

DIGITAL TECHNOLOGIES AND ENTERPRISE ARCHITECTURE

The Architect in the digital era



Digital technologies and Enterprise Architecture

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December 2018

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OVERVIEW

With the transformation of companies related to the development of digital technology, Enterprise Architecture issues are following the evolution of information systems. The continuous integration of new technologies significantly modifies information systems, which in order to remain efficient and effective, must continuously transform and adapt this relationship between technological integrations and architectures in line with the company's needs. However, companies must deal with a context that is now increasingly volatile and uncertain, and also often complex and sometimes ambiguous.

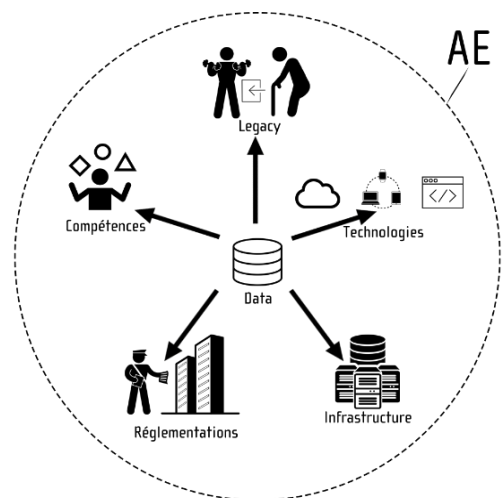
An increasingly agile business means not only adapting in order to meet requirements, but also redesigning whilst complying with new constraints. The effects of digital technology are less on the architectures themselves, which will evolve in a logical and continuous way, than on the governance to be implemented and on the role of architects in a changing and multifaceted context.

The digitisation of the corporate environment confirms and reinforces former convictions. System and infrastructure boundaries are disappearing, and therefore, the ecosystem is expanding. "Business models" are changing rapidly and positions are insecure. New paradigms are dominating debates: online services (Cloud), place of data, security, mobility, and connected objects. The Enterprise Architect's responsibility becomes crucial. Although data has always been central on the conceptual level, it is now central in the search for mastery of architectures that facilitate the emergence and power of new business models. Simply speaking, the architecture is built on data that is collected and processed by robust and secure back-ends.

Although "legacies" should be treated in a lasting way, they remain the foundation of digital constructions. The architect must integrate them, make the best use of them and consider their development in difficult balances.

Digital technologies (Big data, Cloud, IoT, 5G, AI) are multiplying data collection, processing and storage options in all forms. The architect is responsible for ensuring that they are integrated in a long-lasting, scalable and secure way. New parameters need to be taken into account such as service excellence provided on a 24 /7 basis and regulatory compliance.

The architect is therefore much more than just a technical expert, with his leadership, his Business vision, his open-mindedness, his ability to mediate and advise, and also his rigour and intransigence when the essential is at stake: security, protection of assets and overall consistency.



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Foreword

The survival of companies now depends on their ability to adapt to new market requirements. However, it is difficult to anticipate all evolutions in their ecosystems, evolutions that are sucked into a technological whirlwind that is speeding up. The information systems of companies are experiencing the full force of this transformation, which is not only forcing companies to review and adapt their architectures to meet it but also to anticipate the possibility of integrating digital technologies.

For this document, Cigref's study began based on our willingness to explore the effects of these digital technologies on information systems and their architecture. It was assumed that architectures could be diverse depending on the end purpose of the information system and the technologies that they integrated or would integrate; hence the importance of studying these new architectures. In addition, very early on in the discussions between the members of the working group, it came to light that the main impact of these technologies was not technical and that information system mutation was part of the usual evolution of information technologies. Therefore, we were less concerned by technology than by business.

Discussions have now shown that business strategies focus on data owned by business departments that seek to obtain the most added value. Architectures are therefore adapting to focus on data. This adaptation, although driven by technologies, is nevertheless organisational with an inversion of the paradigm: processes and services are adapted to data, and not the other way round. Consequently the roles of those contributing to this transformation, such as IT departments, business departments and Enterprise Architects, are changing. The changing roles of players is the focus of Cigref's study.

The impacts of Digital technologies are less on the architectures themselves, which will evolve in a logical and continuous way, than the governance that needs to be implemented and the role of architects in a changing and multifaceted context.

Introduction

Progressively over the last few years, with the transformation of companies related to the development of digital technology, Enterprise Architecture issues are following the evolution of information systems. The regular integration of new technologies is having a profound effect on information systems, which in order to remain efficient and effective, must continuously transform and adapt this interlinking between technological integrations and architectures in line with the company's needs.

In its 2008 report, [L'Architecture d'Entreprise, un cadre global de coopération pour les acteurs de l'entreprise](#)" (Enterprise Architecture, a global framework of cooperation for company players), Cigref focused on the agility of all players as the main challenge for the implementation and longevity of an Enterprise Architecture approach. In 2018, most cultural and organisational developments related to the digital transformation of companies have made it possible to meet this need to implement a framework of cooperation between company players by promoting cross-functionality between projects and agility, which has become indispensable.

Enterprise Architecture, a systematic approach adopted by business lines, has now become holistic encompassing all of the company's business dimensions and taking into account internal and external player interactions, all information systems and obviously their related technologies. Nevertheless, this transformation is currently taking place under increasingly disruptive conditions:

- Companies that used to be rivals are now partners (the opposite also applies)
- Architectures once designed to protect us must be increasingly open whilst maintaining a high level of security
- The business units that focused on their business are inclined to explore new horizons that may change company business models
- Due to their rapid evolution, digital technologies are driving the change in these business models.

Companies must deal with a context that is now not only increasingly volatile and uncertain (e.g. on the regulatory level with invalidation of Safe Harbor, replaced with the Privacy Shield, or implementation of the General Data Protection Regulation), but also often complex (i.e. use of the Cloud that not only has had a technological, but also organisational, security, contractual and cultural impact, etc.) and sometimes ambiguous (setting up a Blockchain architecture will eliminate third-party players of trust but not their function, which is distributed among the players of a Blockchain¹ consortium).

In addition, with their desire to redesign their information system, companies must take into account the multifaceted nature of user requirements: mobility, security, multiple data sources (Big data), online services (Cloud), integration of connected objects and cooperation with multiple players of the company's ecosystems (APIs).

¹ See Cigref's report regarding this subject, "[Blockchain: from theory to practice in large companies](#)" - October 2018

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In response to this evolution, companies have had to develop their architectures and infrastructures accordingly. While urbanisation plans put in place at the beginning of 2000 and subsequent Enterprise Architecture approaches have significantly reshaped information systems, an increasingly agile business now means not only adapting in order to meet requirements, but also redesigning whilst complying with new security and regulatory constraints.

Therefore, Cigref wanted to conduct a study on the new architectures transformed by or emerging from digital technology. Although, this document explores a few characteristics of the new architectures related to the Cloud, IoT, mobility, Big data, in relation to access to data, micro-services, APIs, etc., through workshop discussions and also feedback from around ten companies, it mainly analyses the role of the Enterprise Architect and his development in a context where agile teams are given more autonomy and where digital technology is having an increasingly significant impact on business.

The digitisation of our environments confirms and reinforces former convictions. System and infrastructure boundaries are disappearing, and therefore, the ecosystem is expanding. "Business models" are changing rapidly and positions are insecure. New paradigms are dominating debates: online services (Cloud), place of data, security, mobility, and connected objects. The Enterprise Architect's responsibility is crucial.

1. Data at the centre of the architecture

Initial IT architectures were shaped by combining technologies responding to a business need. The main feature of this technological approach was to provide short-term answers for users by using controlled solutions. The first architects predominantly held a technical advisory role for business units.

The first information system “urbanisation²” plans enabled companies to organise the functional areas of their information system in order to provide a global and shared view to IT players and business units. However, architecture is moving beyond the strictly technological sphere and is gradually taking over the field of business processes whose optimisation by the information system is becoming a company challenge. Enterprise Architecture principles are therefore used to develop a business dimension within any value chain through organised information system cross-functionality and the shared responsibility of all players contributing to business process performance.

Based on a model assisting the company in its transformation, these Enterprise Architecture approaches extend the action of urbanisation approaches by truly taking into account how business processes are organised with regard to the information system’s capabilities and at the same time defining governance that is suitable for achieving this. In 2008, Cigref therefore gave the following definition: “Enterprise Architecture represents how the company operates and must transform itself. It is used to control the transformation. It brings together all company players and facilitates their synergy. It provides a target, an analysis of deviations and a migration schedule (the roadmap). It is a dynamic and iterative process³.”

With the introduction of digital technologies such as the Cloud, IoT and above all Big data, architecture issues have shifted. A number of concepts have appeared with the emergence of SOA⁴: “as a Service” (IaaS, PaaS, SaaS, etc.) models, micro-services with their flexibility, re-usability and resistance, APIs for exchanging and interoperating between systems, objects or micro-services and ultimately data.

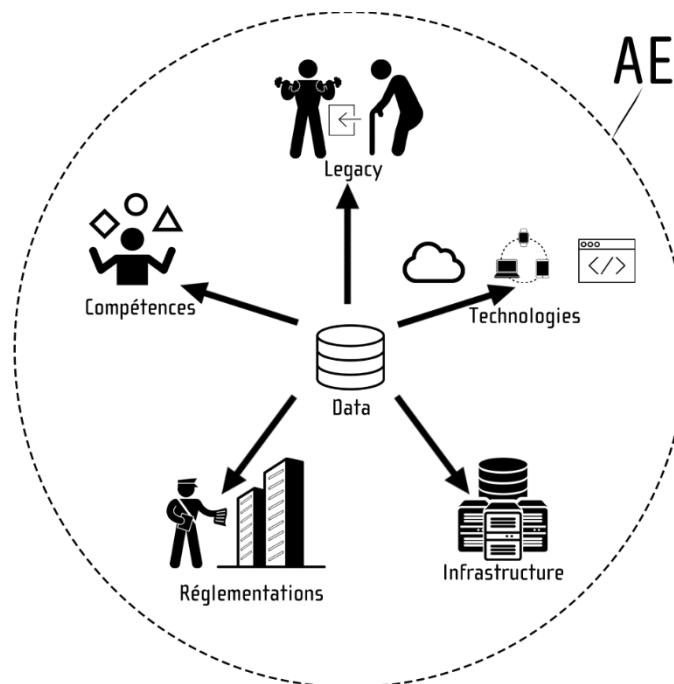
Initially at the heart of the approach, processes have gradually given way to data. Companies are therefore more concerned about how to develop their information systems to become “data centric” in order to make the most of the value potential of this black gold. Whereas previously, processes handling data were highly valued, data has become a central resource on which processes operate, and algorithms are applied to give it a business meaning and value. This is a major change.

This evolution is significantly changing the architecture models that used to be siloed then cross-functional: a single datum in its domain is of little importance, what becomes important is the correlation of data from different business areas (customers, HR, partners, use, etc.).

2 The French concept of “urbanization” of information systems is similar to an optimized, process-oriented optimization of the functional architecture

3 See Cigref’s report, “L’Enterprise Architecture - un cadre global de coopération pour les acteurs de l’entreprise” - October 2008 (French)

4 SOA: Service Oriented Architecture



Source: Cigref

Figure 1: Data at the heart of interactions

From a theoretical point of view, the architecture of an information system can therefore be seen as a centripetal data lake: data, the basis of Enterprise Architecture, is at the core and value-added services are built around it. Developing an information system by facilitating the integration of new technologies, but always with data at the core constitutes a major architectural challenge.

In this new context, all technologies built around data (Cloud, IoT, AI, etc.) affect the architecture of the information system and concern all company players. In order to meet new needs driven by technologies, the company must adapt continuously, and the IT function must ensure good quality data, decide how to process it, maintain a high level of performance whilst guaranteeing the security of this data. Business units are mainly concerned about how to structure this data, share it and make the most of and capitalise on its added value. The competitive edge of an information system is no longer driven predominantly by the cost factor, but by the business value of the data: therefore, this is less about optimising processes and more about extracting value from an efficient “data centric” architecture.

Although data has always been central on the conceptual level, it is now central in the search for mastery of architectures that facilitate the emergence and power of new business models. Simply speaking, the architecture is based on data that is collected and processed by robust and secure (internal or external) back-ends.

2. Impact of technologies on the architecture

2.1. Integrating into the existing, the legacy

Before looking at new technologies, it is important to bear in mind that there is an existing information system, the legacy, which will be profoundly affected by their integration.

Its architecture already effectively meets a number of uses and represents a stable, controlled and secure technical platform. If new systems need to be built and integrated, its ecosystem will also need to be maintained.

However, transformation projects tend to make these legacy systems change, sometimes severely, decompartmentalise and open in order to implement more recent technologies.

In order to use the existing, maintaining and developing this technical platform is inevitable. For example:

- making the legacy compatible with a data centric strategy, when it has been constructed in a business process optimisation and response logic;
- and making sure that it is able to collaborate with new solutions and new technological ecosystems via APIs for exchanging and managing shared data.

Its architecture will therefore be changed accordingly, but whilst bearing in mind how to manage its inevitable obsolescence.

This adaptation takes place in both directions, each making one step towards the other. If the legacy cannot technically evolve towards a new technology or that this technology cannot be integrated, the solution envisaged is often considered as not viable for the company's information system.

Keeping a coherent "legacy + technological innovations" whole is therefore a major challenge.

2.2. Integrating new technologies

As seen previously, the architecture of company information systems is tending to become data centric. Before Big data, came the Cloud for unlimited data storage, the IoT for data capture without any true technological limitations (any object can become a sensor) and subsequently, we are now seeing the arrival of artificial intelligence and quantum computing which is feeding on these data, with impressive processing, use and recovery promises.

2.2.1. Big data

Data often requires the implementation of an infrastructure suitable for its capture, storage, analysis and retrieval. In addition, data is multiplied, therefore data qualification, deduplication and concentration is often necessary. The capture or collection of data is not only based on multiple sources, such as connected objects, but also specific internal databases or other external

data sources. If the sources differ, the formats also differ, therefore collection involves initial processing to qualify this data and make it understandable and usable. Nevertheless, with the emergence of Data as a Service, no model has stood out from all others. In fact, a wide range of possible models exists around data, old data warehouses but also data discovery⁵, analysis, visualisation tools, etc.

Storage is also a key issue for Big data infrastructures: should an internal data storage be chosen in order to be able to maintain control or is it more effective to outsource storage issues? The issue of data ownership and control is vital and these questions are pivotal for the various strategic decisions related to Enterprise Architecture. Moreover, some companies are fully aware of their inability to have the necessary storage and maintain the related infrastructures. The question then arises on use of the Cloud.

2.2.2. Cloud

With the proliferation of services offered, the information system must now be Cloud ready. Architectures have transformed to address this. Initially equipped with dedicated, restricted and backed up data centers, companies have got rid of them, or at the very least, reduced their numbers by switching over to the Cloud.

The Cloud revolution is taking place on several levels.

Firstly, with regard to the infrastructures that need to be reviewed, either to manage their own internal Cloud, or to be able to use external or hybrid Clouds: in this case opening the information system is inevitable but this produces other constraints (contractual, administration, security, etc.). Also, the technologies used in the company are not always suitable for the Cloud: they need to be “Cloudified” beforehand.

Secondly, since the Cloud has released the IT department from managing bottom layers, the IT department’s teams have been able to focus on the new services architectures and Big data to be put in place. However, not all of the architectures distributed are relevant. For example, differences exist between a Cloud ready architecture, which is used to “containerise” the code and applications, and make them mobile in a hybrid architecture, and a Cloud native architecture, where the code has been redesigned from the beginning so that the power of the Cloud can be used and exploited to the maximum. When making these choices, the size and complexity of the company must also be taken into account when offering a radical change or significant migrations.

Lastly, the implementation of services in the Cloud based on data has genuinely enabled it to be provided to other populations (within and outside of the company) and therefore to be decompartmentalised. However, private Cloud uses must be clearly distinguished and defined from public or hybrid Cloud uses.⁶ The option of public Cloud is relatively mature for data that initially does not seem to be “important”. Also, it would be hard to imagine entrusting third-party companies with sensitive data. The question then is “How far should you go into the Cloud... or not?”

⁵ Data analysis method that makes *Big data* analytics accessible to business users

⁶ See Cigref’s report, “[La réalité du Cloud dans les grandes entreprises](#)” (Cloud reality within major companies) - October 2015 (French)

2.2.3. IoT

The IoT contributes significantly to the increase in the amount of data generated. Connected objects are now everywhere (in industrial equipment, in office automation, etc.) and continuously transmit huge volumes of data that then need to be processed.

Various types of connected objects exist that, depending on their use or location, transmit more or less data, with variable transmission frequencies. However, the majority of connected objects transmit and exchange data that must be processed and accessible in real time, with a minimum latency time, so that it can be “consumed” immediately. The architecture must therefore be designed to be compatible with this immediate data management.

In order to obtain the most possible added value from the data, some companies combine data from various sources, domains or sectors. With these combinations, companies are now able to understand a set of events and attempt to anticipate them. For example, it is possible, via an object's data, to identify by correlation any malfunctions related to specific uses, characterise an error rate, run patch developments or industrial modifications, schedule an explanatory communication campaign, etc.

2.2.4. Mobility

Mobility has transformed architecture principles because it involves making all software solutions functional on any platform (smartphone, tablet, laptop, etc.). This basic prerequisite means that the software and hardware architecture layers are as independent as possible so that an application can be applied indifferently on a slow, mobile, or Wi-Fi network, etc. These layers must be as standardised and generic as possible to permit various portabilities.

Mobility therefore affects Enterprise Architecture by introducing the need to make the various layers of the architecture model independent in every respect.

2.2.5. AI and chatbots

These technologies are very recent and not completely mature. Nevertheless, artificial intelligence is gradually appearing in the IT department⁷.

This is also the case of chatbots, or virtual assistants, and many companies are currently in the process of producing POCs. The domains the most commonly covered are online calls, office automation assistance, software support or access to documents.

The problem for integrating chatbot into an architecture is its scaling up. Chatbots cannot operate independently and often depend on a specific business unit. Maintaining a combined IT and business commitment over the long-term in order to industrialise this new technology with a true business contribution is proving to be complicated.

⁷ See Cigref report “[Artificial intelligence in companies: Strategies, governance and challenges of data intelligence](#)” - October 2018

2.2.6. Importance of compliance

In Europe, “compliance” places the user and citizen at the core of digital technology. Currently, if the system was designed taking these requirements into account, maintaining compliance will be easy. The problem arises, from an architectural point of view, when compliance requirements were not taken into account at the design stage: this is particularly the case with a large number of American information systems.

In the past, many systems were designed “open” by default with a security layer added *a posteriori* to protect them. Nowadays, systems must be designed from the beginning with integrated security requirements.

Although “legacies” should be treated in a lasting way, they remain the foundation of digital constructions. The architect must integrate them, make the best use of them and consider their development in difficult balances.

Digital technologies (Big data, Cloud, IoT, 5G, AI) are multiplying data collection, processing and storage options in all forms. The architect is responsible for ensuring that they are integrated in a long-lasting, scalable and secure way. New parameters need to be taken into account such as service excellence provided on a 24/7 basis and regulatory compliance.

3. Evolution of the role of the players

Transforming organisations requires aligning the business and IT. This alignment requires changing people's attitudes. Producing added value in business terms involves switching from traditional processes (SLA compliance measurements, optimisation through costs, silo teams, stabilisation of applications, firm contracts, etc.) to a new way of providing IT services (measurements via business KPIs, innovation processes, intelligent automation of processes, end-to-end product responsibility, continuous evolution of applications in order to control disruptions, flexibility of contractual commitments, etc.).

3.1. The role of the Enterprise Architect is changing...

Although very close to the IT department, the Enterprise Architect now mainly has a business leaning. Admittedly, his positioning is blurred, sometimes within and sometimes outside of the IT department, but nevertheless he has an "enterprise" dimension that makes it easier to find his place within a business organisation.

As with digital technologies where everything is feasible and possible, the Enterprise Architect's argument of authority, related to his technological knowledge, is waning... or rather changing. His authority is now generated through elements such as an economic and systematic view of the company, his knowledge of compliance principles, and his ability to anticipate; these words are not just reserved for engineers. Dialogue with certain players is therefore becoming more difficult. For example, IT teams see problems through a technical and technological prism, whereas the Enterprise Architect also relies on excellent understanding of business units and business. Enterprise Architects must train the IT teams and the various players in understanding and adapting architectures: they are the catalysts for collaboration.

This new language with business departments highlights new skills: soft skills or behavioural skills. The architect collaborates more than he imposes, builds story lines, measures +the suitability between the need and the technologies, and manages and applies principles rather than rules. He is a leader who is able to mediate. He circulates information between all relevant players, multiplies points of view, shares knowledge and nevertheless always manages the technical debt...

Therefore, the Enterprise Architect understands business units needs in a different way. Before, it was thought that you had to discuss the issues with business departments in order to understand them. Now, a matrix organisation with integrated teams controlling the business platforms seems more suitable: needs and problems are no longer collected in order to be met or solved, situations are experienced in order to anticipate them.

The Enterprise Architect's mission is to enable the company to be ahead of and anticipate needs through the link between business processes and the information system. For this, the architect must decode the digital ecosystem using excellent knowledge of the company and its ecosystem to detect relevant and sustainable technologies, whilst paying close attention to trends.

This function must therefore be scalable and flexible in order to adapt to future needs: it is difficult to anticipate all environmental changes in which applications, products and services are

operating. We need to be prepared to integrate things that we are not yet in control of, which means relying on a stable but scalable architecture. In this case, the architect's role is key.

This role may arise through a fairly wide architectural committee that does not just include technicians, and whose legitimacy is validated by the decision-makers. However, care must be taken with the risk of impasses that may be caused by the over-centralisation of this committee. In some companies, project teams (IT and business units) have been grouped together and federated by architects (or committees) who raise the questions of scalability, evolution, security, etc., therefore, with the approval to implement often falling under the architects' responsibility (permit to build). This explains why they are increasingly required to be present when business departments are making decisions.

Enterprise Architects, who are quite clearly stakeholders in strategic thinking (regarding the digital, the place of data, etc.), have become true leaders of digital transformation with IT departments.

3.2. ... and so is the role of the IT department

The IT department is no longer a simple support function, it has a much more cross-functional position in the company, making a close relationship with the business departments that initiate most projects absolutely essential. Thanks to this close relationship, the IT department trains the business departments on Digital and Enterprise Architecture, encourages them to define their needs with regard to the advantages and promises of new technologies, and helps them to achieve their objectives.

Creating combined IT department and business unit, functional and technical teams is a way forward to identify and meet needs. Thus, some companies are setting up workshops or "innovation days" bringing together IT departments, Enterprise Architects, business departments, as well as managers, in order to explain the issues related to AI, Cloud, Blockchain, etc.

As data is becoming central, the CIO (Chief Information Officer) is often also associated with the Chief Data Officer (responsible for the data strategy), in order to define a common business unit/IT department language and build projects together. The IT department works in close collaboration with the Enterprise Architects regarding the technological but also business potential of digital technologies.

The main challenge for an IT department, when integrating new technologies, concerns the upscaling. In addition to the viability of a new solution, it constitutes a significant architecture issue: technologies that were used in the POCs often require significant investment to be able to enter the framework defined in terms of architecture. Also, this investment must be agreed by all players. Upscaling involves being faster in the cycle for industrialising the solutions expected by the business departments. The time between pilot assessment and industrialisation is often considerable, which contradicts with the short-term challenges of business departments.

Lastly, the arrival of the Cloud has changed the architecture of the company's information system because it requires a different way of thinking. Thinking "Cloud first" means that some answers to business unit questions may no longer be directly controlled by the IT department, but also depend on Enterprise Architects.

3.3. Digital appropriation by business units

Business units do not always think about the implications of their requests. In addition, understanding the Digital (in the business sense) involves anticipating Enterprise Architecture problems and being aware of the cross-functionality resulting from digital technologies. Thinking outside of the box requires agile thinking and organisation.

It is important to raise business unit awareness of the company's agility at scale⁸, a new representation of the requirements (vs detailed 300-page specifications), and a story line with differentiated decision-making based on the options that can or cannot be implemented.

Introducing this architecture awareness-raising into employee skills would make it easier to adopt digital technology in all business branches, and would raise the company's culture in relation to digital technology.

As in most cases today, a company's information system architecture is global, and the need for the construction of new services by the business units leads to validating, adapting and possibly redesigning the company's architecture. This puts pressure on the IT departments in terms of time, technology, finance and skills, etc. For example, we can see in some companies users that have taken the lead on the IoT, support services that engage directly with suppliers, etc., resulting in the appearance of Shadow IT. In addition, while all players can and want to intervene and make choices, believing that they know everything, the risk of major industrial error increases.

Raising awareness of architecture would make it possible to better understand and share the roles and responsibilities of the required evolutions. We need to accept that business entities can take initiatives. The IT department is responsible for making sure that these technologies are understood by and accessible to business units, and the Enterprise Architect is responsible for making sure that the "Shadow IT" is carried out cleanly in terms of architecture, security, contracts, etc., and becomes its positive version, the "In Business Computing".

The architect is much more than just a technical expert.

With his leadership, his business vision, his open-mindedness, and his ability to mediate and advise.

But also, his rigour and intransigence when the essential is at stake: security, protection of assets and overall consistency.

⁸ See Cigref's report regarding this subject, "[Agile at scale - Implementing agility on a company-wide scale](#)" - December 2018

4. Conclusion

Enterprise Architecture is the centrepiece of the digital transformation of companies.

Alongside IT departments, Enterprise or Business Architects are finding their place within the business organisation. They are the catalysts of a new collaboration between the IT department and the business departments, with a business view of data as cement.

Their global vision means that they are involved in wide range of domains: infrastructure, technology, data, security, networks, compliance, integration, and adaptation of “In Business Computing”. They may contribute to strategic plans, organise product teams in agile mode, and intervene in mediation and regulation bodies.

With the establishment of “data centric” architectures, new models are forcing Enterprise Architects to redefine the rules and principles to be applied concerning APIs and micro-services, SOA transition, “Data as a Service”, Cloud readiness, and “Security and Privacy by design”, etc.

In addition to the technical skills required, this Enterprise Architect role has always required knowledge of the company’s organisation and excellent understanding of its operation. However, his skills are complemented with essential soft skills that include collaboration, agility, the ability to discuss with business units, build story lines and mediate (permit to build).

Enterprise Architecture has now entered the era of digital maturity.

ABOUT CIGREF

KEY PLAYER IN THE DIGITAL SOCIETY

Cigref is a network of major French companies and public administrations set up in order to develop its members ability to acquire and master digital technology.



NETWORK OF MAJOR COMPANIES

Created in 1970, Cigref is a nonprofit organization. It counts among its members some 150 major French corporations and public administrations across all business sectors, all users of digital services.



DIGITAL PLAYER

It is a key player and federating body in the digital society, thanks to its high-quality thinking and the extent to which it represents its members.



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15 Board members, elected by the General Assembly, ensure its governance. A team of 10 permanent members leads the activities.