career path for data center engineers.

"I'd always been interested in sustainability," says Flucker. "In 2007, it was only just starting to become something the industry cared about. Nowadays it is everyday. It is just standard practice. You simply wouldn't do a new design without thinking about it.

Sustainability is no longer something left-field, she says. Part of the reason for this is that "the recession has made people more cost aware," a change which cleared away some of the PR-inspired "greenwash" marketing, which ►

► corporations bought into, to make themselves look better: “Now, sustainability is a way to be innovative, to push the boundaries, and to be better than your competition.”

This has driven a major change in hardware, she says: “Ten years ago you would not have thought of doing a non-refrigerated data center,” she says, something that is commonplace now.

The industry standard power usage effectiveness (PUE) metric has helped make this happen, she says: “It’s a simple concept. You can communicate it to non-engineers.”

When she won her award in 2007, the newly-formed Green Grid was just publishing its proposals for PUE. Ten years on, it has been endorsed to become the basis of a standard from the International Organization for Standardization (ISO).

“Data centers improve their PUE by focusing on power and cooling,” says Flucker. “It doesn’t look at what happens on the servers, or at the total environmental impact, including embodied energy in terms of the materials used in the manufacturing process, and in electrical distribution.”

At the same time, she says IT loads have addressed efficiency through virtualization and containerization, while the enterprise is coming to terms with moving to the cloud, because it’s cost effective.

Virtualization is the basis for the software-defined data center which Beaty sees as the main change of the last decade. But while virtualization enables efficiency, Beaty warns that it also opens up the potential for near-infinite demand, by turning everything into software.

“Software is not dependent on something being manufactured first, so if it catches on it can grow, without any real limits,” says Beaty. “The speed of load growth is pushing to more of an extreme than occurred in the past.” This means that data centers can’t predict their future requirements.

Software engineers don’t see this as a problem. “If I were a software engineer, I would say it is easy to change anything. Just change some code!” he says. “Software engineers have no concept of how hard it is to change. Everything is a game. They don’t see it as a problem: but it’s easy to see how big a disconnect there is, and what a challenge it is.”

This situation needs flexible, scalable systems, but hardware has physical limitations and a limited lifespan. Virtualization is a response to this, taking everything and converting as much as possible into “software defined” services, such as storage on demand.

“The more the physical world can act like the virtual world, the better it will be,” says Beaty. “But the physical world can’t be converted to a virtual one, so we have to come up with ways to make it look and feel like it is virtual.”

Meeting existing demand is hard enough, but how do you deal with the unpredictable nature of future demand? “At a fundamental level, whatever we think is going to happen, it can be different than that,” says Beaty.

Traditionally, the way to deal with unpredictable demand is to overprovision massively, but that is ruled out by the current emphasis on efficiency (and the tight cost margins in data centers).

The fight between software and hardware has similarities to the age-old struggle between IT and facilities management, says Beaty. Once again the data center is the battleground between two world views.

While the hardware may hit physical limits, due to the waning of Moore’s Law and the cost of energy, the requirements will still be there. “It’s a supply and demand thing. Companies will be able to outpace other people, so whoever has the biggest demand will get the resources - including energy.”

If energy demand is increasing, Flucker thinks that everyone will have to take green energy more seriously. “How clean your energy is makes a massive impact on your environmental impact,” she says. Concentrating on cooling and IT misses the bigger picture: “A lot of people are making noises about being 100 percent renewable, as they realize that the kind of energy they use makes a difference.”

All these issues make it fairly clear that data centers will continue to provide a serious career path, and Flucker and Beaty are both happy with theirs.

When Flucker won her award, she was working at EYP Mission Critical Facilities, a 300-strong consultancy that was bought by Hewlett-Packard. “Working in a larger corporate environment was a really interesting experience,” she says. “It opened a lot of doors, and I did projects overseas.” But after some big-company experience, she moved to Operational Intelligence, a small consultancy led by Rober Tozer. “It’s been an interesting journey,” she says. “It’s nice to work for a smaller company and have something that is your own. ●





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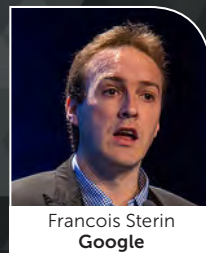
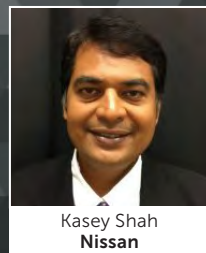
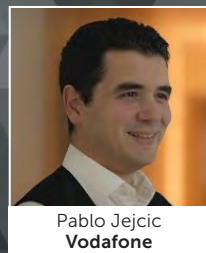
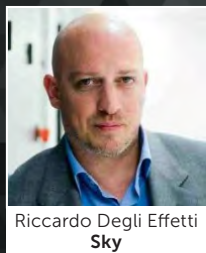


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Michael Hurley
Reporter

 @HurleyMichael

If Britain really does exit the European Union, the region's data center landscape could change. *Michael Hurley* looks at who might benefit

In recent years, the world's largest data center operators have invested heavily in their European networks, aiming to meet tougher data residency regulations and to host information closer to the edge of the network to reduce latency and serve customers better.

In January 2016, Equinix bought TelecityGroup for \$3.6 billion, gaining more than 40 data centers on the continent. Meanwhile, Apple, Microsoft and Google are investing in Irish, Dutch and Scandinavian facilities. Big US providers and enterprises are fortifying their presence closer to their end users across the Atlantic.

But in June, a referendum in the UK signalled a potential change in the make-up of Europe, with 52 percent of British voters opting to leave the European Union. Since then, small and mid-size data center operators, and the European nations which

host them, have been considering how best to respond to the vote, popularly known as 'Brexit'.

Scandinavian countries, for instance, have a cold temperate climate that reduces cooling costs, are politically stable, and has cheap renewable electricity.

In northern Sweden, the non-profit

Node Pole group guides data center investors to any of four municipalities of Boden, Luleå, Pitea and Alvsbyn, near the Arctic Circle.

The Node Pole Alliance brings together technology and construction partners that have so far built a sizable cluster of ten data centers, which includes Facebook's 290,000 sq ft facility in Luleå.

Hydro66 is a UK-based company that was convinced to split its operations between a London sales office and Swedish data center. Its Boden site hosts a 100 percent hydroelectric-powered colocation facility, located next to the Lulealven River, which it says helps provide Europe's cheapest electricity.

Andy Long, Hydro66's chief executive, says the company has been able to offer

something compelling, as part of a tight-knit tech cluster. He told *DatacenterDynamics*: "We found an incredibly supportive local government, business and academic community. By working in partnership we've been able to make a data center which makes Facebook or Google operating economics available for everyone."

The company's website displays readings showing how much cooler it is in

Boden compared to London, and shows the comparative electricity costs in the UK – an explicit bid for custom that might otherwise head to London.

Long says Hydro66 is not concerned at the effect of Brexit on operations. Instead, he predicts strong business from the UK, Germany, the Nordics,

and expects US companies will be more likely to consider continental Europe, instead of the UK, to serve EU customers.

According to a 2015 report published by consultancy firm BroadGroup, the power available to data center operators in the Nordic region is expected to triple by 2017, as a predicted surge in demand hits. ▶

Europe could be up for grabs

Brexit negotiations have yet to start, but the effects are already being felt

► The Node Pole is not alone however: “There are a couple of other [cluster] areas that have had success too, but I think they are in locations where the percentage of renewable generation is quite low and there are capacity constraints,” Long said.

Amsterdam and Frankfurt are already well established, but the next major tech hub to emerge could be Paris.

France has abundant cheap nuclear power and a skilled workforce so, if Paris can overcome the language barrier, Brexit might just provide the impetus to attract new clients looking for a European presence.

Equinix already has seven IBX data centers in the French capital, and in August it completed the \$212 million purchase of a St. Denis facility from Digital Realty, located on a site where it already owned two IBXs. France is a “key market” for Equinix, according to the company’s chief executive, Stephen Smith.

In July, France-based Data4 heralded the return of growth to the country’s data center market, announcing plans for three new facilities at the same time as it completed the expansion of its 110-hectare campus near the capital, having sold 6MW in three months.

Adam Levine, Data4’s chief commercial officer, put this into context for *DCD*. Paris has around 127MW of data center power capacity in total, which is only about one third of London’s aggregate power. But the market has huge potential, he said.

“The [addition of] 6MW predates the UK’s vote to leave the European Union, but the possibility of Brexit could be a boost for the site,” he said.

Paris lacks the popularity of hosting cities like Dublin, London, Frankfurt and Amsterdam, admits Levine, but he says the Paris cloud market has had to overcome teething troubles: “Now we are over a lull which was caused by enterprises reluctant to adopt the cloud.”

But this is starting to change, as prospective customers wake up to benefits which include relatively cheap power for a Tier 1 city, a central European location and tax breaks from the French government.

Amazon is understood to be planning to build two new data centers in Europe in the next year. One could be in Italy, after Amazon founder and CEO Jeff Bezos met Italian PM Matteo Renzi in July to discuss opportunities within the country.

Moves such as these, which increasingly politicize the construction of data centers, may become more common as data protection regulation evolves and nations try to lure providers to their territories for financial gains.

Luxembourg’s government has long been making concessions to attract data center developers. In 2006 it set up a private company to kick-start the country’s digital economy with the aid of public funded loans.

But government involvement can sometimes produce more problems than solutions. Outside the EU, in 2015 Russia introduced legislation which demanded that information about its citizens be stored within its borders. Large US tech companies including Google and Facebook initially hesitated to comply, not relishing the cost and inconvenience of moving their data out into colocation facilities.

Eric Schmidt, executive chairman and former chief executive of Alphabet’s Google, warned in 2013 of the prospect of the Internet’s ‘Balkanization’, as a consequence of the over-involvement of individual national governments in handling data created within their borders.

The development of a compartmentalized Internet, with local rules for protecting data of citizens, would create “a federation of different data centers, each fiefdom with its own different rules,” said Steve Clemons, a senior fellow at the New America Foundation thinktank, in a *Financial Times* article.

This would undermine the economies of scale relied on by cloud computing operators, the article observed, and also potentially have a cooling effect on US investment in the European data center market.

The EU’s General Data Protection Regulation (GDPR), which will be implemented in 2018, attempts to unify the approach of member states to handling service users’ information, and may ultimately help create a more positive environment for data center operators.

It has also adopted the Privacy Shield agreement to impose stronger obligations on US companies exchanging data with EU states. The controversial agreement, devised to replace the Safe Harbor agreement that was struck down as invalid by the European Court of Justice, leaves many observers unconvinced and may yet be the subject of further appeals and subsequent revisions. However, it too could draw investors away from the UK as companies move to meet requirements of hosting within the EU.

Amidst the uncertainty, some industry figures have speculated that the UK’s data center market may well emerge in a healthier state than before the Brexit vote.

It is possible the UK government might seek to devise its own, more pro-business regulations to supercede the EU-brokered agreements once it completes its exit, though if it wants to ensure an easy exchange of data, adopting the ideas embodied in GDPR, in line with the rest of the EU could be a more sensible approach.

Trade association TechUK has said opportunity exists in Brexit, and has

published a plan to ensure the country remains a desirable hosting location.

Cynthia O’Donoghue, a lawyer and partner at Reed Smith, has said the UK’s location between the US and EU could provide a chance for it become a ‘data haven’. Automatically generated data, or big data, can be exchanged relatively easily between the UK and EU, according to Convention 108 of the Council of Europe, and thereafter between the UK and US, she told *Computer Weekly*. Brexit does not affect the UK’s membership of the Council.

But major US companies wanting to host within the EU as a result of GDPR could choose to locate data centers on the continent, instead of picking London.

Hosting provider Rackspace anticipates about \$70 million of “negative impact” as a result of Brexit, its chief executive, Taylor Rhodes, said in August.

Its UK customers are spending less - something Rhodes attributes to the weakening of the British pound.

On a smaller scale, UK hosting provider Memset revised its plans to expand in the country in the light of Brexit, and is instead investigating growth in Europe and the US.

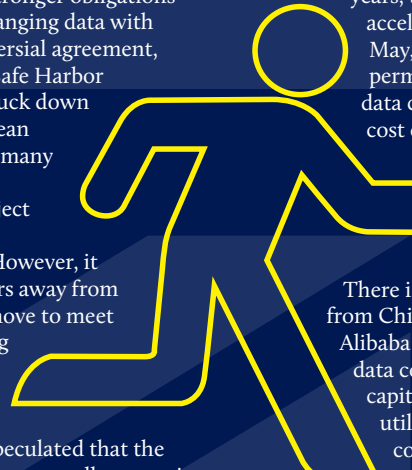
Ireland may be the destination that is best placed to profit from any decline in UK investment. Though it remains a relatively small market in comparison to London, it is close to Western Europe, with good connectivity infrastructure, has a low rate of corporate tax and a pro-business Irish Data Protection Act.

Even considering Ireland’s popularity as a hosting destination over the past few years, there has been a recent acceleration in development. In May, Microsoft secured planning permission to build four new data centers outside Dublin at a cost of €900m (\$1bn), while in August Apple’s €850m (\$947m) Galway facility was finally granted approval after months of legal wrangling.

There is even interest in Ireland from China, with e-commerce giant Alibaba scouting out potential data center locations near the capital, Dublin, in July. State utility provider Eirgrid said the country’s electricity capacity could support up to \$7.7bn of investment beyond 2019.

The UK’s Brexit negotiations have yet to begin and much remains to be decided, including the country’s post-Brexit digital strategy. But the financial effects of the vote are already being felt.

The likes of Sweden, Ireland, and possibly France are planning to expand, and could be ready to take advantage of any changes to Europe’s structure. ●



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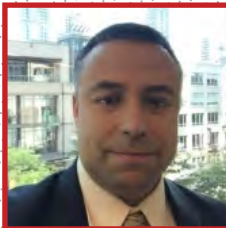
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Pre-packed hardware

Hyperconverged IT systems simplify the stack.
Dan Robinson says it's time to give pre-configured tin a try



Dan Robinson
Freelance



@TheDanRobinson

IT infrastructure can be difficult to manage, particularly at scale, but the trend over time has been towards greater complexity. Meanwhile, IT budgets have either stagnated or been cut in real terms, leading administrators to seek out solutions that will help them cope with the increased demands of modern applications and users.

Hyperconverged infrastructure is one such approach, having already been adopted by countless organizations as a convenient way to deploy applications such as virtual desktop infrastructure (VDI) or operating Hadoop clusters for running analytics workloads. Hyperconverged infrastructure is an easily deployed point solution for such requirements, but it could have broader use cases that will see it become more widely adopted.

Simplivity, one of the leading hyperconverged vendors, recently signed a deal to transform a Fortune 50 financial services firm's data center, moving the entire range of workloads on to Simplivity's platform. This reflects a shift that has been apparent for the past year or so, according to Roy Illsley, principal analyst for infrastructure solutions at Ovum: "Hyperconverged infrastructure is now finding a wider market than just the VDI [virtual desktop infrastructure]

and SMB use cases where it seemed to have been lumped. We're seeing a big shift to enterprises using hyperconverged for running a private cloud internally, because it's simpler to manage and you can just get your virtualization admin guy to look after it."

For those unfamiliar with hyperconverged infrastructure, it is based around the concept of an appliance-like node – typically a 1U or 2U "pizza box" rack-mount chassis – that integrates compute storage and networking with centralized management. Also implicit in hyperconverged infrastructure is a focus on virtual machines, although some vendors, such as Nutanix, are now adapting their platforms to support workloads running as microservices in containers.

These appliance-like nodes are designed to be used as infrastructure building blocks, enabling the user to scale as required simply adding more nodes, which in reality are little more than x86 servers fitted with direct attached storage, at least in terms of their hardware.

The difference between a hyperconverged system and any old x86 server stuffed with internal storage is the software. This typically includes a 'single pane of glass' management console through which to operate the cluster, plus a software-defined storage layer that creates a shared pool of storage across multiple nodes in a cluster.

This is what makes hyperconverged infrastructure such an ideal platform for VDI deployments. Virtual desktops can place heavy demands on storage, and so it makes sense for the compute and storage to be coupled as closely as possible, rather than relying on a more traditional storage area network (SAN), for example.

By contrast, plain converged infrastructure, though it is also aimed at simplifying IT delivery, offers pre-integrated systems composed of traditional server, storage and networking products.

One criticism of hyperconverged infrastructure is that this software layer is often proprietary and unique to a specific vendor, and therefore carries the potential risk of a lock-in for the customer. Whether this risk is any greater than it might be when selecting Microsoft Windows or an Oracle database, or any other enterprise software, is open to debate, and organizations may decide that the benefits of easier deployment and management may make such a risk worthwhile.

With proprietary management tools, a hyperconverged deployment could easily become yet another silo within the data center for the IT department to maintain,

unless the organization intends to use it to replace other infrastructure.

Hyperconverged systems can also be a challenge to the structure of an organization's existing IT departments (see box). If you have teams dedicated to servers, storage, networks and security, which one gets to manage the box that combines all four?

Another criticism is that the software-defined storage layer may not be as mature as traditional enterprise storage systems, and may be lacking key capabilities required by enterprise customers, such as quality of service or data replication support.

Some hyperconverged vendors have now been through several years of development and improvement, and have begun to fill in the gaps. Simplivity, for example, claims to

include a full range of data center features in its OmniStack software, including backup, deduplication and wide area network (WAN) data optimization.

Other issues may be cultural. With integrated compute, storage and virtualization, it may not be clear which IT team within an organization should be given responsibility for hyperconverged infrastructure, and this could lead to friction. But it is still relatively early days for the hyperconverged infrastructure market, and changes are still happening. One trend, for example, is for the software platform to be separated from the hardware, purportedly in the interests of offering greater customer choice.

The two largest hyperconverged firms – Nutanix and Simplivity – have struck deals with server vendors such as Dell and Lenovo, enabling them to offer a hyperconverged solution based around partners' server hardware. The upshot is that customers interested in deploying hyperconverged infrastructure can procure from a supplier they may already have a relationship with, while Nutanix and Simplivity are free to focus more on their software platform.

Likewise, VMware seems to have quietly sidelined its own EVO:RAIL hyperconverged product and is instead touting a software stack comprising the latest version of its virtual SAN software-defined storage platform, along with vSphere and vCenter. This can be seen in the VxRail system that was launched earlier in 2006 by VCE, another division of the EMC federation, along with VMware.

However, Illsley believes the biggest challenge for hyperconverged vendors is in the way they scale, by adding new nodes to the infrastructure. While this is part of the simplicity of the hyperconverged approach,

adding an entirely new node can lead to some resources being underutilized if a workload simply requires more memory, for example.

In response, some vendors now allow buyers to customize the processor, memory and storage configuration inside nodes, but this complicates the procurement process and moves away from the simple drop-in-and-go appliance-like marketing message.

Nevertheless, Illsley expects to see adoption of hyperconverged infrastructure grow for at least the next few years, to the level where it may even account for 15-20 percent of data center infrastructure spending. "It will continue to grow for the next few years," he says, "by which time it will have become just another part of the data center, and by then something else will probably have replaced it as the next big thing." ●

Tokio Marine

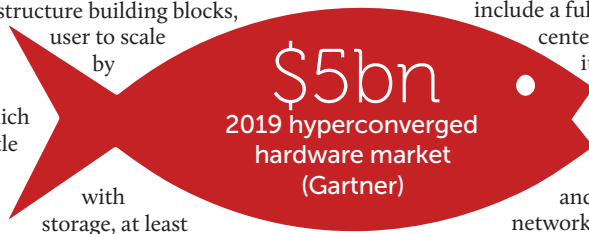
When IT services head Aaron Ooi revamped the technology at Malaysian insurance firm Tokio Marine, his biggest challenge was management. With a complex mix of hardware from the past 15 years, including blade systems, an IBM AS/400 and legacy hardware, it took 70 employees to manage 100 servers.

Regulations ruled out a move to the cloud, but the company was testing Nutanix hardware for a VDI project. Ooi faced this easy to extend: "In Tokio Marine, everything was already virtualized; everything was on VMware," he said. "We just needed to migrate the [virtual machine] images over, and it would just run with the VMware image."

Separate boxes for SAN, switches and servers are going: "You only need one box for the whole virtual machine environment," Ooi said.

The biggest challenge was not the technology, but combining the teams handling network, storage, servers and security. "With hyperconvergence, there is no ownership of this piece of hardware; it is not a server, storage or network by itself," he said. Ooi is now working to establish an infrastructure team with the right skills to adequately oversee the new environment.

Singapore Datacenter Week takes place from 13-16 September. Find out more at bit.ly/1VWbhQu





Max Smolaks
News Editor

 @MaxSmolaksDCD

The new kid on the block: HybriDIMM

Want persistent memory at the speed of DRAM? HybriDIMM could be just what you are looking for, says Max Smolaks

Not all solid state memory is created equal. DRAM and flash have very different properties, but a memory maker from the US thinks it can combine the two to get the best of both worlds.

At the recent Flash Memory Summit in San Jose, California, Netlist demonstrated a product that marries DDR4 and NAND chips on the same board. The resulting 'HybriDIMM' memory claims to offer persistent storage with large capacities that can perform at close to memory speeds.

Best of all, the server sees HybriDIMM as just another DRAM module, making it fully compatible with current generation x86 systems without the need for BIOS and hardware changes.

The performance

of CPUs doubles approximately every two years and servers of the future will need large quantities of fast, persistent memory in order to keep up.

DRAM memory – DDR4 in particular – is really fast, but it's a massive power hog and can't store information once the machine is turned off. Flash can store data without using any electricity, but it is too slow for in-memory databases, and has lower durability.

For a while now, memory makers have been dreaming of building memory modules that act as storage: they have called this holy grail 'storage class memory' (SCM).

In 2015 Netlist and Samsung teamed up to develop standards-based SCM. Netlist also signed up Xilinx and Integrated Device Technology (IDT) as partners.

With HybriDIMM, the company has successfully combined NAND flash with DDR4 Load-Reduce DIMM – a type of memory that replaces a register with a memory buffer chip in order to increase supported capacity. The device claims to improve access times by 100x versus PCIe SSDs, but also costs up to 80 percent less per GB than quality server DRAM.

HybriDIMM also features a storage co-processor that uses PreSight technology to intelligently prefetch the required data from flash to DRAM, so the device always runs at maximum speed.

Netlist says this is the first SCM product to operate across current Intel-based x86 servers without changes to their hardware or software. For example, HPE's Persistent Memory, announced earlier this year, works in a broadly similar way, but relies on batteries that are part of the company's ProLiant servers and requires modifications in BIOS, which means it can't

be installed in third-party machines.

"By delivering the industry's first plug and play SCM solution, Netlist is helping to make big data analytics accessible for the broader market," said Chun Hong, chairman and CEO of Netlist. "We are excited to be working with global partners to the benefit of end customers."

The first HybriDIMM production modules are expected in 2017. ●

The device is faster than flash, but can cost 80 percent less than DRAM

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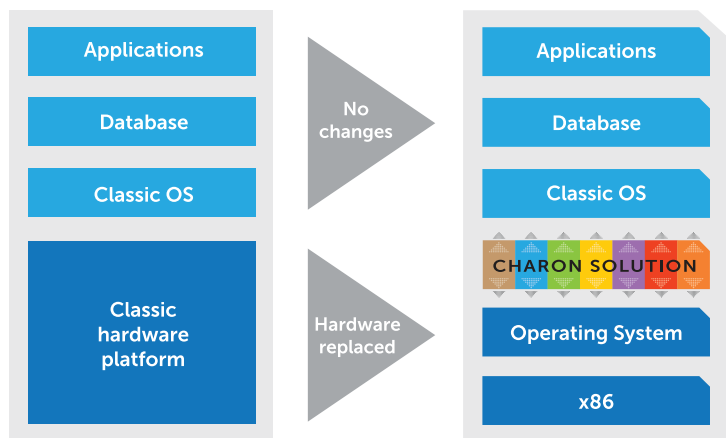
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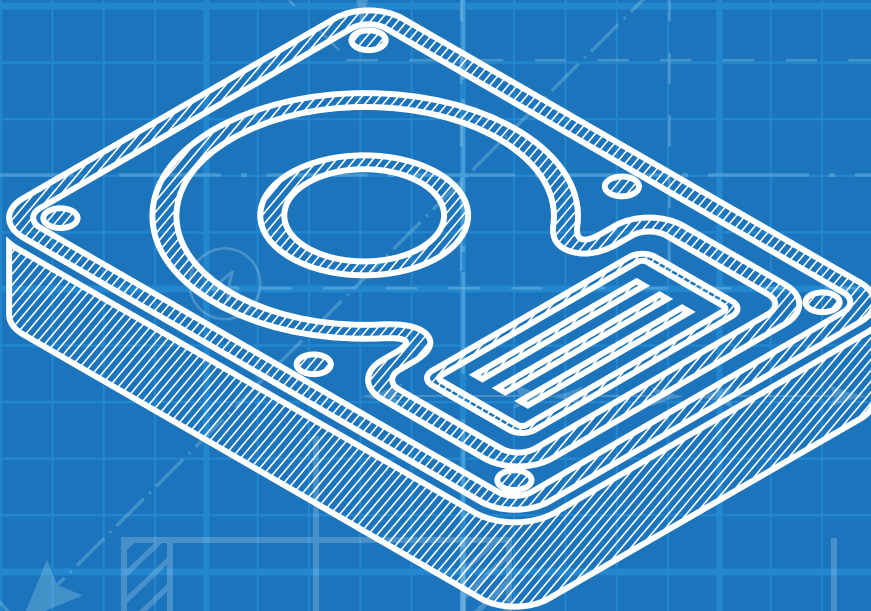
Building a better hard drive

The purchasing power of hyperscale cloud vendors is shaping the next generation of data center equipment. A hard drive makeover is well overdue, *Max Smolaks* believes



Max Smolaks
News Editor

 @MaxSmolaksDCD



The data center industry is changing at a breakneck pace but one thing remains as constant as the northern star - the humble 3.5-inch hard drive. These devices have come a long way in terms of capacity and storage density, with the largest 3.5-inch HDD on the market today measuring a hefty 10TB, but they retain the shape and size inspired by the 3.5-inch floppy disk drives of the eighties, complete with all the attendant drawbacks and limitations.

In order to satisfy the requirements of future data centers, hard drives have to become larger, and we don't just mean capacity, but their physical size too.

In February Eric Brewer, VP of Infrastructure at Google, issued a strange call to arms: he promised the company would work with industry and academia to develop new types of disks that are a better fit for the needs of hyperscale data centers.

Among the most interesting suggestions was a taller form-factor that would enable manufacturers to fit more disk platters per casing to increase capacity, while simultaneously lowering the costs of packaging and components.

Brewer also suggested batches of multiple drives packaged as a single unit, with a very large cache and improved power distribution.

Yet another scenario called for hard drives to be made less reliable, as long as it resulted in lower prices. It turns out that in hyperscale environments, a higher target error rate would have little effect on overall durability, since all data is distributed and backed up across multiple physical locations. ▶



► Google is a huge consumer of hardware and has recently joined the Open Compute Project, which means it has gotten used to simply asking its partners to create the equipment it needs. But while anyone can build a server, hard drive manufacturing is an extremely complex, technical and capital-intensive task and there are just three vendors out there that can meet Google's demands: Seagate, Western Digital and Toshiba.

Between them, these three companies make nearly all of the hard drives in the world. Western Digital is currently the largest, with about 43 percent market share, followed by Seagate with 39 percent, and Toshiba with a 17 percent share.

According to Uli Plechschmidt, managing director for cloud systems and electronic solutions at Seagate EMEA, in the past the storage industry was held back because large drive manufacturers couldn't experiment with radical ideas – everybody wanted to buy a drive that fits comfortably in an existing category, nobody wanted the new (and potentially risky) device, no matter how mind-blowing it was.

“Now the handcuffs are off,” Plechschmidt told *DatacenterDynamics*. “We can really innovate, because there are now market segments which allow and are willing to pay, and sometimes even co-fund fundamental innovation on the drive side, whether it's HDDs or SSDs. It's a really exciting time.”

Eight or ten years ago, Google's suggestions would have been dismissed out of hand, but now the cloud giant buys more drives than traditional storage vendor EMC, and paying close attention to its needs makes sense.

“There are two segments where we as a company are engaged directly – that does not necessarily mean selling directly – but being engaged directly, in order to really capture the bleeding edge of requirements. One is the big cloud service providers, the hyperscalers – the Facebooks, Googles, Microsofts, Emersons, Alibabas, Tencents and so on. With all of them, we have really big teams which really understand their requirements, because what they need today, probably in 3 to 5 years will become mainstream.

“And the same is true for the largest supercomputers on the planet, and the largest users of object storage. It's the people who already have triple-digit petabytes, and plan to be in the exabyte range by 2020-2022.”

These two groups are moving the hard drive industry forward and will continue to do so, even as consumers switch to flash. But back to the question of the tall

drive: how feasible is it, really?

“If Google says they need it – let's really understand what do they need it for – and if that is a use case that many other cloud service providers might have, then it might be a good idea to develop something, initially for Google but then to productize it and monetize it around the world.

“There must be a business case – that has not changed. But I think most IT companies nowadays are much more open if a large customer has some, at first sight, unusual ideas. We are doing a similar thing on the SSD side with Facebook. Basically Facebook tells us: ‘this is what we need, and we can't get it from anyone else.’”

And indeed, at the Open Compute Project Summit in March, Seagate showcased a prototype of the fastest solid state drive ever built, achieving throughput performance of 10GB per second. Plechschmidt added that, even though the device was built with a particular customer in mind, it will be available to other cloud service providers – some of which haven't reached Facebook's level of maturity yet.

Does that mean that, very soon, hard drives will finally change their familiar shape? It certainly does. Disk-based storage is the last remaining bastion of exclusive, proprietary tech. Hyperscale data centers deserve credit for kickstarting initiatives like the Open Compute Project and teaching the rest of the industry to trust in open source cloud platforms, white box servers and no-name networking equipment. This community is also working hard to encourage the creation of new hardware standards, like the upcoming 21-inch Open Rack.

Unfortunately we can't order our HDDs from outsourcing specialists like Quanta or Penguin Computing, but it looks like the traditional hard drive vendors themselves are finally starting to listen to their customers, and realizing that there are important considerations in large data centers that go beyond speed and capacity. ●

How we got here

In 1956, IBM launched the first ever hard drive, the IBM 350. The device weighed a ton, was the same size as a pair of large refrigerators and offered 3.75MB of storage space. In 1962, the company managed to reduce the physical dimensions of a drive to a size of a washing machine with its model 1311, creating the first standard HDD form-factor.

Later drives were designed to mount directly in a 19-inch rack. However the microcomputer revolution required much smaller storage devices and it made sense to base the design on hardware that was already present. And so, the next three hard drive sizes were derived from floppy-disk drives: first 8-inch, then 5.25-inch, and that's how we arrived at the familiar 3.5-inch shape.

The format was standardized as EIA/ECA-740, co-published as SFF-8301, and adopted in 1999.

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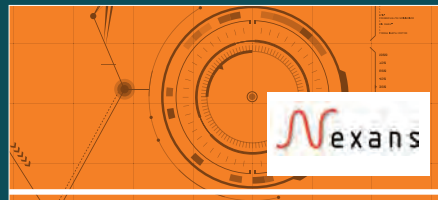
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Efficiency versus reliability

Chasing efficiency can make your facility less reliable, unless you can quickly move down the Universal Learning Curve, warns *Jack Pouchet*

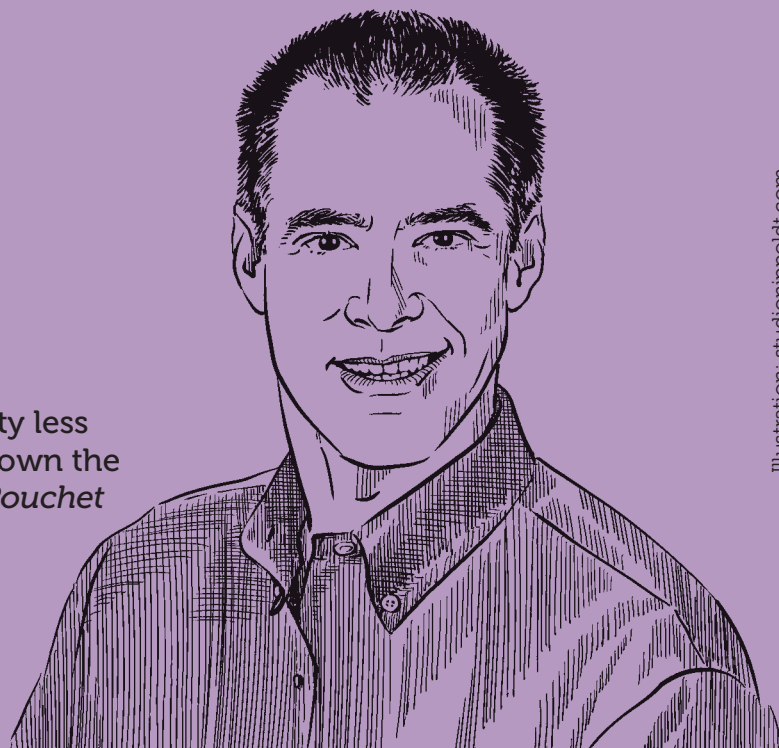


Illustration: studioippolati.com

Last year I had the privilege of joining my son, who is serving in the US Navy, on board the USS Nevada SSBN-733 nuclear submarine. That experience was marked by fatherly pride and a deepening respect for the brave crew. However, I also couldn't help but pay attention to the practices and procedures that ensure these complex machines are always 100 percent battle-ready.

In 2008, nuclear scientist Romney Beecher Duffey and aviation regulator John Walton Saull published *Managing Risk: The Human Element*. The book explores the challenge of managing complex homo-machine systems (HMS) and comes to the conclusion that any complex HMS will fail within 150,000 to 200,000 hours.

That sounds like bad news, but the organization and the operators of an HMS will accumulate experience that reduces the rate of failures. Duffey and Saull illustrated this with the Universal Learning Curve, a graph that moves lower as experience is gained. Effective organizations such as the US Navy combine organizational experience with operator experience to minimize failure.

The obvious lesson for the data center industry is that a complex HMS will fail. We need policies and procedures to operate our facilities knowing an event will occur, managing the environment accordingly to keep the facility operational. We also need to use design to make it resilient to external and internal fault events, and employ best practices, such as proper

factory witness testing and commissioning, to eliminate the most nascent failures.

But the question my experience on the USS Nevada left me wrestling with was whether our industry's push for higher efficiency and reduced costs has inadvertently compromised overall availability, reliability and resiliency due to a lack of understanding of the Universal Learning Curve.

For many years we designed and operated Tier IV facilities using a 2 (N+1) architecture and sound operational practices lifted in large part from the military. With operational learning, real-world feedback, and knowledge-sharing within the consulting engineering community and critical infrastructure OEMs, we moved down the curve and, for the most part, operated without single-event outages. Then we started chasing power usage effectiveness (PUE), and now data center outages are making headlines almost every week.

The kicker is that the two aren't mutually exclusive. Switch operates several Tier IV, classic 2 (N+1) data centers with annual PUEs below 1.3. Infrastructure technology has improved to the point where numerous highly reliable Tier IV designs are now capable of PUEs below 1.2 in certain climates.

New architectures might appear on paper to have a calculated reliability that is 'close

enough' to what we want to be worth the risk. But that 'paper' doesn't tell the whole story. Using new components, infrastructure, systems and operational practices move the entire HMS so far back up the curve that mere factory tests are not sufficient to mitigate risk.

To achieve both reliability and efficiency, we need a better understanding of the cost of ownership and the cost of failure. The Ponemon Institute in Michigan has already quantified downtime costs for various industries, and Emerson Network Power is working with Ponemon to quantify data center ownership costs based on facility size. What we are finding is that "plant" costs (building and infrastructure), when amortized over a typical data

center lifecycle, represent a small percentage of total costs for all data center sizes.

Try to work with consulting engineers and infrastructure partners on design, construction and startup to help improve your organizational experience. These partners can also be valuable resources in helping you develop learning and skills for your facility personnel, creating the training and operating practices for smooth, predictable operations and continued uptime. Remember, Murphy was an optimist! ●

Jack Pouchet is VP of market development at Emerson Network Power

Has our industry's push for efficiency reduced reliability?

10 INNOVATORS SOUTH OF THE RACK



Here are ten revolutionaries, changing the way mechanical and electrical technology supports the data center



BOB BOLZ

Aquila

Aquila has created the first fully liquid cooled Open Compute system - with Bob Bolz at the helm of the company's HPC and data center developments. The AQUARIUS water cooled supercomputing system releases this year, promising a (partial) PUE as low as 1.06. The company believes that air cooling is set to hit a ceiling soon, with water cooling the only way to keep up with power demands. Bolz has been a proponent of open source since the '90s.



ANDREW CENCINI

OpenDCRE

After years at companies like Microsoft, Rackable Systems, Nebula (and a stint as an assistant code enforcement officer), Andrew Cencini turned his eye to the data center. The result: the Open Data Center Runtime Environment, a modern, open, data center monitoring and management API. Created by Vapor IO, the company he co-founded, OpenDCRE is an open source product aimed at everything from the hyperscale data center market to those on the edge.

YUVAL BACHAR

LinkedIn

After spells at Cisco, Juniper Networks and Facebook, Yuval Bachar is now LinkedIn's principal engineer of global infrastructure architecture and strategy. He has re-thought LinkedIn's network architecture, and launched the Open19 rack, which brings the benefits of the Open Rack to 19 inch racks.



BEN CUTLER

Microsoft

If you decide to go for a scuba dive, there's a small chance that, among the crabs and seaweed, you will happen upon a data center. Microsoft's Project Natick is headed by Ben Cutler and aims to find out if data centers can live below the waves, taking the idea of water cooled racks to the very limit. Before this Jules Verne-esque project, Cutler was a program manager at DARPA, where he was behind the US Army's next generation battlefield intelligence system, Insight.





JONATHAN HEILIGER

Open Compute

The open source data center movement owes a lot to this ex-Facebook VP and current venture capitalist, for Jonathan Heiliger is the creator of the Open Compute Project, as well as a founding member of the Open Networking Foundation. As a VC, Heiliger helped to raise funds for Coolan, advising the company as it grew, until its sale to Salesforce in July. He now works at Vertex Ventures, once again looking to fund the next big thing.



PHIL HUGHES

Clustered Systems

Phil Hughes created Clustered Systems Company to solve the difficulties around deploying large HPC systems. The company's first foray into the market was its two-phase pumped refrigerant Touch Cooling tech which reduces energy consumption by up to 50 percent. Clustered products are used in the SLAC National Accelerator Laboratory, achieving 2 million server hours with zero failures.



SHANKAR RAMAMURTHY

Virtual Power Solutions

Ramamurthy spent decades running companies such as Esseven Infotech, Guru, Inc and Epiance, before launching Virtual Power Solutions as a stealth start up in 2012. The company, which automates data center power management, quickly raised funding and clients, launching ICE (Intelligent Control of Energy) a hardware and software solution to maximize performance in the data center.

ARNOLD MAGCALE

Nautilus

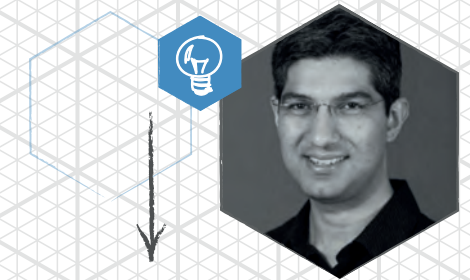
The notion of a data center on the high seas seemed to have ended in a watery grave, as the likes of Google and a former US Navy Admiral failed to turn their ideas into a shippable product, but then Nautilus came on the scene. Founder Arnold Magcale first launched the company in 2013, and then became the first to launch a waterborne data center prototype. Nautilus uses river or sea water in a primary circuit, with a closed secondary water circuit cooling its racks. Other Nautilus founders include Jim Connaughton, a former White House environmental advisor. Sun Microsystems founder Scott McNealy is on its advisory board.



CHRIS MALONE

Google

Keeping the sprawling behemoth that is Google online is no easy task, and as a 'Distinguished Engineer' at the company, Chris Malone is responsible for its data center infrastructure and IT hardware R&D, including power distribution (power plant to chip), IT hardware design (chip to cooling plant), and controls. He heads the team responsible for developing Google's next-generation data centers with a focus on efficiency, sustainability, and cost, and has over a hundred US and international patents to his name.



KUSHAGRA VAID

Microsoft

Does anyone actually like lead acid UPS batteries? This is the question that drives Vaid as he works to eliminate the need for them entirely, instead replacing a separate UPS with small lithium ion cells placed directly in the server rack. Vaid, the general manager for server engineering at Microsoft's cloud and enterprise division, hopes this approach can deliver a 5X cost reduction, 24 percent reduction in facility footprint and a 15 percent improvement in PUE.



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Highlights from DCD Webscale San Jose, July 19-20



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Patrick Flynn
Salesforce.com

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Debasing tech for fun and profit

It's a well-known fact that in order to take a technology beyond research labs, it needs to be made palatable to consumers. Just take a look at our cover story – computers were originally boring office machines, and then in 1972, *Pong* came along and we discovered that they can be used for entertainment. Since then, video games have helped miniaturize our hardware, increase our processing power and make networks faster, as gaming went mainstream and players sought to eliminate low frame rate and lag.

Most importantly, games were responsible for rapid advances in a class of devices called Graphics Processing Units or simply video cards, used to build rich, detailed 3D worlds. The same hardware has been used to create special effects in movies and detailed engineering drawings in CAD applications, but that's not all.

Over the past few years, the industry has discovered that the parallel processing capabilities of GPUs have applications in machine learning and construction of artificial neural networks, guaranteeing them an increasingly important role in the data center. So indirectly, *Call of Duty* has enabled the creation of automatic language translation, and *GTA* is helping cure cancer.

Another example of this axiom is an app that has caused a lot of commotion at the *DatacenterDynamics* headquarters, called Prisma. You are familiar with the idea – Prisma takes a picture and applies a 'filter' to make it better. But instead of fiddling with color and contrast, it feeds the image to a cloud-based artificial intelligence system that had previously ingested Van Gogh and Mondrian. The results are glorious (see left).

The app was inspired by DeepArt, an academic project at the University of Tübingen, based on neural network developed at the University of Oxford and powered by GPUs. The original research went unnoticed by the unwashed masses, while DeepArt gained some recognition thanks to its online presence, but was forced to offer users a choice in order to offset its hosting costs: pay €1.99 per image or wait up to an hour in the queue. In order to become commercially successful, Prisma took the same algorithm but made it 1,000 times faster. As a result, the app has been downloaded millions of times and is now funded by advertising.

Now, if we are being completely honest, improving the quality of selfies can't really be defined as useful work. But the technology developed for Prisma could have wider benefits – advances in hardware and software brought about by commercialization of deep learning will eventually be used in healthcare, transport and city planning.

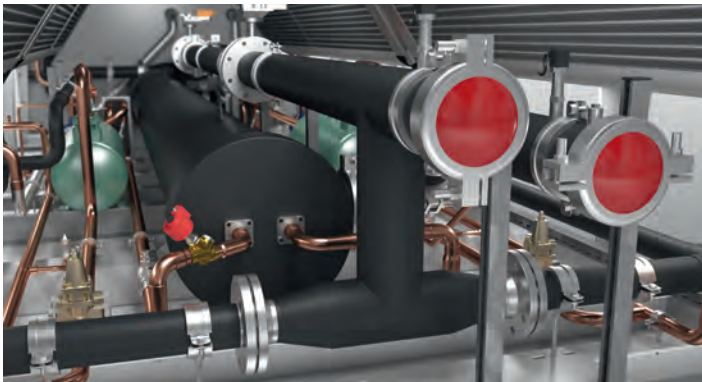
So let's debase technology and play more games – future generations will be grateful.

•
Max Smolaks - News Editor
 @MaxSmolaxDCD

*Indirectly,
 Call of Duty
 has enabled
 the creation
 of automatic
 language
 translation, and
 GTA is helping
 cure cancer*

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