Opinion paper

Digital Vision
for Supercomputing & Big Data

Trusted partner for your **Digital Journey**

Atos

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Adrian Gregory, Chief Executive Officer, Atos UK & Ireland

Digital Vision for Supercomputing & Big Data

In times of such rapid change and complexity, no business or country can afford to underestimate the value of its data.

Imagine if we could photograph and analyse every inch of the Earth to understand where to plant crops most productively and sustainably. Imagine if we could control each individual street lamp according to the specific environment they are in. And imagine if we could manage the movement of every single vehicle on every road, to ensure there were no traffic jams, and never any accidents. Then imagine if we could marshal enough data to quickly pinpoint and stop the path of a deadly virus before it damaged livestock or infected humans. Today we don't have to imagine these feats. The technology exists to make them possible and many are described in this paper.

Major advances mean that technology is no longer merely a facilitator; it is an engine driving the transformation of businesses and public services and is the defining force for new operating models across all sectors. The fuel for this change are the insights provided by analytics and supercomputing platforms drawing on almost boundless volumes of data.

Big Data, analytics and supercomputing are inevitably technical – but their utilisation will not be driven by technologists alone. We believe these technologies should now be on the radar of every type of leader. In times of such rapid change and complexity, no business or country can afford to underestimate the value of its data.

In this paper, we have aimed to demystify some of the key developments in the areas of Big Data, analytics and supercomputing. What they mean for business and the future of public services, and present how some of society's most pressing challenges and opportunities can, and will be, addressed through newly gained insights as we harness the power of these super-tools.

Gavin Thomson, Senior Vice President, Big Data & Security UK&I, Scotland, Ireland and Wales, Atos

Reinventing our world through data

We are at the dawning of the Age of Data. In the 21st century, data is the new currency. In the coming years it will be collected and traded as part of a burgeoning data economy.

The arrival of automation, robotics and machine learning has been a quiet revolution. Behind the scenes these technologies are being used by businesses to improve performance, enhance customer service and drive efficiency. In smart manufacturing, energy, retail, and telecoms, to name just a few, there is a flow of Big Data that is already transforming our day-to-day experiences. This data doesn't just provide us with information, services and entertainment; increasingly, it can predict what we need to run our homes, keep our cars on the road and look after our health and wellbeing.

Becoming truly data-driven

A staggering 90% of the data that is in the world today was created in the last two years. As data continues to proliferate, the challenge for any organisation of any size and in any sector, is how to turn some of that data into a tangible advantage – to find new revenue streams, support better decision-making, target resources more profitably, and anticipate what their customers might want or do.

Rapid technological change, as we all know, is now a fact of life. The ability to innovate and adapt to it has become an essential attribute for any enterprise to survive and thrive. Big Data and analytics are both the products and the enablers of digital transformation. Harnessing data, becoming truly data-driven and innovative by design will be the hallmarks of successful organisations in this Age of Data.

Sustainable and secure data strategy

No organisation can afford to ignore these possibilities. Many are in the early stages of their analytics strategy. The ability to generate insights from large volumes of structured and unstructured data is done by technologies that learn as they go, and heralds a future in which robotics and artificial intelligence are the norm. But this isn't just about technology. It's about a change in mindset and process to become data-driven. And there are other challenges: to transcend organisational silos, to source relatively scarce data science expertise, and to integrate real-time analytics into a sustainable, coherent yet agile data strategy for the long-term. One aspect must remain constant: there can be no compromises when it comes to security. Every enterprise needs to identify its critical information assets and ensure that cyber security is an enabler at the heart of any new data project. We all need to prepare for the unpredictable in the hyper-connected world, because what cyber security is there to safeguard – as with the threats it protects against – changes constantly.

New convergences

As for the future of data and analytics? The Internet of Everything will be a ubiquitous communication network of everything: people, processes and locations, that enables public and private sector organisations to capture and effectively manage data from billions of objects. In the Fourth

> "There will be more opportunities than ever before for cross-sector collaborations – between insurers, manufacturers and the public sector for instance – to deliver smarter and better products and services using Big Data"

Industrial Revolution, organisations will strive to reinvent themselves through smart cities, connected stores, smart utilities and more. There will be more opportunities than ever before for cross-sector collaborations – between insurers, manufacturers and the public sector for instance – to deliver smarter and better products and services, all using Big Data.

Supercomputing that provides the scale and throughput of computing power necessary to gather, process and store vast amounts of Big Data will become increasingly commoditised as a service that organisations buy in. This looks likely to converge in the next decade, with new quantum computing that brings fundamentally different concepts to 'traditional' binary computing, and opens awe-inspiring new possibilities for almost every sector, both in terms of what kinds of problems computing algorithms can solve and the exponential rates at which this can be done.

These are surely exhilarating times. While it cannot be predicted exactly what the future will look like, what is certain is that agile analytics – the ability to gather, process and get insights from data in real time across an entire enterprise – will be critical to any business. Becoming truly data-driven by integrating Big Data, analytics and supercomputing into the fabric of organisations delivering a virtuous circle of improvement is perhaps our most definitive step into the digital age.

Supercomputing and Big Data at the heart

£241 billion
added by Big Data revolution to the UK GDP by 2020[1]

88%
of global enterprise data still unexploited for better business insights[2]

300%
is the projected increase in artificial intelligence investment globally in 2017[3]

Information-centric
organisations are 110% more valuable than their less analytically driven peers[4]

93%
of UK adults own a smartphone[5]

75%
of mobile data traffic will be video content in 2020[6]

50 billion
connected objects around the world by 2020[7]

Global live internet stats[8]
44,005GB of internet traffic per second
59,945 Google searches per second
68,990 YouTube videos viewed per second
2,583,435 emails sent per second (67% of which is SPAM)

[1] http://www.techuk.org/insights/reports/item/9469-the-uk-s-big-data-future-mind-the-gap
[2] http://resources.idgenterprise.com/original/AST-0127029_The_Forrester_Wave_Big_Data_Hadoop_Solutions_Q12014.pdf
[3] https://go.forrester.com/wp-content/uploads/Forrester_Predictions_2017_-Artificial_Intelligence_Will_Drive_The_Insights_Revolution.pdf
[4] https://atos.net/en/solutions/atos-codex-insight-driven-outcomes/atos-codex-consulting
[5] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/577906/CONNECTED_FUTURE_ACCESSIBLE.pdf
[6] http://www.techuk.org/insights/reports/item/10388-5g-can-be-transformative-for-the-uk
[7] https://www.linkedin.com/pulse/supercomputers-new-superpowers-economy-thierry-breton
[8] http://www.internetlivestats.com/

3.6 billion
internet users worldwide[9]

Stored data
is growing at 4x the speed of the world's economy[10]

1.7 megabytes
of new information will be created every second for every human being on the planet by the year 2020[11]

100.2 zettabytes
projected global Big Data traffic by 2020[12]

1 trillion-fold
The increase in computing performance 1956-2015[13]

20 million PCs
The equivalent performance of the Bull Sequana supercomputer by 2020[14]

97%
of global companies that adopted HPC could no longer compete or survive without it[15]

[9] http://www.internetlivestats.com/
[10] http://www.cloudnews.com/every-day-big-data-statistics-2-5-quintillion-bytes-of-data-created-daily/
[11] https://www.forbes.com/sites/bernardmarr/2015/09/30/big-data-20-mind-boggling-facts-everyone-must-read/#46a3ccf217b1
[12] http://www.visualistan.com/2016/12/big-data-present-and-future-infographic.html
[13] http://pages.experts-exchange.com/processing-power-compared/
[14] https://www.linkedin.com/pulse/supercomputers-new-superpowers-economy-thierry-breton
[15] https://ascent.atos.net/hpc-yes-i-want-my-supercomputer/

Alan Grogan, Head of Data, Analytics and Business Intelligence, Business & Platform Solutions, Atos UK&I

Connected communities

Sensors are permeating our lives. They're all around us – from smartphones that record temperature and vibration, to water pumps underneath our streets that monitor the flow of water.

The Internet of Things (IoT) is the exploitation of the data captured from those sensors to effect a smarter action, either automated or not. Its ubiquity creates connections between areas of our lives that were previously separate; for example, the triangle of dependencies starting to exist between public services, manufacturers and insurers.

Circular data flow

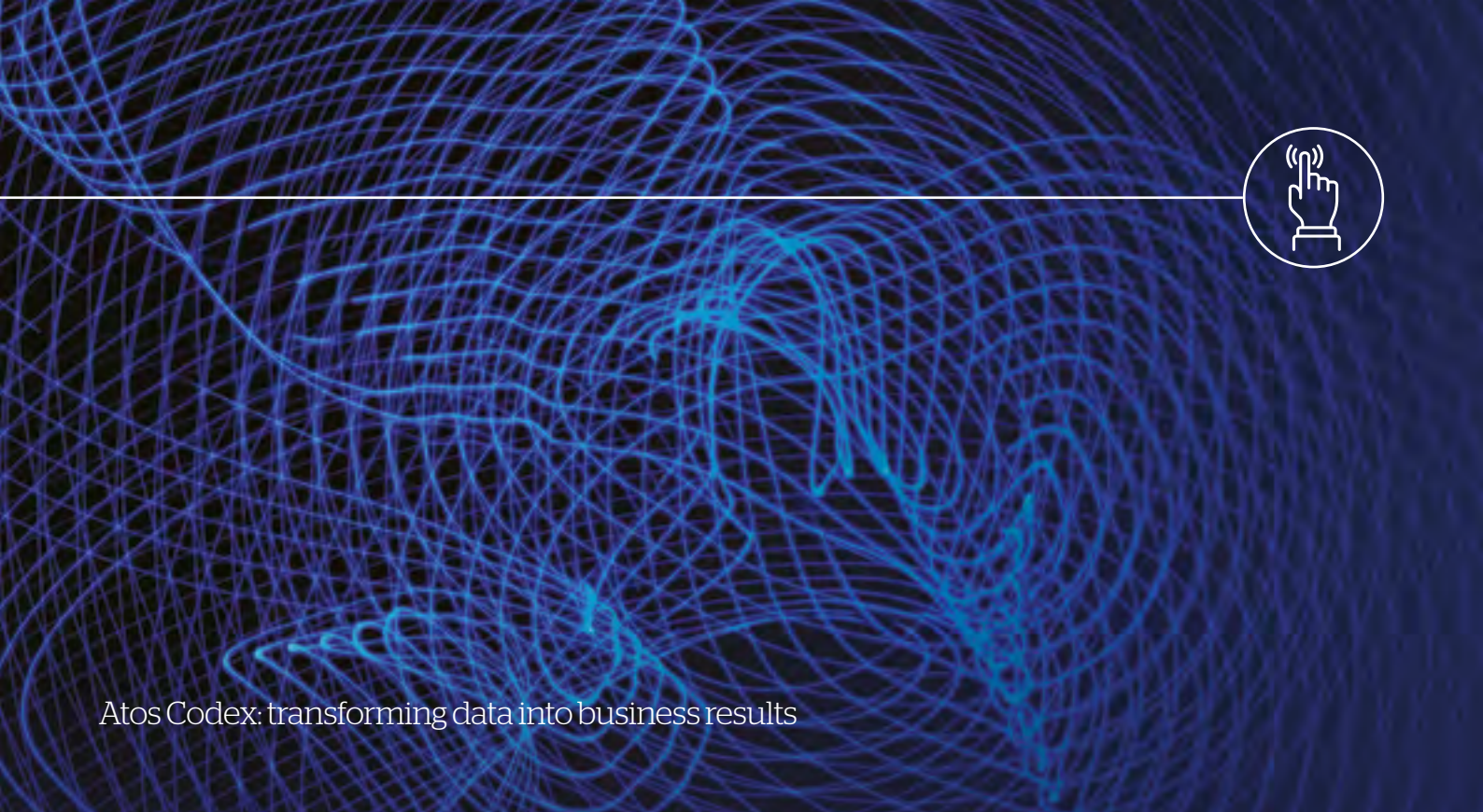
We have reached a point where we can control individual lightbulbs with our smartphones. Using the insight from those connections transforms the way homes can be managed and safeguarded. It impacts our insurance premiums because there is data on whether a tap has been left on; if a house is occupied when it should be empty; or if electricity usage spikes. Manufacturers are developing new products to meet increasing demand for connected devices and to be a part of this new ecosystem.

Let's extend the lighting example into the public sector. Connected street lighting is self-maintaining, with the ability to predict when lights need changing. City councils and insurers can get a real-time understanding of what's going on in the neighbourhood; in turn, insurance premiums and council spending can be more effectively targeted. The flow of data is circular: the lightbulb is connected to the insurer; manufacturers get maintenance data for future product design.

Safer communities

While the data from connected devices is itself quite straightforward, it's the volumes that are challenging: in this case, approximately 13 million homes, each with multiple devices. Supercomputing power is essential for the efficient and timely capture and processing of high volumes of data for decision-making. In the real-time world, any latency has consequences. Here, supercomputing is less about data storage and more about how to compute – or hypercompute – the data deluge. And it's not binary. With streams of data coming in, supercomputing algorithms prescribe what's happening in multi-dimensional environments.

Atos has been using supercomputing in work with some local government and public agencies to build data-hubs that stream anonymised data in connected communities. Real-time data on activities and movements is analysed, together with information on council assets (council offices, crime data, council gym activities, cycle hire schemes and so on) to enable a council to deliver better community outcomes. This is about using data and supercomputing to diagnose what's happening and direct resources (both real-time and planned) in a better-targeted, more holistic way – for example, what streets should be lit when, what public spaces should be staffed, where local policing should be in evidence, where urban redevelopment should be done. This can also be connected to insurers and manufacturers to take action.



Atos Codex: transforming data into business results

Atos Codex is a suite of business-driven data, analytics, artificial intelligence (AI) and Internet of Things (IoT) solutions and services. It enables organisations to turn data into business outcomes. With Atos Codex, organisations in every sector can accelerate progress on their digital projects by leveraging data in four key areas:

- **IoT** – bringing intelligence to and from connected devices
- **Business Intelligence** – tracking performance of enterprises
- **Big Data** – analysing behaviours and finding patterns in large amounts of data
- **Predictive** – enabling prediction and adaptation in real time
- **Cognitive** – using AI where the computer learns and adapts.

Atos Codex is supported by Atos intellectual property and a strong partner ecosystem (SAP, Dell EMC, Pivotal, Microsoft and Siemens). It offers data, analytics and cognitive solutions end to end, from infrastructure to business applications and technologies that enable businesses to benefit from the IoT.

There are seven main components to Atos Codex:

- **Methodology and data science** to help organisations discover how to turn their data into value
- **Customer design labs** to enable customers to test and fast-start their projects
- **Business solutions** for accelerated implementation of industry use cases
- **Platform Factory** to enable the transformation of our customers to the platform economy
- **High performance technology platforms** such as our large-scale, memory-intensive bullion systems that can process and analyse Big Data
- **Security solutions** such as cyber security for the IoT and Identity and Access Management
- **Broad range of solutions from our partner ecosystem** such as Siemens Mindsphere as an IoT connector platform, and SAP HANA as an IoT business platform.

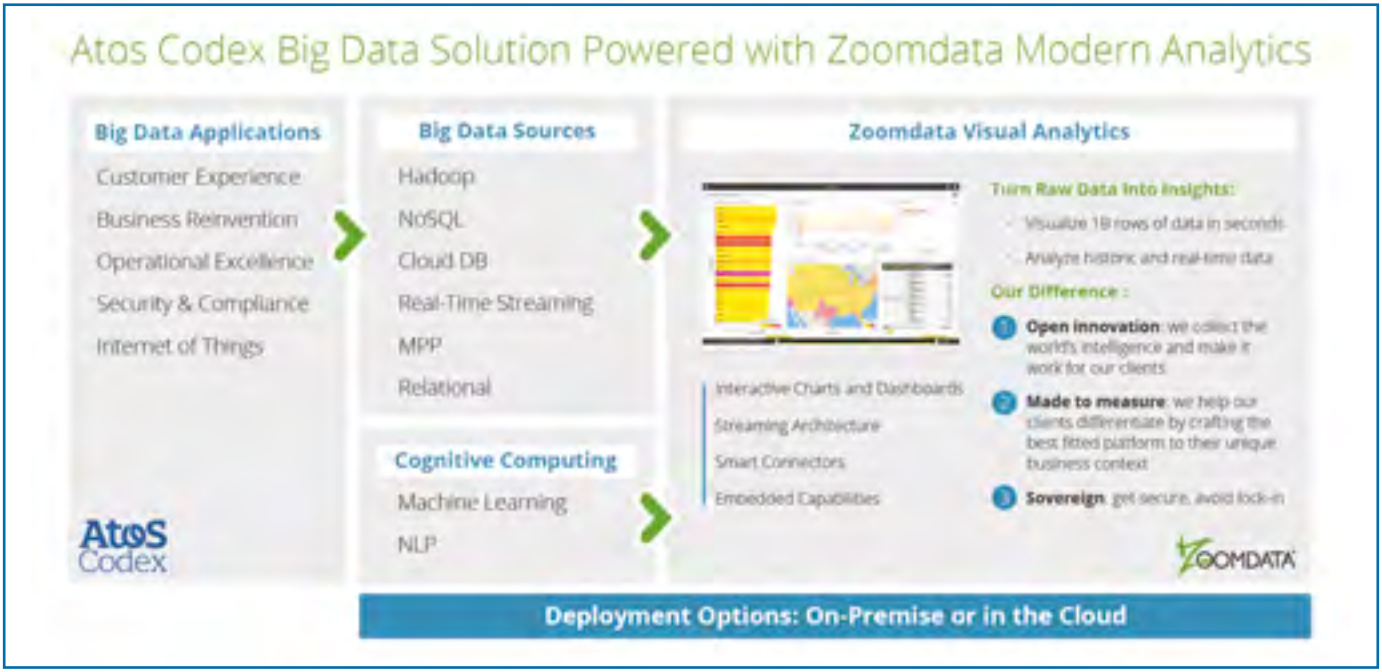
Atos Codex is used by a growing number of organisations including large utility companies, car and truck manufacturers, major banks, oil and gas companies, large telecoms operators and government departments. Our objective always is to help enterprises join up their thinking on data and analytics and IoT and cognitive while enabling them to quickly get business value from their data.

Bringing speed-of-thought Big Data visualisation to business

Integral to Atos Codex is the option to use Zoomdata, the world's fastest visual analytics tool for Big Data. Zoomdata delivers a spectrum of real-time, interactive visualisations of data, making data and analytics accessible and easy to use for business users across an enterprise.

With Codex and via Zoomdata, multiple static and streaming feeds are integrated and presented as a wide range of live visualisations, from exploratory analysis to interactive charts and dashboards that users can play, pause and rewind just as they would a live streaming video. Users can query, analyse and explore real-time and historical data drawing on tens of billions of records in seconds, meaning that datasets can be practically unlimited in size.

In this way, business intelligence becomes available and actionable across the organisation, with interactive visualisations shortening the learning curve for turning raw data into insight.



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The Business Intelligence landscape is rapidly evolving, from a tool focused on tracking operational activities, to a tool that also analyses behaviors and delivering actionable insights on Big Data in Real Time. As a Modern Business Intelligence and analytics platform, Zoomdata's technology is a natural component of the Atos Codex platform. Codex customers can now work with Atos to purchase and deploy Zoomdata across the enterprise.

Russ Cosentino, Zoomdata co-founder and VP, Channels

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Professor Stephen Jarvis, Head of Department, Computer Science, University of Warwick and member of the Alan Turing Institute Programme Committee

Imagining smart cities for high quality urban services

In just a few decades the world's population will exceed nine billion, 70% of whom will live in cities.

Enabling those conurbations to deliver services effectively, efficiently and sustainably, while keeping their citizens safe, healthy, prosperous and well informed, will be one of the most important and logistical challenges facing the global community.

At the University of Warwick we are working with cities, including London and New York, on the means to gather city-scale data and the apparatus to transform that data into knowledge. Our scientists, working alongside industry experts and city officials, are capitalising on emerging developments in Big Data and interdisciplinary solutions to forge a step-change in knowledge and understanding.

- Birmingham City Council is the largest local authority in Europe. It administers a city of more than a million residents, at the heart of a £94 billion regional economy, placing it in the top 100 cities in the world. Our urban analytics on historical city data archives is allowing Birmingham to understand its developing service provision needs and highlight areas in the city where pre-emptive intervention would be most effective.
- In London, we are working with the Greater London Authority (GLA) on modelling pre-diabetes risk across the city. Diabetes costs the UK nearly £10 billion a year and with the GLA we are identifying at risk populations and environmental factors which exacerbate that risk.

Many city challenges require data analytic platforms that combine traditional map-reduce (a programming model for processing large data sets on clusters of computers) architectures with real-time data streams. We seek architectural solutions that can, for example, execute sophisticated machine-learning for feature extraction whilst at the same time combine dynamic temporal data. This will allow us to develop practical, transformative solutions in areas including transportation, utilities, security and health. All these solutions require more computing power to handle ever-larger pools of data. This is our challenge: dealing with an explosion of data to correlate and to analyse as fast as possible.

Spotlight

Sentiment analysis: converting revenue opportunities in rugby

Given the huge power of social media to influence behaviours and markets, being able to analyse what's said about your business can add to the bottom line.

With the sheer volume and seemingly-overwhelming diversity of data, tools exist to transform that into insights that can help businesses to take advantage of underlying opportunities, improve communication and protect their reputations.

One example is French rugby club, Stade Toulousain. Founded in 1907, it became professional in 1998 and has the best track record in French rugby, with 19 French championship titles and four European cups. With around 100 employees and budgets in excess of 35 million euros, the club's ambition was to develop its business and grow revenues. Key to this was finding new ways to sustain business throughout the year - not just around seasons and successful matches, but also to build fan loyalty by offering new merchandising and services that would go beyond their expectations.

Real-time dashboards

To get more informed and inspired, the club asked Atos to find a way of using Twitter to spot trends and opportunities among its fan base and beyond.

Using a cloud-based Big Data analysis infrastructure, Atos developed a tool in partnership with TIBCO solutions, a specialist provider of integration and analytics software, to analyse all mentions of the club on Twitter. The tool takes in and filters feeds from Twitter, indexes them, then displays the analysis in an easy-to-understand, real-time dashboard for the club's stakeholders to use and act on.

One significant challenge is to interpret the specific sentiment in tweets to determine whether they are positive, negative or neutral – even when a mixture of language and emoticons are used. The capacity of supercomputing to store, analyse and tag each tweet, combined with data scientists' expertise to assess the results and algorithms that constantly learn from the data makes this level of analysis possible.

Higher sales and richer experiences

New insights into behaviour and supporters' thoughts and feelings have helped the club to target its social media more effectively. For example, the dashboards identify key influencers on Twitter, who can be targeted for engagement by the club to develop its profile on social media. It also identifies the most popular players, whose images can then be used in promotions.

> New insights into behaviour and supporters' thoughts and feelings have helped the club to target its social media more effectively.

The club can react more effectively to real-time sentiment and provide a more engaging, satisfying customer experience – especially via the supporters' app. Fans can get offers to buy drinks without queuing, or buy a club jersey in their particular size straight after a match with reference to how they might be feeling.

The analysis has also been used so that merchandising sales can be better timed and targeted. For example, the analysis reveals reactions of supporters to particular games, which provide insight into future attendance at the stadium and ideas for designs for new jerseys. Not only does the solution provide the club with real-time visualisation of Twitter feeds, it also classifies tweets based on location. This means that tweets posted from outside the stadium can be used to generate an alternative marketing campaign.

The sentiment analysis tool used an existing technology blueprint that can be deployed for any type of business on any public or private cloud. For Stade Toulousain, the results have given the club a commercial edge - not just a sporting one, but in supporting growth in the sales of merchandising and achieving stadium occupancy rates of over 90%.

“Siloed thinking and too much focus on the tools alone are key causes of analytics project failures.”

Jean-Christophe Spilmont,
Head of Strategy & Portfolio, Big Data & Security, Atos

Jean-Christophe Spilmont, Head of Strategy & Portfolio, Big Data & Security, Atos

The future of value: monetising and maximising the flood of data

We've heard it for years: Big Data, analytics and artificial intelligence (AI) are cornerstones of digital transformation. Yet while the power of data may be undisputed, some observers have estimated that it could take decades to harness it. Is that really true?

Recent independent research by Forrester, '*The Future Belongs To Those Who Monetize And Maximize Their Data*', has revealed that the pace of change is dramatically accelerating. To explore how fast Big Data and analytics are changing business, Atos commissioned Forrester to survey nearly 600 business and IT leaders in North America, Europe and Asia Pacific across 11 industry sectors, including Manufacturing, Retail, Financial Services, Energy and Public Services. The research looked at use cases, benefits, challenges and key drivers for investment in data and analytics – and the results were illuminating.

Crossing the chasm

What shone through in the research results was the importance that businesses already place on data. Over two-thirds (69%) consider data analytics to be a top strategic priority, and 40% of organisations already use analytics in key business functions. More importantly, this rate will double in the next three years to exceed 90% by 2020. Next-generation analytics are crossing the chasm into the mainstream, with 65% of organisations fearing that failure to invest would see them disadvantaged.

Are these investments making good returns? For the most part, yes. 90% of respondents said they get positive results from analytics; and 50% have already significantly improved revenue and their bottom line as a result. Yet here is the second major lesson from the survey: 67% of organisations believe that they are still failing to take full advantage of the depth and breadth of their data. More worryingly, it is rare that analytics are effectively shared across business functions meaning that organisations are making strategic decisions without access to all the facts.

In a nutshell, the research found that the analytics of the past are no longer enough. New approaches are needed if businesses are to survive and thrive in the new data-driven digital age. To address this challenge, the research identified three lessons to help organisations monetise and maximise the value from their data.

Prioritise and invest in data analytics or risk obsolescence

With businesses predicted to double their use of data analytics investments over the next 12 months, it's vital for organisations to invest in analytics if they don't want to be left behind.

Break silos and close the gap between IT and business: think business insights first

Siloed thinking and too much focus on the tools alone are key causes of analytics project failures. The value doesn't come from technology or data; it comes from contextual, actionable insights that can improve business performance at the point of decision. The road to success is to think business outcome first and embed that insight into systems and processes across the organisation.

Get ready now for the data torrent and tomorrow's security challenges

Start now, start small, be quick; but make sure your data foundation is solid at the same time. With the increasing convergence between insight systems, deep learning and High Performance Computing (HPC), we're on the verge of the 'Exascale' era of supercomputing. Be prepared for explosive growth and for the resulting requirements in analysis power and risks management.

Clear objectives, business-centric thinking, agility, security and scalability are key to success for Big Data and analytics projects. These are exactly the challenges we help our clients to address through Atos Codex. Whatever your business, this is the time to consider accelerating investment in analytics.

You can download '*The Future Belongs To Those Who Monetize And Maximize Their Data*' at: http://go.atos.net/LP=573

Robin Zondag, Global Head of Analytics Consulting, Business & Platform Solutions, Atos

Revolution and evolution: where businesses start their analytics journey

As life becomes increasingly digitalised, the potential of data to deliver better business outcomes and create new opportunities is almost limitless. When devising an approach to data and analytics, there are three key areas in which organisations tend to engage.

It begins with ambition

Organisations are usually very clear on the challenges they want to address, but seldom on how to use data and analytics to provide the answer. The challenges that data analytics can help with are many and varied. It could be testing a new product or business model, increasing operational efficiency or finding extra capacity. Specific examples might be how to pinpoint-predict the number of loaves of bread required at a specific supermarket location or, on a macro level, how to optimise train capacity for rail companies.

Alternatively, an organisation might want to look across its existing analytics use cases and identify which ones to accelerate for the best returns on investment.

Insight as a Service

Some organisations are simply curious and looking for greater insight and advantage. So rather than a particular business issue, it's about enabling authorised employees and partners to easily access all relevant data resources of the organisation in the right way.

The objective is to make it easy for people to access, use and gain value from a company's data so that this becomes routine. Businesses want tools that enable that to happen and equip staff with immediate analysis and visualisation tools for querying and using the data. This 'Insight as a Service' is, increasingly, something organisations want to invest in across their enterprise.

Building a strategy to become data-driven

A proportion of organisations want to define an over-arching strategy to enable them to become data-driven. This is a holistic exercise to look at which parts of the business will improve, what cultural and behavioural changes will be needed, and how the business can build up its own analytics and data science competence – a particular challenge in this relatively new domain. Inevitably there are a number of technical questions such as:

- What analytics technologies should we use?
- How can we optimise algorithms?
- How do we assure the right levels of cyber security?
- What kinds of inputs of data and potential sensors might we need?

Yet using data and analytics is never just about a particular technology or platform: it is about focusing on what the business needs to achieve and transforming the business to enable it to get there. This means a technology-agnostic mindset is important, with the ability to deploy new data and analytics technologies alongside existing organisational tools or services from third party providers.

> "Scaling up analytics for the age of the mobile hyper-connected customer is critical"

Age of data

Just a few years ago, reporting on key performance indicators and key financial metrics to inform operations and strategic planning was the norm for businesses. It was broadly based on universally recognised and standard accounting and business management processes.

Now we are seeing business decisions directly informed through the use of real-time data analytics. This is the fundamental change in business. So not only can those traditional metrics be sliced and diced in real time instead of through an antiquated monthly report mechanism, but businesses are scaling up analytics for the age of the mobile hyper-connected customer. New challenges are pushing established organisations beyond just integrating multiple data sources on a single platform. They now need to achieve the real-time flexibility, agility in the management supply chains and fast times-to-market to meet the expectations of their similarly-informed customers.

What we know for certain is that tomorrow, insight will be richer, solutions smarter and products better as a result. Expertise can provide guidance while always keeping focused on the unwavering principle for enterprises everywhere: following the customer. It's all about keeping the momentum to be data-driven and unlock innovation and competitive edge across the enterprise.

> Digital transformation is moving from light speed to warp speed and every single industry will be disrupted. With 50% of the workforce to be millennials by 2020, recognising the impact of digital is essential in creating a workplace environment that will attract and retain vital talent.

Jim Henrys, Director of Business Solutions and Digital Transformation, Intel

Jim Henrys, Director of Business Solutions and Digital Transformation, Intel

Digital fusion: why business should take note

Today's unprecedented digital disruption should be on the agenda in every boardroom

According to US financial institution PNC, 40% of businesses in the Top 20 of every industry will be disrupted by digitally transformed competitors by 2018. With a staggering 50% of today's Standard & Poor's 500 companies predicted to be wiped off the list within the next 10 years, no business can be complacent. Business leaders are clearly taking note: 70% of Global 2000 CEOs have committed to putting digital transformation at the centre of their corporate strategies for 2017.

Physical, digital and biological worlds combining

It is not hard to see why this has become such a priority. Innovation is accelerating faster than at any other point in time. Historically, major technological and economic breakthroughs have happened around once every 100 years. This started in the 1700s with the emergence of coal and steam and continued into the 1800s with electrification. Fast-forward to the 1960s and the compute and communications revolution. Since then, IT has quickened the pace of change to such an extent that while we are still adjusting to the full effects of the transformation powered by social media, mobile, analytics and cloud technologies, we are also witnessing the beginning of a new era. With this comes something altogether different: the fusion of the physical, digital and biological worlds.

While the concept of 'digital fusion' might sound futuristic, it is already being felt in everyday life. Take cognitive technologies: the already-familiar incarnations Siri, Cortana and Alexa are the tip of a very large iceberg. Backed by continued advances in artificial intelligence (AI) and machine learning, these cognitive systems will transform our digital experience. Wearables are also evolving very fast, moving beyond fitbits to smartcaps that monitor brainwaves and sense fatigue, with obvious applications for heavy industry.

Connectivity and data

With virtual and now augmented reality in the mainstream, 'merged' reality is the next step, fusing physical and virtual worlds. For example, In the near future, a miner will be able to operate machinery in a safe virtual environment that is a "digital mirror" of the physical world, whilst a remote robot performs the actual work in the high-risk physical environment. In another example, a surgeon in one part of world may soon be able to operate on a digital version of a patient with a robot carrying out the physical procedure on the actual patient in another country.

Making all this possible will be 5G. This isn't just the 'next G': 5G connectivity will provide us with the bandwidth to support the flow of huge volumes of data from device to device and the Internet of Things. The astoundingly low latency of 5G technologies (which means data can be transmitted accurately and without delay) makes it possible to move a scalpel on the other side of the world with the degree of accuracy necessary for a live operation; and can cut the braking distance for a driverless car from six metres to just half an inch; and makes it possible to 3D print skin and other body parts. It supports digital ledgers, the technology that underpins bitcoins. Digital currencies provide an undisputed audit trail of data, opening up new models for accounting and for fighting fraud.

Change at warp speed

What is driving this level of transformation are the capabilities of very powerful computing and the ability to transmit, process, analyse and store complex data sets. Perhaps what's most astonishing is that it is likely that this is the least amount of change we'll ever see in our lifetimes. Digital transformation is moving from light speed to warp speed and every single industry will be disrupted. With 50% of the workforce to be millennials by 2020, recognising the impact of digital is essential in creating a workplace environment that will attract and retain vital talent. It's also important to remember that companies need to do more than just embrace technology enablers such as Big Data, supercomputing and analytics. They need to develop a hyper-agile work style, focus resources on innovation and re-evaluate their business models if they are to embrace and achieve truly successful transformation.

> "70 per cent of Global 2000 CEOs have committed to putting digital transformation at the centre of their corporate strategies for 2017"

Michael Davison, Industry Principal, Financial Services, Atos UK&I

Essential competitive edge for financial services

For banks all over the world, analytics is the most disruptive technology now impacting their business models.

With tough market conditions and hungry new players, there is intense pressure on financial service organisations to find new ways to improve, optimise and innovate. Agility, efficiency and flexibility are the watchwords, which is why moving their IT systems into the cloud is increasingly common in this sector.

Previously, banks tended to rely on in-house or private cloud services to ensure the tightest cyber security and data protection. Hybrid cloud solutions, which use a mix of public and private cloud services however, are now becoming more commonplace. As public cloud services have evolved, the hybrid cloud can offer the right balance between agility, cost-efficiency and security for the large volumes of information held on customers and counterparties, much of it sensitive personal data.

Analytics in the hybrid cloud

The convergence of data analytics with hybrid cloud is a game-changer. With cloud, it is easier and faster to aggregate and share rich data from across the enterprise and to develop data-driven applications to support decision-making and operations. This new generation of analytics can unlock competitive advantage across the whole enterprise, both cost-effectively and with all the agility and flexibility that are the hallmarks of cloud. Benefits include higher revenues, lower costs, better customer experiences and more effective risk management and responses to fraud. The challenge, however, is how to put in place an enterprise-scale, value-driven analytics strategy together with access to the skills needed to deliver it.

Both analytics and cloud are key strategic assets in the drive to transform how financial services organisations think, act and respond to challenges in their market. This is why the next phase of hybrid cloud analytics is going to be exciting.

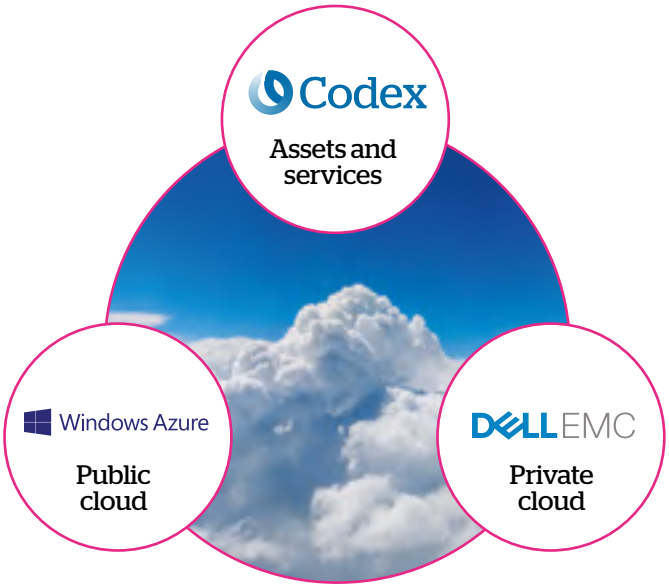
Solution assets and services

- Atos Codex analytics platform, blueprints, consulting, systems integration and managed services
- Dell EMC Enterprise private cloud - Microsoft
- Microsoft Azure public cloud.

Atos, Microsoft and Dell EMC join forces

To help companies gain a competitive edge from analytics in the hybrid cloud, Atos has established a strategic collaboration with Microsoft and Dell EMC. This enables financial services' organisations to accelerate cost and business performance benefits from enterprise-wide data analytics.

The three-way collaboration brings together Atos Codex assets and services with Microsoft Azure's public cloud and Dell EMC's Microsoft Enterprise Private Cloud. It delivers end-to-end services, from helping to formulate an effective hybrid cloud analytics strategy and defining the highest leverage areas for performance improvement, to proving value from each use case through rigorous testing and transitioning to enterprise-scale workloads.



cambium

Tony O'Donnell, Partner, Cambium LLP

Solving global sustainability challenges through smarter innovation

Global challenges and sustainability

The need to address global challenges driven by megatrends such as population growth, associated resource scarcity or increasing global health risks, is creating a powerful catalyst for data driven innovation in many markets. Meeting these challenges is driving demand for new innovative solutions to address problems that affect all aspects of society. The impact areas include:

- **Economic:** Provision of decent work and economic growth supported by new infrastructure – sustainable cities, housing and transport.
- **Environment:** Ensuring sustainable supplies of clean energy, food and water, whilst maintaining biodiversity in the face of a changing climate.
- **Social:** Meeting rising aspirations for good education, healthcare, justice and peaceful lives for people everywhere.

Big innovation + Big Data = Big opportunities

Governments and businesses everywhere are interested in how they can develop 'smarter' innovative responses. In 2015, 193 governments came together under the auspices of the United Nations to agree and endorse 17 United Nations Sustainable Development Goals (SDGs). It has been estimated that up to $12 trillion of new market opportunities can be created by meeting these goals in just four economic systems, specifically: Cities and infrastructure, Energy and materials, Food and agriculture, Health and well-being.

Sustainability is of great interest and growing importance to leading businesses in strong part due to enterprises confronting the accelerating and complex mix of risks and opportunities. Meanwhile, consumers and investors are better informed than ever before. They have elevated expectations that businesses will act responsibly and reduce their negative impact on the planet.

In response to this increased risk and consumer expectations, new tools to help organisations accelerate away from traditionally accepted approaches are increasingly prevalent. For example, the manufacturing sector is starting to address challenges such as rising energy prices and rapidly depleting raw materials to move to new methods of production which are more sustainable across the whole supply chain. Data modelling and the use of supercomputing play a pivotal role here; the opportunities to differentiate from the competition and deliver competitive advantage are boundless.

Enabling smarter sustainable innovation - the role of data and technology

For some time, computer-supported modelling and simulation have been widely recognised as the so-called third "leg" of the scientific method, alongside theory and experimentation. The development of innovative products and services that address these complex challenges is increasingly unlikely to be successful without the use of these advanced data-centric technologies. For example, these technologies can also play a role in:

- Acquiring constant live data from a huge range of sources using the Internet of Things (IoT). This is faster than any manual approach can achieve.
- Integrating this data with other data sources into a Data Lake where vast data quantities can be turned into meaningful information. This is done by finding patterns using analytics or cognitive technologies, enabling new solutions or opportunities to be identified.
- The identified solutions can be modelled using High Performance Computing (HPC) to show the best outcomes.
- The best outcomes can be communicated to people using visualisation techniques to enable informed decision-making.

Smarter innovative organisations can make the best of opportunities by exploiting a mixture or all of these techniques. This allows them to become more efficient, effective, faster to market and more profitable and sustainable.

New forms of collaboration are vital for successful smarter innovation

Successful smarter innovation is not just about data and advanced technology; people are vital too. Many stakeholders are interested in creating a smarter, more sustainable future. As in nature, where ecosystem strength is linked closely to the breadth of biodiversity, collaborations also find strength in their diversity of skills, experience and perspective.

Successful collaborations may include expertise from multiple disciplines such as science and engineering, as well as creative arts such as design. Equally, they may involve participants from a range of organisations from both the public and private sectors.

The real power of smarter innovation comes from harnessing motivated multi-disciplinary teams, equipped with the latest data insight produced by advanced HPC technologies. This enables innovative solutions to global challenges. Solutions built in this way both maximise the economic value of the innovation in major new growth markets, whilst also making an important contribution to the creation of a sustainable future for us all.

Cambium, InCEPT™

Cambium help organisations of all sizes adopt a smarter approach to translating their ideas or research into sustainable and profitable business applications.

Challenge

The goals of better productivity, increased exports and greater growth are shaping the UK's and many other countries' drive to strengthen their competitiveness and secure sustainable economic success. Crucial to achieving these objectives is the ability to extract maximum benefit from the latest generation of High Performance Computing (HPC), Big Data and cognitive technologies. In the UK for the Hartree Centre, with its extensive portfolio in all of these areas, a key question is how to bring its research expertise to bear on industrially relevant challenges and translate this into cost-cutting, time-saving, innovation-enabling applications of practical value to UK businesses.

Solution

Working in collaboration with Cambium, the Hartree Centre has developed a structured process called InCEPT™ which is rooted in close engagement and dialogue with the UK business community. This process is enabling the Hartree Centre to map its research capabilities onto industry needs more effectively than ever. Developed and delivered with Cambium, InCEPT™ is applicable to any sector, any field of science and engineering, or any specific challenge such as drug development or food security, for example. Following identification of a potential research idea, a workshop is hosted involving a cohort of 8-12 relevant businesses, to review, critique and refine the research concept to enhance its applicability to priority challenges faced by those businesses. One-to-one discussions are used to fine-tune the idea before a follow-up workshop enables scrutiny and validation from a business risk/reward perspective.

Benefits

The InCEPT™ process ensures a strong link between the creation of digital assets and real business problems. Companies – both those involved in the process and others – can then reap the commercial benefits of these digital assets via a range of routes such as licensing agreements, spinouts or service offerings. Direct involvement of relevant businesses in the process can also reap rewards such as enabling access to real company data or input that strengthens and validates the projects that emerge. Keeping the process closely linked to industry ultimately creates a faster, smarter pathway for UK innovation for tangible economic impact.

Unlocking value from data

Challenge

Johnson Matthey is committed to continuous improvement at its plants. With key metrics often recorded on paper or in spreadsheets, much time was spent collecting and agreeing the data rather than on analysing it to gain new insights. Manufacturing operations at the company's plant in Royston, UK, wanted to empower staff on the production line to focus on improving quality and production control; not on validating information.

Change

A data and analytics repository and dashboard was created to become a single version of the truth, pulling in data from all existing sources into one place. This gave staff easy access to accurate, up-to-date data. Shift supervisors and plant managers could 'slice and dice' the data and carry out their own analytics to uncover new insights.

Impact

Production meetings were transformed, with staff able to pinpoint data to prioritise and focus improvement efforts for maximum results. They could spend more time collaborating and problem-solving and could make better-informed decisions.

Challenge

The Centro Nacional de Análisis Genómico (CNAG-CRG) carries out genome sequencing projects in areas such as cancer genetics, rare diseases and the single cell studies. The Centre has many next generation sequencers making it one of the top European centres in terms of sequencing capacity. Indeed, CNAG can sequence and analyse more than 20 human genomes every day, and needs to conduct quick, accurate analysis to process such large volumes of data as efficiently as possible. Identifying the small number of variations that drive breakthrough medical insights can be time-consuming and highly complex.

Change

To decipher the information contained in the human genome, the CNAG-CRG has set up a powerful bespoke supercomputing platform from Atos that conducts in-depth high-performance data analytics on genome sequences.

Impact

The new platform maintains the Centre's position as a leading genomic research facility, enabling it to achieve higher output while driving cost savings. The CNAG-CRG offers in-depth and comprehensive genomic analyses to other healthcare organisations and pharmaceutical industry in order to further improve treatments.

Challenge

When a deadly virus emerges in animals, scientists must respond rapidly to track its spread and stop it from devastating livestock and possibly infecting humans. As a global leader in this field, The Pirbright Institute needed more flexible and powerful supercomputing that could accelerate progress in areas such as computational genomics of complex viruses and hosts, and epidemiology studies to monitor virus migration.

Change

The Pirbright Institute chose a Bull supercomputer from Atos that can run diverse workloads on a unified environment to increase performance and throughput, avoiding the time and expense of moving vast amounts of data across multiple systems. This allows The Pirbright Institute to pinpoint and track a virus' properties and path much faster.

Impact

Scientists get rapid results, gaining insights to aid the development of diagnostic tools, vaccines and treatments. This helps scientists and policy-makers to reduce the impact of viral disease, ensure food security and improve the quality of life for animals and humans.

Challenge

Waters designs and manufactures state-of-the-art mass spectrometry systems, widely used in the pharma, chemical, food and other industries to measure substances' unique chemical 'fingerprints'. In this fiercely competitive market, success depends on adding new types of functionality to systems – a complex process that can take years. To integrate new components into its products seamlessly and cut time to market, Waters needed a step change in the speed, sophistication and versatility of its modelling and simulation capabilities.

Change

With 50% funding from Innovate UK, a three-year Knowledge Transfer Partnership is providing full-time support for a Hartree Centre expert to tailor a widely used computational fluid dynamics tool to the company's specific needs. This also enables Waters to run simulations on multiple compute cores (of a scale not viable in-house) and access a range of supporting specialist expertise.

Impact

Waters can now layer a variety of user-designed functions onto the basic software package. This makes it possible for example, to integrate the effects of key parameters on charged particles known as ion motion, into its mass spectrometry systems. Waters is confident that the Knowledge Transfer Partnership will enhance product performance and increase its share in key markets.

Crispin Keable, Distinguished Expert for HPC, Atos

The convergence of High Performance Computing and Big Data

In the decades since the invention of the computer, High Performance Computing (HPC) has contributed significantly to our quality of life – driving scientific innovation, enhancing engineering design and consumer goods manufacturing, as well as strengthening national and international security. This has been recognised and emphasised by both government and industry, with major ongoing investments in areas encompassing weather forecasting, scientific research and development as well as drug design and healthcare outcomes.

More recently, with the explosion of data available from the development of the internet, businesses and other organisations have recognised that data represents a gold mine of competitive possibility. Companies like Uber, Airbnb and Expedia may be the poster children for Big Data Analytics (BDA), but at the same time more traditional organisations from advertising to weather forecasting looking to Big Data solutions as they try to find new ways to interact with customers and create new business models and opportunities.

In many ways, the case for convergence between HPC and BDA is obvious: lots of people in the HPC world can't quite understand what all the Big Data fuss is about. They think they have been doing BDA for years. A typical operational weather forecasting operation ingests, digests and produces many terabytes of data per day – that is hardcore Big Data!

HPC has long been working on the sorts of things you need in order to deal with large volumes of data that should be useful to the BDA business – how to scale algorithms, run parallel processes efficiently, automate data management, build high performance networks and, above all, how to carry these out affordably.

But of course, it isn't quite as simple as that. BDA deals with new types of data, very different from weather forecasts or engineering models. Data such as sentiment analysis of social media or connectedness as a tool for law enforcement or security agencies present new challenges and require new analytical methods. Which data is real and which bogus; what weight do statistics have; other questions of this sort make Big Data analytics more of a software challenge than anything else.

Most tasks, whether they are deemed HPC or BDA, are part of a wider workflow. For example, to get value from HPC, it is not enough to run a weather forecasting model. You have to collect the data, massage it into a form the model can accept, run the model, interpret the results, and finally present them in a form that people can use: umbrella, or no umbrella?

Without doubt, the convergence of HPC and BDA is happening through a combination of techniques and methods from one workflow with the other. Improving shampoo formulation (an HPC task) using sentiment analysis from customers (a BDA task), or using HPC to automate image analysis within a time-critical period in order to locate a person of interest using Big Data that has been gathered on their movements are all convergence examples.

As HPC and BDA become increasingly ubiquitous and connected, we expect this type of synergy to deliver results that neither discipline could produce alone. We expect the boundaries to continue to blur as we strive towards better products, services and outcomes.

Andy Grant, Head of Big Data and HPC, Atos UK&I

To out-compete you must out-compute

Increasing competition, heightened customer expectations and shortening product development cycles are forcing the pace of acceleration across all industries.

In turn, this is driving an increased demand in new digital technologies to support the modelling and simulation of complex systems using High Performance Computing (HPC) and Big Data Analytics.

Previously the preserve of Government laboratories and top research universities, the use of these technologies has now become much more pervasive, partly due to new access models such as cloud. In the early days, supercomputers were essentially enormous mainframes optimised for scientific computing, typically running proprietary operating systems and bespoke software environments. To reduce costs, today's supercomputers use much more standard components combined into large computing clusters with specialist interconnects. The beauty of this model is that theoretically it is infinitely scalable to tackle the most complex problems. However, harnessing all of this computing power is where the challenge lies.

It would be unthinkable today for a car manufacturer or a pharmaceutical company designing a new product not to use HPC to first simulate those products. This drastically reduces prototype costs and product development cycle times, whilst also driving innovation into the product designs. As the computational models increase in complexity, the requirement for more power increases proportionally. For example, with today's technology it is possible to model component parts of an aircraft; however, the industry is already demanding the ability to perform whole aircraft simulation.

Addressing the requirement for increased capability (which is mirrored across industries) means that several challenges need to be overcome. These relate to energy efficiency and total cost of ownership, software scalability, reliability and accessibility.

Energy efficiency and total cost of ownership

If the performance of the internal combustion engine had increased at the same rate as computer technology over the last 50 years, then you would be able to drive the distance to the moon and back on a single tank of fuel. The insatiable demand for computing capability continues apace; by the middle of the next decade exascale machines will exist that are 1000 times more powerful than today's largest systems. To be able to power these machines, we will need radical innovation in processor design and energy efficiency. The Atos Bull Sequana supercomputer has been designed to accommodate emerging exascale technologies and uses direct liquid cooling to dramatically increase energy efficiency. This means that the total cost of ownership to run them is massively reduced. Atos is also working on technology which allows jobs to be scheduled according to how much energy they consume rather than just how long they take to run.

Software scalability

Modern supercomputers frequently have around 100,000 processors and for the next generation of systems this is likely to increase into the millions. Harnessing all of that power to simulate large models requires considerable skills in scalable software development, skills that are hard to find. To help with such challenges Atos has created the Centre for Excellence in Parallel Programming. The Centre, a virtual facility, provides a large portfolio of services from analysis, consulting, parallelisation, to optimisation of application codes. An international team of experts with skills in different subject areas can help address these kinds of application challenges.

Accessibility

With the increased need to use HPC and the shortage of skills required to harness the power there is a danger that the benefits of HPC cannot be realised. To make the technology more accessible to non-experts, Atos has developed extreme factory, a cloud portal that makes HPC available as a service, hiding the complexity of the systems and essentially allowing the capability to be accessed as a 'black box'. extreme factory gives businesses of all sizes, in all sectors, access to made-to-measure supercomputing resources. With remote visualisation back to the desktop, such mechanisms allow the HPC system to be used as if it was a super-powerful workstation.

Together, these technology changes are helping to transform the HPC landscape so that it is no longer just large organisations that have access to the technology, but also those in their supply chain. Providing access as a service, so that organisations can tap into the power as and when needed without having to employ specialist support staff or build their own data centres, is leading to the democratisation of HPC. Essentially organisations of every size can now out-compute in order to out-compete.

Frederik Kerling MSc., Senior Quantum Expert, Business & Platform Solutions, Atos

The second quantum revolution

In the early 20th century, the first quantum revolution, pioneered by Einstein, Heisenberg and Schrödinger among others, gave birth to major inventions such as superconductivity, transistors, lasers and fibre-optic communications.

The second quantum revolution has started with the arrival of quantum technologies. Of these, quantum computing is a new type of computing that will be a major disruptive force over the coming decades.

From medicine to agriculture through finance and industries, quantum computing will impact many aspects of our lives. It will address the explosion of data generated by Big Data and the Internet of Things and it will generate major advances in deep learning and artificial intelligence.

What is quantum computing?

Quantum computing offers vast improvements over traditional computing in computation time, quality, cost and energy usage. Based on quantum physics, quantum computing is non-binary – which means that unlike traditional computing, it doesn't provide a definite answer. Instead, it averages the right answer over multiple identical iterations and works with multiple states at the same time.

Even now, there are some processes and tasks that have been hard, if not impossible, to achieve using traditional computing. Quantum computing changes this. It redefines what is difficult and makes the once impossible possible, such as complex physics simulations and comprehensive data analysis on the Internet of Things. It alters the way we can approach major scientific and technological hurdles – and it can make research and industrial processes faster, better and cheaper.

Atos Quantum

Atos has already embraced quantum computing as one of the game-changing innovations of our time. Atos Quantum is our response to the global development of quantum computing and is the first quantum computing industry programme in Europe.

As part of this, we are developing a quantum simulation platform to enable researchers to test, algorithms and software for future quantum computers – together with a portfolio of quantum applications, in particular for Big Data, artificial intelligence, supercomputing and cyber security. We have also created a new quantum research and development laboratory near Paris, with a dedicated quantum team. A critical part of Atos Quantum is cryptography. This is about re-thinking our cyber security strategy and approaches to be quantum safe and to ensure our clients are quantum safe in the future.

Early business cases

One of the first applications of quantum computing is chemical simulations to simulate and predict physics and chemistry. These results could, for example, be used to create carbon capture catalysts to drastically reduce pollution or be used by biotechnology companies to model medicines and significantly speed up their times to market.

And there are many other applications. Aerodynamics in aircraft manufacturing, for instance, has been a challenging area for traditional computing. With quantum computing, aerodynamics can be fully modelled, saving billions per plane design. There are also applications for finance; banks conduct full numerical simulations to assess the conditions of their whole enterprise. This highly intensive task now takes a day and can be done in just half an hour in the future, potentially saving millions of euros in a day. For companies in these sectors, these are easy business cases to make.

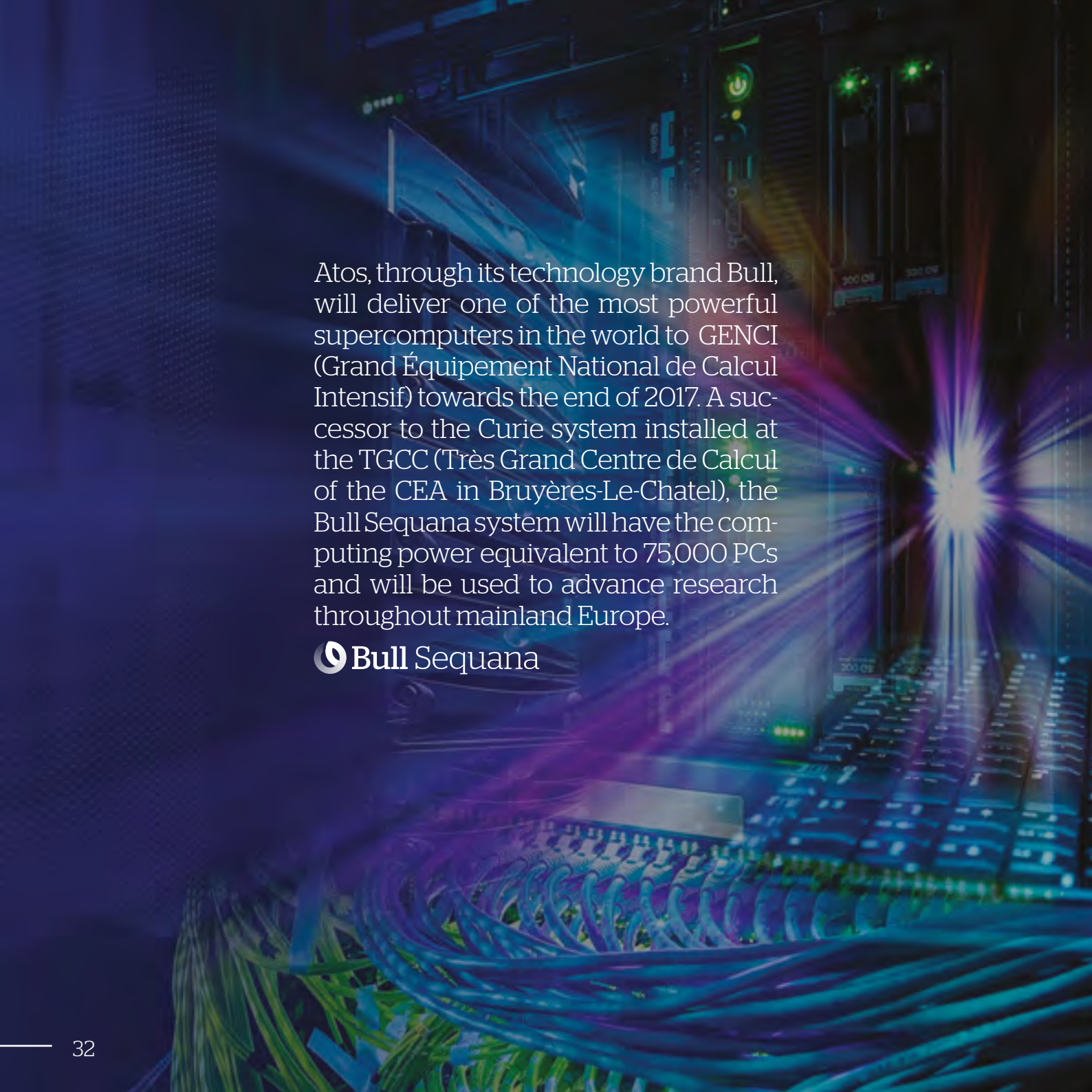
Becoming mainstream

Commercial applications of quantum computing are expected to be a standard addition to high performance computing from 2020. By 2020-23, we expect to see many more applications: learning algorithms, major industrial platforms, pattern analysis for fraud protection, processing of high-volume data from 3D and 4D imaging that we don't have the capacity for right now. And there are other quantum domains: quantum communication, making communications more secure than they have ever been; and quantum sensing to dramatically increase the sensitivity and effectiveness of sensors.

In this rapidly developing area, Atos has moved quickly to stay ahead of the curve. We are already exploring applications with major global companies and are looking to establish partnerships with leading research centres and universities. These are very exciting times as quantum technologists all over the world prepare for this truly revolutionary and awe-inspiring technology to enter the mainstream.

Thierry Breton
Chairman and CEO of Atos

"The changes that quantum physics will lead to in the IT space will have significant effects over the coming decades, both in terms of computing power and cybersecurity. As an industry leader in Europe, Atos is committed today to lay the foundations for the IT of the future, providing researchers worldwide with solutions enabling them to take advantage of the innovative opportunities provided by quantum computing. We are proud of the work done by our research teams, who are supported by a world-renowned Scientific Council, which enables us to fully play our part in what is likely to be a major evolution in our industry."



Atos, through its technology brand Bull, will deliver one of the most powerful supercomputers in the world to GENCI (Grand Équipement National de Calcul Intensif) towards the end of 2017. A successor to the Curie system installed at the TGCC (Très Grand Centre de Calcul of the CEA in Bruyères-Le-Chatel), the Bull Sequana system will have the computing power equivalent to 75,000 PCs and will be used to advance research throughout mainland Europe.

Bull Sequana

Jean-Marc Denis, Distinguished Expert, Head of Strategy, Big Data, Atos

The world's greenest supercomputer

With the advent of the Internet of Things and the associated avalanche of data, we are beginning to understand the hidden correlations between all connected devices. When placed alongside the emergence of artificial intelligence (AI) we will be better able to control our environment through autonomous devices across our connected world, in cars, factories, healthcare services and much more.

These emerging technologies will create new and unexpected usage models and ultimately the economy as a whole will be impacted. Many jobs will change as a result; while some roles might disappear altogether, many more will be created bringing new opportunities for many. This is just one example of the exciting yet dizzying change brought about by convergent technologies.

These changes require sophisticated tools to collect, consolidate, store, filter, analyse and extract relevant information from the massive and continuous flow of data.

Future-proofing technology

The Bull Sequana supercomputer is an advanced high-performance tool for collecting and analysing in real time, the mass of data and information companies require in order to make fast decisions and that scientists require to better support new discoveries.

Capable of a billion billion calculations per second, Bull Sequana is the most flexible and fast-evolving supercomputer anywhere. It is capable of leveraging the synergy between extreme computing and extreme data. So, whatever the future holds for the evolution of microprocessor technology and the new methods to emerge to study the flow of data, Bull Sequana is powerful and agile enough to withstand this. It performs up to the exascale range and simultaneously uses the most innovative and advanced technological computing elements and communicating networks.

This computing is so advanced that we can foresee in the coming years that one Bull Sequana supercomputer could, for example, predict in advance, significant earthquakes with a magnitude of seven or above on the Richter scale. This is thanks to its capabilities in the ultra-fast analysis of data that could be sent from billions of sensors located around the world on or next to seismic fault lines to measure pressure and movement in the ground. This data would be sent to a small number of specialist supercomputing centres and analysed using the latest AI and deep learning techniques to predict whether a powerful earthquake is imminent.

Democratisation of supercomputing and Big Data

With the abundance of data and the potential this provides businesses of all types and sizes, supercomputing is beginning to move from the margins to the mainstream with 'as a service' usage models increasingly available. Typically, this gives companies access to 'high performance analytics' but at a fraction of the cost, with pay-as-you-go remote access and on-hand consultants proving an increasingly attractive option for data-rich businesses searching for competitive advantage.

It follows that due to the heavy processing loads placed on the significant number of computer chips, such computing power consumes high levels of energy which in turn produce plentiful heat together with the challenge and cost that this creates. Designed to minimise operational costs and confront this challenge head-on, Bull Sequana is the greenest supercomputer in the world. Ultra efficient, its energy consumption is 10 times lower compared to the previous generation of supercomputers and is an energy-aware system through the use of integrated energy sensors. It is 100% cooled with a proven cooling technology that minimises the global energy consumption of a system by using water up to 40°C.

Furthermore, Bull Sequana is as easy to operate as a simple workstation, whatever the mix of technologies inside. This makes it a very flexible and cost-effective production environment for massive data analysis.

When combined with sector expertise and other technological innovations such as Big Data and artificial intelligence, such supercomputing power will become increasingly prevalent. It will be a critical enabler for the next decade, irrespective of the specifics of how technology and science progress.

> "We can foresee in the coming years that one Bull Sequana supercomputer could predict a significant earthquake"

Zeina Zakhour, Global Chief Technology Officer, Cyber Security, Atos

Prescriptive Security: the journey to self-learning cyber security

In 2016[1], over three billion records were publicly leaked worldwide, endangering sensitive data and potentially undermining trusted relationships between organisations, citizens, partners and other stakeholders.

In the same year, 87%[2] of organisations reported at least one cyber-attack. With cyber threats expected to grow in size, frequency and complexity, the annual global cost of cyber-crime could rise to around US$6 trillion by 2021[3].

As recent experience has shown, the digital threat landscape continues to evolve. It's clear that a shift in paradigm is needed in how to effectively manage cyber security. This is a shift from the traditional in-depth cyber security model based on multiple layers of protection to a new model based on supercomputing and automation that uses data to learn from past threats to interpret and prevent future attacks before they strike.

Today it takes on average 146 days[4] to detect a malicious attack in an organisation's environment, reflecting the lack of necessary cyber security expertise. In this time, vast amounts of information may already have been stolen and entire infrastructures infected and hacked. In the constant struggle against time, this new model named Prescriptive Security compresses it, making time work for organisations instead of against them.

How does Prescriptive Security work?

In essence, Prescriptive Security brings together two key technology building blocks:

- **Analytics** and machine learning. We can reduce cyber-crime by using supercomputing to learn from historical data and putting algorithms in place in response to this learning. A data lake powered by high performance storage and analytics software makes it possible to collect, aggregate and access high volumes of data. Prescriptive Security analytics integrates all key elements in the environment (from the Internet of Things (IoT), operational technology and information technology) and leverages threat intelligence gathered outside the organisation (surface web, the dark and deep web, social media and partners' feeds) to proactively block upcoming cyber-attacks. By analysing structured and unstructured data, we can develop behavioural and contextual profiles to protect against current and future threats. Indeed, we can stop attacks before they happen by using the data we've collected to develop notions of what's next and by extending our scope of data collection (hunting outside the organisation as well as inside) so that a state of readiness is preserved.
- **Automation.** When threats are detected, a response must be instant. Prescriptive Security minimises the need for human intervention by using automation to expedite a clean-up, not only resolving the threats but also analysing their root causes and protecting against them in the future. Automation means resolution happens faster and more efficiently, freeing up resources.Using this new Prescriptive Security model, organisations can employ the right resources to apply Big Data Analytics (BDA) across complex, global IT architectures to detect, isolate and solve threats in real time.

Optimising technical and human resources

Prescriptive Security can optimise an organisation's cyber security resources and free them from spending valuable time detecting threats and then acting on them. This means that cyber security teams can focus their resources elsewhere.

The pace of digital change will never be as slow as it is today and data volumes will grow exponentially. What's termed 'Big Data' today will appear dwarfed in just a few short years. By 2020 there will be more data than grains of sand on the planet. New digital innovations and opportunities will

[1]IT Governance UK December 2016 report
[2]Bitglass Threats Below the Surface Report April 2017 Report
[3]Cybersecurity Ventures' 2016 Cybercrime Report
[4]Mandiant Report 2016

continue to emerge. The success of this digital revolution will depend on how quickly and efficiently cyber security evolves to counter increasingly complex, rapid and aggressive threats as they occur. This is essential to protect every institution that is susceptible to attack, from multi-national enterprises and central governments to smaller companies and local government agencies.

Prescriptive Security Analytics

Turning complexity into Actionable Intelligence

Improved Detection	Extended Functionalities	Automated Responses
Learn Quickly	Analyse and Store	Act Rapidly
Predictive	Automation	Supercomputing

> "The pace of digital change will never be as slow as it is today"

Deborah Dillon, Lead Auditor, Business & Platform Solutions, Atos UK&I

Getting ready for new EU data protection legislation in 2018

With Big Data, artificial intelligence (AI) and machine learning becoming widespread, there are major implications for privacy and data protection – especially in the case of personal data.

The General Data Privacy Regulation (GDPR) comes into force across all EU member states on the 25 May 2018, requiring organisations' compliance from day one. This is an overhaul of the current Data Protection Act to cover biometrics and genetic data, bringing the regulatory environment up to date in relation to Big Data.

Transparency and accountability

The new Regulation is designed to promote and facilitate data-sharing by putting in place appropriate principles and safeguards that protect individuals' privacy and ensure that cyber security is maintained. Transparency and accountability are key, with extra levels of transparency for individuals around how their data is used and processed, and more rights for people who have questions about their own data.

New best practice will be to combine encryption with the anonymisation of Big Data to safeguard personal details and protect against their misuse. A new code from the Information Commissioner's Office describes the steps that organisations can take to ensure that anonymisation is conducted effectively while still retaining useful data.

Roadmap for compliance

Based on the Information Commissioner's Office best practice, organisations will need to consider the following critical questions as they prepare for GDPR:

- Do you know what personal information you hold, and on which system it resides?
- How will the 'right to be forgotten' impact your organisation?
- Will data portability have an impact?
- Do you have a Data Protection Officer that reports at board level?
- Do you have complaints from the Information Commissioner's Office and undertake root cause analysis on each case?
- Are all your Data Privacy policies updated on a regular basis and how do you check that they are effective?
- Do you delete personal information in line with a retention schedule?
- Are your models for obtaining consent in line with GDPR requirements?
- How would a GDPR fine of up to €20million affect your organisation?

Specialists can undertake a detailed Data Protection Act gap analysis for organisations against their current provisions, with improvements and areas of good practice highlighted. These then map to GDPR provisions to identify high-risk areas that need extra focus in the run-up to implementation and to develop a practical, prioritised roadmap for this important area of compliance.

With these preparations in place, organisations can confidently state that they have mitigated the risks associated with the new Regulation, and can ensure data protection is built into data and analytics projects from the start. If followed correctly, the Regulation won't hinder the use of data; it will enable its wider use by helping organisations to address any risk and ensure the transparency and security of data that is needed in the digital age.

> "Atos Information Governance, Risk and Compliance Consulting (IGRC) division draws upon multi-sector client reach and experience to provide compliance solutions"

Natalia Jimenez Lozano, PhD, Life Sciences Business Development Manager, Atos UK&I

The healthcare model is changing

As demand grows and medical advancements push the boundaries of treatment, today's healthcare systems need to evolve into a more sustainable model that maintains people's wellness rather than just treating them once they become ill.

New capabilities in Big Data, analytics and High Performance Computing (HPC) have a critical role to play. Proactive human decisions and actions – all supported and enabled by rich data and intelligence – can create a new paradigm for care that is much more precisely directed at each individual.

From bench to bedside

We can call this new paradigm Precision Medicine: the ability to predict and prevent disease, with the additional capability of biotechnology and pharmaceutical companies to develop and deliver more effective, personalised drugs and medical devices, and the empowerment of patients to participate more actively in their own health and wellbeing.

Powerful information and communication technologies are merging with life sciences and healthcare to create new capacity to acquire, store, distribute, match and interpret vast volumes of complex data from patient health data, research, clinical trials and population health studies. This convergence fills the gap between cutting-edge research and everyday healthcare – taking knowledge 'from the bench to the bedside'. It also creates exciting potential to fundamentally change our concept of health and medicine and how the biotechnology and pharmaceutical industries interact with the healthcare sector and with us as individuals.

Virtuous circle

Precision Medicine is based on four key pillars of care: Predictive, Preventive, Personalised and Participatory. The gathering and analysis of general intelligence (biomedical, pharmacological, socio-economic and so on), together with data specific to each patient (including medical records, family history and sensor measurements) means that screening, prevention, diagnosis and treatment of diseases can all be refined and personalised. This creates a virtuous circle, with huge amounts of raw data processed using the very latest in HPC and data analytics tools to significantly speed up the discovery process to develop more personalised care. This in turn should improve population health by minimising the need for major medical interventions.

When it comes to the various data sources, genomics (which studies the role of the genome in living processes) is of paramount importance. The genetic profile is key in determining the onset, development and inheritance of diseases. Understanding an individual's genome and incorporating it into medical records enables healthcare professionals to intervene early and tailor the monitoring and treatment of each patient. So, for example, people with a genetic predisposition to diabetes can be regularly monitored, with appropriate interventions as soon as any clinical signs appear. Or healthcare providers can check before prescribing a drug whether the patient is likely to suffer secondary effects because of a genetic predisposition.

A new continuum

In the future we envision an ecosystem of researchers, biotechnology and pharmaceutical companies, healthcare providers and citizens enabled by supercomputing and Big Data technologies to collaborate and share information. And the results?

- An increased understanding of life processes, disease and ageing, opening new research lines available to a wider network of research institutions and scientists
- More transparency and collaboration across the ecosystem, leading to faster and less expensive research cycles, shorter times to market and more affordable, better targeted drugs
- More routinely personalised medicine, leading to more efficient treatment approaches, increased health levels in the population and diminishing healthcare costs.

All this will underpin a new continuum of healthcare and wellbeing that is seamlessly integrated into our day-to-day lives. Here is an example of one citizen's journey to illustrate how this all comes together.

Natalia Jimenez Lozano PhD, Life Sciences Business Development Manager, Atos UK&I

A patient's journey

Let's look at an example of how the blend between Big Data Analytics (BDA) capabilities together with High Performance Computing (HPC) systems could bring important outcomes in the healthcare setting.

Sarah is a 45-year-old British citizen worried about her father's death last year due to a heart attack.

She makes an appointment with her doctor, who offers to perform whole genome sequencing with previous informed consent.

The doctor carries out real time sequencing by introducing Sarah's blood drop into a mini sequencing portable device that plugs directly into the USB port of her laptop.

Processing of the genomics data (filtering, mapping and variant calling) is carried out in the mini-High Performance Computer embedded into the sequencing device.

Anonymised and encrypted, Sarah's processed genomics data is sent to a Big Data Computing Platform where the analysis of the genomics variants is made.

The Platform counts also as a repository where the healthcare data gathered through different clinical pathways for every patient in the NHS healthcare system is stored. This Platform is hosted in an NHS Data Centre in the UK and has been implemented by putting in place cutting-edge cloud, security and cyber security technologies that are fully compliant with all valid European and UK laws. These technologies ensure the privacy of the data at rest and in movement. The data stored in this Platform can only be accessed by authorised medical doctors and healthcare authorities to decide the better treatment options for the patient or to design preventive measures based on stratification. There is a strict audit programme monitoring this Platform that keeps track of all the processes launched on it.

The doctor relies on a decision support system (DSS) that can infer an accurate diagnosis from the bulk of scientific, imaging, medical, clinical, omics, research and social data available. Cognitive computing is the mainstay of the system.

Unfortunately, Sarah carries three variants that are related to cardiovascular diseases: the same as her father.

After validating the diagnosis, the doctor executes another module of the DSS to find the most suitable treatment for her patient based on her clinical (arterial hypertension), social (single and no family support) and genomic profile (three cardiovascular risk variants). The doctor is advised by the DSS to prescribe a medication that has been tested in 100,000 patients with identic genomic profile with good results. She also recommends a diet to control her blood pressure.

She suggests the use of a T-shirt that enables monitoring of Sarah's electrophysiological heart activity in real time. The T-shirt is connected to a mobile application that sends the data (electrocardiogram and symptoms as requested) to a trained system that can predict any possible anomalous event.

Sarah stays asymptomatic until the age of 61 when the system alerts her doctor about the risk of arrhythmias. After performing a TT Echocardiogram, an aortic valvulopathy is detected and she programs an aortic valve replacement. The valve is printed on a 3D printer based on the images taken from TT Echocardiogram.

The doctor requests the help of a cardiovascular surgery expert in US who proposes robot-assisted surgery with augmented reality.

The surgery is successful and Sarah is now enjoying a healthy life.

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For Precision Medicine to be effective, we need secure technology that can store, analyse, and explore medical Big Data from a range of sources including high-throughput sequencing. This technology can’t work in isolation, though. It must align with information governance policies that allow the use of confidential medical data for healthcare research without compromising patient privacy or the trust of public, clinicians, and government alike.

We are making progress in all these areas. The research community is working closely with the National Health Service to share resources and data that will fuel research and innovation. Precision Medicine will help to target better treatments, create new research opportunities, and offer more creative forms of care than was previously possible. This is about a better future for healthcare and for the patient.

Dr Kevin Ashelford, Lead Bioinformatician, Wales Gene Park

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Hartree Centre
Science & Technology Facilities Council

Dr Robin Pinning, Chief Technology Officer, Hartree Centre

Big Data, Big Impact

We live in the information age where data is being produced at an ever increasing rate.

90% of all data in existence has been created in the last two years and it's no longer just business or governments who are amassing it. With the broadening adoption of the Internet of Things (IoT) (seen in smarter homes, city sensor networks, personalised medicine, smart transportation, rise of social media and the ubiquity of smartphones and wearables that can record our physical movements), we are creating vast quantities of personal data as well.

The challenge presented by Big Data isn't just because of its sheer volume; it also comes from the variety of the different types of data involved and the velocity at which it is created. The value of all this data lies in the useful information and meaning that can be extracted from it, and it is now being used in all aspects of life. In crime prevention, it helps police to spot trouble before it starts and facilitates cross-border or cross-institutional crime prevention. Bankers and insurers can use Big Data to spot irregular behaviour and bring about huge reductions in fraud.

The information our smart devices gather about us can be linked to public health records and allow the development of personalised applications that can help and monitor health conditions such as Alzheimer's and diabetes. Algorithms can work their way through a maze of data that's impenetrable to the human eye and mind to come up with recommendations that can better focus the money the NHS spends on prescriptions. The human genome project took 13 years and $3 billion to sequence the first human genome. New DNA sequencing machines can perform the same task in less than a day at a cost well below $1,000, making it possible to tailor treatments to both the patient and the disease by choosing the most appropriate combination of medicines to manage the specific range of conditions of a particular patient, minimising side effects.

There are various approaches to processing Big Data. In our work with industry, the requirement we often see is for 'fast data', i.e. the ability to process vast quantities of data in as short a timeframe as possible so that decisions can be made while there is still an opportunity to realise a benefit. For Big Data to deliver on the promise of big impact, its processing power needs to be time sensitive. This inevitably leads to a requirement for supercomputing.

Reaping all the benefits that Big Data offers means constant innovation in computing and communications. The current generation of supercomputers is limited by very high power consumption levels. Working with Atos, we are developing energy efficient computing techniques to help usher the next generation of exascale supercomputers that will be able to perform a million trillion calculations every second. STFC and the Hartree Centre have a long history of working with industry to realise the benefits of supercomputing and Big Data technology. We are proud to be at the forefront of ambitious scientific experiments such as the Square Kilometre Array (SKA) and Gaia galactic survey which are pushing the boundaries of the technology and will drive new innovation for the next generation of systems.

Meet the team

Ed Stephens
Pre-Sales Engineer, Big Data & Security, Atos UK&I

Role
As part of his role, Ed promotes demonstrable value when discussing clients' data challenges and champions the tailoring of offerings around the needs of business to rapidly bring best-fit solutions to market.

He ensures delivery of agile, adaptable, resilient and cost-effective architectures, aligned with long-term future strategic direction and more immediate business requirements.

Qualifications
Computer Science with Artificial Intelligence BSc, University of Nottingham

Hobbies
Running, mostly the school run for his six-year-old daughter. Paragliding, perhaps to escape running around after his six-year-old daughter.

How would you define Big Data?
Big Data offers a methodology to bring to market new innovative solutions providing actionable insights to modern day business challenges.

Sandy Forrest
Client Executive, Cyber Security, Atos UK&I

Role
Responsible for coordinating end-to-end cyber security capability (advice, services and products).

Previously, Sandy oversaw delivery of IT Services to the UK's National Security and Intelligence. For the London 2012 Olympic Games he was the liaison between Atos (as Worldwide Information Technology Partner for the Olympic Games), the Intelligence Agencies and the Olympic Security Directorate.

He currently sits on the Mayor of London's Cyber Security Advisory Panel.

Qualifications
30 years in law enforcement and eight years as Atos Client Executive in the field of cyber and national security.

Hobbies
Motorcycles and skiing.

How would you define cyber security?
Cyber Security is currently seen as an overhead. For me, it should instead be seen as a secure business enabler that can deliver competitive advantage.

Crispin Keable
Distinguished Expert for HPC, Atos

Role
With over 25 years' experience in supercomputing, Crispin has worked through the evolution of High Performance Computing (HPC) from proprietary systems in hardware and software to open standards, open source and commodity technologies.

He works with a wide range of scientific and technology organisations to help define, translate and realise their technical and simulation goals.

Qualifications
PhD in Astrophysics

Hobbies
Cycling

How would you define supercomputing?
A supercomputer is a tool for exploring our models of the world in ways we cannot conveniently test in any other way because of cost, excessive time, scale or safety.

Zeina Zakhour
Global Chief Technology Officer, Cyber Security, Atos

Role
Zeina creates innovative solutions to be a step ahead of cybercriminals. She covers the end-to-end spectrum of cyber security, from security advisory to security integration, managed security services and IoT and Big Data security. She worked closely with Fortune 500 companies to advise them in their security strategy and secure their infrastructure and protect their data.

Qualifications
Bachelor of Engineering in C.C.E from Notre Dame University Lebanon, M.Sc. from Telecom Sud Paris and an Executive MBA from HEC. Also a Certified Information Systems Security Professional (CISSP) and a certified ISO 27005 Risk Manager.

Hobbies
Snorkelling, Phoenician Civilisation, Astronomy, Piano

How would you define cyber security?
Cyber security is about building trust. Trust in the digital world of today, trust in disruptive technological innovations to come.

Lynn Dwyer, Head of Commercial, Virtual Engineering Centre

A safe place to take risks: the business benefits of virtual reality

Virtual reality (VR) has advanced dramatically in recent years thanks to more powerful computing and graphics capabilities. Headsets and consoles offering life-like experiences are now found in living rooms all over the country. The experience that any gamer can get is richer and more immersive than ever before – and it is that quality of experience that is so important when it comes to introducing VR into work environments.

Immersive manufacturing

In essence, VR is about helping organisations to look at their data in a life-like 1:1 format to increase understanding and help decision-making. Advanced visualisation tools are now being used by industries right through the product lifecycle – from concept design, to manufacture, marketing, sales, distribution and maintenance and end of life disposal.

In manufacturing, problems have traditionally been uncovered once products are in physical production, which can become very costly to address. The Virtual Engineering Centre (VEC) has been working with a range of advanced manufacturing companies to look at ways they can adopt technologies such as virtual simulation into their processes to improve efficiency and productivity. Working with a variety of organisations such as Bentley Motors, we have introduced these tools early in the design process across different functional teams. Not only does this help the designer to ensure that the car looks good and is ergonomically functional before it is physically built, but also enables many more design configurations to be considered and examined during the concept phase. Designs can be tested and modified at an early stage to improve the quality of the end product and reduce times and costs of manufacture. These visualisation techniques are just as applicable in other areas of modern manufacturing.

Increasingly accessible

With price points lowering significantly VR has become more accessible and cost-effective to organisations. This opens up opportunities for smaller companies who don't have access to expensive facilities. When taking products to exhibitions, for example, which may have been costly and difficult to transport, sales and product teams can now demonstrate a very complex product on a 1:1 scale using a low cost portable VR kit.

Training is another huge area of potential. Using virtual and augmented reality, companies can train staff in the manufacture of a product before it has rolled off the production line, including training maintenance staff and machine operators in the virtual world first before they carry out complex tasks, such as in aerospace and transport ensuring that they have reached suitable levels of competency. Virtual environments can be used to check and improve maintenance processes before implementation; the nuclear industry, for instance, is already exploring these technologies for planning decommissioning processes.

Transformational innovation

The virtual world is a safe and cost-effective space to take risks and experiment. Organisations can make truly transformational change by attempting things that they simply would not try in the physical world.

Building on the digital tools developed in collaboration with Bentley Motors, the VEC has been working with surgeons on their pre-operative planning process at Alder Hey Children's Hospital. With surgeons operating on extremely small hearts, using just traditional CT and MRI scans it is not possible to fully interrogate a problem before surgery or interact intuitively with that data. Now, using data taken from MRI scans combined with virtual reality technologies, surgeons can easily manipulate a bespoke virtual heart generated directly from the scan data either through voice recognition or gesture controls. This enables them to test and de-risk procedures, communicate more effectively with the clinical team pre-procedure, improve outcomes which may result in fewer patient interventions. In future, they will be able to manipulate a bespoke 3D print of a patient's region of interest, such as a heart, to virtually navigate the its internal structure and external surroundings using a virtual reality headset.

Believability and opportunity

With so many different applications, depending on the rendering requirements and the application, virtual reality tools can operate on systems ranging from high end workstations to more powerful High Performance Computing (HPC). In addition, the better the quality of the data and how it is structured, the better the digital experience and outcome.

The level of immersion is still developing rapidly, with haptic feedback giving users a cue that they're touching something by applying forces, vibrations or motions. The quality of experience in what you see, touch and hear is becoming more and more realistic. The level of believability and immersion is crucial as use of the technologies expands.

Yet despite all the technological possibilities, we are always challenge-focused, so we start with what a business wants to achieve rather than the capabilities of any particular tool. Once a team is working with its own data and processes in its own environment, new challenges and opportunities then keep emerging. The potential of these technologies is almost limitless, depending on how organisations want to use it and their commitment to innovation.

A University of Liverpool, School of Engineering led initiative, the VEC was catalysed by funding from the ERDF and the former Northwest Regional Development Agency and is located at the Science and Technology Facilities Council (STFC) laboratory at Daresbury as well as the Engineering Building at the University of Liverpool. Enhancing capability through Virtual Innovation, the VEC is the UK's leading centre of Virtual Engineering technology integration and digital solutions for industrial and commercial applications.

Science & Technology Facilities Council

Prof Tony Hey CBE FREng, STFC Chief Data Scientist & Joint Chair, UK E-infrastructure Leadership Council

Excellent research requires excellent research infrastructure

The UK's ability to carry out research using ever-increasing volumes of complex data is at the heart of the National Industrial Strategy and is essential to our long-term development and success.

Such knowledge underpins a significant part of our economy, facilitating growth, creating jobs and generating ongoing innovation.

This kind of research capability depends on a research e-infrastructure, which encompasses High Performance Computing (HPC), large-scale data repositories and high-bandwidth networking resources, together with the necessary human resources and skills.

Discussions about the importance of infrastructure in growing our economy are often limited to physical infrastructure such as roads, rail, airports and ports. However, the development of our national research e-infrastructure deserves the same recognition. The UK national research e-infrastructure is relied on by over 100,000 scientists from universities and industry who undertake increasingly complex simulations and process and analyse vast amounts of scientific data.

A sustainable long-term funding plan for the e-infrastructure component of the national research infrastructure is a key priority for all science, research and innovation. In addition to the facilities that generate, process and store data, the other key components of our research infrastructure are the highly skilled people who write the algorithms and software that manipulate and extract actionable information from data, and who provide the security that protects and enables authorised use of data.

Developing our technology ecosystem

The HPC ecosystem in the UK consists of Tier 1 supercomputers, Tier 2 HPC systems and Tier 3 local university HPC resources. The Tier 1 resources, which provide the current highest capability research HPC machines, are based at Edinburgh Parallel Computing Centre; the new Bull Sequana supercomputer named 'Scafell Pike', at the Hartree Centre; and the machines of the DiRAC consortium which is the integrated supercomputing facility for theoretical modelling and HPC-based research in particle physics, astronomy and cosmology. These machines provide the capacity to deliver leading-edge science and the capability for research software engineers to develop competitive, next-generation applications.

In future, UK industry would benefit further from the establishment of a 'Secure HPC and Data Centre' area at the Hartree Centre, with support from several industry sectors including the pharmaceutical, aerospace and automotive sectors. In effect, this would mean safeguarding the intellectual property of companies working on new products by establishing specific industry zones.

Improved access to supercomputing enabled through the cloud is a significant step forward.

Operating computing infrastructures in the cloud is a way to deliver the cost-efficiency, agility and flexibility required for the digital age. Hybrid cloud solution (a blend of commercial and private cloud services) is increasingly common as often the most cost-effective option.

At present, studies both in the US and the UK have shown that it is not commercially viable to use non-specialist commercial cloud services either for the largest supercomputer codes or for long-term storage of very large data sets. However, specialist HPC cloud services are now starting to emerge and the UK's scientific research community needs to continue to monitor their cost-effectiveness and potential for research proposals to funding bodies.

Developing talent

Post-Brexit, the UK needs to have the best research infrastructure in Europe to attract the best researchers to both our universities and our industry. The use by start-ups of the UK's research infrastructure needs to be friction-free.

Our UK centres of expertise in software engineering, security, data management and data analytics need to be encouraged to offer more support to start-ups and SMEs. Incentives for co-location of start-ups in incubation centres on science parks next to universities and centres of expertise could also make a positive difference.

All research fields now see an urgent need for talent development both in research computing and in data and information management.

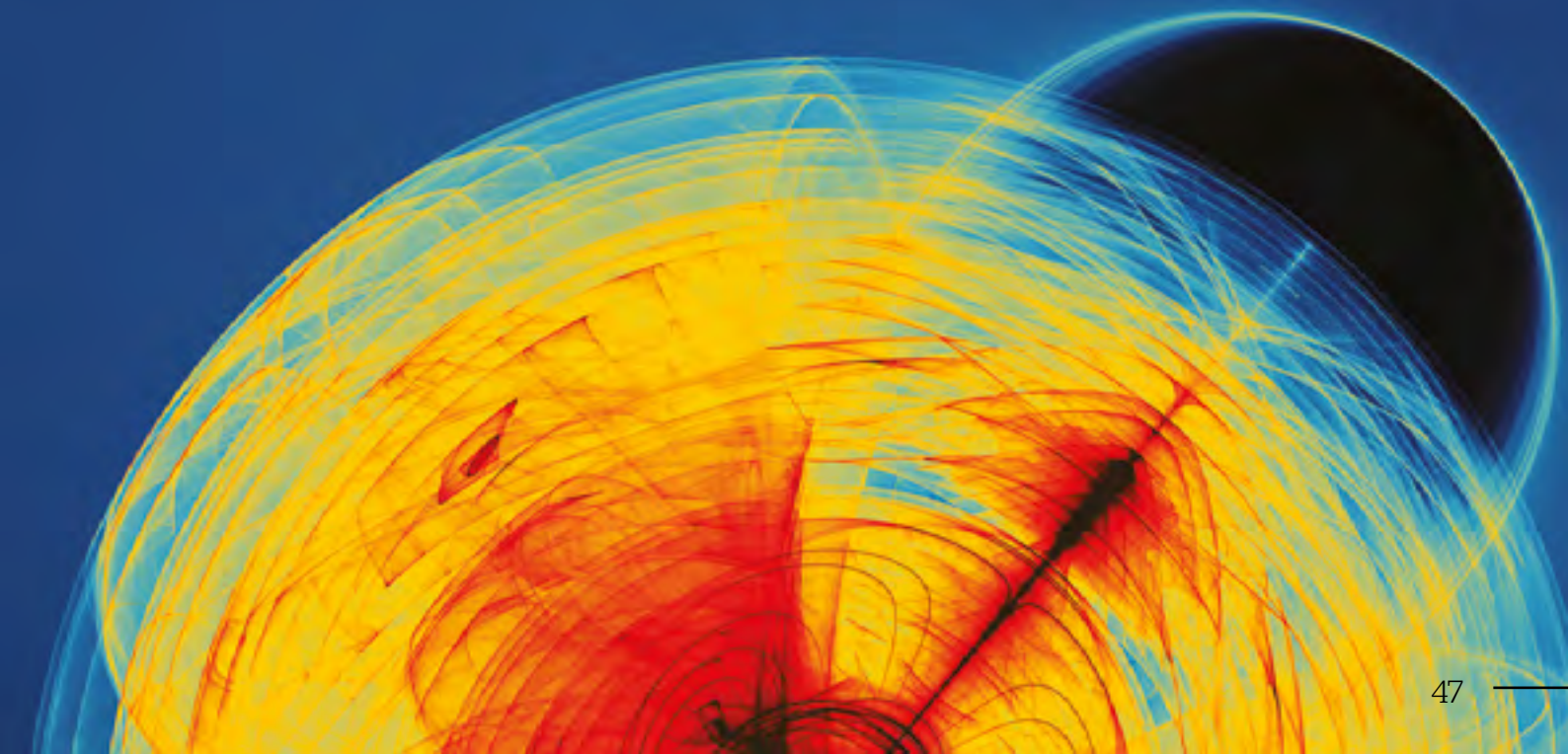
Andy Grant, Head of Big Data and High Performance Computing, Atos UK&I

A major physics breakthrough

The ability to process huge volumes of data at one end and generate actionable insight at the other is paramount for scientists.

Supercomputing twinned with Big Data Analytics (BDA) is fast becoming the method of choice to inform and power today's scientific discoveries. In February 2016, an international team of scientists including Cardiff University's Gravitational Physics Group announced the detection of the first-ever gravitational wave, providing evidence in support of Albert Einstein's 1915 theory of general relativity. This was heralded as one of the biggest breakthroughs in physics for the last 100 years, with scientists saying that these tiny ripples in space-time offer new ways of exploring the universe.

The discovery was supported by a supercomputer developed at Atos, which combed through extensive data gathered by over a thousand scientists and researchers. The research team used the Bull supercomputer to conduct simulations of black hole collisions to produce theoretical models, confirming the signals detected were, in fact, gravitational waves. These waves interact very weakly with particles and need incredibly sensitive equipment to detect them, which is why supercomputing has been so important in their detection.



> The potential of data analytics, backed by the power of high performance computing, is still to be fully realised. Providing organisations across the public and private sectors with a fuller understanding of the associated opportunities in analytics is key to ensuring the UK remains at the forefront of this digital revolution, and competitive on a global scale.
>
> **Julian David, CEO techUK**

Sue Daley, Head of Programme for Cloud, Data, Analytics & AI, techUK

Why HPC is vital to the next stage of the UK's Big Data journey

Organisations across both the public and private sector are today gaining real business value from using Big Data and analytics to unlock hidden insights and knowledge from large datasets.

As the amount of data being created continues to increase, this raises the question of how UK organisations, particularly SMEs, will be able to manage and analyse bigger and bigger data sets and continue to unlock the power of Big Data in real time. High Performance Computing (HPC) may hold the answer and will be vital to the next stage of UK organisations Big Data journey.

The exponential increase in data creation

We are creating more and more data - it is estimated that 2.5 quintillion bytes of data is being created every single day. This data creation is being driven by the digital transformation across both the public and private sector and the way we interact with technology in our daily lives. This level of data creation is unlikely to stop anytime soon. For example, a single connected car is expected to produce 30 terabytes of data a day. With 20 billion connected cars expected to be on the road by 2020, the automotive industry alone will create in excess of 600 zettabytes a day.

This data can have huge economic and social potential for organisations and citizens given the impact Big Data is already having across sectors and industries. Retailers such as John Lewis and media companies such as Netflix are using Big Data to increase customer interaction, develop personalised services, reduce costs and increase operational efficiency. In the public sector, Big Data also has a key role to play in helping public service organisations to increase efficiency and reduce costs whilst delivering more personalised services to citizens. The recent UK Government's Transformation Strategy outlines how "better use of data" will be key to the next stage of digital transformation between now and 2020.

> "High Performance Computing may hold the answer"

Converting Big Data into opportunities for Britain's companies and institutions

It's important to remember, however, that the opportunities Big Data offers don't come simply from creating and storing large amounts of static data. The real value comes from analysing Big Data to unlock insights that can be used to develop personalised products, goods and services based on customer needs and wants.

Given the amount of data expected to be created, it will be thanks to the computing power of HPC that organisations will be able to do this and find that data needle in a data haystack. For example, the UK's HPC at the Hartree Centre is capable of more than a thousand trillion calculations per second. This computing power means vast quantities of data can be analysed in real time and provide businesses with information that could mean the difference between gaining and losing its competitive edge.

The work of the Hartree Centre must continue to be supported if the UK is going to be able to fully benefit from Big Data analysis. We must also do more to ensure UK organisations, particularly digital entrepreneurs and SMEs, are aware of how they could benefit from using HPC. The partnership between Hartree and the Liverpool City Region 4.0 programme which is helping SMEs to consider how HPC technologies could solve real business challenges is a great initiative that should be replicated around the UK. More projects like this are needed to help SMEs understand what HPC could mean to their Big Data driven future.

Clearly the UK is not at the start of its Big Data journey. As we move forward, the UK has opportunity to be a world leader in Big Data by using HPC to drive UK economic growth, productivity and job creation. However, this opportunity will only be fully realised if we ensure all organisations understand that the next stage of UK organisation's Big Data journey is one where Big Data and HPC go hand-in-hand.

Spotlight

Atos and the Olympic Games

Atos has been a key technology provider for the Olympic Movement since 1989 and as Worldwide IT Partner since 2001. In 2013 Atos was selected by the IOC as the IT Service provider for the Olympic Games until 2024.

Wherever the Games have travelled, so has Atos. Together with the International Committee we overcame multiple challenges: The IT security situation in Salt Lake in 2002. The operational readiness challenges in Athens 2004. The delivery of London 2012, alongside the emergence of social media, then Rio 2016, the most connected and data rich Games and now, introducing cloud moving forward.

The Games in numbers

26 Countries

37 Competition venues with complete IT infrastructure

42 Sports

80 Different systems and applications

250 Servers

306 Events

10,500+ Athletes

30,000 Media

70,000 Volunteers

200,000 Hours of testing

300,000+ Accreditations

4 BN TV viewers worldwide

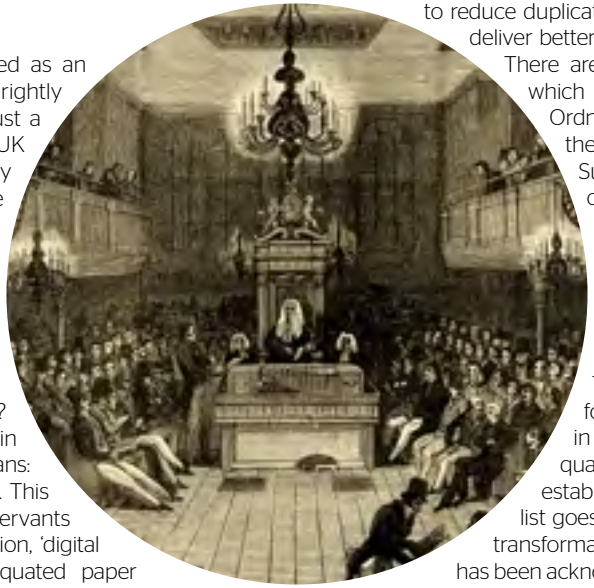
Kulveer Ranger FRSA, Vice President, Strategy & Communications, Atos UK&I

The digital political challenge

Digital transformation takes centre stage

Could it be that the time has genuinely arrived for the digital transformation of public services in the UK and Ireland? Why now? Because the Government has established a framework and prioritised the need for technology to stand on its own and act as a critical part of the nation's infrastructure.

No longer should technology be viewed as an add-on for policy makers; it is now quite rightly seen as the engine for a vehicle, not just a nice to have extra. During the recent UK general election, digital was identified by the Conservative Party as a key challenge to make the country and its public services transform through the prism of digital technology. This statement was also supported by numerous specific policies to create a framework and flesh out the vision.



What does this political direction promise? Five words that have been used by many in industry but now come from the politicians: 'Digital transformation of public services'. This ambition has been muttered by civil servants for many a year. Even creating the mission, 'digital by default' to describe changing antiquated paper based processes to a web based services. But if the website merely replicated a process, albeit on a digital screen, then this type of conversion has never really delivered the digital transformation that many felt it should. Redesigning processes, improving and making them frictionless is when real value is delivered. It is why it is critical that we see Government committing to delivering digital services that will be fully accessible and transformed.

Positive change

This opportunity obviously opens the door to significant change and includes a commitment to provide transparency for 'operational performance data of all public-facing services for open comparison as a matter of course'. The Government has also set out many other policies to enable this transformation to materialise. From introducing Digital Transformation Fellowships to enable a greater flow of private sector talent and innovation into Government, to the need to better use and achieve value out of the great swathes of 'big personal data' that is housed both within Government departments, while also acknowledging the great frustration of data replication. So objectives to reduce duplication, improve efficiency and, dare I say it, deliver better value for the taxpayer are all welcomed. There are other initiatives, such as Digital Land, which will seek to combine the Land Registry, Ordnance Survey, the Valuation Office Agency, the Hydrographic Office and the Geological Survey to establish the largest repository of open land data in the world; and working with industry and charities to establish a 'Digital Charter' to provide a framework that aims to balance freedom with protection for users and clear obligations for businesses and platforms. There is a plan for an Institute of Digital Technology; there will be an increasing focus on STEM and technical disciplines in the education system and even a new qualification known as the T level, all aimed to establish a rich seam of digital education. The list goes on because the possibilities from digital transformation are genuinely endless. The challenge has been acknowledged, and now needs to be delivered.

Government and business working to realise digital transformation

It cannot be ignored that post the election, the political landscape has changed and will no doubt continue to evolve. However, the ambitions and direction set by a new Government needs to be supported. Industry must play its part as a trusted partner to Government. We should not be cynical of governments' ambition when it comes to digital transformation. Technologists, solution architects, data scientists, and all those who understand the art of the possible should align and encourage ministers who have realised that delivering faster broadband should not be the limit of their ambitions. We are entering an era where the digital citizen will now want to connect and engage with a truly digital Government.

> Five words that have been used by many in industry but now come from the politicians: Digital transformation of public services.
>
> **Kulveer Ranger FRSA, Vice President, Strategy & Communications, Atos UK&I**

Lexicon

3D Printing: the action or process of making a physical object from a three-dimensional digital model, typically by laying down many thin layers of a material in succession.[1]

5G: The next telecommunications standard for mobile networks. 5G connectivity will deliver unparalleled speed (10Gbit/s speed), ultra-low latency (<1ms) and reliability (99.999 per cent), while offering 1000x the capacity of 4G.

Algorithm: A mathematical formula placed in a software program that performs an analysis on a dataset. The algorithm often consists of multiple calculation steps. Its goal is to operate on data in order to solve a particular question or problem.[2]

Analytics: a process in which a computer examines information using mathematical methods in order to find useful patterns.[3]

Artificial Intelligence (AI): The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.[4]

As a Service: Something that is made available over the internet to a customer as a service – e.g. Data as a service (DaaS), Network as a service (NaaS), Platform as a service (PaaS), etc.[5]

Augmented Reality: a technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.[6]

Big Data: Extremely large data sets that may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions.[7]

Biotechnology: The exploitation of biological processes for industrial and other purposes, especially the genetic manipulation of microorganisms for the production of antibiotics, hormones, etc.[8]

Byte: A unit of data that is eight binary digits long. A byte is the unit most computers use to represent a character such as a letter, number or typographic symbol.[9]

Terabyte: 1,000 gigabytes of computer storage – equivalent to approximately 212 DVDs.

Exabyte: 1 million terabytes

Zettabyte: 1 billion terabytes. The combined space of all computer hard drives in the world was estimated at approximately 160 exabytes in 2006. As of 2009, the entire World Wide Web was estimated to contain close to 500 exabytes. This is one half zettabyte. The volume of worldwide digital data is projected to reach 44 zettabytes by 2020.[10]

Cloud Computing: The practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.[11]

Cognitive Computing: The simulation of human thought processes in a computerised model. It involves self-learning systems that use data mining, pattern recognition and natural language processing to mimic the way the human brain works.[12]

Convergence: Convergence is the coming together of two different entities, and in the contexts of computing and technology, is the integration of two or more different technologies in a single device or system.[13]

Cryptography: A method of storing and transmitting data in a particular form so that only those for whom it is intended can read and process it.[14]

Cyber Security: The body of technologies, processes and practices designed to protect networks, computers, programs and data from attack, damage or unauthorised access.[15]

Data Lake: A Data Lake is a storage repository that holds a vast amount of raw data in its native format until it is needed. While a hierarchical data warehouse stores data in files or folders, a data lake uses a flat architecture to store data.[16]

[1] https://www.google.co.uk/#q=define+3d+printing
[2] http://www.techrepublic.com/article/mini-glossary-big-data-terms-you-should-know/
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Data Modelling: The analysis of data objects and their relationships to other data objects. Data modeling is often the first step in database design and object-oriented programming as the designers first create a conceptual model of how data items relate to each other. Data modeling involves a progression from conceptual model to logical model to physical schema.[17]

Deep Learning: Part of a broader family of machine learning methods based on learning representations of data.[18]

Deep Web (also called the Invisible Web or Hidden Web): Parts of the World Wide Web whose contents are not indexed by standard search engines for any reason. The content is hidden behind HTML forms. It is estimated that the deep web makes up 96 % of the whole internet.[19]

Distributed Ledger: A consensus of replicated, shared, and synchronised digital data geographically spread across multiple sites, countries, or institutions. One distributed ledger design is through implementation of a public or private blockchain system.[20]

e-Infrastructure: A combination and interworking of digitally-based technology (hardware and software), resources (data, services, digital libraries), communications (protocols, access rights and networks), and the people and organisational structures needed to support modern, internationally leading collaborative research be it in the arts and humanities or the sciences.[21]

Exascale computing: Computing systems capable of at least one exaFLOPS, or a billion billion calculations per second.[22]

FLOPS: Floating point operations per second, a measure of computer performance, useful in fields of scientific computations that require floating-point calculations.[23]

Examples of devices whose performance can be measured within each order of magnitude:

kiloFLOPS (1 thousand FLOPS): early supercomputers
megaFLOPS (1 million FLOPS): Atari 2600, Sega Genesis, Apple iPhone
gigaFLOPS (1 billion FLOPS): Apple Watch, Samsung Galaxy S6, Xbox 360
teraFLOPS (1 thousand gigaFLOPS): Xbox One, PlayStation 4
petaFLOPS (1 million gigaFLOPS): Supercomputers
exaFLOPS (1 billion gigaFLOPS): Supercomputers[24]

Gravitational Waves: Ripples in the curvature of space-time. They transport energy as gravitational radiation, which is a form of radiant energy similar to electromagnetic radiation. They were predicted by Einstein in 1916.[25]

Haptics: The science of applying touch (tactile) sensation and control to interaction with computer applications.[26]

High Performance Computing (HPC) / Supercomputing: High performance computing (HPC) is the use of parallel processing for running advanced application programmes efficiently, reliably and quickly. The term HPC is occasionally used as a synonym for supercomputing, although technically a supercomputer is a system that performs at or near the currently highest operational rate for computers.[27]

Hybrid Cloud: A cloud computing environment which uses a mix of on-premises, private cloud and third-party, public cloud services with orchestration between the two platforms.[28]

Internet of Things (IoT): The interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data.[29]

Machine Learning: A type of artificial intelligence (AI) that provides computers with the ability to learn without being explicitly programmed. Machine learning focuses on the development of computer programs that can change when exposed to new data.[30]

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Lexicon

Map-Reduce: A Big Data batch processing framework that breaks up a data analysis problem into pieces that are then mapped and distributed across multiple computers on the same network or cluster, or across a grid of disparate and possibly geographically separated systems. The data analytics performed on this data are then collected and combined into a distilled or "reduced" report.[31]

Massively Parallel Processing: The simultaneous processing of multiple tasks but using hundreds, if not thousands of processors to do so.[32]

Moore's Law: The observation that the number of transistors in a dense integrated circuit doubles approximately every two years.[33]

Orchestration: The automated arrangement, coordination, and management of computer systems, middleware, and services.[34]

Parallel Processing: The simultaneous processing of multiple tasks at once through multiple processors. This is how supercomputers process tasks. This process is far more like that which takes place in the human brain.[35]

Prescriptive (Analytics): Prescriptive (analytics) is related to both descriptive and predictive analytics. While descriptive analytics aims to provide insight into what has happened and predictive (analytics) helps model and forecast what might happen, prescriptive analytics seeks to determine the best solution or outcome among various choices, given the known parameters.[36]

Quantum Computing: Quantum computing studies theoretical computation systems (quantum computers) that make direct use of quantum-mechanical phenomena, such as superposition and entanglement, to perform operations on data. Quantum computers are different from binary digital electronic computers based on transistors.[37]

Right To Be Forgotten: The concept that individuals have the civil right to request that personal information be removed from the Internet.[38]

Sentiment Analysis: The application of statistical functions on comments people make on the web and through social networks to determine how they feel about a product or company.[39]

Serial Processing: Processing a task one at a time using a single processor. This is how a generic computer handles tasks.[40]

Smart City: An urban development vision to integrate Information and Communication Technology (ICT) and Internet of Things (IoT) technology in a secure fashion to manage a city's assets. A smart city is promoted to use urban informatics and technology to improve the efficiency of services.[41]

Smart Manufacturing: A technology-driven approach that utilises Internet-connected machinery to monitor the production process. The goal of smart manufacturing is to identify opportunities for automating operations and use data analytics to improve manufacturing performance.[42]

Surface Web (also called the Visible Web, Indexed Web, Indexable Web or Lightnet): The portion of the World Wide Web that is readily available to the general public and searchable with standard web search engines. It is the opposite of the deep web.[43]

Virtual Reality: the computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.[44]

Visualisation: Data visualisation is a general term that describes any effort to help people understand the significance of data by placing it in a visual context. Patterns, trends and correlations that might go undetected in text-based data can be exposed and recognised easier with data visualisation software.[45]

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Acknowledgements

We would like to thank the following contributors. If you wish to send feedback, please tweet using **#DVfSCBD** or email: **AtosDigitalVisions@atos.net**

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