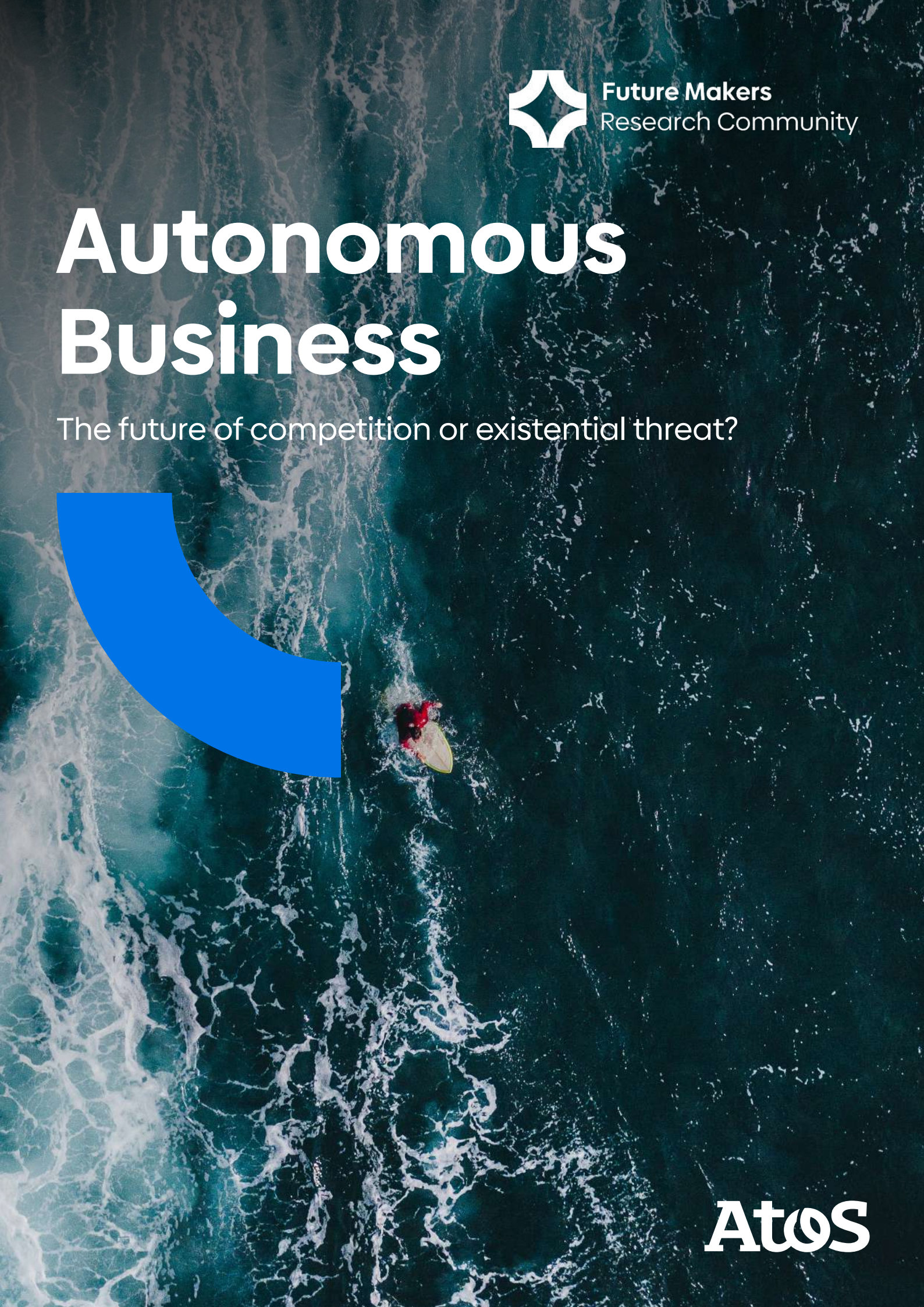


Future Makers
Research Community

Autonomous Business

The future of competition or existential threat?

Atos

Table of contents

Contents **02**

Management Summary **03**
Introduction 03

Autonomous Business **04**
The next big leap 05
Process-centric 05
Data-centric 05
Ingenuity-centric 06
Uncharted territory 06

Three Key Motivators **08**
Increase business productivity and reduce costs 09
Increase business resilience, performance and agility 09
Improve quality and brand equity 09

Building Blocks **10**
Transparency and trust 11
Availability, control and quality of data 11
Artificial intelligence 12

Orchestration **13**
Independent orchestration 14
Components of the independent orchestrator 15

Business Examples **16**
Consumer business 17
Vertical or horizontal? 19
Self-reflection AI 20
Potential future scenario: Mergers and acquisitions (M&A) 20
Potential future scenario: Resources 21

Trust **22**
Development of Trust 23
Examples of Trust 23

Ethical Aspects **24**
Replacing people's jobs 25
Preserving data privacy and sovereignty 26
Malicious use 26

Summary and Final Thoughts **27**

About the Authors **28**

Acknowledgements **28**

Management Summary

Introduction

Let's start with the obvious: The following is meant to be a thought-provoking essay, rather than a scientifically detailed white paper. It is a vision of a potential, arguably likely, future of doing business. As such, it needs to stay relatively general, but our goal is to touch on all relevant technology elements and topics. We will not provide definitive answers. It is meant to be a heads-up — some would say a warning, while others might consider it a promising outlook — of what may come to pass. Things we need to prepare for, just in case. In essence, we predict that companies will rise and potentially fall, but in any case, they will act and react at a much faster pace than today. Such development will prompt necessary changes for companies, and these changes already need to be taken into consideration today.

The potential developments outlined below might seem unrealistic to some, while others deem them to be highly certain and perhaps occurring just around the corner. Could these developments happen over the course of the next five to ten years? Or, is the complexity so high when entire businesses are involved that the potential timeframe is even longer or infinite? In mobility, we have all seen predictions of truly autonomous driving which have not unfolded as quickly as they seemed at the outset. Yet, the developments around autonomous driving are already governing the business and consumer decisions we make today.

So, some of what we will describe could qualify as "bad Sci-Fi" — visions of an undesirable future. Yet, the question remains: What do we do about it?

Autonomous systems are constantly evolving in many different industries, and these improvements are generating value for society. Whereas automation first started with a focus on automating small steps, it now leads to performing complete processes. Today, this process-centric approach is covering many kinds of business processes. Automation based on data will soon aim at replicating human intelligence. Thus, decisions will be made not only based on the data available, but also in the absence of data.

In business terms, entire business value chains could soon be managed without any human interaction. This likely leads to a situation where environments of autonomous businesses will compete against each other. In this uncharted territory, some players will establish environments like these more quickly than others, potentially creating unbalanced situations — not just from a business perspective but in terms of creating undesirable effects on society. Automation will eventually transform or merge into autonomy.

The key motivators of such developments are obvious: increase business productivity and reduce costs, increase business resilience, improve performance and agility, and finally, improve quality and brand equity.

Thus, autonomous business is not a development on its own. It is the result of a combination of ongoing developments on multiple technological topics like AI, cloud, and security — and a result of how we think and behave as humans.

As a necessity, independent orchestration will allow isolated automated systems to interact within a market or an industry ecosystem, creating an end-to-end autonomous chain. Consequently, autonomous ecosystems will force us to rethink how our society — and thus business — is constructed. In a world where true autonomous businesses operate and compete, we need to find a new social balance in everything we do, and we need to predict the way such competition will occur and ultimately affect us.

The latest publication of the Atos Scientific Community, Atos Journey 2026 - Unlocking Virtual Dimensions,[1] describes the potential possibilities when stretching the current physical boundaries. In this paper, we will continue exploring. As we stated at the outset, it is not meant to provide answers to all the questions that exist today. It is merely a thought exercise to discover the questions we (as humans and as organizations) should ask while the developments are progressing.

1 Atos Journey 2026: atos.net/en/lp/journey-2026

Autonomous Business



The next big leap

New generations of autonomous systems are constantly appearing in many industries, with examples like autonomous vehicles, self-managed solar plants or automated checkouts in retail stores. All of these are driven by emerging technologies like AI,[2] IoT,[3] blockchain, edge, hybrid cloud or quantum computing.

Society makes use of these improvements to create value for people and businesses, contribute to economic growth and make progress on unsolved societal challenges while taking ethical and environmental aspects into consideration.

Although no one can predict in detail what will be the ultimate impact of automation and its related technologies, companies and workers need to constantly adjust to keep up with such developments. Individuals and companies need to assess themselves to determine how to adapt and benefit from the new possibilities. In addition, many public and private institutions (like the European Parliament) have launched initiatives to prevent the unwanted outcomes of automated business decisions. Thus, they are regulating the potential ethical aspects of automated systems, an aspect which companies and their employees also need to take into consideration. This will have a transformational impact through at least the end of this decade.

In almost any enterprise, one can distinguish activities like product development or production from roles like marketing or human resources. While IT has made it possible to automate activities with RPA[4] (the "doing"), roles can also be augmented with AI (the "thinking"). Taken to the extreme, this new reality will augment or even replace humans, with the ability to make complex decisions much faster than today. Finally, decision frequency will accelerate to a rate that humanity has thus far seen only in comparatively simple vertical process scenarios.

Autonomous driving is just such an example, where the car will be able to make decisions much faster than any driver by ingesting and processing environmental data in real time, such as to avoid an obstacle on the road.

Intelligent automation will ultimately make much more complex decisions by itself to cope with the increased need for low-latency business action and create a strategic competitive advantage, as already observed in the financial trading sector. With technology evolution, this new kind of automation enables a leap rather than incremental progress — from manual and systematic (structured and repeatable) cognitive tasks to highly complex, non-systematic cognitive tasks. This will add greater autonomy to products and services: With those developments, enterprises will shift from automated business towards truly autonomous business.

Process-centric

Looking back in time, the first steps in automation were mainly focused on automating small tasks within a specific process. Over time, especially with the introduction of ERP[5] systems, entire processes were automated. It was clear when and what to expect in each step of a process. One of the key aspects of this paradigm was a significant increase in frequency — acceleration, in other words.

Historically, we have seen many examples — such as how parts of manual stock trading were moved to today's algorithm-based High Frequency Trading (HFT). Quite similarly, today we are starting to see platforms, automation and AI helping businesses act quickly when it comes to automating relatively simple business processes like the typical online hotel booking. In essence, aspects like HFT automated a single, repetitive business process, just like purchase-to-pay or supply chain processes within an ERP environment.

Over time, many of those types of business processes were automated (and eventually federated) to cover a wider range of business processes.

Data-centric

The next step was automation based on data. In this case, data can consist of not only structured information but also documents, social media, sentiment analysis, etc. In the example of a merger or acquisition, data should form the basis for the decision to acquire a company (or not). However, automation does not totally manage it: In the end, the decision is still made by humans today.

In such processes, data is gathered and subsequently combined with personal experience and, at times, sentiments. While these "ingredients" might seem different in nature, they could also be described as just "more" and "deeper" information. In a data-centric approach, automation will be able to make decisions by itself, taking more data sets into account far faster to determine the most efficient path forward.

2 AI: Artificial Intelligence

3 IoT: Internet of Things

4 RPA: Robotic Process Automation

5 ERP: Enterprise Resource Planning

Ingenuity-centric

In this emerging phase, automation will be based not only on the availability of data, but also on a lack of data. Ingenuity is automation that can truly create. Examples are the design of products like new cars or a ground-breaking strategic business decision, including its delivery set-up.

Today, this is almost exclusively the territory of architects, designers, artists, entrepreneurs and the like. However, the combination of process, data and ingenuity-centric automation will, in the end, lead to completely autonomous businesses. In this type of business, full-scale business automation will be the first level where humans and automation coexist, but for the first time, the center of gravity will fall on the autonomous, rather than the automation side. Part of this phase will be a replicator-based stage: There would be no human intervention and interaction in the activities executed within a business, at least for a certain timeframe.

Thus, when automation acts like a replication of human beings, a business can truly become an autonomous business. An autonomous business is automated from design to production, logistics and (after)sales. Everything will be designed, managed and executed without human involvement — at least not during the operations of the business case. A possible example could be the performance of an end-to-end business value chain (prepare-create-sell) based on an invention. For example, a piece of music could be generated by an autonomous ecosystem, then managed, marketed and sold without any human interaction.

Uncharted territory

It remains to be seen what comes after the ingenuity-centric stage. At the crest of the big wave pictured in Figure 1, the ingenuity-centric environments will be released into the wild. At this time, it is rather difficult to predict what will happen, and what the effect on society will be.

One could expect to see competition or collaboration using the autonomous business environments we have described. Some will be quicker than others to establish such environments, potentially creating an imbalance. There might even be the danger of a loss of control over an autonomous business, or over complete ecosystems of these businesses acting autonomously.

Organizations need to prepare themselves to interact with autonomous businesses, which can increase their own workload and stress their human-based back-ends.

This potentially calls for regulation. It might even be viewed as bad sci-fi from today's point of view, as it is surely uncharted territory.

Interestingly enough, recent developments like ChatGPT and Google Gemini were not foreseen in such general use until recently. If you would have asked people one year ago about the generative AI functionalities we see today, it would have been called sci-fi as well. Now, all software development companies are adding generative AI to their products, such as Microsoft Copilot. This has also changed the agenda in the boardroom, prompting discussions of how generative AI could support the business. The general public and employees are also incorporating generative AI into their workflows or into their businesses.

For a glimpse of potential issues, one need only look at the role of autonomous systems trying to interfere with the 2020 US elections. Such events can materialize at a speed and significance which rivals the impact of some longer-term trends — and will not always appear in ways that were intended or anticipated. The questions we have today about topics like risk, privacy, transparency and ethics will remain.

The key motivators of such developments are obvious: increase business productivity and reduce costs, increase business resilience, improve performance and agility, and finally, improve quality and brand equity.

In summary, autonomous business is not a development on its own. It is the result of a combination of ongoing developments on multiple technological topics like AI, cloud and security — and a result of how we think and behave as humans.

By necessity, independent orchestration will allow isolated automated systems to interact within a market or an industry ecosystem, creating an end-to-end autonomous chain. As a consequence, autonomous ecosystems will force us to rethink how our society, and thus business, is constructed. In other words, this means that in a society, autonomous systems will have a more prominent role next to human beings.

What does that mean for an individual? Will we still have jobs? Is there a future for our children? In a world where true autonomous businesses operate and compete, we need to find a new social balance in everything we do.

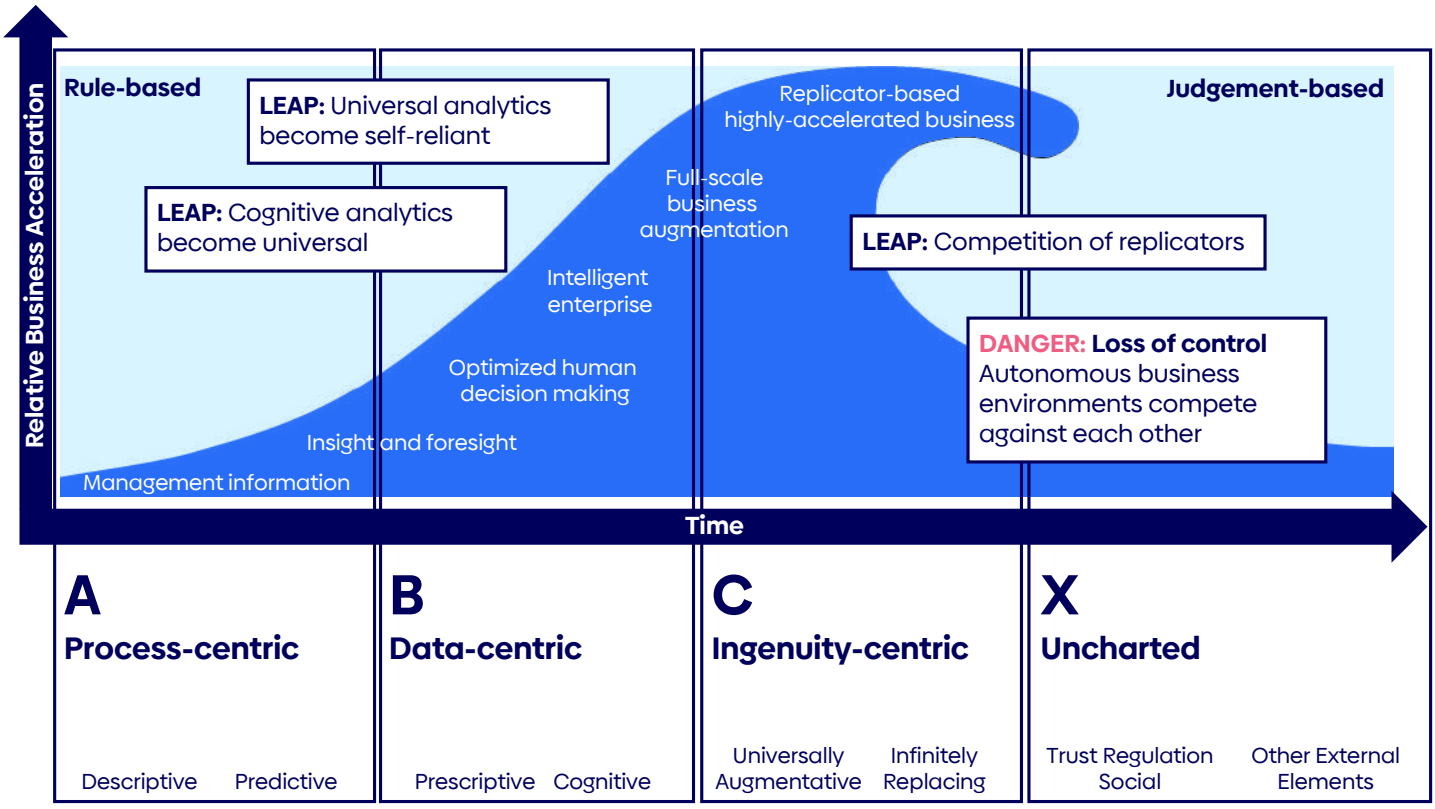
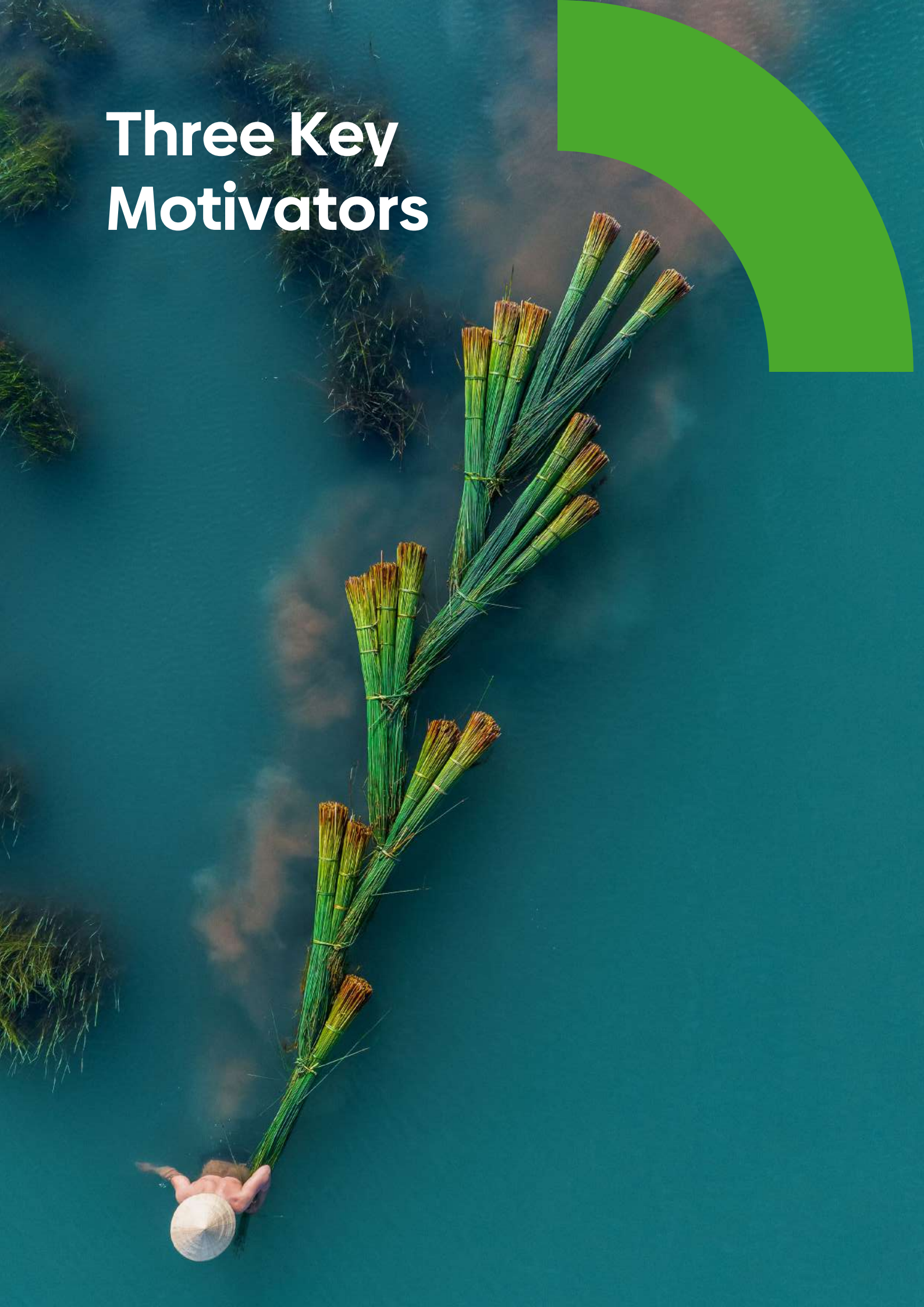


Figure 1: From process-centric to ingenuity-centric and beyond

Three Key Motivators



Automation is no longer the prerogative of industries like discrete manufacturing, automotive or logistics, which were precursors in the last century. It now impacts all industries. Most companies have already automated core business processes such as repetitive tasks, and it will accelerate in coming years as they invest massively in robotics and AI. They are moving gradually to the next level which is, in our opinion, a stage of an intelligent enterprise, where data-driven automation is used at large scale.

The COVID-19 pandemic and its huge impact on the manufacturing industry has demonstrated the need for enterprises to become more resilient. Companies supported by governmental funds are now launching plans to modernize their plants, digitalize their business processes and invest massively in automation while reducing their carbon emissions. Such efforts will require a significant transformation of the organization, its processes and technologies, as well as strong change management to enable humans and machines to collaborate at their best.

Maturity and the speed of adoption will differ between sectors. High-tech companies (particularly the AAMAs[6]) and telecom companies can be considered "automation natives" that are at the leading edge. Yet, manufacturing, automotive, food, textiles, the financial sector and energy/utilities are also large consumers that will continue automating more processes as they have been doing for decades.

The motivating factors are nearly identical between industries, even if some will dominate within a given vertical. These motivators each address well-known dimensions which can be grouped into three main categories:

Increase business productivity and reduce costs

Cutting cost is still the main reason companies choose to automate their processes. The objective is to optimize core business processes while reducing (and therefore transforming) the involved workforce. It started with Taylorism and accelerated with the Third Industrial Revolution. Examples are quote-to-cash and procure-to-pay processes, which have proven to be good use cases for automation. We are now seeing chatbots in most customer care organizations improving service quality with AI, reducing human interaction, increasing service coverage, and moving from a "care" to a "serve" approach. Chatbots that serve customers not only supply the requested information, but actually perform tasks for the customer.

Industry 4.0 has also brought the next level of automation, with highly connected plants and fully autonomous sub-processes already — such as allowing automated software uploads into vehicles on the shop floor during automotive production. Automation also contributes to mitigating resource scarcity and managing widespread retirement, which is now affecting most EU countries.

Increase business resilience, performance and agility

Companies are looking to increase their sales, adapt to demand and improve time-to-market to win market share in an increasingly competitive environment disrupted by new digital players. They are also looking for a stable environment and resilience to external events. Automation helps them accelerate data treatment and improve forecasting and decision making with real-time processing. This will be accelerated with autonomous systems that can make decisions by themselves much quicker than humans could. In the future, the spread and impact of a pandemic like COVID-19 could be anticipated thanks to AI models, allowing organizations to take appropriate action to protect workers or relocate production and supply chains. Organizations are improving agility and scalability, removing some human-related constraints and interfaces which prevent fast decision making.

The IT sector has already reached a good level of maturity — with software solutions allowed to develop, test and deploy new services in a fully automated way. Cognitive data centers with predictive maintenance and nearly autonomous incident resolution are another evolution in IT which is already heavily used by companies offering hyperscale services. Another example could be a factory that is able to transform its production lines in few days to adapt to market demand or to local events of any kind. The benefits for manufacturers of such an approach would be clearly evident during a security or pandemic crisis, mitigating the impact of sick staff and the challenges of refocusing their production.

Improve quality and brand equity

Automation enables us to improve quality controls, reduce human error and anticipate defects with AI diagnosis in healthcare, industrial machine learning, predictive maintenance, or digital twin scenarios in manufacturing. Autonomous vehicles or even ADAS[7] help improve driver experience, but also increase safety by reducing accident rates. However, any accident caused by an autonomous system will have a huge impact on brand equity. In IT services, chatbots and systems that adapt to actual needs have revolutionized the customer experience. They have reduced resolution or provisioning delays from days to minutes and nearly eliminated defects — contributing to the brand image and spectacular growth of cloud providers.

6 AAMA: Alphabet, Apple, Meta, Amazon

7 ADAS: Advanced Driver Assistance Systems

Building Blocks



Autonomous business is the result of a combination of ongoing developments in technological topics like AI, distributed cloud, practical blockchain, security, compute power, edge and swarm computing. Yet, it is also a result of how humans work, think and perceive changes in society that are caused by globalization and culture. The following section is not meant to exhaustively explain these topics. Rather, these are merely the building blocks which are described in depth in Atos publications mentioned in the respective footnotes.

Transparency and trust

Any IT-driven collaborative environment faces the same dilemma: How can one manage the balance between collaborative transparency and the required trust, reliability and accountability?

Since the dawn of globalization, this question has been key, and there is little difference when it comes to autonomous business today. Here again, the question is how to deal with the two countering extremes of open collaboration versus a tight grip on the autonomous business environment.

In Atos's Journey 2024 (Redefining Enterprise Purpose: Thriving in an ever-changing world) publication, we found that rules of cooperation can be unclear and dynamic environments can make it challenging to maintain trust and transparency in the involved business transactions.[8] Of course, it can be highly attractive for business owners to open up and build their platforms on the rapid exchange of data between parties. We anticipate that it will be very important to keep an eye on how autonomous business environments behave and run. The more business owners open up, the more they will lose grip on their models. As stated in Journey 2024, players like clients, regulators and competitors aim to govern processes and value, thus making the risk of collaboration apparent.[9]

In general, approaches like ecosystems which enable a trusted exchange of data, services and value between otherwise distrustful parties[10] can manage this dilemma to a certain extent. Yet, the question remains whether such an approach will be feasible in truly autonomous business environments. The respective answer is probably "no," or at least "it depends." Autonomous business environments will need to behave exactly like the legacy business environments that preceded them. Where possible and necessary, they will be a trusted ecosystem, but they also must be totally open environments in other application cases.

In contrast to the usual trusted ecosystems which rely on structured API[11] management and machine learning (plus an intermediary to enable trusted data exchange), an autonomous business environment will need to establish such a trusted intermediary on its own.[12]

Availability, control and quality of data

When it comes to the ingredients of IT-driven business platforms, cloud and edge are well established today. According to Atos's vision, one important future step will be the added aspect of swarm intelligence.

While cloud and edge have broken down the barriers of physical data centers and brought computing closer to the actual business action, the element of swarm intelligence — which dynamically combines such ingredients — is an intriguing future vision for any autonomous business. In addition, edge would come in handy based on its potential to reduce latency and large data transfers. That way, such an autonomous business environment could form, scale and disassemble the necessary elements of its IT-driven delivery as needed. Smart objects, edge compute nodes, micro data centers and other elements will form a continuum of cooperation throughout this end-to-end landscape, which can be called swarm computing.[13]

In addition, combining artificial intelligence can further accelerate the technical setup. Cloud, edge and swarm then emerge into increased diversity and flexible distribution of services. At the edge, AI will serve as a strong driver for on-the-spot business decisions with self-healing capabilities,[14] a concept already discussed in the case of optimizing factory operations.[15] [16]

However, for an autonomous business to run successfully, the location of compute ultimately does not matter. Yet, we foresee that the availability of data and low latency will most likely benefit the development of autonomous business.

8 Atos Journey 2024: atos.net/en/lp/journey-2024

9 Ibid.

10 Ibid.

11 API: Application Programming Interface

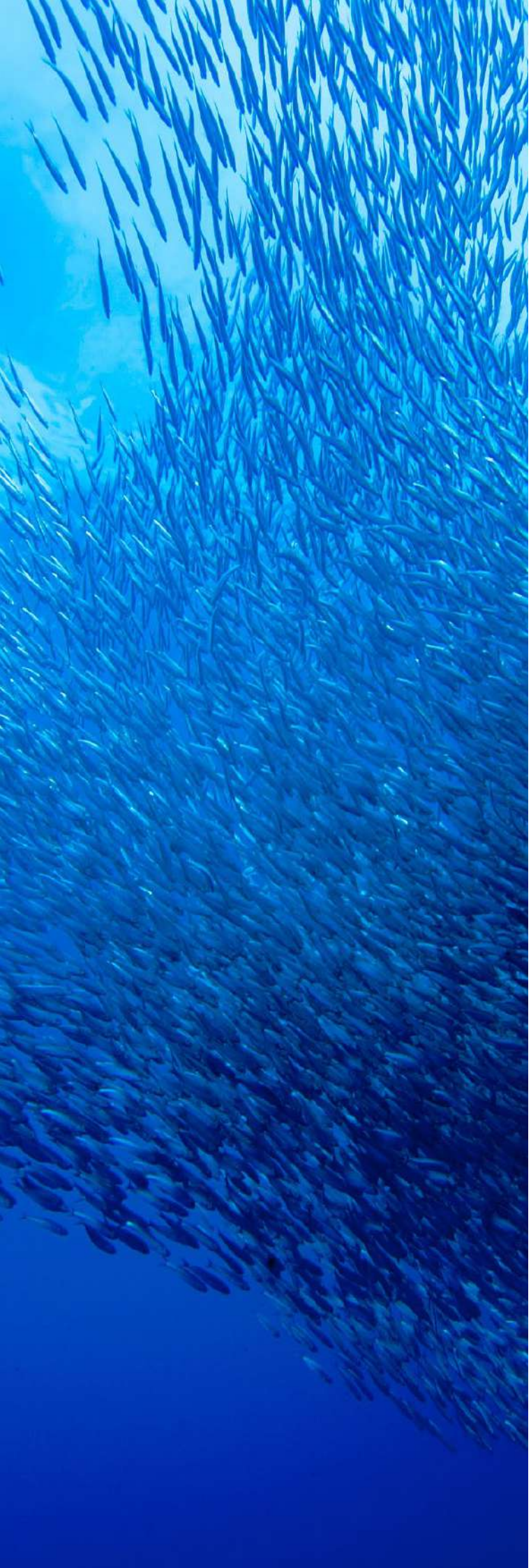
12 Read more in Atos Journey 2024: atos.net/wp-content/uploads/2020/06/atos-journey2024.pdf

13 Computing beyond Edge, Welcome Swarm: atos.net/en/blog/computing-beyond-edge-welcome-swarm

14 Swarm intelligence: Concept, vision and application: atos.net/wp-content/uploads/2020/01/atos-swarm-intelligence-white-paper.pdf

15 educba.com/swarm-intelligence-applications (accessed December 17, 2020

16 Atos Journey 2024: atos.net/wp-content/uploads/2020/06/atos-journey2024.pdf



Artificial intelligence

As seen above, the element of artificial intelligence (AI) is a necessary ingredient for autonomous business. From its early days, the IT-driven development of artificial intelligence has aimed at assisting, improving and finally replacing human cognitive tasks. Traditionally, AI was applied to rather confined vertical scenarios. We currently see digital decisioning gaining momentum as one of the elements that drive decision making.

Now, combined with swarm, cloud and edge, these scenarios can be federated more easily throughout and eventually across different verticals. This will then be called contextual AI. The more combination happens, the more breadth artificial intelligence will cover. Consequently, more complex business use cases will be able to be executed or handled by such contextual and federated AI — which will then be able to support truly autonomous business decisions.

As technology and access to data progresses rapidly and people's expectations of AI change, companies will have to take extra care to balance the socioeconomic dimensions. What is next in AI will drive significant transformational change in the way businesses operate and how their services are consumed. We believe the current state of automation is a precursor to an intelligent enterprise, where data-driven automation is applied at large scale, with ancillary functions and decision support progressively moving to semi-automated and trusted solutions.

This will dramatically increase the speed at which decisions can be made and actions can be taken. Many years ago in financial services, we saw how manual stock trading moved to algorithm-based high-frequency trading. Such levels of automation demand careful regulation and control to avoid unwanted side effects. We need to build trust and preserve empathy and humanity when automation is continuously learning and adapting. Confidence is essential when we encounter the unknown, and there should be possibilities to provide feedback and allow for manual intervention where necessary for the greater good.[17]

17 See: Atos Journey 2024:
atos.net/wp-content/uploads/2020/06/atos-journey2024.pdf

Orchestration



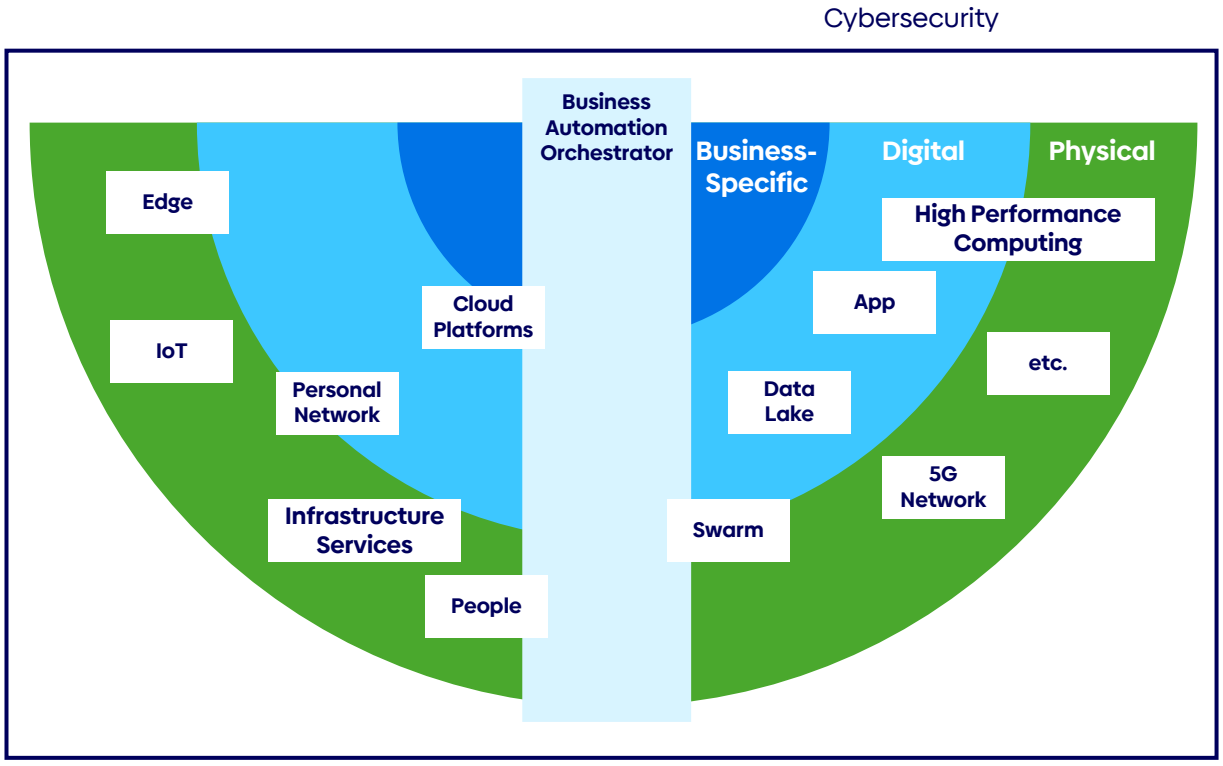


Figure 2: Technology components of business automation orchestrators

Independent orchestration

What is a conductor without musicians? The more sophisticated a composition is, the more complex or ingenious the underlying architecture must be to deliver a fine performance. Behind this lyric parable, if orchestration permits us to design and monitor the proper execution of a business process, the correct data (accessible at the right time) is the "oil" that powers the process.

Much has been written about orchestration. In our current era, orchestration is usually based on rules, input and output. When we compare chatbots and personal assistants we saw a development in capabilities and execution: When creating the Atos Digital Workplace offering, we started with chatbots that provided only the requested information — like "what time is it?" or "how do I connect an external keyboard to my laptop?"

The response from AI to such a question was a single piece of information like a knowledge base reference. At best it, was a collection of such questions and answers in a row. Today, however, such bots can execute activities. When you tell the bot that your PC is slow, it may offer to run some scans and perform corrective activities. An independent and autonomous chatbot could tell you that your PC is not running well and that a replacement PC will be delivered in two hours with all your data.

Further down the road, such systems will be able to respond to a desired end-state or perceived problem. That would include, in the extreme, requests like "build me a profitable business" or "make my business more environmentally sustainable." Such questions are instances where humans would use creativity, insights and decision making.

Following the analogy of the conductor, at this point, an independent party or technology platform seems highly preferable or even necessary, because in an environment of ecosystems, autonomous businesses need to orchestrate the trusted exchange of data, services and value between otherwise potentially distrustful parties. These platforms will need to have data sharing and service mindsets that can synthesize data from multiple information sources, analyze context and conflicting evidence to offer the best-suited solutions.

In other words: Business orchestration will define the "rules of engagement," i.e., a set of rules, procedures and technological components that describe and guide how different systems work together.

Each autonomous business will have its own set of components, from purely digital to physical like 5G, edge or swarm. The combination of components used in an autonomous business will vary based on the needs and nature of its business. The role of the orchestrator will be to make sure those different businesses can work together. It needs to ensure not just procedural but technological interoperability between the different autonomous businesses seeking to connect.

Thus, independent orchestration will essentially allow isolated, automated systems to interact within a wider ecosystem, creating an end-to-end autonomous chain for a specific pre-determined (or even a not-yet-fully-determined) purpose. This orchestration layer will likely leverage an interoperability layer enabled by cloud, AI and data lake technologies for example, and will support business functions which are integrated through APIs. Those autonomous systems will then be able to interact with each other, creating environments of autonomous systems able to address adjacent markets and more complex business use cases.

A first generation of such orchestrators are currently being developed or already exist at prototype stage:

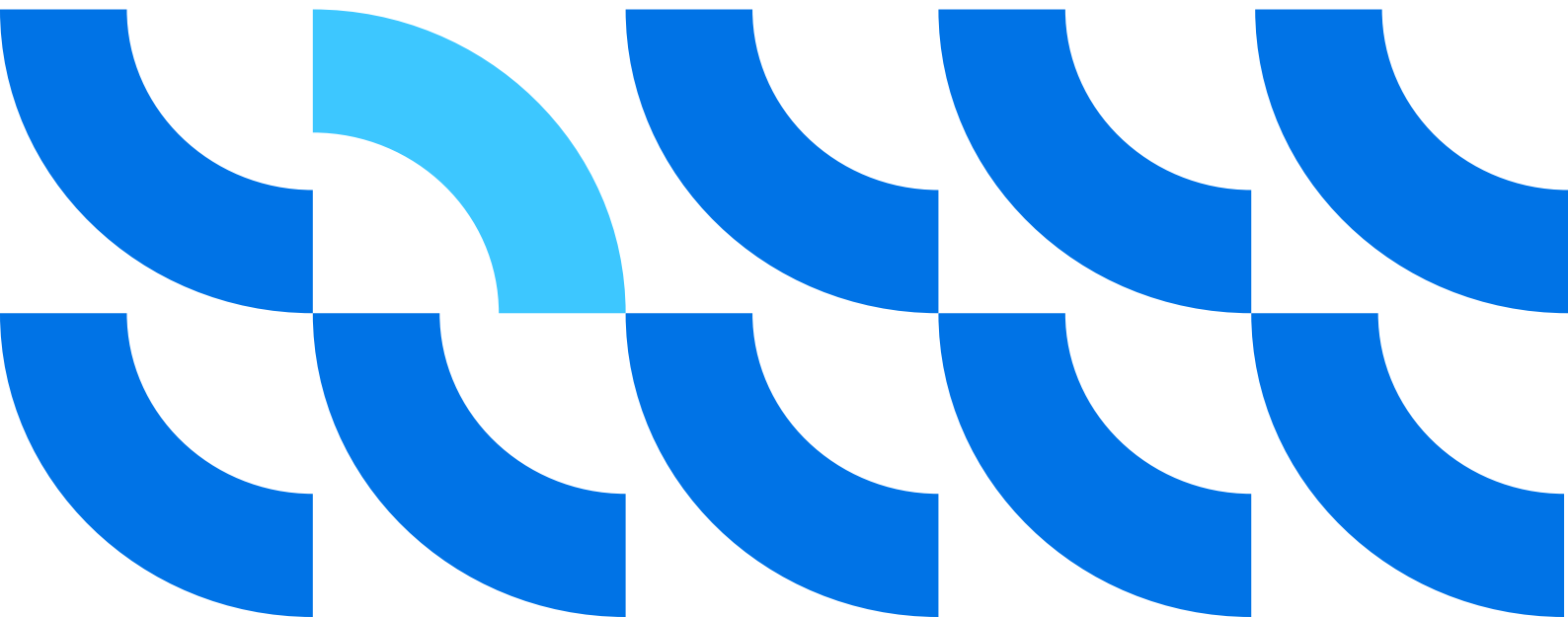
- **Autonomous driving** requires real-time orchestration between vehicles, with platforms and the ecosystem (such as smart cities). Even though many use cases involving advanced driver assistance systems (ADAS) or intelligent transport systems (ITS) already exist, humans are still in control. Tomorrow, with the integration such systems within a single environment and the deployment of 5G, we will see real autonomous vehicles on the road.
- **Hyperscaler-owned platforms** are already orchestrating the core platform and services, enabling business use cases for vertical IoT.
- The **GAIA-X initiative**[18] launched by the EU is going one step further and will orchestrate systems across multiple cloud platforms. It will provide an area with portable and interoperable services in a fully secure and trusted environment. The creation of data spaces by industry and country will enable ecosystem orchestration and the creation of autonomous systems we are referring to.

Components of an independent orchestrator

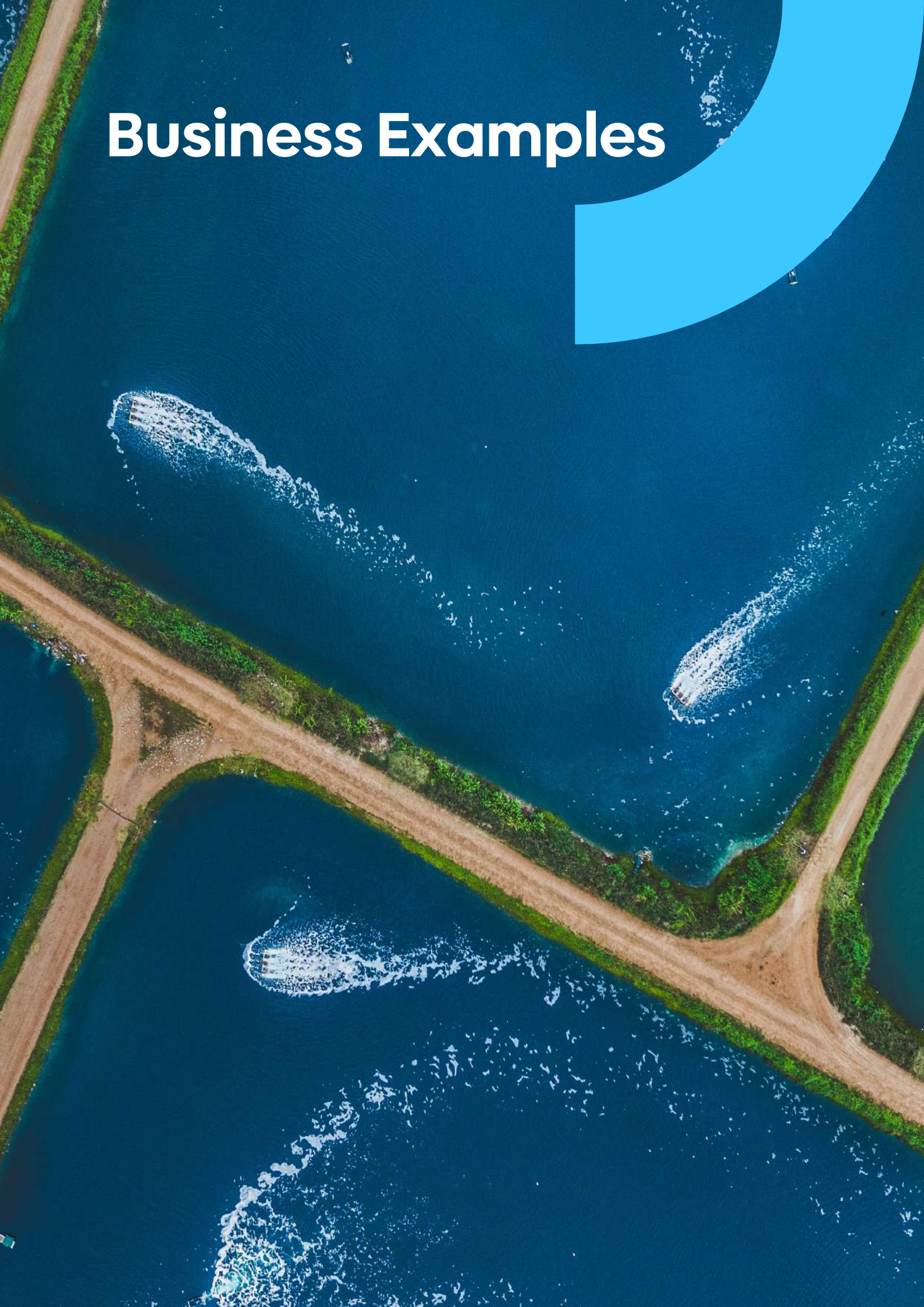
On the previous page, Figure 2 above schematically depicts the possible layers of components that provide data and intelligence to feed the orchestrator. New generations of networks and 5G platforms will offer new connectivity at higher bandwidth with low latency, supporting numerous devices and industry use cases. The complexity brought by such new sources of data at the physical level (edge/swarm) requires using artificial intelligence and eventually HPC[19] to compute unknown or uncertain situations.

18 data-infrastructure.eu/GAIAX/Navigation/EN/Home/home.html (accessed March 16, 2021)

19 HPC: High Performance Computing



Business Examples



When it comes to applying the concept of the advanced ecosystems mentioned in the previous chapter to business terms, the figure below depicts an entrepreneur-driven business utilizing such ecosystems.

In a nutshell, once initiated, an entrepreneur could nearly withdraw from the business environment, leaving the autonomous business cycle to make its own adjustments and manage the interaction with clients. The entrepreneur would simply move on to initiate the next circle or the next business idea, while reaping the benefits of the first business that was set up.

Quite naturally, once at this stage, the targeted client could also be a similar autonomous ecosystem. Thus, long client-to-entrepreneur business chains could be established — or be self-establishing over time.

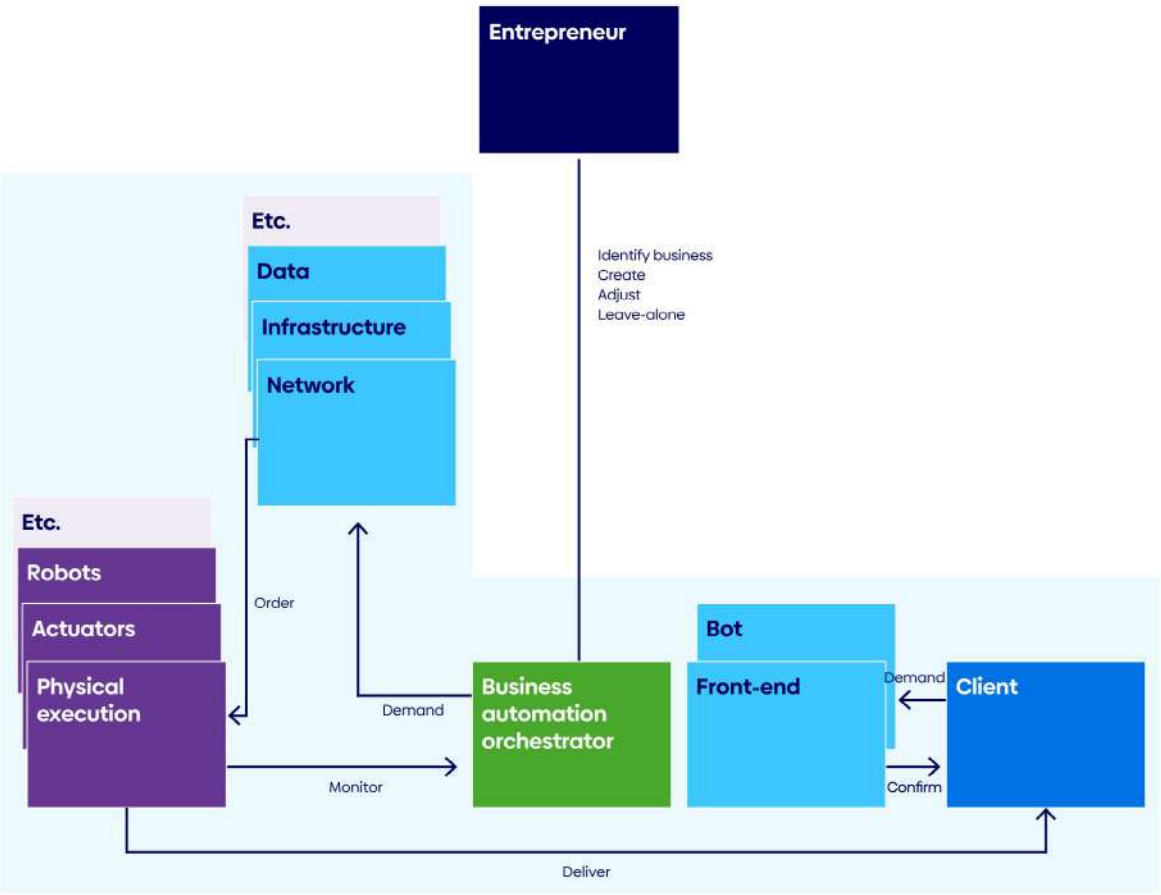


Figure 3: Autonomous business in business terms

Consumer business

Let us look at two examples: When you go to a club, the DJ must sense the mood of the audience. Are people dancing? Smiling? Singing? Based on the mood, the DJ will most likely change the playlist. In this simplified example, a computer could take over the role of the DJ, determining the mood and not only adjusting the playlist in real time, but also creating new music to entertain the audience.

While business decision making, sentiment analysis and business process execution come together in this example, more is needed for a true autonomous business. Let us look at another scenario:

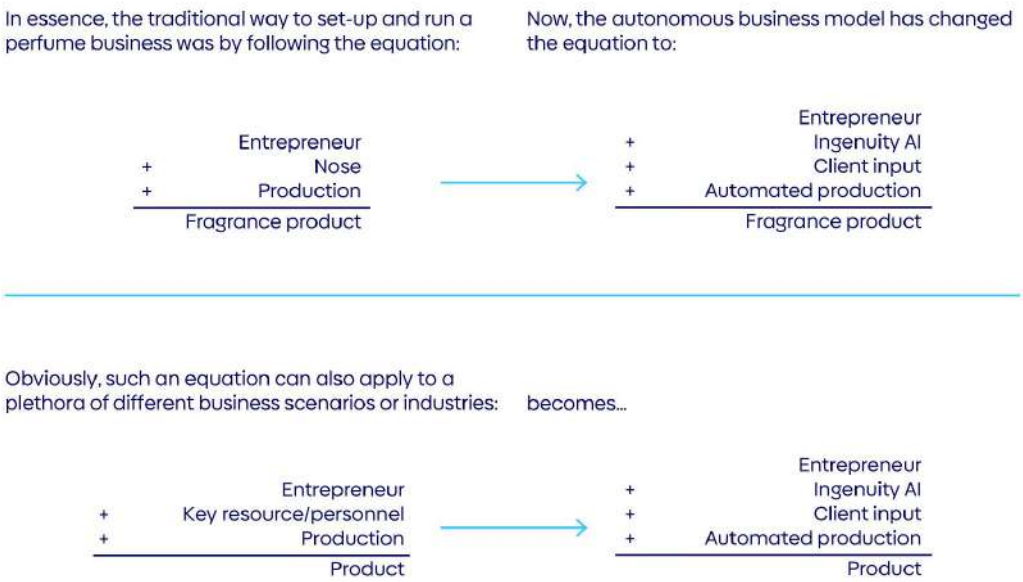
In today's world, just a few "noses" (human scent experts with superior olfactory capabilities), determine how the world smells when it comes to formulating perfumes. In 2017, a Dutch designer, technologist and filmmaker started to think about a different approach to making perfumes: By putting all the judgement for what is created into the hands (or noses) of the customer, one could give them direct control over what they finally get as a product.

Thus, the concept of a generative perfume was born. An AI-based system lets the customer play with the composition of the to-be-produced scent to create a personalized perfume. The customer is in the driver's seat, deciding how their fragrance should smell. Experts are essentially not involved during the creation of the perfume product.

Based on the clients' input (preferences, background, place of origin, socio-demographic data, etc.), the AI composes a hyper-personal perfume by combining individualized data with existing learning. A perfume recipe is then sent to a physical machine which creates the custom perfume by mixing the different ingredients. The result can then be judged and the specific components can be modified based on the customer's preferences. After this iteration, the machine will create a new sample. The feedback loop is fed into the AI for future use and refinement of the algorithm.[20]

When we relate this example process to the phases of an autonomous business defined in Figure 1, it fits into the ingenuity stage. Before a customer feeds the AI, there is no product — only a machine that can design and create a product. There is no human intervention from a supplier or production point of view. There is only interaction between the AI and the customer. The AI designs the product by itself, then the design is produced automatically.

Basically, the entrepreneur of an autonomous business achieves the same or better results in a certain business environment while approaching the traditional way of working in a different way. Usually, certain limitations (often human limitations) are eliminated during this process. In the perfume example, we eliminated the noses — a scarce and limiting resource in the perfume industry.



20 perfumerflavorist.com/fragrance/application/finefrag/ScenTronix-to-Bring-Public-Launch-of-Algorithmic-Perfumery-to-New-York-567012571.html; perfumesociety.org/robo-shop-scentronix-allows-you-to-co-create-scents; ars.electronica.art/keplersgardens/files/2020/09/cyberarts2020.pdf; algorithmicperfumery.com (all accessed on November 27, 2020)

Vertical or horizontal?

Whereas we often talk about orchestrating inside a business (horizontal value chain), the same logic applies to interactions between businesses (vertical value chain). In this case, the availability of data and decision making must be aligned and managed, and above all, cybersecurity is essential to ensure and preserve trust.

It is safe to assume that not all businesses will have the same growth path to becoming autonomous in a specific value chain. Any player (such as a supplier) in the value chain that lags in its autonomous business development could be subject to the same negative effects vis-a-vis their competition that we described in the "Uncharted Territory" section above.

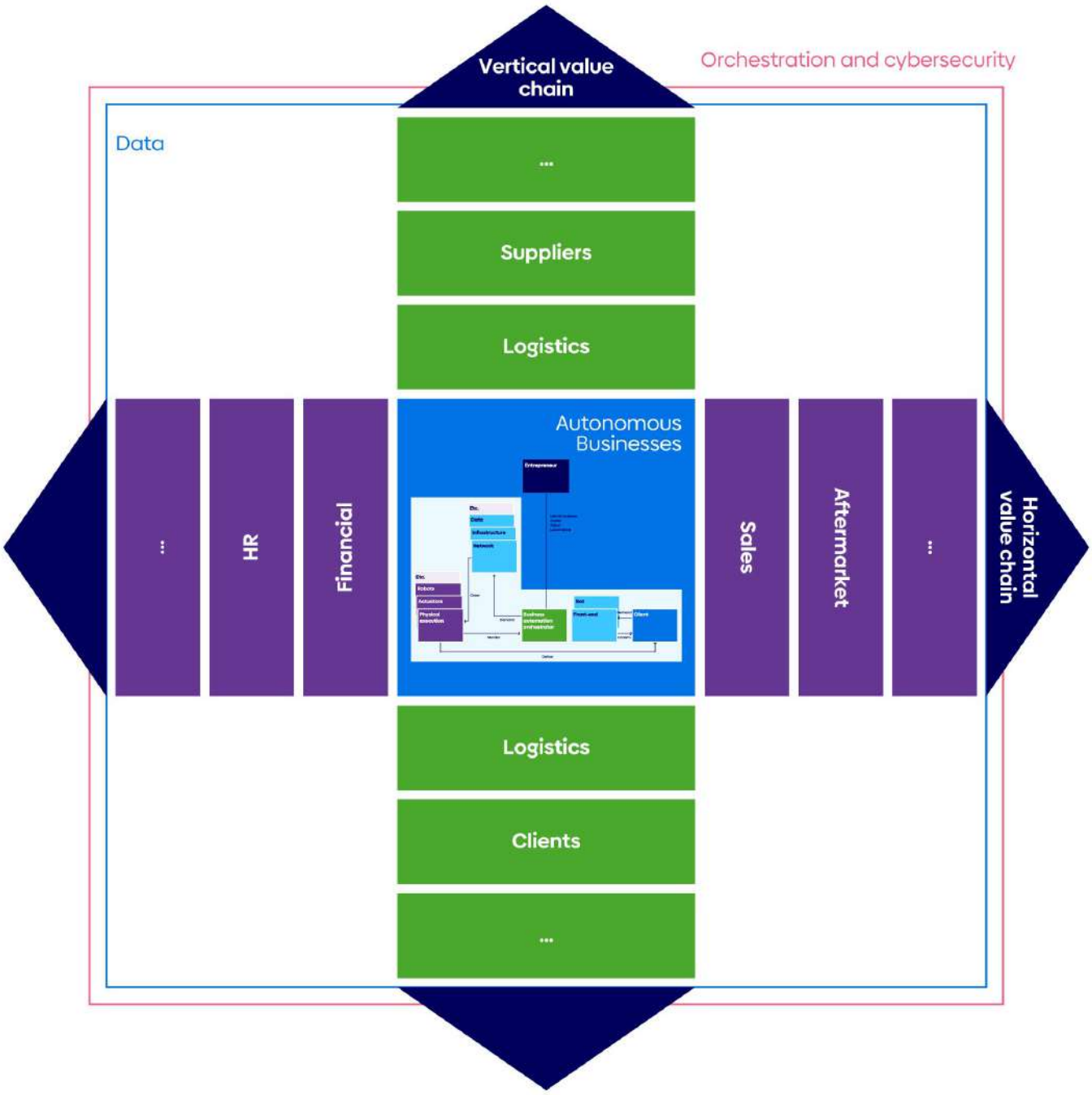


Figure 4: Vertical and horizontal value chains

Self-reflection AI

When looking for use cases on the verge of crossing the barrier to becoming ingenuity-centric, non-business-oriented scenarios arguably seem to be farther ahead in their development. A good example is an essay entirely written by an autonomous system, published in The Guardian on September 8, 2020.[21]

Along the lines of what is depicted in Figure 3, the autonomous system was given an instruction to create an outcome, rather than a description of what steps to take to reach a goal.

In a large sense, the result was not very different from a human-written essay. The autonomous system in fact produced eight different essays, which then served as a basis for a human-edited "best-of" essay — in other words, a hybrid version. The editors also pointed out that the editing process did not differ from the standard process of editing human outputs. In fact, they pointed out that in the end, it was easier to deal with than the usual human writing.

This demonstrates where we stood on the proposed roadmap to autonomous business at the time. As of late 2020, we were on the verge of the ingenuity-centric stage, and just about to cross the line entirely.

More recent use cases include companies using data and AI to run their core businesses. Among those are Chinese fashion firm Shein® and China-based video game company NetDragon Websoft®.

NetDragon Websoft appointed an AI-powered virtual humanoid robot as CEO of the company in August 2022[22] and named it Tang Yu.

In a statement, the company wrote that Tang Yu will also serve as a real-time data hub and analytical tool to support rational decision-making in daily operations, as well as to enable a more effective risk management system.[23]

Shein is known for its transformation from fast retailing towards real-time retailing, being able to introduce hundreds of new styles every day. To understand what consumers want, data collected via social media and apps is fed into an AI. Shein "can use the data they harvest to create a new item within a week and the data will help them accurately estimate predicted sales within minutes of it going live."[24] The system will automatically trigger production orders to the company's manufacturing network.

Potential future scenario: Mergers and acquisitions (M&A)

Arguably, among the most remote autonomous business scenarios are complex business decisions which rely on data that forms the basis of a decision but does not totally predict it.

A good example would be an M&A decision to buy, sell or form a joint venture with another company. In such processes, data is gathered and subsequently combined with personal experience and, at times, sentiments. While these ingredients might seem different in nature, at the end of the day they could also be described as simply "more" or "deeper" information: the typical decision data, data from outside the company, data from personal education, past events, etc.

In other words, are the main difference between humans and AI nothing more than "feelings?" When do feelings have more value than AI and when don't they?

We can envision a future wherein technology can collate all such M&A ingredients in a more effective manner than it is today. Thus, the most complex business decisions could be taken in an autonomous, technology-based way.

There are at least three identifiable prerequisites to define such a leap:

- The availability of the maximum amount of data/information, or at least more information than today's processes and technology enable.
- The digestibility of such information by means of technology and AI.
- The collectability of various information sources to derive the most meaningful, "best" decisions.
- Infinitely and fast-repeating cycles of informational and contextual updates of the above

So, while today's M&A decisions are often based on data rooms in combination with human assessments, the combination of both will finally drive better, more effective complex business decisions — ultimately outperforming human interaction in both informational depth and future business success rates.

21 The Guardian, "A robot wrote this entire article. Are you scared yet, human?"; theguardian.com/commentisfree/2020/sep/08/robot-wrote-this-article-gpt-3 (accessed December 17, 2020)

22 independent.co.uk/tech/ai-ceo-artificial-intelligence-b2302091.html (accessed June 1, 2023)

23 prnewswire.com/news-releases/netdragon-appoints-its-first-virtual-ceo-301613062.html (accessed June 1, 2023)

24 dailymail.co.uk/news/article-9936113/How-shadowy-teen-brand-Shein-uses-algorithms-harvest-data-users.html (accessed June 1, 2023)

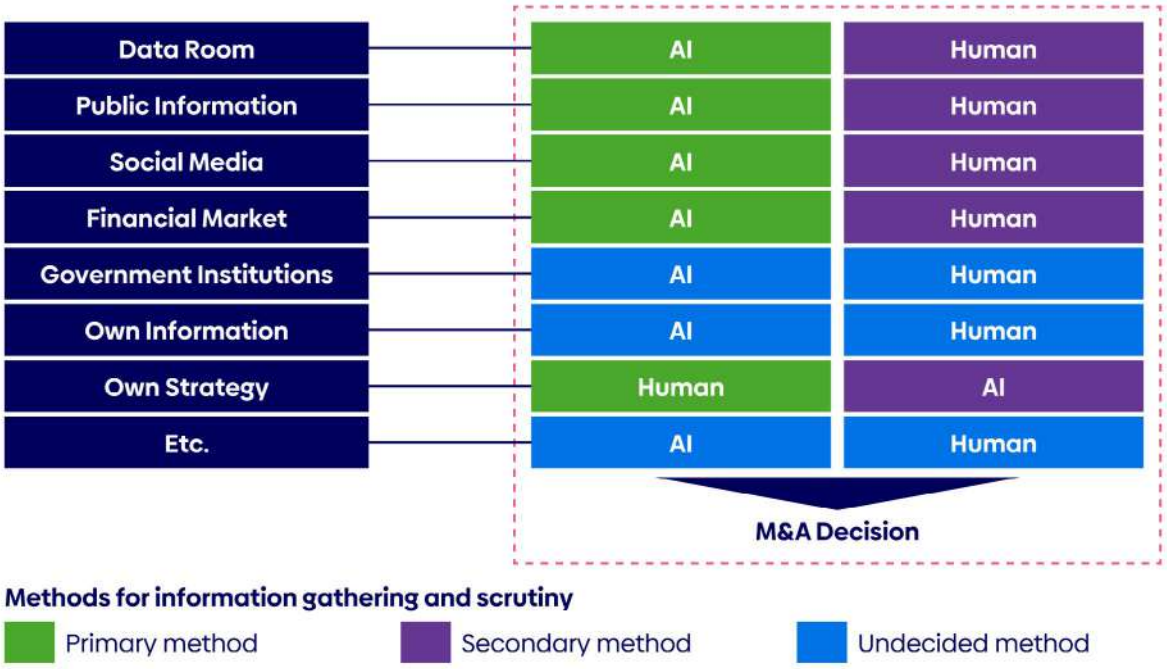


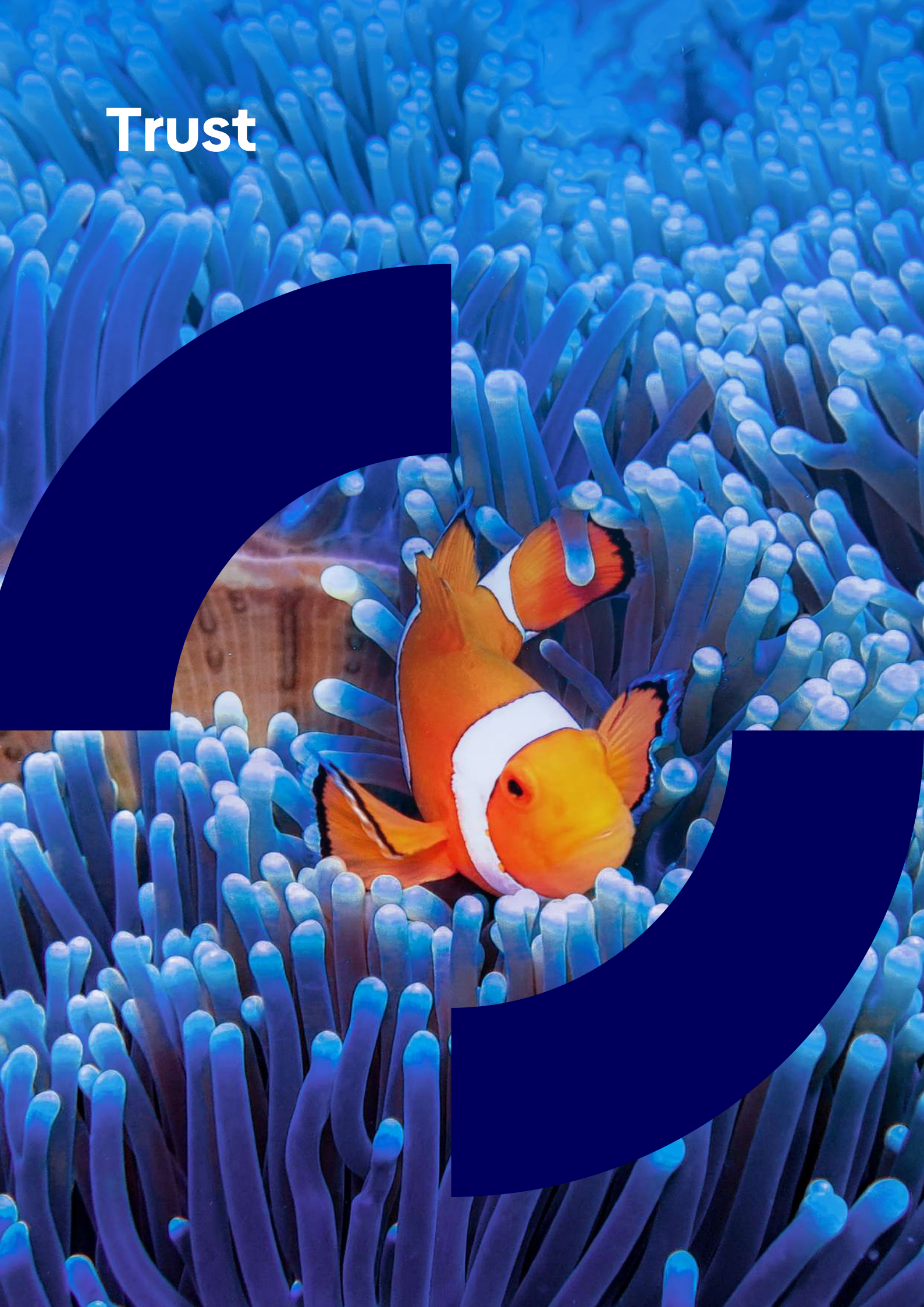
Figure 5: Typical bases for M&A decisions and AI applicability

Potential future scenario: Resources

The zero-employee company is not a new concept. It is nearly a reality in some industrial plants — like oil refineries — where location and life conditions do not allow people to live and work safely. The next phase is to replicate this concept in more traditional activities like retail, manufacturing and the sharing economy. Behind the business platform, we still find employees ensuring the smooth running of back-office activities.

In the future, thanks to robust AI, these activities will be replaced by intelligent bots, enabling platforms to multiply. Also, anyone will become able to operate locally or globally, because the implementation will become instantaneous at some point. There will potentially be no need to recruit, set up a company, or run a business process.

Trust



Regarding the maturity of autonomous developments, next to the purely technical possibilities, there is the element of human trust. We define trust in this sense as the trust put into the technical possibilities. In other words, if and how much humans will entrust their decision making to the technology. This trust will determine at which point a human being will let go of their decision-making authority, which will impact the future of the technology itself, the business or company, as well as the human being's future fate. Essentially, is the tech context-aware enough to be fully trusted?

Development of trust

When we look at the maturity of the stages defined in Figure 1 (process centric, data centric, ingenuity centric, uncharted territory) we see that the amount of trust required increases with each subsequent stage. In other words, without trust in the underlying automation it will be very difficult to move to the next stage. However, having enough trust does not mean an organization will take the next step automatically. It will all be dependent on the decisions being made by management — or the AI in charge, of course.

There are potentially differentiating aspects (or stages) which could be identified when entrusting. For example, the potential future reach of decisions could be an interesting angle. There also may be differentiating technical, tactical and strategic factors which could impact 'decision making – and trust.

Arguably, technological decisions could be reversed more easily than tactical decisions — like changing a software vendor (technical) versus reversing a decision to enter a certain market domain (tactical). Strategic decisions would be even harder to reverse than tactical ones, such as whether to change the business focus of the company altogether.

It is rather simple to imagine a technological decision-making process, but the differentiation between tactical and strategic might be harder to make. The pinnacle of autonomous decision making will not be an either/or, but a combination of technical, tactical and strategic decisions. At a certain stage, there could be a tipping point as to when such true autonomy occurs. There have been many recent examples that demonstrated extensive autonomous decision. Most of them, however, have a pre-defined set of limitations, which also determines the trust required in them.

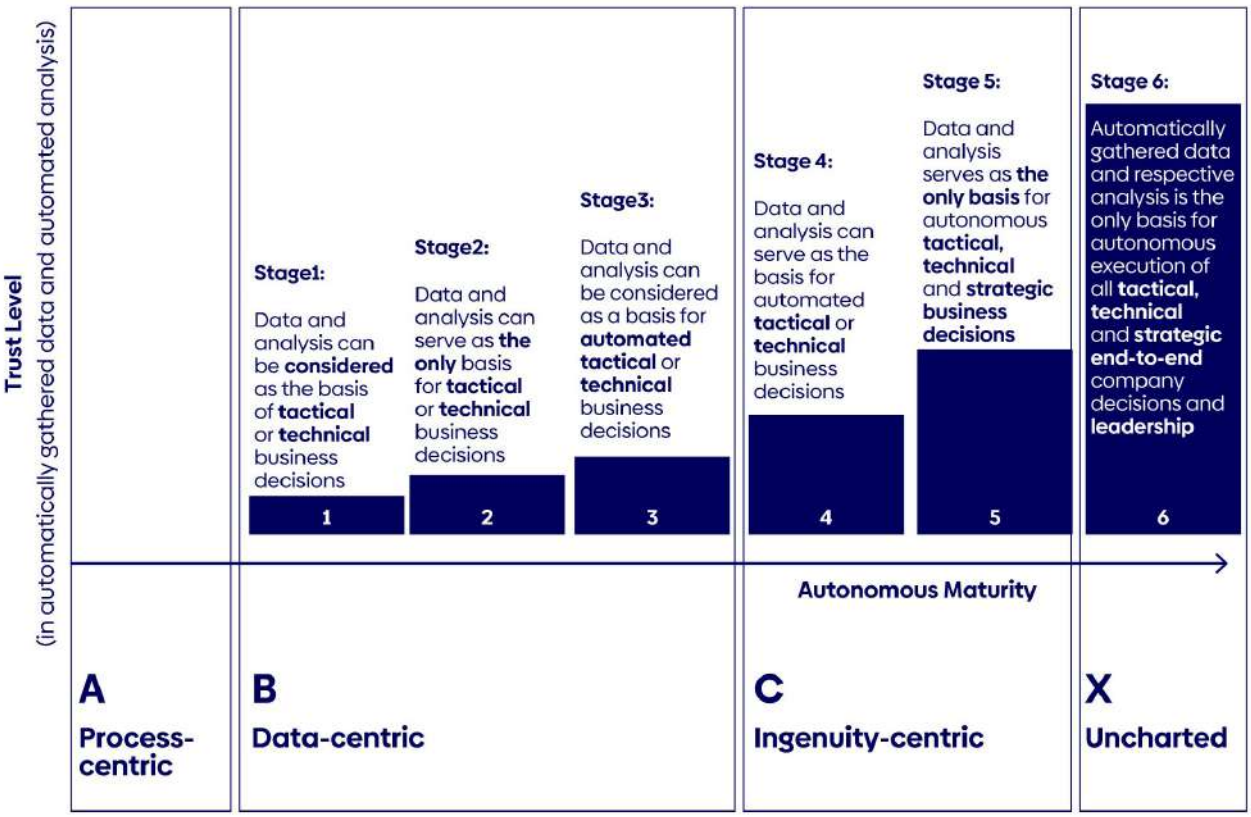


Figure 6: Autonomous business maturity stages and trust levels

Ethical Aspects



When we talk about self-operating businesses, we face important questions about what is right and what is wrong. Will such businesses replace people? Can they be taught to do the "right" things? Will our personal information stay private? How can we control these kinds of businesses?

Many groups, both public and private, are trying to make sure these types of businesses follow good rules. One important set of guidelines, the Ethics Guidelines for Trustworthy Artificial Intelligence were introduced on April 8, 2019 by the European Commission.[25] They have proposed some early rules to manage or even stop certain types of artificial intelligence. This idea is a big step towards controlling AI technology on a global level. Nevertheless, a subset of critics (with commercial interests) contend that these regulations might impede innovation.[26]

Big technology companies are setting up their own rules to make sure their computer programs do the right thing. For example, Microsoft has its Microsoft AI Principles™, Google talks about AI at Google, our principles, Telefonica® follows AI principles of Telefonica, and Telia® has its Guiding principles on trusted AI ethics.

At Atos, we are developing a new Ethics by Design policy that will become the framework that governs how we operate. All these initiatives can help control and avoid the unintentional ethical errors generated by autonomous businesses. A thorough analysis can be found in the material developed by the Atos Scientific Community's 2022 Ethics of Autonomous Systems track.[27]

The primary takeaway from those studies is the necessity for companies to adopt an ethics by design approach when confronting the realm of autonomous business. However, lingering unanswered questions might portray self-operating businesses as a potential threat to individuals. To derive benefits from autonomous business, ethical design principles must guide our deliberations. This goes beyond just working out the technical difficulties.

Replacing people's jobs

A key aspect of autonomous business is the substitution of human roles by autonomous processes. This is not a new concern. Historical innovations have shifted human labor from routine and low-value tasks to more creative job roles. This also led to (potential) improvements in overall quality of life. The new self-operating businesses require us to think differently. Companies must change how they hire and train people to fit the new jobs that will be needed, which most likely will reshape human resource strategies. It might even change how people and businesses work together. This leads us to the (for now) hypothetical question of whether we need people in business anyway.

The race to self-reliant business models and their competition

Imagine that you have launched a self-reliant autonomous business. This business can and will compete with other business by any means, whether they are run by humans or are autonomous as well. Will your business only focus on its own growth or take into account the status of the competition? Is its natural goal to make the competition go bankrupt? In other words, is it ethical to use AI-based autonomous businesses to fight the competition in the respective business area?

This question does not have a black-and-white answer, so the main issue here is to understand to what constitutes an acceptable level of risk with self-reliant autonomous businesses.

In particular, is it acceptable to risk negative personal consequences for the humans involved in competition with an autonomous business?

Is it ethical to accelerate business to the level made possible by autonomous business — especially after seeing the effects of similar developments like high frequency trading that made business faster but did not necessarily achieve a better outcome?

We all must work on the answers.

25 ec.europa.eu/digital-single-market/en/news/ethics-guidelines-trustworthy-ai (accessed December 17, 2020)

26 wsj.com/articles/artificial-intelligence-facial-recognition-face-curbs-in-new-eu-proposal-11619000520 (accessed May 21, 2021)

27 Atos Journey 2022, Ethics in autonomous Systems – page

Preserving data privacy and sovereignty

Another pressing ethical concern is data privacy and sovereignty. Although governments and private institutions have outlined principles and guidelines to address this issue, it remains partially unresolved. Hardly a day passes without news of private or sensitive information being used to train AI, like the training of Large Language Models.

Examples are numerous, supporting online meetings with AI[28] or the possibility to let AI create images.[29] The integration of AI into autonomous environments can potentially lead to even more data privacy concerns. Unlike human cognitive limitations, AI can rapidly process and interpret vast datasets. As our digital lives become increasingly exposed, our behaviors, interests and emotions become susceptible to monitoring, even in attempts to safeguard our data. Automated processes might mitigate human errors in data creation and utilization.

Although legislation seeks to regulate data usage, the reality is that individuals often share their private data — and companies find legal ways to use it. Adopting a broader perspective can help address concerns about the intersection of privacy with broader human rights like equality, non-discrimination, freedom of expression and opinion. The mishandling of private data could engender unjust outcomes and power imbalances between corporations, governments and individuals. While several initiatives aim to bridge this data privacy gap,[30] the issue remains unresolved.

Malicious use

As with any emerging technology, autonomous businesses can be harnessed for positive outcomes, enhancing lives and offering advantages to entities across the spectrum. Regrettably, new tech can also be used for nefarious purposes, ranging from cyberattacks and terrorism to manipulative tactics via misinformation.

Some research, like the The Malicious Use of Artificial Intelligence: Forecasting, Prevention, and Mitigation by researchers from universities and organizations like the Electronic Frontier Foundation,[31] shows that less attention has historically been paid to how AI can be used maliciously.

The report describes four high-level recommendations like alignment between politics and technology, definition of best practices, expanding the range of stakeholders and awareness of dual-use of AI developments.

We think that the continuous presence of AI and privacy in the news leads to an increased awareness regarding the pros and cons of AI, not only by policymakers and developers, but also by citizens.[32]

28 techcrunch.com/2023/08/08/zoom-data-mining-for-ai-terms-gdpr-eprivacy/ (accessed Aug 14, 2023)

29 theverge.com/2023/1/16/23557098/generative-ai-art-copyright-legal-lawsuit-stable-diffusion-midjourney-deviantart (accessed Aug 14, 2023)

30 hello.elementai.com/data-trusts.html (accessed December 17, 2020)

31 img1.wsimg.com/blobby/go/3d82daa4-97fe-4096-9c6b-376b92c619de/downloads/1c6q2kc4v_50335.pdf (accessed December 17, 2020)

32 hec.edu/en/knowledge/instants/why-do-we-share-our-personal-data (accessed Aug 14, 2023)

Summary and Final Thoughts

The journey from automation to autonomous is constantly evolving in many different ways. As of the time of this publication, these improvements are already generating value for society. Whereas automation first started with a focus on automating small steps, it is leading to the autonomous performance of complete processes.

The process-centric approach is now covering all kinds of business processes like purchase-to-pay and others. The next step is automation based on data. Along with structured data, unstructured types of data like sentiment analysis, social media and documents can be used to add value to an automation process. While these ingredients might seem different, they could also be described as more and deeper information. In a data-centric approach, the system prepares the decision criteria, but the actual decision is still made by humans.

In the next stage — where decisions are made by the system — they will be based not only on available data but also on the absence of data, enabling entire business value chains to be managed without human interaction. Automation will act like a replication of human beings. We call this the ingenuity-centric stage. During this stage, competition between autonomous businesses is most likely to occur. Some might be quicker than others to set-up such competitive environments, most likely causing imbalanced situations with undesirable societal effects. This will be a stage of uncharted territory.

Autonomous business is not a development or product on its own. It is the result of a combination of ongoing developments on multiple technological topics like AI, cloud, security and others. It is also a result of how we think and behave as humans.

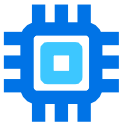
To successfully lead any business towards becoming autonomous, there are four important building blocks:



Transparency and trust



Availability, control and quality of data



Artificial intelligence



Independent orchestration

Independent orchestration will allow isolated automated systems to interact together within a market or an industry ecosystem, creating an end-to-end autonomous chain — just like a conductor and an orchestra. Accordingly, autonomous ecosystems will force us to rethink how our society is constructed. In addition to the economic or financial point of view, we must determine what kinds of decisions made by autonomous businesses we will accept — and which we will not.

Will autonomous businesses change our opinion of what is or is not ethical? Will we cope with unemployment if all the work is done by autonomous processes? What about universal basic income? Will these autonomous environments pay income tax?[33]

In a world where real autonomous businesses operate and compete, we need to find a new social balance in everything we do. We must build trust when automation continuously learns and adapts, while preserving empathy and humanity.

It is our duty to adjust the bias of autonomous businesses competing, tipping the balance towards smart cooperation rather than fierce competition.

In the introduction of this document, we mentioned that this paper will not prescribe how to reach a state where autonomous businesses compete. Our goal was simply to provoke your thinking on this topic.

For those looking to take concrete action, the first step is to determine your current state of maturity. Nothing stands in the way of starting this journey, by identifying opportunities or even building your own autonomous business. If you are ready, let's ride the wave.

33 Bill Gates thinks the robot that takes your job should be taxed: youtube.com/watch?v=nccryZOcrUg (accessed December 17, 2020)

About the Authors

This paper has been prepared by the Future Makers Research Community with contributions from:

Arthur Meelhuijsen
Innovation Manager
Northern Europe
Atos Tech Foundations

Michael Chicheportiche
Account Executive
Southern Europe
Atos Tech Foundations

Purshottam Purswani
Chief Technology Officer
APAC
Atos Tech Foundations

Sascha Kaulen
Head of Operations & Excellence
Global Strategic Sales
Atos Tech Foundations

Almudena Alonso
Head of Data Analytics & AI
Southern Europe
Eviden

Frédéric Malicki
Chief Technology Officer
Southern Europe
Eviden

Acknowledgements

The authors would like to thank the following colleagues from the Atos Scientific Community for their reviews and valuable comments on early versions of this white paper:

Fabio De Pasquale

Albert Seubers

Thierry Caminel

Jordan Janeczko

Peter Kalmijn

Bilyana Lyubomirova

About Atos

Atos is a global leader in digital transformation with 105,000 employees and annual revenue of c. € 11 billion. European number one in cybersecurity, cloud and high-performance computing, the Group provides tailored end-to-end solutions for all industries in 69 countries. A pioneer in decarbonization services and products, Atos is committed to a secure and decarbonized digital for its clients. Atos is a SE (Societas Europaea) and listed on Euronext Paris.

The purpose of Atos is to help design the future of the information space. Its expertise and services support the development of knowledge, education and research in a multicultural approach and contribute to the development of scientific and technological excellence. Across the world, the Group enables its customers and employees, and members of societies at large to live, work and develop sustainably, in a safe and secure information space.

Find out more about us
atos.net
atos.net/career

Let's start discussion together

About the Future Makers Research Community (FMRC)

The Future Makers Research Community is a global network of our Future Makers - exponential thinkers and forward-looking technology thought leaders - across Atos.

Our Future Makers are united by profound curiosity, a strong growth mindset and a passion for shaping the future through exponential technologies applied in a deep industry context. We collaborate on thought leadership, (co)-innovation and R&D across all innovation horizons, and our ambition is to elevate organizations and drive lasting impact.

In close co-creation with our clients and partners, we deliver bold ideas and industry use cases, by anticipating trends and market needs that will reshape businesses and society.

Together, we're not just imagining the future — we're building it.

106482 - JS + GR - Autonomous business