



Cloud migration strategies

A structural challenge for companies

January 2023



Cigref

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EDITORIAL

Since the French Ministry of Economy and Finance took over responsibility for industrial and digital sovereignty in July, cloud computing has become an even more central component in strategic autonomy. The international disruptions brought about by the strategic competition between China and the United States, the Russian threat at the gates of Europe, and the assertion of new players in the global balance of power is giving rise to a new dynamic for France and the European Union in the digital field.

On 17 May 2021, the French government announced a new national cloud strategy that emphasised control over dependency, whether in terms of suppliers, supply chains, customers, even employees when these have strategic skills.

There are many fears, and laws with extraterritorial reach give the countries enacting them a "right of review" – or more of a "right to interfere" – and allow them to tap into data stored in the cloud for economic intelligence purposes.

This led the Bank for International Settlements to sound the alarm last July. They noted that the dependency of European institutions – financial and otherwise — companies and users called for swift action as it constituted a threat to our wealth of data, industries and the economy.

Cigref's work has focused on promoting transparent and balanced contractual relations that respect competition and protect against cyber threats and extraterritoriality. Our ambitious mission seeks to protect sensitive data assets and push back against using the cloud as a way to assert non-European powers' economic and cultural hegemony.

Another concern is digital sobriety. Data centres and cloud computing account for 20% of digital technology's environmental footprint, and it is urgent that we recognise that the cloud is transforming our societies.

The working group looked at the many constraints and opportunities related to the cloud and analysed the technical, financial and geopolitical cloud migration strategies.

**Jean-Christophe LALANNE, EVP IT of Air France KLM,
and Stéphane ROUSSEAU, CIO of Eiffage,
co-leaders of the working group**

OVERVIEW

The Cloud Migration Strategies working group is continuing the work it started in 2020-2021. This report is an updated version of the first edition of the Cloud Migration Strategies report.

Cloud migration is a multi-year project, and members are still in the process of migrating. In this respect, the prediction we made last year seems to be coming to pass: by 2025, most organisations will have made their migration to the cloud.

While we may no longer need to reiterate the benefits that this shift can offer companies, such as agility, flexibility and time to market, several topics still need to be addressed.

With this in mind, the study focused on the means used to migrate to the cloud – the "how", in other words. The group then focused on **software migration**, a key issue in this year's work. Finally, we considered **the secondary benefits of the migration**, such as mapping the software base, securing the IT system, dealing with technical debt, and responding to environmental challenges.

In addition to these technical aspects, migration to the cloud requires addressing the subject of **economic performance and how projects are monitored financially**. Cloud computing is often presented as either a black hole or a miracle solution that reduces IT departments' costs. It is therefore necessary to examine the financial mechanisms that are at work in migration.

Migration also brings profound and structural changes to the lives of companies and their employees, so it's worth examining how IT teams change and are reorganized during the migration to the cloud. Organisations' needs are increasing, and the skills they are looking for can come from multiple fields such as cloud computing, FinOps, and security. Profiles that meet these requirements are few and far between, which leads to what we can only refer to as a "war for talent".

Not only is cloud computing shaking up how companies organise themselves internally, **it is also changing relations with the outside world, especially suppliers**. The complexity of contractual relationships, which we already highlighted last year, has only increased with the development of the cloud. Cloud providers are changing business models and overwhelmingly offering SaaS (Software as a Service) solutions. This tips the scales against user companies, who want to balance technological developments with control over their dependencies.

At the end of the second year of work on cloud migration strategies, the group shares a twofold observation: on the one hand, many of the questions raised have been answered through the discussions and comments of the members and, on the other hand, these discussions have revealed new problems that require some distance for solutions to emerge. For this reason, Cigref does not plan to maintain this working group in its business plan for 2022-2023. The cloud will remain present in several other Cigref activities, notably in the Supplier Relations working groups. The objective is to allow member companies and administrations to pursue their migration plans and gain experience on the subject before possibly setting up a new working group in the future.

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INTRODUCTION

This report is an updated version of the first edition of the Cloud Migration Strategies report.

Presented last year as the essential foundation for IT in companies and public administrations, cloud computing continues to be deployed within organisations. In 2021, the cloud was present in 21% of European companies, five times more than in 2018, according to Eurostat. The question is no longer whether to migrate IT to the cloud, but how to do it.

The working group acknowledged that each company is a special case. The goal of this second year was to share feedback so that each organization can get the information it needs, know the risks it faces and mitigate them, where possible.

SOME DEFINITIONS

The definitions presented in last year's *Strategies for Migrating IT to Cloud Computing* report¹ are still relevant and form the basis for discussion and understanding this document. They are reiterated below.

Initially, a "cloud" is a technological solution, but how it is defined depends mainly on how it is used. Some will have a "service" understanding of the cloud, while others will approach it through a "technology" prism. The former will think in terms of "applications and user services"; the latter will think in terms of infrastructure and data centres. The two are obviously related, but the use, the customers and the required skills are different.

Cloud computing means on-demand and self-service access to configurable shared IT resources via a telecommunications network. Cloud computing offers power for industrialisation, standardisation and economies of scale by pooling storage and computing resources. It also helps to pool systems maintenance and invoice on a pay-per-use basis. This optimises resources and costs while allowing IT teams to focus on tasks that add value. Cloud computing is also agile in how it provides computing resources so that companies can quickly experiment with new services.

In its 2015 report on the subject,² Cigref laid out four fundamentals for cloud computing:

1. A "cloud" is always a virtual space that can be stored on one or more physical media,
2. Contains information that is fragmented,
3. The fragments of which are duplicated and distributed in this virtual space,
4. Which has a "delivery console or program" to reconstitute the information.

The provision of tailored cloud services makes it easier for the user to understand, use and upgrade infrastructure and software and take up standard solutions through SaaS mode. The IT architecture becomes more flexible and resilient and can offer "agile" services ("*Business as a Service*"), leading to innovation and a greater openness to the user ecosystem.

For the purposes of this document, let's try to briefly clarify some of the terms used:

¹ Cigref report, *Strategies for migrating IT to cloud computing: a strategic adventure for enterprise*, <https://www.cigref.fr/strategies-for-migrating-it-to-cloud-computing-a-strategic-adventure-for-enterprise>

² Cigref report, *Réalité du cloud dans les grandes entreprises*, 2015, <https://www.cigref.fr/rapport-cigref-la-realite-du-cloud-dans-les-grandes-entreprises>

- **Data centre:** a physical site that brings together computing equipment including servers, routers, commutation switches and hard drives that store and distribute data belonging to one or more companies over an internal network or the Internet.
- **On-premises:** using the company's own computing hardware for its systems and applications.
- **Internal private cloud:** establishing and using cloud technologies in an infrastructure that the company controls, whether its own data centres or a shared, "outside in" data centre.
- **Outsourced private cloud:** the use of cloud technologies from a provider without sharing servers between clients.
- **Public cloud:** the use of cloud technologies from a provider, which offers shared and standardised resources worldwide.
- **Trusted cloud:** the use of cloud technologies that meet the technical, technological, legal, control, security, reversibility, portability, interoperability and transparency requirements imposed by the market and public authorities (see Cigref's *Trusted Cloud Reference Guide*³).
- **Hybrid cloud:** the simultaneous and coordinated use of public and private, internal and external, private and public cloud resources.
- **Multi-cloud:** coordinated use of several clouds of the same nature, public or private, depending on needs and uses.
- **Shared data centres:** using a data centre operated by a third party that rents space out to multiple customers to host their IT systems.

CURRENT CONTEXT

As Cigref's *Strategic Orientation Report* points out, cloud computing is now the "essential foundation of the digital data structure" and therefore drives all other areas of IT, such as IoT, 5G, and quantum computing.⁴ The pandemic has made cloud solutions even more popular since they are very well suited to hybrid ways of work. This is helping to make cloud computing essential to businesses.

Organisations also need to consider which offer best suits their needs and strategy. While public cloud solutions from a provider give access to near-infinite shared and standardised resources worldwide, private clouds give companies control over the infrastructure. However, there is still the choice between an internal private cloud, where the company does the engineering, and an outsourced private cloud, where the architecture inherits as much as possible from standardised public cloud solutions. They can also opt for a hybrid cloud, which combines several types of cloud (internal/external private and public). Finally, they can also choose a multi-cloud system, which consists in "the coordinated use of several public cloud providers according to needs and functions".⁵ This entails additional technical layers to make the cloud environment seamless.

In addition to the technical reasons, we must also consider the political and financial aspect of these choices. Some cloud providers now offer to fund part of their clients' migrations, for example by offering to train teams in return for long-term contracts. These are all variables for companies to consider in their business relationships and their cloud migration strategies, in particular.

³ *Trusted cloud. Reference document V02*, 2022, <https://www.cigref.fr/le-cigref-accueille-favorablement-lannonce-du-projet-de-creation-de-numspot>

⁴ Cigref Strategic Orientation Report Digital futures: which pathways? 2021, <https://www.cigref.fr/cigrefs-strategic-orientation-report-2021-digital-futures-which-pathways>

⁵ Cigref report: Strategies for migrating IT to cloud computing, 2021, <https://www.cigref.fr/strategies-for-migrating-it-to-cloud-computing-a-strategic-adventure-for-enterprise>

The increased demand for cloud solutions is accompanied by changes in providers' billing policies and managed services. Software solutions are also seeing a shift from on-premises to SaaS-only models, making target architectures increasingly heterogeneous and companies more dependent on their suppliers.

The increased needs and exchanges raise many issues, from security to data protection to independence from foreign solutions outside Europe. The issue of the sovereignty of cloud environments has been raised for several years. Answers are beginning to emerge, offering new possibilities and scenarios.

In its 2022 agenda, the European Commission included "*A Europe fit for the digital age*", allocating €7.588 billion to the digital budget for the 2021-2027 period.⁶ Protecting Europe's information assets highlights the need for strategic autonomy. Companies want to innovate and be competitive, while at the same time they are aware of the challenges they face in protecting their business and financial data and using the best technological tools.

WORKING GROUP ISSUES

The "Cloud Migration Strategies" working group was a continuation of the previous years' work. This work highlighted the need to further explore issues such as data management, financing and cloud hosting options.

The aim was to draw on concrete experiences, both ongoing and completed, learn from them and, rather than approaching the subject through a theoretical study phase, **share results, observations, recommendations or warnings.**

In order to best answer the questions related to cloud migration strategies, the working group set itself the following objectives:

1. Analyse the criteria for choosing between a private and a public cloud, especially the technological opportunities and the legal or contractual differentiating factors, as well as the obstacles and levers to be taken into account,
2. Measure the attractiveness of cloud solutions, distinguishing between cloud solutions hosting "dedicated data environments" and those hosting transactional applications,
3. Define and understand multi-cloud systems in order to determine whether it can be a relevant response to the difficulties companies foresee in their migration to the cloud.
4. Analyse the prospects for the cloud market (see KPMG report, April 2021)
5. Evaluate future innovations in cloud technologies (omni-cloud, prospective approach, etc.)

⁶ "Digital Europe Programme gets green light from Council", Council of the EU press release, 16/03/2021, online: <https://www.consilium.europa.eu/fr/press/press-releases/2021/03/16/digital-europe-programme-gets-green-light-from-council/>

1 WHY MOVE TO THE CLOUD?

In its work in 2020-2021, the working group attempted to answer the question, "why move into cloud computing?" and focused on the criteria for migration.

The members were all in the process of migrating to the cloud, at least through SaaS solutions. All sectors of activity are impacted by cloud computing, including those in which data is a sensitive subject.

The importance of the move and its consequences on life within the companies was highlighted. The migration is a chance to develop network technologies and sometimes comes with interesting side effects such as support for foreign subsidiaries abroad that may not have as good a mastery of telecommunications. But this transformation is not just technological, it also has repercussions on the financial model.

In addition, thinking about the cloud strategy also leads us to the question of whether the company is moving to the cloud *in order to change the way it does things*, or whether *the changes are a result of the migration*. The approach is certainly not uniform: it depends on a multitude of factors, such as the company's core business and its needs, expectations and future projects.

There is a very large gap between the promises of "ease of implementation" and the reality.

Today, the migration to the cloud is still relevant for organizations and responds to multiple motivations. This migration also represents a strategic change for large enterprises and government agencies, with its share of challenges and obstacles identified.

1.1 MULTIPLE MOTIVATIONS FOR ORGANISATIONS

Initially, companies and public administrations have a number of objectives when they decide to move to the cloud:

- Responding to new business stakes and pressure from business units,
- Increasing their agility, responsiveness, flexibility and time-to-market and deployment at scale,
- Benefiting from new technologies, packaged services, especially for data,
- Achieving global coverage and replicating in multiple geographic areas,
- Harmonising and centralising systems to bring about economies of scale,
- Securing its IT systems,
- Reducing technical debt by using managed services and automation tools that cloud providers offer,
- Streamlining their data centres and infrastructure,
- Adapting to peaks and troughs in business,
- Promoting new ways of working for agile IT teams,
- Implementing a strategy to retain and attract talent by improving employees' skills and offering them support,

- Integrating Dev and Ops teams more natively with the aim of building a Biz/Sec/Ops value chain,
- Building business platforms and opening up potential for innovation.

But once the migration is underway, new benefits emerge:

- Valuing solutions financially and optimising IT costs,
- Taking advantage of technological opportunities, particularly those that allow stock to be taken of the IT system as a whole,
- Allowing the development teams to configure environments and produce releases independently,
- Building the organisation's future hosting strategy (future of the internal data centre and the private cloud),
- Adapting network topologies by abandoning MPLS and deploying SD-Wan and a Zero Trust strategy.

1.2 A STRATEGIC SHIFT

Each company has its own migration story. This profound transformation affects how the teams operate and are built, governed, organised and managed from an HR perspective. Each time, the context in which this happens is different. Decisive factors include the organisation's history, the company's application base and its past technological choices. There is no "one size fits all" solution.

Companies need to assess the feasibility of their migration, their cloud readiness and, above all, anticipate the consequences of their decision, both good and bad. This is a long-term project that relies on a number of factors, some internal and others external to the company.

However, despite the specificity of each situation, a consensus emerged from the discussions that migrating the IT system to the cloud is not an issue for the IT department alone. Quite the contrary, this "strategic adventure" involves the whole company and leads to profound changes and a new way of seeing work and lifestyles: it is sometimes referred to as a "new world".

1.3 SOME OBSTACLES

The working group's vision of cloud computing was far from idealistic: it heard feedback about the migration that could sometimes be very critical, so it seems important to list the obstacles that the group identified. Most migration paths offer a holistic, or at least rather global, look into the most frequent challenges.

Some difficulties – which can turn into obstacles – prevent organisations from fully adopting cloud computing. The issue of securing and protecting assets and data from both a legal and technical point of view is one of the main concerns.

Among the main obstacles and barriers, the working group identified:

- Managers' lack of understanding of cloud computing issues,
- Regulatory requirements (essential operators, sector regulations),

- Exposure to extraterritorial laws when choosing an international supplier,
- Confidentiality of company data,
- The protection of commercial, financial, technological and industrial secrets,
- The expected economic performance,
- The "cloudification" of critical systems (e.g., industrial IT),
- The scale of the investment required (time, means, resources) for as-yet unproven gains,
- Arbitration and prioritisation of projects,
- The imbalance in relations with certain major suppliers,
- The problem of reversibility when you want to migrate your data or software to another provider,
- The organisation's internal maturity in terms of human resources and skills. Employees may fear for their job security, either removal from their usual role or even loss of their job. This concern could even prevent cloud computing from being adopted. On-premises cloud managers are particularly impacted. These elements are discussed in greater detail in the section dedicated to the [Recruitment and training strategy](#).

Being aware of all these obstacles allows us to anticipate and assess the risks in comparison to issues of strategic autonomy, among other things. In addition, the complex migration process itself can be prove to be a hindrance to deployment. This is especially the case since the ecosystem itself is still evolving and finding its place. Finally, the feedback shows the complexity of the "cloudification" of critical systems, which seems to be a really new issue for some participants, including their suppliers.

The issue of cyber security is also identified as one of the obstacles, which requires us to find a delicate balance between trust, freedom and security. The discussion on this point shows that participants are more likely to trust large hyperscalers.

All these elements must be taken into consideration in the strategy and the migration choices according to the risks they generate for each organization.

For example, in some companies, the data centre may be operated solely by in-house staff to maintain control over security and protect core business know-how and intellectual property.

2 HOW TO MOVE TO THE CLOUD ?

Most Cigref member organisations are using multiple cloud computing resources in their migrations, including internal, external, private and public clouds (hybrid cloud - see 1) and using multiple public cloud providers in a coordinated way depending on its needs and uses (multi-cloud - see 2):

- 1) Hybrid cloud: organisations are increasing their use of cloud services through a strategy of purchasing cloud solutions and/or migrating existing applications (by "lift & shift"⁷ and/or application modernisation). Legacy IT, often contained in the company's or its service providers' data centres, and private cloud applications thus interact with services hosted in the public cloud.
- 2) Multi-cloud: organisations use the expertise of multiple cloud service providers to benefit from the most efficient and competitive services on the market and use competition to limit the risk of being locked in with a single technology provider.

Note: there is also "mono-cloud computing" which, as the name suggests, consists of an organisation having only one cloud computing system.

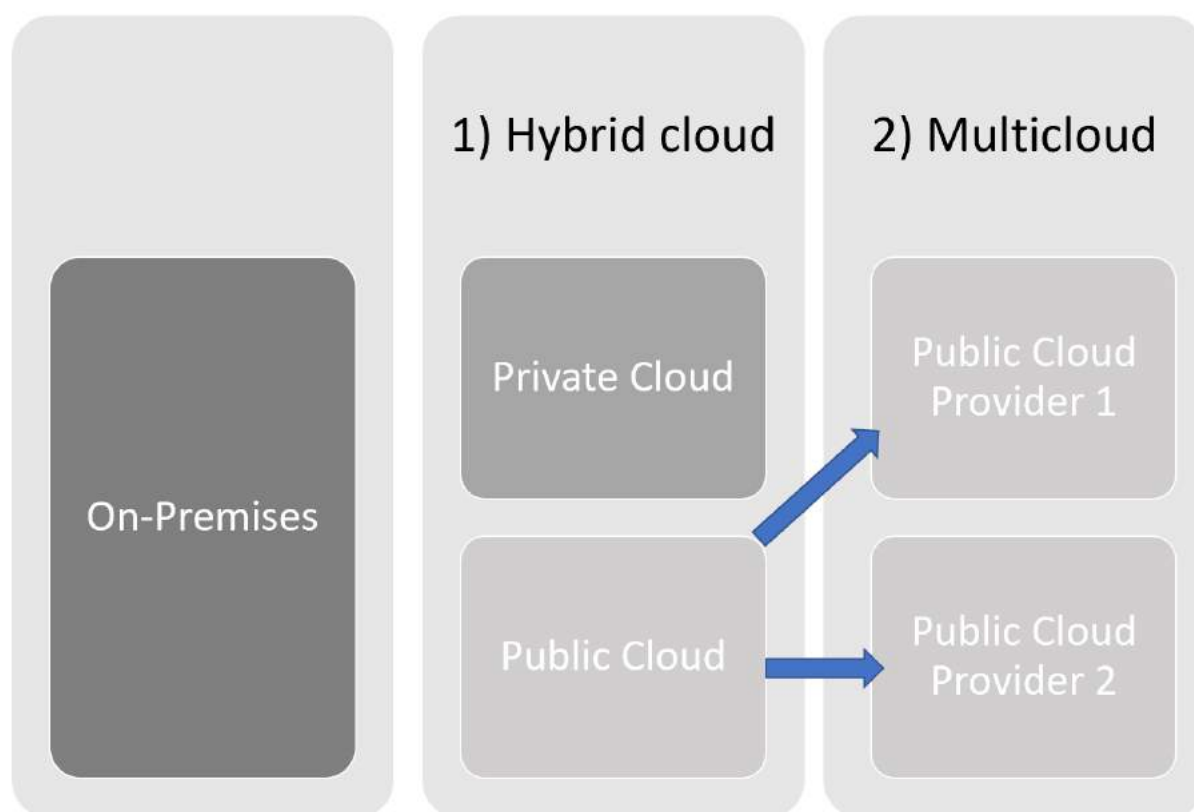


Figure 1: Hybrid and multi-cloud. Source: 2020 Cigref working group

⁷ "Lift & shift" is a "rehost" or "reinstall" method of cloud migration. This is a very basic technique used for quick migrations. It offers few benefits, particularly in terms of scalability, unlike migration methods that transform applications in depth, such as re-architecting. It does not allow for technical debt to be corrected, either. For more information, see *Options for transforming the software base*.

Once the reasons for switching to the cloud have been identified, IT departments follow a number of steps, including application mapping, choice of migration method, use of cloud-readiness criteria, and negotiating a type of partnership and contracts with the supplier(s).

2.1 THE SUBJECT OF THE MIGRATION: APPLICATIONS AND/OR DATA?

Moving to the cloud requires making important strategic choices. The first step is to decide on the scope of the migration, either applications or data.

The working group noted a clear distinction between support for applications and support for raw unstructured data that is not created or integrated into an application (raw materials, volumetry). The issues, motivations and investment are very different.

This difference in support between applications and data is then reflected in strategic choices and requires global data governance.⁸ There are different reasons for the choice of suppliers (see the chapter on increasingly complex supplier management), and this difference can lead to a form of multi-cloud in companies.

It seems that the choice to migrate data to the cloud is first and foremost a business decision, with the primary objective of taking full advantage of all the processing possibilities. Companies generally choose to implement large data warehouses using open-source solutions. Using the cloud to store and process data still depends on the choices that the company will make for its software. Moving software to the cloud allows structured data to be brought into the cloud, which companies also want to cross-reference with unstructured data.

We then find ourselves in a context where data is everywhere, dispersed and replicated in several places, which can create real "data swamps". This situation makes it very complex to process, cross-reference and analyse all the data. We go into greater depth on this crucial issue in the fourth part of this report, dedicated to software migration.

In software, we distinguish between SaaS applications, which are purchased on a turnkey basis, and software to be migrated to the cloud (IaaS or PaaS).

For each application, we must define the hosting destination (the "landing zone") and choose the most suitable provider if the company is not developing its own internal cloud system. Hosting options can include using cloud technologies in the company's own data centres or those of its service provider or migrating to a public or private cloud system.

Once the scope and hosting have been decided, the company must choose each application's "future place" in this new destination, i.e. choose from the various software transformation options (see section 2.2. Software Migration), and the time scale in which each application will be transformed.

These decisions must take into account many parameters including strategic issues, internal skills, the state of the software base and environmental requirements. Each company therefore generally establishes a decision tree, a software assessment matrix to decide what will happen to the software and establish priorities in a software migration roadmap (see figure below).

⁸ Cigref report, *Data & Analytics Governance and Architecture: Developing and implementing a data strategy*, 2023, <https://www.cigref.fr/data-analytics-governance-and-architecture>

For most companies, **the aim is not to migrate their entire IT to a cloud system**, especially if it includes sensitive data. The goal is to find the best opportunities that cloud computing can offer the company.

In a very general, non-exhaustive way, this simplified tree structure can be represented as follows:

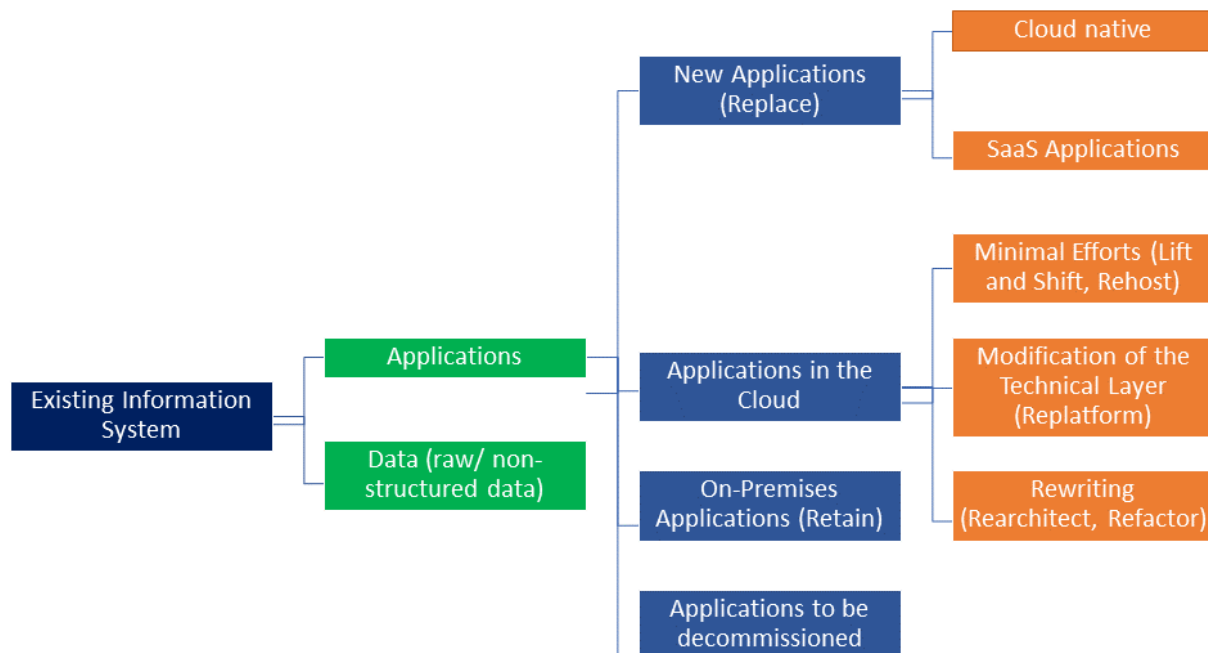


Figure 2. Tree of possible decisions

According to the so-called "7 R's"⁹ cloud provider strategy, "rebuild" should be added to the solutions presented above. This solution is recommended when it appears that "re-architecting" an application would require too much effort. This cost is weighed against the application's value to the business – for example, if rearchitecting seems complex and the business units are using the application less and less.¹⁰

If the software base is on premise, it can be helpful to distinguish between:

- Business software, on the one hand, for which it is necessary to go further into the functional and architectural aspect with the Business Owners, Devs and Ops,
- On the other hand, shared services which provide the transversal functionality linked to things such as identity, monitoring and backups.

⁹ Other sources refer to the 5 R's, 6 R's, or even 7 R's. The 5 R's are the most common. The 7 R's refer to the following migration methods: *Rehost, Re-platform, Refactor or Rearchitect, Repurchase or Replace, Relocate, Retain and Retire*.

¹⁰ See the article "Cloud rationalization", Microsoft website, <https://learn.microsoft.com/en-us/azure/cloud-adoption-framework/digital-estate/5-rs-of-rationalization>, 01/12/2022.

What about on-premises software?

While the above diagram focuses on software already in the cloud, the fact remains that the software base, whether on premise or in the cloud, raises questions about the migration strategy to be implemented. The approach presented is thus also valid for so-called "on-premises" software.

2.2 DEVELOPING A HYBRID CLOUD STRATEGY

Most large companies are engaged in *de facto* hybrid cloud strategies because of their existing IT stored in their historical data centre, be it owned or leased. At the end of its second year of work, the **working group highly recommends a hybrid cloud system**. This is seen as an innovation with **two main advantages**. First, it is useful for optimising supplier relations and opens up many possibilities. It also helps to optimise costs, especially if the company adopts a good FinOps approach, which is almost systematically backed up by a Green Ops strategy.

Services, or the search for added value, play a more important role in motivating people to opt for a hybrid cloud system, given that managed services, especially packaged solutions, exist in the hybrid cloud. Hybridization requires an investment in time and a certain amount of foresight. The challenge is not to become heavily dependent on one, single hyperscaler. In addition, few on-premises services can be supported under a perpetual license.

Members raised a change related to permeability: previously solutions were designated for either private cloud systems or on-premises solutions. Today, there are solutions that are almost unique for the hybrid cloud. Ex: Microsoft used to specialise in on-premises solutions, then moved into the public cloud, and is now turning to the hybrid cloud.

Many companies started their cloud journey by using an outsourced private cloud. Some made the choice to go directly to the public cloud as early as 2013, but they were few in number. Many are currently trying to find a balance between maintaining their assets in the private cloud and their desire to increase their use of the public cloud. There are still companies that have very little IT that use cloud technologies. Some administrations or companies subject to specific regulations have set up their own private cloud on proprietary infrastructures.

Today, many companies recognise that it is increasingly "easy" to migrate their software base to the public cloud. The offers on the market are gradually overcoming the barriers initially identified in security, data protection – including intellectual property control – and skills. Furthermore, in the case of one organisation that chose to migrate to the public cloud, there is a consensus among contributors that all new software will be developed as public-cloud native unless there are specific technical, financial or confidentiality constraints.

However, some IT departments do not wish to redevelop their cloud-unready legacy IT, so there will be a more or less significant remainder depending on the company and its strategic choices. As long as the company has this existing IT, it is not advisable to migrate it solely for economic reasons. For example, the supermarket checkout system is a distributed system installed in the shop, almost like an early edge computing system, which will continue for a number of years.

Conversely, for functional reasons, the IT department may choose to rebuild and transform this existing IT and migrate it to a public or private cloud and take full advantages of the services this can offer.

2.2.1 SENSITIVE AND CRITICAL DATA AT STAKE

The ratio of sensitive and critical data to the rest of the company's data also remains a determining factor in understanding the migration to a public cloud system.

If this ratio is very low or perceived to be very low, then the company may choose to migrate many of its IT assets to the cloud and keep the remaining sensitive data in-house.

Conversely, if this ratio is very high, the company or organisation will be reluctant to migrate to the cloud as there are not enough guarantees for data protection and confidentiality, especially with regard to industrial platforms.

Service continuity issues in a factory, for example, can require certain data to be kept internally out of a fear of the cloud being unavailable in case of a telecoms problem.

Some data will therefore necessarily remain in their on-site environment. Data that is not meant to be put in the cloud could be put in the edge platforms.

Cigref's study on the need for a trusted cloud indicates that approximately 15% to 25% of data, depending on the industry, is sensitive enough to need protection from the risks of non-European cloud services. This data will require using cloud services that either meet the requirements associated with a trusted cloud or come from European initiatives such as Gaia-X.

2.2.2 A DECREASE IN THE NEED FOR AN INTERNAL PRIVATE CLOUD

Nevertheless, there are several arguments in favour of reducing the use of internal private cloud, i.e. one managed by the company, whether it is hosted in its own data centres or in those of a service provider:

- The rapid pace of technological change offered by public cloud requires using the most standard solutions possible and keeping pace with all the technical roadmaps of the software and IT components.
- The current shortage of advanced skills will increase, and retaining teams is becoming very difficult due to salary requirements.
- The obsolescence of the infrastructure requires considerable investment to maintain the expected level of availability.
- The issues of digital security that need to be covered are growing in the face of ever-changing threats.
- Environmental requirements could become very stringent for all kinds of equipment.

There are many reasons why companies are now speeding up their migration to public cloud. Meanwhile, there will be different answers to the issues of maintaining and implementing a private cloud.

2.2.3 ASSUMPTIONS ABOUT THE FUTURE OF PRIVATE CLOUD

The working group's contributors considered several options on how private cloud will be used in the future. They vary depending on the companies' strategies and the offers on the market from cloud

providers, integrators and operators. These could be summarised in (at least) the following three models:

Option 1: Maintain a private cloud platform based on a specialised platform within the company's infrastructure, such as Openshift,

Option 2: The internal private cloud system disappears in favour of a single cloud with two components: the traditional "public cloud" component and a "private cloud" component that consists of a private replica of the public cloud installed through a converged hardware and/or software solution offered by public cloud providers such as Azure Stack or AWS Outpost,

Option 3: A single public cloud model is established. There are few cases that still justify using a private cloud, and all efforts to modernise company software are being made towards using public cloud.

2.3 MULTI-CLOUD ISSUES

While several participants have migrated to a multi-cloud system – sometimes segmenting by domain, sometimes by project, and sometimes opportunistically – multi-cloud continues to raise questions.

Is multi-cloud realistic? Can the company afford to master two or three different technology spectrums?

What does "multi-cloud" mean?

Remember, there are two commonly accepted meanings of multi-cloud:

- The first is the use of multiple cloud providers - increasingly including those coming from a trusted cloud provider - for different infrastructure and software within the same information system to make the most from each offer.
- The second meaning is when it is technically easy to change suppliers, but the contractual aspect is often a stumbling block. This requires hosting platforms to be interoperable, and software must be able to be ported from one platform to another.

Multi-cloud also allows workloads¹¹ to be distributed according to both FinOps and strategic criteria and to the desired relationships with the various public cloud computing systems. This raises the issue of competition between cloud

providers to get the best deal.

Many doubts arose last year since the entry ticket to a good level of security seemed high. Participants said that care should be taken to avoid putting their data and software in the hands of a single provider. It is preferable to choose provider A for the software and provider B for the data. The working group also saw trust issues emerging, including with US hyperscalers.

It is also important to emphasise the complexity of multi-cloud management: multi-cloud requires building skills in several cloud systems (public or private), which raises the issue of support for

¹¹ This is an information system's processing capacity.

employees. Similarly, using multiple public clouds means each provider may offer less advantageous prices. While the multi-cloud promises savings, some argue that it will be hindered by the suppliers themselves since they have no interest in companies choosing this solution.

We can also see that large digital-native players such as Netflix and Spotify have chosen a single cloud provider in order to build their expertise and competitive advantage by mastering a single offering. Traditional companies, which do not have the same leverage, must beware of the mirage of multi-cloud promises which risk diluting their limited expertise.

In addition, identity management is an increasingly important issue in the multi-cloud.

Note: getting support from an integrator, although frequent, is not systematic, even for companies using multi-cloud technologies.

The working group highlights an awareness of the potential operational impact (cloud stickiness, etc.) justifying a move towards a hybrid cloud or towards a theme-based, vertical multi-cloud strategy. In this respect, Cigref and CISPE signed a charter of ten principles for fair software licensing in cloud in April 2021.¹² The risks involved are not only commercial, they are also political and geopolitical, hence the interest in being able to switch from one solution to another.

These elements call for a more specific study of software migration.

¹² Ten Principles of Fair Software Licensing for Cloud Customers, CISPE and Cigref, April 2021, <https://www.cigref.fr/ten-principles-to-end-unfair-practices-of-software-gatekeepers>

3 SOFTWARE MIGRATION

Software migration was one of the topics that received significant attention from members during this year's work. In fact, two sessions were devoted to this topic.

3.1 SOFTWARE MIGRATION METHODS

3.1.1 THE MAIN STAGES OF SOFTWARE MIGRATION

No matter the organisation, the main stages of software migration are generally similar.

One large participating company detailed its plan for managing software migration, which is broadly the same from one company to the next. It distinguishes five stages:

- Identify the criteria and make an inventory of all IT software,
- Filter out applications that should not be evaluated or migrated,
- Use four criteria to assess the software to be migrated,
- Review the results of the evaluation using a prioritisation grid,
- Develop a coherent roadmap for the IT department and the company.

The company used four criteria to establish a grid to evaluate the software for migration:

- Business & IT strategy
- Technology
- Migration complexity
- IT risk management

Cloud ineligibility criteria are identified in the evaluation grids. These may include regulatory criteria (strict legislation for a country or a sector for certain data), confidentiality, obsolescence, or the decision to change technologies.

Each application is sorted into a prioritisation grid with the level of technical change required to deploy the application in the cloud on the x-axis and the business priority on the y-axis.

3.1.2 OPTIONS FOR TRANSFORMING THE SOFTWARE BASE

Software migration mainly raises the question of which method to use to transform the application with a view to migrating it to the cloud. This decision must be made for each application.

These choices can be grouped into six families:

- Minimum effort:
 - Reinstall (or "lift & shift"): the application is migrated as is.
 - Rehost: like "lift & shift" but with minimal corrections made for the operating system and application databases.
- Modification of the technical layer:
 - Replatform: application's lower level is replaced (like a switch to PaaS).

- Redeploy: the software is redeployed on a new technical platform.
- Rewriting the application:
 - Rearchitect: modifies the application's code, for example when shifting to Continuous Integration and Continuous Delivery (CICD) (also equivalent to refactoring or rewriting).
- Replacement:
 - Replace: an alternative is implemented.
 - Repurchasing: new solutions on the market are purchased.
 - Retain means maintaining the application while consolidating environments.
 - Retire: decommission the software.

In a feedback exercise described in greater detail in the appendices, Air-France KLM focused on four software migration paths:

- *Reinstall* ("lift & shift")
- *Rehost*
- *Redeploy*
- *Replatform*

Each of these paths has both a cost and a business value, which increase proportionately. For example, rehosting is a low-cost solution but provides little business value. It should be noted that "rearchitect" is a solution used for some complex applications.

Air-France KLM has set itself an ambitious plan with a significant number of applications to be migrated per year over the course of its project. To sort applications among the various migration paths, the group uses its *Configuration Management Database* (CMDB)¹³ – some applications are not intended to be migrated immediately, while others will "die" in the next two or three years and therefore do not require migration. Other applications that must be transformed still need to be analysed, keeping in mind that the core business applications are the most complex in terms of architecture and technology.

¹³ The *Configuration Management Database* or CMDB gives an overview of the components of an information system.

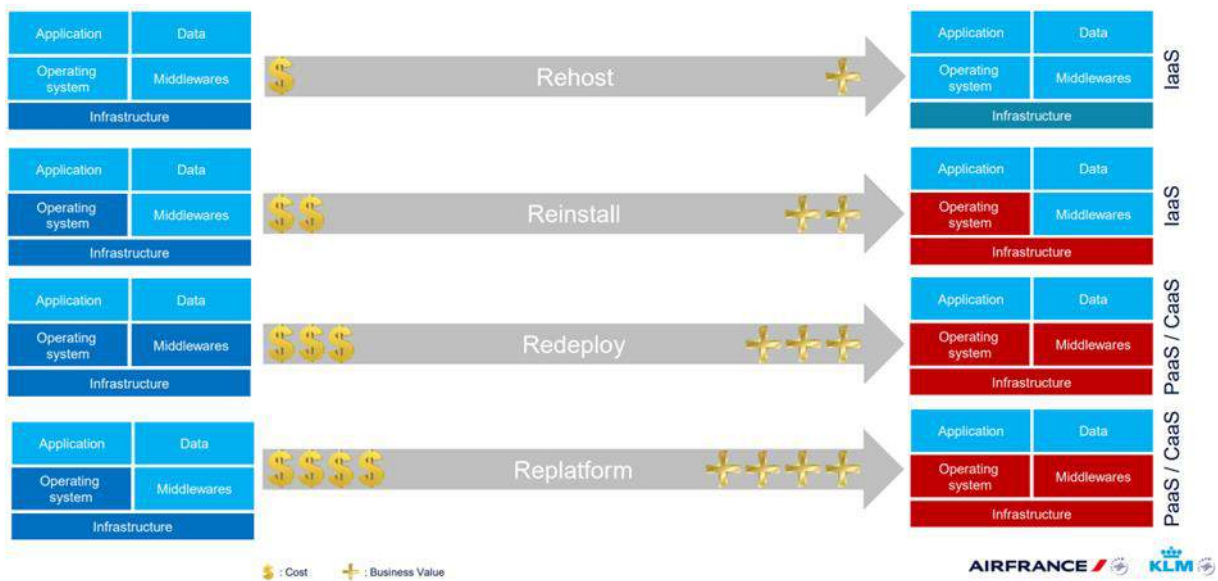


Figure 3. Migration paths: costs and business value. Source: Air-France KLM feedback

Assessing the benefits and costs of software migration in light of the chosen "path" can be compared with studying the benefits that can be obtained through each transformation option presented by Accenture in its presentation last year. The table below takes into account companies' issues, listed in the columns.

6R	Infrastructure	Application	Roadmap Projets	Equipes	Budgets	Planning
REHOST	•••	•	•	••	•	•
REPLATFORMING	•••	•••	••	••	•••	••
REARCHITECT	•••	•••	•••	•••	•••	•••
REPLACE	••	••	•	••	•	•
RETAIN	•	••	•	••	•	•
RETIRE	•	•	•	•	•	•

Legend: > Niveau de bénéfices réalisés

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Figure 4. Benefits obtained as a result of migration options. Source: Accenture

Today, we can see that international companies do a lot of "lift & shift" and "rehost". A simple "lift & shift" is very limiting: it does little in the way of horizontal scalability (or "elasticity"), and thus does little to fulfil cloud computing's promises. To get the most out of cloud computing, it is best to

transform your software. This is the strategy that member companies of this working group are increasingly adopting.

Companies are realising that there is often no simple lift & shift. They should examine the ability of their existing IT system to migrate to the cloud and compatibility with vendor cloud technologies or services.

A great deal of work is required to prepare the applications and make them cloud ready. The decision to rewrite applications to make the most of what cloud computing offers increases the transformation costs needed to ensure future gains. These points are explained by Cast (see the "Cloud Readiness" and the multi-cloud "Cloud Stickiness" indicators).

This is why a company that decides to migrate massively to the cloud will choose not to put certain historical legacy applications there that will be decommissioned in the coming years.

3.2 CLOUD READINESS

The notion of "cloud readiness" refers to the company's cloud maturity and its preparedness to migrate to this technology. Before it makes the transformation, the organisation must evaluate its information system. For migrating an application, the first step is to define criteria and draw up an inventory of all the applications on the IT system.

Cast's presentation

Cloud Readiness and Cloud Stickiness

During its presentation, Cast presented its **cloud indicators "Cloud Readiness" and "Cloud Stickiness"**, recently developed and supported by one of its three solutions: *Cast Highlight*. This solution is based on a very fast analysis of applications' source code, and it compiles a certain amount of information to provide indicators to assist decision-making for a software portfolio. Two indicators are especially relevant to the cloud strategy, including the above-mentioned "cloud stickiness" which is the most recent addition to the solution. The solution fits a software inventory and classification philosophy in line with Gartner's 5R segmentation. This tool looks for "blockers" and "boosters" to migration and cross-references this data with statements provided by the company: the reasons for its migration project, the objectives it is aiming for (e.g. to meet a business objective or to use a managed machine learning service, etc.).

The Cloud Stickiness indicator looks for patterns in relation to eight service categories to determine how dependent a company is on a cloud provider. These are exclusive services provided by the hyperscaler that will lead to additional effort to migrate from one cloud service to another:

- Proprietary database,
- File storage,
- FaaS (serverless): this is a particularly important point, because if the code is written with the resources offered by a hyperscaler, such as Azure Functions for Microsoft

or Lambda for AWS, for example, everything will have to be rewritten to move to another cloud provider,

- ETL: all data transformations,
- Load balancing, which becomes more complex in cases where the company has containerisation solutions,
- Monitoring and logging for observability,
- DevOps and container management,
- Real-time data flow.

The three major cloud providers, AWS, Google and GCP, which have the strongest strategy in terms of using managed services (e.g. turnkey PaaS offerings), are at the centre of CAST's offering.

More globally, Cast proposes segmenting the software portfolio according to Gartner's 5R segments as well as other parameters such as software agility, i.e. an application's ability to easily take into account new functionality and take advantage of the cloud provider's managed services and to quickly increase the application's business value – its business impact – which help decide which applications are to be migrated and functionally expanded to speed up and maximise ROI.

In the example given, the application with the greatest adherence to the cloud provider is the one with the lowest business impact and also the one that would be the most complex to change. We can see the details of the adhesion patterns according to the eight categories mentioned above. Here as well, the Cast tool helps companies to make the best choices according to the parameters, and therefore the strategic priorities, it defines.

[More information in Appendix 4]

3.3 SOFTWARE MIGRATION: LEARNING FROM FAILURE

While the cloud market is growing rapidly, it appears that only 30% of enterprise applications are deployed in the cloud, either the simplest applications, which require the lightest migration processes, or cloud-native applications designed specifically for cloud development.¹⁴

Two arguments are put forward to explain this phenomenon.

Firstly, legacy applications are very difficult to migrate to the cloud. The challenge is such that in almost a third of cases, it is necessary to "repatriate" these applications to the on-premises solutions from which they originated.

Secondly, the failure of migration often lies in the initial phase of projects. Gartner highlights six ways your cloud migration can go off the rails: **Wrong Team, Wrong Emphasis, Mistimed Work Effort, Rushed Application Assessments, Poor Landing Zone Design** and **Hidden Costs**¹⁵. In terms of software

¹⁴ TECHanalysis Research Shows Cloud Workloads Vary by Platform, but Data Rules : <https://virtualizationreview.com/articles/2020/01/17/cloud-workloads.aspx>

¹⁵ Gartner article, "6 Ways Cloud Migration Costs Go Off the Rails", July 2021, <https://www.gartner.com/smarterwithgartner/6-ways-cloud-migration-costs-go-off-the-rails>

migrations, the most common "mistakes" are *Wrong team*, *Rushed App Assessment* and *Mistimed Work Effort*.

Wrong team refers to choosing the wrong partner to carry out the migration, or, if the transformation is entrusted to in-house teams, these teams' lack of experience.

Rushed Application Assessment refers to situations where the company thought it had "identified" its software base in the initial phase - the so-called assessment phase - when in reality it was unable to truly understand the architecture and dependency chains to assess the applications' ability to migrate (their "cloud readiness"). It also means that the company did not fully appreciate the security aspect of the migration, since it increases the attack surface.

Mistimed Work Effort stems from a poor anticipation of the time needed for transformation. Indeed, 60% of a developer's working time is spent on understanding the project, "what needs to be done", while migration represents only 6% of this time. In other words, it takes 10 times longer to understand the application than to modify and migrate it!¹⁶

In the course of the discussion, one participant pointed out that the very fact of having a schedule, although essential, is in itself a challenge. Sometimes, the pressure of deadlines leads to "botching" the cloud transformation to meet targets. Sometimes deadlines simply cannot be met because of the lack of a realistic timetable. Often projects take longer to complete than originally anticipated. Underestimating this time can be detrimental to the optimal completion of the migration project.

In the course of the discussion, one participant pointed out that the very fact of having a schedule, although essential, raises challenges. This is because projects take longer than originally anticipated. As a result, the desire to meet deadlines at all costs can lead to a botched cloud transformation. But... On the other hand, it may not be possible to meet the deadlines because of the lack of a realistic timetable. Underestimating the time needed can be detrimental to the optimal completion of the migration project.

More than a poor estimate of time, realistic (and therefore certainly longer) planning involves "telling the truth". There are therefore two possibilities:

- The most accessible, low-hanging-fruit option where the company chooses to go fast, proceeding by lift & shift, even if it will surely have to repeat this work later by transforming the applications in greater depth, for a true migration to the cloud.
- A longer transformation in which the company seizes the opportunity to renovate its IT, it carries out a "re-architecting" and accepts that the transformation will take some time.

Finally, another pitfall to avoid is the **cloud frenzy**. Teams are faced with an abundance of cloud services, and they must not get carried away by the vast field of possibilities. Moreover, we can see a trend in which, within internal teams, it is not uncommon for employees to show a preference for an architecture that they have built themselves, whereas an expert (a hyperscaler) already offers a "tried and tested" operational architecture. This is what one of the members calls the "**not invented here**" approach: it is necessary to insist on the need to let go of a certain number of technical orientations and trusting external contributors with proven expertise. Whether choosing a service or a cloud solution provider, the recommendation is certainly to be as alert as possible when making a choice, but accepting the chosen solution once it has been adopted in order to move forward and get to the heart of the matter.

¹⁶ These figures come from Cast's analysis, which was presented in a working session. More information in the appendices.

4 WHAT MIGRATION ALSO ALLOWS

When discussing migrating to the cloud, some similarities with moving from one house to another emerged. When moving house, people usually make an inventory of what they want to move, at least in broad categories. This is also the time to sort through your belongings, identify those that are no longer in use, that are too old, or that you decide it's time to change, and get rid of them - the simplified equivalent of decommissioning.

However, there is an important difference between moving house and a migration: migration is generally not from point A to point B. There are multiple points A and, depending on the strategy adopted, multiple points B as well (hybrid and multi-cloud). The many layers and environments of the information system make this process very complex. It's like never really leaving your previous homes and having to constantly fetch information and data from multiple locations.

This metaphor is all the more relevant in the light of recent discussions in the working group. One of the questions the participants asked was whether the most difficult phase of the migration was not the one where the company is between two homes, paying two rents, and is worried about the fate of two coexisting assets. It seems that being in the middle of the switch is a much more complex situation than having completed one's migration or not having started it. It is precisely because the move to the cloud is a medium-term project that it is beneficial to note the indirect benefits of the migration.

4.1 MAPPING YOUR SOFTWARE BASE

When migrating to the cloud, you need to map your software base in order to decide what should be migrated and how.

The mapping of the software base has a financial aspect, since it involves knowing the full cost of an application. This is also a stage that requires the implication of the business units, which must be involved as much as possible with the migration decisions of the candidate applications.

On a technical level, you must comb through the base – the tools, the level of depth, the type of workload, even code analysis sometimes – to obtain a reliable inventory.

This mapping is essential for migrating software to the cloud, and more generally it allows for better management of the software portfolio, but it also reveals the extent of the IT debt and obsolescence. In addition, a good knowledge of the software base ensures that not too much time or money is spent on applications that are not worthwhile.

This analysis of the software base can be carried out directly by the company – or by a third party for some external insight and to make the best decision.

4.2 DEALING WITH THE INFORMATION SYSTEM'S TECHNICAL DEBT

Dealing with the information system's technical debt is one of the drivers of the migration. It is about "treating" or "reducing" technical debt, not eliminating it.

Managing technical debt (also called Life Cycle Management) is a major argument for migrating to the cloud. It becomes simpler, more coherent and better synchronised, thanks to the tools available.

We can see that most of the applications chosen for cloud migration are within the scope of technical debt management, i.e. they are considered by the organisation to be in need of modernisation according to the criteria in place.

The extensive preparation of cloud-ready applications allows obsolete applications and components to be modernised. The decision tree also allows or decommissioning, which is a challenge in itself that should not be neglected.

For example, some companies that have already spent a portion of their IT budget on technical debt reduction may shift that budget to cloud migration (budget substitution or avoidance).

Organisations are therefore obliged to deal with the technical debt when migrating the software base to the cloud. Nevertheless, there will always be some technical debt, including in the cloud, but the cloud has tools to address this in an automated way. This was explained in Cigref's *Managing IT debt and obsolescence* report¹⁷, published in July 2021.

4.3 SECURING YOUR IT SYSTEM

The company must find a balance between security and the technological opportunities offered by cloud computing and to do so, define an ad hoc security policy.

Major cloud providers have sufficient financial and human resources to secure their services, which may be greater than other players - smaller providers and enterprises - can muster. It is therefore beneficial for companies to rely on the ability of hyperscalers to secure their systems.

We feel that companies can achieve better security using cloud computing with equivalent means and resources, provided that they acculturate their teams and allow them to appropriate the suppliers' security offerings.

The company must have a dedicated policy to integrate specific issues and to stay on top of the security rules. Some companies are wondering how best to get security teams on board in cloud environments, which is a prerequisite for success. In addition, companies have to deal with the decentralisation of applications into different cloud systems, which undermines the overall coherence of the information system, leading to blind spots, and makes its centralised security governance more complex.

Challenges include container and application security, credential and access management, encryption key management, network segmentation, vulnerability and incident management, compliance with and monitoring of internal security policies. When migrating to the cloud, it is highly recommended to deal with software vulnerabilities and the technical debt of the operating environment (list obsolete OSes, identify patching gaps, etc.)

In terms of data security, end-to-end encryption is presented as an important advance, but the critical issue is to control the keys. One member company took an interest in the issue and identified several steps in thinking about this complex topic. First, you must study the technological offers on the market, look at the needs for financing and innovation, identify how to do the encryption itself, control the keys by using a third-party authority (not owning them), and finally, increase the skills of the security and cloud teams. However, encryption seems to limit the benefits of using cloud services, especially for data analysis, if the data is encrypted.

¹⁷ Cigref report: Managing IT debt and obsolescence, July 2021, <https://www.cigref.fr/managing-it-debt-and-obsolence>

Additionally, new concepts are emerging such as Forrester's Zero Trust and Gartner's SASE (Secure Access Service Edge). Note that this is more about securing access devices than cloud computing as such. They are increasingly being studied by teams to strengthen the security and connectivity of cloud architectures (see Cigref Zero Trust report¹⁸).

Security aspects should be emphasised in communication with top management, alongside asset protection and sovereignty. Migration to cloud computing gives the information system a larger attack surface: it therefore comes with opportunities as well as risks.

4.4 OTHER IMPACTS OF MIGRATING TO THE CLOUD

Migration to the cloud will also impact the design of enterprise networks, especially WANs. Companies need to provide high-speed internet connections between their own infrastructures and those of their cloud providers. As a result, an increasing number of companies are opting for an SD-Wan network, which allows them to create and manage their WAN in software, replacing MPLS. It is a fundamental building block of the SASE.

Furthermore, it is logical to assume that the use of outsourced cloud services for applications will reduce the use of data centres. A two-pronged strategy must be put in place to optimise and progressively decommission the legacy infrastructure.

4.4.1 CLOUD COMPUTING AND THE ENERGY CRISIS

The current health context and energy crisis have highlighted the issues of IT sobriety. Migration to cloud tends to be presented as a more efficient alternative to data centres. These centres are renowned energy consumers, and this migration leads them to close.

- Data centres account for 5% of the world's electricity consumption, which is also increasing by 5% per year,
- Data centres' installed capacity is also growing: estimated at 60 GW in 2020, it should reach 80 GW in 2025,
- The volume of data stored is expected to increase fivefold between 2018 and 2025.¹⁹

Additionally, the sharp rise in the price of electricity is a cause for alarm: **how are data centre operators coping? Will they even cope?** For the largest players in the sector, their solidity should enable them to hold out, at least in the medium term, without passing on the rise in electricity prices to their customers, or only to a very limited extent. However, the situation is different for smaller data centre operators, who will either have to increase their prices drastically, reduce their activity or terminate it.²⁰

¹⁸ Cigref report "Towards a Zero Trust philosophy: a break in continuity for application security", March 2022, <https://www.cigref.fr/towards-a-zero-trust-philosophy-a-break-in-continuity-for-application-security>

¹⁹ "Les datacenters au cœur de la crise sanitaire", questions put to Eric Lamendour, director of the data centre customer segment and offering at ENGIE, 20/04/2020, ENGIE website, online at <https://www.engie.com/data-center-c%C5%93ur-crise-sanitaire>

²⁰ Dominique Filippone, "Crise énergétique : les compteurs s'affolent pour les hébergeurs et opérateurs de datacenter", 19/09/2022, *Le Monde Informatique*, online: <https://www.lemondeinformatique.fr/actualites/lire-crise-energetique-les-compteurs-s-affolent-pour-les-hebergeurs-et-operateurs-de-datacenter-87990.html>

In France, the ARENH system (regulated access to historical nuclear electricity) serves as a safeguard against soaring prices. It allows operators to buy EDF electricity at a regulated price. However, it has three limitations:

- The price of the megawatt-hour was revised in the summer of 2022 from €42/MWh to €49/MWh,
- Eligibility for the ARENH scheme is not granted to operators whose data centres represent only a tiny part of their activity, thereby excluding many players who are nevertheless in difficulty,
- If the overall demand exceeds the threshold of 120 TWh per year, then the ARENH volumes cannot be delivered in the requested proportions.

Although data centres are often seen as a symbol of energy-intensive digital technology, it should be noted that some data centres use low-carbon energy or allow their heat to be reused for other buildings. Institutions such as ASHRAE²¹ are also issuing standards to use data centres in the most virtuous way possible by limiting refrigeration. In this sense, reducing air-conditioning in data centres is one of the levers put forward by the French government at the beginning of October in its plan for energy sobriety. This document promotes "exemplary government" and includes a commitment to reduce the government's digital consumption by improving the energy efficiency of data centres.²²

A few weeks earlier, in mid-September, the government had unveiled a plan to help individuals and businesses access electricity at affordable prices. However, giving the uncertainty as to the duration and extent of the crisis, it seems increasingly necessary to add European measures to France's price shield²³.

With the exponential increase in the need for digital services, both data centres and the cloud computing are being affected by the challenge of energy efficiency.

4.4.2 WHAT ARE THE ENERGY BENEFITS OF MIGRATION?

The Power Usage Effectiveness (PUE) indicator is used to assess data centres' energy performance and is obtained by calculating the energy consumption ratio of the entire data centre to the computing equipment. The closer the value is to 1, the better the energy performance. According to a 2020 study on the data centres' energy consumption in Europe, this would be 104 TWh, with an average PUE of 1.54. In Western Europe, this consumption is estimated at 37.2 TWh, with an average PUE of 1.45²⁴. The details of the PUE are as follows: 1.93 for traditional data centres, 1.55 for cloud data centres, and 1.17 for hyperscale data centres. The PUE indicator is therefore an argument in favour of using cloud computing to address energy issues, although the indicator is not perfectly reliable since it does not take into account the specific characteristics of the data centre being evaluated (e.g. type of air conditioning, location), nor the performance of the servers in the data centre.

In terms of technology, several avenues are being considered to make the cloud more frugal. One of these is the implementation of specific hardware and software components. The choice of processor

²¹ American Society of Heating, Refrigerating and Air-Conditioning Engineers.

²² *Plan de sobriété énergétique. Une mobilisation générale*, press kit, 6 October 2022.

²³ See the European Commission's guide to best practices, "2022 Best Practice Guidelines for the EU Code of Conduct on Data Centre Energy Efficiency", Joint Research Centre Technical Report, European Commission, 2022.

²⁴ Masanet, E., Shehabi, A., Lei, N., Smith, S., and J.G. Koomey (2020) "Recalibrating global data center energy use estimates", Science, vol 367, ISS 6481. The figures presented are taken from and commented on by the ADEME report "Évaluation environnementale des équipements et infrastructures numériques en France", report 2/3, January 2022.

plays a decisive role. Other architectural possibilities should also to be considered by placing the calculation and data processing operations as close as possible to, or even within, the components themselves, or by using non-volatile memories or even "local clouds" or "cloud at the edge".²⁵

Also, cloud computing is particularly advantageous for "green" sourcing and the price per kilowatt hour it offers. There are many ways to save money through automation and cloud computing in general.

In short, the situation invites us to think of cloud computing as a driver to transform companies and help them respond to their environmental and societal challenges.

²⁵ "Quel avenir pour le cloud face aux enjeux de frugalité" Explanation , CEA website, March 2022,
<https://www.cea.fr/presse/Pages/actualites-communiques/ntic/quel-avenir-pour-le-cloud-face-aux-enjeux-de-frugalite.aspx>

5 ECONOMIC PERFORMANCE AND FINANCIAL MONITORING OF MIGRATION

Members are particularly concerned with analysing the economic performance and monitoring the financials of the switch to the cloud. Additional information can be found in the Cigref the report on IT cost reduction levers to be published in 2023.

5.1 ECONOMIC PERFORMANCE OF MIGRATION

To launch a cloud transformation programme, organisations need to justify not only the business stakes but also the economic gains to fund the associated projects. However, most of them mention that cloud computing is primarily chosen for business reasons, whether to become more agile, accelerate time-to-market, benefit from new technologies or implement new working methods and practices.

However, we should note that the financial gains are still largely unproven. Faced with the great flexibility of the cloud, the transformation brought about by migration is characterised by unpredictable costs, difficulties in auditing and complex multi-cloud management. Companies are even talking about a “drift” or “cost explosion” in the public cloud, although private cloud is said to be cheaper. They want to be able to create as much or more value at lower cost in the cloud. But this wish seems to be achievable only under limited conditions and is still far from being a reality for many organisations.

Currently, companies do not have enough experience to concretely demonstrate the gains made by switching to the cloud. It is difficult to complete the business case since the indirect gains are hard to materialise. It is very complex to arrive at a positive business case for lift & shift migrations.

In addition, many managed cloud services have no equivalent in proprietary or leased data centre environments. The comparison between on-premises and cloud services does not make sense financially, but cloud computing services still appear as an additional expense. The counterpart does not appear on software suppliers' invoices either due to the multi-year contracts.

Cost avoidance approach proposed by Accenture

Accenture proposed a cost-avoidance approach to the working group participants. The ROI of the migration should be calculated based on a constant budget for the IT department, i.e. the budget it uses today with the expectation of spending the same in the future without the “do the same” cloud migration. This is a financial comparison of two future situations: one in which the organisation migrates its IT to the cloud, and one in which the migration project is not approved and the IT department continues with the current projects and infrastructures.

This approach identifies and integrates all IT costs that are relevant to cloud migration, not just infrastructure costs.

Following this logic, it is therefore necessary to identify all the gains and costs generated by the migration. Accenture distinguishes between five main families of IT spending:

- Infrastructure: hosting, equipment, networks, software, security,

- Applications: development, evolution, maintenance,
- Project roadmaps: updating or evolving infrastructures, applications,
- Team: training, change management, outsourcing,
- Budget: contract exit fees, request-for-proposal costs.

Accenture also recommends that the company include in its business case:

- The impacted costs of each family,
- The total avoided costs of technology renewal and life cycle management (application and infrastructure),
- The high cost of transforming applications,
- The costs of internal organisation, project roadmaps, as well as recruitment,
- The monetisation of constraint fields.

The exercise of "monetising the fields of constraints" is complicated. An attempt should be made to calculate the application's total cost of ownership (TCO) related to application performance and consumption. It is also recommended to calculate the TCO of the infrastructure on the one hand and the applications' TCO on the other. You must also consider the compute costs and the operational readiness maintenance (ORM) costs of the virtual machines (VM) before and after the migration.

Accenture highlights several types of gains associated with migrating to the cloud, including:

- Software and hardware,
- System standardisation,
- Team reorganisation and productivity,
- Value creation and innovation,
- Technical debt and application lifecycle management,
- Maintenance (third-party application maintenance),
- Optimisation of security solutions and business continuity, etc.

In addition, there are several types of steering costs associated with the migration to cloud computing:

- Development of the business case,
- Integration of FinOps,
- Change management,
- New catalogue of services,
- Level of investment required from business units,
- Work with the business on the application roadmap,
- Team and talent transformation costs (continuous upskilling).

To increase the economic value of the migration to the cloud, the IT department must also think about profoundly transforming how its activities are organised. The human potential freed up by implementing tools offered by the cloud can be reinvested in the expertise needed to create value. As a result, additional gains can be identified (reduction of subcontracting, job optimisation) and complement a strict financial equation based on infrastructure costs. This approach implies developing an appropriate sourcing strategy, such as outsourcing, nearshore, or offshore. For several subjects, it may make sense to use a service provider/integrator.

5.2 FINANCIAL MONITORING OF THE CLOUD MIGRATION

The cloud, and its link with the new FinOps responsibilities, is one of the areas of study covered in the update of the Cigref cost repository.²⁶ These themes are in fact particularly concerned by the need to develop and create indicators for the reference framework. As a result of this year's workshops, a new **Economic and Ecological Management Model** was published in October 2022.

Technology investments used to be slower to implement and evolve, but DevOps and Agile methods have changed that. Spending in the cloud represent a growing share of CIOs' financial commitments and are expected to increase in the coming years at the coming years at five times the rate seen in 2020.

The cloud operating model is still being built. Operating and managing the cloud is very different from traditional information system management. Decisions are made in near-real time and split between different teams – such as finance, procurement, technical and business – to balance operational and financial control. These teams are faced with a new method of invoicing and expenses that are difficult to identify or control. In fact, cost management is the second most important challenge facing CIOs, just after security, according to a 2020 Flexera study.²⁷

Migration to the cloud requires a move from software asset management to pay-per-use for cloud services. Many companies are finding it difficult to adapt to these new pricing models and public cloud offerings evolving pricing policies, which are a departure from traditional purchasing models. It also means a shift from capex (capital expenditures) to opex (operations expenditures), because while asset management was a capital or business investment, cloud computing entails pay-per-use for the services used.

As a result, companies need to merge the financial models of multiple fields: traditional infrastructure (e.g. mainframe), billed on a per-unit-of-work basis, and hybrid cloud (private and public), billed on a per-use basis. Financial control of hosted servers and applications is more difficult, as is the management of operating costs.

Companies are also struggling to control the growing use, and therefore cost, of cloud computing services. Either the company does not cap the use of cloud services, allowing the costs increase to sharply over time due to the accelerated cloud uptake and the pay-per-use model, or the company adopts an instance pooling model that restricts usage and keeps costs under control. The challenge here lies in accurately estimating the number of instances to be reserved. In some cases, the "post-migration" bill is sometimes higher than what was expected, or higher than the one before the migration.²⁸

You should also not forget to take into account all the hidden costs of migrating to the cloud, such as hosting in two different places at the same time during the migration, "hidden extras", and data transfers²⁹ (see *Le Monde Informatique* article).

²⁶ The repository is available on the Cigref website: *Economic and Ecological IT Management Model*, updated in 2022, <https://www.cigref.fr/economic-and-ecological-it-management-model-2022-edition>

²⁷ Flexera report "State of the cloud 2020", <https://www.flexera.com/about-us/press-center/flexera-releases-2020-state-of-the-cloud-report>

²⁸ See Mistake No. 6: *Hidden indirect costs*, Gartner, supra, *6 Ways Cloud Migration Costs Go Off the Rails*, <https://www.gartner.com/smarterwithgartner/6-ways-cloud-migration-costs-go-off-the-rails>

²⁹ *Les 7 noirs secrets derrière les tarifs du cloud*, *Le Monde Informatique*, June 2020 <https://www.lemondeinformatique.fr/actualites/lire-7-noirs-secrets-derriere-les-tarifs-du-cloud-79497.html>

In recent years there has been an increase in the actual migration speed from 150 services/month to 300 services/month. This also reflects companies' goal to see an economic return on migration in the first year, the so-called "cash year". These observations seem to argue in favour of developing fairly radical migration strategies: the bolder and faster the plan, the more the company seems to achieve the desired economic gains.

However, as soon as an application transformation component is added, such as refactoring or rewriting, we see that the ROI needs to be readjusted: it will take longer to obtain but will also be more significant.

In addition, there are many questions about the indicators to use to build the business case as well as for monitoring (e.g. number of servers or applications).

Data centre closures: is the business case *really* attractive?

One of the organisations shared its experience: as owner of a number of data centres and a tenant of three others, it is switching between private and public clouds and going from managing some of its data centres itself to having them managed by professional third parties.

The business case takes into account the surface area of a data centre in square metres as well as its energy and cooling. The savings from closing data centres are related to the surface area rented, the surface area sold, and the energy performance, and there is a huge difference in the latter between the company and the professional.

Similarly, the price of energy, for which the professional is able to negotiate preferential rates, is much more attractive in this configuration than when it was paid by the company.

Finally, this also eliminates expenses related to the maintenance and renovations of data centres, such as bring them up to standards and renovating electrical installations in the coming years. Such work would represent a considerable cost, much higher than that of a cloud migration.

For another member organisation, the expected savings were initially achieved through a 90% lift & shift strategy. Thus, they were able to save money on rent, electricity and air conditioning, which were no longer needed after closing data centres. The company saw a reduction in the run to a less demanding cloud model and was able to remove unnecessary/obsolete machines after the discovery phase (stopping telecoms links, physical security solutions, etc.).

As a result, the business case for closing a data centre is not positive at the outset given the costs of physical migration and transition, but afterwards the costs strictly related to the physical infrastructure (floor space, energy, security) can decrease significantly.

Because of these difficulties in establishing the right business case with certainty, methods for estimating the cost of a migration to the cloud have been developed.

The solutions available on the market are all different and offer decision-making aids to the organisations that use them. APM (Application Portfolio Management) solutions such as LeanIX and Mega Hopex rely on the reporting provided by companies. Another possibility: inventory solutions

(Stratozone, Flexera, Azure Migrate, etc.), which do not just rely on reports but are also based on a scan of the network environment in production. This allows them to identify specific elements such as the type of version used, in order to determine the required infrastructure. However, these solutions do not deal with the applications themselves. On the other hand, this is what the solution developed by the above-mentioned Cast company (Cast Highlight + Cast Imaging) offers. It effectively deals with applications, providing an estimate of costs on the one hand and analysing ways of speeding up applications' transformation on the other. This analysis is based on the structural understanding of the software base and the information system³⁰.

5.3 IMPLEMENTING A FINOPS APPROACH

The FinOps approach helps the company to better understand the costs of the cloud and make the necessary compromises in a responsible manner. FinOps is a key strategic function that is still emerging in relation to the enterprise architecture. It keeps cost governance practices up to date by aligning them with the company's strategic issues.

The FinOps approach offers many attractive promises: low operating expenses (Opex), streamlined purchases, better control over cloud service providers, eliminated organisational silos, and a stronger relationship between the IT department and the financial services and business departments.

FinOps is an approach, an organisation and a tool to provide users with a view of what they consume in the cloud. At the heart of the cloud strategy, it is an instrument for optimising and making costs flexible and making them visible to the business units.

One Cigref member company has defined three pillars to characterise the fundamentals of this approach: inform, optimise and operate.

The "**Inform**" pillar is essentially based on the "showback as a service" approach, which consists of showing a billed view of the various infrastructure services, according to their consumption by the entities. To do this, you need to set up a map of uses and consumption. Today, the main difficulty is to anticipate pay-per-use. This vision is also integrated into the regular, more global reporting of the IT department.

The "**Optimise**" pillar is based on "chargeback", i.e. the re-invoicing of services consumed. Implementing this logic of re-invoicing infrastructure costs internally (at cost, without any margin for the IT department) helps business units realise the true cost of the services. Companies can have a pricing policy, allowing them to compare themselves internally with other companies or with public cloud providers.

This benchmark is a tool for analysing and identifying the most effective services.

The "**Operate**" pillar consists of improving the knowledge of existing FinOps practices within the Group, whether it be on the management of the private cloud platform or on its use of the public cloud. This knowledge is needed to find the right levers for optimisation, such as commercial negotiation, application sizing, waste, and server decommissioning.

Companies' experience with FinOps is very recent but growing and still generally relies on a reactive or corrective approach based on consumption data with optimisation after-the-fact. An appropriate

³⁰ For more information on Cast's tools, see the appendices.

FinOps organisation must also be found (see next chapter 6. Reorganisation of and changes to the IT teams).

Today, the main challenge is to see FinOps in a hybrid and multi-cloud way: the approach must sometimes support the strategy of independence from suppliers. A cross-platform view of the information system spend needs to be aggregated and automated.

Another challenge is to integrate FinOps into the design of applications from the beginning of the project in order to adjust the architecture model and processes. This FinOps-by-design approach should eventually cover both the existing base and the software in the cloud.

The companies all agree that, for the moment, no organisational model or tool appears to be well established. The market does not seem to be mature, especially for multi-cloud tooling. However, FinOps solutions are becoming increasingly sophisticated. Indeed, the costs of migration often exceed those of maintaining the system on-premises. Therefore, optimisation work through FinOps solutions is necessary and has been made easier by recent improvements.

The right FinOps approach can help get the most out of the hybrid cloud. It is therefore only natural that the subject has gained in importance in recent years.

Costing is often based on a FinOps solution, such as Densify, TSOlogic, Cloudeasier. Each solution specialises in something. Some focus on middleware optimisation while others are oriented towards a particular cloud provider. What they do is take the needs of the business and cross-reference them with the different offerings available on the market to help determine the ideal configuration for the business's transformation and finances.³¹

³¹ For more information on costing, see Cast's presentation and the notion of control loops in the appendices.

6 REORGANISATION AND TRANSFER OF IT TEAMS

6.1 CHANGE MANAGEMENT AND ONBOARDING EXECUTIVES

6.1.1 ONBOARDING'S CHALLENGES

The IT department may be confronted with reluctance on the part of teams who do not wish to move to the cloud or on the part of cybersecurity teams, who have very stringent requirements for migration. The difference between cybersecurity expectations for on-premises and cloud solutions is significant.

To meet these challenges, we must offer training, acculturation and support to make the project a success.

Migration can indeed be seen as an opportunity to reorganise production teams.

Changes occur frequently within teams, where an integrator may take over the management of the infrastructure, as does outsourcing, which will allow the CIO to increase the skills of the internal teams with a view to entrusting them with the operational management and running of the cloud, once the contract with the integrator has expired.

Overall, working group members mentioned the need to account for the cultural aspect of migration and stressed that it also concerns the shareholders, who can interfere in the migration project if they have a bad image of it.

6.1.2 RECRUITMENT AND TRAINING STRATEGY

Participants acknowledged the need for training. Teams need to be trained, but more specifically, in what? This question echoes the on-boarding of the business units.

Companies have a variety of ways it can give teams the opportunity to learn. It can ask the cloud provider or an integrator. It can also organise the training modules internally, or even train its service providers.

The main difficulty lies in setting up the training itself: it must be established and, above all, it must be "accommodated" in the already busy schedules of the teams. In the midst of a major transformation such as cloud migration, allocating time and funds for training can be a challenge.

When drafting a business case, this training time is sometimes counted as "non-productive" time. However, as Cast has pointed out, the learning that the company does over time is not negligible, so much so that it is taken into account in the company's tools. While the migration becomes more difficult during the project, the learning curve follows the same trajectory and contributes to a better migration performance.

Training requires the HR department to work on training techniques so that they are at a level suits the project the project and to provide the IT department with the means to support it over the long term.

6.2 CLOUD PROGRAM STEERING STRUCTURE

It is important not to think of - let alone present - a cloud computing migration plan as an IT strategy; in reality it is a **global business strategy**. This gives a more accurate and positive picture of this transformation, especially since all cloud computing projects have a business aspect.

To achieve their objectives, companies set up a cloud computing team to serve as both the core and the driving force behind the migration.

Some companies set up a "happy cloud team", a multidisciplinary team made up of IT, security and compliance specialists, lawyers, buyers, Ops and Devs. These people came from multiple entities and subsidiaries, some for the infrastructure, others for the Devs. This core team experienced the entire cloud migration and was given a role in communication. Regular communication is a key factor. This belief led the company to hold a series of events, bringing together the purchasing and legal departments and part of the management team so that the IT culture could be disseminated into the various teams.

Similarly, Cloud Business Offices (CBOs) or Cloud Centres (or CCoEs for Cloud Centres of Excellence) are set up to support the teams. The CBO brings together representatives of the affected entities in the company, including Ops, Devs, Security, and the business units, to obtain a clear mapping of cloud projects and to guide new requests through a qualification process. The CBO is also responsible for judging the suitability of proposed new opportunities or strategic cloud-computing pivots.

Additionally, the CBO offers training in the first reflexes and information relating to cloud computing (What is cloud computing? How can we use it?), while presenting the benefits that the cloud can offer the company. Enthusiasm remains moderate and an effort of involvement is required, but the Cloud Business Office helps to reach the business units. "Tech cafés" are held so that business unit teams can meet the IT department and ask questions.

Some companies like to talk about "pollination": the people most involved in the migration - the front runners - help bring the teams on-board in the transformation. This support is valuable, whether it comes from IT or from other parts of the company.

Underlying these meetings is the need to understand – teams need to know and be able to understand the roadmaps in the different strands of the cloud migration project.

6.3 NEW SKILLS AND NEW JOBS

To face the new challenges brought about by cloud computing, companies have set up training programmes to boost their teams' skills. In this way, job losses are avoided through a transformation of jobs.

6.3.1 CAN WE REALLY SAY THESE PROFESSIONS ARE NEW?

Remember, the emergence of a new job profile is the result of a process that takes about two to three years: initially, skills from specific practices appear in a disparate way in the existing profiles. Then, a consensus is reached on the definition of these skills. When a maturity is reached in one or other of

these skills and they require specialisation, corresponding profiles appear, with a consensus description gradually emerging. These can then be integrated into the HR Nomenclature³².

These professions are emerging in a context of new concerns, such as networks, which especially concern the teams: what impact(s) does migration have on networks, in terms of security, greening, capacity planning and costs? This aspect has become increasingly important in the projects.

However, it should be noted that the Cigref Nomenclature offers generic job profiles. Thus, in the 2022 version there is no specialisation in cloud computing, DevOps, SecOps, FinOps or infrastructure development. However, we can see that these specialisations are beginning to appear in a consensual manner in job profiles' skills. Although this is not yet the case, it is highly likely that in future versions of the nomenclature, Cigref's member companies will agree to define new professions related to these fields by consensus.

6.3.2 THE EVOLUTION OF "NEW PROFESSIONS" LINKED TO CLOUD COMPUTING

With the adoption of cloud computing, which has transformed the notion of service models (IaaS, PaaS and SaaS), some companies have had certain roles specialised in this technology. Among them, we can find:

- The Cloud Evangelist whose mission is to use storytelling to explain cloud computing. Their role is to raise awareness of the challenges that this technology presents to the company and explain the benefits of integrating it into the information system. They play an essential role at the beginning of any plans to move the information system to the cloud.
- The Cloud Architect applies architecture principles to the information system to integrate a cloud infrastructure, develop it, and eventually hybridise it with the existing infrastructure, so that this transformation meets users' needs. In addition, they can also manage the migration of the information system to cloud solutions.

Cloud computing has also given rise to new collaborative organisational processes between IT operations management teams (Ops) and teams specialising in certain areas, such as development (Dev), finance (Fin), security (Sec), CSR (Green) or cloud computing. We can speak of a culture "XOps": DevOps, SecOps, FinOps, and more recently GreenOps, and CloudOps.

For example, here are some of the practices adopted under the model:

- DevOps: integrates specialised applications and automates their deployment from end to end.
- SecOps: implements security in cloud environments.
- FinOps: aggregates consumption information given by cloud providers, analyses this information and looks for ways to control costs.
- CloudOps: orchestrates the specificities of different cloud providers, controls how applications function in a multi-cloud or hybrid environment.
- DevSecOps: integrates security into DevOps practices. In some cases, there may be different business unit participants that cover the same issue (e.g. trader/agency/mobile app security), and we can even talk about BizDevSecOps.

³² <https://www.cigref.fr/nomenclature-rh>

6.4 EMPOWERING DEVELOPMENT AND PRODUCTION TEAMS

Migrating to the cloud has an impact on the organisation of development and production: it is indeed very complex to maintain the organisation of the teams concerned between the time before and after the migration. Moreover, we must expect a form of reluctance on their part with regard to changing the organisation.

For example, there has been a shift in the roles of the "Dev" and "Ops" teams. Indeed, the migration invites us to rethink the how Dev and Ops roles are distributed. In addition to the dynamics of empowerment of development teams, this distribution leads those on the Dev side to fear job losses.

The concept of DevOps - a contraction of Development and Operations - consisting of the continuous development and integration of an application and operations, has revolutionised organisations by eliminating existing silos and increasing the agility of teams. With cloud computing, the responsibility of application development teams is greater. They have access to tools with many possibilities. For example, the run, for which the production teams were responsible, now requires maximum supervision on the application side: the development teams have an increasing impact on production. The activities continue to exist, but they are no longer carried out in the same "place" nor by the same people.

Similarly, some participants indicated that the purely technological part (definition of the landing zone, cohabitation of PaaS and CaaS, etc.) is no longer the prerogative of the operational teams. It is now handled by the development teams and the integrator.³³

Another example is the Continuous Integration/Continuous Delivery (CI/CD) chain³⁴ of on-premises solutions, which is now automated and should lead to fewer incidents in the future.

Another trend has been the replacement of DevOps approaches by BizDevSecOps (Business Development Security Operations) approaches, which is increasingly leading to business units and IT working together. These changes also entail an evolution towards a suitable business model.

Furthermore, the IT department must define rules (patterns) to avoid having as many development models as there are projects and integrators, leading to a very heterogeneous and uncontrolled environment.

In defining these rules, three objectives must be considered: a high-performance and efficient application architecture, security to meet the company's requirements, and a capacity for non-adherence to avoid being locked in with a supplier and allow reversibility, or at least application porting.

To make it easier to prototype and release new applications, one company created three types of accounts depending on the needs of the development teams:

- A "Sandbox" account: create a sandbox in minutes by providing a server and environment isolated from the corporate network and without corporate data.

³³ For more information on this topic, see the feedback in the appendices.

³⁴ CI/CD allows new features of an application to be deployed more quickly. It consists of two stages: CI, which aims to automate development operations as much as possible, and CD, which concerns deployment operations. CI/CD allows for an automated, simple and fast process consisting of several tests in short iterations. As a result, errors are detected very quickly, the production of applications is accelerated, as is the deployment of new features. It is therefore a process that serves the objectives of DevOps by reducing the time to market.

- A "You build it, you run it " account: create an environment managed by the development team itself, with infrastructure service supervision and an architecture framework. Some companies are adopting the philosophy of, "you build it, you run it, you own it, you pay for it".
- Managed account: provide an environment fully operated by the infrastructure department or the cloud skills centre.

In short, all the upheavals affecting the organisation of teams, roles and work processes must not be overlooked. To address the difficulties of reorganising teams, it is ideal to think during the migration about who will be responsible for what after the migration.

6.5 IN SEARCH OF AN OPTIMAL FINOPS ORGANISATION

Most companies are in the early stages of the FinOps organisation, and some plan to increase the size of the team depending on the optimisation capacity and profitability it brings. The teams are very motivated to optimise the applications because there are real savings to be made.

The role of the FinOps team is at the junction of many projects, and it is difficult to find the optimal positioning, especially for scaling. The FinOps team is usually transversal with the infrastructure and cloud product teams. It is located at the edge of the world of finance, purchasing and technology departments and the business units.

The FinOps team is made up of employees who often come from an IT background, who have an interest in finance and who want to grow. But it is also possible to find sharp management controllers with cloud computing skills. The knowledge and dissemination of FinOps knowledge can also be organised by communities with a "FinOps guild".

However, these profiles are rare and difficult to find on the market. Most of the time they are trained in-house with support from specialised companies. Today, profiles capable of doing FinOps by design with both financial and IT skills are rare on the market. FinOps is a business of the future.

Moreover, FinOps is a real opportunity to raise awareness among business units of the problems of cloud services, to make them understand the stakes and possibilities, and ultimately to reinforce the company's digital transformation strategy.

7 INCREASINGLY COMPLEX SUPPLIER MANAGEMENT

Managing supplier relationships is recognised as being increasingly complex, especially with the move to the cloud. The suppliers represent both the providers of cloud services - hosting and processing - and the entire ecosystem of software vendors and information system components.

It should be noted that the transformation of organisations and the training of teams is a prerequisite in relation to selecting and managing cloud providers.

7.1 STRATEGIC CHOICES OF CLOUD PROVIDERS

As mentioned earlier in the report, migrating to the cloud requires deciding whether to be multi-cloud and whether to implement a strategy across one or more cloud service providers. This choice is based on a number of criteria, starting with the strategic and sectoral positioning of the supplier and the company in question.

It seems that it is not so much the cloud services themselves or their pricing policy that distinguishes the proposals of suppliers, especially those of the hyperscalers, but other factors: business interests, especially their footprint in other sectors, their recognised capacity on one of the desired issues and their capacity to support companies. Providers are also chosen on the basis of their ability to meet data protection challenges in terms of security and compliance with legal standards and their level of deployment on an international scale.

Choosing a supplier is a strategic and structuring decision because of the long-term consequences on the information system's architecture: choice of technologies used, skills developed internally, control of dependence, etc.

Focus: the self-referencing trap

Between learning applications' architecture, the infrastructure necessary for their execution, the definition of the landing zone, the environment, the reservation of what the company needs according to the options (logging, business plan, organisation of the contract with the supplier), the whole is quite complex and produces **self-referencing effects**. Clearly, depending on the choices made, this implies that this or that modification may or may not be made.

Looking at the three major hyperscalers, Amazon Web Services, Google Cloud and Microsoft, it is beneficial to know the technical and non-technical strengths and specificities of the providers.

Regarding the market shares of these hyperscalers in the French market for public IaaS infrastructure services in 2022, Gartner has estimated that Amazon holds 38.9% of the market share and is therefore in first place, followed by Microsoft with 21.1% of the market share; Alibaba (9.5%) and Google with 7.1% of the market share and the strongest growth (63.7%).³⁵

³⁵ "Gartner Says Worldwide IaaS Public Cloud Services Market Grew 41.4% in 2021", June 2022, [Gartner website](#).

It is widely recognised that Amazon Web Services (AWS) offers very attractive infrastructure services but its competitive positioning in many sectors excludes it from bidding for some large companies, for example in retail.

Microsoft is known for its strong position in the professional software market, particularly in the office automation sector, which it has been doing for 40 years. This strengthens its reputation in terms of its technological performance, its presence in the ecosystem, and its large and qualified workforce to support companies. Microsoft has announced strategic partnerships with Amadeus, Axa, and Total Energies.

For its part, Google Cloud is chosen in particular for its data processing and cross-referencing capabilities and its more developed open-source approach than the others. Google is also proactive in proposing strategic partnerships, as recent announcements have shown with LVMH, Carrefour, and Renault. In terms of data protection, large French companies are especially interested in the trusted cloud offerings of hyperscalers (whether the "Blue" offering made up of the trio Orange, Capgemini, Microsoft, the Google & OVH partnership or the very recent Google & Thales partnership) and those from European players (cf. Cigref's Trusted Cloud Reference Document).³⁶ Details are provided in the appendices.

With multi-cloud computing came the concept of "CloudOps" – a contraction of Cloud and Operations – which manages operations across different cloud systems and to obtain a centralised and continuous view of all clouds. Some platforms are already offering to combine access to several cloud providers on request. Companies will also choose according to their own capacity and knowledge of certain suppliers previously selected for smaller scopes. Thus, large strategic partnerships are often extensions of previous agreements, although the choices may change. The aim is also to account for offerings from traditional IT vendors, nearly all of whom are in a "cloud-first" mindset, whatever their size. Publishers are currently investing in the development of new services in cloud environments, and it is commercially beneficial to encourage their existing customers to migrate their products to the cloud.³⁷ It is noticeable that some small and medium-sized publishers have not made their own migration, so their software solutions are not suitable for the cloud.

7.2 SUPPLIERS, OFFERINGS: HOW TO MAKE THE "RIGHT" CHOICE

One of the difficulties for large companies and public administrations that are preparing to migrate their IT to the cloud is finding the "right" supplier(s) and the "right" offer(s).

The right supplier depends on the company's expectations and specificities. The history of the information system is also important: depending on the choices made in the past, certain solutions will appear to be more appropriate than others (e.g. preference for Azure in the case of a Microsoft history). The choice may also be influenced by the nature of the migrations to be carried out (applications, infrastructure, data, etc.).

The question of maturity also comes into play here; if a company wants to become a multi-cloud provider, it must already have acquired a certain level of maturity. Failing that, the prudent choice for several participants is to turn to a cloud provider with which they already have some historical link. For

³⁶ Cigref Trusted Cloud Reference Document, updated 2022: <https://www.cigref.fr/cigref-publishes-its-second-version-of-the-trusted-cloud-reference-document>

³⁷ These topics are the subject of regular meetings between Cigref members and publishers within the framework of the Cigref Suppliers Relations Club.

example, a company that has been used to using Workspace for years will likely turn to GCP. This example is of course not a hard and fast rule, and it is quite possible to choose a different supplier than one with whom the company already has a contractual relationship.

While the stakes are high for the company, the choice of cloud provider should not monopolise its attention indefinitely: as one member points out, it is important to be able to move on to the implementation of the project and not have any regrets once the cloud provider has been chosen. The decision is the result of a careful evaluation of the offer, and wondering afterwards about the supposed opportunities of contracting with another provider is a waste of time that hinders the migration journey. (See Application Migration: Understanding its failures)

This is similar to the **Wrong Team** error mentioned above. As Gartner points out, companies are sometimes so blinded by its historical relationship with a provider that it considers only that provider for its cloud migration, to the detriment of other important criteria such as the experience of the provider.³⁸

The choice of offers is also a concern for organisations. This is because there are so many sub-services, options, and details to consider when choosing a cloud provider. However, this time-consuming analysis must be carried out before the right services (with the right level and ownership) have been provisioned for the developers to carry out the migration. The entry ticket to become truly industrial in the migration of all identified applications is therefore high.

7.3 NEGOTIATIONS WITH HYPERSCALERS

Suppliers and publishers recognise that we are at a major inflection point and that the initial choice of provider is critical, so they are running major campaigns to encourage migration to their cloud system. There is a real market war. They are investing heavily in marketing and business proposals. Faced with this, companies need to know their business model, the metrics used to achieve their commercial objectives and to identify ways of avoiding too great an imbalance around the negotiating table. It is necessary to build teams with multiple skills to find the right levers with suppliers and know the best practices.

Many organisations find that negotiating with hyperscalers to get a good pay-per-use offer is more difficult than getting good prices on reserved instances. This is particularly problematic when one of the very advantages of the cloud is its great flexibility, which conflicts with the principle of commitment to reserved instances.

When beginning the migration, there are two things to consider. The lack of a reliable estimate of the actual consumption of the service makes it difficult to project the number of instances that will need to be reserved. When adopting cloud services, companies often experience peaks in consumption that must be managed and then brought down. This is possible through FinOps tools (see dedicated section), hence the importance of starting training at the beginning of the project. Interoperability is also a major issue for user companies prior to migrating to the cloud and in discussions with suppliers (see section on multi-cloud). In discussions with hyperscalers, integrators can add significant value by bringing negotiating leverage, such as access to key executives, and through their previous experience.

³⁸ "Many I&O leaders select a migration partner based on familiarity or low pricing rather than experience." Gartner article cited above, <https://www.gartner.com/smarterwithgartner/6-ways-cloud-migration-costs-go-off-the-rails>

7.3.1 CHALLENGES ENCOUNTERED

It seems that integrators are progressing at the same speed as their customers on the field. Integrators are facing very high demand and a real resource problem, if only for skills and salaries. This problem is becoming more acute in the context of cloud migration; given the volume of demand, integrators cannot keep up. The high staff turnover contributes to the relatively slow learning process. Moreover, they build their expertise thanks to the knowledge they acquire in their customer feedback, but it is difficult to have completed experiences (let alone feedback) on cloud migration, especially in France, since projects are still fairly recent. The result is that a significant part of the workload for the development of the migration roadmap falls on the internal teams, which have a good knowledge of the application portfolio.

Cast's presentation

IT consultancies and hyperscalers: two different mindsets

According to Cast, implementation with hyperscalers and integrators has two main issues: Firstly, there is a difference in mindset between IT consultants and vendor experts. For the former, it is the expert who will bring the most value by compensating for or taking over limited solutions. For the latter, it is the solutions that provide the most value, with the consultants merely using the outputs provided by the solutions.

CAST has a more natural tendency to implement features that automate a maximum number of analysis tasks, whereas IT consultancies will be satisfied with continuing to do them manually, which is the very essence of their business.

Secondly, the other problem is the difficulties between the specialists (Docker, Kubernetes, etc.) who have trouble communicating even though they are working on more or less the same issues.

[More information in Appendix 4]

7.3.2 WAYS TO SUCCEED

Coordination between the integrator and the company and strong support from internal teams are key factors in the success of the migration.

One of the participating companies indicates that in their case, the integrator was economically involved in the cloud migration project. Clearly, they had as much interest in the success of the project as their client. At the organisational level, this translates into the integrator and the IT department "co-piloting" of the process in a "mirror" mode.

Feedback recommends carefully preparing the sprint 0 with the integrator. Sometimes, we can see that the sprint 0 was underestimated well after the fact.

7.3.3 THE TRANSVERSAL BENEFITS OF INTEGRATOR SUPPORT

Quality support from an integrator or even a cloud provider is an opportunity to make progress in the field of security.

In addition, when faced with obstacles, companies develop the ability to adapt and anticipate difficulties. Thus, some felt that the cloud migration cost presented by the integrator should be doubled to be more accurate. This precaution allowed them to manage costs more comfortably.

CONCLUSION AND OUTLOOKS

At the end of this second year of work and sharing, the subject of cloud is still rich in questions and perspectives.

Although the majority of companies have embarked on this transformation, there are still many questions, particularly about the support they can receive and the expected and real benefits of the migration. Indeed, several participants admit to having been disappointed by IT consultancies that were unable to avoid the hassles that come with cloud migrations. There are many reasons for this: integrators' staff often work with many other companies. This does not give them enough time to anticipate difficulties on a case-by-case basis. Similarly, the customer portfolio is so large that, when a risk occurs, it represents only a tiny percentage of the total number of users of the solution... which explains why IT consultancies do not necessarily highlight this flaw. In addition, the increase in staff turnover in IT consultancies means less knowledge is acquired through the work they carry out for/with their clients, hence the importance of **capitalising on knowledge on topics that will need to scale**.

As stated last year, it is up to CIOs to take on the subject of the cloud, especially since business units' managers are pushing for this choice. **Cigref's recommendation remains unchanged: we must continue to question the subject and its implementation collectively and proactively.**

Thus, the focus is on **knowledge capitalisation**. The members mentioned the idea of building a Knowledge Place, a knowledge automation system that would shed light on the use cases of companies that decide to migrate to the cloud (with the percentages of risks observed). An integrator could set this up directly, building on the results of its customers, compiling data and producing statistics to identify and warn of threats. Sharing this data with user companies would help them avoid the same malfunctions or falling into traps that these IT consultancies have already identified.

Issues of financing and return on investment are still latent, as the change in economic model (from CAPEX to OPEX) linked to the cloud is one of the most destabilising elements of the migration. As publishers sell more and more SaaS, the running costs are increasing and challenging IT departments, which are also pressured by general manager or finance to reduce its running costs.

Furthermore, throughout the working group's discussions, the key issue of dependency, the risks of confinement or loss of sovereignty remained a crucial strategic issue. Finding the most secure migration solution for organisations and their ecosystems is a necessity in the current geopolitical context.

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[Protection des données dans le cloud avec l'AFAI et l'IFACI](#), 2013

APPENDIX

Since the document presents the work of two years, we thought it useful to include all the feedback shared by the members to be able to see how organisations have changed and progressed in their migration projects. Thus, the feedback from the year 2020-2021 follows that from the period 2021-2022, presented below.

2021-2022 FEEDBACK

FEEDBACK FROM SYSTÈME U

U IRIS is responsible for Groupement U's IT and has nearly **500 application solutions** as well as **two data centres**. In 2020, due to the end of Cloudera on-premises support, U IRIS prepared to migrate its big data and business intelligence to the cloud. Aware of the level of maturity required to be "hybrid multi-cloud", it turned to its traditional partner, GCP. In addition, the migration of the core business information system will be gradual, following a **trajectory lasting until the end of 2028**, taking into account strategic business issues. The overhaul of the technological and methodological base began in 2020. The teams quickly became convinced of the strategy adopted: Google was involved in presenting the expected benefits. The business quickly saw the initial benefits of the big data migration: the reliability, response time, and results were beyond comparison with those from data centres.

Meanwhile, U started a Move2Cloud study to accelerate its transformation based on the study of **three scenarios** for the AS400 code transformation: code conversion (1), code conversion **and** lift & shift (2), lift & shift (3). Each is looked at on a cost-benefit basis.

The issue of code conversion is of particular concern to the group, which is waiting for a PoC (proof of concept) before starting, as the tools proposed so far are Base 100 and G4, for which there does not seem to be sufficient feedback at this stage.

On the cost side, while the closure of data centres is on the medium-term agenda, the ROI on this aspect of the project is low: it does not "pay for" the project. An ROI on the RUN is being estimated. Concerning big data costs on GCP, there was no "cost explosion", as might have been feared, undoubtedly because quotas per big data lab were set: if they are exceeded, the request is rescheduled for the next day.

The project is still ongoing: the data migration is underway, and the big data migration will be completed by the end of 2022. For code conversion, U is waiting for feedback from the first GCP tests with Converge.³⁹ Moreover, if a decision to accelerate the transformation was taken, it would be initiated by the whole group, not by IT alone. The observation at the moment is that the initial migration phase is very complex: between the emergence of new subjects (with the related learning and configuration needs), as well as the analysis of the services to be chosen and the issue of cost control, launching the project is a challenge. The benefits that Système U is already reaping could lead to new services for the shops, which would help predict promotional sales, for example.

³⁹ GCP and Converge signed a partnership for the conversion of AS400 code to GCP, with the first trials to be held between 2022 and 2023 in the US.

FEEDBACK FROM AIR FRANCE KLM

In 2019, Air France KLM embarked on a public cloud strategy: the project aims to streamline all private cloud and public cloud initiative projects, anchoring them in a Next Generation Data Centre (NGDC) programme. The programme started in 2020 with three integrators working in "mirror mode" to get the most benefits out of the migration.

The company has made a special effort in the area of application migration, focusing on security issues, CI/CD, service catalogues and how to place the various application transformations. According to the timetable, the project is ambitious: it involves migrating 300 applications per year, with charts by type of application. By 2021, most applications were opened, with each release migrating a number of eligible applications. In terms of training, the timeline followed the planned order of migration by training people whose applications were candidates before the transformation wave.

The business lines need innovation in the face of accelerating processes in the company and technical debt (AF KLM has very old tools in its IT system). It was therefore necessary to deliver a new technical platform and to set a clear ambition for the next four years by transforming massively to the public cloud. The M2C is intended to be both quantitative (everything eligible is migrated) and qualitative (avoid technical debt).

In order to do this, the group set up some golden rules:

1. Public cloud first,
2. First SaaS, then PaaS, then CaaS, then IaaS,
3. Cloud Ready Unless: we don't just lift & shift, we do L&S as a last resort because that doesn't solve the technical debt,
4. Cloud provider agnostic: the company seeks transparency above all,
5. Very limited engineering so you don't have to redefine or redevelop – the whole point of the cloud is that native things are used. This doctrine leads to a preference for cloud-native technology as soon as the need for a service arises.

Air France KLM relies on a transparent exchange with the different units of the company, whether through dialogue with the top management or communication with the teams. Three of the group's eight entities joined the IT department at the start of the project to have their applications installed on the new platform.

At the budgetary level, while significant gains are expected, the budget is ultimately larger than anticipated: in fact, several transformations have been blocked, making correction necessary. Since we are investing in value-producing business innovation projects, application migration should be too.

Cloud computing is a new way of cooperating. While the strategy is still under construction (the first version of the MVP will begin on the public cloud in 2022), the steps taken so far underscore the importance of shared decision trees so that decisions are taken together and take into account everyone's interests. The NGDC is a global project that must interface with other company programmes.

FEEDBACK FROM GRTGAZ

In 2017, GRTgaz, the main operator of the gas transmission network in France, launched a project to migrate its IT to the public cloud.

There were many reasons for this: obsolescence of data centre infrastructure, the desire to move away from outsourcing and have more control over the infrastructures, the need to control costs and reduce time to market for the business.

The company chose the public cloud and quickly adopted a multi-cloud strategy with the desire to completely shift part of its information system from data centres and avoid a hybrid data centre/cloud system.

At the same time, an organisational transformation of the IT Department occurred, switching from a "service mode" to a product organisation for greater agility while maintaining the same goal to control costs and reduce time to market.

A Cloud Business Office (CBO) was set up to ensure compliance and consistency with the cloud rules and best practices chosen by the company. It is also in charge of leading the FinOps, SecOps and operations communities. The Cloud Business Office is composed in part of the project team that created the base on the cloud, and managed the migration of applications.

At the end of the migration project, design and operations were handed over to the product teams ("you build it, you run it").

To keep cloud costs under control, GRTgaz signed two Enterprise Discount Programs (EDP), consisting of a contractual commitment to a volume of consumption of between one and four years, mainly dedicated to migration.

In addition, by working with an Amazon partner, GRTgaz obtained MAP credits⁴⁰ equivalent to 33% of its consumption during the move. The complexity, however, lies in the provider's obligation to obtain the partner's approval.

In addition to these measures, optimising how the platforms are used allows for significant savings: the cloud allows for on-demand consumption, and a machine that is switched off is not charged.

In fact, non-production environments are switched off, and pre-production is only switched on if necessary, since start-up can be initiated very quickly.

Only certain services, such as networks, operate continuously. Instance reservation and saving plans (specific to AWS) are therefore used as much as possible to optimise costs according to the range of use (up to 60%).

Two factors of success for the cloud migration project are the organisational transformation (product orientation, setting up pizza teams⁴¹), and the implementation of management 3.0. The deployment of the DevOps approach, which is still in progress, is facilitated by the use of public cloud systems.

At the team level, there is no longer a production team as such, and the management of cloud environments has been delegated to the product managers. GRTgaz has undertaken an internalisation plan so that almost half of the CBO team is made up of in-house staff. The company has focused on training its staff in FinOps and cybersecurity, which are handled internally.

⁴⁰ MAP = Migration Acceleration Program

⁴¹ A multidisciplinary team of eight people according to a method popularised by Amazon for optimal IT project development.

Their way of working has also been affected, since the migration has helped to reduce the number of manual tasks and automate as many actions as possible.

For development, the choice of catalogue follows the "best of breed" rule. This method is supervised to ensure the IT system remains coherent as a whole and to avoid risky and costly choices or having too many tools. A community made up of reference architects from each profession approves the choices.

At the end of 2021, the project will have been completed, and five years after the start of the migration, the company estimates gains of around 10% on the complete costs of the migrated scope.

It should be noted that an important source of gains is the use of open source, managed software to replace licensed products, especially databases.

The cloud, which allows the company to know exactly what it is being charged for, has led to a reduction in running costs through a holistic analysis of direct and indirect costs. Half of the project costs are investments in the base, and the bundle⁴² per application is more or less respected, allowing for savings on applications when they can be rebilled.

Again, there are some savings, but these could have come from the data centres, although the project is quite positive at this stage.

⁴² A bundle is a set of applications that can be grouped together in the software catalogue.

CAST'S PRESENTATION

Introductory remarks: since WGs are in principle only attended by members, Cast's presentation is an exceptional event. Historically close to Cigref, their participation in one of the working group sessions was unpaid.

Who is CAST?		
<p>CAST is the pioneer and leader in software intelligence. CAST provides insight into the structural state of software assets. CAST's technology is called the "software MRI" – the most accurate on the market. It provides directly actionable information on software composition, architecture, structural defects and quality levels, cloud-readiness levels and the legal and security risks of open source. This information is crucial to speed up the modernisation to the cloud, increase the speed and efficiency of software engineering, increase control of open-source risks, and perform technical due diligence accurately. CAST has a global presence with operations in North America, Europe, India and China. It is both a publisher and a consultancy.</p>		
<p>Its solutions include CAST Highlight for rapid analysis of a portfolio of applications and CAST Imaging and CAST Dashboards for in-depth analysis of critical systems using comprehensive reverse engineering, which helps to build an IT modernisation plan.</p>		
Cast Highlight	Cast Imaging	Cast Dashboards
<p>Very fast analysis</p> <p>Checkpoints:</p> <ul style="list-style-type: none"> • Application health (robustness, scalability, complexity), • Cloud-readiness level • Open-source risk: an exhaustive search for all components that can be embedded and the related risks of cybersecurity, intellectual property, and obsolescence. 	<p>In-depth analysis</p> <ul style="list-style-type: none"> • Full reverse engineering, • Precise visibility, <ul style="list-style-type: none"> ○ Links between applications ○ Layer cohesion ○ Dependencies <p>Indication: refactor and rearchitect</p>	
<p>Indicators: Cast has developed a number of indicators that summarise the factual elements resulting from the structural analysis of applications for use by IT decision-makers. Two indicators address the cloud issue: One is the "Cloud Readiness" indicator, and the other is the "Cloud Stickiness" indicator.</p>		
<p>How does it work? Cast's tools provide a visualisation of the information system's software architecture and of each application. In a cloud strategy, they are used in two stages:</p>		

- 1) Assessment of migration effort: CAST uses a three-step method to calculate the migration effort: sampling, calculation of the effort for the application types in the sample, and then the definition of the methods that will be used to extrapolate this to the whole migration portfolio. This method is the most accurate on the market because it takes into account the elements of code, architecture and the overall sum of the efforts.
- 2) Use of CAST solutions throughout the project to accelerate the migration and transformation of applications. The solutions identify what could block migration, provide the references that identified each blocker, and even recommend the right managed services for the situation.

A factual and detailed view of the information system's structural elements helps you make the best decision: rehost, refactor, rearchitect, or even rebuild.

However, solutions are not sufficient on their own: the **human expertise** of the company and Cast must be combined with technology for an optimal result.

Cast and cloud providers: Cast is increasingly working with suppliers, who pay for their customers using the tools. Cast was commissioned by Microsoft to measure cloud readiness towards Azure, and later this system was also developed for AWS, IBM Cloud and finally GCP this year.

2020-2021 FEEDBACK

FEEDBACK FROM AMADEUS

Amadeus is a large European company of crucial importance in international trade. In 2019, it carries 2 billion passengers, representing 50% of global traffic. Its core business is travel distribution using a two-sided platform between providers (airlines, hoteliers, tour operators, car rental companies, etc.) on the one hand and travel agencies on the other. In SaaS mode, Amadeus provides technological solutions to airlines (reservation systems, inventory, yield management and boarding management), hotels (reservation, reception), and airports (gate and passenger flow management). In the summer of 2020, after a period of experimentation, Amadeus decided to migrate its entire IT to the public cloud. In 2016, the IT department decided to set up a private cloud, experiment with the public cloud, work on Kubernetes and prepare the application for the transition to cloud technologies. Through the implementation of the private cloud and the use of the public cloud, Amadeus has become aware of the level of sophistication of the three hyperscalers and their level of technological mastery, which is superior to many other companies. Three important challenges tipped the scales towards a hyperscaler: the requirements of data processing localisation, latency and response time, and maintaining their technological leadership in the face of competition.

Amadeus stores and processes data for all of its customers at its data centre in Bavaria, Germany. This situation is becoming complex to maintain since many clients are beginning to have data processing localisation requirements, either due to national regulations or their strategies. In terms of latency, customers often require a response time of less than 10 milliseconds. The company manages what is known as "heavy transactional", i.e. about 100,000 user transactions per second (comparable to Google). Amadeus has to manage very demanding SLAs (Service Level Agreements) of 99.95% with its customers and sometimes contractually approaches 99.99%, excluding planned maintenance. The services' response time is what makes it stand out for its customers and can therefore be translated into market share gains, but this requires global coverage, which only hyperscalers can offer. In terms of technological leadership, buying the hardware required to maintain the calculation centre is becoming complicated. The major cloud providers are becoming increasingly efficient by using very high-level proprietary hardware (ARM processors, for example, offer a 30 to 40% performance gain), combined with a technological gap in the network.

The company issued a call for tenders for a seven-year IaaS migration contract with a three-year migration period. It wants to outsource at least 50% of the volumes to a single cloud provider under a worldwide contract as a 'partner'. This comes with a number of conditions to be negotiated regarding Service Level Agreements and Objectives (SLA/SLO), a guarantee on data localisation, encryption mechanisms, jurisdiction, audit rights, compensation in case of problems, migration credits to compensate for temporary double hosting, dedicated support for implementation without having to resort to an integrator, and the establishment of a real partnership to propose new services and offers together. In the end, Microsoft was awarded the contract⁴³.

⁴³ Amadeus and Microsoft form strategic partnership to drive future innovation in travel - 2021: <https://amadeus.com/en/insights/press-release/amadeus-microsoft-strategic-partnership-drive-innovation-travel>

FEEDBACK FROM AIR LIQUIDE

In 2013, the Air Liquide Group launched a major transformation of the entire Group's infrastructure. Supported by general management, this infrastructure globalisation programme was presented as a way to drive competitiveness and agility for the company. The aim is to have infrastructure seen as a value centre instead of a cost centre. Continuous innovation leads to a more resilient infrastructure and improved security of IT systems. Technical debt has not been the major factor in adopting cloud computing, since the company tends to isolate legacy environments.

That year, the company began to structure its then-decentralised teams, which led to the creation of the Global Infrastructure Office (GIO), which employs 200 people and handles managed outsourcing contracts for the cloud. GIO operates a large part of the infrastructure. The entity manages a private cloud system through an outsourcer with a variable cost approach and has adopted an initial public cloud strategy with a preferred partner (AWS). At the beginning of the transformation, Air Liquide also co-built a new operational model with an IT consultancy because the previous one was unsuitable for cloud computing and the "migration factory".

The GIO chose not to implement a Cloud Management Platform (CMP). A CMP offers business IT departments, which are less "knowledgeable" than the GIO, access to all services on a self-service basis. However, the software overlay of the CMP may hinder the use of services. The GIO has therefore overseen the creation of a catalogue of services and set up a portal for CIOs to provision the desired infrastructure bricks, whether they are in the private or public cloud.

In 2017, Air Liquide decided to speed up its move to the public cloud after a major study on the benefits of the public cloud and in particular AWS. The GIO took the decision to create a cloud expertise centre to have both the right intrinsic skills and the right mindset. 2018 saw the scaling up of the strategy with the migration of the historical IT infrastructure from the Asia-Pacific region and then North America. Air Liquide chose to do 95% lift & shift as a first step, and then realised that they needed to transform applications to generate savings and improve performance.

The GIO set up a migration factory with two options: either the private cloud or the public cloud. Gradually, adoption spread throughout the company thanks to the action of cloud evangelists: the benefits of cloud computing have been demonstrated, the Total Cost of Ownership (TCO) is reduced, so emulation begins. In Europe, 30% of applications in the public cloud have been reworked by replatforming. This allowed us to begin the software transformation. About 5-6 applications are redesigned to be cloud-native out of more than 200 applications, the others are refactored instead.

Air Liquide has implemented FinOps best practices on their own, relying on tools such as Aptio and reports such as Power BI to have full control of costs with respect to the cloud and the business units. Consideration should be given to tools for scaling up, for automating compliance and non-compliance detection and for enabling self-correction.

The hybrid cloud strategy that combines the use of several types of cloud resources (private/public) will have to be maintained for some time since some applications are not portable. Often it is possible to switch to a new supplier after a new tender, but sometimes it is still impossible. The company continues to explore all options to make the most of the possibilities offered by cloud computing in order to remain competitive.

FEEDBACK FROM SODEXO

Sodexo, a global leader in quality-of-life services, made its first move to the AWS cloud in 2014. Since 2018, the Move to Cloud programme has been structured around a major partnership agreement with Azure15. Today, fairly large applications are hosted on Azure, which is also used for IoT, big data and analytics. The cloud is turning the technologies in data centres into commodities. This brings agility, speed, scaling, and true evergreen automation of updates.

With more than 100 million consumers served every day in 64 countries and 420,000 employees, Sodexo has approximately 35,000 sites, most of which are client sites. The company has the particularity of having a history of multiple, diverse and autonomous entities with a decentralised organisation. For several years now, the IT department has been aiming to reconsolidate local applications within standardised and centralised data centres.

In the cloud migration strategy, one of the objectives is the recentralisation and standardisation of systems to generate economies of scale. Since September 2019, the IT department has encouraged this globalisation and taken the decision to centralise the budget. This has resulted in an identical Total Cost of Ownership structure for all countries and economies of scale in operations.

In autumn 2018, IT teams embarked on an application evaluation grid with several possible options for applications: (1) migrate to Azure cloud, (2) migrate to a global data centre, (3) replace with a global application, (4) replace with a SaaS application, or (5) decommission. More than anything, the migration has been a chance to take stock of the gigantic software base and estimate the number of applications to be decommissioned.

Other drivers are also speed of development and production, environment creation (time to market) and safety. The positive impacts on IT security are very important but very difficult to quantify.

Sodexo's IT teams have found that the lift & shift option is very difficult for some applications, since there are network flow as well as architecture, security and environmental issues. Indeed, sometimes the company has only one production environment, whereas migrating to a cloud system necessarily creates several, which is necessary, more secure but also more expensive. Certain rules are required to do a minimum of re-engineering of all applications to make them "migratable". The IT department needed to define the application's existing architecture before migrating. So, it was necessary to recreate documentation and reassess the application's risk of criticality for support as well as for rules towards Azure.

The company requested several types of support from Microsoft. Microsoft provided expertise on tools and products, but the operational, skills and FinOps are provided by Sodexo's internal teams with the test & learn approach.⁴⁴

⁴⁴ Sodexo and Microsoft announce global partnership to improve facility management intelligence
<https://news.microsoft.com/europe/2018/09/25/sodexo-and-microsoft-announce-global-partnership-to-improve-facility-management-intelligence/>

FEEDBACK FROM STELLANTIS*

In 2018, the ex-PSA Group chose to use the cloud for new applications, primarily to gain agility, flexibility and time to market. The aim was also to benefit from new technologies, particularly for data processing. They chose a "PaaS first" approach to take advantage of the functional and productivity benefits of managed cloud services. Finally, the group wanted to benefit from the global coverage of the cloud to deploy its information system internationally.

After a slowdown in activity in 2020 due to the COVID-19 crisis, an acceleration in the adoption of cloud computing was expected in 2021, with the posting of a "Cloud first" strategy for new developments.

The Move to Cloud programme of the former PSA Group was set up to organise a global strategy and to provide a framework for the growing number of development and deployment initiatives in the public cloud. Its aim was to clarify the objectives and define the guidelines for using the public cloud and to steer its adoption in all its components: technical, economic, organisational and skills-related.

As part of this programme, the IT department set up a multidisciplinary team involving all the business units concerned to manage this change. A monthly committee with the CIO and their team has been in place since the beginning – and continues to this day – to steer the project and make the necessary arbitrations. Regular updates are organised with the main cloud providers.

Cloud computing has numerous and varied impacts. One of the main ones concern enterprise architecture and data architecture. Where the company had, like many others, built a centralised and unique vision of its data lake to develop data projects based on cross-using data from different domains, cloud computing uses a centrifugal movement to distribute data in different clouds and different locations, potentially far away.

The challenge now is to continue to provide a unified view of this distributed universe of data, in other words to build a distributed data lake in the cloud through a so-called "data mesh" architecture. The challenge is functional (data governance) and technical (overcoming distance and latency). Several pilot projects, based on different concepts and technologies, are underway.

() This feedback is from the PSA Group, at the time of the creation of STELLANTIS. STELLANTIS' cloud policy is now built on convergences between the ex-PSA and ex-FCA strategies.*

FEEDBACK FROM SYSTÈME U

Groupement U is a large-scale food retailing cooperative with strong local roots, governed by three entities: U Enseigne coopérative, U Logistique, and U IRIS. U IRIS is responsible for all IT resources, including design, development, integration, hosting, operation, infrastructure and security.

The ambition of the IT transformation is to respond to future challenges with e-commerce, new modes of consumption, the personalisation of customer relations, the evolution of the distribution market, the automation of production methods, and prediction in supply systems. The business units have built a strategic plan to renovate the software for central and shop sales management, logistics and procurement.

Système U adopted a cloud migration strategy fairly recently with a pragmatic preference for SaaS solutions. The decisions of the IT department are guided by the value brought to the business, reactivity and time to market. The company has chosen to make the most of managed services with

cloud first, SaaS and then PaaS and to offer them through a catalogue of cloud services, not necessarily migrating its entire infrastructure to the cloud.

U IRIS thus positions itself as a cloud service provider for the company: a "cloud broker" for internal customers. It is a hybrid cloud strategy by nature, but it is also a choice because the current information system is resilient with a very good quality of service. The IT department will carry out a functional breakdown of the information system and use API and micro-services to open it up. It will also move new applications to the cloud when there is a business interest, as well as performing containerisation, including in the data centres.

The company faces two major challenges. First is FinOps, which is seen as an additional cost with a real challenge in quantifying the benefits of the cloud and reorganising and training teams, which is needed from the start to avoid a two-speed information system. Additionally, there is a balance to be struck between having multidisciplinary skills in the teams and spreading them throughout the company. U IRIS chose Google's cloud platform for several reasons: the very good image of Google in the company after the deployment of GSuite, the potential for containerisation with the automation of all deployments via the Terraform tool, the implementation of a Kubernetes project associated with the migration project, as well as the launch of a major data project. Since Google Cloud Platform is based on more open source standards, notably PostgreSQL, this opens up the possibility of repositioning in the future.

As part of its Data strategy, U IRIS wants to create a central access point for conducting analytical, AI and other work, consolidating all the data it handles and making it accessible so that the business units and brands can use it themselves without depending on IT. In 2016, the creation of a big data system helped to open up the raw data (with dedicated tools) to the business units. From 2019 to 2021, the business units have successfully adopted the platform. But the current analytical platform is cumbersome due to an overly rich ecosystem, excessive recovery times, redundant SQL solutions, and costly data cross-referencing with the BI system.

At the end of 2020, U IRIS launched its Data.Next programme to migrate these two platforms to the cloud, which allowed for a comparison of the Big Query and Snowflake solutions, both of which are highly valued by their respective customers. Google presented the Big Query roadmap with interesting key features and also proposed a device for securing the project build, with a steering system by the GCP board. The IT department decided to migrate the big data and then the BI system the following year, using the capabilities of a dedicated internal team.



Achieving digital success to help promote the economic growth and competitiveness of its members, who are major French corporations and public administrations, and users of digital solutions and services

Cigref is a network of major French corporations and public administrations set up with a view to developing its members' capability to acquire and master digital technology. It is a unifying player in the digital society, thanks to its high-quality thinking and the extent to which it represents its members. Cigref is a not-for-profit body in accordance with the French law of 1901, created in 1970.

To achieve its mission, Cigref counts on three business units, which make it unique.

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