

HOW SCALING TECHNOLOGIES CHALLENGE DIGITAL ARCHITECTURE

Digital Architecture Study 2022



MANAGEMENT SUMMARY

Companies around the world are rapidly driving digital transformation to prepare their business for future demands. These transformations towards a fully digital E2E business are empowered by data analytics and AI in combination with a broad range of new technologies like 5G, IoT, Blockchain, and Edge Computing, which are often based on new Digital Business Platforms. But how can business and IT organizations handle the rising number of technological and architectural decisions as well as deliver new functionalities in time to meet business expectations? Which key architectural requirements and new capabilities are needed to enable the business value of these scaling technologies?

In practice, a well-implemented Enterprise Architecture Management (EAM) enables companies to overcome these challenges towards a future-proof IT. The Capgemini Invent Digital Architecture Study 2022 examines the current state and future role of Enterprise Architecture Management and how new technologies challenge enterprise architecture. Our key findings can be summarized in the following four outcome statements:

- Enterprise Architecture Management plays an indispensable role in digitalization projects and strategic alignment between business and IT: EAM is a key factor in cross-functional strategic decision-making and consistent implementation of new technologies and IT solutions. Therefore, it operates as a proactive driver and enabler of digital transformations. EAM improves the impact on time to market by avoiding accidental and unnecessary complexity and technical debt accumulation. Similarly, it is essential to expand architecture governance to define and implement company-wide principles to realize the benefits of new technologies.
- Insufficient availability of digital expertise and skillset requires stronger strategic prioritization of Enterprise Architecture Management to take full advantage of technological opportunities:

A clear IT strategy based on the company's business strategy is the foundation for defining the technology roadmap. Many companies thus demand a stronger role of EAM to ensure a sustainable IT landscape that is aligned with the overall strategy. Therefore, it is essential to settle a clear target architecture vision for the new technologies' usage at an early stage in transformation and implementation projects so that the growing IT landscape diversity does not become a burden in the long term. To achieve this, companies are implementing microservices, however, there is no substitute for skills and experience of the respective workforce. Security, along with public cloud services and infrastructure currently have the biggest impact on the development of enterprise architecture:

The study showed that security is the most difficult non-functional requirement to meet, followed by availability and reliability as well as deployability. The high relevance of security is thus also reflected in the influence of the scaling technologies on architecture dimensions. According to the participants, the security & privacy architecture dimension will be the second most affected for all examined scaling technologies. The current state of scaling technologies is highly dependent on the respective industries of the participating companies. Manufacturing and energy & utility companies have already identified many application areas for IoT, while 5G & Edge Computing is especially relevant in the sectors of manufacturing and telecommunication. Blockchain, on the other hand, is currently being driven more by banking and financial companies. Therefore, companies are not driven primarily by hyped technologies anymore but instead focus on technologies for which they anticipate the most strategic business value.

• Digital business platforms strongly influence the application architecture as it requires modularization of enterprise architecture:

According to participants of this study, the data analytics platform has the highest relevance of all new platforms for the corporate strategy and operations and underlines the overarching relevance of data-driven decision-making. The customer engagement platform is ranked as the second most relevant, while the IoT platform and ecosystem platform are ranked lower, although they are still fundamental to architecture. In particular, cloud services and APIs are cited as by far the most important enablers for operating digital business platforms, ensuring rapid scaling of services as well as effective and secure integration in an agile manner. Security, on the other hand, not only plays an important role as an enabler but is also cited as the most challenging non-functional requirement, ahead of agility and scalability & elasticity. As new business platforms can be customized to the company's needs with relatively little effort, cost efficiency was rated as the most important value proposition.

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PURPOSE AND CONTENT OF THIS STUDY

Today's enterprise business and technology landscape continues to be heavily driven by digitalization and necessary innovations. New digital players in the market and startups are not held back by legacy systems or technical debts and can keep up with the speed of the digital evolution. Established, long-standing companies have difficulties keeping up due to their existing, historically complex grown processes, data silos, and IT landscape. Within this environment, IT leaders must deliver new capabilities in a short time to meet the expectations of the business. Thus, a growing number of companies are willing to enhance flexibility, reduce costs and improve their time to market by implementing a proactive Enterprise Architecture Management (EAM) fitting to the digital era.

Enterprise Architecture (EA) provides a holistic view of business and technical core structures of an enterprise and their relationships to each other. Enterprise Architecture Management (EAM) enables the creation, maintenance, realization, and optimization of enterprise architecture using various tools, methods, and frameworks such as TOGAF. In addition, it empowers business and IT leaders to deliver smart investment decisions by adding context and support to help teams collaborate, providing better flexibility, agility, and autonomy in decision making, as well as facilitating faster time to value and time to market.¹

For us, Digital Architecture extends EA with the architectural design of modern digital solutions (such as Analytics, IoT, Cloud) and business structures which helps companies build efficient and optimal technological support for their business model.²

Gartner's survey finds, that "By 2023, 60% of organizations will depend on EA's role to lead the business approach to digital innovation".³ But how can Enterprise Architecture Management contribute to the establishment of a competitive technology stack as well as architecting an adaptable and resilient business? Our Digital Architecture Study 2022 explores in which ways the enterprise architecture is changing within ongoing digitalization and is affected by the rise of new technologies. Therefore, we answer the following four key questions:

- 1. How is the role of Enterprise Architecture Management perceived within organizations today?
- 2. What trends are recognizable in organizations regarding Enterprise Architecture Management?
- 3. How are scaling technologies of 2021/22 like Internet of Things (IoT), Blockchain, 5G & Edge Computing as well as Digital Business Platforms challenging the enterprise architecture of companies?
- 4. How can enterprise architecture structures be scaled quickly and efficiently to guide the digital transformation of companies and which architecture capabilities are needed in this regard?

Our questionnaire of 46 questions was developed by and provided to business and IT experts as well as managing enterprise architects. The following chapter will briefly outline the company size and industry distribution of participants in our survey.

¹ Gartner (2020). https://www.gartner.com/en/documents/3980001/enterprise-architecture-primer-for-2020

² We will use the terms Enterprise Architecture and Enterprise Architecture Management throughout the following chapters as they are more familiar to participants. ³ Gartner (2021). https://www.gartner.com/smarterwithgartner/enterprise-architecture-enables-digital-innovation



PARTICIPANTS OF THIS STUDY

The insights of this year's Capgemini Invent Global Digital Architecture Study are based on the contribution of participating companies and their experts from 11 different countries, located in Europe, North America, and Australia. The participants represent various industries, markets, and company sizes. In the following section, the participants of the anonymized study are described based on their stated characteristics.





In this study, the industries Energy & Utilities (19%), Retail & Consumer Products (19%), and Manufacturing & Industrial Products (16%) are particularly well represented. The study includes companies with a wide range of business models and revenue categories so that business challenges of

all varieties can be addressed. Most of the participants (83%) are employed by companies with more than 1,000 employees. More than half of the participants (54%) work for a company with more than 1 billion euro in revenue as shown in Figure 4.





In general, the participants mainly agree with the overall hypothesis of this study that adopting new scaling technologies is of particular importance for their company (see Figure 5). The study elaborates on these in more

Figure 4 Organizations' revenue distribution



detail in the upcoming chapters and aims to identify the current state of Digital Architecture and trends of scaling technologies within enterprises.

Figure 5 Adoption of new digital and scaling technologies is of special importance



of the respondents mostly agreed with the statement "In my company the adoption of new digital and scaling technologies (e.g., 5G, Edge Computing, and IoT) is of special importance."

CURRENT STATE OF ENTERPRISE ARCHITECTURE MANAGEMENT

Enterprise Architecture Management bridges the gap between business and IT and introduces company-wide, practical standards that guide the optimal use of available technology resources. Enterprise Architecture Governance, as part of EAM, provides recommendations for aligning policies and projects to achieve targeted business outcomes that exploit relevant business disruptions, delivering value to business and IT leaders. This promotes decentralized decision-making and guidance through enterprise architects for architecture topics at the operational level. Nevertheless, corporate practice often differs from theoretical constructs, so it is necessary to take a deeper look into the corporate reality of EAM.

As shown in Figure 6, 50% of the study participants stated that the business department is usually the main driver of digitalization projects. 31% reported that the IT department is the main initiator of digitalization projects. Only 19% of the participants stated that digitalization is mainly driven by the management board. This in combination with our previous studies suggests that digital transformation is increasingly being initiated and driven by business and IT departments, which in turn means that the digital transformation has arrived within the organization. But how does Enterprise Architecture Management get involved in the digitalization of enterprises in a world of rapid change and uncertainty?



The Digital Architecture Study 2022 reveals that 61% of the contributing companies have Enterprise Architecture Management as an established corporate function (see Figure 7). EAM is a key function in digitalization projects and is increasingly seen as an enabler for business-IT

agreed that EAM fulfills this purpose in their company. Among those that have established EA as a corporate function, the share is 96% (see Figure 7).



EAM as an enabler of digital initiatives and collaboration between IT and business units

EA as corporate EA not as corporate function function

Figure 7

collaboration. 69% of the participating companies mostly

Furthermore, we can observe that EAM is a very important topic and crucial for the selection and implementation of new technologies in 81% of the participants' companies (see Figure 8). The Architecture Board is an essential function in EAM to adopt the decision on the selection and implementation of new technologies and to steer directions. Nevertheless. 22% of the participants still do not have an Architecture Board (see Figure 9). Through our day-to-day insights, it appears that traditional Architecture Boards do not fit in modern product-based operating

models of the participants and now face the challenge of agility and decision-making competency. Nowadays, architecture decisions are made on an ongoing basis in self-organized teams. An annual centralized Architecture Board can only provide limited, slow support for urgent architecture decisions. Based on our approach, Architecture Boards must be closer to product teams in the respective departments to be able to support them with guiding principles and architecture.



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- 3% of the respondents mostly agreed with the statement "In my company, the Architecture Board is a helpful steering committee for strategic decisions on the selection and implementation of new technologies or IT applications.
- Totally disagree
- © Capgemini Invent 2022

A key finding of our study shows that EAM is seen as a function, which supports the adoption of new technologies (69%). Furthermore, the participants revealed that Enterprise Architecture Management particularly drives architecture standardization (89%) and IT efficiency (72%). Other aspects that are promoted by EAM are cross-sectional collaboration (56%), transparency (50%) as well as agility and flexibility (39%) (see Figure 10). This indicates the benefits of an established EAM in the company, which are particularly related to the standardization of architecture and the resulting efficiency. The fact that standardization is seen as a positive aspect of EAM is expected based on last year's studies. Another interesting finding is that while EAM used to be seen as an obstacle to agility, today 39% of

the participants state that EAM is beneficial to agility. Due to the fast pace of digitalization and the resulting focus on agility, frameworks like Scaled Agile Framework (SAFe) have come into the spotlight in recent years. Nevertheless, our experience shows that especially decentralized and productoriented teams require a good architectural basis, which can be enabled by EAM. This is also reflected in the rising role of architects in SAFe, which underlines the importance of proper architecture in a complex and scaled environment. Although EAM provides decent transparency for costefficiency, proactive controlling (11%) is an underestimated factor for cost reduction among the participants.





Architecture governance is of significance for wellgrounded technology-driven decision-making. Without good guidance, central architecture repositories and principles, architecture is not feasible at scale in large corporations. EAM establishes company-wide principles for over 70% of the participants (see Figure 11). However, there is still a need to catch up, because guiding principles either do not exist or are not used sufficiently in the companies of the participants. 58% of the participants state that EAM contributes significantly to the cost-efficiency of the IT landscape, by consolidating and standardizing IT applications and infrastructure (see Figure 12). These results underline the thesis that IT efficiency is an untapped lever of EAM.

Figure 11

EAM function defines company-wide principles for all technology-driven decisions



- Totally agree Rather agree Rather disagree
 - Totally disagree

0% of the respondents

mostly agreed with the statement "In my company the Enterprise Architecture Management function defines company-wide principles which must be taken into account for all technology-driven decisions.

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Figure 12





58% of the respondents mostly agreed with the statement "In my company Enterprise Architecture Management contributes significantly to the cost efficiency of the IT landscape (e.g., by identifying IT applications or service providers to be consolidated).'

As already outlined before in Figure 7, EAM is a pivotal factor in digitalization projects and is increasingly seen as an enabler in business-IT collaboration. 64% of the participating companies report that EAM enables collaboration, by facilitating strategic decision-making between business and IT (see Figure 13). Consequently, 97% of the participants totally agreed or rather agreed that IT teams will be an important part of the digital transformation and a major factor for a successful digitalization (see Figure 14).

Figure 13

EAM in terms of strategic decision making between business and IT



of the respondents mostly agreed with the statement "In my company, Enterprise Architecture Management facilitates strategic decision making between business and IT (e.g., outsourcing, implementation of new technologies, IT-security and quality management,...)."

64%

Totally agree Rather disagree Rather agree Totally disagree

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Future role of IT in the development and Figure 14 adoption of digital technologies



Totally agree Rather agree Rather disagree Totally disagree

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1%

of the respondents

the role of IT in the

the future."

mostly agreed with the

statement "In my company

development and adoption

of digital technologies will

increase significantly in

- Key takeaways about the current role and importance of Enterprise Architecture Management:
- The digital transformation is increasingly being initiated and driven directly by business and IT departments, which indicates that digitalization projects are not driven top-down. Enterprise architects are a decisive factor for the alignment between business and IT departments.
- EAM is seen as a function which supports the adoption of new technologies like Internet of Things (IoT), Blockchain, and 5G & Edge Computing.
- Only 53% of the participants mostly agreed that the Architecture Board is a helpful steering committee for strategic decisions and the implementation of new technologies. This underlines the perception that current Architecture Boards do not fit in the agile and fast-moving environment of companies.
- The main promoted aspect by EAM according to the participants is the standardization of architecture (89%), which facilitates alignment with business strategy. By standardizing architecture, companies can reduce legacy systems and technical debts. This results in higher IT efficiency, which is considered by participants to be the second largest promoted aspect by EAM (72%).

SCALING TECHNOLOGIES AND DIGITAL BUSINESS PLATFORMS IN ENTERPRISES

As a consequence of the rapid digital transformation, enterprises are increasingly challenged to make a multitude of technology decisions in a short period of time. This trend has been significantly amplified and accelerated by the COVID-19 pandemic. Future-oriented organizations are reshaping their technology stacks by focusing on automation, big data, and cloud computing. Furthermore, they depend on agile and modern architectures that help them stay competitive in a high velocity market. We asked this year's survey participants to provide their point of view on how scaling technologies like Internet of Things, 5G & Edge Computing, Blockchain, as well as Digital Business Platforms challenge enterprise architecture.

Architectural Challenges of Scaling Technologies

Traditional strict boundaries between business and IT departments lead to more impediments regarding agility for complex IT solutions. 100% of the participants mostly agreed that a one platform collaboration with business and technology experts will have a decisive positive impact on the adoption of innovative technologies (see Figure 15). Strengthening the business and IT alignment is hence a first step for the successful introduction of scaling technologies. However, cross-disciplinary product teams with business and IT representatives seem to achieve better agility and higher performance (time to market) to gain a competitive advantage through scaling technologies.

Figure 15

Totally agree

Rather agree

Combining business and technology experts in one platform team with E2E responsibility leads to a faster adoption of innovative technologies



of the respondents mostly agreed that combining business and technology experts in one platform team with E2E responsibility leads to a faster adoption of innovative technologies.

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In addition, 77% of the participants mostly agreed that the technology roadmap and the selection of innovative technologies are carried out in consideration of the business strategy (see Figure 16). This shows that business strategy is an established key driver of the technology roadmap and vice versa. The role of EAM is to implement applications sustainably and transparently. This enables executive management to steer the transformation of business strategy into a fitting IT strategy. Although EAM is already seen as a function that promotes the adoption of new technologies and the standardization of architecture (see Figure 10), 94% of the participants mostly agreed that EAM needs an even bigger role in guiding the integration of scaling technologies (see Figure 17). By incorporating EAM early in new initiatives it can ensure an IT landscape that is aligned with the overall strategy of the organization.



The technology roadmap is aligned with the business strategy



of the respondents mostly agreed with the statement "In my company, the creation of the technology roadmap and

selection of new technologies is being carried out in consideration of the business strategy.

Totally agree

Rather disagree

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Totally agree

Rather disagree

EAM needs a stronger role in guiding the integration of scaling technologies



Rather agree Totally disagree

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of the respondents

Management needs a

integration of scaling

stronger role in guiding the

technologies to ensure an IT

landscape that is aligned with the overall strategy.

mostly agreed that Enterprise Architecture

The participants stated that the most concerning aspects of the architecture when implementing new technologies is the business architecture, followed by the data architecture, and the application architecture (see Figure 18). This result is counterintuitive as the focus has so far been often on application architecture. However, the observed trend towards data-centric architecture as well as the use of data as the key asset of organizations make this finding plausible. The infrastructure architecture, while important, is now seen more and more as a commodity, due to standardized cloud infrastructure.

100% of the participants mostly agreed that data is a key asset that supports scaling technologies as well as business value. A modern data architecture needs to be built on shared data and effective integration of the increasing number of sources for structured and unstructured data. Current challenges regarding data architecture according



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to the participants are data silos (69%), data quality (64%), and data integration (58%) (see Figure 19). Data silos are the most concerning problem due to a lack of overarching data governance. This often results in a lack of data ownership on an enterprise level and no end-toend process perspective. The use of open, non-proprietary data formats and the access of data by standardized APIs enables better integration of scaling technologies and the possibility to operate in an agile way. However, 23% of the participants stated that this is not fully realized in their company (see Figure 20). Proprietary formats and nonstandardized APIs are not necessarily an immediate problem but will become one in a few years when there is a need for new technologies which must be implemented in an agile way. The importance of data architecture is also reflected in Capgemini's TechnoVision Study 2021, which uses the metaphor "be like water" as information and data flows must be shapeless and formless, yet always flowing.⁴



Rather agree Totally disagree



Overall, the study has shown that there are several impediments towards scaling technologies (see Figure 21). Technology and IT have evolved significantly in the last few years due to topics like Cloud, AI, IoT, and DevOps. This leads to a lack of skills (75%) and experts for data management capabilities (47%). Organizational aspects (53%) can be an impediment due to no existing committee structure and missing processual and operational guidelines for new scaling technologies. Security aspects and insufficient budget were both identified as a barrier by 42%. The know-how and skill portfolio in the companies have not been able to keep pace with the trends and are therefore falling behind technological development. It also sets the focus on Enterprise Architecture Management to adopt agile working principles to be an enabler for flexible developments. This implies room for improvement in two ways: The management must establish an organizational structure that enables the adoption of scaling technologies. Additionally, it needs to be ensured that the employees are enabled and sufficiently skilled to adopt them in the company.



Impediments towards scaling technology when implementing new technologies



The introduction of scaling technologies such as IoT and 5G also requires a suitable application architecture to fully utilize their benefits. This is best supported by an application architecture consisting of microservices that ensures the required agility and scalability. That is also reflected by 97% of the participants (see Figure 22), who mostly agreed that a modular architecture supports the adoption of new technologies. The microservice

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architecture enables smaller and faster deployments and easier testing and monitoring of single service components by using DevSecOps and automated testing approaches. However, when introducing microservice architecture, it is crucial to use design patterns from the start that optimize performance and reduce negative impacts of network calls and security checks on performance.

Figure 22 An application architecture consisting of modular objects facilitates the introduction of new technologies

Totally agree Rather agree Rather disagree Totally disagree



of the respondents mostly agreed that an application architecture consisting of modular objects facilitates the introduction of new technologies.

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Key takeaways about the architectural challenges of scaling technologies:

- Stronger alignment between business and IT is a first step in the successful adoption of scaling technologies. Therefore, business impact and changes in business architecture require greater consideration. 100% of the participants mostly agreed that a one platform collaboration relationship between business and technology experts will have a decisive positive impact on the adoption of innovative technologies.
- 94% of the participants mostly agreed that EAM must play an even stronger role in guiding the integration of scaling technologies. Incorporating EAM into new initiatives early on can ensure an IT landscape that is in line with the company's overall strategy.
- It can be observed that the focus is shifting from application-centric architecture to datacentric architecture and that data is seen as an important and valuable asset of companies. But companies must ensure that their data is expressed in open non-proprietary formats to enable the exchange of data in an agile and scalable manner. Data silos (69%), data quality (64%), and data integration (58%) are current challenges regarding data architecture.
- 97% of the participants mostly agreed that microservice architectures are a key enabler for the introduction of new technologies. However, the biggest impediment towards the adoption of emerging technologies is a shortage of skills and talents (75%).

Current state of Scaling Technologies and their impact on Enterprise Architecture

In the following section, our study takes a closer look at the status quo of the three scaling technologies Internet of Things (IOT), Blockchain, and 5G & Edge Computing as well as the challenges and implications for enterprise architecture.



In a comparison of the three technologies, IoT is already the most widespread in analyzed companies, so that only 22% indicated that there are no plans for the technology yet compared to Blockchain (56%) and 5G & Edge Computing (53%) (see Figure 23). This is also reflected in the relevance of implementation of IoT for the corporate strategy, since participants who are at least in the ideation phase rated it mostly high with 64% (see Figure 24). The majority of the participants have not developed any business cases for Blockchain technology, as well as 5G & Edge Computing. This underlines the discrepancy between the perception of technologies in public debates and the strategic relevance of topics in companies. A specific use case for the introduction of hyped scaling technologies does not emerge for every industry and every company. Among scaling technologies, which are functioning as part of the IT strategy, IoT was indicated as most relevant to supporting participants' corporate strategy, followed by 5G & Edge Computing and Blockchain technology. In the respective companies, 5G & Edge Computing are particularly relevant in the telecommunication and manufacturing sectors. The greatest relevance of Blockchain technology can be identified in the banking and capital markets sector, where it is already partially live. The results indicate that the manufacturing and government & public sectors are also already more intensively engaged with Blockchain technology. IoT plays a very significant role in the logistics as well as manufacturing and energy & utility sectors in particular, with more than two-thirds of the companies in each case stating that it is of high or very high relevance to them.



Figure 24 Relevance for the implementation of the corporate strategy

This study shows that security is the most important factor since it is stated as the most important technology enabler for 5G & Edge Computing and Blockchain as well as the second most important enabler for IoT (see Figure 25). Data is gathered in more and more touchpoints. The touchpoints are getting closer to the customer, so that data collection involves security risks. Therefore, data management is also an important factor in the secure and targeted use of scaling technologies. Cloud services are seen as © Capgemini Invent 2022

a multi-purpose enabler, since scalable infrastructure is necessary for technologies like IoT, Blockchain, and 5G & Edge Computing. Without cloud services, many modern technologies are not feasible. APIs also take an important role in scaling technologies for the participants. They are crucial to enable scaling and integration, as well as platforms and ecosystems. UI frameworks and master data objects are almost completely irrelevant and have become commodities for the participating organizations.





We asked the survey participants to provide their point of view on the most challenging non-functional requirements of the scaling technologies (see Figure 26). The results once again highlighted the importance of security for the participants, but also the complexity of it. 5G and IoT will be an even bigger security concern in the upcoming years due to the significantly expanded attack surface driven by the increase in volume and variety of connected endpoints and

Figure 26

attack vectors. The number of industrial IoT connections is estimated to grow by 107% from 17.7 billion in 2020 to 36.8 billion in 2025.⁵ Another finding is that ensuring availability and reliability is a big challenge for the participants, while agility is not outlined as a major challenge. Availability is a necessary requirement and must be optimized by cloud and resilience technology.



Most challenging non-functional requirements

Due to different requirements of the scaling technologies, various architectural dimensions are affected to different degrees. Security & privacy architecture will be of particular importance, ranked as the second most important dimension for all three scaling technologies, right after infrastructure (5G & Edge Computing), business architecture (Blockchain technology), and data architecture (IoT technology) as shown in Figure 27. EAM can provide valuable impulses for innovation and evaluation of technologies by creating transparency of the different architecture domains. The large number of connected devices through IoT and the exchange of data create the need for enterprises to redesign their data management capabilities to be able to handle a large amount of data. Leveraging existing data can be crucial to maintain an organization's competitive advantage, retain customers and grow revenue. However, generating, collecting, and analyzing valuable data through IoT poses a great risk to companies if data privacy and quality are not handled appropriately. 5G, IoT, and other technologies that need to process large datasets in realtime are driving the increasing demand for cloud and edge computing and thus greatly impact the infrastructure architecture of enterprises. With Blockchain changing the enterprise by eliminating third-party facilitators, the participants indicate that it will have the biggest impact on the business architecture domain.



Figure 27 Impact of scaling technologies on architecture dimensions

Key takeaways about the current state of scaling technologies and their impact on enterprise architecture:

- Identifying use cases for scaling technologies is still very industry-dependent, which means that a direct comparison of the technologies can be misleading. However, it is shown that IoT is particularly preferred in the manufacturing sector, while telecommunication is advanced in the field of 5G & Edge Computing. Banking & capital markets lead the implementation of Blockchain technology.
- Cloud services are seen as a main multi-purpose enabler after security, especially for IoT and 5G & Edge Computing, as they are the key to realizing scaling technologies. UI frameworks and master data objects, on the other hand, are no longer relevant.

Digital Business Platforms in Enterprises

For us, digital business platforms are a combination of "bestin-class" technologies and associated activities, which are aligned with a specific business objective. Digital business platforms need to be modular and detached from each other to be flexibly integrated. That modularity allows companies to innovate independently, continuously improve the platform, and scale quickly. Companies that rely on digital business platforms can react faster to external and internal changes and benefit from greater scalability of their business models. More than 2/3 of German companies believe that the operation or use of digital business platforms is necessary to ensure the future viability of their own company.⁶

The Digital Architecture Study 2022 reveals that data analytics platforms have the highest relevance for the participants (see Figure 28). Today's businesses are experiencing a demand to increase analytics use cases that require a comprehensive analytics platform to enable analytics to be fully operationalized across the enterprise. Data analytics platforms empower data-driven decision-making and cover the end-to-end process from data collection to analysis and data management. The high relevance of data analytics platforms reinforces the increasing focus on data. It underlines our understanding that data analytics platforms are the foundation for all other digital platforms in a company.

Customer engagement platforms are named as the second most relevant platform by participants. We can observe that today's customers expect to be engaged seamlessly, knowledgeably, and efficiently across multiple platforms at every touchpoint with a company. In a digital world with multiple customer channels across the entire customer journey and customer data being distributed in different databases, this poses a challenge for organizations. However, customer engagement platforms help companies to manage, analyze and optimize the customer experience at different touchpoints throughout the customer journey. In addition to improved value creation from the company's data and the company's continued focus on the customer, around 1/3 of the companies surveyed still need to further develop their information system architecture and improve operational excellence in their internal processes and workflows (see Figure 28). The various digital platforms possess overlap and have relevant interdependencies. The survey clearly shows that many companies are still caught between the conflicting priorities of data, customers, and operational excellence and are not yet able to address the tasks at hand.

The result in Figure 28 suggests that ecosystem platforms to create and connect to external ecosystems and marketplaces, as well as IoT platforms for networking, control, and monetization of physical assets, are only relevant for a minor group of companies. Such companies are already one step further and have developed an evolved understanding of customers (regarding ecosystem platforms) and data (in the sense of data ecosystem). Although many of the participants are at least in the ideation phase for IoT, the number of participants who have IoT running in their enterprise is relatively small and so the relatively low relevance of IoT platforms is no surprise. But as IoT devices are becoming more and more common, enterprises will search for unified platforms that make it possible to track and manage their devices.

	Relevance of digital business platforms for the implementation of the corporat	
Figure 28		strategy
1		Data Analytics Platform
2		Customer Engagement Platform
3		Information Systems Platform
4		Ecosystem Platform
5		IoT Platform
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⁶ BDI (2021). https://bdi.eu/artikel/news/deutsche-digitale-b2b-plattformen-2021/

According to the participants, cloud services (78%), APIs (75%), data quality management (50%), and security (47%) are the most important technology enablers for digital business platforms (see Figure 29). Cloud services are key enablers for digital business platforms, as they minimize upfront costs, allow the platform to go live and scale quickly. The combination and connection of multiple application systems, services, and technologies within one digital business platform require an effective and secure integration. APIs are of vital importance for achieving this in an agile and scalable manner. Ideally, companies build an

API management platform that offers governance, security, API design, and developer support. The exchange of data within a platform and with ecosystem partners makes it necessary to establish regularization and security rules to ensure that sensitive data is handled properly. In addition, analyzing various factors, e.g., customer engagement, sales, production, IoT devices, as well as services and products from partners, to derive valuable insights with the help of data analytics platforms make data quality and data management an essential enabler for digital business platforms.



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Furthermore, we asked the participants about the most challenging non-functional requirements for digital business platforms. The results underline the findings of Figure 29 regarding the importance of security (72%), agility (44%), and scalability & elasticity (36%) in the form of modular platforms (see Figure 30). At the same time, the results show that the enablers are also the greatest challenges.



Figure 30 Most challenging non-functional requirements for digital business platforms

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The participants of the Digital Architecture Study 2022 state that digital business platforms (33%) have the biggest impact on the application architecture (see Figure 31). Due to the loosely coupled nature of digital business platforms, companies must shift their application architecture away from monolithic systems towards a modern, flexible, modular application architecture, which allows quicker scaling, updating, and detachment of digital business platforms. Business architecture and data architecture (each 25%) are stated as the architecture domains with the second biggest impact due to digital business platforms. This shows very clearly that digital business platforms influence company thinking and action. Companies are faced with the challenge of rethinking siloed data and process structures, breaking down classic ownership and governance structures more than ever before, and consistently aligning the organization with the platform strategy e.g., acting as a platform provider. With data analytics platforms being the foundation for other platforms and a necessity for exchanging information between systems within a platform, the data architecture of organizations is also highly impacted by the establishment of enterprise platforms. The non-existent impact on infrastructure architecture according to the participants shows that the necessary infrastructure for scalable and modular platforms is already existing in enterprises



Ideally, platforms are highly modular and open. At the same time, companies can easily access an unprecedented range of innovative digital services to tailor their platforms to their needs without a high effort. Thus, cost efficiency is ranked as the most important value contribution of digital business platforms (see Figure 32). The second most important value contribution of digital business platforms according to the participants is the increasing innovation capability. The modular nature of digital business platforms allows companies to innovate independently, continuously improve the platform and scale quickly regardless of whether you are an operator or a user of the platform. Although the results show that digital business platforms drive innovation, companies' platforms do not result in new business models yet and are consequently not in top-line growth.

Ranked value contribution of digital business platforms to the following topics

1	Cost efficiency
2	Innovation capability
3	New business models
4	Top-line growth

Key takeaways about digital business platforms:

- The high relevancy of data analytics platforms according to the participants underlines the value of data within companies and the focus on data-driven decision-making.
- Security is seen as the biggest non-functional challenge for digital business platforms (72%).
- Digital business platforms have the biggest impact on the application architecture (33%) since their modular nature makes a shift towards modern and flexible application architecture necessary.
- Cost efficiency is ranked as the highest value contribution of digital business platforms. In contrast, the low-value contribution in terms of top-line growth and new business models indicates that digital business platforms have not reached their full potential yet.

Figure 32

CONCLUSION AND OUTLOOK

This study underlines that Enterprise Architecture Management (EAM) accompanies the selection and adoption of new technologies. EAM takes a comprehensive view of the organization by enabling business and IT alignment and is therefore increasingly involved in digitalization initiatives. The impact of new technologies and digital business platforms influences the entire enterprise architecture across organizations as well as existing business models. This benefits from an early alignment with enterprise architecture.

We can observe the trend that IT becomes more and more decentralized. The study shows that this shift leads to new challenges regarding scaling and security. The emergence of scaling technologies and the loosely coupled nature of digital business platforms lead to an increasingly granular IT and underlines that the trend continues to move away from monoliths towards modularity. In the future, a stronger role of EAM will be needed to govern and manage a large number of small business services and applications to ensure a consequent alignment with business strategy and a platform-oriented business capability management. Without sophisticated governance and shared central API-driven enterprise architecture repositories in the cloud, companies soon risk becoming overwhelmed by the increasing numbers of applications, interfaces, and data objects. Therefore, agile and central structures in EAM and enterprise governance are needed, which enable product-oriented project teams to quickly make enterprisecompliant architectural decisions and thus build on a reliable architectural foundation. Particularly in a decentralized and fast-moving environment, it is necessary for prospective architecture to rely on automated IT and EA solutions to manage microservices efficiently. This enables architectures

consisting of a large number of modular applications and services to be deployed or to detect and resolve errors through the use of automated processes. EAM is therefore required to provide the basis by setting standards concerning monitoring, security, and infrastructure.

We can see across all scaling technologies and the importance of data analytics platforms that data architecture is becoming even more important. This focus on data will continue to grow through movements like datacentric architecture. While systems and applications are changed frequently, data as a resource outlasts often many generations of applications. A data-centered architecture sets the data as the digital core and builds the applications around it. Companies are therefore required to ensure that their data is easily transferable and expressed in open, non-proprietary formats.

Overall, we can see that skills and knowledge regarding cloud computing, data management, and security are needed for the successful adoption of scaling technologies. This study also revealed that the biggest limiting factor in the introduction of emerging technologies is a shortage of skill and knowledge e.g., in the field of IoT or Machine Learning. This view is also reinforced in a study conducted by Gartner, in which 64% state that talent availability is the most significant adoption barrier of emerging technologies.⁷ Due to the increasing willingness to adopt new technologies it is likely that in the near future there will be an even tougher battle for experts. Without the necessary knowledge and architecture, it will be difficult to prepare IT in the company for new technologies and trends.

CAPGEMINI INVENT'S CONTRIBUTION TO ENTERPRISE ARCHITECTURE

The Capgemini Invent Digital Architecture Portfolio delivers various services to our clients, from establishing agile and innovative Enterprise Architecture Management departments to providing the right tools and methodologies to design flexible and capability-driven system landscapes in IT and business transformations. Key architecture principles must be defined for each company and should cover areas like agility, customer experience, regulation, and security. Our approach is based on the following five architectural core components that aim to optimize value contribution of established Enterprise Architecture departments.





The goal is to maximize value-added activities of Enterprise Architects by acting as a trusted business advisor rather than documenting and maintaining legacy systems. Our key offerings, structured in the following three core domains, enable digital architecture transformations on all five core components.



Architecture Strategy & Governance

Provide snapshots for trends and strategic drivers that influence best-practice architecture decision



Define **clear governance** structures, align and enable IT–strategy, process and portfolio management



Evaluate the maturity of your Enterprise Architecture and identify future potentials in digitalization



Enterprise Architecture

Enterprise

Platforms





Establish a transparent overview of your EA and create a **target architecture** that support your business strategy



Perform a capability driven **vendor** and software selection to reinforce a holistic EA transformation



Perform inside-out and outside-in analysis of your current **enterprise platforms** to assess demand for action



Derive design principles for reshaping your **enterprise platform strategy**



Leverage our enterprise platform technology library to design your future **enterprise platform service portfolio**

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