Thought Leadership

Journey 2020
Digital Shockwaves in Business

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Ascent Journey 2020 can also be viewed through an interactive mini-site designed for portable devices, such as laptops, tablets and mobiles. The full publication can be downloaded at ascent.atos.net/journey2020

Foreword to Journey 2020

Welcome to **Ascent Journey 2020**, our vision of the evolving world of business, society and technology that we hope will stimulate and challenge your thinking about the forces that will shape business during the next few years.

Throughout the 4 incarnations of our "Journey" series, the **Atos Scientific Community**, which I personally chair, has sought to identify, define and research some of the most disruptive technologies and business trends that are impacting our world. As we now look towards 2020, we are observing that the pace and impact of technology on business and society is increasing. People are spending more of their day interacting digitally on multiple devices, and products and services (consumer-oriented or industrial) are increasingly personalized, data-intensive and context-aware. At the same time, trust is becoming disintermediated and transactional as objects interact directly with each other and with people, generating valuable data streams. However, whilst numerous core developments are growing exponentially, the rate of change in the most disruptive technology applications is not always so predictable – progress is "lumpy" and in some cases, may even lead to dead ends.

"The impact of Digital Shockwaves on business will intensify competition in all industries."

Sometimes emerging capabilities combine to provide the kind of coordinated breakthroughs necessary to help realize innovations like fully autonomous vehicles, computerized medical diagnostics, genetic editing or smart virtual assistants. At other times, concerns over ethics or personal privacy will cause the application of certain technologies to stall or even backtrack. We portray this situation as a series of "**Digital Shockwaves**", like ripples on the surface of a pond, emanating from different sources but interacting with each other in complex patterns. The business and social impacts of these shockwaves will intensify competition in all industries, require new employee skills, and often cause worker displacements.

To help anticipate the impact of these Digital Shockwaves, we have identified **4 possible sources of disruption**: **Ways of Working** (how people will collaborate with people, machines and virtual 'beings' in entirely new ways); **Business Models** (how companies are taking advantage of digital technologies to find new markets, business models and revenue streams); **Disruptive Technologies** (how certain specific technologies may single-handedly create notable societal and economic disruptions) and **Evolving Challenges** (topics like security, whose constant evolution demands radically new reexaminations). All of these disruptions are technology-enabled, and this Journey 2020 document will help you understand their implications.

"Industrial Data Platforms will be the controlled medium for data-intensive inter-enterprise collaboration."

To fully realize the business potential, we must address the challenge of data ownership and data management. Who owns and controls the huge quantities of data that will be produced and what are the most effective ways to process it? We expect the rise of "Industrial Data Platforms" as a controlled medium for inter-enterprise collaboration. Industrial equipment manufacturers will use such platforms to help protect their intellectual property and restrict visibility of sensitive performance data, whilst at the same time facilitate collaboration and co-innovation with other parties.

The rest of this document contains our vision, as well as detailed insights on the areas of disruption and their potential for business. I'm sure you will find this an essential guide to assess the impact of Digital Shockwaves on your area of operation during your journey towards 2020.

Thierry Breton
Chairman and CEO, Atos

Executive summary
for CxOs

Disruptions enabled by emerging and maturing technologies are impacting business and society with increasing pace and depth, and this trend will persist in the next few years. More importantly, such **Digital Shockwaves** will interact with each other in unexpected ways. This will create a complex and uncertain environment, which will be ripe for opportunity if appropriately anticipated, understood and acted upon.

Perhaps the most significant business disruptions will come from a combination of the connected sensors, devices and objects (Internet of Things), coupled with new ways to analyze, action and monetize the resulting data streams. This will complement, and may help counterbalance, the existing capabilities of digital giants (Facebook, Google, Alibaba, Baidu, Amazon, etc.) to engage directly with consumers via their mobiles, wearables or computing devices. Commoditized sensors and actuators will provide both rich context and precise control to an almost limitless range of use cases. In such a highly connected world we will see an explosion in the potential to understand status, anticipate outcomes and automate processes. If we are able to couple this with the ability to share and act upon the associated data and derived insights, significant new business opportunities will arise. Some of these situations will emerge as **transient business moments** that necessitate an immediate and orchestrated supply chain response; others will arise from the application of deep learning to observed trends and behavioral outcomes.

New business models will emerge both within and across organizations**.** Traditional organizational silos will disappear, simplifying trust and contractual agreements. Business performance will be measured by new digital business KPIs and LIs (Key Performance Indicators / Leading Indicators). New security models will be developed that enable trusted collaboration and bring a balance between 'Block and Prevent' and 'Detect and Respond'.

Increasing automation will cause off-shoring to diminish and favor a 'Gig Economy[1]'.

As **automation** (both physical and virtual) replaces an increasing range of human tasks, we must rethink our ways of working and the types of skills that are required for the future human workforce. Offshoring of roles as a means of wage arbitrage will wane as human tasks are increasingly executed by robots, smart machines, smart systems and 'bots' capable of interacting in natural language. Virtual service desks, driverless vehicles and medical and legal research are just some examples of areas that will be heavily influenced by automation. We also expect that some traditional employment models will shift to regulated "Gig economies." There is even the real possibility (according to a growing cadre of economists) that many human jobs will disappear; work may become a privilege, and concepts like Universal Basic Income may become a real consideration for governments in some countries.

We have already seen the impact of Digital Shockwaves in the world of consumer services – from taxis to hotels rooms and on-line shopping to house buying. We can now enjoy more immediacy, personalization and convenience, and often at more competitive price points. Data and **service aggregators** have rapidly risen to a position of market dominance in this arena. In many ways, the battle for end customer engagement has already been won by the Digital Giants. Digital marketplaces, search engines and virtual assistants relegate product and service providers to the position of somewhat disaggregated component parts of the supply chain. As the range of real-world interactions facilitated by personal smart devices increases, consumers will become more reliant on digital personal assistants to interact with the world around them – from household appliances to bank accounts and healthcare providers to grocery shopping. As a result, the role of the service aggregator will become even more significant, and the Apps Era will wane.

Industrial Data Platforms will help incumbents to digitally reinvent their leading roles.

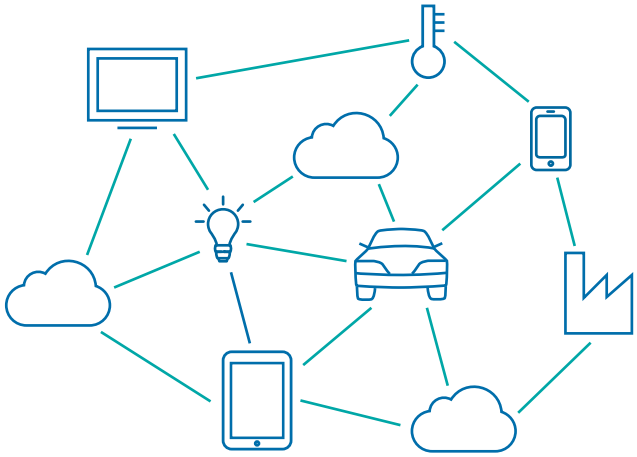
The changing business models and applications of technology we have already observed in the B2C world are now propagating through B2B interactions. We anticipate that the result will be both exciting opportunities and business disruption (e.g. some logistic chains will disappear in favor of on-site 3D printed parts; wind farms will reach optimal performance by the autonomous coordination of smart and social wind turbines), just as we have experienced with consumer services. Whilst we expect the impact to be even more far reaching, it will not be a repetition of the B2C case. If wisely implemented, **Industrial Data Platforms** hold the potential to digitally reinvent a leading role for service incumbents (e.g. a truck manufacturer selling smart truck usage à la Uber and displacing transport companies; a logistics company reinventing itself digitally to be the champion of 3D printing services) before they are displaced by the Digital Giants.

A few of the areas will probably not have a mainstream impact until well beyond 2020, but we believe they should be factored into an organization's strategy today. For example, whilst gene editing is already possible and has been carried out in humans, the associated ethical implications are unprecedented and must play a part in our thinking now, since its eventual impact will be far-reaching. Likewise, whilst generally available **Quantum Computing** is still some way from becoming a reality, when it arrives it will render most current security and analytics technologies obsolete almost overnight.

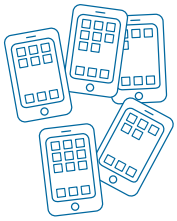
[1]"A gig economy is an environment in which temporary positions are common and organizations contract with independent workers for short-term engagements" http://whatis.techtarget.com/definition/gig-economy

Managing the single face to the customer

By 2020 billions of hyperconnected people, devices, sensors, machines and virtual beings will constantly exchange oceans of valuable data



B2C



B2C companies get significant value from being able to interact directly and digitally with the end consumer.

A multitude of applications!

B2B

MindSphere

Predix™ From GE. To Everyone.

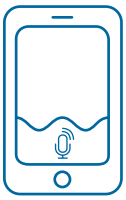
IBM Watson

Industrial Data Platforms emerge as the controlled medium for data-intensive inter-enterprise collaboration.

but

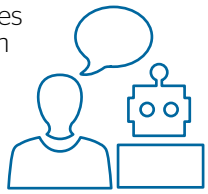
Service Gateways and Digital Aggregators are winning the battle for the interface to the consumer.

Will this mark the end of the App era?

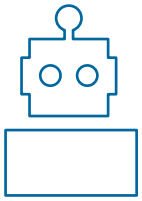


"Cortana, will you order me an Uber and turn off the heating please?"

As business processes are enriched through data-driven insights, collaboration and cyber physical interactions...



...who will own the user engagement?



"I recommend replacing the number 2 bearing thrust pads."

Who will manage the single face to the customer?

Take-aways
for business

During the next few years, businesses will experience a fluctuating and tremulous environment. Waves of change originating from long term megatrends will be compounded by Digital Shockwaves, impacting business models, organizational structures, operational processes, collaboration, financial models... practically all aspects of business. Navigating such change and disruption will not be straightforward and there will be no one-size-fits-all solution. Nevertheless we do believe that there are a number of areas that businesses can and should focus on to ride the Digital Shockwaves.

Emphasize situational awareness before strategy: map the context, driving forces and trends affecting your business. Define your strategy from that dynamic map and do not limit yourself to previous customer journeys, which you may not be able to influence directly. Otherwise you will be limiting the scope of your thinking just when disruption calls for brand new concepts.

Simplify all aspects of your business: operations, processes, structures, portfolios... everything. Simplicity and automation (where possible) are keys to attaining the efficacy, efficiency, flexibility and adaptability necessary to thrive in the context of shockwaves.

Prepare for Common Industrial Data Platforms, as a host or a stakeholder. Which aspects of your data should really never be shared under any circumstances? Which data that you do not own could bring radical advantages to your business? Who are the potential partners that own such data? Which win-win mechanisms can you devise for joint and secure exploitation of shared data? Think of possibilities such as limitations of use, temporal limitations or guarantees of reversibility.

Increase the granularity of your processes and transactions so they can be easily recomposed in real time through Advanced Analytics (Fast Data, Deep Learning). Coarse-grain processes will result in inefficiencies, obstacles to automation and lack of adaptability and competitiveness when interacting with third parties.

Maximize Automation of processes as well as interactions, except where it would negatively affect Customer Experience, Trust or Compliance. Prepare for social machines, smart contracts and other types of more advanced interactions. In a few years, some machines will be indistinguishable from people from the perspective of business process and interaction: they will decide, orchestrate common actions, make requests or execute payments on their behalf.

Flatten your organization and enable new (transformational) leadership to emerge: Social Collaboration and Knowledge Sharing tools will be indispensable in enabling Innovation Value Webs, but prepare adequate change management since organizational culture will also have to be transformed.

Break internal siloes: this is one of the major roadblocks that companies face in their transformation, especially B2B and industrial ones. Siloes hinder evolution, waste the most valuable resources and lock organizations into inward looking dynamics.

Put the customer in a central place even if you are a B2B company: Operational Excellence alone will not do the trick. As an example, some standards came into being due to design or manufacturing limitations which may no longer apply: can your products and services be less homogenous and more adapted to your customers' needs?

Multi-speed IT is not a magical solution: balance carefully its advantages and drawbacks. It can be smoother and more cost effective in some cases. It could be an unnecessary intermediate step and even a constraint to full digitalization in others.

Counterbalance the digerati: digital giants are in fashion, and certainly have powerful strengths, but traditional businesses have their own strengths – identify and exploit them. In particular, seriously consider Industrial Data Platforms, both proprietary and shared ones.

Disruptive vs incremental innovation: whilst the latter will be useful, its role should be carefully balanced in the next few years. Emphasize disruptive business innovation, leveraging on digital technologies. Experiment more.

Invest in data collection, stewardship and analytics: the most important aspect of this effort will be developing the talent necessary to execute these critical requirements.

These concepts are discussed in more detail in the following pages, we hope that in the messages presented you will find topics of supreme relevance to your own Business, both directly and indirectly.

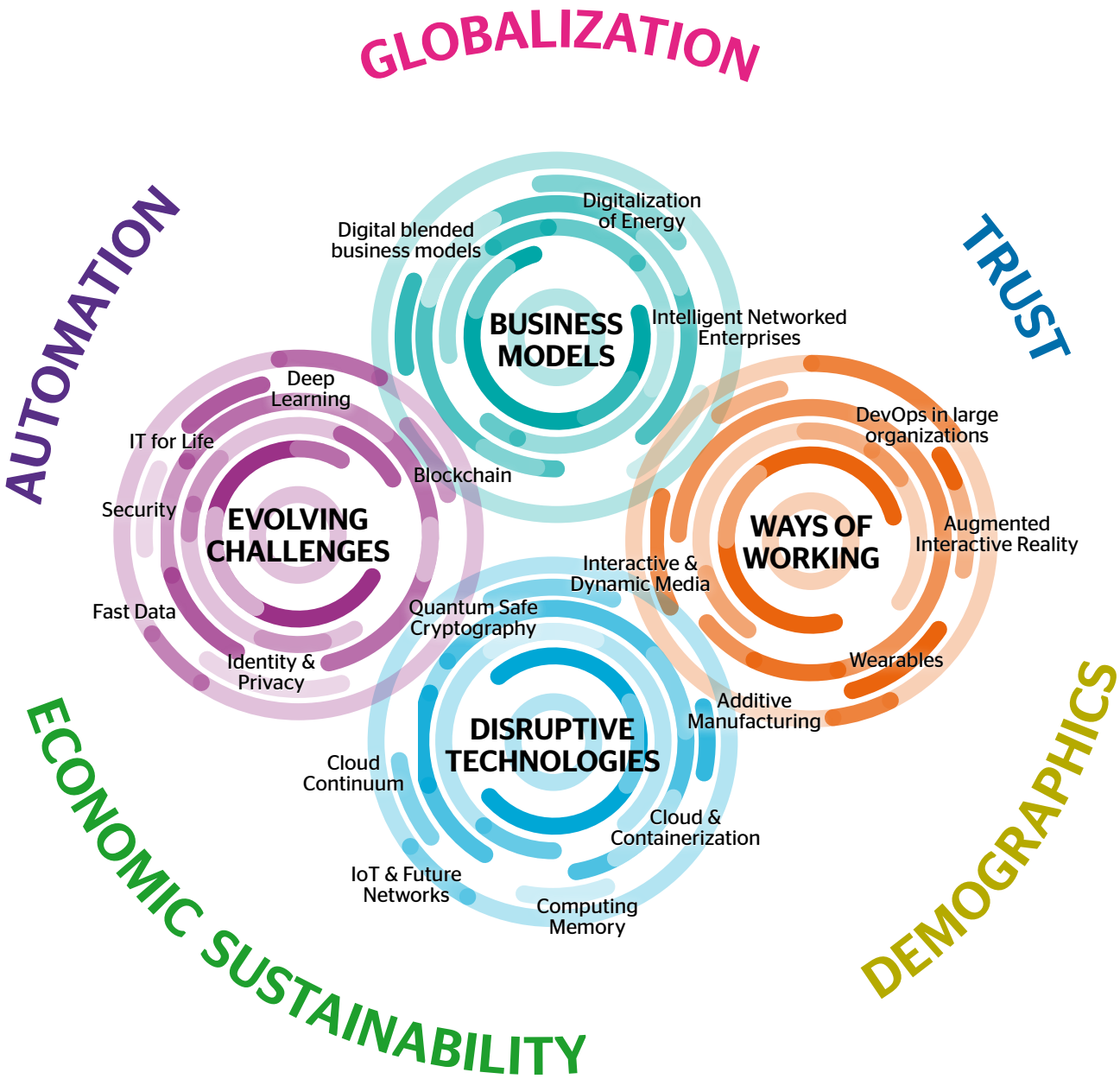


Figure 1 – Digital Shockwaves in Business

Digital shockwaves in business

The Earth's crust is composed of tectonic plates. These plates move slowly yet powerfully, coming together, separating or grinding against each other along fault lines. Over very long periods of time, their movements cause continents to drift gradually, but they can also cause rapid and violent phenomena such as volcanoes, earthquakes and tsunamis.

The "geology of business" is going through eventful times. The "earthquake" of the 3rd Digital Revolution[2] has already been felt in Business-to-Consumer (B2C) markets, as organizations and business models have emerged and transformed under a growing expectation of "Anything, anytime, anywhere" and personalization. **Digital Shockwaves are now rapidly propagating towards Business-to-Business (B2B) markets - their impact will be significant by 2020.**

Digital Shockwaves in Business will go further than just reshaping the consumer market; they will deeply affect end to end production and service processes in all sectors of the economy. We expect the impact to be felt as a series of shockwaves emanating from a number of sources aligned to specific aspects of the 3rd Digital Revolution. Just as can be observed with analogue waves, the Digital Shockwaves will interact and interfere: sometimes reinforcing their impact and sometimes cancelling each other out. Some will impact certain industries more than others; some will bring positive effects, others will bring potential threats. Continually anticipating and responding to their impact for a given business context and strategy will be essential as we continue on the digital transformation journey.

We expect to see digital disruption emanating from four main sources:

Business models

Through new sources of business value and partnership, driven by data and connectivity.

Ways of working

Resulting from changes in Business processes and the very nature of work.

Disruptive technologies

The developments that bring revolutionary changes to the "art of the possible" not just evolution.

Evolving challenges

Those familiar challenges that need to be addressed with different perspectives as a result of the emergence of new influences.

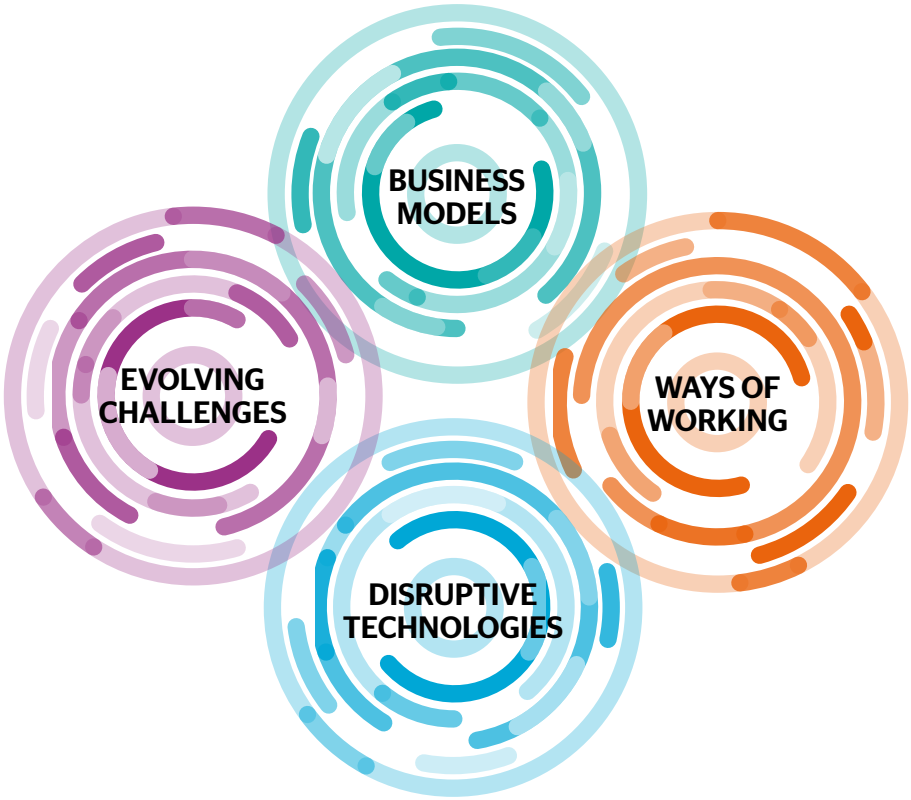


Figure 2 – The 4 sources of Digital Shockwaves

[2]Ascent Journey 2018 – The 3rd Digital Revolution: Agility & Fragility https://ascent.atos.net/downloadJ2018

Business models

Data, connectivity and partnerships are enabling digital and digital-blended business models. Common Industrial Data Platforms will drive network effects in the B2B world.

We expect to see much greater levels of collaboration and co-operation, as conventional enterprise boundaries become ever more constraining in a world where context, connection and responsiveness are the expected norms. A growing number of market opportunities will be transient in nature, driven by the impact that a consumer's context has on product and service requirements: A timely and holistic view of relevant data will be a key to identifying and unlocking these Transient Business Opportunities.

As a result, we will see supply chain ecosystems established around **Common Industrial Data Platforms** where participants will intentionally share data relating to design, production, operations and markets. This will allow companies to generate superior products and services by responding to identifiable customer desires and market conditions.

These Data Platforms will become the very essence of collaborative working and will be the catalyst to exploit the "positive externalities[3]" created by enterprise partnerships. Just as is observed with Multi-Sided Markets in the B2C world, Common Industrial Data Platforms will drive network effects in the B2B world.

To be effective, these business network relationships need to be underpinned by some form of contractual relationship and value exchange. In the B2C case this often takes the form of an agreement to use personal data, in exchange for no or low cost services. In the B2B case, the company, subcontractors and customers will form networks or **Innovation Value Webs** that use platforms to share industrial data in specific and possibly time-limited contractual relationships. Sharing of data will need to be organized in a similar way as for an outsourcing contract, where details about operations are shared with the outsourcing company by the industrial enterprise for a limited period of time, usually with a guarantee of reversibility at the end of the contract.

Despite this new level of openness, each company can still maintain its "DNA" and Intellectual Property by performing its own analytics and deep learning to create differentiation through improving understanding and situational awareness when preparing the next generation of its products and services.

In Multi-Sided B2C Market platforms, each side may expect the other to reach a certain size before they themselves engage. In B2B relationships the situation will be similar, with the result that the ramping up of the Industrial Data Platform may suffer from something of a "chicken and egg" problem for platform investment and participation: The data platform needs to be fed by the very cyber-physical systems which have to be cost justified by the value that can be realized through the platform – the full benefit will only be gained when the Industrial Data Platform covers the whole supply chain and the complete process. Platform Owners will have a critical role in breaking into this cycle.

The major providers of industrial equipment will probably have a vested interest in creating their own proprietary platforms. This will pose a significant dilemma to their subcontractors and large customers, since they will likely serve or be customers of several potentially competing major industrial companies. To deal with this, the concept of **data multi-homing** will have to be addressed. One possible solution is that of Industrial consortia playing the "platform owner" role in specific market sectors such as Automotive, Aircrafts or Aerospace. We expect other sectors such as Finance or Public Sector to also adopt Industrial Data Platforms.

[3]A positive externality is an indirect benefit that is enjoyed by a third-party as a result of an economic transaction.

Ways of working

Automation, communities and digital leadership are radically reshaping the work landscape.

In 2012[4] Atos introduced four megatrends that, in our view, lie behind most of the significant changes the world is experiencing: **Globalization**, **Demographics**, **Economic Sustainability** and **Trust**. Now we are adding a fifth emerging megatrend: **Automation**. Whilst it can be argued that automation has been around in one form or another for centuries, the abundance of historical and real-time data and the means to effectively extract predictive and prescriptive insights are opening the way to previously unanticipated applications of this technology. The new ways of automation will not only dramatically improve the responsiveness and repeatability of processes, they will give rise to intelligent systems that will perform increasingly complex tasks that were previously impossible to conceive.

The strengths of traditional companies are fundamentally based on scarcity of resources, causing value creation to scale linearly with the availability of those resources. Digital technology enables the creation of value at global scale through an abundance of data and non-material resources. Automation, orchestration and web-scale technologies make it possible to achieve diminishing marginal costs, maybe even zero marginal costs[5].

The Internet makes flexible access to large global communities feasible, allowing small core teams within an organization to collaborate on-demand with a large community of users, customers, alumni, vendors, partners, fans and staff. Small core teams could end up being the only fixed part of an organization's employee base, with the majority of existing staff moving to the community (loosely coupled but highly inspired and mobilized), or to the crowd (loosely coupled and involved on an occasional basis). Successful and responsive businesses will need to leverage this **community and crowd**.

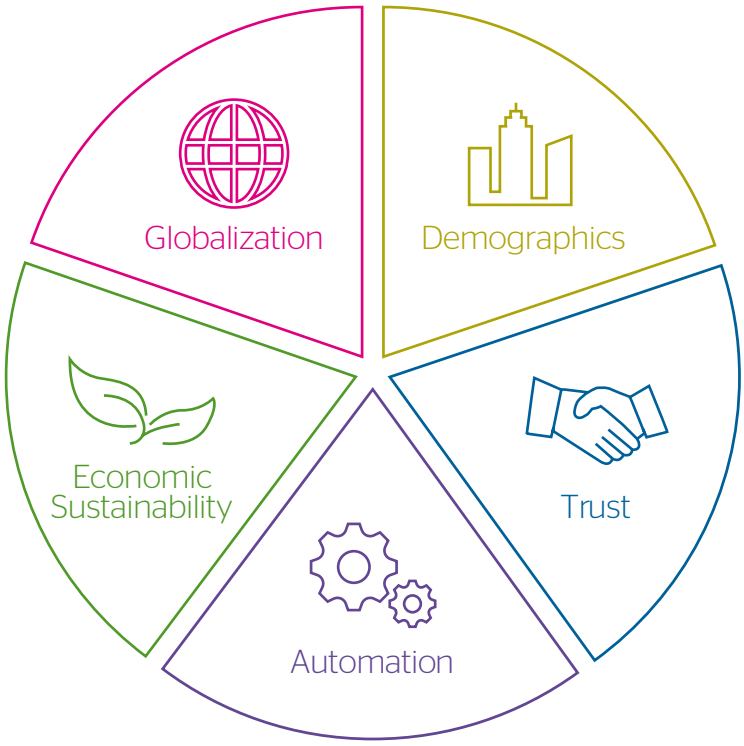


Figure 3 – The 5 megatrends

This transformation will affect all roles and positions, accompanying the existing trend towards flatter **organizations**. As the spotlight on the "value of activity" intensifies, we may be facing a possible economic recovery not accompanied by job creation. Shadow jobs have already disappeared due to the increasing pressure on businesses to maintain growth and profitability. Phony jobs that seem to be maintained solely for political and social reasons and not for business ones, are seen to be redundant even by people who hold them. Many jobs are forecasted to disappear as a result of Automation, and the loss might not be compensated by so-called 'jobs of the future', resulting in net job destruction. Some even forecast a scenario where as little as 5% of the population will suffice to produce the GDP[6] of the future.

[4] Ascent Journey 2016 – Enterprise without Boundaries https://ascent.atos.net/downloadJ2016
[5] "The Zero Marginal Cost Society: The Internet of Things, the Collaborative Commons, and the Eclipse of Capitalism" by Jeremy Rifkin, 2014, St. Martin's Griffin (ISBN 978-1-13728-011-4)
[6] "The End of Work" by Jeremy Rifkin, 1995, Tarcher (ISBN 978-0874777796), and later works by varied authors

Our vision

Careers could in turn become more temporal and opportunity-specific, with labor shifting to a **gig economy** – potentially more unstable but more rewarding. Will labor unions experience a transformation or will they be substituted by other means of protection? If workers' protection decreases significantly, what will be the effect on income, purchasing power and ultimately national GDP? How will we deal with a significant percentage of the population that could become chronically unemployable? Would schemes such as a Universal Basic Income be realizable, beneficial and well-perceived? Would alternatives such as Negative Income Taxes be preferable? These debates will take place in societies where inequality is on the rise.

Machines are playing increasingly important roles in analysis, decision making, planning and strategy. **Humans could end up taking a subordinate role** in certain areas and situations. If the roles of humans and machines start reversing in certain areas, how can wellbeing at work be ensured? What effects would such shifts have on human motivation, autonomy, accountability and team work? Will organizations decide to reserve certain roles for humans for ethical and wellbeing purposes? These discussions will be important for businesses and societies much before the advent of the hypothetical singularity – the point where Artificial Intelligence exceeds human intelligence in being able to recursively improve itself.

Relevant **education** and training will be of paramount importance to meet the seemingly ever changing skills requirements. A solid background in key areas (i.e. computing) will enable people to continually learn and adapt, in contrast to the idea that people must become quickly specialized in very specific topics (i.e. big data). Overspecialization and oversimplification will not suffice.

Disruptive technologies

Connected Everything, Swarm and Artificial Intelligence are disrupting the way we understand and conduct business.

At the core of the computing world, the trend is toward fewer more powerful centers. At the periphery, the trend is towards more powerful and numerous "small computers": smartphones, tablets, wearables, connected things. As a result of these trends, the collective computing capacity in the hands and pockets of people is surpassing that in centralized data centers. These powerful computational shifts are the 'Techtonics'[7] that are going to create and amplify the B2B Digital Shockwaves.

As this range of compute capability in the cloud and at the edge becomes increasingly connected, we will see the emergence of a **Computing Continuum**. One feature of this will be localized and temporal interactions between compute nodes that combine resources to achieve a task greater than can be achieved with those nodes operating in isolation. Much as we see swarms in nature acting as intelligent collectives, the individual limited computing capacity of objects will be complemented and supplemented by their connection to other objects in relevant communities. One example of this **Swarm Computing** would be autonomous vehicles, each capable of acting independently, but also interacting with connected objects around it and to centralized information and control centers to optimize traffic flow and improve safety.

Swarm Computing will emerge as a co-operative interaction between individual entities (including "connected people"), each with their own autonomy, but working together for the benefit of the collective community. It will give rise to the phenomenon of **Social Machines** – connected smart systems that are able to share information and autonomously regulate their performance in a concerted fashion, with the objective of optimizing results, solving problems and mitigating detected risks.

Since 2014 we see increasing numbers of Connected Products, like connected cars, trucks, tires, agricultural machines, household appliances and even clothes. These Connected Products feed back information on their status, performance (e.g. for maintenance) and on how they are actually being used. Connected Consumers can in turn provide immediate feedback about the products and – if they wish – receive real time information and suggestions on the 'journey' they are in.

Real-Time Prescriptive Analytics and **Artificial Intelligence** will have major impact in the automation, optimization and flexibility of connected ecosystems as we head towards 2020. This will be especially so in industrial supply chains as they become increasingly collaborative and responsive to market demands.

These disruptive technologies will start to amplify some of the changes we will see in Ways of Working. **Connected Robots**[8] will be managed and controlled in completely new ways enabled by the offloading of selected processing to the Cloud. Furthermore, they will be able to operate in collaborative Swarms. The same concept can be extended to include completely Connected Production Chains with Connected Production Assets. There will be the potential for remote control centers and technical operation centers that manage several production facilities (for example, drilling multiple oil or gas wells). At the human level, we will see the **Augmented (and Connected) Worker**, who receives relevant information – via wearables or hand-held devices – about the production assets being operated or maintained. A revolution in HMI (Human-Machine Interfaces) could happen in the next few years, moving towards the **Invisible Computer** that supports the Connected Worker and the engagements of workers and customers with systems and with each other via **Interactive Virtual Agents**.

[7] 'Techtonics' as wordplay for (digital) technology tectonics
[8] Atos Ascent White Paper "Connected Robots", November 2012, Simon Elliott et.al. http://ascent.atos.net/?wpdmdl=1066

Evolving challenges

Privacy, labor and cyber-physical security will remain open challenges by 2020, as businesses and societies continue to learn that no technology can fully solve the world's problems.

Evolving challenges are those that we have been facing for some time now – perhaps through ongoing manifestations of underlying global Megatrends – but as a result of other influencing factors, are now presenting themselves in a new light.

A number of the evolving challenges link not to technologies themselves, but to the way that they are used or perhaps abused. The last few years have witnessed the appearance of **Technosolutionism**, a failing vision of technology being the answer to the world's problems. With such a perspective, key human problems can be superficially addressed with over simplistic digital solutions, which tend not to solve the underlying problems, and may even exacerbate them. This trend has been notably denounced by Evgeny Morozov[9].

Privacy and **Personal Data Protection** debates will continue as the needs, wishes and expectations of stakeholders (citizens, governments and businesses) evolve. Citizens have been unhappy with some monitoring actions of governments but are also willing to tolerate certain measures against risks like terrorism. As consumers, citizens have shown more tolerance towards private companies' use of their personal data, often expecting an advantageous access to products and services in return. It is not clear to what extent consumers are aware of the amount and nature of personal data they are giving away – with unintelligible and obscure EULAs (End-User License Agreements) being part of the problem. Controversies and legal actions are on the rise in the case of citizen-versus-citizen disagreements. Some companies are already providing digital vaults and digital graveyards to facilitate the right to be forgotten.

Ethical debates in society and business are likely to gain momentum by 2020, due to two main drivers: structural changes (a necessity in the current economic and financial crisis) and technology-driven changes.

Many countries are reaching the highest levels of wealth and income inequalities in many decades. The trend is growing, leading to a number of wealthy individuals forecasting grave social problems if the trend is not reversed. The rise of a strong and numerous middle class in emerging economies, increased mobility of people at a global level and the full digitalization of businesses are all factors that can help balance such trends, but not without hiccups. Furthermore, such balance can be reached only in average terms – inequality will still remain.

The demographic pyramids of different areas are markedly different and in opposing evolution (ageing vs renewing societies). **Migrations** are expected to play a more prominent role, due to transfers between regions of different demographics as people look for better opportunities, flee from conflicts in their native soil, or escape the effects of **climate change**[10] (droughts, natural disasters, famines). Migrations may cause tensions in a world where geopolitical friction and the threat of terrorism lead to increased protectionism and border controls. In the case of terrorism, **major cyberattacks** could also take place by 2020, especially those dangerously bridging the cyber- and physical worlds, such as the Ukrainian power grid hack of late 2015.

Machines make more and more decisions on their own. But if a driverless car's decision caused an accident, who would be responsible? The passenger? The car manufacturer? The company who developed the software? Legal and insurance implications are yet unresolved. Then there are the growing ethical challenges raised by the application of digital technologies in the **Life Sciences area**. Which kind of decisions will be acceptable and which not? Which will be for the person or family to decide, and which will be reserved for physicians? What if some of those medical decisions are in turn being made by machines? Beyond 2020, further technology disruptions (nanotechnology, bioengineering, genomics, metabolomics, etc.) will only strengthen the need for such ethical debates.

In order to avoid Technosolutionism, the right questions must be asked: what are the actual problems, in all their complexity, to be solved by technological means? How can society make better use of technology for the benefit of most? What are right and wrong uses of technology, considering cultural implications in a global world?

[9] In books such as "To Save Everything, Click Here: The Folly of Technological Solutionism" , 2014, Publicaffairs (ISBN 978-1610393706)
[10] The effect of Climate change has been seriously considered in 2015 by politicians (COP21 Conference) and investors (see BlackRock's "The Price of Climate Change: Global Warming's Impact on Portfolios")

Forces that drive continuous transformation

These emerging and evolving research topics will play a major role in business in the Digital Shockwaves context.

In 2020, data will continue to play an ever increasing role in determining business value and shaping business transactions. **The Economy of Data** described in Journey 2018 will increasingly extend to the B2B world, driving a new emphasis on enterprise collaboration. **Data sharing platforms will become the driving force for a new "Economy of Platforms"** that enables informed and orchestrated supply chains, delivering **Smart Services** and highly market-reactive products. These platforms will collect, share and analyze the whole spectrum of data sources pertinent to a given production ecosystem, allowing it to automate and optimize the production and operation of all its products and services.

The Economy of Data Lifecycle will thus become:

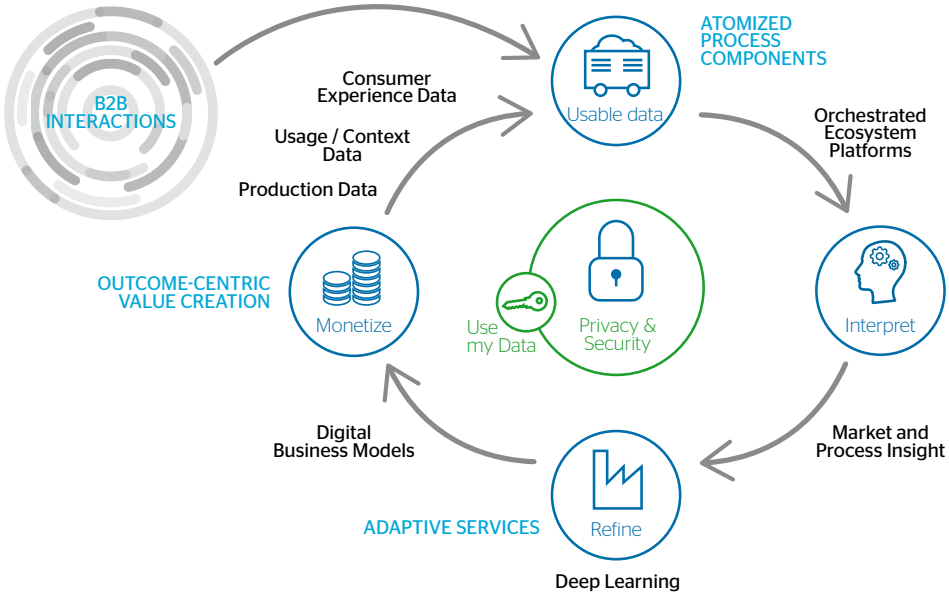


Figure 4 – The Economy of Data Lifecycle

The cycle starts with the collection of Production Data from automated factories, Usage Data from connected products and finally Consumer Feedback Data. Respecting the rules of privacy and ensuring security, this data will be made available for a range of Analytics use cases. Predictive insights will be gleaned for operations management and maintenance optimization; and prescriptive intelligence will assist with automated decision making – with or without additional human intervention. The "Next Digital Revolution in Industry" will allow reduced time to market, with increased flexibility and efficiency along the entire supply chain.

The Atos Scientific Community has conducted research into a number of emerging and evolving topic areas. Each of these is expected to play its own part in the Digital Shockwaves that will be experienced as we head towards 2020. Although we can expect complex interplays between the sources of digital disruption, we will align our 19 tracks of research with the 4 categories described earlier.

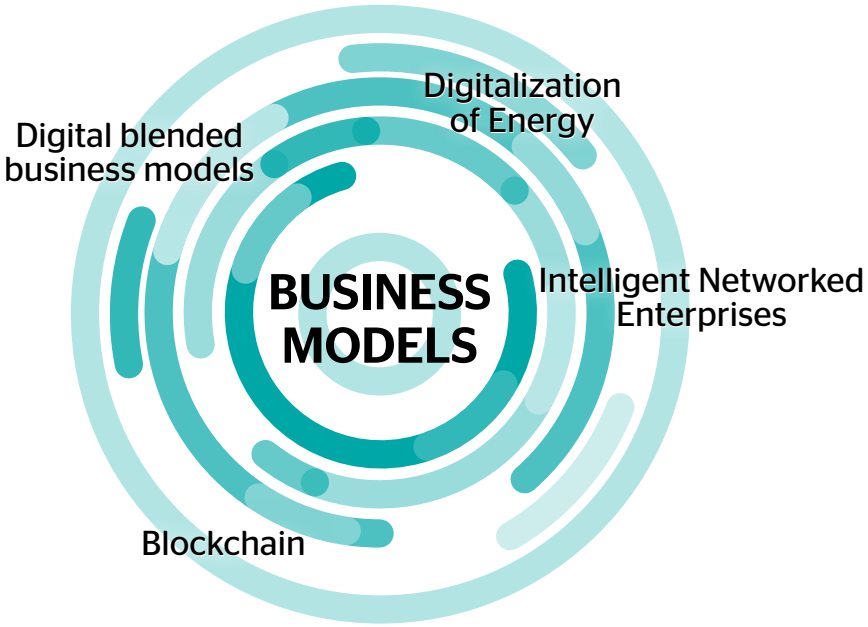
Finding new markets & revenue streams

The increasing importance of the Economy of Data in a B2B context will result in greater interaction between cross business processes. This will give rise to **Intelligent Networked Enterprises**: ecosystems of capabilities that are able to collectively adapt to market requirements, initially reactively, but eventually proactively. We will see flexibility not only in production facilities, but also in the employee skill base with the rise of the so-called "Gig Economy" helping to ensure the right talent is deployed as required.

New **Digital Blended Business Models** will emerge that are able to reflect an evolving mix of traditional and digital economies. Such models will encompass the approaches we already see within multi-sided markets in the B2C world, but will become much more sophisticated as they look to protect individual player's Intellectual Property and ensure fair value distribution along supply chains.

We will see certain markets continue to grow in complexity e.g. as power generation and distribution becomes increasingly disaggregated; we will see the **Digitalization of Energy** through predictive and adaptive control networks that balance supply, demand, cost and sustainability factors. Related business models will continue to evolve in response to the multi-faceted prosumer market challenges.

Traditional means of establishing trust when transacting business in dynamic supply chains will prove inflexible and ineffective. As an alternative, technologies like **Blockchain** may offer completely new means of enforcing and verifying "contractually binding" exchanges in essentially trustless business relationships. Centralized, intermediated and fragile-by-design mechanisms will be substituted by cryptography-secured public ledgers of transactions that are verified by network consensus.



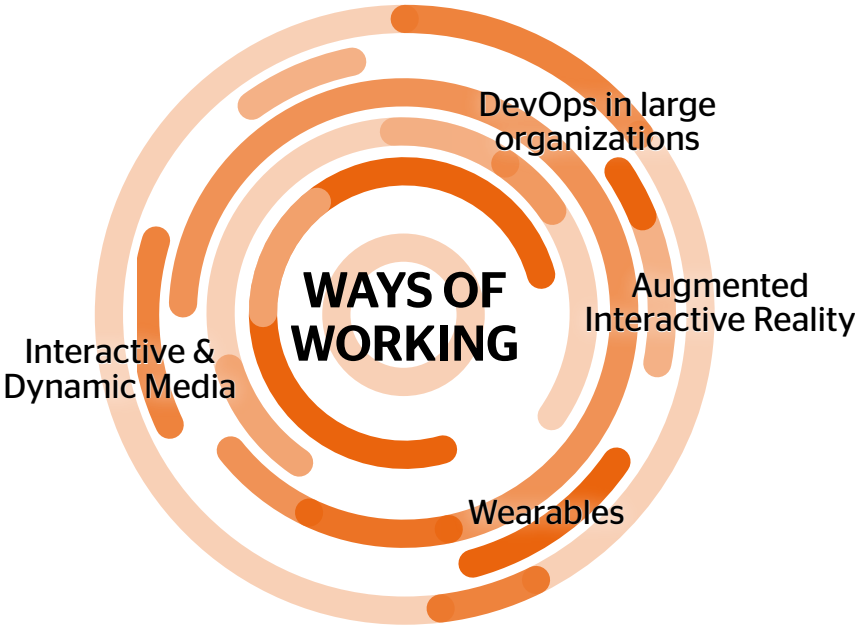
Collaborating with people, machines & virtual beings

Disruptive technologies are changing not only the things we can do, but also the ways that we work. The workplace of the future is virtual, collaborative and flexible. The divide between personal and working life becomes increasingly blurred and our interactions with both become more immersive.

User Interfaces are gradually evolving to extend to more senses than just sight, with the inclusion of sound and touch in haptic interfaces. Gaming and other entertainment technologies are enriched to deliver increasingly immersive experiences and **Interactive Dynamic Media** are in turn applied to business contexts through **Augmented Interactive Reality** and **Wearables**.

With the potential for fully contextualized and connected working, the scope of tasks that can be performed by relatively unskilled workers will expand considerably. Real-time collaboration with real and virtual subject matter experts will transform working roles from industrial maintenance engineers to plant operators and even doctors.

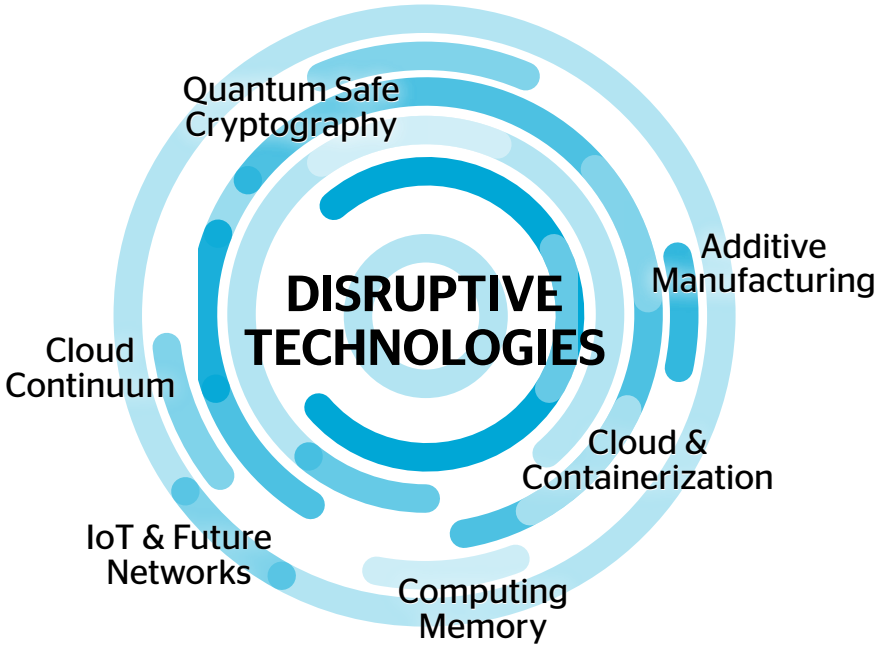
We are already seeing disruption in the ways that IT applications are developed, deployed and operated. Regular code releases driven by incremental addressing of specific business requirements, is unleashing a new found agility in innovation. **DevOps** will increasingly be the means of achieving agility in the full application lifecycle (development and operations) - even for large programs of work. Agile principles will be overlaid on top of the management of legacy infrastructure and application environments to help mitigate the risk from the growing chasm of responsiveness disparity between "digital" and "legacy" IT deployments.



Mastering the technologies of disruption

With 50 billion connected objects expected by 2020, the **Internet of Things** and **Future Networks** will lead to incredible disruption. Connected objects will act both as sensors and actuators, with gateways controlling data flows to ensure real time or near real time performance within a fully distributed architecture. Depending on the specific business use cases, data will either be processed in a distributed manner by algorithms hosted in hybrid clouds, or be processed locally using algorithms hosted within or close to the connected object. We shall face a new **Cloud Continuum** that extends from vast centralized data centers to a huge array of edge devices. The increasing levels of compute capacity deployed in mobile devices and the Internet of Things will ultimately lead to the ability of connected objects to self-organize and configure according to changing needs - we call this **Swarm Computing**.

Such dynamic and responsive interaction demands real-time prescriptive analytics that will at least in part be delivered by local gateways, sensors and actuators. New **Computing Memory** architectures will bring together both the processing and storage of data in a single processor, significantly increasing computational performance whilst reducing energy requirements.



Managing and protecting such a disparate and distributed compute environment will present significant challenges. **Containerization** of applications or platforms will be a means of transforming the way that compute workloads are deployed, managed and secured. They will facilitate orchestration within hybrid cloud environments, supporting the "atomization" of workflow elements such that processes can be easily adapted to changing demands whilst at the same time ring-fencing security risks at a very granular level.

We will experience significant disruption throughout entire manufacturing production chains as **Additive Manufacturing** (industrial 3D printing) comes of age. This exciting technology will enable fully digitized product lifecycles, offering lower development costs, shorter lead times, reduced energy consumption during manufacturing and less material waste. In some cases we will see a shift from mass production to full customization, and from centralized to distributed production. The more general sphere of robotics will be similarly disruptive, whether this is in areas of physical robots delivering configurable manual task automation or whether we consider virtual robots exhibiting artificial intelligence insights in all manner of use cases ranging from IT service desks, to financial advice and medical diagnostics.

Finally **Quantum Computing**, which is expected to create a massive disruption in the medium term future, is likely to firstly impact the security arena. Today's highly secure data encryption could become easily crackable using certain quantum algorithms. Businesses should start preparing for this disruption now, by implementing strategies for **Quantum-Safe Cryptography**.

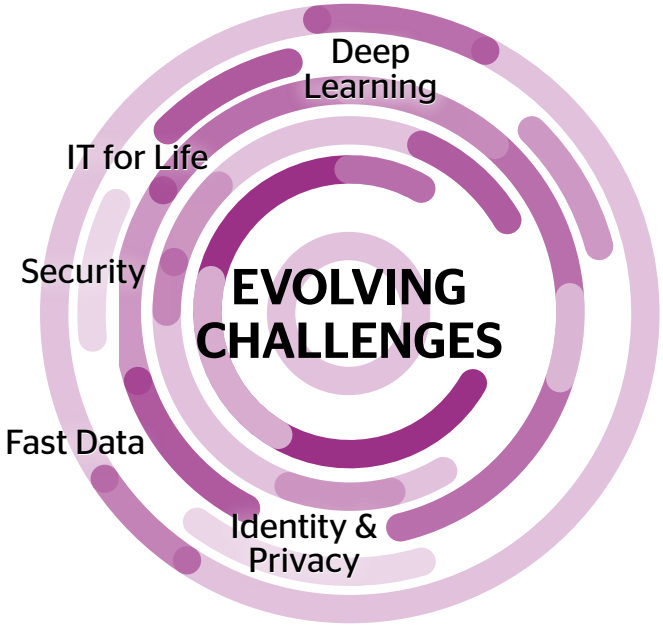
Addressing ever changing challenges

Evolving challenges include those areas that are not necessarily new, but are ones where it seems that the goalposts are continually moving, impelling us to deal with them in radically different ways.

Advancements in medical technology and food production technology for example, are creating all kinds of new possibilities, but with these come a whole set of moral and ethical challenges that must now be factored into our considerations of **IT for life**.

The value of data is well understood, but the rate at which data is now being produced and the increasing diversity of sources are bringing new challenges to the area of analytics. Particularly as it advances to bring predictive and prescriptive capability, we are faced with the challenge of **Fast Data** and the ability to analyse data streams in real time. At the other extreme we have the challenge of **Deep Learning** as we look to exploit an ever increasing pool of data, using machine learning and algorithmic searching to unlock otherwise hidden insights.

Identity and Privacy and **Security** are no strangers to our Journey series thinking and yet they continue to evolve both in their nature and in the technologies that are deployed to address the challenges they present. With a move to increasingly collaborative working between potentially trustless parties and with the promised advent of high disruptive technologies like Quantum Computing, these topics are more relevant and impactful than ever.



Anticipated consequences

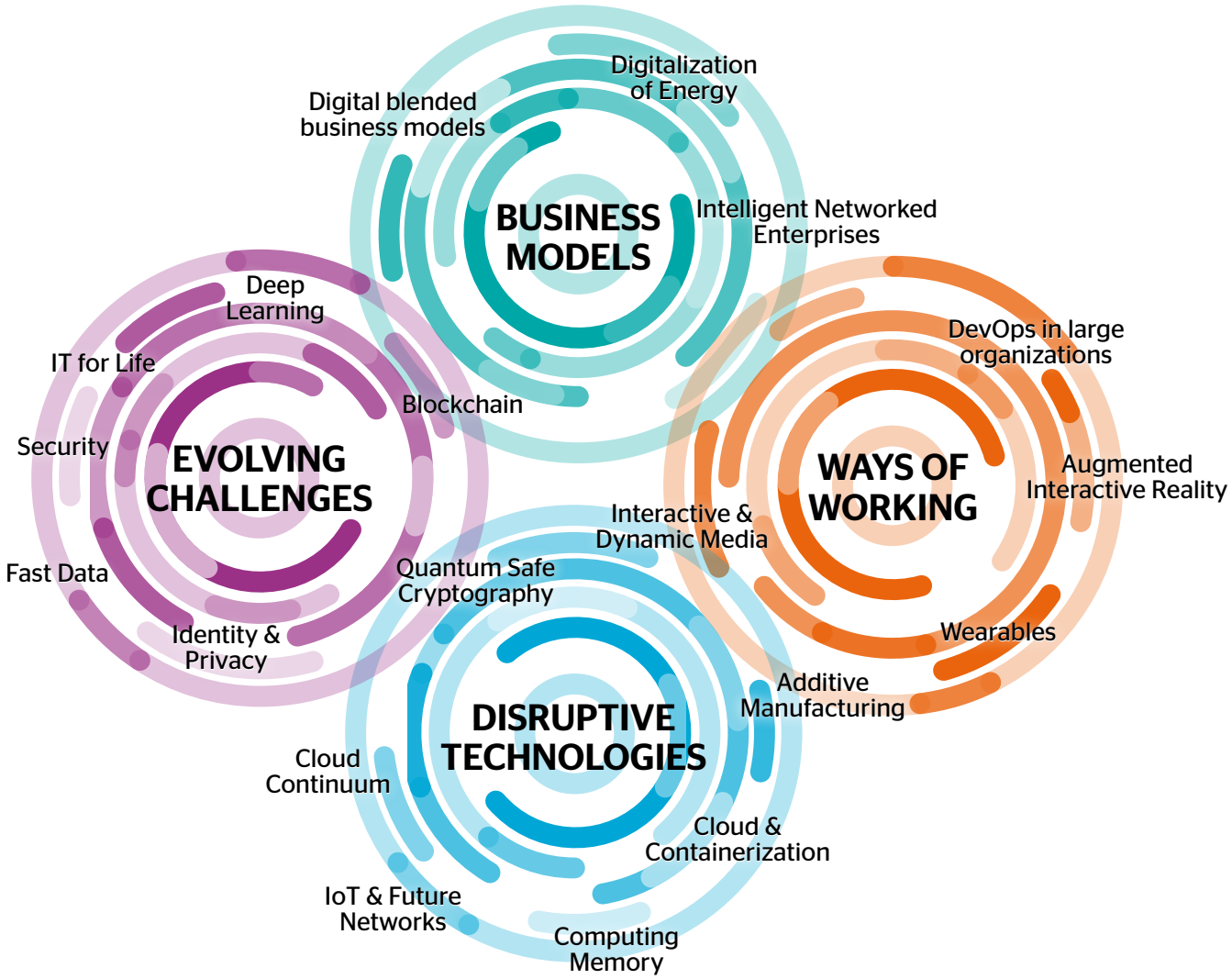


Figure 5 – Mapping between Journey 2020 topics and the four areas of disruption

If making predictions has always been a risky affair, it borders on the naïve to attempt to accurately predict the combined impact of the Digital Shockwaves emanating from these four areas of disruption. What is clear however is that the impact will not be a one-time event, **businesses must prepare for successive waves of change** – some will bring severe challenges, others incredible opportunities. Those businesses able to anticipate and react to the shockwaves in the context of their specific industry will be those that will take a leadership role in the digital era.

In the rest of this document you will find details on the specific areas of disruption and technical advance that have been referred to above. Consider each one in the context of your area of operation and see how they will play a role in your journey towards 2020.

1. Business models

Intelligent networked enterprises
Digital blended business models
Digitalization of energy
Crypto-currencies & Blockchain

Intelligent networked enterprises

In 2020 almost every process, product and/or service will become digitally enabled, which will lead to the creation of an information enabled economy, offering enormous opportunities that the business world hasn't seen before. Enterprises have to truly understand and internalize the economic data life cycle as described earlier in 'Dealing with Disruption'. Doing so will help identify opportunities to transform their internal business, supply chain and innovation processes; leading to improved and new products, services and business models.

It requires a redefinition of corporate strategy on the one hand and the explicit use of data and technology on the other, combined with a vision of how to add value in a more business ecosystem driven world.

In 2020 intelligent networked enterprises, organised in business ecosystems, will make the B2B world thrive.

Organization impact

Organisations need to become more "intelligent". Analysis of production data derived from software and hardware sensors will predict and prescribe both tactical and strategic outcomes. These will be presented at the appropriate level using operational dashboards that help empower employees to take the right decisions and actions. Those dashboards are connected, from specific operations to aggregated leadership dashboards, creating a transparent and data driven enterprise for intelligent and connected decision making on all levels.

Work will become less and less routine through the automation of processes that are repetitive or predictable. This will shift organizational needs to employees who possess and master more non-routine skills. I.e. typical human skills, like creativity, interactive problem solving or cross functional collaboration, leading to team formation, collective learning, innovation and taking ownership.

To free the full potential of those employees and reach the level of agility required, seizing the opportunity to establish (ad hoc) bottom up and top down networks combined with strategic direction setting is key. Employees need the opportunity to decide for themselves, within the boundaries of their capability, where they can deliver the most added value. They can achieve this by **swarming together in transient, purpose-driven working groups** that form internal and external networks, sometimes with the involvement of the open crowd, to address challenges and opportunities collectively, whilst concurrently keeping the current business running. Adopting this **micro-entrepreneurial mind-set** is the responsibility of all.

To ensure employees are collaborating in the right direction, **a connection between organizational, team and individual employee objectives and measurable results has to be established.** Objectives and key results are set by every member of the organization, from top management to the shop floor. These are derived from the mission statement, strategy and corporate values and are completely transparent for all organizational members. This allows every employee to clearly understand what is being expected of him/her, what can be expected of their colleagues and where the uncovered opportunities to deliver the most added value lie. We term this the **'Intelligent Networked Enterprise'.**

Technology impact

A prerequisite for an 'Intelligent Networked Enterprise' is an open platform that facilitates synchronous and asynchronous human to human, human to machine and machine to machine communication and collaboration. This implies an IT architecture which provides agility, speed and ease of use for development with a highly scalable infrastructure, making use of an API ecosystem. On top of this API ecosystem, end users must have the ability to craft their own workflows and data analysis in a user intuitive manner. The most likely candidate to fulfil this role is a **Workplace Communication and Collaboration** (WCC) solution; one that is designed from a user centric perspective with easy integration in mind. The core technology stack of WCCs is built for integration, by making use of API's and leveraging their own and other micro services architecture(s). WCC platforms become the information hub and work stream engine for end users, by connecting, enhancing or replacing systems of engagement (email, Unified Communication, ESN, etc.), systems of record (ERP, ECM, Big Data, etc) and systems of operation (IoT, machine data, etc.). WCC platforms will evolve to **Digital Workplace Platforms**, the technology foundation for an 'Intelligent Networked Enterprise'.

Market impact

Organizations had traditionally two strategies for growth and market success: they built the required capability and capacity internally (organic) or they grew through acquisition (inorganic). There is however a third path to growth: **leveraged growth**. An enterprise creates leverage by connecting external complementary resources, building on solid business relationships and as a result, creating a business ecosystem. All parties involved are able to grow and innovate faster, in a more capital efficient manner. In other words, business ecosystems enable the translation of the sharing economy from the consumer to the B2B world. The principals of the sharing economy will give rise to **"Common Industrial Data Platforms"** where a business ecosystem of supply chain partners will share design, production, operational and market data to craft better and new products/services together based on (foreseen) market demand.

Employees of different partners within a business ecosystem will flock together, based on insights derived from their Common Industrial Data Platform, in an **'Innovation Value Web'**, a temporary purpose driven, inter and mostly virtual organization form, to make innovation happen. Innovation value webs have in their nature a better understanding of the supply chain through the combination of the specific knowledge and experience of the organizations involved. This results in improved operational and customer excellence, for themselves and the business ecosystem as a whole.

A requirement for achieving these benefits and for ensuring successful cooperation in the business ecosystem is strategy alignment, trust, openness and connectedness on leadership and involved employee level, thereby supported by an integrated business ecosystem communication and collaboration platform, offered by a common and integrated Digital Workplace solution.

Markets in 2020 will be increasingly dominated by **'Intelligent Networked Enterprises'** cooperating in business ecosystems, leaving less room for traditional large scale enterprises, because they cannot compete with the agility, innovation power and growth acceleration of those fully networked organizations.

Conclusion

B2B companies have to become more data driven to be prepared for the digital shockwaves which are propagating from the B2C world. Organizations have to become intelligent and networked, internally, and externally in business ecosystems, thereby transforming the way they operate.

IT offers business ecosystem members the opportunity to combine all of the different data streams from the ecosystem participants in **'Common Data Platforms'** in order to unleash synergy to improve production across the value chain and foster market innovation with more impact, less cost, resulting in more beneficial growth for all.

To ensure success, **seamless communication and collaboration** within the business ecosystem is a necessity. This will be enabled by a common Digital Workplace solution accessible to all involved employees within the business ecosystem.

In 2020 'Intelligent Networked Enterprises' organized in business ecosystems will outperform the competition, by capitalizing on their combined data sources and cooperation power to innovate and deliver faster with better results than the more self-centered organizations.

B2B interactions will become increasingly data driven, dynamic and intelligent with networks emerging around common Industrial Data Platforms.

Digital blended business models

How to discover the digital competitive advantage.

In the last decade, new and disruptive digital business models have rapidly risen to prominence in B2C interactions. As examples, Uber's and Airbnb's business platforms have enabled the monetization of under-utilized 3rd party resources at marginal cost, putting significant pressure on traditional taxi and hotel businesses. However, many digital customer interactions are also dependent on end to end supply chains that incorporate more traditional B2B interactions. To maintain the agility and flexibility with which services are delivered to end customers, B2B services will need to support highly responsive product lifecycles.

Data and the inherent value of the insights that it brings, continues to play a key role in digital service optimization and as the marginal cost and latency of sharing data decreases, the data lifecycle described in Journey 2018 will be traversed ever quicker.

We believe that those traditional businesses that are most successful in "digital engagements" will be those with the capability to blend existing capabilities with new digital business techniques.

Realizing digital advantage

Pure digital business often requires less capital expenditure, relying instead on IT platforms and data intermediation for success. Flexible operation and marginal costs close to zero enable digital businesses to tap into global markets with initial "below cost" pricing to stimulate multi-sided market network effects. Yet, several of the underlying approaches used by pure digital businesses can be successfully applied to existing traditional ones to help accelerate their digitalization:

1. **Digital businesses have lower, more flexible cost bases.** Pure data driven business have minimal material costs - Capex is often limited to Information and Communication Technologies (ICT) or office infrastructure. Traditional businesses can embrace the transition to "as a service" procurement, whilst at the same time having a much better understanding of the business rationale for capital investment - giving a competitive advantage when investments cannot be avoided.

2. **Digital business techniques enable business simplification.** Business process digitalization and automation helps realize additional productivity, repeatability and cost reduction, taking traditional enterprises to the next level of operational excellence and customer experience.

3. **Digital business brings significant competitive advantage through connecting markets and undercutting prices though cross-subsidization.** Digital or data driven business models are changing the boundaries of markets. This can isolate traditional players and severely test the loyalty of their customers. By aggressively entering connected markets, traditional players can avoid losing market leverage. Traditional businesses are not inevitably disintermediated from the digital world as was feared during the first wave of internet business; it is simply that a different form of market engagement is required.

4. **Digital businesses learn fast via a trial and error culture:** In general, digital businesses profit from a trial and error culture, while cultural inertia and risk aversion within traditional businesses can make change difficult. The transformation from traditional to blended business will require a significant culture shift, but is absolutely achievable.

[11]Marketing budgets seem to be the exception in this comparison of cost advantage since digital businesses are younger than traditional businesses. Quite often, advertising and marketing budget exceeds the implementation and operations budget.

Digital blended business: the how

1. **Make it part of your business strategy process to consider digital revenue models:** It is not just a question of universal digitalization at all costs - A digital market unit should look at the competitive forces on the business, as adapted from the well-known Industry Competition Model from Michael Porter:
   a. **Customers experience** can be enhanced when you understand their behavior better through digitalization.
   b. **Supplier collaboration** can be enhanced by participating in market platforms that help generate larger market share.
   c. **Reactiveness** of new digital entrants can be counteracted by the suitable use of alliances.
   d. **Innovation should be considered as a continuous improvement lever**, making substitution more difficult.

2. **Adapt your company organization (agility, DevOps methods, autonomy, ...):** Traditional businesses spend a great deal of effort minimizing risk based on old fashioned, slow processes, while digital businesses have a culture of designing fast feedback loops to quickly identify and implement requirements. The combination of traditional and digital business approaches can deliver the advantage needed to stay ahead, but again require a significant cultural change.

3. **Innovate digital services:** After enhancing your existing business by applying digital principles the next natural step is to invent and introduce your own new digital services.

4. **Co-creation of digital services:** The final step is the co-creation of new services with customers and business partners.

For these levels of digital business, you need to understand your data ecosystem and think 'digital added value' along the entire value chain. In essence this will turn closed business organizations "inside out", transforming them into networks driven by new and more transparent forms of value and risk distribution. Companies that are more market than cost driven will find this easier and might have already decided which model to pursue (see figure 6).

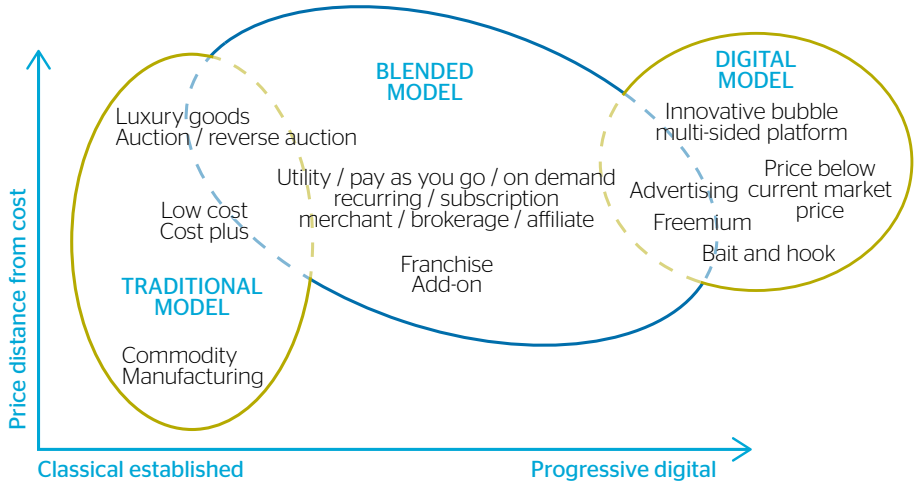


Figure 6 – Clusters of business models

The Blended Future

In the next 3-5 years the digital / traditional business equilibrium will be reset. Many traditional industries will undergo regular M&A shifts. Data will become increasingly commoditized, data sources will be easily acquired and algorithms will derive substantial new value. As products turn into services, commodity businesses will become fully automated ecosystems – from negotiation to delivery. New B2B platforms will emerge, ensuring risk sharing and a more efficient value distribution. In many markets this will lead to spot pricing and highly personalized/ targeted pricing based. Analysis of downstream ecosystem data will allow the optimization of both product features and supply chain speed. Companies need to learn to handle the schizophrenia of collaboration AND competition.

Digitalization of energy

Digital shockwaves in energy models

If there is a field where the "Digital Shockwaves" will be profoundly felt, and with long-lasting effect, that is Energy. So far in human history, **economic growth has been closely linked to energy consumption**, and consequently to its undeniable negative environmental impact. Long term sustainability goals demand that we reduce this coupling as much as possible.

One key element to achieve this is the accelerated evolution towards a new energy model, based more and more on true decarbonized energy production. It is driven by the combination of more mature distributed renewable energy sources (mainly, solar and wind), emerging energy storage technologies, and the deep **enhancements in control that ICT bring to energy networks**. However, this accelerated change also raises negative aspects, such as the ever growing complexity of the future interconnected energy networks which also increases their fragility. Cyberattacks have already shown that essential supply can be severely disrupted.

Most importantly, the new energy model creates important challenges to the business of existing energy companies. They have to adapt to a more demanding and active customer ("energy prosumer"), who because of their micro-generation capabilities, expects more advanced services and a deeper interaction well beyond a barely informative monthly bill. Energy companies have to cope simultaneously with the change in energy sources and the diminishing margins in their traditional core business: a combined trend that for some authors anticipates potential "energy for free" scenarios[12]. Incumbents also have to confront new, nimbler and more agile "outsider" competitors, exemplified by solutions like the Tesla Powerwall[13]. Finally, they have to comply with stricter national and international regulations, about security, trust and environmental responsibility, with more to come from the Paris Climate Conference, COP 21. Reinvention of their business models, delayed for a long time, is now a pressing necessity.

Energy networks reimagined

Business reinvention starts at the bottom, with profound changes in how energy networks are controlled. They will evolve towards a fully distributed energy network model, combining traditional "centralized" sources with widely decentralized renewables. They will require distributed control and intelligence, including predictive and prescriptive analytics capabilities in all the nodes. Long-term network supervision will evolve towards an overarching model, combining information and control at different scales (continental, national, regional, local and in-building), which we could call **"Fractal Grid Supervision"**.

Network and energy source complexity will increase demands for proper design, requiring use of **High Performance Computing** (HPC) for tasks like high-resolution grid simulations or the optimization of oil & gas production in existing reservoirs. Security will increase its importance even more, as energy networks are life-sustaining infrastructures. The huge "attack surface" of the new networks demands a new approach to cybersecurity, combining security "by design" with distributed, analytic-based behavioral threat detection.

For operational maintenance, new energy networks will demand optimized field operations, delivered by expert workers that make extensive use of **context-aware "augmented" technologies**. For example: the combined use of secured mobile and wearable devices, integrated with other IoT networks; knowledge at the field provided by Enterprise Social Networks through Augmented Reality; and the cooperation of different types of robots and drones.

EMERGING ICT FOR ENERGY

- "Fractal" Smart Grid
- Robots & Drones
- Fog/Edge Computing: Distributed SCADA
- Blockchain for Distributed Energy Resources
- Big Data–HPC integration for Smart Grid
- Cognitive Computing for Energy Analytics
- Teleremote Field Support
- Field Worker of the Future: AR, VR, Wearables, IoT
- "Two-Speed" Energy Companies
- Distributed Prescriptive Analytics in the field
- Additive Manufacturing for Energy Infrastructures
- Multi-sided Market Services for Energy Prosumers
- Distributed Behavioural Cybersecurity
- Identity Management in IT/OT
- Sustainable Connected Home
- Web of Systems: Convergence with other Smart-Infrastructures

[12] Jeremy Rifkin, "The Zero Marginal Cost Society", 2014
[13] Tesla PowerWall homepage: https://www.teslamotors.com/powerwall

Business model reinvention

For the interaction with their more digital-savvy customers, Energy companies have to better embrace the rules of the **new Economy of Data**[14]. They have to implement innovative energy-related services with third parties that exploit the concepts of Multi-Sided Markets in B2B2C and B2B scenarios. For example, Energy companies may partner with facilities management and consumer goods companies to provide energy efficiency services for homes and buildings, based on the **combined information from domestic IoT devices and Smart Meters**.

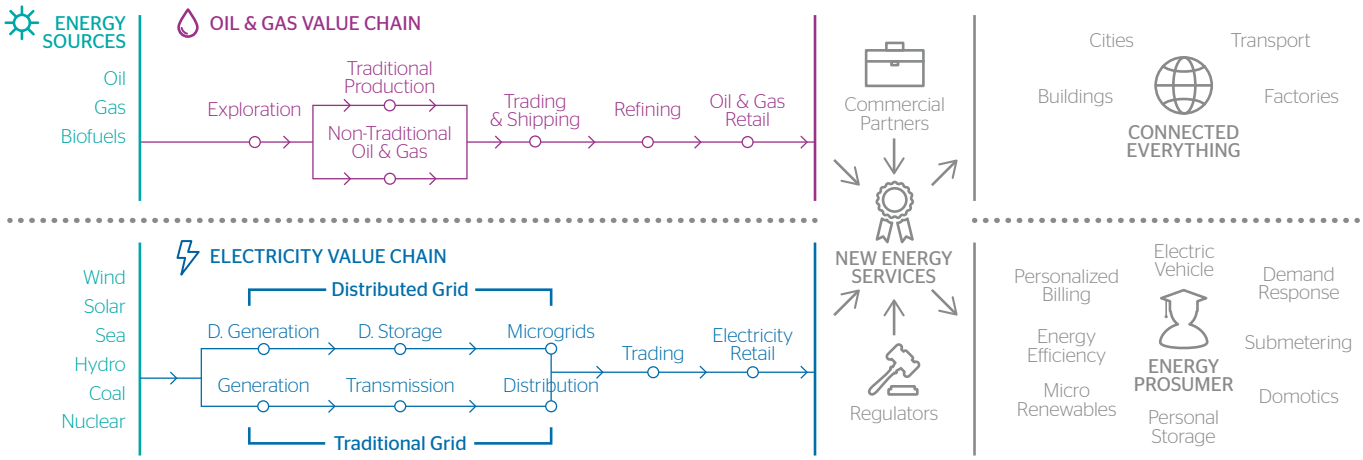


Figure 7 – The Digitalization of Energy

There are also plenty of business opportunities that may come from a stronger interaction with other **smart infrastructures** (Cities, Buildings, Factories, Transport) enabling new use cases, like energy optimization for Industry 4.0. Another interaction that can be enhanced is the relation with regulators, with approaches like **"evidence-based regulation"** where simulation and analytics may help "validate" complex regulations before they get fully enforced.

Environmental & business sustainability

Combined, all aspects of the Digitalization of Energy mentioned before have a clear impact, as studies by international groups have shown[15]. Not only environmentally, by reducing greenhouse gases emissions (estimated at 1.8Gt CO2e or 15% of all sectors studied), but also by providing additional revenue (estimated at US$ 810 Billion) to energy companies. To attain this, Digitalization of Energy can help improve margins by achieving higher levels of operational excellence, while at the same time increasing revenue with innovative energy-related services driven by new business models.

And all this without forgetting the essential target from a societal viewpoint: achieving concurrent environmental and economical sustainability of **digitalized Energy Value Chains** is fundamental for global long-term civilization progress.

[14] See the "Digital-Blended Business Models" section in this document
[15] GESi SMARTer2030 report: http://smarter2030.gesi.org/downloads/Chapter_Energy.pdf

Crypto-currencies & Blockchain

In the world of ubiquitous connectivity and peer to peer interactions, the challenge of establishing and maintaining trust, security and privacy has never been greater. As the digital revolution drives the potential for increasingly disaggregated supply chain processes and relationships, there is a growing demand for **a new approach to managing the integrity of business transactions.**

A new model for trust

In 2008, the **Blockchain** concept was presented as a means of establishing trust between essentially trustless transacting parties - It became the underpinning protocol for the somewhat notorious crypto-currency Bitcoin. Within established Financial Services institutions there was much initial skepticism around Blockchain and crypto-currencies generally, largely due to their lack of regulation and their association with various black market activities. However the subject of Blockchain is now firmly on the agenda of almost every major Financial Services institution and is seen as the potential means of completely transforming existing banking processes, removing an estimated $20Bn a year from payment and compliance costs. It is even being hailed by the World Economic Forum as **an emerging Mega-Trend**.

Within the Economy of Data, it is clear that certain data assets will be transacted in a similar way to regular fiat currencies. A means of establishing **smart contracts** that validate such transactions is therefore required. Blockchain could be at least part of the answer and therefore applied in almost every industry from Manufacturing (for the authentication of supply chain transactions) to Media (for Digital Rights Management). Furthermore, as **transaction ecosystems** within the Internet of Things evolve, establishing trust between essentially trust-less entities will become critically important.

An immutable public ledger

Blockchain is a public ledger of transaction blocks that are verifiable and auditable against an agreed protocol. It is cryptographically secured and distributed amongst a consensus driven network of users. The "committing" of transactions to the ledger requires "miners" to validate the appending of a new block chain to the end of the chain in accordance with a "proof" protocol. The transactions can reflect simple asset transfers or more complex self-executing conditional contracts.

The Bitcoin Blockchain uses hash calculations in a "Proof of Work" scheme that makes it both difficult and costly to mine new blocks, but also virtually impossible to change the contents of the chain. Other Blockchain variants propose "Proof of Stake" schemes, where users' mining rights are dictated by the size of their currency holding. Both schemes have their strengths and weaknesses.

The attraction of Blockchain is largely due to the core principles upon which it was built:

- **Trustless**: The Blockchain protocol enables transactions between parties who have no previous relationship or trust.
- **Distributed**: The Blockchain is copied to and validated by many peer nodes.
- **Peer to Peer**: There is no central authority involved in transactions and therefore no intermediary charges.
- **Immutability**: Cryptographic security and peer community consensus means little chance of fraud, manipulation or coercion.
- **Open source**: No single entity can control the protocol to its advantage.

Data is an emerging currency. We need a means to secure its value even in distributed and essentially untrusted ecosystems.

Blockchain technology challenges

For all the strengths and opportunities, there are a number of potential challenges that need to be considered:

- **Sustainability**: "Proof of work" Blockchain mining requires significant and costly compute power. Miners are currently rewarded for their efforts, but the point may come where the reward does not justify the cost of mining.
- **Volatility**: Bitcoin valuations (e.g.) have proved to be quite volatile compared to major fiat currencies. Should the value crash, perhaps as a result of security breaches, disruptive regulation or loss of confidence, Blockchain may cease to be mined and would fail.
- **Integrity**: Blockchain relies on highly secure cryptography to maintain its integrity. Emerging technologies like Quantum Computing could render current cryptographic schemes powerless to brute force attack.
- **Capacity**: There are current limits to the transaction volumes that can be handled by certain Blockchain schemes. This may limit their viable use cases.
- **Lack of governance and protection:** Currently, in the case of the public Blockchain, there is little or no protection for users who require some kind of transaction refund or compensation. If Blockchain is to be used to facilitate transactions in regulated industries, this will need to be addressed.

The concept of **"Private" Blockchains or Sidechains** can help address some of the challenges outlined, but depending on the approaches adopted, these may require compromises to some of core principles. As an example: A private Blockchain could be used by a single entity to hold a ledger of transactions specific to its products and services – the ledger might still be distributed to a consensus driven peer network of interested parties, but the mining process could be managed by a central "admin miner" to guarantee capacity and sustainability and facilitate governance. It is also possible to foresee consortia of [otherwise] competitors establishing **"Community Chains"** to address a specific market requirement with a tailored set of protocol and process overlays.

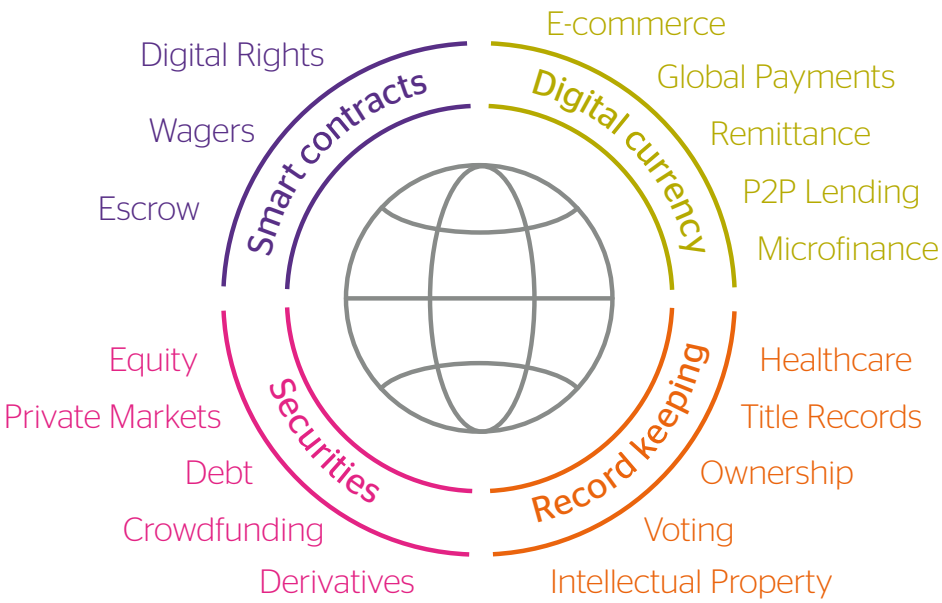


Figure 9 – Example use cases for Blockchain technologies

It is anticipated that Blockchain and its derivatives have the potential to become a primary means of authenticating any business process transaction.

Conclusion

Interest from banks, governments and industry is gaining momentum and driving investment in this technology – If the necessary levels of governance can be appropriately applied there could be an opening of the flood gates in the practical use cases. It is anticipated that Blockchain and its derivatives have the potential to become a **primary means of authenticating business process transactions** and will see mainstream adoption by 2020.

2. Ways of working

Interactive & dynamic media
Augmented Interactive Reality
Wearables
DevOps in large organizations

Interactive & dynamic media

Traditionally media has been based on linear narratives but now interactivity, context and user/viewer behavior enable **customised experiences for each user**. This allows narratives to evolve and change in response to implicit or explicit real-time feedback, social network analytics and changing context which will even include user biometric information via wearables. Soon we will see radical new ways of experiencing media, built around narrative forms that have as much to do with gaming as they do with traditional linear story-telling.

In general, **dynamic content** is referred to the content that changes frequently but here we are referring to content that is created, changed or is adapted in response to real time feedback such as in video games. The scope may go well beyond gaming in terms of the type of content, type of feedback and information influencing how the content is created or adapted.

The media & gaming industries

Until now the traditional media and gaming industries have existed separately. While they do compete for consumer spend and eyeballs, and at times collaborate in cross media projects such as games based on movies, they do not compete in terms of content. Consumers of traditional media who wanted highly interactive content played games; those who wanted a more static or linear experience were consumers of traditional media. But the multi-screen, pervasively connected web is driving mass media from an audience relationship to a socially connected, interactive customer relationship. While major landmark events such as the Olympic Games will continue to be consumed simultaneously by billions of people, the perspective that users take on these events will be increasingly personal and interactive and the experiences will become socially connected with other end-users.

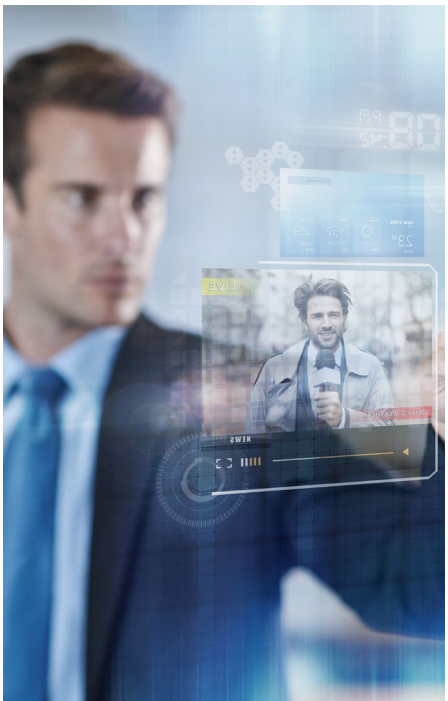
Gaming has traditionally been driven more by action and objectives (scoring goals, earning points, passing through to a new level) rather than by storyline, character development or narrative. But gradually this is changing. An early manifestation of the evolution of gaming towards the traditional media space was machinima – the use of gaming engines to create cinematic productions. The combination of video and social media (for example using live streaming platforms such as Twitch.tv), have brought a sort of interactivity for video into the mainstream as well as blurring the distinction between content creator and content consumer.

Thus media is tending towards **interactivity and personalization** and gaming is tending towards narrative, storytelling and stronger characterization. This interactivity and dynamic content is based on user actions as in gaming today but in future will not only be based on combinations of inputs from individuals but also from collectives, both **in real time and in non-real time**. These inputs will be utilized all through the value chain: in content production to improve the content based on explicit or implicit content, in content consumption and in monetization.

In 2015 the gaming industry had already surpassed movies in terms of revenues[16] and this will only continue to increase. **Our vision for 2020 is of a converged entertainment industry where games can also be narrative, and narratives can also be interactive and dynamic.**

New Hardware and Technologies

One of the main drivers for the trend towards dynamic and interactive content is the emergence of a combination of immersive, interactive and mobile technologies. These include better hand gesture and voice technologies, the explosion of wearables providing real time access to user context and biometric information, vastly more powerful mobile devices, and the arrival of virtual and augmented reality headsets to the mass market as described in the Augmented Interactive Reality topic (pages 34 and 35).



[16] http://businesstech.co.za/news/lifestyle/88472/the-biggest-entertainment-markets-in-the-world/

Dynamic narrative

Dynamic and interactive narrative is where the storyline changes with different inputs. These inputs may be explicit actions by the user/viewer or other inputs of any number of other sources (biometrics, social media, context, user profile, etc. or random). In the video gaming world most content is interactive and dynamic, with much of the rendering of the animation being done in real time. This allows the content being produced to "fit" with the storyline up until that moment. For non-animated content this is much more difficult to achieve because typically the content cannot be created in real time (it is snippets of audio and video that are retrieved in response to inputs). Therefore it is far more difficult to ensure narrative coherence (Is someone's hair combed the same way from one scene to the next? Was one of the characters who appear in that scene eliminated previously?).

Because of this, dynamic content and media (especially games) are currently almost entirely reliant on animation. Whilst computer graphics qualities are constantly improving there are limitations on how close we can come to recreating natural scenes, especially those involving humans. Therefore an emerging area of interest is **Content Oriented Broadcasting** in which building blocks of media are created in ways that allow them to be composed and adapted in real time and personalized for everyone according to the context, profile, actions, etc. of them and others.

Something similar has already been seen in the music industry. We cannot only generate random music at will, but also create original pieces in the style of any famous musician such as "Jimi Hendrix" – Bizet's Carmen as Hendrix would have played it!

Conclusion

Digital media is being transformed; the ways in which we consume and interact with content are evolving towards more immersive, interactive and social experiences. The introduction of dynamic, interactive content allows people to feel more engaged and creates a much more personalized experience. Associated with these personal experiences are, of course, the enhanced possibilities for **monetization**.

The current generation is used to working with media in their daily lives by, for example, using game elements to enhance the way of working (or even thinking), learning and adapting their behavior. Using the emerging new technologies, dynamic and interactive media can be a real asset to organizations. The possibilities of using Virtual Reality (VR) or Augmented Reality (AR) (or a mix of those two; Mixed Reality) can enhance the way of working for everyone by appropriating elements from media and gaming, transforming other domains such as education and training, customer service or virtual sales.

Game-like narrative experiences with shared, collective experiences will be an important part of the media landscape by 2020. The disruptive nature of this in terms of business as well as new forms of creativity and the creative process will be huge in the media industry but will also be felt in society at large.

The Symbiosis Between Social Networks, Gaming and Media

At the core of the future evolution of media is the symbiosis and convergence between social networks, gaming and more traditional forms of media such as television and film. MMOG (massively multiplayer online games) such as World of Warcraft and virtual worlds such as Second Life were perhaps the two most paradigmatic earlier forerunners of this.

At the same time social media has become a standard measurement tool for online viewing of linear television. Facebook and Google (YouTube) are waging a battle to be the social search leader for media distribution and live streaming gaming platforms such as twitch.tv are becoming wildly popular. They include playthroughs of video games by users, broadcasts of e-sports competitions, and are based around established and/or ad hoc communities who follow particular gamers. That is, gaming + social + video.

Augmented
Interactive Reality

Imagine a technology that would allow you to **perceive more than the pure physical environment**; one that allowed you to access and interact with information in the field of view beyond what we naturally observe. We are on the verge of being able to widely adopt technologies that seamlessly integrate the digital world of remote data centres into our own personal field of view. Such developments will support and enrich our daily activities in new, contextually appropriate and interactive ways, through the enhancement of our perception of reality.

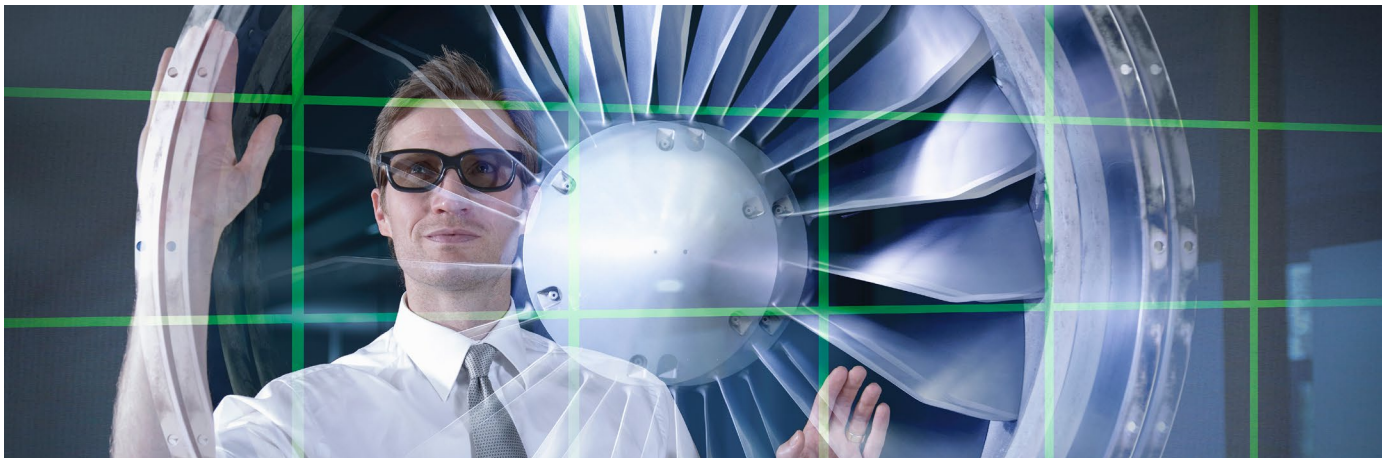
Augmented Interactive Reality (AIR) is Atos' response to this emerging trend that aims to create a "next generation, reality-based interface to connect the remote digital world with the observer's field of view, delivering IT services and information through interactive holograms". AIR enhances real world information with virtual 2D/3D graphical (computer-generated) holograms that appear to coexist in the same space as the real world while supporting interaction through gestures and speech. AIR advances the classical concept of augmented and mixed reality by **utilizing a service-oriented approach**. Video processing and digital enrichment are provisioned by remote service providers, enabling high scalability and ensuring maximum operation time[17] of mobile devices. It also enables secure access to vast amounts of backend information and services. **This ability to combine holograms with backend services and data pushes the boundary of reality** and delivers new avenues to perceive and interact with the environment.

In order to enable AIR, the visual scene must first be digitized though video-recording, deploying the digital camera of a mobile device. The frames of the captured video are streamed into an image-processing service provider in order to recognize feature characteristics (e.g. marker-, image-, object-based) within the digitized field of view. These features are further analyzed to determine the spatial location and orientation (e.g. SLAM-based) of the user and to recognize specific physical entities being observed. Based on the location and context of the user and perhaps recognized entities, associated AIR-content is compiled to provide **hierarchically composed 2D/3D holograms** that are interlinked with further service-oriented interaction processes. The holograms are streamed back into a semi-transparent display of the mobile device to be spatially aligned and overlaid on the digitized field of view. By gesture or voice control, the user can interact with various holograms and its associated services.

The Augmented Interactivity Wave

Technology is at the heart of this new **Digital (R)evolution**. There are several technologies and new devices that will facilitate all these ideas becoming a reality in the coming years:

- Mechanics could see instructions tagged on the unknown equipment when repairing.
- Surgeons could see ultrasound scans of organs while performing surgery on them.
- Soldiers could see enemy positions spotted by unmanned reconnaissance aircraft /drones.
- A plant maintenance engineer is able to view all parameters such as temperature of the hazardous liquid in a pipe he is looking at.
- Automotive plant designers are able to analyze interfering construction components, plan production lines and workshops, compare variance and verify parts in a simulated world.
- Consumers are able to browse reviews of shops & restaurants while walking along a shopping street, by identifying shops automatically.



[17]Image processing executed on mobile devices significantly reduces battery time due to its high power consumption

Business impact

Since the emergence of smart phones (iPhone 2007) and tablets (iPad 2010), powerful mobile computing has become viable and has revitalized the concept of AR (a concept that has existed since 1960). With the experimental launch of Google Glass in 2012 and release of the Epson BT-200 in 2014, AR content has also been delivered directly into the field of view, but these solutions more or less stayed in the realms of research and early adopters, as no saleable solution for AR capabilities or intuitive-human machine interface (HMI) existed. But this may change soon. With the ongoing launch programme of Microsoft's smart glass technology HoloLens and its powerful software development kit, the market for AR/AIR will most-likely experience an economic revolution. With its highly innovative, full-vision augmenting HMI which enables in-the-air tracked finger gestures and its optimized design for service-oriented application scenes, it is well positioned to serve the upcoming AIR market. Triggered by Microsoft's initiative, holographic smart glass technologies from Apple, Google or Magic Leap won't be far behind.

By 2020 augmented reality market is projected to generate $120 billion - Digi-Capital.

Augmented Interactive Reality will be furthered by technologies like **HoloLens** and it is truly a foundation technology of the future which will drive next generation transformations across many industries (manufacturing, field services, retail, real time collaboration, etc.). AR/AIR is expected to play a key role in realizing digital transformations across the entire value chain from product concept through to production, even extending to after sales support and services.

Market adoption

And where is all this heading over the next few years? It's beginning to mature into a viable market, just as the mobile phone did, nearly a decade ago. Mobile analysts expects AR to be adopted by a billion users by 2020. Intel believes that AR will be transformative. The chip maker is investing $100 million over the next 2-3 years to fund companies developing 'perceptual computing' software and applications, focusing on next-generation, natural user interfaces like; touch, gesture, voice, emotion sensing, biometrics, and image recognition.

"AR /AIR will be the interface for the Internet of things."

Greg Kipper, Senior Security Architect and Strategist at Verizon

By 2020, AIR will certainly have exceeded its present capabilities, enhancing the entire performance spectrum ranging from simple textual information overlays over discrete interactive holograms to an entire virtual replica of the reality (holodeck) blurring the lines between virtual and mixed reality. Eyewear will evolve over this timeframe with comfortable stylish glasses that contain powerful embedded technology. They will range from Google Glass-style glance-at displays that might also replace the phone with **stereoscopic 3D-viewing wearables** for everyday use. It is currently expected that the market will not see a perfectly augmented experience with movie-quality special effects seamlessly blended into reality by 2020.

Conclusion

There is no doubt that use cases for Augmented Interactive Reality will proliferate across industries by 2020. Moreover all of these applications will likely generate unmanageable amounts of digital content which will need to be handled in real time. The quality and size of digital data will mean that it cannot be handled on wearable devices themselves. Both the content for augmented reality and the AIR service must be hosted in a data center to cater to the tremendous amount of digital data and to provide the required, high powered video analytics. Therefore, AIR must be delivered as a highly scalable service accepting a high volume of parallel-ingested video streams and data, analyzing the videos in real time, selecting context-sensitive digital content from distributed storage systems and returning it back to the mobile device where it is rendered directly into the digitized field of view.

In summary, **the Augmented Interactivity Wave is gaining strength and by 2020 it will be powerful enough to propagate into several aspects of our everyday lives**. This may call for a revision of business models and will also presumably herald a revolution in the technological market place, calling for both flagship products and AIR compatible versions of existing models.

Augmented Interactive Reality will change several of our day-to-day services in our real world by integrating the virtual one.

Wearables

The term **Wearable** is used to describe items worn by humans somewhere on or even within their body, instead of being in their pockets like smartphones, which are capable of performing some type of computing. Miniaturisation, advanced power-management and integration of smartphone technologies has led to **small powerful connected devices** which support sensors to detect the current context the person is in.

We face many situations in daily life where existing devices such as smartphones, tablets and laptops are not able to support us with necessary services. Wearables have the opportunity to play a major role in the following situations:

- **Hands free:** There is a demand for devices like smart glasses and textiles that can free up our hands.
- **Assisted:** Where an individual is not able to handle traditional devices due to ability or health reasons. This enables solutions for babies, the elderly and the disabled.
- **Real time:** Processing activity takes place all of the time, independent from a human interaction. There are cases to monitor the body (including heartbeat, position, blood pressure, brain activity, temperature) or for security reasons such as prisoner tracking.

Business impact

The wearables market is entering a rapid growth phase. Wearables will be one key contributor in the growth of the Internet of Things, enabling the collection of Smart Data. This adoption will also be facilitated by the huge base of existing smartphones worldwide (1.8 billion in 2015) that will be the perfect complementing gateway for these devices.

The global wearables market will grow at a compound annual rate of 35% over the next five years, reaching 148 million units shipped annually in 2019, up from 33 million units shipped this year[18]. We predict that smart watches, digital badges and smart bands will lead the wearable market in the coming years, followed by smart glasses, emerging intelligent textiles and embedded accessories.

This current evolution is possible due to new technologies becoming available, such as:

- **Sensors:** Accelerometers, GPS, heartbeat sensors, bio-ink, radiation detectors, air quality monitors and many more.
- **Displays:** Flexible displays and OLED technology.
- **Battery:** Lifetime and size improvements, contactless charging and energy harvesting.
- **Communication:** New low-energy communication protocols such as Sigfox.
- **Augmented and Virtual Reality:** Enabling powerful new experiences.

The ecosystem is very large and fragmented. We can split the origin of the vendors into three main categories: Devices, Platforms and Solutions. While some of the key players are trying to extend their activities, it is clear there is a requirement to integrate these different components in order to provide end to end solutions to business. We must master the whole range of wearables as they will become an **essential part of services in a connected world**. The opportunity to collect and make use of increasing quantities of data generated by sensors must, however, be balanced with careful treatment of the information to retain consumer trust.

Wearables improve business performance and employees will be more efficient and productive at work.

[18]Business Insider

Market adoption

The market distinguishes between consumer and professional usage of wearables. The customer oriented market (B2C) mainly includes use cases in the areas of fitness and sports, fashion and apparel, home automation and remote identification, gaming and recreation. The non-consumer use cases (B2B) are mainly related to defence and security, enterprise and industry, healthcare and education. The market for consumer wearables will increase from 6 billion in 2014 to 22 billion in 2018 where the non-consumer market increases from 3 billion in 2014 to 8 billion in 2018[19].

The wearables market today is therefore mainly focused on B2C where the main participants are seeking to increase their customer base. But we can also observe huge deployments in B2B in domains like healthcare, retail, manufacturing, military/police, transport, workforce and sports. Most of these B2B initiatives are based on the business performance improvement that can be achieved by the use of these wearables:

- **Smart Glasses for assisted surgeries** for doctors, production quality assurance and employee trainings
- **Bracelets for access management** for hotels, hospitals, manufacturing
- **Smart Clothes** to measure driver's health transporting people or goods
- **Smart Watches for stock management** in retail

Within the B2B sector, Field Service and Assisted Maintenance are the main activities where wearables will bring major changes and huge cost reductions. Smart Glasses will bring $1b savings per year from 2017[20]. Wearables will assist through:

- Helping to **diagnose incidents** by collecting data from video and audio sensors, supported by image recognition technology.
- **Providing instructions** to the support technician who still has his hands free.
- **Collaborative troubleshooting** by sharing video and audio with any specialist anywhere.
- Integration with a SCADA system, to allow the technician to directly control the components.

Conclusion

The evolution of wearables is happening in many markets, starting from a trend in consumer electronics and now evolving to business. To develop successfully, it requires end-to-end solutions, from device to applications, including connectivity and security, and to realize the value of collected data.

Wearable technology can improve the work environment by freeing up the hands, providing ubiquitous access to information and enabling transparent data collection. It will bring added value services, deliver cost reductions and transform business processes. The collection and analysis of a growing amount of data through wearable sensors will enable macro trends to be identified. This resulting Smart Data brings the opportunity for new business models.

Our vision is that in 2020, one third of internet users in developed countries will wear at least one wearable at any time. Concepts like Body Area Networks will enable a seamless integration of all wearables around a single person.

Wearables challenges for adoption

Energy Management: Wearables have to be available during a complete usage cycle, including the possibility of recharge
Usability and Comfort: interaction with a wearable has to be limited by its size, purpose & ergonomics
Dependability: There must be a failover strategy available to protect the user, which may be as clear as preemptive warnings about the battery level or a transfer of functionality to other devices
Privacy & Security: wearables have to be transparent as to when and what information they handle
Legal & ethical aspects: If wearables are to be used in critical situations they must abide by legal and ethical constraints such as product liability set forth in medical-device regulations
Effects on the human organism: wearable electronic devices will be in direct contact with the human body. The effects of materials (allergic reactions) and radiation must be manageable and analyzed.

[19] BCC Research
[20] Gartner

DevOps in large organizations

For large organizations to survive in a Digital world, businesses recognize that **building a strong DevOps capability will be vital**[21]. A successful DevOps implementation is a subtle recipe as it requires major transformation to build an excellent software delivery capability. One aspect of the transformation is the change in Technical Capabilities (which represents 30%[22] of a DevOps implementation effort), but the major effort (the remaining 70%) is the introduction of the necessary processes, culture and organizational structure.

DevOps in a nutshell

DevOps is an approach for how to build software which aims to:

- focus on business value
- catalyze a highly collaborative environment in which teams seek to continuously improve
- automate integration, test and implementation activities to enable frequent delivery
- evolve away from monolithic towards microservice architectures

to increase **IT Performance** defined by **Change Throughput** and **Stability in Production.**

Technical capabilities

Many organizations have already adopted **Continuous Integration** and by 2020 most will have expanded this to Continuous Deployment. **DevOps is a real "game changer"** with infrastructure-as-code accelerating deployments and the business driving release planning. Cloud platforms will be the default choice and there will be significant advancement is in the use of Machine Learning and Artificial Intelligence to robotize software delivery and operation.

A key challenge will be the transformation of an organization's legacy **enterprise application** landscape to an **enterprise service** landscape, an area where architectural styles can help.

The microservice architecture style[23], as one example, supports fast, feature based delivery and removes the need for large releases and their associated risks. However, in order to continuously deploy and operate microservices, they must be robust, self-healing and scalable. The 12 Factor App[24] is an example set of design principles that can be used to achieve these goals.

The emerging **Serverless architectural** style will become more relevant in a future of ubiquitous computing capabilities, with new services created simply by a combination/mashup of cloud services via their APIs, fully abstracting the underlying infrastructure.

DevOps **reduces** the size and complexity of individual software releases, however it **increases** the frequency and number of releases. This is only sustainable if the requirement for human involvement in the process can be reduced. Humans will define the high-level goals for testing[25], but the detailed testing steps will be specified and performed by "virtual intelligent robots", organized in swarms and able to adapt and learn together.

Machine Learning and **Artificial Intelligence** will help to reach this level of automation and interaction, not just for releases, but also for proactive monitoring. The impact that this will have on traceability, duty and responsibility will be a key topic in the coming years.

Building enhanced Technical Capabilities requires not just choosing practices and installing appropriate software tools, but also developing the skills of employees so that they can use these practices and tools effectively.

[21] Computer Associates "DevOps: The Worst-Kept Secret to Winning in the Application Economy"- October 2014
[22] Report of the Syntec DevOps Camp-Paris Feb. 2016
[23] http://martinfowler.com/articles/microservices.html
[24] http://12factor.net/
[25] Artificial Intelligence Applications for Improved Software Engineering Development (2010) by Farid Meziane & Sunil Vadera (University of Salford, UK)

Process, culture & organization

Larger traditional organizations have the need to transform their structure to an ecosystem of interdependent services to improve business agility[26].

Conway's law[27] states that "Any organization that designs a system...will inevitably produce a design whose structure is a copy of the organization's communication structure".

Large organizations are often structured around functional siloes based on the assumption that the delivery capabilities benefit from economies of scale. To deliver software in the new enterprise service landscape, **teams need to be organized around the services**. These teams will be highly focused on meeting the needs of the service consumers and will adapt and respond to consumers' feedback (whether they are end users or other internal teams). This change in approach results in better knowledge retention, team stability, and fewer handovers. For large organizations, given Conway's law, this transformation of the organizational structure is mandatory for them to become service-centric.

Cooperation means people being more involved and knowledgeable of areas outside their own specialty or department. **Adopting DevOps requires a solid foundation built on trust - trust in people, tools, processes and automation**. A Generative culture (vs. a Pathological or Bureaucratic culture) as defined by Jon Westrum[28] is mandatory for DevOps. As a result, the workforce is not only much happier and more engaged, but also more productive: "Job satisfaction is the number one predictor of organizational performance"[29].

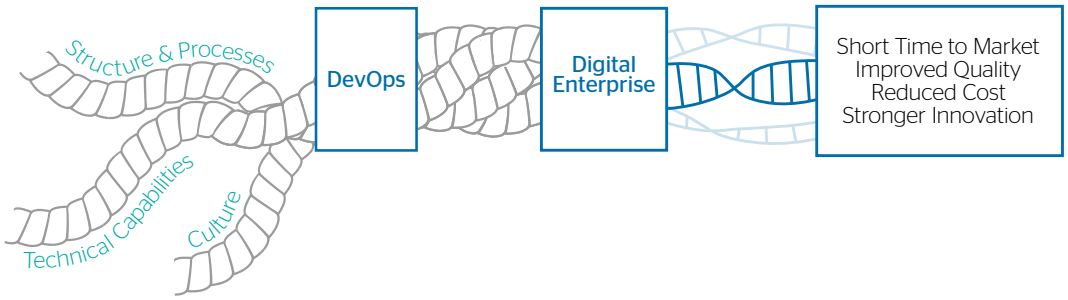


Figure 10 – Strands of DevOps enabling a Digital Enterprise

A digital shockwave survival kit

In the coming years, **DevOps will be mandatory for any organization to survive in an increasingly digital world**.

Many tools and best practice enablers for DevOps are now well established; in this respect, it has never been easier to adopt DevOps. Transforming to an Enterprise Service Landscape and increasing automation with "virtual intelligent robots" are major challenges ahead.

The biggest challenge for large traditional organizations is the change in processes, culture and organizational structure that successful DevOps adoption requires. They will have to transform themselves into an ecosystem of interdependent services (see Intelligent Networked Enterprise). Teams will need to be organized around and measured against these services and be empowered to continuously improve how these services deliver value to their users.

The Bi-Modal IT model can be used tactically to prioritize the implementation of DevOps for areas where it will have the biggest impact and hence deliver some "quick wins". However, this is not the end goal: for a successful digital transformation, the entire scope of the enterprise application landscape will require the speed, flexibility and robustness that DevOps brings. The ultimate aim should be to **implement DevOps everywhere**.

Due to the huge impact on business and organization that adopting DevOps will have, **senior executive sponsorship is mandatory** for it to be successful. Including DevOps adoption as a core component into business strategy enables organizations to prosper in the world of digital disruption.

[26] http://www.infoq.com/news/2015/11/enterprise-services-planning
[27] How do committees invent? By Melvin E. Conway 1968 - http://www.melconway.com/Home/Committees_Paper.html
[28] A typology of Organizational Cultures (2004)
[29] https://puppetlabs.com/2014-devops-report

3. Disruptive technologies

Internet of Things & future networks
Cloud continuum
Computing Memory
Cloud & containerization
Additive Manufacturing
Quantum safe cryptography

Internet of Things
& future networks

In recent years the **Internet of Things** (IoT) has been a major trend shaping the future of markets such as health, transport and the home. Wearable sensors that measure one's activity and heart rate are impacting on Healthcare. For transportation, connected and autonomous cars are beginning to emerge. In the home, there are a growing number of **connected objects that allow us to automate** the watering of our plants, the opening of window shutters and control our central heating systems.

It is predicted that 25 billion IoT units will be installed by 2020 and growth in IoT services will reach $230 billion[30]. We identified this in Ascent Journey 2018, acknowledging its importance for the future, but recent trends are causing us to take into account new challenges. As outlined by our work on Security and Privacy, the protection of personal data is a key preoccupation of the connected citizen, and connected objects can appear as the weakest link in one's security chain.

The connectivity of objects, with each other and to the Internet, is now an essential part of the operation of many business critical processes, demanding a resilient, reliable way for objects to connect within their vicinity. While today's IoT connectivity often relies on a Cloud or central platform, the growing importance of local object to object communication for critical processes is calling for a rethink of the way devices participate in the IoT ecosystem.

Business impact

IoT will transform the landscape for business and create new opportunities, but there are several challenges to overcome. The need for rapid, tactical decisions requires a **redistribution of the intelligence** required to ensure the system's autonomy, robustness and manageability. Objects also need to be able to exchange data locally very quickly using a wide variety of networking technologies. This local computing and communication capability must be associated with a method to discover what the capabilities of the other objects are. In the future, by using **Named Data Networks**, such a local data exchange and discovery will be straightforward. These challenges drive the evolution from a rather pyramidal Internet of Things today to a meshed, inter-networked web of connected systems.

In these future systems ad-hoc local communication between objects won't replace potential long-haul connections to a remote cloud platform, but will complement them. Objects will be able to use a wide variety of network technologies, from a very local reach (such as NFC, Zigbee, Z-Wave, LiFi and Bluetooth), to very long range technologies like LoRa or Sigfox which enable the transmission of very few bits of information over long distances within a limited energy budget. In the near future all of this will be utilised by **Swarms** of distributed (and perhaps moving) computing-enabled objects to take real-time collective decisions.

Named data networks (NDN)

Named data networks (NDN) have been designed to address limitations of accessing data on the classical Internet. Named data networks are architected to retrieve content or access resources by using the name of the resource itself rather than by having to find the address of a node hosting it.

From gateways to Micro Clouds

These challenges lead to a tension between the growing need to distribute the intelligence as close to the object as possible, or even in the objects themselves, and the limited networking, computing and energy capabilities that most objects participating in the IoT ecosystem have. To address this pressure **IoT Gateways** have been introduced into the overall system architecture. Acknowledged by many standards bodies and vendors, gateways make the link between the classic IT systems (Computers, datacenters and wide area networks) and the exciting new world of connected objects. They can help objects discover one another and exchange information. These gateways will in future be complemented with more processing power and steered from a set of logical controllers, borrowing concepts from Software-Defined Networking. Those new capabilities will allow them to host virtualized computing functions and assist a set of objects in their mutual operation. In that regard, they will evolve into IoT "**Micro Clouds**"; autonomous systems that constitute the IoT applications. They can (and have to) provide a means to protect the data against unintended use. These IoT Micro Clouds can help to implement effective monitoring and secure software lifecycle management. They also have to cope with multiple data consumers sharing the data in a standard

[30] http://www.gartner.com/smarterwithgartner/the-internet-of-things-is-a-revolution-waiting-to-happen/

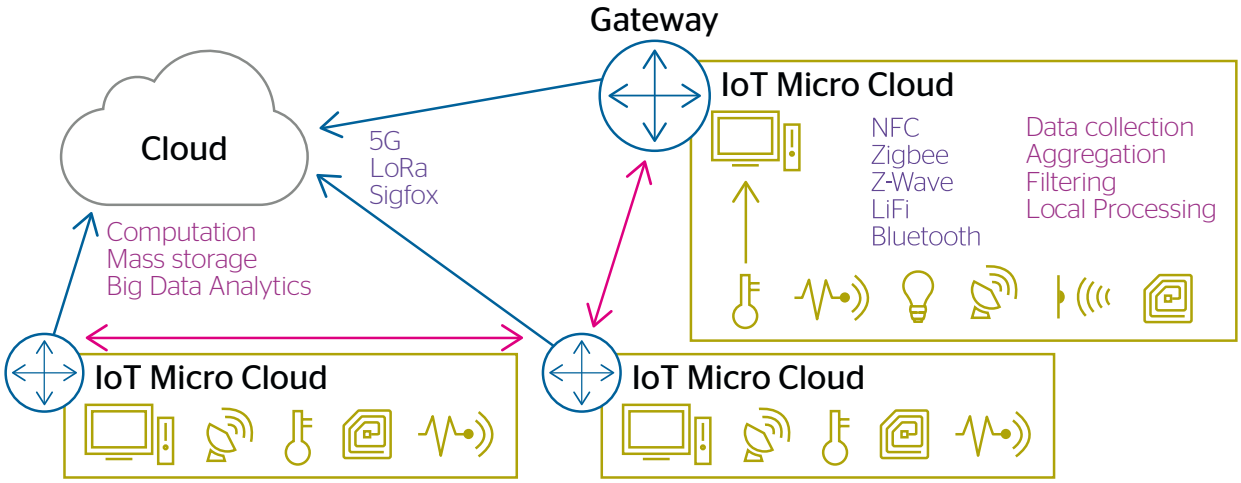


Figure 11 – Data flow exchange between Cloud, Gateway, IoT MicroCloud and Sensors

format for different purposes, and are a form of Edge Computing in the Cloud Continuum.

By 2020 the IoT **Micro Clouds** will be a key component of the ecosystem, and a battlefield between telecommunication operators, object manufacturers and Internet giants vying for control of the IoT world.

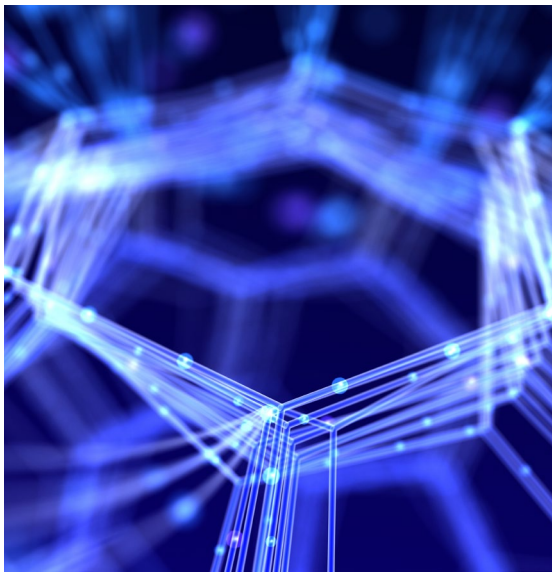
In the meantime further developments need to take place. A proper method to manage the gateways needs to be established. In the Telecommunication world, Network Function Virtualization aims to allow the deployment of some functionality on commoditized equipment, be it the server in a datacenter or a set-top box you have at home. Additionally, we need to address the security and privacy of data exchanged between objects and the users of this data. The IoT Micro Cloud might play a role of performing access control on behalf of the object, or by re-encrypting data transmitted through it to a cloud platform. In addition, the intelligent gateway will ensure that sensors can be reached and will monitor their behavior. Such monitoring capabilities are essential for use cases where reliability is a key requirement. Finally, the **intelligent gateway** will be the Babel Fish of the IoT world, ensuring protocol translation and interoperability for sensors previously lying in isolated silos. All of this in an emerging set of standards, such as the IEEE P2413 IoT Architectural Framework.

Conclusion

In 2020, the IoT ecosystem will be quite different from what we see today. Whilst we currently experience a set of isolated silos that connect objects to a vendor-specific cloud platform for data retrieval, in the future we expect this ecosystem to be less vertically integrated, forming a **web of interconnected systems** where objects and gateways will be able to interact using open standard protocols. This shift will have a technical impact, but more importantly an economic impact on the business models adopted by the market players.

IoT and the Circular Economy

The "Circular Economy", as defined in 2014 by World Economic Forum, will disrupt the current linear "take, make, dispose" economic development model and aims to create a more sustainable world by enabling efficient use and flow of energy and resources so that natural and social capital is preserved.
IoT could strongly support the Circular Economy through the monitoring of renewable resources and providing instrumentation that enables the optimization of resource yields.



Cloud continuum, enabling Swarm Computing

Cloud Computing, IoT and the strategic use of data and analytics are the foundations of a new digital revolution. The business opportunities are massive - as is the potential economic impact on our society. Public cloud computing has become mainstream today and estimates of future adoption continue to grow. The Cloud market is evolving to a Hybrid model which aims to optimize costs and avoid vendor lock-in. At the same time the number of connected devices is growing from the current 20 billion to at least 100 billion in the most conservative forecast.

There is common agreement on the future of digital services:

- **Public cloud platforms** are making analytics mainstream for many organizations, simplifying the experimentation and adoption of advanced data processing technologies.
- These cloud platforms are also **democratizing IoT**; providing the backbone capabilities to easily interact with devices and sensors.
- Recent Edge Computing developments are streamlining the connectivity among IoT devices, sensors and gateways. These IoT "Micro Clouds" are enabling more advanced solutions such as local machine to machine communication and cooperative decision making.
- Many organizations are increasingly investing and experimenting in Multi-Cloud models; assembling together Public IaaS, PaaS, SaaS services with private deployments.

Cloud Computing is evolving; bridging together several domains and moving towards a **computing continuum** that is a key enabler for what we have termed **Swarm Computing**.

The duality of Cloud & Edge

The technologies underpinning Cloud Computing have reached a high degree of maturity and are providing responses to more complex scenarios than just IaaS or SaaS. Cloud has become the default platform for start-ups and many enterprise organizations have already fully embraced the cloud model; be it Public, Private or a Hybrid.

On the other hand, organizations that aspire to lead in the future digital business are pioneering solutions based on connected devices and IoT related technologies. Maturity, standards and adoptions are in early stages even though there is a common consensus that these technologies are the next big thing.

Two complementary trends are shaping and driving the digital economy and Cloud computing in particular:

- Firstly an evolution of **centralized specialized cloud and multi-cloud hybrid models**.
- Secondly, a new trend which brings distributed computing to the edge of the network, to respond to the specific needs of IoT applications.

There is currently a polarization of new digital solutions; some enterprises targeting mainly the pure Cloud market and others the IoT market at the edge. At this stage very few players are able to offer a comprehensive vision and associated solutions across the whole cloud continuum.

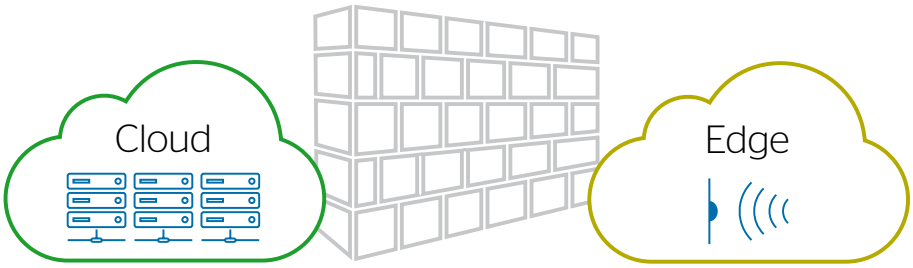


Figure 12 - Cloud vs IoT Edge market

Think big, think swarm

Swarm Computing combines network and cloud capabilities in order to create on-demand, autonomic and decentralized computing.

The combination of complex multi-cloud architectures with **Edge computing** will enable Swarm Computing scenarios to develop. Swarms are temporal infrastructures, created on demand in order to respond to a specific need. The swarm approach is a digital shockwave for existing computing environments; forcing existing offerings that

have emerged as part of a centralization paradigm to evolve to a hybrid decentralized and autonomically managed model.

Edge computing within a Swarm vision will evolve into a set of computing and storage platforms able to provide low latency and near real time responses with security focusing on the physical entities.

Cloud Computing will develop into a set of platforms with high computing power, able to process huge data volumes with complex algorithms and deep learning performed on the data collected at the edge. Any processing required for immediate action and low latency will happen at the Edge; the rest of the work will run in the cloud. All in an automated, self-organized and self-managed model.

The evolution of today's multiple clouds towards Swarm Computing relies on both Cloud and Edge adoption. Many of the current cloud capabilities need to be further developed to overcome security, trust and legal compliance issues which act as barriers for a wider uptake. Another obstacle for wider adoption is the prevalence of proprietary solutions and lack of standards that lead to a potential vendor lock-in situation for early adopters.

To enable this Computing Continuum vision new investments are required to evolve solutions deployed in the cloud and enable the transition from one cloud to another. **Containerization combined with open-standards and open meta-data** will overcome currently incompatible technologies and aid in the deployment of applications. In order to succeed, data, algorithms and configuration settings must be able to flow between the different clouds, creating a vendor agnostic ecosystem.

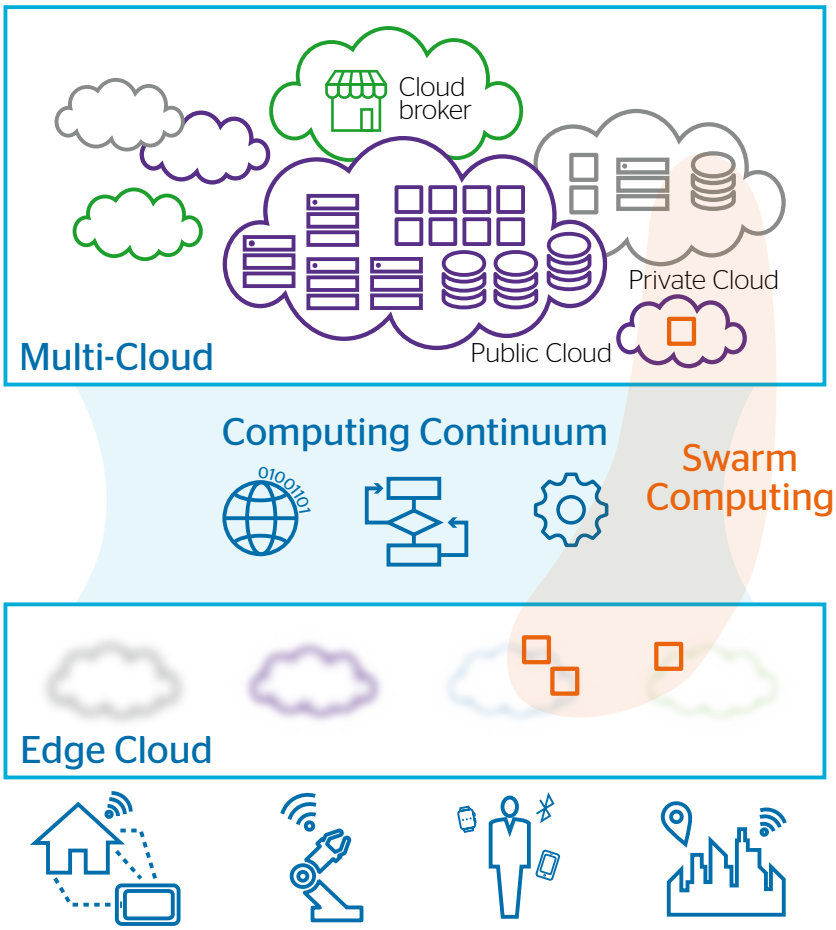


Figure 13 - Atos vision for Swarm Computing

Looking ahead

Looking to the future, the emergence of Swarm Computing will be a general trend towards specialization and decentralization which will impact the cloud and computing market as a whole. This will be felt by companies in all industry sectors and provide the underlying enablers for new and yet to be envisioned use cases in the industrial and consumer space.

In the context of Industry 4.0 further integration of real-time factory and shop floor sensor data with high performance computation in the cloud will enable true **prescriptive intelligence for automated decision making** as part of the next industrial revolution.

In the Smart Home Swarms will be constructed to provide care for the elderly, nutrition and energy management; controlling and monitoring a large variety of in-home and wearable devices.

In the Smart City Swarm Computing will become a success factor in maintaining community liveliness, and contribute to addressing the global economic and environmental challenges in the areas of energy management, traffic control, and emergency and community services.

Computing Memory

For most of Information Technology's history computing services have been constrained by the availability of hardware, software and people. Tomorrow's IT services will compete on their ability to minimize energy use. A complete change in the cost function of IT requires a new form of IT.

The high cost of active primary memory ("RAM"), which loses information when the power is turned off, has led to the extensive use of passive storage technology; magnetic disks, and more recently Flash. New and emerging memory technologies promise to deliver a thousand times the capacity together with data persistence which will remove the need for secondary storage. This new era of computing will combine compute operations previously performed in the CPU directly with addressable memory in a single device. We call this **Computing Memory**.

Computing Memory will revolutionize the way computational problems can be addressed, enabling new algorithms and approaches to be taken. This will apply to analytics, pattern searching in genomics and other life sciences, fraud detection in the financial industry, predictive analytics in video surveillance and large "web-scale" computing infrastructures. The billions of sensors that will underpin the Internet of Things will also benefit from such non-volatile Computing Memory chips.

One aspect of Computing Memory that will be applied in some situations is that it can avoid the storing of data for later processing. This allows **a threefold improvement in energy efficiency** as with current architectures data is handled once for initial processing (input), once again for interim storage and a third time for final processing (output). Computing Memory analyzes raw data in-depth as it arrives and translates relevant parts directly into knowledge that is retained, whilst irrelevant data is discarded immediately. This type of **stream processing** allows us to deal with exponential data growth and will be adopted in IoT, pattern matching and analytics scenarios.

With combined Computing Memory technology, the von Neumann architecture principles established in the 1940's are blown away.

Reversing the flow

Compute and memory technologies were separated at the birth of computing for technical reasons and their distinct respective priorities; speed required for compute operations versus capacity for memory.
With vastly growing data volumes and essentially fixed CPU performance per core, transporting data to the CPUs becomes increasingly impractical to meet the necessary speeds which applications require.
When data becomes too big to travel you must reverse the flow and move the compute capability to the data instead.

Business impact

For the enterprise, Computing Memory enables differentiating market-specific solutions to be developed to address particular information-processing needs. It will permit **real-time data analysis on much wider or deeper datasets**, which can currently only be performed in batches – so new business value and opportunities will emerge.

For Web-Scale companies Computing Memory is especially critical, because together with deep machine learning and cognitive computing software, it enables them to maximize the value from exponential data growth whilst keeping energy costs flat. Their investments will also allow benefits of the technology to be delivered to businesses; directly through cloud services, and eventually by the migration of open source and open compute solutions to the enterprise environment.

Whilst these new technologies are still being developed, Computing Memory can already be emulated today and there are prototypes implemented for specific use cases. Therefore in new software projects, any refactoring and middle-ware choices should be made with Computing Memory compatibility in mind. The eventual impact entirely depends on the competitive context, but if cloud computing and the Internet giants impact an enterprise's business today, we believe Computing Memory will make an even bigger difference tomorrow. This will truly be a Digital Shockwave in business.

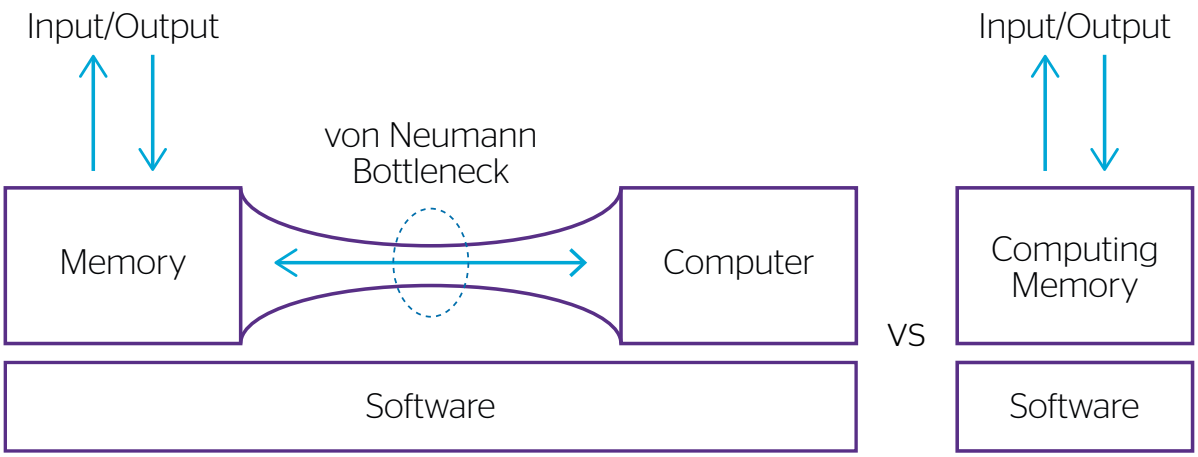


Figure 14 - How Computing Memory eliminates the Von Neumann bottleneck

Market adoption

Native Computing Memory products are not yet widely available, though a number of innovators are making ready their particular solutions relating to the concepts we have described here. We expect several iterations and distinct types of Computing Memory implementation to emerge; some of which will be made available through **Atos' own Bull Technology brand**. Similar to the way that the IT industry has GPU offload engines to assist in the processing of certain workloads in HPC environments, we see **Computing Memory devices complementing CPUs to process workloads** appropriate to them. Access to these offload engines will be abstracted through the use of standard APIs, enabling an iterative transformation of legacy workloads to the new model of compute.

Conclusion

Combining compute capability together with memory brings a step change to the performance of processing certain types of data, whilst bringing the energy cost of computing down.

Computing Memory reverses and even eliminates historical work-arounds dating from the early days of computing which are no longer efficient and offers a more natural way to process information in the quantities we now have in the 21st Century. Prototypes are already available that demonstrate improvements of several orders of magnitude, either in speed or energy savings.

Finally, we see Computing Memory taking us even further and towards **Neuromorphic Computing platforms**; a radically different computing architecture that physically mimics the neurons and synapses present in the human nervous system. Neuromorphic computing has applications in visual processing, auditory processors, object recognition and autonomous robots.

ResistiveRam, 3D memory, the elusive Memristor. All of these technologies will contribute to the evolution of Computing Memory.

Cloud & containerization

Containerization is a form of virtualization that is able to create **lightweight partitions inside the same operating system instance**. Though this concept was initially introduced in 1979, it has only recently gained momentum. It can enhance the management of applications in today's ubiquitous cloud environments. Driven by a burgeoning ecosystem in which Docker is playing a significant role, Containers can be expected to gain a foothold in, and ultimately become a fundamental part of, enterprise cloud strategy by 2020.

Cloud adoption across enterprises was an inevitable result of the movement from bare metal to virtualized infrastructures. It offers infrastructure as a dynamic, adaptable yet cost-effective resource that is able to power business applications for agility and responsiveness. Nevertheless, enterprise IT still faces key challenges such as:

- Handling different flavors of Infrastructure as a Service (IaaS) and Platform as a Service (PaaS).
- Moving workloads across different clouds to meet portability requirements and avoid vendor lock in to the cloud providers.
- Enabling lightweight but efficient, consistent, and repeatable deployment of applications.

The term **"Cloud Native"** expresses the need for cloud based IT to fundamentally shift the mind-set away from infrastructure as discrete, large, expensive components that are slow to change. Though cloud computing has redefined infrastructure management, it has yet to redefine application management. This shift from compute & storage level to application level can be enabled through containerization.

The infrastructure based services brought by virtualized cloud platforms are useful but are insufficient to meet demanding business needs. Users directly interact with applications, not with servers, networks and storage. The latest versions of containers are a powerful and highly decomposable abstraction within a cloud environment that enables applications and services to run completely independently of the underlying hosting platform.

Containerization in the Cloud will increase application portability, efficiency and agility across multiple environments/clouds with seamless Operations Management. In other words, applications are deployed and managed in exactly the same way, regardless of the platform. Containers running within a single operating system are more efficient and this will underpin the future of the cloud infrastructure industry, based on virtual machines. Hypervisors will still play an important role mainly because of their ability to support workloads running different operating systems (or kernels) and to leverage the security of hardware assisted isolation.

Business impact

The general benefits of containers, when used in any environment are:

Performance in provisioning speed, execution overhead and superior consolidation rates: Compared to traditional virtualization, it is possible to run up to 4x more server instances on the same hardware.

Cost reduction and improved cost effectiveness by leveraging maximum resource utilization of the infrastructure.

However, the business benefits of Containers in the Cloud go beyond technology into IT Operations as a whole:

1. **Through the full automated nature of the container ecosystem** and the adjusting of IT practices to actual resource utilization and service demands rather than industry benchmarked productivity ratios, IT organizations can save 15-20% of their existing costs.
2. **The portability of workloads** among different service providers brings true "market based" multi-sourcing with the benefits of price/value competition & elasticity and elimination of vendor lock-in.

With the rise of Cloud Native Applications (CNAs) and DevOps, companies who can innovate, experiment, and deliver software-based solutions quickly are outcompeting those that follow traditional delivery models. Containers play a key role in addressing the demand for 'Speed of change'. CNAs, Microservices, DevOps & Containers enable clients to move from deployment in weeks to minutes, with the ability to deliver enhancements and/or new features within hours and if necessary, the ability to roll back.

Innovation shockwaves

With all the technology and operational advantages that containerization offers, the ecosystem is filling in the current functional gaps and providing insight into the different shockwaves of innovation and evolutions expected over the next 5-10 years (illustrated in Figure 1, page 7). Some in particular will play a significant role in disruption:

Hardware-assisted workload isolation will open up container use-cases that are currently restricted to virtual or physical machines.

Cross-platform instrumentation and automation will be key to deployments that mix and match Windows, Linux, x86 and ARM on a single environment.

Tiered/Hierarchical Orchestration enables users to deploy their own orchestration layer instead of the ones offered by Service Providers. This is a fundamental piece in the portability and vendor agnostic game.

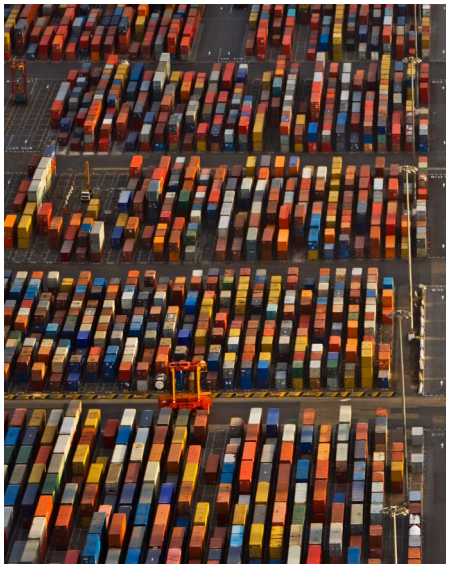
Trusted Computing features for "Software Defined Everything" (Network, Storage, etc.) will remove or substantially mitigate trust and security concerns when moving workloads among Service Providers and/or locations. This brings the notion of "Bring Your Own Trust" as one of the enablers for truly portable applications.

Conclusion

Containers face similar headwinds as previously experienced with server virtualization. While leading B2C cloud players have already embraced Cloud Native Applications and Technologies, the Enterprise is now beginning to accept them to deliver its services.. In the real world of 2 speed IT, organizations still run legacy applications, manage the lifecycles of IT assets and take care of the service levels.

The wave of adoption of Containerization in Cloud remains a future state for most organizations. However, with Business Digitalization challenges dealt with and with increasing access to maturing technologies, the time to start implementing such a strategy is now. Cloud Native Technologies generate feedback loops inside the organization that inevitably increase the speed of development and innovation. Businesses today need such transformation and increasingly we will see that strong pressure for adoption will be driven from the CEO's office rather than the IT department.

Adoption will take its time due to multiple technology waves but the aggregated affect suggests that **by 2020, we will witness the highest adoption of Containerization within Cloud environments which will transform the way the businesses are run**.



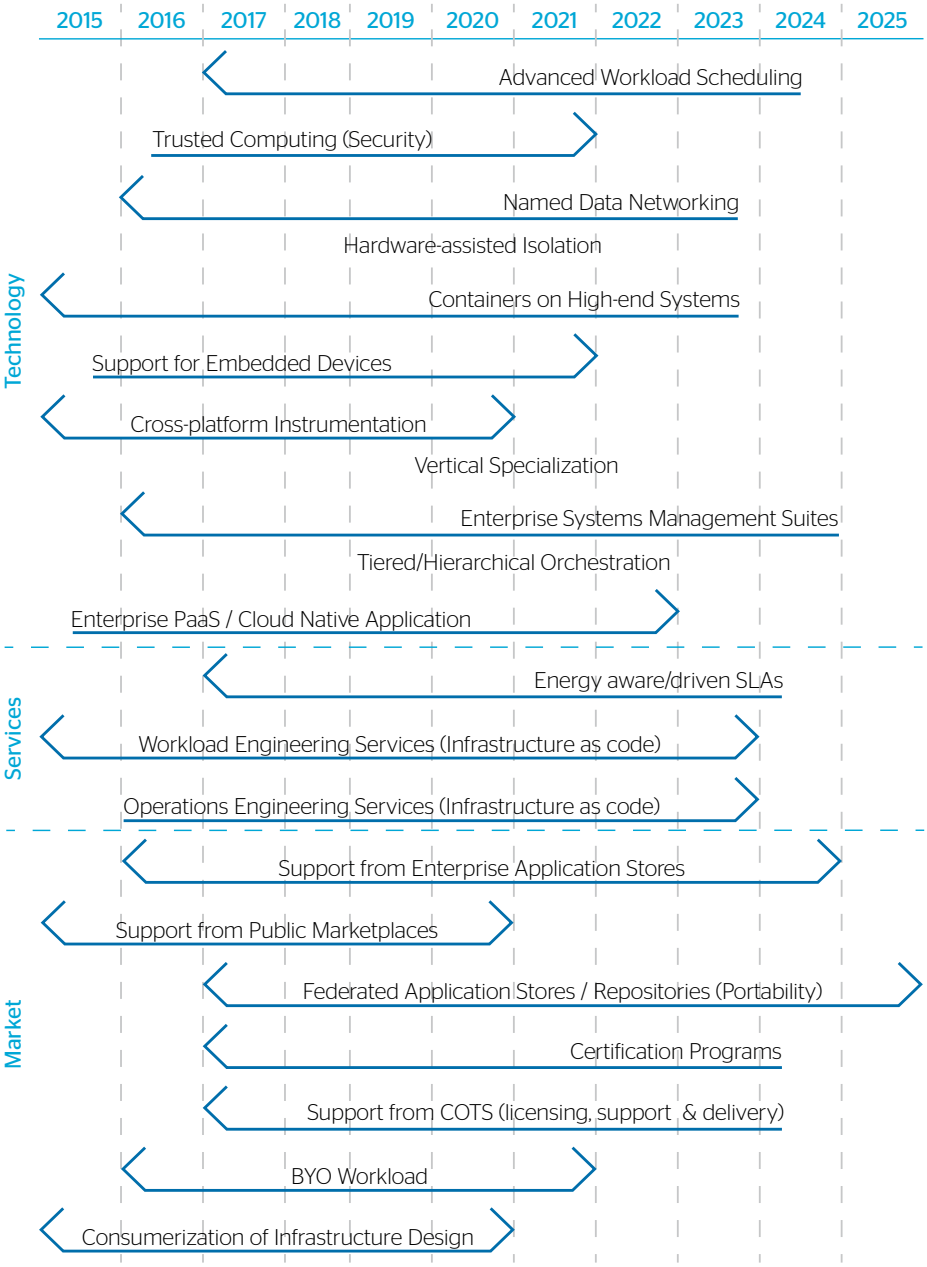


Figure 15 - Cloud Containerisation Ecosystem

Additive Manufacturing

Additive Manufacturing (AM) can be defined as the process of joining materials to make objects from 3D model data, usually layer upon layer - a radically different approach to subtractive manufacturing methodologies[31]. Also known as **"3D printing"**, both terms are usually used interchangeably, although the term AM is more related to the use in an industrial environment and 3D Printing is identified more with consumer goods and home appliances.

AM offers the ability to produce **personalized products with lower development costs, shorter lead times, less energy consumed during manufacturing and reduced material waste**. It can be used to manufacture complex parts, and enables manufacturers to reduce inventory, make products on-demand, create smaller localized manufacturing environments, and even improve supply chains. A wide range of materials can be used, from technical polymers (ABS, Polyurethanes or Polyamides). Metals (aluminum and titanium alloys, steels, superalloys), ceramics, even concrete, food or organic tissues.

"AM could disrupt the manufacturing value chain, allowing a shift from mass production to full customization."

Several changes in the industry will happen by 2020 when we expect AM to be profusely adopted.

- Design and manufacturing of parts will evolve to take full advantage of AM. Retail channels and product distribution models will change in order to embrace these techniques.
- AM will require **compatibility of digital models**, 3D printers and other manufacturing means. Information flows will evolve in order to fulfil industry needs for full digitalization.
- New solutions in Digital Rights Management, Security and Traceability will arise to address the preservation of Intellectual Property (IP), ensuring that printers can only produce the licensed amount of copies or items. When transferred, digital models will not persist in the memory of machines.
- The maturity of AM technologies is not homogeneous and depends on the material used and the type of deposition and consolidation process. New materials for AM will be developed and the real-time control of process will be improved.
- Supply chain & logistics will decide the most convenient manufacturing process for each product. It will become commonplace to print fully customized spare parts at the place of consumption.

Figure 16 - Additive Manufacturing in Industry 4.0

Business impact

AM is a potential game changer that could disrupt the complete manufacturing value chain, allowing a shift from mass production to full customization, and from centralized to distributed production. Combined with IoT, manufacturers will monitor and improve their products, designs and performance.

However, a present challenge is that many of the traditional manufacturing sectors are not aware of, or do not fully understand, how to utilize AM. It will replace certain manufacturing methods, but not all of them. And it has the added potential to complement many of those it cannot substitute, creating a more powerful concept: **hybrid manufacturing**. This offers the full integration of additive and substractive technologies, capable of processing several materials in the same product in one production run.

AM will transform manufacturing, but its profound business value will not be fully realized unless the proper tooling is provided: product design, productive means and associated systems are being transformed in order to serve the new manufacturing scenario.

[31]Definition from ASTM American Society for Testing Materials

CAD-CAE-CAM (Computer-Aided Design, Computer-Aided Engineering and Computer-Aided Manufacturing) systems will be enhanced with new features to enable complex designs in an agile way. New tools will be provided for amateur designers so that they do not need sophisticated tools. AM represents an impressive advance in the ability to design and manufacture products in a limited production run or even one-offs for a single individual - by drastically reducing time-to-manufacture and time-to-market. The boom of AM in the industrial processes will drive changes in the production concept itself, with customization and final user-centric approaches integrated into ERP and PLM systems.

Retail and distribution concepts will shift from centralized to distributed production. The **"bill to print" concept will impact logistics and operations**, reducing storage and transportation costs. Sustainability will also be enhanced via energy savings and, most importantly, material waste reduction.

Market adoption

AM reached a market volume of € 5.1Bn in 2015[32], with an average annual growth above 30% since 2012. Up to 75% of the adoption took place in the MRT market (Manufacturing, Retail, Transport). The fastest growing sectors are automotive and aerospace, but medical applications are also growing quickly.

Based on different estimations, the market volume is expected to rise up to between € 12.2Bn and € 21.0Bn globally. Nearly half of this market will be services related to AM industrialization (consulting, engineering), with 20% corresponding to materials production and 30% to AM systems development.

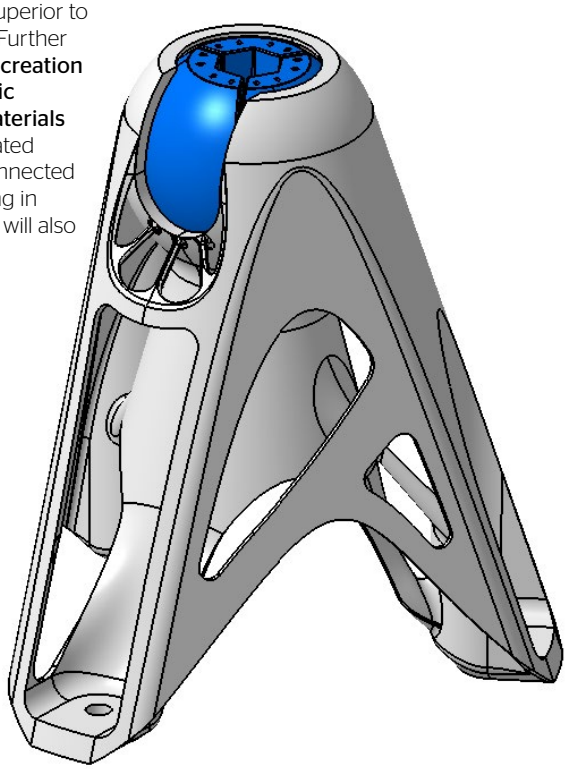
Conclusion

AM is currently used profusely for prototyping and for manufacturing final parts in several applications, such as dental aids, prosthetics, parts for secondary structures in airplanes or final components in turbine applications. Full industrialization of AM is just a few years ahead, so now is the time to prepare your business to reap the benefits.

In the following years, the three main adoption drivers of the AM technology (personalization; new materials, structures and properties; decentralized production) will initiate game-changing innovations, and help deliver spare parts all over the world and even in space.

AM will enable new business models and new products (formats, characteristics) superior to conventionally manufactured ones. Further applications will be **smart materials creation (4D printing), bionic design, gigantic structures, bio printing or multi-materials combination**. Sensors will be integrated seamlessly inside parts for a fully connected industry and the possibility of printing in space with extra-terrestrial materials will also be a fact.

Atos design of an integrated customised support for a space application, awarded Best Design for Additive Manufacturing (Additive World Challenge 2016).



[32]According to Wohlers Associates report of 2016: http://3dprintingindustry.com/news/3d-printing-passes-5-1-billion-in-latest-wohlers-report-2016-75874/

Quantum safe cryptography

The cloud and the "Internet of Things" are booming developments that use public encryption technologies to protect data, algorithms and systems from exposure. This protection is however destined to be toppled by some algorithms that run on quantum computers. The principle of computational hardness used in conventional encryption approaches does not apply in the same way to **quantum computing**. Publicly sent and possibly intercepted encryption keys that rely solely on computation difficulty are of questionable security. Quantum computing forms an unprecedented threat to one of these traditional strongest links in cybersecurity: **asymmetric encryption**.

The arrival of quantum algorithms that can run on actual quantum computers heralds a vast field of new applications. Once difficult calculations can become easily possible and some calculations that were impossible before will suddenly become possible. This will create opportunities for a wide range of industries, which rely on ease of computation, and in the same way affect those industries, which rely on computational difficulty. **Quantum cryptography** includes an encryption standard and can be amended by new quantum technologies to secure key distribution. Understanding and adopting quantum computing and cryptography can successfully prepare an organization for the cybersecurity threats of the future and help such organizations to learn about its own future quantum computing possibilities. At the same time, it enables organizations to review their security management procedures with familiar benchmarked technologies and processes.

Sensitive data handlers, who assess risks to their IT infrastructure and security processes, will need to become quantum safe compliant.

Business impact

Business opportunities are presenting themselves today, often triggered by requirements of data security standards and legislation for both the public and private sector. The number of quantum safe cryptography suppliers and developers is steadily growing. They offer a large array of ever diversifying products and services.

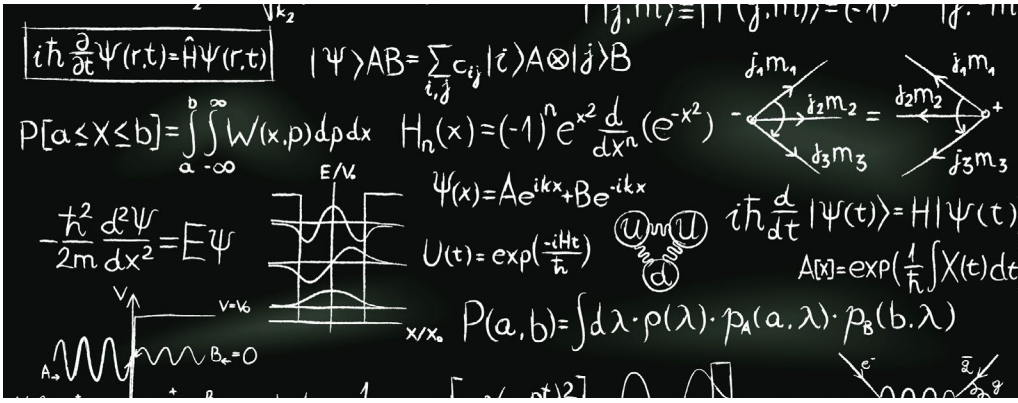
All data which is currently protected by classical encryption standards has to be lifted to **quantum safe standards** to remain safe in the future. Considering that the first quantum computers will be commercially available between 2020 and 2025, and security standard changes being time consuming, this makes for a precarious 'critical period'.

Quantum cryptography offers the potential to address these challenges with a consistency and level of protection that was previously impossible. The ability to implement **Quantum Key Distribution and post-quantum encryption** is not a trivial process, but requires specialized infrastructure, processes, and people. The quantum computing related risks are generally those associated with supporting technologies like cloud storage and data transmission. Securing the solutions in this domain will form the future paradigm in data handling and security standards and need for quantum related IT will only grow over time.

Key challenges in adoption of Quantum Safe Cryptography

- Absence of experts
- Absence of formal quantum assessments
- Need for standardization
- Definition of official evaluation reports and audits
- Integration of Best Practices

The 'critical period' is between now and the availability of commercial quantum computers, minus the time data needs to be secure. Once passed your data are at risk.



Technology impact

The technology consists of the two main concepts; **Post-Quantum Encryption (PQE) and Quantum Key Distribution (QKD)**. Both aim at providing protection against threats exerted by quantum computers.

PQE primarily uses mathematical encryption code which is secure against currently known quantum computing algorithms. PQE with specific key lengths are benchmarked and widely available today, whilst new PQE is developed by specialist research groups.

QKD generates and distributes secure shared keys over a physical network. QKD is based upon determining if a line has an additional (unwanted) observer and successful distributed keys can hence intrinsically not be decoded by eavesdroppers.

Key focus areas for PQE:
- Implement PQE at company-wide level, minimally quantum safe.
- Monitor, review PQE algorithms and provide recommendations
- Prepare IT infrastructure for encryption adaptability and possible integration of QKD
- Focus on development and testing of new PQE

Key focus areas for QKD:
- Implementing digital security gateways between different geographical sites of high security facilities
- High security cloud Services to upgrade the current infrastructure with Quantum safe options
- QKD subscription to Network
- Custom made QKD implementation and local network

Depending on the security requirements a hybrid world exists, with minimally quantum safe environments, that exchange the encryption standards without changes to other security concepts, and high quantum safe environments, that incorporate QKD and integrate algorithm services within the security infrastructure. Algorithm services monitor advances in quantum algorithms and the possible threats related to them.

Market adoption

"Every new IT infrastructure should be minimally quantum safe" as new security design principle.

The market of quantum encryption, quantum computation and all other quantum related IT will steadily grow over time. Solutions in the QKD field are mature and the new encryption types have already entered the benchmarking process. Since this benchmarking is a lengthy process, current PQE standards consist out of existing encryption types, with adapted key lengths.

Early adopters will be those organizations that have high demands on their communications to be secure. Additionally, those companies that have a lot to gain from computing quantum algorithms will also be early adopters as they have a clearer picture of the possibilities.

The increasingly 'Smart' infrastructure for utilities and transport, in combination with IoT form an increasingly large scope for quantum safe cryptography. Failure to take on the quantum challenge is what Kaspersky Lab aptly coined in their 2015 security bulletin, the 'cryptopocalypse'.

Quantum computing poses a threat to conventional information security systems.

Conclusion

Quantum safe cryptography will create an important new mind-set within the digital security arena impacting individuals, companies and governments. Before 2020, every business with high security requirements has to be quantum safe. **Adopting quantum safe cryptography today will safeguard the future of an organization on a cybersecurity level**, whilst paving the first steps to grasp the future quantum opportunities by already implementing minimal quantum safe security on conventional computer architectures.

The immediate next steps forward are for companies to do an assessment about their quantum security needs and quantum possibilities, and decide upon how to prepare their IT infrastructure for the future with quantum computers.

4. Evolving challenges

IT for Life
Fast Data
Deep Learning
A simplification in cybersecurity
Identity & privacy

Evolving challenges

IT for Life

As 2020 approaches, Demographic trends and Climate Change are likely to put pressure on healthcare services and on the availability of food and water. Human behavior will also play a decisive role in the sustainability of energy and in how we choose to socialize in a globalized world. Ethical dilemmas will force us to ask difficult questions in the rapidly transforming areas of healthcare and social interaction. **IT for Life** examines the role that the 3rd Digital Revolution will play in overcoming these challenges by 2020.

Access to healthcare has already attracted significant attention from governments, academia and the private sector. Without sweeping reform, the aforementioned pressures will challenge the ability of healthcare providers in the developed world to improve, or even maintain, the quality of care that they provide. The 3rd Digital Revolution has unlocked innovations that could hold the key to sustainable healthcare provision. However, certain ethical considerations must be carefully made before any potential solutions can be adopted.

Omics & healthcare

The large volumes of patient data created by digital medical technologies will be a valuable resource towards increasing the quality and availability of healthcare. The insights provided by this data will enable significant efficiencies in healthcare provision by facilitating a shift towards a **P4 healthcare model**: **predictive, preventative, personalized and participatory**.

On the B2C side, the digital revolution in healthcare has increased the volumes of patient genetic data. Innovative Life Science players have disintermediated healthcare providers by supplying millions of individuals with direct-to-consumer insight into the impact of their genetic profile on their health. However, genetic data alone often is not enough to accurately diagnose and treat a patient. By 2020, healthcare providers will look to other sources of biological information, including epigenetics, proteomics, and metabolomics, (the -omics umbrella) to enrich their biological understanding of patients.

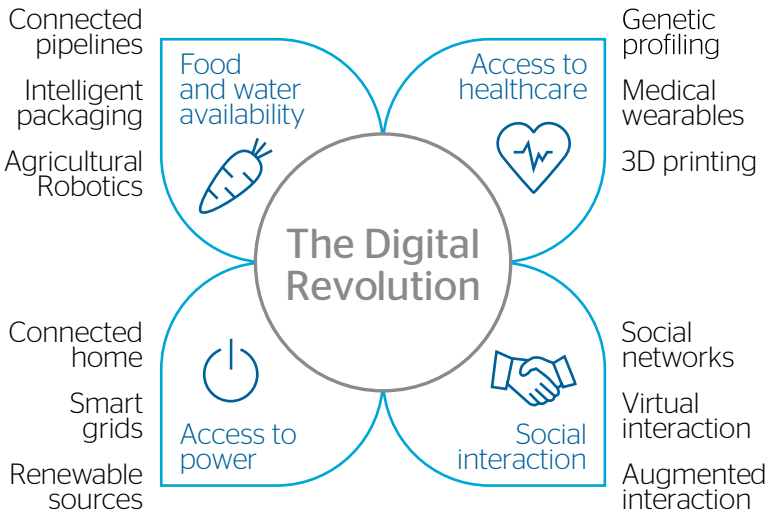


Figure 17 - Where digital technologies will help overcome the challenges of sustainability.

A new approach to healthcare

Widespread use of -omics techniques will redistribute the bulk of the workload from the hospital laboratory to data centers, where High-Performance Computing (HPC) will facilitate the conversion of patient data into meaningful insights that will drive diagnosis and treatment decisions.

For diagnosis, **-omics and clinical data stored in patient's Electronic Health Record (predictive) will be interpreted with prescriptive analytics**, in the context of a patient's real-time lifestyle and wearables-gathered data (preventive). After diagnosis, healthcare providers will rely on Cognitive Computing to design the most suitable treatment in the context of the patient's -omics profile. In the case of surgical replacement of biological structures, the combination of precise 3D printing driven by CT (Computed Tomography) scan models and -omics data, will play an important role (personalized).

As **wearables** become increasingly ubiquitous patients will be encouraged and empowered to participate in their own healthcare. People will record and monitor their exercise and diet through provisioned portals or bots, as well as undertake personalized physiotherapy through Augmented Reality devices and smart musculoskeletal tracking technologies (participatory). **Cybersecurity and privacy must be a primary consideration**; the systems will need to be compliant with all relevant national and regional standards and legislation.

Impact of IT for Life

The knowledge and tools enabled by -omics, real-time data analytics and digital technologies will help to secure continued economic and social progress, impacting across multiple sectors (veterinary medicine, industrial biotechnology, high-productivity agriculture). In healthcare, the patient journey will be transformed from a largely reactive one towards a P4 model.

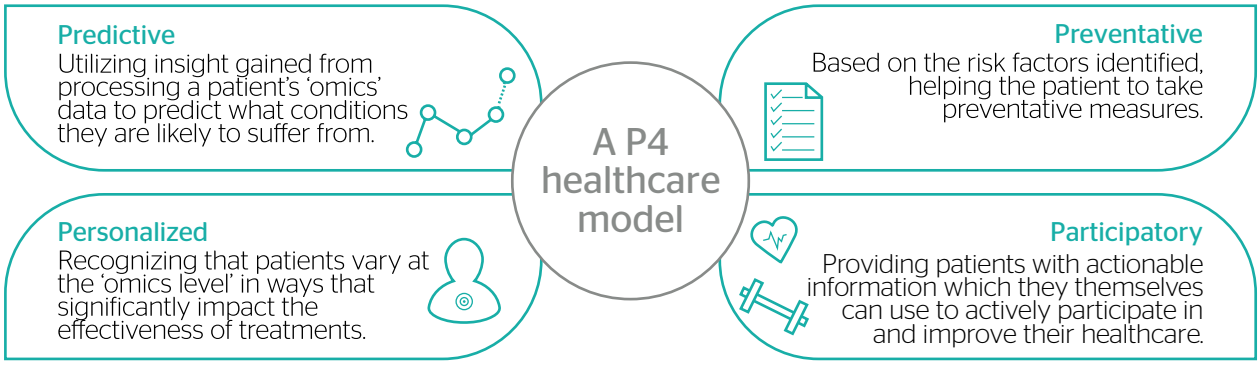


Figure 18 - P4 healthcare

Business impact

The ability to predict, monitor and prevent the onset of costly conditions will offset the cost of proactive investment in P4 techniques over the course of a patient's lifetime. Enabling patients to participate in their own healthcare will help to drive financial sustainability by taking pressure off providers. **Automation and Robotics** will help to drive operational excellence in both hospital environments and out-patient care, ensuring nurses and care workers are utilized efficiently.

As healthcare providers move beyond treating ailments and towards maintaining patient wellbeing, **data-driven, outcome-based patient services will become more prevalent**. Healthcare providers will be rewarded for the successful treatment of patients, incentivizing a more proactive approach to patient treatment. However, such change will not be simple and it is likely that **healthcare providers will face scientific, regulatory and reimbursement barriers** on the journey to 2020.

Ethical impact

The shift to a P4 healthcare model raises a number of ethical concerns. If healthcare providers were to offer outcome-based services, will these be more expensive for those who are unlikely to achieve positive outcomes? Could this lead to an inequitable situation where those who are genetically, physically or mentally fit pay very little, whilst those who are most in need are unable to afford these services? Differences in life expectancy between the wealthy and the rest of society could be exacerbated in absence of legislative intervention. IT companies cannot put themselves outside of that decision making process. As providers of the technology it is our job to take a much more cautious approach and not embrace technology for technology's sake.

Fast Data

Business in 2020 will be driven by data. Whilst Big Data answers "how to take care of the data that I have or will have", Fast Data puts the emphasis on **generating actionable intelligence at high speed, enabling immediate response based on insights derived from deep analytics of incoming data streams**.

Data lakes (historical data) help us understand the past and predict the future based on trends and patterns. Fast Data, however, is time-critical. Its value and derived insights exist within a small window of opportunity as it initiates actions or decisions based on the events identified and on the analytics applied thanks to the historical analysis.

Sources such as Telecom networks, smart sensors and connected devices provide fast event streams that exceed several thousand events per second and now are approaching millions per second. This reality has prompted the development of distributed streaming computing platforms: the seed for Common **Industrial Data Platforms**.

Fast Data is needed to meet the performance commitments of such ecosystems, due to its ability to bring intelligence closer to the data collection point, and to provide prescriptive analytics to act based on this information in real time.

Fast Data is "Data in Motion" where from any kind of incoming information streams, actionable output is obtained in real-time.

Technology enablers

With the implementation of Future Networks, particularly for IoT, there is no longer an excuse for devices not to be connected. Both low bandwidth networks (such as LoRa and SigFox) and high bandwidth networks (like 5G, WiFi or BlueTooth) will ensure that any connected device will have the required bandwidth to optimally communicate with its surroundings and with analytics gateways and clouds.

Data processing capacity will be virtually unlimited when combining this connectivity with **Swarm Computing**. In order to implement the principle of subsidiarity of intelligence, there will be ample computing power available via:

- devices themselves: to make local decisions
- distributed gateways: to make higher level decisions
- data lakes: to review and improve algorithms based on history.

Fast Data will create reimagined implementations of fault-tolerant clustered message queues, in-memory streaming engines, and databases with very high in-memory processing capability and linear scalability.

Algorithms together with their optimized computation architecture will be the critical differentiator in the successful implementation of Fast Data. **HPC technologies** will enable multiple use cases such as image analysis in autonomous cars (using GPUs) and usage of Blockchain in energy gateways (using FPGA's). The low-latency interconnects will allow for scalable clustered message queues.

Fast Data and "Edge Computing" with "Swarm Intelligence" - In the next five years, 15 to 40 billion additional connected devices are expected to hit the market. By some estimates, there will be a 285% increase in the number of connected devices. Thus, a flood of data originating from "things," will raise a whole new set of challenges for enterprises.

Business impact & market adoption

The adoption of Fast Data also **requires organization agility to address and make real-time decisions**, this drives a need for coordination between networks of people. Since the value generated from fast streaming data depreciates rapidly with time, businesses need to reduce the gap between events and decisions in order to exploit transient business moments.

Fast Data solutions will excel where real-time information processing brings a clear business value and gained insights can be actioned at the moment they are obtained.

Fast Data is transversal to all business areas and will transform the way businesses are run today by taking full advantage of new sources of information.

Examples of market specific use cases include:

- **Public Sector**: Connected citizen, predictive and real-time policy data, smart city management, tax non-compliance and fraud detection.
- **Health**: Epidemiology, genomics, connected patient. New healthcare applications, paired with nanotechnology advances that can provide instantaneous real-time diagnostics and take immediate actions based on health indicators of patients.
- **Manufacturing**: Especially in Industry 4.0 environments, Fast Data can provide predictive asset optimization and spare parts forecasting, with self-repairing, maintenance and calibration of machines based on real time data to improve quality of the produced goods. Adding product field feedback can also benefit market and sales forecasting and make significant improvements in operational planning, creating prescriptive supply chain management actionable models.
- **Retail**: Further improvements in customized marketing, where personalized offers can be sent in real-time to potential customers based on the combination of historical profile and current behavior: geolocation, social network activity and mobile activity, which will lead to price optimization, real-time promotions and truly cross-channel customer management. Relationships with clients can be extended through connected devices and wearables.
- **Transport**: Applications for traffic flow forecasting, route and schedule optimization, and predictive asset management. Automatic vehicles will be significant users of Fast Data technologies. In this case the hurdles of computation and autonomy are somehow less of a problem as the vehicle can be itself a computation hub; nevertheless agility and real-time decision making algorithms will be required for them to become a reality.

Conclusion

As the Internet of Things expands with many billions of connected devices and with the maturity of Industry 4.0, **Fast Data and distributed analytics are becoming the mainstream solution approach to the whole decision making chain**: (1) batch-oriented massively parallel analytics (MPP) for predictive analytics, (2) design, development, testing, training and continuous refinement of the algorithms (Swarm, Deep Learning), (3) distribution of algorithms and intelligence to the edge nodes for automation (distributed Artificial Intelligence), and (4) final decision-making implementations in Fast Data environments.

Deep Learning

Deep Learning (DL) is a branch of Machine Learning that has enabled significant progress in tackling problems such as large-scale image processing and automatic speech recognition. It has its roots in Neural Networks, a 40-year-old technology which has continued to be researched and improved upon, but without any significant breakthroughs until recently. Then in the mid-2000s, new algorithms were devised that allowed researchers to overcome many of the inherent challenges with Neural Networks, making it possible to **build and train very large and multi-layered networks in massively parallelized forms**.

Business use cases

Currently most DL applications use **"supervised learning"**, where a network is trained with a large set of labelled data examples for various object categories - for example, an image of a cat is labelled 'cat'. The examples are used to produce a model which can then be used for identifying and categorizing new samples. This technique allows thousands of data patterns to be recognized quickly with unprecedented performance in terms of error rate. The most common use cases for DL are in image and speech recognition through applications such as voice controlled personal assistants (Google Now, Siri and others), autonomous vehicle guidance, facial recognition, video surveillance, image classification, and industrial computer vision systems.

DL can also be used for natural language processing, notably to build "high-dimensional word spaces" where potentially associated words are placed according to their proximity in large sets of text. For example, in a word space created from history books, we could see that the relationship "King" - "Male" + "Female" can be interpreted as "Queen", i.e. the network has 'discovered' hidden semantic relations between these words. Other kinds of models, called "recurrent neural networks", can automatically generate text based patterns learned from examples. The combination of such models has proven to be very effective for automatic translation, sentiment analysis, keyword extraction, text summarization, automatic question-answering machines or information retrieval.

Last but not least, DL can also be used for action planning. A DL system can notably outperform other approaches for reinforcement learning, by learning from actions performed in a simulated system and teaching itself the optimal action plan. For example, software is able to teach itself to play chess so effectively that it can win at the chess "grand master" level; some robots have learned to grasp objects without any need of human assistance; and an automated CRM system can automatically suggest the optimal direct marketing action plan for a given customer.

Enabling technologies

DL algorithms can be implemented across a very wide range of hardware, from embedded devices, farms of GPU based servers or HPC clusters. Single-precision GPUs currently provide the most cost-effective computational power, but it is likely that dedicated hardware solutions based on e.g. FPGA or Computing Memory will emerge to optimize the efficiency of applications.

On the software side, easy to use frameworks have been developed by companies like Google, Facebook or Microsoft. These have been open sourced with a view to accelerate the diffusion of these technologies in research centers and industry. Thanks to this approach, DL has become one of the most active research topics in computer science, and has revitalized the research in **Artificial Intelligence** (AI).

Evolving challenges

Challenges for 2020

A single neural network does a very specialized task. **A significant challenge is that of how to combine several networks alongside other machine learning and AI techniques, in order to perform more complex tasks** within a given application. A Google program, which received much attention recently by beating a human Go game champion, illustrates the power of such an approach.

Another important challenge for DL is how it evolves into a more **unsupervised learning** tool, i.e. the ability to identify objects, speech and images without having been previously trained on a related dataset. Such abilities are akin to what humans are capable of - automation at this level of sophistication clearly holds tremendous potential. It is likely that early advances will make "pre-trained" models more readily available, thereby reducing the required investment in terms of data samples and time to set up an initial model for a new application. Such an approach should enable a domain specific SaaS based model factory, where **standard models could be tailored by customers** for their specific needs, and improved iteratively through a managed factory workflow.

Conclusion

In a data-driven environment, DL techniques will enable a compelling and powerful solution which is capable of **automation of information extraction and identification at an industrial level in a relatively seamless manner**. Most industries will be impacted, for example, sectors using image recognition, such as Security, Manufacturing or Healthcare, are likely to have many valuable applications. Many companies will see huge benefits from annotating large content repositories, which will in turn enable vastly improved recommendation systems. DL's ability to learn how to plan sequences of actions will enable the development of intelligent agents to automate knowledge work and create context aware robotic systems.

The first wave of DL applications has focused predominantly on "supervised learning" approaches and single networks. However with multi-network designs, cost effective general and special purpose hardware architectures and the promise of robust, readily available 'unsupervised' tools, the benefits are likely to increase exponentially.

Businesses can already benefit from the power of Deep Learning in very specialized tasks. By 2020 benefits will grow exponentially due to increased unsupervised learning and the extension to more general tasks.

A simplification in cybersecurity

In today's hyper-connected era, almost every device can be considered part of the information technology ecosystem. They interact in a dynamic way and without strict supervision, giving rise to new challenges and threats in the context of cybersecurity. In addition, new and exciting opportunities are provided to offer deeper integrated and open solutions aimed at improving overall situational awareness and increasing organizational and system resilience.

Emerging technologies

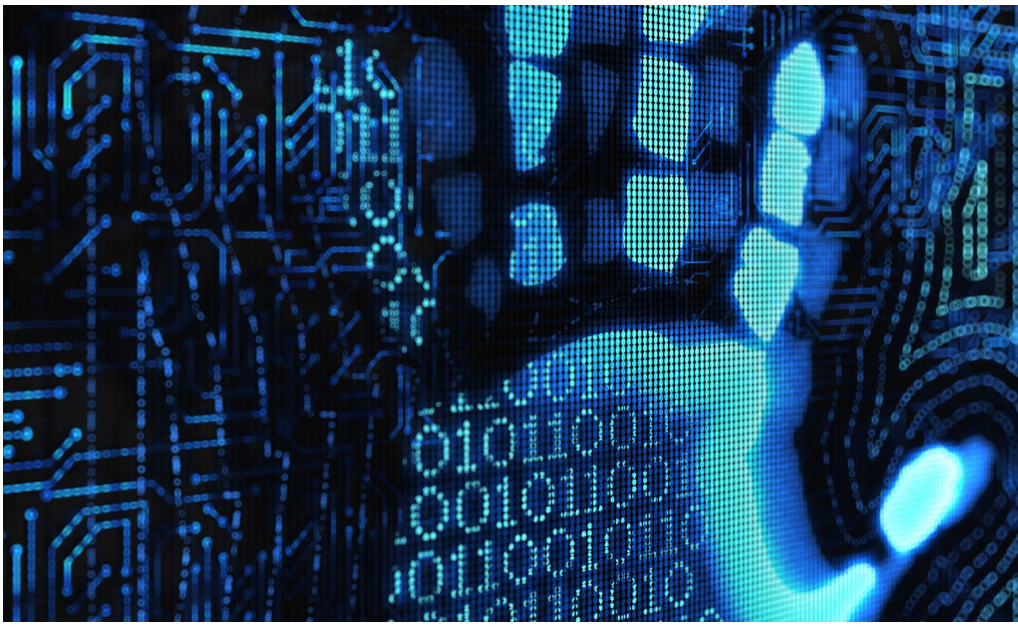
A number of upcoming technologies will by 2020 combine to become important drivers of **simplicity and automation in cybersecurity engineering and operations**. Those technologies will support concepts for the security of interconnected value chains – like trusted brokers, dynamic access control, application shielding or cyber ecosystems – use-cases that were introduced in Ascent Journey 2018.

Software-defined security architectures implement layers of abstraction and intelligence that cross traditional boundaries, like network topology, security domains and business process management. All security mechanisms such as network segmentation, intrusion detection, data loss prevention and identity and access management are interoperating in a business process contextual manner. These mechanisms will be under the governance of dedicated policy-driven software that ensures the orchestration of dynamic security controls which can automatically adapt over time to changes in system configuration, underlying infrastructure or risk situations.

Cyber-resilient systems have the ability to independently adapt to changing threat or impact levels as a result of dynamic business processes. Evolving business requirements have to be fulfilled using dynamically re-configuring infrastructure and connectivity. This requires protective, detective as well as reactive and – if possible – prescriptive controls within the respective cyber physical system, whilst at the same time dealing with the challenge of limited performance and storage capacities.

Real-time security analytics allows the interrogation of large volumes of data in real-time to quickly reverse-engineer attacks to their source and neutralize the attacks - or even pre-empt attacks via target threat intelligence. Such an approach allows the storing and access of security information at a fast pace to detect abnormal behavior, predict security threats and prescribe countermeasures before any incidents are able to have an impact. Correlation and observation of huge amount of data will be simplified through such analytics engines.

Next generation cryptography encompasses the innovative technologies in trusted computing that are expected to mature by 2020. It includes such topics as Blockchain or homomorphic encryption. Blockchain enables a new form of distributed, secure and accountable cooperation without the need to trust a central intermediary. Homomorphic encryption on the other hand is a technology still very much in a research stage that allows the processing of encrypted data without the need to decrypt it. This feature is particularly interesting to implement privacy-compliant processing and allows not only for transition and storage, but also for the operation of data in untrusted or third party environments.



Evolving challenges

Business impact

When organizations are resisting the adoption of new digitalization concepts because of fear from cyber threats, we can objectively state that **cybersecurity has ceased to be an IT issue and has become a business critical concern**.

The costs associated with the protection of cyber assets is expected to continue growing in the foreseeable future. Evolving from a manual approach to security control to automated cybersecurity will be essential in order to manage the scale, complexity and volatility of risks emerging with increasingly digitalized business models; especially when enterprise IT, production IT and smart products merge into an Internet of Things (IoT) or Internet of Services (IoS).

Market adoption

Markets with shorter innovation cycles, such as personal vehicles, home appliances or other consumer electronic goods have already experienced the first waves of digitalization and are already experiencing the risk of constraint from emerging regulation.

Other more regulatory or standards-driven sectors, such as Rail transportation, Aerospace, Manufacturing and Energy will be expected to reach digitalization by 2020 and beyond, and solutions will need to demonstrate cybersecurity by design.

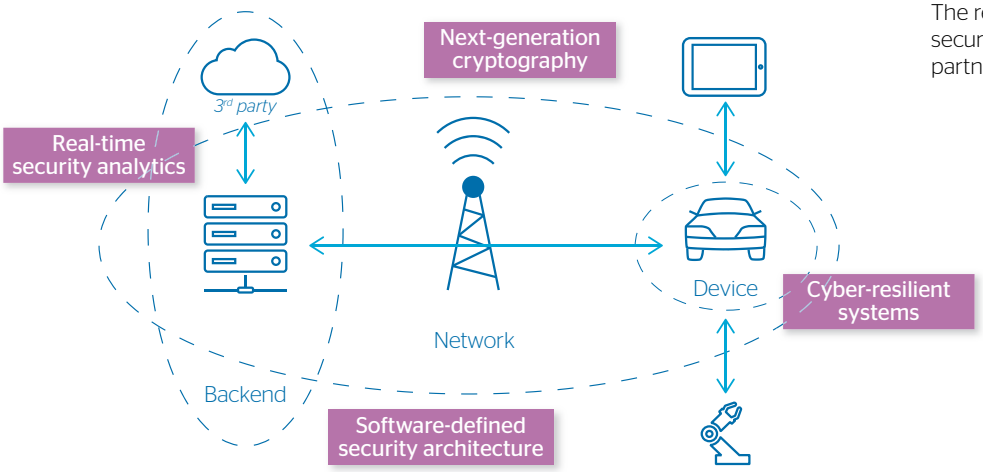


Figure 19 - Emerging cybersecurity technologies for connected ecosystems

More and more enterprises are realizing the extent of cybersecurity challenges when moving into a digitalized and connected ecosystem. The deployment of an interconnected ecosystem presents a daunting array of components and software with few existing standards, requiring extensive set-up services. The application of emerging cybersecurity technologies will reduce the time for the expected cybersecurity information flows to materialize and be integrated into business risk processes and operational culture.

Conclusion

Cybersecurity will be a key enabler when it comes to a digitalization of business models, and we move increasingly towards a circular economy. As a result of the huge scalability, volatility and complexity of digital business processes, a simplification of cybersecurity management is needed to ensure sustainability of solutions and processes. The required evolution into automatized security controls (on premise or via trusted partners) will pave the way forward.

Identity & privacy

Compliance and transparency are key components of the digitalization and increased monitoring of human behavior.

Ubiquitous computing in combination with a high volume of information has all the characteristics to make privacy a concept of the past. However it is also evident that **global surveillance, recurring identity thefts and data breaches have created mistrust** between individuals, governments and corporations. So while consumers still understand that sharing data has become the key to many of our daily activities, they expect increased protection of their identity as well as value and rewards in return for the exploitation of their data.

More and more **data protection** legislations are being adopted across the globe to strengthen the obligations of entities that process personal data, ensuring that they improve its individual protection and control. The continuous increase in enforcement of the principles these laws impose will play a fundamental role in the way organizations manage personal data and implement processes to ensure compliance.

In addition to data protection rules, **KYC** (Know your customer) **requirements** will be much stronger in 2020 than they are today. Specific regulations in various business areas will further drive this change.

In response to such increased monitoring and surveillance, consumers are already widely adopting "privacy enhancing" technologies or techniques such as ad blockers or the intentional "dirtying" of databases. Users are also increasingly ready to change providers if not satisfied with how their personal data is handled. By 2020, almost every aspect of human behavior will be analyzed, recognized and managed through data analytics. "Digital" has started going beyond producing virtual and dematerialized services and is actually starting to influence the way in which humans do or should behave. In some cases this trend towards **"algorithmic governmentality"**[33] has already led to a shift in behavior with customers rejecting digital services in order to regain freedom or to sub-consciously self-censor and withdraw from debate[34]. At the same time, concerns for national security as well as the thirst for innovative services which almost always involve the processing of personal data, continue to place individuals in a form of "privacy schizophrenia". By 2020, upgraded data protection regulations will be in full effect, helping to re-establish trust.

Business impact

New alliances will be formed. Competing technology companies and even civil society will align their positions to address privacy concerns in the face of governmental access requests to data. While motivations will certainly vary, objectives will converge.

Combined with the continued **blurring of the lines between the roles of data controllers** (i.e. entities defining the purposes and means for which data is processed) **and data processors** (i.e. entities which process data on behalf of data controllers) this will lead to the emergence of a new genre of common interests. Data operators will re-invent and re-think the allocation of their respective obligations and their relationships with public authorities. They will progressively adopt common data protection policies (codes of conduct, binding corporate rules).

Data Protection by design and by default as well as **accountability** are now defined by laws. They will have a disruptive effect on the conception, creation and development of goods and services. Companies will thus change their technological approach from creation to delivery. By 2020, we expect that data protection by design will have moved away from policy into fundamental process and service design.

The increased compliance risks associated with the exponential growth of data processes will force entities to adopt **automated measures and processes** to efficiently manage and enforce data protection rules. To achieve a substantial part of this objective, organizations will consume more and more security services provided by organizations that are specialized in data protection and risk management. In 2020, **data and identity pseudonymization** techniques will be amongst the most widely used to protect the identity of individuals while still allowing efficient processing of the data.

Various companies are exploring Personal Information Management Systems (PIMS) that will act as an intermediary service to let consumers control personal data and allow them to decide how to share different pieces of that data with various companies. To become a reality, this emerging market requires a **shift from 'organization centric' to 'user centric' personal data management.** New regulations supporting transparency, openness, user control and granularity of choice are all drivers, since they force existing players to open their silos. Technology is also on the rise with Attribute Based Credentials or protocols such as User Managed Access.

[33] Antoinette Rouvroy, Thomas Berns, and Dominique Deprins. "Algorithmic governmentality: computed reality, contemporary governmentalities and new processes of subjectivation"
[34] Elizabeth Stoycheff: "Under Surveillance: Examining Facebook's Spiral of Silence Effects in the Wake of NSA Internet Monitoring"

Evolving challenges

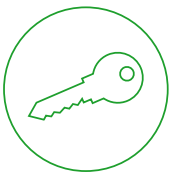
Market adoption

Increasing consumer awareness and concerns over data protection will raise the focus of service providers to demonstrably remain "data protection compliant". Accordingly, adoption and demonstration of compliance through transparency, notably with regards to subcontractors and business partners, will be a necessity to survive in the market of service providers or manufacturers dealing with personal data.

Identity is the first link of the digital value chain. Holding and securing it is vital for corporations. In this area, we expect the generalization of **continuous authentication** solutions – relying on user devices, behavioral biometrics and featuring Privacy Enhancing Technologies to enable pseudonymization. The growth of global digital business should also favor emergence of **sophisticated documentary fraud** management solutions.

At a national level, the **identity trust framework** will reach a critical size and help tackle the issue of digital identity and attribute sharing – see NSTIC in the USA, IDGov in UK, FranceConnect in France...

Data protection will be at the heart of process



Identity will be secured

Users will become empowered

Conclusion

Individuals already demand better privacy protections and better controls in relation to their digital identity. Even though people may be concerned and want control of their information, it will not significantly slow down the pace of creation, processing and sharing of personal data. The Digital Era is the cause of the current situation, but it also provides a remedy by enabling the distribution of personal data control to each individual.

The importance of brand trust and reputation will therefore be even higher in 2020 than today and the manner in which the protection of identity and personal data is managed will be one of if not THE key element in this battle.

About the
Atos Scientific Community

Innovation lies at the core of Atos' business strategy and the company has organized itself to think one step ahead to help its clients to reinvent their growth models. The Atos Scientific Community brings together **over 120 best-of-breed business technologists** from all Atos geographies and businesses, representing a rich mix of skills and backgrounds. Its aim is to help Atos anticipate and craft its vision of upcoming technology disruptions and the future business challenges that will be faced by the markets it serves. By making this vision available to its clients, and by investing in areas related to the findings, **Atos intends to help its clients make informed decisions as the Trusted Partner for their Digital Journeys**.

The Scientific Community are "creators of change", highlighting the importance of innovation in the dynamic digital services market and taking a proactive approach to identify and anticipate game changing technologies. They are mentors in the **Atos IT Challenge**[35], a competition encouraging the next generation of IT talents from universities across the world.

> The Scientific Community is the best 120 scientific people from within the organization. They are "creators of change", making sure that whenever our clients choose us they always get the best solution available.
>
> **Thierry Breton**
> Atos Chairman and CEO

Key achievements

- **Proofs of Concept** implemented in various domains, including Wearables & Connected Assistance, Additive Manufacturing, Blockchain, Augmented Interactive Reality, Intelligent Networked Enterprise, Digital Manufacturing Platform, Homomorphic Encryption for Industry 4.0, Interactive & Dynamic Media (Smart Player Stadium) and IoT & Connected Home. Atos Business Technology Innovation Centers (BTIC) in Atos Paris HQ, Munich (Germany), Pune (India), London (UK), Madrid (Spain), Vienna (Austria) and Amstelveen (Netherlands) are designed to showcase proofs of concept to clients.

- **Publication** of *Journey 2014*, *Ascent Journey 2016* and *Ascent Journey 2018* – extensive studies providing insight to future technology trends and how businesses can use technology to grow and transform.

- **Seminal and instrumental role** in the Siemens-Atos joint R&D and Innovation investments.

- **Partnership with key Research Institutions** including CEA in France and Fraunhofer Institute in Germany.

- **Key contributions to Atos Intellectual Property** (patenting & patent reviews).

- Providing the lighthouse for **bringing new concepts and services into the Atos portfolio**, such as the Atos ambition to be a Zero E-Mail™ company, Atos Codex, Industrial Data Platforms or Quantum Computing.

- Extensive contribution to **pilot projects** that prove the business use of breakthrough technologies and support Atos' clients' digital journeys.

- Activities carried out or originated by the Atos Scientific Community have resulted in a number of **awards**, such as the Digital Impact Award 2015 for City Pulse[36], the Design for Additive Manufacturing Challenge 2016[37], the EVS C-Cast APPlied Challenge for SMART (Sports Media Application in Real Time)[38], the 2015 European MAKE Winner recognition for enterprise-wide collaboration and knowledge sharing (blueKiwi)[39] and the 2015 Cambio16 Innovation Award for Atos' contribution to businesses' adaptation to the new production models of Digital Transformation[40].

The Scientific Community regularly publishes **white papers**, most of which are downloadable[41]:

- 3D Printing
- Advanced Mobile Payments
- Cloud Messaging
- Cloud Orchestration – A Real Business Need
- Connected Robots
- The Convergence of IT and Operational Technology
- Data Analytics as a Service
- Digital Preservation in the age of Cloud and Big Data
- Economy of Internet Applications
- Fabric-Based Computing
- The Future of In Store Shopping
- Information Overload
- Internet Evolution
- IPv6
- Liquid IT
- Media Metamorphosis
- Open Innovation
- PaaS – Making the Most of Clouds
- Real Time Traffic Forecast
- Security for BYO Concepts
- Service Integration and Management: Motivation, Challenges and Best Practice
- The Connected Train
- Unlocking the Potential of Additive Manufacturing
- Video – The Power of Moving Pictures From Glass to Glass

[35] The Atos IT Challenge promotes innovation in an open environment amongst best-in-class Universities and students as well as support young innovators in taking their ideas forward. Find out more at atositchallenge.net
[36] ditss.nl/atos-wins-digital-impact-award-citypulse/
[37] additiveworld.com/News/Atos-and-cassidy-silbernagel-winners-design-for-additive-manufacturing-challenge-2016

Acknowledgments

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Development of this document was led by the **Ascent Journey 2020 Editorial Board** of the Scientific Community:

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[41]ascent.atos.net/ascent-white-papers/

About Atos

Atos SE (Societas Europaea) is a leader in digital services with pro forma annual revenue of circa € 12 billion and circa 100,000 employees in 72 countries. Serving a global client base, the Group provides Consulting & Systems Integration services, Managed Services & BPO, Cloud operations, Big Data & Cyber-security solutions, as well as transactional services through Worldline, the European leader in the payments and transactional services industry. With its deep technology expertise and industry knowledge, the Group works with clients across different business sectors: Defense, Financial Services, Health, Manufacturing, Media, Utilities, Public sector, Retail, Telecommunications, and Transportation.

Atos is focused on business technology that powers progress and helps organizations to create their firm of the future. The Group is the Worldwide Information Technology Partner for the Olympic & Paralympic Games and is listed on the Euronext Paris market. Atos operates under the brands Atos, Atos Consulting, Atos Worldgrid, Bull, Canopy, Unify and Worldline.

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Let's start a discussion together

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