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Change The Way You Change

How can banks stay ahead of the curve?

August 2019

Executive Summary

Cloud's benefits and value for banks
Cloud enables banks to improve their agility, drive innovation by tapping into cutting-edge technology, leverage industry-specific solutions, and shift their spending paradigm from CapEx to OpEx.

Why have banks been reluctant to use cloud?
Regulations, data security, the challenges of transformation to the cloud and the risks associated with the outsourcing of critical processes have so far discouraged many banks from adopting the cloud. Reacting to that, major cloud service providers have increased their global physical presence and have already resolved many issues around regulatory and legal obligations, e.g. regarding data location. Transformation challenges can be overcome by adopting a structured approach to adoption of the cloud. A thorough risk assessment and ongoing vendor management process (i.e. an ongoing process aiming at nurturing and developing the relationship with the vendor to get the most out of their products) should enable banks to mitigate data risks and third party risks.

Key success factors for cloud transformation
Any cloud transformation must start with the definition of a cloud strategy aligned with the organisation's broader business strategy, followed by a definition of risk management and governance requirements, and a financial analysis justifying the investment. The subsequent actual migration to the cloud will call for a corporate culture change to drive innovation and fully leverage cloud capabilities.

Compliance with regulatory requirements
Using cloud services raises complex questions about compliance with regulations, because processing sensitive information or client identifying data (CID) comes under strict rules. These have so far prevented many banks from embracing the cloud. Since regulations differ between countries, this report presents the general considerations (country-specific considerations can be obtained from your local Deloitte offices).

Cloud cyber security
Cloud services extend the IT footprint of organisations, which might impact the risk of cyber attacks. Robust arrangements for cyber security should therefore be put in place. These should cover seven cyber domains: Network and infrastructure security; Identity and access management (IAM); Data protection; Logging and Monitoring; Resilience; DevSecOps; and Governance, Risk, and Compliance.

How to select the right cloud service provider
Finding the best cloud service provider for your use cases depends on your current and future operating model, your own service offerings and the type of delivery model you want (IaaS, PaaS, or SaaS). Deloitte recommends a framework for assessing your operating model and the service offerings of potential cloud service providers, from different perspectives: regulatory aspects; compliance; cyber security; and technology issues. To avoid vendor lock-in and comply with legal obligations, we also recommend banks to go for a multi-cloud strategy.

Introduction

Cloud is not the future or an emerging trend anymore: it is the present and it constitutes a critical tool for financial institutions to stay competitive in today's challenging business environment. Success with process re-engineering and efforts at digitalisation with emerging technologies such as artificial intelligence are dependent on cloud computing.
Banking regulators and supervisors recently published guidelines to encourage banks to make more extensive use of cloud services, whilst at the same time stating that banks cannot relinquish their accountability of outsourced IT services.

This report provides an independent perspective on the major opportunities and risk management issues, but also - based on our practical experience - a high-level roadmap to cloud transformation and the common pitfalls that banks should consider. This report also provides tools to answer certain questions about IT:

- How can we seize opportunities while mitigating risks?
- How can we keep up with innovation while not making costly mistakes?
- How do we survive and thrive in the cloud?

Leveraging cloud offerings represents a shift in management attitudes– organisations are moving away from a do-it-yourself mentality towards using external providers with scalable, flexible, faster and sometimes cheaper services. While some organisations are apprehensive about using the cloud, it is an integral component of today's service-delivery model and it enables banks to tap into new market opportunities and access new delivery channels.

Many suppliers and banks are therefore moving to a 'cloud first' strategy. Cloud deployments with off-the-shelf offerings are becoming ubiquitous, while on-premise deployments are becoming the exception. Many RegTech companies [1] offer software as a service out of the cloud. Banking-focussed boutiques offer managed services which are already compliant with banking regulations across all technology layers (from the infrastructure up to the software), enabling banks to accelerate their adoption of the cloud by providing out-of-the-box compliance with industry-specific regulations.

Banks and major cloud service providers are on a collision course. For example, Amazon offers cash services, credit cards and other basic financial products including Amazon Pay. Another example is Alibaba with its spin-off AliPay, which has over 900 million customers, far more than the largest US bank. Both Alibaba and Amazon have improved their ability to offer business banking services on their platforms. More broadly, there are predictions that devices such as Alexa, Siri or Google Home will be the future of banking, since these smart AI bots will act as a financial assistant in everyday life. To get financial guidance, imagine asking Siri: "Can I afford this car now or should I wait until next year?" Embracing the cloud is a matter of survival in a business environment where innovation, disruption and competition are pushing banks to improve efficiency and become more agile, while adding value for their customers. Successful leaders should think 'cloud first' if they want to survive in today's fast evolving and competitive marketplace.

Use Case: Deutsche Bank and Quantiguous Solutions

"Deutsche Bank today announced that it has acquired Quantiguous Solutions, a Mumbai-based software company, to strengthen its Global Transaction Banking franchise. With the help of Quantiguous, the bank will accelerate the development of its Open Banking platform that forms the core for developing innovative client applications and connecting corporate clients, FinTechs and partner companies to Deutsche Bank's Transaction Banking platforms and services." [2]

Cloud quick ckeck – Is your bank getting cloud right?

01. Do we understand how cloud can help us reach our strategic objectives?

- ☐ Yes
- ☐ No
- ☐ Better get some advice

02. Do we know which parts of our business will benefit from cloud?

- ☐ Yes
- ☐ No
- ☐ Better get some advice

03. Is your team nervous about transitioning to the cloud?

- ☐ Yes
- ☐ No
- ☐ Better get some advice

04. Do you know what your competitors are doing with cloud?

- ☐ Yes
- ☐ No
- ☐ Better get some advice

05. Can our bank remain competitive without using cloud?

- ☐ Yes
- ☐ No
- ☐ Better get some advice

What is Cloud?

The cloud consists of a broad range of offerings where services are provided by an external third party and purchased as a service. Offerings vary from basic computing resources, to platforms, to fully functional software ready to deliver business value. These are referred to respectively as Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS).

Cloud deployment models

- Public cloud (off-premise or external): cloud computing services provided by suppliers to multiple customers via a cloud computing architecture that allows customers to share computing resources. Telekom Cloud or DigitalOcean are examples of public clouds. A hyperscale public cloud is a category of public cloud providing a larger pool of resources, serving millions of users and combining hundred thousands of individual computers into a low cost resource pool with maximum availability. AWS, Microsoft Azure, IBM, Oracle, Alibaba and Google Cloud are prominent providers of hyperscale public clouds.
- Private cloud (on-premise or internal): cloud computing services owned and operated on-site by a single organisation.
- Hybrid cloud (integrated public and private service): a mixed environment combining public cloud and private cloud or on-premise solutions.
- Community cloud: a public or private cloud shared by an industry group, government agency, or other association with similar demands or interests.

Cloud delivery model

- Infrastructure as a Service (IaaS). This provides low-level resources such as computing, storage and networking for customers to build scalable applications. AWS EC2 is an example of IaaS providing 'virtual machines'.
- Platform as a Service (PaaS). One level above IaaS, PaaS provides a managed environment to develop applications such as a Java runtime or a NoSQL database. Google Cloud's App Engine is an example of PaaS providing a managed Java, Python, Go or node.JS environment for developing applications without the need to manage the underlying infrastructure.
- Software as a Service (SaaS): This provides user-ready, out-of-the-box software providing a specific built-for-purpose business service to the customer. Microsoft's Office 365 is an example of a SaaS, where customer can use the service without managing any aspects of the underlying software and infrastructure.
- Managed Services (MS): MS are an additional layer of services delivered on top of cloud services, to manage processes such as 24/7 SLA monitoring, operational management, liability frameworks, ecosystem integration, audit, security, fail-over management, compliance and other processes. In the banking industry, Avaloq's Managed Services offering ensures that banks are in compliance with regulations and manage all the operational and regulatory aspects of the underlying systems.
- Business Process as a Service (BPaaS): Business Process as a Service (BPaaS) is a form of business process outsourcing

  (BPO) that employs a cloud computing service model to deliver automated services sourced from the cloud and operated within a shared multi-tenant infrastructure. Whereas the aim of traditional BPO is to reduce labour costs, BPaaS reduces labour costs through increased automation and economies of scale. As an example, Deloitte's BPaaS offerings provide managed logs analytics and managed cyber risk with specific industry skills, especially for customers in highly-regulated industries.

Cloud stack

A cloud stack is a software layer that can be deployed on computing infrastructure to provide a cloud environment. As an example, Microsoft installs an Azure layer or stack on top of dedicated hardware (e.g. HPE, Dell or Lenovo) which creates the Azure environment. An Azure Stack can also be deployed in a private data centre to simulate some features of Azure cloud in a private environment.

"Many large corporations, especially those for which security is important, such as banks, have tended to prefer private cloud, or a public/private hybrid, because of the additional security, perceived or actual, it provides. This hesitancy on the part of large companies is disappearing. Where they can, they now tend to deploy public rather than private cloud." [3]

Benefits of the cloud for banks

Running a business in the cloud offers numerous advantages, depending on the industry, business size and location.

Deloitte has grouped the potential benefits for banks into the following four categories:

- Improve business agility
- Innovate through consumption of external services
- Leverage industry-specific solutions
- Paradigm shift in IT spending

Each of these attributes brings valuable benefits when implementing a cloud strategy. For example, a shift in spending can enable companies to reduce working capital and free up cash to invest in the exploration of new technologies; while an improvement in agility can facilitate innovation and also accelerate the shift towards IT service consumption instead of IT ownership, which impacts the spending paradigm. A successful cloud transformation should capture the benefits all four areas.

Benefits of the cloud for banks

"Many banks around the world are aggressively pursuing a mobile-first strategy. Some have launched mobile-only bank brands to fend off FinTech challengers, while a vast majority are enhancing their mobile apps with new features such as person-to-person payments, personal financial management tools, and virtual assistants." [4]."

Improve business agility

Major banks heavily rely on legacy systems, such as mainframes and old programming languages, e.g. COBOL: this restricts business agility. The rise of the digital economy has put pressure on financial players, and triggered the need to pursue digital transformation and integrate new digital technologies quickly in order to respond to changes in the market and consumer behaviour. Legacy systems sometimes do not provide the appropriate level of agility that is needed to keep up with the pace of change.

FinTech companies were created 'digital and cloud native'. Disruptors such as N26 and Revolut are not only able to deliver solutions at much faster pace; they also attract customers and gain market share due to their user-friendly and innovative solutions, fuelled by an agile, cloud-based infrastructure.

Deloitte recommends a multi-stage approach for traditional banks to move forward from legacy systems towards the cloud. This begins with an evaluation of the suitability of the cloud for key applications and processes, and a gradual shift from legacy systems towards the public cloud (where compatible with regulations) since this type of cloud model yields the most benefits in terms of elasticity, functionality and cost efficiency. A hybrid cloud strategy is the industry standard today and there will be an increasing shift towards the public cloud due to the benefits from hyperscale cloud services.

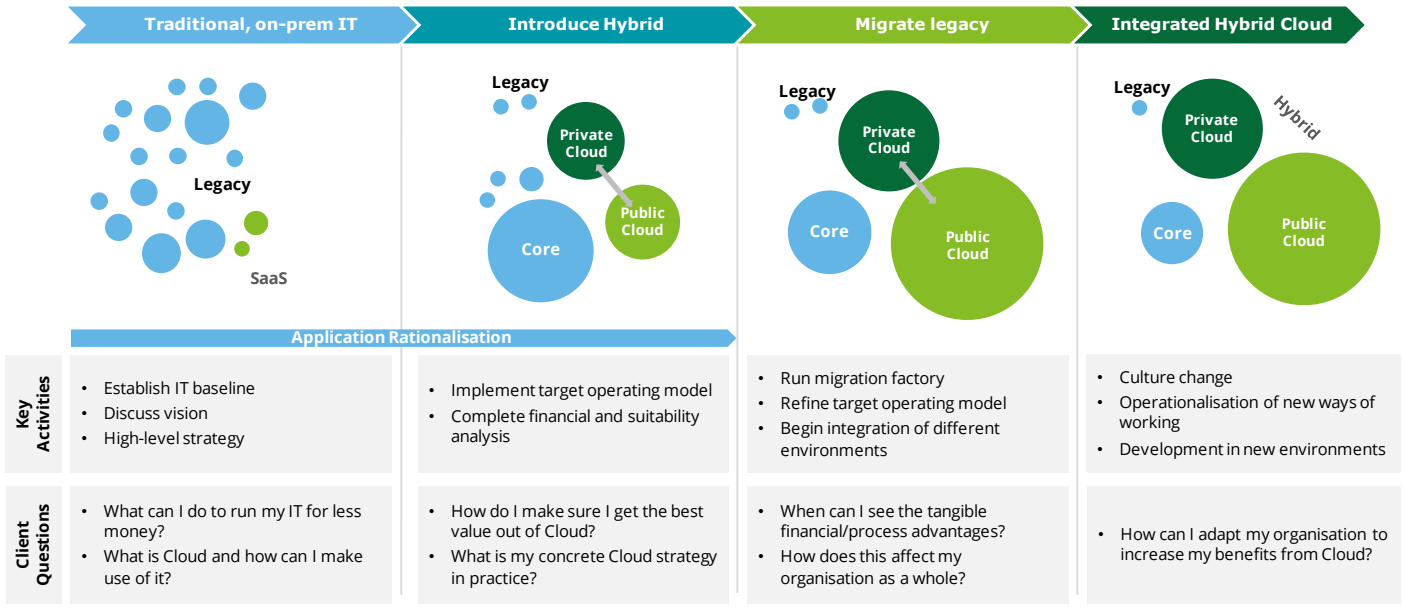
Innovate through consumption of external services

Banks need to embrace the cloud fully and re-imagine processes. The only way for a bank to be competitive in the future will be to embrace big data across all its product offerings and leverage AI to change the customer experience. This cannot happen without at-scale computing and storage. It is impossible to re-imagine mobile banking, payments or efficient lending without an underlying cloud platform. In the future, Robo-investors (AI bots that act as portfolio managers and outperform them) will need systems that can process huge volumes of data, something that banks cannot do easily and cost-efficiently on-premise. What if banks could carry out credit scoring and risk assessment using big data and AI?

Disruptive technologies are strategic assets in the financial industry, but adopting and extracting value from them within a reasonable timeframe can be a challenge. What if you could use them as an outsourced service, instead of hosting and owning them? By giving access to a range of specialised tools and services, cloud services provide an ecosystem of Centres of Excellence that can be accessed rapidly through the internet, making organisations more competitive.

State-of-the-art cloud platforms offer key capabilities in strategic domains such as analytics, blockchain and distributed mobile applications enabling software development teams in banks to stay ahead of the innovation curve. Developing or

Stages in the journey from legacy systems to the cloud



owning new technologies becomes an obsolete burden when they can be used in applications as a service in a seamless manner.

Leverage industry-specific solutions

Using IaaS or PaaS to build applications offers enormous flexibility in terms of design and functionality; however, flexibility also comes with challenges. Highly-regulated industries such as banking have a complex burden of regulations and compliance, which makes a do-it-yourself option for applications development both costly and risky. Banking-focussed solutions delivered as higher level services such as SaaS or BPaaS can provide an out-of-the-box solution and help banks cope with the regulatory burden by ensuring regulatory compliance, auditability, transparency and security along the whole value chain, from the provision of infrastructure to the delivery of the service to the end-user. A Managed Services provider can guarantee end-to-end responsibility and act as a single point of contact for banks, greatly simplifying operations and management. This shift to service consumption replaces the in-house software development processes, delivery and operations model that banks have, and this inevitably has implications for the organisation and its employees.

Cloud service providers can deliver banking-specific solutions, such as core banking, risk analytics with comprehensive portfolio management, securities management, online banking platforms, payments or back office services such as settlement services, corporate actions services, and reconciliations. Providers benefit from economies of scale by re-using their solutions across multiple customers, and so in many cases are able to offer their service to banks at a lower cost than an in-house process. Standardisation can also be achieved when using mid- to high-level services such as PaaS or SaaS; however little standardisation is available from IaaS due to the wide variety of design choices that remain available to the developer.

Other functions are not automatically provided when using IaaS or PaaS, such as disaster recovery, integration, supportability and operability assurance: these aspects can also be handled by SaaS providers that specialise in banking.

Paradigm shift in IT spending

Cloud provides a shift from CapEx (Capital Expenditure) to OpEx (Operational Expenditure), switching from asset ownership to service consumption. The following advantages emerge from this change in ownership structure:

- **Flexible pricing** (only pay for what you use). Only consumed services are charged for. This may lead to cost savings, especially for punctual and intensive workloads such as daily, monthly and year-end processing. However, there may or may not be cost savings, depending on the company's use of the cloud.
- **No upfront infrastructure investment.** Taking away large upfront costs enables organisations to reduce their working capital, and the cash this releases can be used to pursue other ventures for growth or innovation. It is important to keep in mind that some upfront costs such as costs of integration, connectivity and migration can still be incurred when moving to the cloud.
- **No depreciation, renewal costs or obsolescence of infrastructure.** With the purchase of infrastructure there is always the risk of aging and obsolescence: this can be avoided by consuming resources as a cloud service.

Use Case: Commerzbank

"[E]ine Bank kann keine Infrastruktur bereitstellen, wie es Amazon, Google oder Microsoft können. Der Aufbau von leistungsfähigen und skalierbaren Systemen über eigene Rechensysteme ist sehr kostenintensiv. Die Tech-Giganten bieten zudem spezielle Entwickler-Tools und Betriebssysteme, die dabei helfen, Algorithmen weiterzu-entwickeln. Doch man muss das Rad ja nicht neu erfinden. Daher nutzen wir diese Anbieter für unsere Zwecke und setzen auf eine hybride Cloud-Strategie." [5]

Use Case: Deutsche Bank

"CloudMargin, the award-winning creator of the world's first and only collateral and margin management solution native to the cloud, and Deutsche Bank, Germany's leading bank, announced today that, as part of its global transformation programme, the bank is working with CloudMargin to integrate the CloudMargin platform into its Collateral infrastructure. In addition to cost savings, the move is expected to improve the client experience by creating a networked solution for Deutsche Bank's collateral management, resulting in additional transparency, reduced operational risk and simpler processes." [6]

Use Case: Deutsche Bank and Avaloq

"The introduction of the Avaloq Banking Suite enabled Deutsche Bank Luxembourg to migrate its various business areas into a new, unified cash ledger, enabling it to offer its customers the full range of services while reducing complexity, risks and costs, and paving the way for future growth. The relevant banking areas migrated in one move from the existing core banking system to the Avaloq IT platform." [7]

Use Case: DZ Bank

"DZ Bank sees the benefit from Cloud computing, especially in the public Cloud offering in that it helps to improve the bank's cost efficiency and reduce time-to-market. Cloud computing makes the bank more agile so that it is able to cope with first demands on capacity." [8]

Why have banks been reluctant to use the cloud?

The cloud has been widely adopted across various industries and has become a pillar for IT systems of modern companies. Yet challenges remain for banks, mostly because of strict data regulations, doubts around data security, third party risks and transformation challenges.

Regulations

National regulatory authorities often insist that data held by domestic companies should be kept only on servers in that country, and that access to data should only be possible from within the country; and they may also impose legal obligations relating to investigations or data recovery, or about the location of employees. This means that a cloud service provider has to use local servers, which creates a major challenge for the operating model of global cloud service providers.

Major cloud service providers have tried to increase their global footprint by building more data centres in new locations close to their customers. This helps banks meet some of the regulatory requirements by having data physically located in the same country. Most of the major cloud service providers offer data centres in Germany and very few do not offer data centres in Europe at all.

Banks need to understand the legal structure and framework within which the cloud company operates, and that it may need to comply with the regulations in multiple jurisdictions – including the Clarifying Lawful Overseas Use of Data Act (CLOUD Act) of the USA – as shown by the efforts of a US law enforcement through US courts to gain access to data on a cloud service provider's server in the Republic of Ireland.

Data security

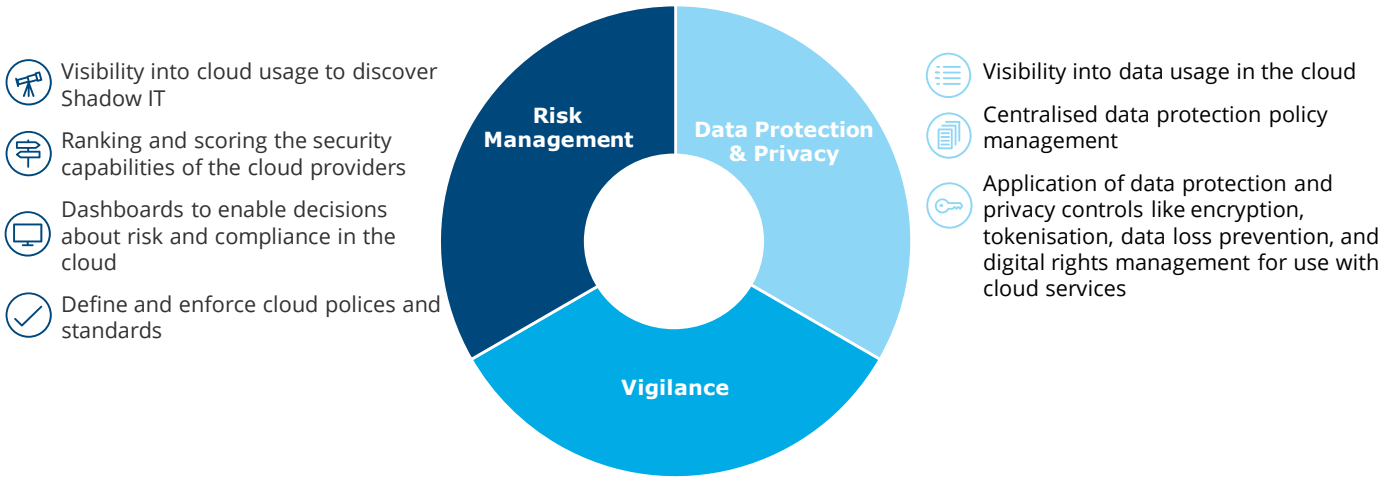
Keeping data safe from unauthorised external access or damage/corruption is a challenge for the financial services industry. Client-side encryption guarantees that an external party or even the Cloud Service Provider (CSP) cannot access data, since the bank and not the CSP holds the encryption and decryption keys, making it impossible for the provider to access readable data. However, client-side encryption may affect performance and significantly limit the benefits of the cloud, such as search capabilities, artificial intelligence and analytics – thus a trade-off between functionality and security must be found. Integration with on-premise solutions for data management, identity and access management policies and other security systems should also be considered. In the case of SaaS or BPaaS, data cannot be accessed by the CSP unless it is agreed or needed to provide the service, for example to restore data or ensure business continuity. In order for banks to pursue the optimal strategy and processes to protect information, Data Protection & Privacy should be a pillar in their cyber security strategy.

Third party risks

Running central systems in the cloud such as core banking systems creates a dependency on the cloud service provider. This calls for a risk assessment and vendor management process to ensure alignment between the business objectives and service delivery from the CSP.

From a technological point of view, relying on a cloud service provider to run critical systems in the cloud should not be considered riskier than running the same systems on-premise, provided that the cloud service provider is compliant with financial regulations (e.g. for data retention, data access, auditability) and the appropriate design and best practices are implemented. To mitigate supplier risks, organisations should implement a process to manage the lifecycle of the supplier relationship and clearly align business goals with the services from the cloud service provider, while also managing risks and maintaining an exit plan.

Deloitte's holistic cloud security framework



Use Case: Commerzbank

"A lot of times we think of digital transformation as a technology dependent process. The transformation takes place when employees learn new skills, change their mindset and adopt new ways of working towards the end goal." [10]

Transformation challenges

Most major banks rely heavily on systems that run legacy applications. In order to move these applications to the cloud and fully reap the benefits of such a transformation, applications need to go through re-design and refactoring, which can be a costly and risky step. Simply switching virtual machines from a data centre to a cloud infrastructure will not deliver the full capability of cloud services: applications should be broken down into API-connected microservices and use 'cloud-native' components to optimise costs, resilience and availability. Since mainframes do not integrate well with cloud applications, banks face a situation that must be addressed in most cases with a 'big bang' approach, raising the transformation risks even higher.
IT is not the only part of a company impacted by cloud - the transformation causes a broad rethinking of the company's processes, operating model and resources. For example, a lack of cloud talent is another major roadblock for banks. Given the broad range of impacts that moving to the cloud may cause for organisations, transformation constitutes an upfront investment which is why many banks hesitate.

Deloitte's IT Vendor Management Framework

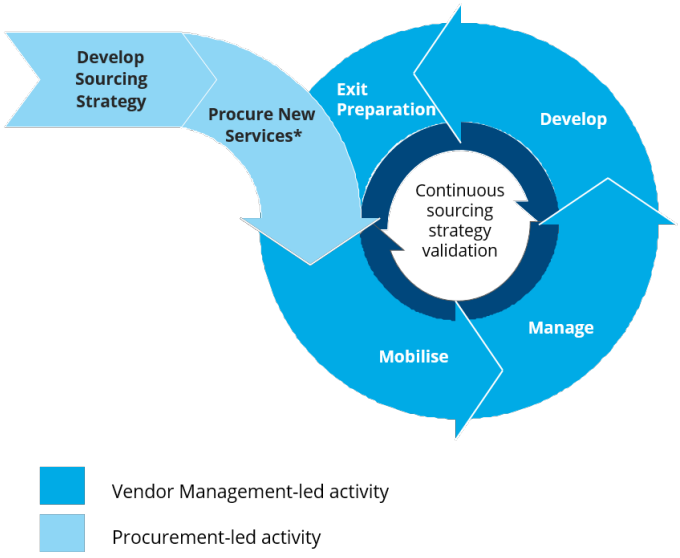
The IT vendor management operating model consists of **four phases and is a continuous activity** that takes place after the procurement of services.

Mobilisation is the initial setup of the Vendor Management activities. This phase includes a final check of key clauses before contract signature and the mobilisation of the team and processes to support the new arrangement.

Manage phase spans the entire contract term and involves carrying out processes and activities required to robustly manage the vendor.

Develop phase focuses on deriving the maximum value from the vendor relationship.

Exit Preparation prepares for the termination or renewal stages of the agreement with the vendor.



*Vendor Managers should be involved in the final stages before contract signature to check Service Scope is clear, SLAs are in place, Pricing / Invoicing is clear etc.

Key success factors for cloud transformation

Using cloud is not just a project: it is a fundamental change in the DNA of a company. To benefit fully from the advantages of the cloud, organisations need a digital transformation that goes well beyond a simple project. Deloitte recommends an approach to cloud transformation that consists of five phases, from strategy to cultural change.

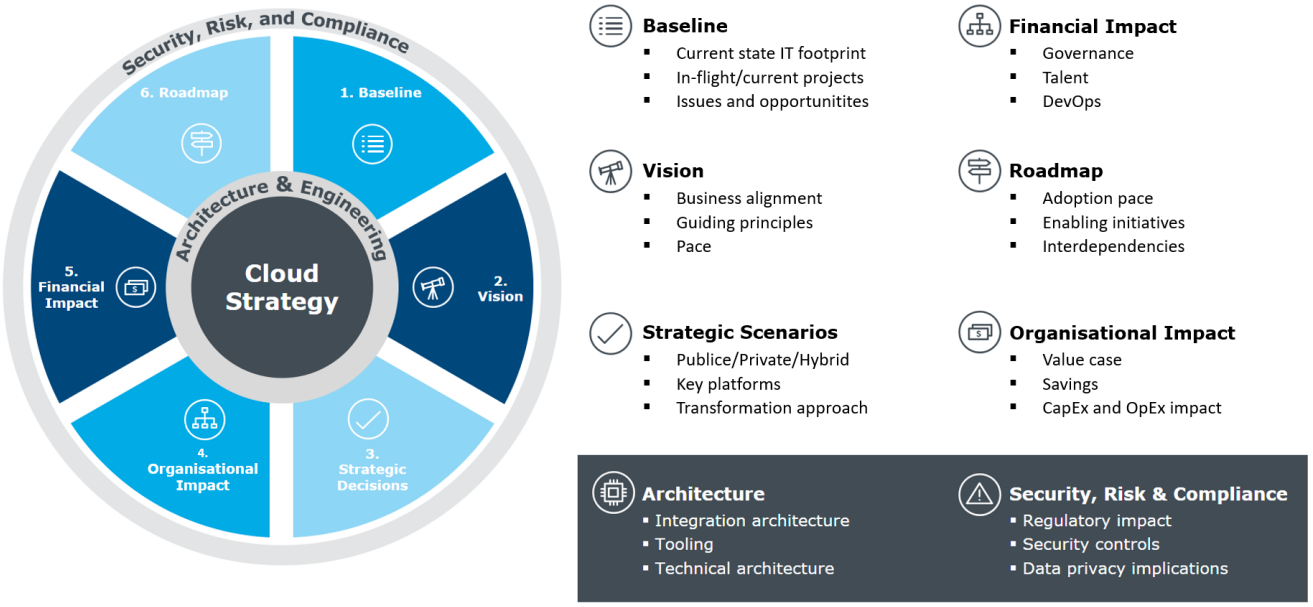
Cloud strategy

Define your objectives for the cloud. The benefits must be clearly articulated – greater operational efficiency, flexibility, agility, increased revenue generation, reduced costs, enhanced security, better risk management, return on investment, to name but a few. Cloud strategy should follow IT strategy, which should align with the business strategy. Cloud initiatives should always be linked to business value and fit with the overall corporate strategy. Deloitte has developed a framework of six building blocks on which you can construct a sound cloud strategy.

Many large organisations already have a 'cloud first' strategy in place, meaning that with any project they look to the cloud before considering the in-house or traditional outsourcing alternatives. A cloud strategy should take into consideration not only the present but also the future; embracing cloud enables banks to adopt tomorrow's technology more easily, blockchain being just one example.

"Organisations often struggle to define a cloud strategy, or to link it to their broader business strategy. Consequently, they find it difficult to generate genuine business value from this type of digital transformation. Cloud has most definitely arrived and is here to stay as a key element of corporate strategy – not just IT strategy, but overall business strategy." [3]

Deloitte's cloud strategy framework



Use Case: KfW and ATICO

"After the evaluation phase, KfW opted for a central application – ACTICO Compliance Suite. The functionalities enabled the automated processing of all compliance-relevant issues, such as sanctions lists checking, financial transactions monitoring, anti-money laundering. The new compliance environment enables KfW Group to achieve more efficient KYC and onboarding processes for banking customers." [11]

Risk management

Moving services to the cloud transfers some of the responsibilities for risk management to the third party cloud service provider. However, it is only the management of the risks that is transferred: accountability for the risks still resides with the bank, and not the cloud service provider. The company's operational risk management framework must therefore take account of the special circumstances arising from cloud service adoption. An important element of the framework should be to classify the information assets - such as intellectual property, customer databases and financial information - so that the inherent risks can be managed. The service contract should include:

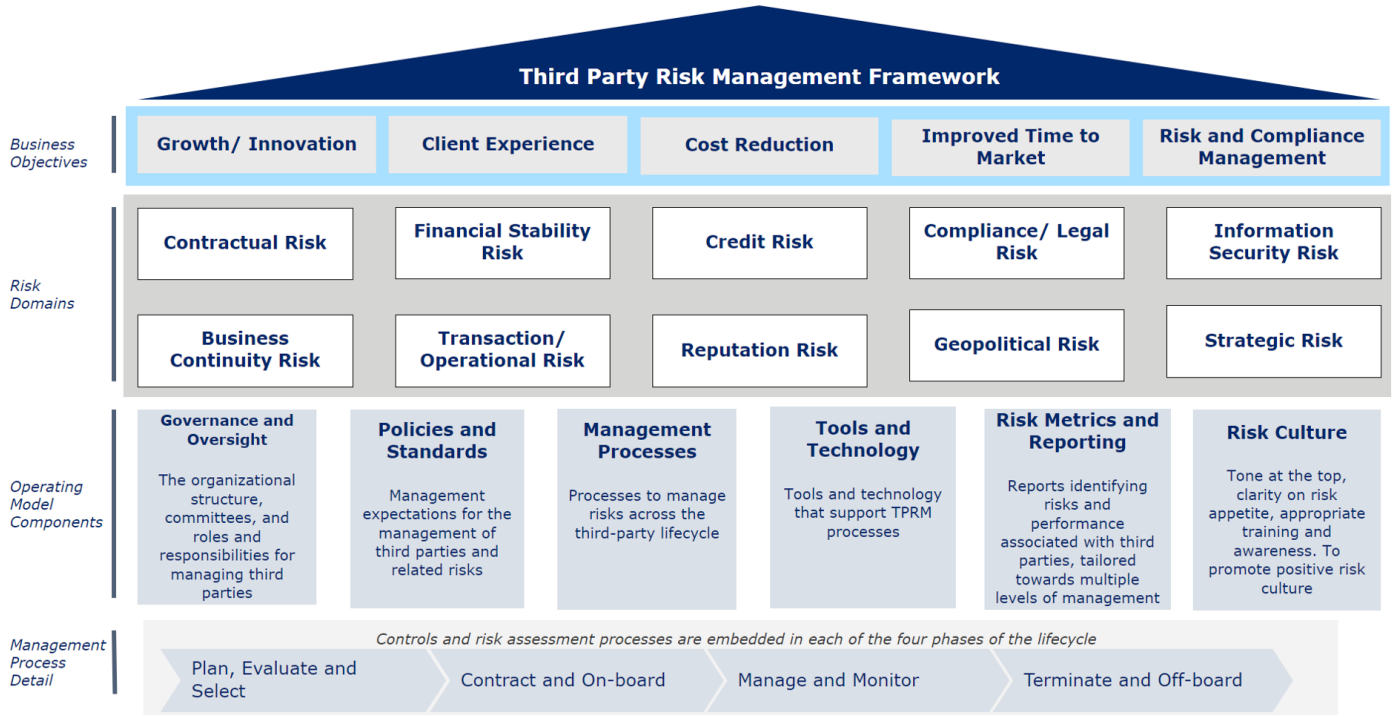
- terms that define the right to audit the cloud environment
- contractural conditions associated to the bank's exit strategy
- a business continuity plan covering the full scope of the cloud service
- IT service management procedures and controls

In accordance to that, the operating model of the bank is then redesigned to ensure the right team structure and capabilities are in place to manage the cloud services.

It is particularly important for banks to consider legal and regulatory compliance during their risk assessment, which should involve the risk management functions and other stakeholders, and should be based on the 'three lines of defence' model. Compliance with national laws and regulations on data is a problem that must be addressed. Who owns the data? In which countries should the data be stored? Who is permitted to access the data stored in another country? Data hosted on cloud services is subject to the laws and regulations of the country where the data is stored. The European Union's rules also apply to data held outside its territory. The General Data Protection Regulation (GDPR), which came into effect in May 2018, is designed to improve data protection for EU citizens whose data is collected, stored and processed by organisations. However, the scope of the Regulation extends to companies using servers outside the EU, if those servers hold data of EU citizens. The full implications of GDPR and other data privacy laws must be understood.

In order to mitigate third party risks stemming from a cloud service provider, organisations should follow a holistic approach, analysing risks into categories or 'risk domains' and mapping them to operating model components in order to ensure monitoring and controls are effective on an ongoing basis. In addition, organisations should consider a multi-cloud strategy for mitigating risks associated to a cloud service provider. Which services on cloud would introduce vendor lock-in? Should we consider multi-cloud strategy for disaster recovery? What if there are security leaks identified in a cloud provider? What if the cloud provider does not have a datacenter in the region of interest? What if the other cloud provider is having a solution for a critical problem for us? All these risks are to be evaluated for a cloud provider. A multi-cloud strategy is crucial for mitigating such risks and should be designed appropriately.

Deloitte's holistic Third Party Risk Management Framework



Within the organisation a risk management framework should be created for the cloud, and a clear risk report should be drawn from it. It is essential to understand the operational and compliance risks of outsourcing. Plotting a route through all the risks and regulatory complexities will ensure that the company gets the planned benefits from the cloud. Due diligence should be a standard requirement for any outsourcing initiative, in order to understand the key risks and embed controls into the contract. Supplier risk must be factored into the equation.

The risk of intruders gaining access to IT systems has forced organisations to improve cyber security. Cyber risk deserves special attention and security must be tight. Complying with national laws and regulations on data is a thorny problem that must be addressed and the full implications of GDPR and other relevant data secrecy and data privacy laws must be understood and adhered to. A decentralized approach with multi-cloud strategy should be considered.

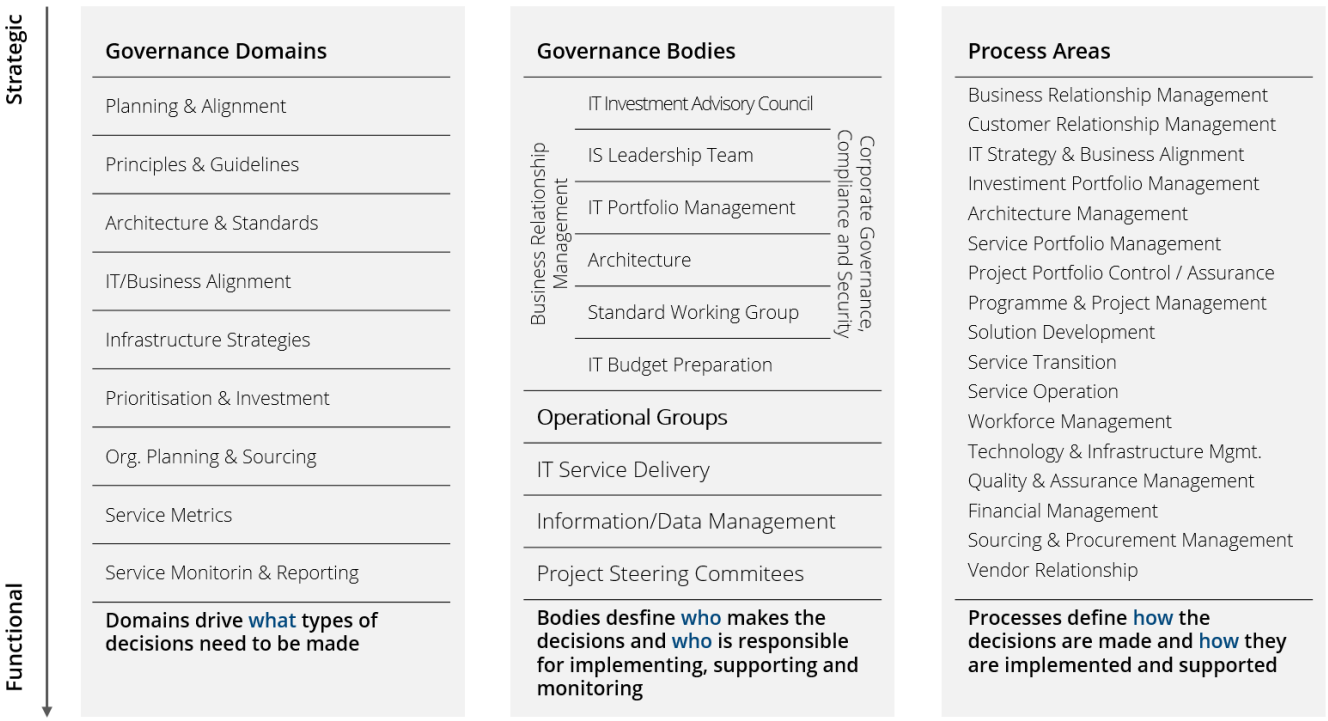
Governance

Banks must define how decisions specific to cloud solutions will be made. Governance processes relating to the use of cloud services should be developed: who is able to request them, how many resources can be provided, and what approvals are required. In addition to setting quotas, providing visibility and reporting usage will help to hold users accountable. Organisations should establish a robust cloud governance structure, with three pillars of governance and ranking of elements within each pillar from strategic to functional.

How can governance be made sufficiently flexible to manage risk while supporting innovation and cost reduction? Establishing governance and controls provides direction for the adoption of the cloud by an organisation. These should consider controls for business processes, applications, data, infrastructure, and organisational management. Structured governance is required to monitor performance continually, improve service effectiveness, and align investments with business objectives.

To avoid new or additional risk, governance should ensure proper due diligence and security, and should specify standards describing which services are permissible and which are not. In practice that could mean for example that business services can get integrated and used, as long the service is built on Microsoft or Google cloud components, if these vendors have already been approved for use by the company.

Deloitte's IT Governance framework



Key dimensions to build a cloud transformation case

Change in cash flow from IT operations	Cash outflow from CapEx & OpEx expenditures • Server costs • Storage costs • Network costs • IT labour costs • Overheads • Facility costs
Cost predicatbility	Optimised IT costs due to utility based pricing • Price transparency • Pay-as-you-go • Improved chargeback
Cost-demand management	Cost control based on IT demand variations • Low CapEx, High OpEx • CapEx cost avoidance • Ease of scale up/down Cash inflow/reduced outflow due to cloud investment • Reduced compute and storage CapEx • Lower facilities costs • Lower labour costs due to automation • One-time shutdown & sale of IT-assets

Financial analysis

A business case should be developed to justify the migration of workloads to a cloud environment, in order to mitigate risks relating to cost management. Organisations should analyse the quantitative financial benefits of transition to the cloud. C-Suite executives want to know: What are the cost drivers for cloud transformation? What are the high-level benefits of embarking on a cloud transformation? How may these benefits be realised? Financial benefits from cloud will not be limited to IT, since they will impact time-to-market, innovation and competitiveness (as outlined earlier in this report). While these business benefits must be considered in each case, they may be difficult to evaluate quantitatively and are heavily dependent on the organisation's structure and strategy. We therefore propose three areas for analysis in building a financial case for the cloud from an IT perspective.

Use Case: HSBC and Oracle ERP

"Global banking giant HSBC used Oracle ERP Cloud to re-engineer the financial management processes across its global Operations, Services and Technology division. The bank transformed procure-to-pay, expenses and project accounting across its global operations and functions, not just in the organisation of its global service companies. Ultimately, all third party costs and a significant portion of the global cost base are managed by Oracle ERP Cloud." [12]

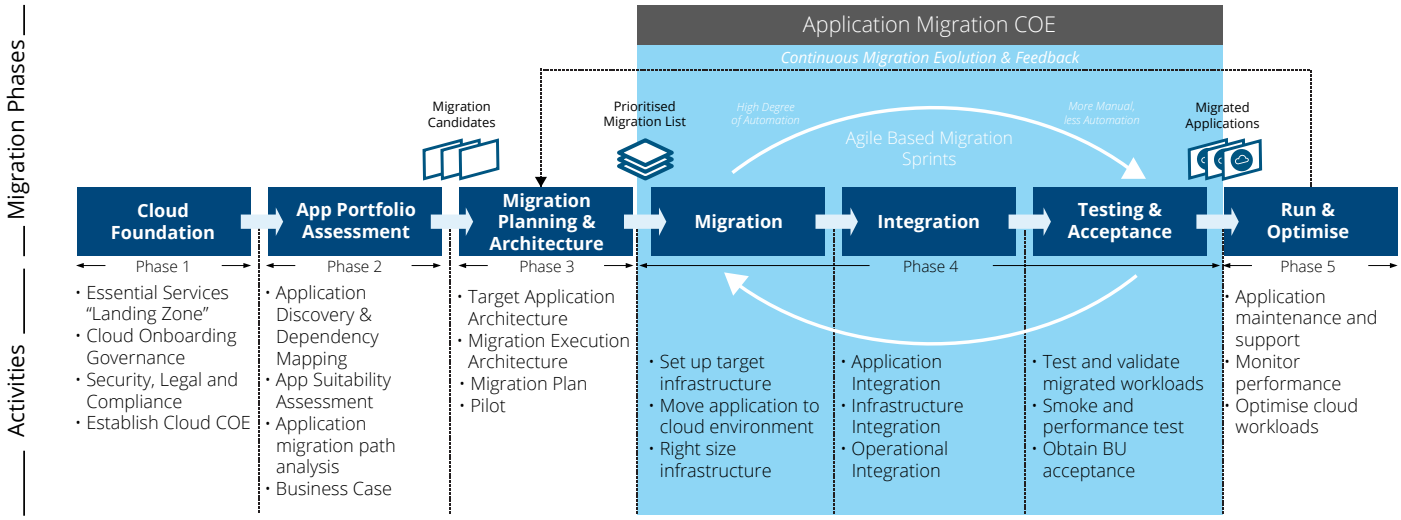
Cloud migration

Applications may follow different migration paths, ranging from a simple 'lift-and-shift' where applications are re-hosted in a cloud environment without further amendments, to a complete refactoring of the application using 'cloud native' components. Each approach has pros and cons: for instance a complete refactoring is costly and creates vendor lock-in, but it also allows applications to leverage fully the capabilities of the cloud such as elasticity, high availability and high resilience. Re-platforming applications on PaaS is a trade-off chosen by many organisations, since in many cases it provides most benefits from the cloud without the lock-in. Organisations should proceed with a phased approach to conduct migration in an efficient manner.

Transporting legacy applications to the cloud is a thorny challenge for many banks – for this reason Deloitte acquired Innowake® [13], which can translate Cobol/PL1 code into Java code, helping to refactor legacy software into cloud-ready applications.

In case of mass migration, an Application Migration Centre of Excellence should be created to benefit from efficiencies and economies of scale. After migrating, ensure shutdown of legacy on-premise systems to avoid parallel operations and costs.

Deloitte's Cloud Migration Methodology (DCMM)



Corporate culture

Cloud is not just about technological transformation, but also about adapting the corporate culture to use of the cloud, and adopting a new mind-set for working and collaborating in order to leverage the technology: 'Think Cloud'. People need to start thinking cloud, for example by adopting DevOps practices. DevOps is a contraction of 'Development and Operations', and is a paradigm for software production which consists of streamlining the application lifecycle from development to production. DevOps enables companies to increase their agility and innovative abilities whilst reducing risks and delivery cycles. Corporate culture needs to change, from a mind-set focused on static, policy driven operations towards small entrepreneurial units that have a much greater freedom of choice. Business leaders should embrace the entrepreneurial spirit and empower business units to take advantage of the flexibility offered by the cloud in line with the defined governance structure. What if analytics and benchmarking tools could be accessible in much finer ('granular') detail, enabling smaller business units to make better-informed decisions?

Organisations should follow a culture change roadmap. Employees need to be guided towards cloud with that roadmap. Thereby, the transformation to cloud should be understood as more than a technical implementation: it is an end-to-end transformation across all dimensions of the bank.

Deloitte's Culture Activation Roadmap

	Strategy	Insight	Activation
	Define a compelling cultural aspiration aligned to the organisation's strategy	**Use cultural diagnostic, interviews and data analysis to define gaps &**	**Activate culture through design thinking, agile executions, our culture tools and accelerators**
	„framing the challenge"	„understand, explore, **synthesise**"	„design for the best value"
	What challenge are we trying to resolve? What outcome are we seeking to deliver through organisational culture?	What do stakeholders think/feel/say about the current culture? What insights can help us realign our culture?	What solutions will deliver the culture we need? How should we manage culture implementation?
	• Determine scope, objectives, purpose & business challenges drawing upon culture principles and culture transformation best practice • Clearly articulate strategic intent and culture aspirations	• Explore stakeholders and the system within wihich they reside • Synthesise insights and define design principles & hypotheses • Identify ideas to address unmet needs and harness opportunitites	• Develop culture solution prototypes • Test and refine (in loops) culture prototypes to determine best value • Decide and implement culture solutions which deliver best value

"Through 2022, at least 95% of cloud security failures will be the customer's fault." [14]

Cloud cyber security

Cloud is not only redefining the IT landscape but also how security measures are designed and implemented. In particular, the migration to a virtual data centre forces organisations to rethink security and privacy from the ground up.

At one time, the security of cloud service providers was a significant concern for many companies, worried that cyber attackers would find it easier to penetrate the cloud than on-premise systems. Even today this issue – together with privacy concerns – is one of the biggest barriers to cloud adoption. However, cloud security (at least at the hyperscale cloud service providers) can in fact be a positive argument for adoption of the cloud, since cloud service providers invest more in security than most multinational companies will ever be able to. Security is in effect part of the main business process of cloud service providers, and not just a support process.

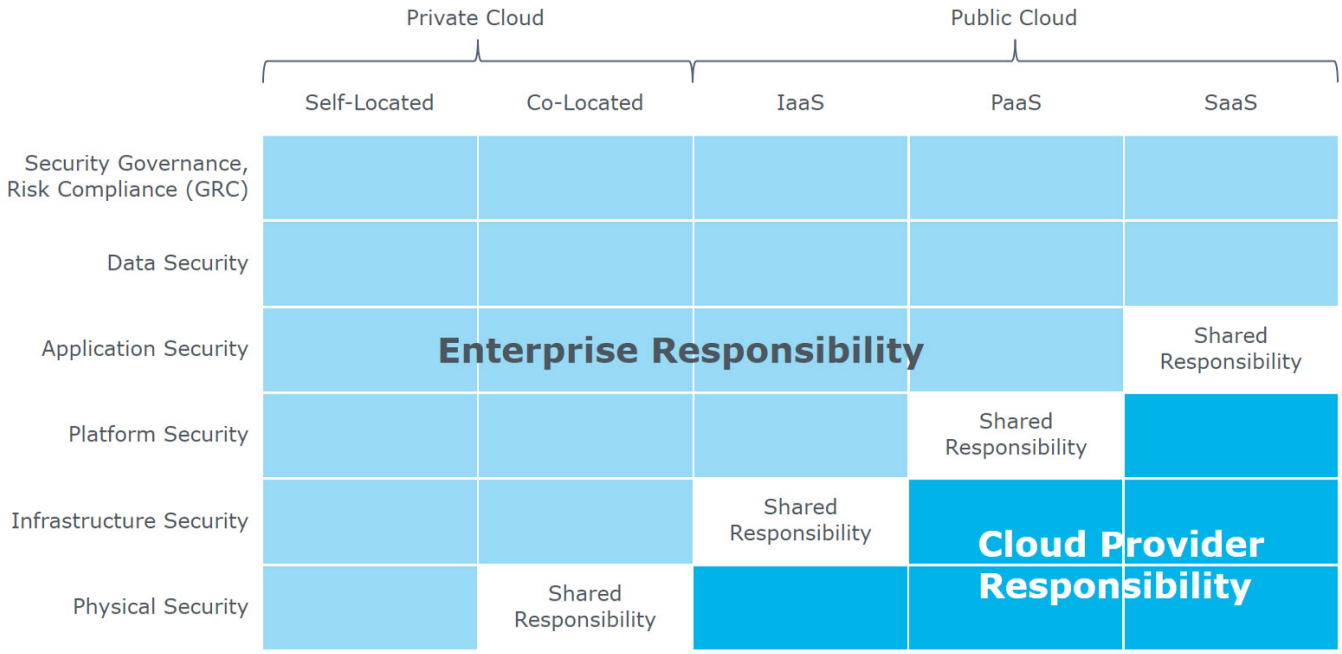
Security of the cloud

The cloud service provider is responsible for the reliability, security and compliance of the services that make up the cloud. These include responsibilities for the integrity of the hardware, software, networking and facilities that run the cloud services.

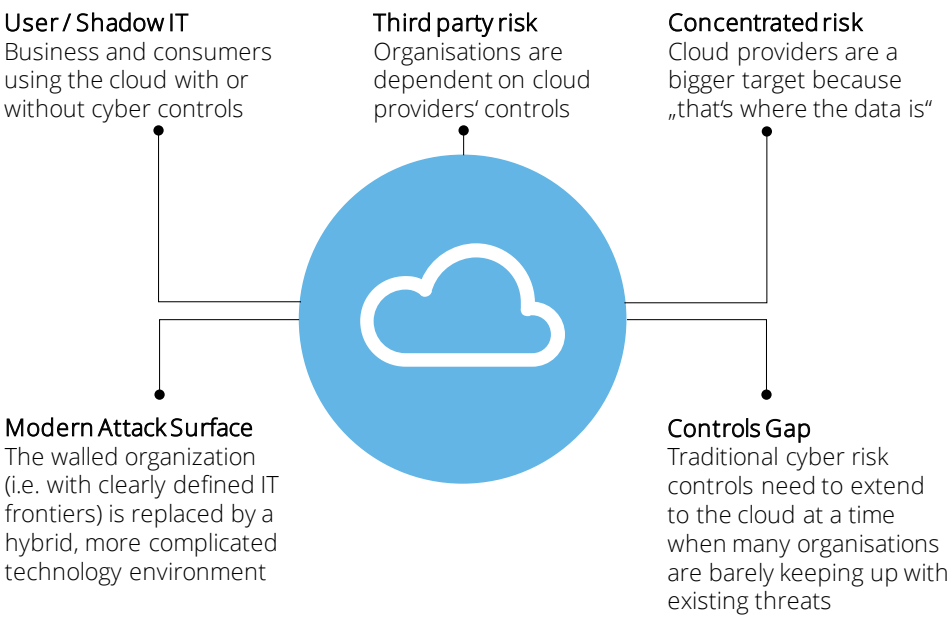
Security in the cloud

Organisations should implement controls for elements which they are responsible for. This will depend on the cloud services they use. For example, if an organisation transfers an application to an IaaS environment, it is responsible for some of the infrastructure security and all levels above (see Figure 13). On the other hand, organisations using SaaS solutions are only responsible for the data, governance and security compliance.

Security responsibilities in the cloud



Cyber security perspective in the cloud



It is important to understand that the division of responsibilities for securing cloud workloads differs between the types of service. However, the liability for data stored and processed in the cloud, as well as overall security of a cloud based solution, always remains with the organisation using the cloud services.

What is new from cyber security perspective in the cloud?

As businesses move to cloud computing, employees in principle are able to access their work applications and corporate resources through almost any internet-connected device. As a result, they want and expect 'anywhere-access' on a device of their choosing. For internet enabled services data is transmitted through unsecure public internet networks and thus the 'old' security solutions for in-house systems does not offer the protection required. In fact, perimeter-based security has not been effective for some time against modern cyber threats; and with cloud computing it is even less effective. There is also a shift from segregated IT systems to a cloud environment where virtual machines and networks share the same physical resources, posing different security challenges for cyber professionals.

User/Shadow IT

The accessibility and ease of subscription to cloud services created a situation in which employees are able to use cloud applications for work-related data exchange that were not approved by the company IT. Similarly business units could buy cloud services they wanted without following procurement procedures, or giving consideration to security or privacy issues. There were various reasons for this, but the consequences were often the same – breached accounts, leaked data, malware spread across the company. Organisations need to have an answer to this problem in order to protect its digital assets. A key element is to be able to identify and manage the cloud services that are used or could be used from the organisation's managed devices and networks.

Third party Risk

When a company uses cloud services it connects its infrastructure to a cloud service provider's. Security for the overall system depends not only on the organisation using the cloud services, but also on the cloud service provider's security controls. Theoretically, however, the cyber risks are the same as with the on-premise infrastructure. This means that physical security of the cloud service provider equipment, software and hardware updates, internal governance processes and technical controls have to be assessed by a potential user in accordance with its own security and privacy requirements. Organisations considering a cloud solution should insist on seeing the cloud service provider's controls and certifications, and check whether there is a single place where such documents are stored (e.g. a trust portal or similar). If gaps in controls are identified, the organisation should either switch to a different cloud service provider or close the gaps with its own security controls.

Concentrated Risk

An accumulation of valuable items will attract the attention of people with malicious intent. This is true for valuable physical items as well as information. The risk of a successful attack is greater for a cloud service provider because it would probably involve the information of many different customers. Companies have to rely on their cloud service provider to address and mitigate many of the risks since they cannot manage the risks themselves within the shared responsibilities model. Cloud service providers in their turn are highly motivated to invest significantly in defence measures to maintain their ability to withstand the threats and make attacks on them cost-prohibitive. In order to select the right cloud service provider, organisations should examine closely how cloud service providers are managing such risks and what kind of contractual liability they have for a breach of data security. In addition they should examine additional risk mitigating functions.

Modern Attack Surface

New technology and digital solutions bring new methods of cyber attack and make old ones obsolete. The cloud is no exception. Employees of cloud-enabled organisations often work from any devices anywhere on the planet, making it more difficult than ever to protect the organisation's data. Not only must the intranet and cloud workloads be secured, but every user device should also have technical measures in place to protect data. To add to the problem all the cloud-enabled devices in the organisation must be monitored 24/7 and in real time, since once a security breach occurs it won't take long for the hacker to target the 'crown jewels' of the organisation's information and data.

Nonetheless, the monitoring and security of user devices is an issue that occurs both for equipment connecting to on-premise and cloud. Securing the infrastructure against attacks, however, is a task which cloud services providers have to fulfill for their environments. Due to their massive investment in security, patches and fixes are usually done much faster in the cloud than on-premise.

Controls Gap

Using cloud services requires a re-think of the controls an organisation should use. Monitoring and securing a cloud-only or (more often) hybrid environment needs new methods, processes and technology, because even the most mature and safe cloud service provider technology still depends on customers using it in a secure way. Risks of failure are high - attacks can go undetected, data can be lost, and reputation can be damaged.

Addressing cyber risks in the cloud

Cyber risks need to be addressed as organisations embrace cloud, mobile, social and analytics technologies. Organisations should develop a cyber risk framework that focuses on delivering end-to- end cloud cyber risk capabilities, incorporating considerations about privacy, security, monitoring, incident response, and governance for integrating cloud services across the organisation. In Deloitte's Cyber Risk Management framework there are three pillars ("Secure. Vigilant. Resilient") and seven cyber risk domains.

Secure

The Secure pillar of a cyber risk management framework provides protective elements. It contains three domains. The first domain, Network and Infrastructure security, covers the virtual infrastructure with a focus on protecting network traffic, hardening endpoints like API gateways and protecting services. Identity and access management, the second domain, is designed to help address different cloud requirements for authentication, authorisation, access governance and accountability. Specific elements include multi-factor authentication, privileged access management and access certification. The third domain, Data Protection, covers controls recommended for protecting data at rest, in transit, and in use: core elements are encryption, key, and certificate management.

Vigilant

The Vigilant pillar involves the provision and integration of information, from both on-premise and cloud sources, to enable security teams to identify, detect, and respond more effectively to security threats. The domain Logging and Monitoring involves techniques for detecting security events, collating a multitude of log sources, and integrating with a Security Information and Event Monitoring (SIEM) system to monitor the cloud, to enable the organisation to identify where critical data assets reside, who accesses them, and how they are used.

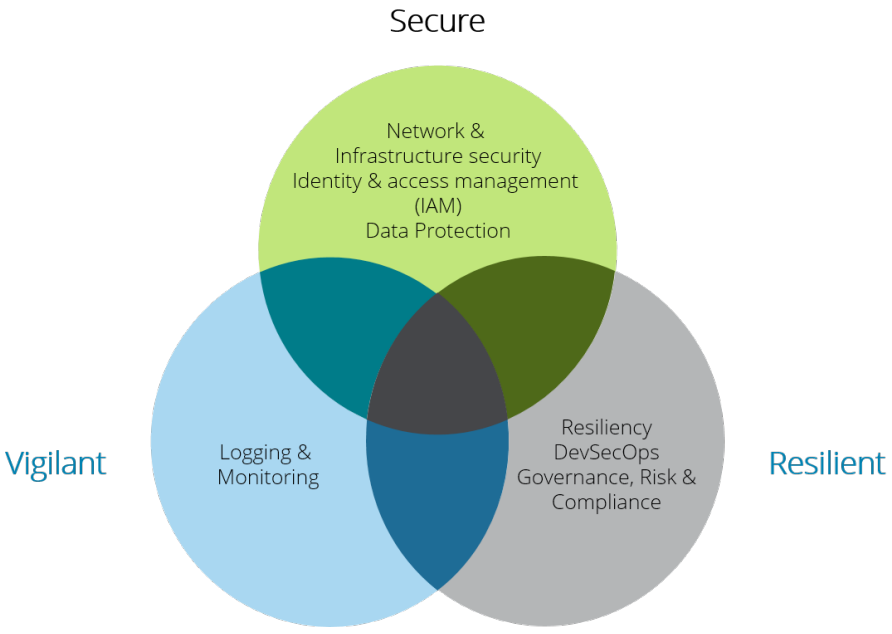
Resilient

The Resilience domain covers designs for 'always on' capabilities, and new models for contingency planning, recovery, and resilience. As cloud computing becomes a more integral part of core business operations, it becomes necessary to reduce downtime due to disruptions, from minutes to seconds. A mature cloud service provider provides accessible features such as scalable, on-demand APIs that allow companies in a cost-effective way to create redundant infrastructure and back-ups with low latency to reduce disruption.

Other design concepts and tools are cross-region replication of virtual instances, multi-availability zone deployments, and data archiving services. The domain DevSecOps, encompasses secure configuration, vigilant security monitoring, and resilient deployment designs. It is worth mentioning that while IaaS provides the building blocks for resilient systems, their effective implementation still relies on the development teams and no availability is guaranteed by the cloud service provider at the application level, since their SLAs stop at the infrastructure level in the case of IaaS. On the other hand, SaaS solutions and managed cloud services can provide SLAs at the software level, giving contractual guarantees of higher level services resilience compared to IaaS or PaaS providers.

The aforementioned security concepts are brought together to achieve business goals with secure software. To define and manage the cyber risk requirements specific to the organisation, the Governance, Risk, and Compliance (GRC) domain provides guidance for establishing governance, policy, standards, processes, technology, and reporting, in order to achieve the goals of the organisation. In conclusion, through the use of a cloud security framework an organisation is able to design, implement and operate cloud services securely and benefit from the inherent security features that cloud service providers provide as part of their service.

Deloitte's Cyber Risk Management framework



"It is no longer acceptable for security teams to hold back cloud initiatives with unsubstantiated cloud security worries. Security and risk management leaders should be tasked to develop new approaches to securely and reliably leverage the benefits of SaaS, PaaS and IaaS." [15]

Selecting the right cloud service provider: A two-step approach

The large number of cloud offerings on the market makes it difficult for organisations to find the right supplier. To this end, Deloitte proposes a two-step approach to shortlisting and assessing cloud service providers.

Step 1: Evaluate your IaaS and PaaS provider based on your SaaS needs

The market for cloud services contains different delivery models (IaaS, PaaS, SaaS) available to banks, ranging from local players to global hyperscaling cloud service providers with local data storage.

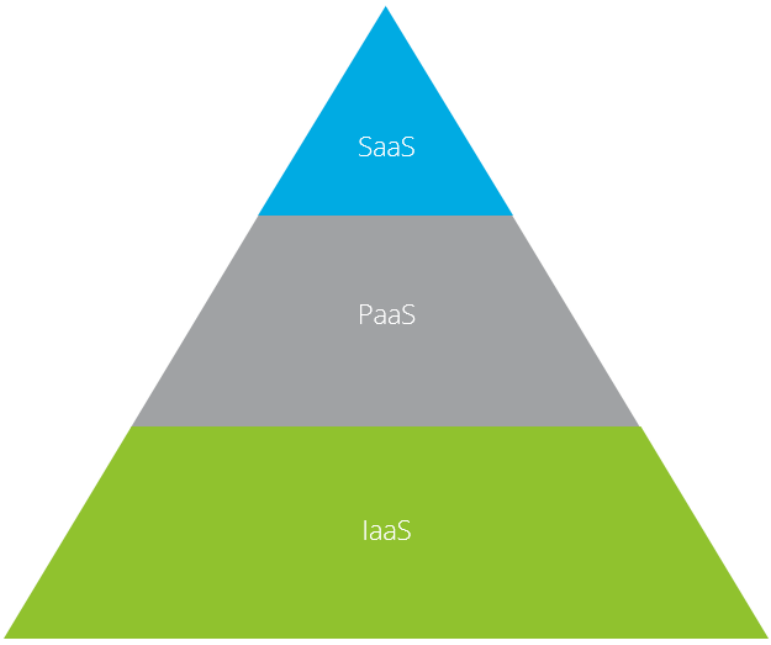
A bank should begin by choosing its cloud service provider(s), which have the best SaaS spectrum coverage for the essential services the bank wants to use, since in the future, most off-the-shelf solutions will be delivered as SaaS. This spectrum should define the requirements for IaaS and PaaS services that the cloud service provider must be able to deliver.

SaaS providers build their services on top of PaaS or IaaS services. As an example, SAP's ERP solutions can be used as a SaaS hosted in Amazon Web Services, Google Cloud or Azure Cloud infrastructure. Based on an inventory of all relevant applications and services an organisation would need to use from the cloud, a decision can be made about which provider should be selected to carry out the risk assessment and due diligence, in order to minimise the number of providers to be assessed.

Deloitte proposes an evaluation of cloud service providers according to two key dimensions:

01. Scaling capabilities
02. Banking specialisation

The cloud standard pyramid



Scaling capabilities

A bank needs to decide from which locations it would like to receive cloud services. For example, regulations in the home country of the bank might prevent the bank from transferring customer or financial data abroad. It may therefore be essential for the cloud service provider to have a global footprint with data centres in multiple regions and with the ability to scale.

Banking specialisation

Some cloud service providers offer generic services such as IaaS or PaaS to various industries, while other cloud service providers provide tailor-made solutions specific to banking. In general, it is easier and less risky for banks to select providers with banking specialisation and knowledge of financial industry laws and regulations, that can for example offer transparency with their internal control system, provide access to audit reports, and have templates for service contracts that are compatible with local laws and regulations.

With the Deloitte framework for defining the required SaaS spectrum, a bank can narrow down the list of available cloud service providers to a shortlist of providers that are able to meet its needs. This shortlist of providers then needs to be assessed further in order to select the one that is most suitable for the organisation's requirements.

Step 2: Assess the shortlist of cloud service providers

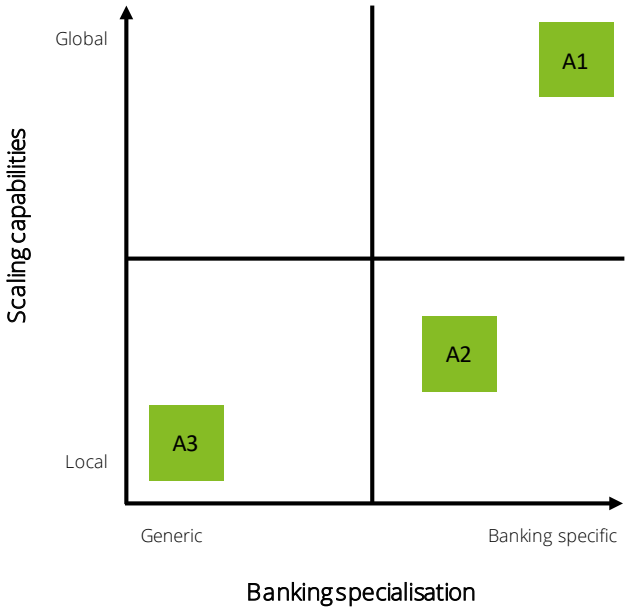
Below we summarise the key aspects for evaluation of cloud service providers by banks.

Data security, data governance and business policies

What is the cloud service provider's position regarding the CLOUD Act and the provision of client data to foreign governments? Where are its data centres located? Since security and compliance regulations vary from country to country, organisations operating worldwide need to be aware of the jurisdiction in which their cloud service provider hosts data, how the data is protected from unauthorised access, and what are its policies regarding local and foreign laws on matters such as data disclosure to foreign authorities (e.g. CLOUD Act).

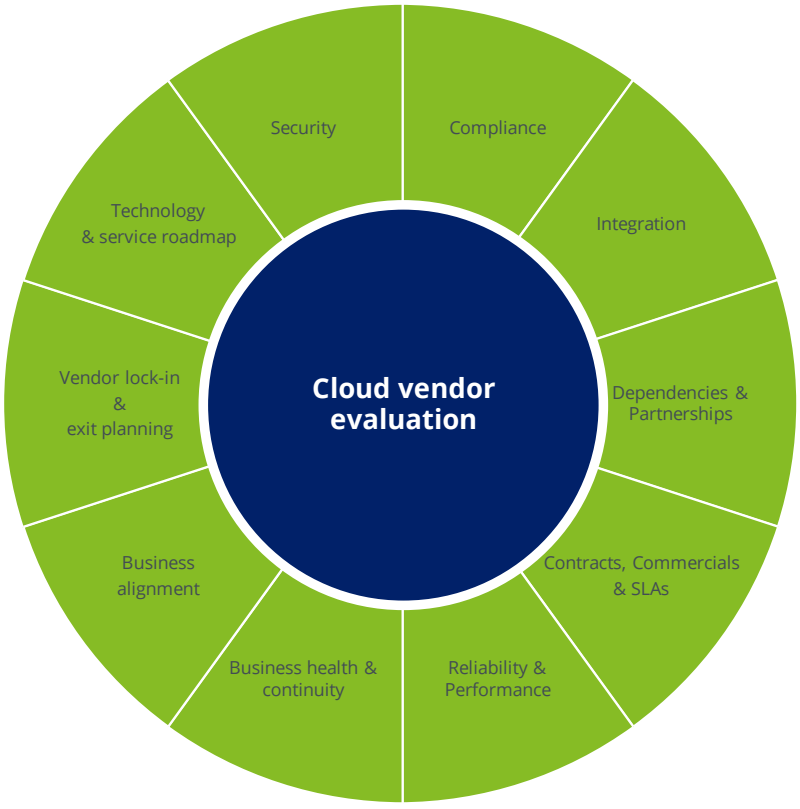
Evaluate the cloud service provider's capabilities in terms of security operations, security governance and system security, and make sure that it has demonstrable risk-based controls aligned with your organisation's own security processes and policies. Verify that

Deloitte cloud appetite framework



SaaS spectrum of three applications (A1, A2, A3) in this example, can help organisations define their PaaS and IaaS requirements.

High-level cloud service provider assessment framework



For each of these dimensions, there are a number of key aspects to consider and important questions to answer.

user access and actions are auditable and are in alignment with the security responsibilities as set out in the organisation's business policies or service contract.

Compliance with regulations, certifications and standards
Ensure that the cloud service provider follows compliance guidelines that apply to your industry and organisation. Whether you are committed to GDPR, SOC 2, PCI DSS, HIPAA, ISO 27000 series or some other standard, make sure you understand what it will take to accomplish compliance once your applications and information are in a cloud environment.

Understand where your duties lie regarding compliance, and which aspects of regulations the cloud service provider will enable you to comply with. Verify that the provider's compliance certificates are valid and obtain guarantees of resource allocations such as headcount and budget to maintain these standards in the future.

Integration with other systems, hybrid cloud capabilities
Consider how processes or data hosted in the cloud will integrate into your workflows now and in the future. For example, if your company has already invested heavily in a provider's ecosystem (e.g. Microsoft's Office 365), it may be a good idea to use cloud services from this same provider (in this case Microsoft Azure), since some of them grant licences and often free credits to their customers.

Integration between a private and public cloud enables banks to create efficient, coherent hybrid applications. This integration can be facilitated by using the same stack in the public cloud as in the private data centre. OpenStack provides an open-source and open standards stack to build highly compatible applications with no lock-in and enables more customisation than branded stacks. Managed versions of OpenStack can be delivered by vendors such as Rackspace, RedHat, IBM or Suse. SaaS solutions should provide APIs to connect applications to other data sources and interact with the bank's systems.

Service dependencies and partnerships
Cloud service providers may have relationships with other providers to deliver their services. Evaluate these relationships and the levels of accreditation, technical capabilities and staff certification of the underlying providers. Analyse dependencies involved in the provision of the cloud service and look for potential flaws or mismatches with the cloud service providers claimed certifications. SaaS providers typically build their services on top of major IaaS providers, so it must be clear from where and how the service is being delivered, and if this fits with the organisation's own policies.

Contracts, commercials and SLAs
Cloud agreements can appear complex, SLA definitions in particular. Cloud service providers often use complex terms and conditions that make it difficult to compare the service levels of different providers. It is important to understand the level of service promised by each cloud service provider and perform a market research to compare offerings and get the best value for money.

Reliability and performance
Analyse performance of the service provider against their SLAs for the last 6-12 months and the cloud service providers transparency with audit reports and control frameworks. Downtime is inevitable and every cloud service provider will experience it at some point. What matters is how the cloud service provider deals with any downtime. Ensure the monitoring and reporting tools on offer are sufficient and can integrate into the organisation's overall management and reporting systems. Ensure that the selected cloud service provider has established, documented and proven processes for dealing with planned and unplanned downtime.

Evaluate the cloud service provider's remedies and liability limitations when service issues arise, as well as its disaster recovery provisions, processes and its ability to support the organisation's data preservation expectations, including recovery time objectives (RTO). This should include at least criticality of data, data sources, scheduling, backup, restore and integrity checks.

Business health, continuity and company profile
While the assessment of the technical and operational capabilities of a potential supplier is obviously important, you must also take time to consider the financial health and profile of your shortlisted providers.

If a cloud service provider gets into trouble, it may not have enough financial resources to meet its obligations or refund losses; to this end, a business continuity plan in case of a default of the cloud service provider including notification period, data migration support and intellectual property must be carefully prepared.

Business alignment
Ensure that the chosen cloud service provider understands the business of the organisation and the precise objectives it seeks to achieve with the cloud. The focus should be on high-level business value such as streamlining product delivery or reducing time to value, rather than low-level, technical indicators such as server up-time or database throughput.

Organisations within a vertical industry such as banks should make sure that the cloud service provider understands the industry; in certain cases, this can mean choosing a smaller specialised player like Rackspace in preference to a hyperscale provider, in order to leverage industry-specific tools.

Managed Service Providers (MSPs) deliver managed cloud services and act like a broker between the end-user and an IaaS or PaaS provider. MSPs provide an additional layer of management to handle contracting, financial management, security and compliance, and can also deliver industry-specific capabilities.

Vendor lock-in and exit planning
Lock-in is a risk not just because of costs, but also because a bank must be able to change and adapt to new regulations and requirements. Being able to move workload on-premise (Hybrid Cloud) or using open standards helps to ensure continuity of the service. Vendor lock-in usually stems from proprietary technologies that do not integrate with those of competitors, or from inefficient processes or contract constraints. The portability of applications may be impacted if they heavily rely on unique proprietary components. Ideally an organisation should choose value added services that have competitive similar alternatives, monitor the availability of those services in the market to spot risks of lock-in early enough, and plan an exit strategy at the start of its relationship with a chosen cloud service provider.

Technologies and service roadmap
Understand where the cloud service provider is heading over the next three to five years and make sure it aligns with the organisation's cloud and business objectives. Does the provider plan changes that would involve re-coding applications? Will there be a change in its certifications or security standards? Assess the impacts on workloads and take them into consideration when building the case for cloud.

Another short quiz

What's your take on cloud?

- ☐ Cloud solutions do not cater to our requirements
- ☐ The way to proper cloud adoption seems cloudy
- ☐ We're already in the cloud
- ☐ Call me

Conclusion

Cloud provides transformative opportunities for organisations and is a vital competitive component in today's challenging market place. Cloud is not an easy technology to adopt, but the potential benefits and opportunities outweigh the challenges and risks associated with cloud transformation. To maximise cloud's added value, an organisation should follow a structured approach, starting with the definition of a clear strategy (and involving a wide range of stakeholders), clarity of vision and expectations, knowledge of options, understanding of business drivers (both opportunities and risks), proper planning, disciplined execution and ongoing governance and management. This report has set out the steps an organisation should consider in order to get things right and become a best-in-class cloud-first company that thrives in today's competitive market.

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References

[1] Deloitte, "RegTech Universe," Deloitte, [Online]. Available: https://www2.deloitte.com/lu/en/pages/technology/articles/regtech-companies-compliance.html. [Accessed April 2019].

[2] Deutsche Bank, "Deutsche Bank acquires India-based FinTech start-up Quantiguous Solutions to accelerate the bank's Open Banking strategy," Deutsche Bank, 15 May 2018. [Online]. Available: https://www.db.com/newsroom_news/2018/deutsche-bank-acquires-india-based-fintech-start-up-quantiguous-solutions-to-accelerate-the-bank-s-open-banking--en-11578.htm. [Accessed August 2019].

[3] Deloitte, "Maintain control in the cloud," 2018.

[4] Deloitte, "The value of online banking channels in a mobile-centric world," Deloitte Insights, 2018.

[5] K. Tomak, "Der Bank Blog: Wie die Commerzbank aus Daten Produkte macht," 31 July 2019. [Online]. Available: https://www.der-bank-blog.de/commerzbank-daten-bankprodukte/digital-banking/37655791/. [Accessed August 2019].

[6] Deutsche Bank, "Deutsche Bank transforms global collateral management with CloudMargin platform," 7 February 2019. [Online]. Available: https://www.db.com/newsroom_news/2018/deutsche-bank-transforms-global-collateral-management-with-cloudmargin-platform-en-11793.htm. [Accessed August 2019].

[7] Avaloq, "Avaloq onboards Deutsche Bank Luxembourg," Avaloq, May 2018. [Online]. Available: https://www.avaloq.com/en/news/-/asset_publisher/vCbePfJNFpkG/content/avaloq-onboards-deutsche-bank-luxembourg. [Accessed February 2019].

[8] Primeur Magazine, "DZ Bank believes in Cloud computing but has to move with caution," 29 September 2015. [Online]. Available: http://primeurmagazine.com/weekly/AE-PR-11-15-77.html. [Accessed August 2019].

[9] Bundesanstalt für Finanzdienstleistungsaufsicht, "Informationstechnik: EBA veröffentlicht Empfehlungen für Auslagerung," BaFin Journal, vol. Januar, p. 13, 26 March 2018.

[10] R. V. Zicari, "On Digital Transformation, Big Data, Advanced Analytics, AI for the Financial Sector. Interview with Kerem Tomak," ODBMS.ORG, 8 July 2019. [Online]. Available: http://www.odbms.org/blog/2019/07/on-digital-transformation-big-data-advanced-analytics-ai-for-the-financial-sector-interview-with-kerem-tomak/. [Accessed August 2019].

[11] ACTICO, "Automating KYC and Onboarding Processes: KfW Group Accelerates Customer Profiling and Onboarding by Centralizing Compliance Applications," [Online]. Available: https://www.actico.com/customers/automating-kyc-onboarding-processes-kfw/. [Accessed August 2019].

[12] Oracle, "Top Oracle partners are building successful ERP cloud businesses. Here's how.," Oracle, 2016. [Online]. Available: https://blogs.oracle.com/profit/cloud-confident. [Accessed February 2019].

[13] Deloitte, "Application Modernization powered by innoWake," [Online]. Available: https://www2.deloitte.com/us/en/pages/technology/solutions/application-modernization.html. [Accessed April 2019].

[14] Gartner, "Is the Cloud Secure?," 2018.

[15] Gartner, "Security of the Cloud Primer for 2019," Gartner, 2019.

[16] Deloitte, "2019 Banking and Capital Markets Outlook - Reimagining transformation," Deloitte Center for Financial Services, 2018.

[17] Amazon We Services, "DBS Bank Case Study," Amazon We Services, [Online]. Available: https://aws.amazon.com/solutions/case-studies/dbs-bank/. [Accessed February 2019].

[18] Microsoft, "Societe Generale's complex financial simulation platform expands on Azure Service Fabric architecture," Microsoft, April 2018. [Online]. Available: https://customers.microsoft.com/en-us/story/societe-generale-complex-financial-simulation-platform-expands-on-azure-service-fabric-architecture. [Accessed February 2019].

[19] Gartner, [Online]. Available: https://www.gartner.com/newsroom/id/3871416.

[20] Deloitte, "Secure and Private Computing for Banks on a Cloud Platform," 2015.

[21] Deloitte, "The cloud is here: embrace the transition - How organizations can stop worrying and think cloud," 2017.

[22] Deloitte, "The future of banking - Seven wicked problems for banks in their strategic transformation," [Online]. Available: https://www2.deloitte.com/nl/nl/pages/financial-services/articles/the-future-of-banking.html. [Accessed March 2019].

[23] Gartner, "Magic Quadrant for Public Cloud Infrastructure," 2018.

[24] Finextra, "BNP Paribas Fortis, HSBC open developer portals," [Online]. Available: https://www.finextra.com/newsarticle/33491/bnp-paribas-fortis-opens-developer-portal. [Accessed March 2019].

[25] NelsonHall, "Wealth & Asset Management BPS - Market Segments: Overall & New Digital Banking Models Focus," 2018.

[26] Amazon Web Services, "Department of Defense Cloud Computing Security Requirements Guide," [Online]. Available: https://aws.amazon.com/compliance/dod/. [Accessed March 2019].

[27] Swiss Bankers Association, "Cloud Guidelines: A guide to secure cloud banking," 2019. [Online]. Available: https://www.swissbanking.org/en/media/positions-and-press-releases/secure-cloud-banking-sba-guidelines-pave-way-towards-future?set_language=en. [Accessed 26 March 2019].

[28] Microsoft, "UBS taps Microsoft Cloud to power business-critical tech," April 2017. [Online]. Available: https://news.microsoft.com/2017/04/26/ubs-taps-microsoft-cloud-power-business-critical-tech/. [Accessed March 2019].

[29] P. M. Mell and T. Grance, "The NIST definition of cloud computing, SP 800-145.," National Institute of Standards & Technology, 2011.

[30] M. Schweiz, "News," 5 March 2019. [Online]. Available: https://news.microsoft.com/de-ch/2019/03/05/big-interest-for-the-microsoft-cloud-region-switzerland-the-swiss-microsoft-cloud-provides-entirely-new-opportunities-in-the-areas-of-data-management-regulatory-compliance-and-governance/. [Accessed 26 March 2019].

[31] Google Cloud, "Infrastructure," 12 March 2019. [Online]. Available: https://cloud.google.com/blog/products/infrastructure/new-gcp-region-in-zurich-growing-our-support-for-swiss-and-european-businesses. [Accessed 26 March 2019].

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