Cigref

Strategies for migrating IT to cloud computing

A strategic adventure for enterprise

November 2021

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EDITORIAL

Today, “cloud computing migration” is at a major inflection point. Indeed, all companies have already experienced this in one way or another, whether through proactive approaches (asset migration) or through the growing use of services hosted on cloud computing platforms (SaaS in particular). But there is consensus on one point: it is indeed a technological, organisational and financial transformation with many consequences for IT.

Adopting cloud computing is a crucial strategic decision. Many elements are currently converging with a rapidly growing market, increasingly mature services, technical standards and well-equipped integrators. The dedicated Cigref working group has identified multiple motivations for moving to cloud computing, such as responding to strong business expectations, accelerating time-to-market, reducing technical debt, promoting agility, scaling up and overhauling working methods. However, there are also obstacles, including the migration budget and the measurable benefits, the human resources required, the uncertainty as to the long-term consequences, and security.

This migration phase must be approached proactively so as not to be on the receiving end of it, since it is a “small” revolution that is shaking up roles, organisations, skills, business models as well as the working methods of the production, network infrastructure and development teams.

Every company is a different case, and there is no one migration model. The answers to the many questions that companies face are not yet clear.

Although we must admit that the technology is mature and that there is little doubt about the requirement to be “cloud ready/cloud native” for the new solutions that our companies develop or integrate, the fact remains that, for existing assets that are often still hosted on proprietary infrastructure and data centres, the path from design to a complete, economically successful, high-performance execution is a challenging one.

Due to their historical IT, most large companies actually apply hybrid strategies. To benefit from cloud technologies, they can choose to build and manage their own private cloud, select an outsourced private cloud (managed by providers) or migrate to the public cloud.

The question that arises is to know what the benefits are and how to get there. The scope (software and data) and the nature of the software migration to be carried out must be chosen.

The working group noted a significant gap between the ease of execution promised by the ecosystem, particularly the suppliers, and the reality of implementation for large French companies and administrations. Each company must chart its own path according to its culture, its heritage, its challenges, and its resources. It is unique with a complex decision tree. The risks during migration are critical: if the “why?” comes before the “how?”, it is because we have to understand and justify the “why” in order to optimise the “how”.

One of the choices to be made is the technological partners and the technological, commercial, legal and contractual arrangements they offer. This is a strategic and structural choice for organisations. There remains a goal to be independent from cloud providers, and the ability to switch from one hyperscaler to another is an objective. Within the framework of the working group, this ambition does not appear as the top priority, because we first we actually need to migrate to cloud computing. We must also prepare for the arrival of “sovereign” solutions now offered by hyperscalers in association with European technology partners as well as trusted cloud offers in Europe.

In short, these are all subjects that our working group wished to address. We consider that the group should be extended because these migration projects are ongoing and will soon deliver a lot of lessons from which to learn.

To conclude, we would like to thank all the speakers and participants who contributed to this study. We hope you enjoy reading this presentation of the conclusions of the working group that we co-coordinated this year.

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

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OVERVIEW

Cloud computing is no longer just a subdomain among others in the digital sector, it is now the one that controls all the others. The cloud offers advantages in terms of flexibility, efficiency, security and scalability. All fields of digital innovation—artificial intelligence, IoT, edge computing, industry 4.0, to name but a few—are now being shaped in cloud computing environments. The latter will become the essential foundation for the information systems of companies and public administrations in the coming years.

So, large companies and public administrations are currently in a period of transition. The Cigref working group estimates that most companies will have moved to the cloud in five years' time. Several aspects encourage this take-up, such as speed of innovation, cybersecurity, globalisation, technical obsolescence, scaling up, and environmental demands.

Most companies say that the transition to cloud computing is considered for business issues first, such as agility, time-to-market, technology, and method. Migrating to the cloud is also an opportunity for companies to tackle technological challenges, map their software bases, process some of their technical debt, better secure their information systems and optimise their networks.

Nevertheless, there is a real difficulty in estimating, evaluating and monitoring the cloud transition programme in a financial sense and then monitoring cloud services' consumption. Cloud computing presupposes a radically different financial model from the traditional investment in a data centre, which is a model that is not managed in the same way. Finalising the business case to switch to the cloud is a real challenge. Cloud computing's contributions to responsiveness and time-to-market are difficult to measure financially. In addition, service consumption can quickly become very significant and complex to understand, making a FinOps approach necessary. Globally, the ecosystem collectively still lacks perspective on the success and economic gains that can be achieved by migration.

The transformation brought about by cloud migration is also shaking up organisations. This requires a reflection on how the teams can progressively take ownership of the issues, opportunities and challenges and how digital departments can reorganise their activities. Cigref member companies see the need for new business units and skills. They can foresee a profound change in how IT teams will function in the medium term.

In addition, the choice to migrate to cloud computing and the methods for doing so are structural for IT. Knowing the technology partners and suppliers is necessary in order to be able to make informed choices. A balance must be found between the economic, legal and technological advantages, gains, risks and impacts that these choices, particularly the choice of partner, can have for organisations.

Finally, this transformation is accompanied by the development of new ways of working, based in particular on a test & learn approach. Companies must undergo a change of mindset and overcome a long learning curve to address all the questions and aspects of cloud computing. This is why they especially need to learn from each other's experiences.

This working group demonstrates that there are many migration paths to cloud computing, with many starting and end points. This report offers a review of the major questions that Cigref member organisations are currently asking themselves about migrating the existing IT to the cloud.

INTRODUCTION

A FEW DEFINITIONS

Initially, cloud computing was a technological solution, but how you define it depends above all on how you use it. Some will have a "service" understanding of cloud computing, while others will approach it from a "technological" viewpoint. The first will think of "user applications and services"; for the latter, it will be "infrastructures and data centres". The two are obviously linked, but the functions, 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 makes it possible to pool system maintenance and benefit from pay-per-use invoicing. This helps to optimise resources and costs while allowing IT teams to focus on value-added tasks.

In the 2015 Cigref report[1], Cigref defined four fundamentals for the cloud:

1. A cloud is always a virtual space that can be on one or more physical media,
2. Contains information that is fragmented,
3. These fragments are duplicated and spread (or distributed) over this virtual space,
4. Has a "console (or program) of restitution" that reconstitutes the information.

The provision of tailored cloud computing services makes it easier for the user to understand, use and upgrade infrastructure or software and adopt standard solutions through SaaS. The IT architecture then becomes more flexible and resilient, making it possible to deliver "agile" services ("Business as a Service") and, therefore, to innovate and open up more easily to their ecosystem.

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

- **Data centre**: a physical site that houses IT equipment such as servers, routers, switches, and hard disks from one or more companies, responsible for storing and distributing data through an internal network or via the Internet.
- **On-premise**: the use of the company's IT equipment for its own systems and applications.
- **Internal private cloud**: an implementation of cloud computing technologies in an infrastructure over which the company has control, whether in the company's data centres or in a collocated data centre ("outside in").
- **Outsourced private cloud**: the use of cloud computing technologies made available by a supplier without sharing servers between clients.
- **Public cloud**: the use of cloud computing technologies provided by a supplier who offers almost infinite pooled and standardised resources throughout the world.
- **Trusted cloud**: the use of cloud computing technologies that meets technical, technological, legal, inspection, security, reversibility, portability, interoperability and transparency requirements imposed by the market and public authorities (see Cigref's Trusted Cloud Reference Document[2]).

[1] Cigref report: "*La réalité du Cloud dans les grandes entreprises*" (The reality of cloud computing within major companies), 2015, https://www.cigref.fr/rapport-cigref-la-realite-du-cloud-dans-les-grandes-entreprises (in french)
[2] Cigref Trusted Cloud Reference Document, 2021: https://www.cigref.fr/cigref-publishes-its-trusted-cloud-reference-document

- **Hybrid cloud**: the use of several cloud computing resources, internal and external, private and public.
- **Multicloud**: the coordinated use of several public cloud computing providers according to needs and functions.

THE CURRENT CONTEXT

Cloud computing is no longer just another sub-domain of the digital sector. It is now the sector that controls all the others and will become the essential foundation for companies' and public administrations' IT.

Large companies generally seem to have started using public or private cloud computing in the years 2012-2014. In 2017, a new wave of companies took on the issue. Today, all of them have projects and are considering scaling up all or part of the existing IT.

Before the crisis, the firm Gartner predicted a 17% increase in cloud computing revenue in 2020. Collaborative tools are increasingly making use of cloud computing, a trend which accelerated during the COVID-19 crisis, which will probably increase take-up of SaaS, an integrated solution operated through cloud computing, as well as infrastructure services (PaaS and IaaS) depending on organisations' needs. The cloud computing market is growing with the involvement of many players in the different areas of expertise needed for cloud computing adoption and migration. Also, according to Gartner, cloud computing's value and the reasons driving companies to adopt it should hold up over the long term.

The COVID-19 crisis has revealed the great need for flexibility in IT's running costs. Companies that have already migrated a large portion of their software assets have shown greater resilience in the face of this need for flexibility and scaling, especially in the context of widespread remote working. These solutions' technical maturity has been proven on a large operational scale thanks to numerous developments in cloud computing technologies in recent years. The crisis has also highlighted the need for cost variability based on the needs at a given time: cloud computing claims to contribute to this through its pay-per-use model. Nevertheless, there was much feedback that reported that customers were accepting minimum commitments in order to get better rates.

THE WORKING GROUP'S CHALLENGES

Today, migrating to cloud computing is a technological, organisational and financial transformation, with many impacts on companies' IT. They are asking many questions about how to approach this decision and the consequences of the choices cloud computing implies.

Most companies already have a foot in cloud computing through multiple services, starting with video conferencing and, increasingly, messaging and collaborative tools. In addition to choosing direct cloud-computing solutions in SaaS, companies are also embarking on the transformation of their IT infrastructure using the IaaS and PaaS layers. This brings new complexities and situations to be managed.

This is why Cigref has set up a working group (WG) on the subject in order to share findings, reflections, and questions between IT department teams. This group was interested in migrating all or part of large organisations' IT equipment, particularly the existing IT (often referred to as "legacy"), to the cloud. We sought to understand the challenges and risks presented by the path from the current situation - with on-premise infrastructures - to the company's desired cloud computing situation. This concerns the migration of development platforms and the own or third-party software base to the cloud, whether internal, outsourced or public.

We chose not to cover the issues around data and industrial tools, and simply touch on those arising from SaaS. Indeed, business units are the ones who first steer the decision to use SaaS. The options are also very dependent on the supplier; Cigref has discussed the opportunities and challenges of this for several years (via its Supplier Relations Club, in particular). It should also be noted that SaaS is increasingly the only way publishers provide their solutions, since they no longer maintain their on-premise solutions.

This report's objective is to offer a vision of how to migrate existing management IT to cloud computing by summarising the testimonials from Cigref management organisations. It is therefore mainly intended for CIOs and IT department teams considering a cloud strategy. More generally, it will interest anyone who wishes to know the overall state of play of this issue in large French companies.

1. WHY MOVE TO CLOUD COMPUTING?

1.1 ORGANISATIONS HAVE MULTIPLE MOTIVATIONS

The organisations represented in the working group generally identify three reasons to adopt cloud computing: business, security and obsolescence reduction. Since the financial gains are difficult to demonstrate (see chapter 7), migrating to cloud computing is justified by other, more strategic issues.

Here is the list of the main motivations for moving to the cloud:

- Respond to new business challenges and pressure from business units,
- Gain in agility, responsiveness, flexibility and time-to-market, deployment at scale,
- Benefit from new technologies and packaged services, especially for data,
- Obtain global coverage and geographic replication,
- Harmonise and centralise systems to achieve economies of scale,
- Secure the IT,
- Reduce technical debt by using the managed services and automation tools offered by cloud providers,
- Streamline its data centres and infrastructure,
- Adapt to variations in business (peaks and troughs in activity),
- Promote new working methods for agile IT teams,
- Build business platforms[3] and open up potential for innovation.

This strategy has impacts which will be detailed in the report:

- Value solutions financially and optimise IT costs,
- Take advantage of technological opportunities that can offer the chance to perform a widescale inventory of the IT,
- Allow development teams to be self-sufficient in environment configuration and production releases,
- Develop the organisation's future hosting strategy (the future of the internal data centre and private cloud),
- Develop network topologies: abandonment of MPLS, deployment of SD-Wan, Zero Trust strategy.

1.2 ORGANISATIONS' STRATEGIC MUTATION

The decision to migrate to cloud computing is a strategic transformation where "going back" is very complex. That is why it is necessary that the whole organisation be aware and understanding. This choice must be understood and supported by top management and business units. It takes a minimum of maturity to do it, but a company cannot "buy maturity".

Migrating to cloud computing induces many very significant changes, whether in governance, architecture or organisation, which incur significant transformation costs and require time to prepare and adapt. It is

[3] Cigref report: New platform strategies, December 2019, https://www.cigref.fr/new-business-platforms-strategy-design-deployment

a programme that happens over time. However, certain steps of migration must be executed quickly in order to obtain the desired benefits.

You have to find the right balance for each organisation. Each company is a unique case when it comes to migrating to cloud computing, given its organisational history and software base. There is no “one size fits all” migration model.

1.3 SOME IDENTIFIED HINDRANCES

There are several hindrances—which can turn into obstacles—that can prevent organisations from fully adopting cloud computing. The issue of guaranteeing and protecting assets from both a legal and technical standpoint is a chief concern.

Among the main hindrances and obstacles identified in the working group:

- Executives’ understanding of the challenges of cloud computing,
- Regulatory requirements (operators of vital importance),
- Exposure to extraterritorial laws when choosing an international supplier,
- Privacy of the company’s data,
- Protecting technological and industrial secrets,
- Expected economic performance,
- Cloudification of critical systems (for example, industrial IT),
- Required investment (time, means, resources) for gains that are yet to be demonstrated,
- Arbitration and prioritisation of projects,
- Imbalance in relations with major suppliers,
- The organisation’s internal maturity: human resources, skills.

It is a matter of anticipating and evaluating the risks faced with the challenges of strategic autonomy. In addition, the complex migration process can be a blocking factor for deployment. In addition, we have to navigate in an ecosystem that is still finding its feet and evolving. Finally, the feedback shows the complexity of the cloudification of critical systems, which, for some participants, seems to be really new, including for hyperscalers.

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

Thus, in some companies, the data centre can be operated only by internal employees in order to control security and protect “core business” know-how and intellectual property.

2 HOW TO SWITCH TO CLOUD COMPUTING?

2.1 SEVERAL POSSIBLE STRATEGIES

Most Cigref member organisations approach migration by using several cloud resources, internal and external, private and public (called hybrid cloud - see 1) and calling on several public cloud computing providers in a coordinated manner, depending on the need and purpose (known as multicloud - see 2):

1) On the one hand, organisations are increasingly using cloud services through a strategy of purchasing cloud computing solutions and/or by migrating the existing software base (by "lift & shift" and/or application modernisation). Thus, the existing, or legacy IT (often in the data centres of companies or their service providers) and applications maintained in private clouds rub shoulders with services hosted in the public cloud.

2) On the other hand, they often choose to rely on the skills of several cloud service providers in order to benefit from the most efficient and competitive services on the market and use competition to limit their reliance on a single technology supplier.

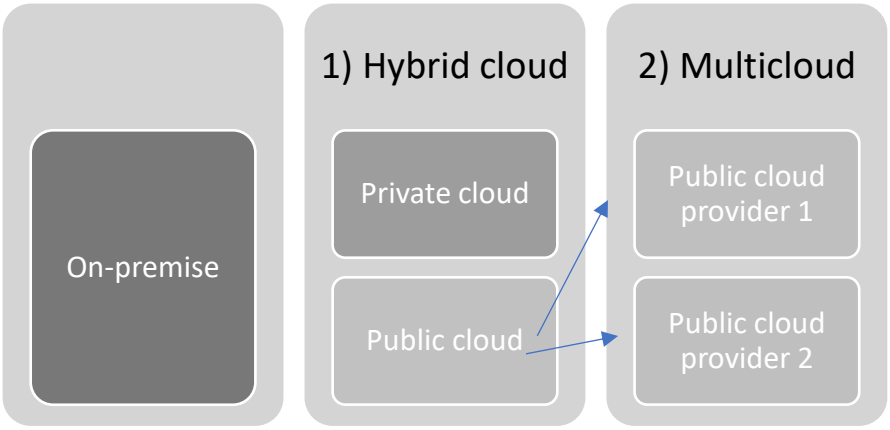

Figure 1: Hybrid and multicloud
Source: Cigref WG

Once the reasons for migrating to the cloud have been identified, the IT department follows a number of steps including a mapping of the software, the choice of the migration method, the use of "cloud-readiness" criteria as well as negotiating the partnership and contractualisation model with the supplier(s).

Migrating to the cloud requires making important strategic choices. The first step is to decide on the scope of the migration: either software or data. In software, we make a distinction: SaaS software that is acquired turnkey, and software to be migrated to cloud computing environments (IaaS or PaaS). The migration of the latter is the subject of this report.
You must define the destination host and select the most suitable host when the company is not developing its own internal cloud. Hosting options can include using cloud computing technologies in the company's own data centre or at its provider, or to migrate to a private or public cloud.

Once the scope and hosting have been decided, the company must choose the "future situation" of each application at this new destination, i.e. make a choice among the different software transformation options (see section 2.2Migrating software), and the time scale for each application's transformation.

These decisions must take many parameters into account: strategic issues, internal skills, condition of the software base, environmental requirements, etc. Each company generally creates a decision tree and a

software assessment grid to determine what will become of them and put in place a prioritised software migration roadmap (see figure below).

There is a huge gap between the promises of “ease of execution” and the reality.

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

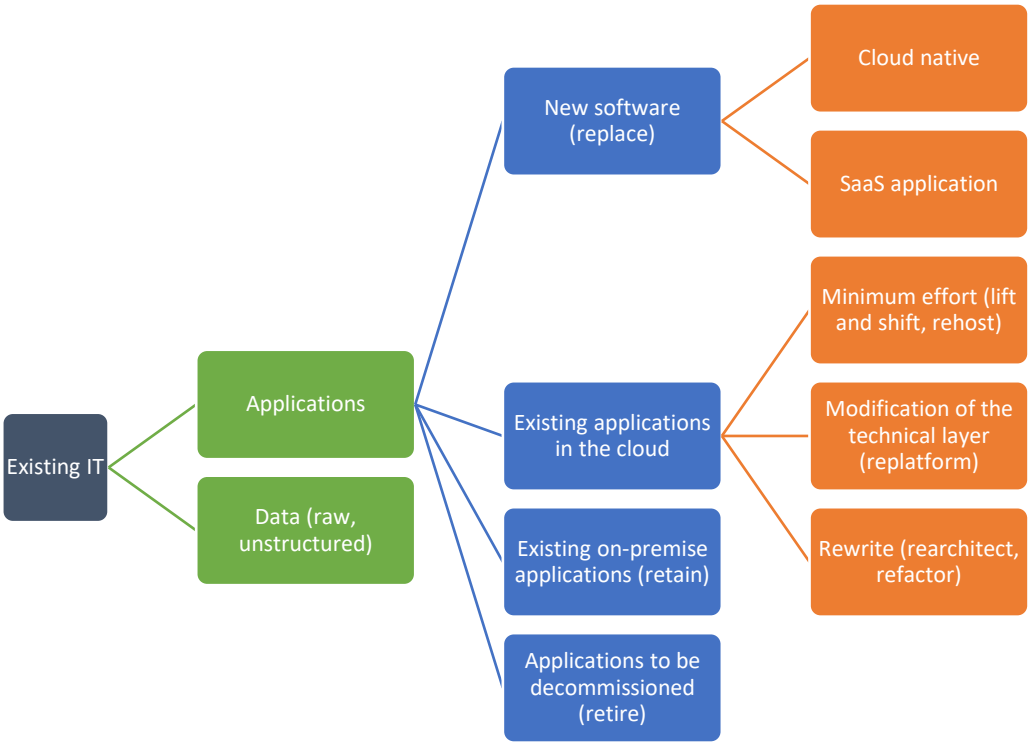

Figure 2: Tree of possible decisions
Source: Cigref WG

2.1.1 Application-data dichotomy

The working group noted a clear distinction between supporting software on the one hand, and unstructured raw data (raw materials, volumetry) on the other, which is not created or integrated into an application. The stakes, motivations and investment are very different in nature.

This difference between software/data is also found in the strategic choices and requires global data governance. The very choice of suppliers is motivated by distinct reasons (see chapter Increasingly complex supplier management”), and this difference can allow for a form of multicloud in companies.

It seems that the choice to migrate data to cloud computing is first and foremost a business issue, with the primary objective being taking full advantage of all the processing possibilities. Companies then generally choose to set up large data warehouses using open-source solutions in the cloud. Using cloud computing to store and process data is still linked to the choices that the company will make for its software. Migrating software to cloud computing brings the structured data that companies also want crossed 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 the processing and cross-referencing of all the data and the analysis work (data analytics) very complex. This subject, although eminently important, was not dealt with as such in the working group.

2.1.2 Hybrid cloud strategy

Most large companies have *de facto* adopted strategies to set up a hybrid cloud because of their existing IT in their historic, own or leased data centre.

Many companies started their cloud computing journey by using an outsourced private cloud. Some chose to go directly to the public cloud, but these were few and far between in 2013. Several of them are currently balancing between keeping 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 using cloud computing technologies. A few administrations and companies subject to specific regulations have set up their own private cloud on proprietary infrastructures.

Today, many companies recognise that it is increasingly "easier" to migrate their software base to the public cloud. The offers on the market are gradually overcoming their teething problems in security, data protection, intellectual property control and skills.

For an organisation that has chosen to migrate to the public cloud, there is a consensus that the development of all new software will be done natively in the public cloud unless there are specific constraints (technical, financial, confidentiality, etc.).

Conversely, some CIOs do not want to redevelop their existing IT that is not "cloud ready" (legacy), so there will remain a more or less significant residual depending on the companies and their strategic choice. As long as the company has this existing IT, it is not recommended to migrate it only for economic reasons. For example, the supermarket cash handling system is a distributed system installed in stores, almost like edge computing before its time, which will last for a number of years to come.

> **Feedback from Système U**
>
> System U has adopted a cloud computing migration strategy quite recently, with a pragmatic approach to adopting SaaS solutions. The decisions of the IT department are guided by the value brought to the business units, responsiveness and time to market. The company has chosen to maximise its use of managed services with cloud first, SaaS and PaaS, and to offer them through a catalogue of cloud computing services. Therefore, they will not necessarily migrate all of its infrastructure to the cloud.
>
> Thus, the IT department is positioning itself as the company's cloud computing services provider: a "cloud broker" for internal customers. By its nature, this is a hybrid cloud strategy, but it is also a deliberate choice because the current IT is resilient with a very good quality of service. The IT department will perform a functional breakdown of the IT with an opening by API and micro services and will switch new software to cloud computing when there is a business interest by adding containerisation, including in data centres.
>
> [More information in the appendices]

Conversely, for functional issues, the IT department can choose to reconstruct and transform this existing IT for its migration to cloud computing (public/private) and to take full advantage of cloud computing services.

2.1.2.1 Issues of sensitive and critical data

Nevertheless, the ratio between sensitive and critical data and the rest of the company's data remains decisive in how to approach migrating to the public cloud.

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 cloud computing and not transfer the remaining sensitive data.

Conversely, if this ratio is very high, then the company will tend not to want to migrate to cloud computing since it does not have enough data protection and privacy guarantees, in particular with regard to industrial platforms. In addition, within the scope of a factory, for example, not all use cases are covered due to service continuity issues. Some data will therefore necessarily remain in their on-site environment. Data that should not move to cloud computing could be moved to edge platforms.[4]

The Cigref study on the need for trusted cloud computing indicates that around 10% to 30% of data is sensitive enough to require protection from the risks of non-European cloud computing services. For this data, we can either use cloud computing services that meet the requirements associated with a trusted cloud or come from European initiatives such as Gaia-X.

2.1.2.2 A reduced need for an internal data centre or private cloud

Nevertheless, several arguments weigh in favour of a reduced need for an internal private cloud, i.e. managed by the company, whether it is hosted on its own data centres or those of a service provider:

- The rapid technological evolution that public cloud computing offers requires using the most standard solutions possible and being able to keep pace with all the technical roadmaps of software and IT components.
- The current shortage of specialised skills will worsen, and retaining teams will become very difficult due to pressure from salaries and stimulating challenges.
- Infrastructural obsolescence requires considerable investment to remain at the expected level of availability.
- There is a growing number of digital and physical security challenges that must be covered given the constantly evolving threats.
- The environmental requirements could become very restrictive on all equipment.

There are multiple reasons why companies today will increasingly migrate to public cloud computing solutions. At the same time, the question of maintaining a private cloud and, in this case, how it is implemented will be answered differently.

2.1.2.3 Several types of positions on the future of private cloud computing

We can see several types of positions emerging on the future of private cloud computing depending on companies' strategies and the offers of the players, such as cloud providers, integrators, and operators. At the least, they could be summed up by the following three models:

Option 1: a private cloud computing platform is maintained on the company's infrastructure, based on a specialised platform such as Openshift or an equivalent.

Option 2: there is only one single cloud computing model with two components: on the one hand, the traditional "public cloud" component and, on the other hand, a "private cloud" component that consists in installing a "replica" of the public cloud in the private domain via a converged hardware and/or software solution offered by public cloud computing providers, for example Azure Stack or AWS Outpost.

Option 3: there is only one model, the public cloud. The cases justifying a private cloud hardly exist anymore, and all the efforts to modernise companies' software are directed towards public cloud computing.

[4] Cigref report: Edge Computing and Post Cloud Perspectives, December 2020, https://www.cigref.fr/edge-computing-and-post-cloud-perspectives-opportunities-and-implementations

2.1.3 Multicloud issues

According to Gartner, more than 80% of organisations today use more than one provider of cloud technologies and services. Multicloud is often presented as a way of securing the supply of technology and covering technological independence.

However, the concept of multicloud has several particular meanings:

- The first is the use in the same IT of several cloud computing providers—increasingly including those from a trusted cloud—for different infrastructures and software to make the most of the offers.
- The second is the ability to easily change supplier on a technical level, the contractual aspect most often being the sticking point. This requires that the hosting platforms be interoperable and software be portable from one platform to another.

From a customer perspective, software interoperability and porting are difficult and expensive to implement. Switching from one hyperscaler to another represents significant costs given the additional layers that need to be added. Given the current difficulties in changing suppliers and moving software and data, choosing a cloud computing supplier at a given moment is structural because it places conditions on the company for the coming years. Many studies and initiatives have been conducted on the subject but still remain mostly theoretical and unapplied in reality.

The providers stress that portability from one platform to another requires a common technology base that reduces service proposals and the use of functions to the lowest common denominator. We must recognise that interoperability is not in suppliers' business interest and can be difficult to achieve.

In addition to the real technological and budgetary constraints for suppliers, there are also commercial or contractual obstacles with strategies that lock in customers, particularly in terms of licenses and pricing. Cigref regularly calls out these unfair practices. Cigref has developed a charter of ten principles for the use of fair software licenses in cloud computing[5] in partnership with CISPE, the association of cloud infrastructure service providers in Europe.

[5] 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

2.2 MIGRATING SOFTWARE

2.2.1 The main stages of software migration

A large participating company detailed its plan to manage software migration, which is broadly the same from company to company. It lays out five stages:

1. Make an inventory of all IT software on the basis of identified criteria,
2. Filter out the software that should not be evaluated or migrated,
3. Evaluate the software to be migrated on the basis of four criteria,
4. Review the results of the assessment in a prioritisation grid,
5. Draft a coherent roadmap for the company's IT department.

The company has thus established an evaluation grid for the software to be migrated based on four criteria:

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

In the software's evaluation grids, the criteria for cloud computing ineligibility are identified. These may include regulatory criteria (strict legislation for certain data in certain countries or sectors), confidentiality, obsolescence, or technology changes.

Thus, each software is positioned in a prioritisation grid, with the x-axis indicating the level of technical change required to deploy the software concerned in cloud computing and the y-axis the business priority.

2.2.2 Options for transforming the software base

Migrating software generally relies on which transformation is chosen for the software with a view to migrating them to cloud computing services. Each software requires a choice.

We can group these choices into six large families:

- **Minimum effort:**
  - Lift and shift: the software is migrated "as is".
  - Rehost: the same as "lift and shift" with a minimal reworking of the software's operating system and databases.
- **Modification of the technical layer:**
  - Replatform: the software's bottom level is replaced (which corresponds to the switch to PaaS).
  - Redeploy: the software is redeployed on a new technical platform.
- **Rewrite the software:**
  - Rearchitect: the software's code is modified, for example with a switch to Continuous Integration and Continuous Delivery (CICD, also a sort of equivalent of refactoring or rewriting).
- **Replacement:**
  - Replace: an alternative is set up.
  - Repurchasing: new solutions are acquired on the market.
- **Conservation** (retain): the software is maintained with a consolidation of environments.
- **Decommissioning** (retire): the software is no longer used.

During its presentation, the consulting firm Accenture gave its assessment of the benefits each option could offer according to the company's challenges, listed in the columns.

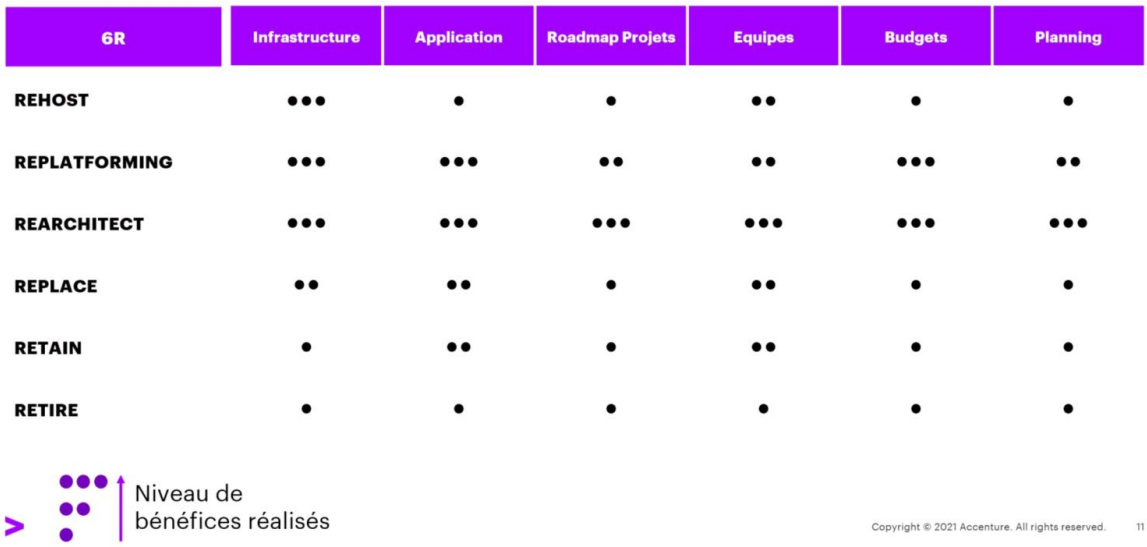

Figure 3: The benefits gained according to the chosen software migration option
Source: Accenture

Today, we can see that international companies do a lot of "lift and shift" and "rehost", but that the real advantage comes from software transformation. This is the strategy that the member companies of this working group are gradually adopting.

Companies are realising that there is often no basic "lift and shift". It is necessary to take into account the existing IT's capacity for cloud computing migration and its ability to be compatible with the supplier's technologies or cloud computing services.

There is a lot of preparation work required for cloud-ready software. The decision to rewrite the software to benefit from the advantages of cloud computing results in an increase in transformation costs, but also future gains.

This is why a company that decides to migrate massively to cloud computing will decide not to put certain existing legacy software there if it will be decommissioned in the coming years.

Feedback from Sodexo

Sodexo's IT teams have observed that the "lift and shift" option is very difficult for certain software; there are real problems in network flows and, especially, in the architecture, security and environment. Sometimes, the company only has one production environment, while the migration to cloud computing creates several, which is necessary and more secure, but also more expensive. Certain rules are required for a minimal reengineering of all the software to make it "migratable". The IT department needed to define the "as is" architecture of the software before even migrating it. Therefore, they had to recreate documentation and reassess the software's risk (risk of criticality for the support but also for the rules to Azure).

[More information in the appendices]

3 WHAT MIGRATION ALSO ALLOWS

When discussing migrating to cloud computing, many similarities with moving house were discussed. When moving house, we generally make a kind of inventory of what we want to take with us, at least in major categories. It's also the time to sort your things, things that you no longer use, things that are too old or that you decide it's time to change. So you get rid of them, which is a simplified equivalent of decommissioning.

However, there is an important difference between moving house and migrating: migrating does not generally go from point A to point B; there are multiple points A and, depending on the strategy adopted, also points B (hybrid cloud and multicloud). The multiple layers and environments of the IT greatly complicate this process. It's a bit like if you never really leave your previous home, and you have to constantly look for information and data in multiple locations.

3.1 MAPPING YOUR SOFTWARE BASE

As part of a cloud computing migration, you need to map your software base to decide what is migrated and how.

There is work on "combing" through the base (tools, depth level, type of workload, sometimes even code analysis) in order to arrive at a reliable inventory.

This mapping is essential for migrating the software base to cloud computing; it allows for a better management of the software base more generally, and it also reveals IT debt and obsolescence.

3.2 DEALING WITH THE IT'S TECHNICAL DEBT

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

We can see that most of the software chosen to be migrated to cloud computing is done so within the scope of technical debt management, i.e. the organisation sees them as requiring modernisation according to the adopted criteria.

The important work of making software cloud-ready allows for obsolete applications and components to be modernised. The decision tree also helps to decide on decommissioning, which is a challenge in itself that should not be overlooked.

Some companies that have already dedicated a portion of their IT budget to technical debt repayment can transfer this budget to cloud computing migration (budget substitution or avoidance).

Thus, organisations are forced to deal with technical debt when migrating software to cloud computing. However, there will always be some technical debt, even in the cloud, but cloud computing has tools to address it automatically. This was explained in the Cigref report on managing IT debt and obsolescence, published in May 2021.[6]

[6] Cigref report: Managing IT debt and obsolescence, May 2021, https://www.cigref.fr/managing-it-debt-and-obsolescence

3.3 SECURING IT

Companies must always find a balance between security and the technological opportunity that cloud computing offers and then define an ad hoc security policy.

Large cloud computing providers have sufficient financial and human resources to secure their services, and these resources can be greater than those of other players, especially smaller providers and companies. Companies can benefit from this ability to secure their systems. Therefore, we feel that companies can get better cloud computing security with the same means and resources, on the condition that teams become familiar with and can take up suppliers' security offerings.

The company's security policy must properly integrate the challenges of cloud computing security to foster adoption while keeping control of security rules. Some companies wonder how best to embed security in cloud computing environments. Software is being decentralised into various cloud computing systems, calling into question the overall consistency of the IT and centralised governance in terms of security. Multicloud strategies are complex and must be managed with solutions that reduce certain security "blind spots".

This situation presents certain challenges including container and software security, credential and access management, encryption key management, network segmentation, vulnerability and incident management, and internal security compliance and monitoring.

In terms of data security, end-to-end encryption is presented as an important advance, but the critical issue is controlling the keys. A member company took an interest in the question and identified several stages in the reflection to tackle this complex subject. First, you need to study the technological offers, look at the needs in financing and innovation, determine how to perform the encryption itself, secure the keys using a third-party authority (avoid being the owner) and, finally, improve the security and cloud computing teams' skills. However, encryption seems to limit the value of using cloud computing services, particularly when it comes to analysing the data if they are encrypted.

In addition, new concepts are emerging, such as Zero Trust from Forrester and SASE[7] (Secure Access Service Edge), developed by Gartner. Teams are increasingly looking at them to strengthen the security and connectivity of cloud computing architectures (see Cigref's upcoming report on Zero Trust).

3.4 OTHER IMPACTS OF MIGRATING TO CLOUD COMPUTING

Migrating to cloud computing will also impact how corporate networks, and WAN networks in particular, are designed. Companies must establish high-speed internet connections between their infrastructures and those of their cloud computing providers. Increasingly, they are opting for the SD-Wan network, which allows them to use software to create and manage their wide area network, replacing MPLS. It is a fundamental building block of SASE.

Additionally, it is logical to consider that the use of outsourced cloud computing services for software will decrease the use of data centres. A dual strategy must be put in place to gradually optimise and decommission historic infrastructures.

[7] Secure Access Service Edge - Wikipedia, https://en.wikipedia.org/wiki/Secure_Access_Service_Edge

4 THE ECONOMIC RESULTS AND FINANCIAL MONITORING OF THE TRANSITION TO CLOUD COMPUTING

The discussions revealed that one of the most significant challenges that businesses encounter concerns the financial justifications for migrating to cloud computing and then tracking consumption. Before migrating, the business case must include a minimum of return on investment (ROI). Once they have moved to cloud computing, organisations must both ensure that the financial objectives of their business case are achieved and keep their consumption of cloud computing services under control.

We can note the savings and advantages of cloud computing for software, hardware, system standardisation as well as team reorganisation, which represents a share of the direct savings that cloud computing brings.

Indirect gains, which are difficult to quantify, concern value creation, innovation, management of technical debt and the software life cycle, team productivity, maintenance, etc.

However, to use the metaphor of moving house, if the costs and/or time spent moving software and data are too great and cannot be amortised in a reasonable amount of time, then the company may prefer to stay in its current situation.

4.1 THE ECONOMIC RESULTS OF MIGRATION

To undertake a cloud computing transformation process, organisations must justify the business stakes as well as the economic gains in order to finance the associated projects. However, most of them mention that cloud computing is mainly chosen for business reasons, whether to increase agility, accelerate time-to-market, benefit from new technologies, or implement new working methods and practices.

We can note that the financial gains still largely remain to be demonstrated. Businesses want to be able to create as much or more value for lower expenses with cloud computing. But this wish seems only to be able to materialise under certain rather limited conditions. It is still far from being a reality for many organisations.

Currently, companies lack the perspective needed to concretely demonstrate the gains obtained by moving to cloud computing. The complete business case is hard to finalise because of the indirect gains that are difficult to quantify. It is particularly difficult to demonstrate positive business cases for “lift & shift” migrations.

Many managed cloud computing services have no equivalent in owned or leased data centre environments. Therefore, it does not make sense financially to compare on-premise with cloud computing services, but these still appear to be an additional expense. The return is not immediate on software providers’ invoices, either, given the multi-year contracts.

The approach the firm Accenture proposed to the working group’s participants is based on cost avoidance. The migration’s ROI should be calculated on the basis of a constant IT department budget, i.e. the budget it uses today while planning to make the same expenses in the future without the “do the same” migration to cloud computing. This is the comparison of the finances of two future situations: one where the organisation migrates its IT to cloud computing, in the other, the migration is refused, and the IT department continues with its current projects and infrastructure.

This approach helps identify and integrate all the IT department’s costs that go into cloud computing migration, not just infrastructure costs.

In following this logic, you must identify all the savings and costs that result from the migration. Accenture distinguishes between five main categories of IT department expenses:

- **Infrastructure**: hosting, equipment, networks, software, security,
- **Applications**: development, changes, maintenance,
- **Project roadmaps**: updates or changes to infrastructure, software,
- **Team**: training, change management, subcontracting,
- **Budget**: contract termination costs, request-for-proposal costs.

Accenture recommends that the company include in its business case:

- The impacted costs of each family,
- All avoided costs such as technological renewal and life cycle management (software and infrastructure),
- The significant cost of software transformation,
- The costs of internal organisation, project roadmaps, as well as hiring,
- Monetisation of stress fields.

The exercise of "monetising stress fields" is complicated. You have to try to calculate the software total cost of ownership (TCO) linked to software performance and consumption. It is also recommended to calculate the infrastructure TCO on the one hand and the software TCO on the other. You must also take into account the costs of computing and the costs of virtual machines' operational maintenance before and after the migration.

There are several types of savings associated with cloud migration:

- Software and hardware,
- System standardisation,
- Team reorganisation and productivity,
- Value creation and innovation,
- Management of technical debt and the software lifecycle,
- Maintenance (third-party application maintenance),
- The optimisation of security solutions and business continuity, etc.

There are several types of management costs associated with cloud migration:

- Business case production,
- FinOps inclusion,
- Change management,
- New catalogue of services,
- The level of investment required by business units,
- Work with the business units on the software roadmap,
- Team and talent transformation costs (continuous upskilling).

To increase the economic value of cloud migration, the IT department must also think about profoundly transforming how it organises its activities. The human potential released when implementing the tools that cloud computing offers can be reinvested in the skills and expertise essential to creating value. As a result, additional savings can be identified (reduced subcontracting, optimised jobs) and complement a strict financial equation based on infrastructure costs. This approach involves developing an appropriate sourcing strategy (outsourcing, nearshore, offshore). For many issues, it may make sense to use a service provider/integrator.

4.2 MONITORING THE FINANCES OF MOVING TO CLOUD COMPUTING

Investments in technology were previously slower to set up and scale, but DevOps and agile methods have changed that. Spending on cloud computing represents a growing share of CIOs' financial commitments that is expected to increase in the coming years at five times the rate seen in 2020.

The cloud computing operating model is still being built. Operating and managing cloud computing is very different from managing traditional IT. Decisions are made in near real time and divided between different teams such as finance, purchasing, and the technical and business units, to balance operational and financial control. These teams find themselves faced with a new billing method and expenses that are difficult to identify and verify. Cost management is also the second most important challenge for CIOs, just after security, according to a 2020 Flexera study.[8]

Migrating to cloud computing requires a shift from software asset management to pay-per-use for cloud computing services. Many companies are struggling to adapt to these new pricing models and the evolving pricing policies of public cloud offerings, which break with traditional purchasing models.

Consequently, companies need to reconcile the financial models of several domains: traditional infrastructure (the mainframe, for example), invoiced based on work units, and the hybrid cloud (private and public), billed on a pay-per-use basis. It is more difficult to verify the finances of the servers and hosted software and manage operating costs.

Companies are also struggling to control the increase in the use and, therefore, the cost of cloud computing services. Either the company does not cap the use of cloud computing services, and costs then see strong growth over time due to the speedy adoption of cloud computing and the pay-per-use billing model. Or the company adopts an instance reservation model and restricts usage. This keeps its costs under control, but it must take into account the difficulty of accurately estimating the number of instances that need to be reserved. In some cases, the post-migration bill can be higher than the estimated or pre-migration bill.

We also must not forget all the hidden costs of cloud computing: hosting in two different places at the same time during migration, hidden extras, data transfers[9] (see article in Le Monde Informatique).

In recent years, the speed of migration has increased with a real increase in migration from 150 services/month to 300 services/month. This also echoes companies' goal of seeing a return on investment from migration in the first year, called the "cash year". These observations argue in favour of fairly radical migration strategies: the faster and bolder the plan, the more the company seems to achieve the desired economic gains.

However, as soon as a software transformation component is added (refactoring, rewriting), we see that the ROI must be readjusted: it will take longer to obtain, but will also be more significant.

Additionally, there are many questions about the indicators to use in drafting the business case as well as those that should be tracked, such as the number of servers or applications.

4.3 IMPLEMENTING A FINOPS APPROACH

The FinOps approach allows companies to better understand the costs of cloud computing and to make the necessary compromises in a responsible approach. FinOps is a key strategic function that is still

[8] Flexera "State of the cloud 2020" report: https://path.flexera.com/cm/report-state-of-the-

[9] *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 French)

emerging in connection with enterprise architecture. It helps to renew cost-based practices of governance by aligning it with the company's strategic challenges.

The FinOps approach offers many attractive promises: limited operating expenses (OpEx), streamlined purchases, better inspection of cloud computing service providers, breakdown of organisational silos, stronger relations between the IT department one the one hand and financial and business units on the other.

FinOps is both an approach, an organisation and a tool to provide users with the vision of what they consume in cloud computing. It is at the heart of the cloud computing strategy, an instrument to optimise and make costs more flexible, and to increase visibility among business units.

One Cigref member company characterised the fundamentals of this approach with three pillars: Inform, Optimise, Operate.

The **"Inform"** pillar is essentially based on the "showback as a service" approach, which consists in showing a billed view of the various infrastructure services according to how the units consume them. To do this, a map of usage and consumption needs to be made. Today, the main difficulty is in forecasting the pay-per-use bill. This vision is also part of regular, more global reports by the IT department.

The **"Optimise"** pillar relies on "chargeback", i.e. rebilling for services consumed. Implementing this philosophy of rebilling infrastructure costs internally (at cost, without a margin for the IT department) raises awareness among business units of the services' true cost. Companies can adopt a pricing policy that allows them to compare themselves internally, to other companies or to public cloud computing providers. This benchmark is a tool for analysing and identifying the most effective services.

The **"Operate"** pillar consists in improving knowledge of existing FinOps practices within the company, whether in terms of the management of the private cloud computing platform or its consumption of the public cloud. This knowledge is necessary to find the right levers for optimisation, such as commercial negotiation, software sizing, waste, or server decommissioning.

Companies' experience with FinOps is very recent and growing, but generally it is still a reactive or corrective approach, based on consumption data with after-the-fact optimisation. It is also necessary to find an appropriate FinOps organisation (see next chapter).

Today, the main challenge is to think of FinOps in a hybrid and multicloud mode; the approach must sometimes support the strategy of independence vis-à-vis suppliers. We need to aggregate and automate a cross-platform view of IT spending.

Another challenge is to integrate FinOps into software design at the start of the project in order to adjust the architecture model and processes. This FinOps-by-design approach must ultimately cover the existing base as well as the software in cloud computing.

Companies share the observation that, for the moment, no organisational model or tool has yet appeared to be well established. The market does not seem mature, especially for multicloud tooling.

5 REORGANISING AND EVOLVING IT TEAMS

Migrating to the cloud often requires a reorganisation of the IT department with a transformation of the IT department's roles, with the appearance of new professions and the transformation of others, support for teams, sometimes a redefinition of certain responsibilities, as well as an evaluation of the investment required by business units.

It is a paradigm shift: the shift from managing inventory (data centre) to managing cloud computing flows. This allows you to manage activities in real time and automate repetitive tasks.

5.1 ONBOARDING TOP MANAGEMENT AND MANAGING CHANGE

Like any major transformation, it is essential to involve top management to have the right level of support (sponsorship). One company has set up a training program for executives to understand the stakes and opportunities as well as the controls over security and costs, for example. Another company organised a learning expedition to Big Tech for its executive committee members.

Some companies have pointed out that it is essential to first educate the entire IT department (from infrastructure services to product and business teams) and that they get organised before providing knowledge to business and support units.

The mindset of the IT department and all stakeholders must change, which is happening very gradually. Awareness and maturity always take much longer than desired, but in the case of cloud computing migration, it is even more important.

Some companies may encounter a lot of resistance to switching to public cloud computing due to security, privacy, and transformation issues. Avoiding the various teams digging in their heels requires a lot of support.

Adopting a test & learn approach is crucial. Accept that there may be configuration errors in problem solving and that we will have to learn from these errors.

CIOs want to avoid the risk of a two-speed IT. Not all projects are in Agile and DevOps mode as they may be in many cloud computing projects. We have to find a model that nevertheless infuses diversity and agility into all projects. However, transposing methods is a long process, and there are concerns about the nature of changes in business units and processes.

One company has created a working group to reflect on employees' career advancement and to support those who may be particularly impacted by reorganisations, by those who have gained confidence. However, some end up completely lost in the new organisations. Fostering mobility in companies helps them to retain talent by offering them other positions in local IT departments or on other projects.

5.2 RECRUITMENT AND TRAINING STRATEGY

Cloud computing requires skills that are quite rare on the market. Large organisations need to invest heavily in recruiting, especially young people who were "born" with cloud computing, and in training internal talent through an appropriate plan.

On the recruitment side, the IT department must support HR in identifying the right skills for recruitment and offering better salaries. The goal is to re-internalise skills, particularly in automation and engineering. The company's use of cloud computing can be a way to make the IT department more attractive. One of

the biggest challenges is recruiting the new skills and then retaining them. We must "nourish" those we hire, keep them interested and offer them interesting challenges to tackle.

On the training side, it is necessary, but not easy, to review the business profiles to introduce multiple skills and train teams, whether on architecture, security, FinOps, DevOps, or automation tools. And this needs to be done early enough in the transformation programme so they can grasp the new tools. Teams need to be able to get the most out of technology for their projects and increase their productivity and efficiency through good training. Reaching the state-of-the-art in cloud computing requires a lot of skills training for teams (especially in automation).

It is recommended to invest heavily in training teams through the cloud computing providers' programmes. Some have developed e-learning platforms to certify teams and demystify certain subjects such as cloud computing security.

5.3 THE STEERING STRUCTURE FOR THE CLOUD COMPUTING PROGRAMME

The Cloud Center of Excellence or Cloud Competency Center at one member company of the working group has helped to develop a dedicated governance for cloud computing, which integrates Program Management and Project & Product Management.

It is recommended to have a value realisation structure, sometimes called the Value Realisation Office (VRO), to complement the traditional Project Management Office (PMO). It must be consulted for investments, purchases and current decisions.

In one large company, the corporate CIO and the entity CIOs have each appointed a cloud computing leader to define the cloud transformation plans. They are the point people on these subjects. The IT department collects ambitions and requests for cloud computing services from cloud leaders and facilitates the prioritisation of requests. They work in very different entities but share the same interests, questions and difficulties. Building a community of cloud leaders stimulates transversality and the sharing of information and experiences, which is very useful in the context of transformation and resolving shared difficulties. It also helps to build a continuous improvement loop.

Figure 4: Organisation of a Cloud Competence Centre

Feedback from Stellantis

The Move to Cloud programme at the former PSA Group was set up in order to organise a global strategy and to frame the growing number of development and deployment initiatives in the public cloud. Its goal is to clarify the objectives and define the guidelines for using public cloud computing and to drive its adoption in all its components, be they technical, economic, organisational or skills related.

As part of this programme, the IT Department has set up a multidisciplinary team involving all the business units concerned to manage this change. A monthly committee with the CIO and their team was set up from the start and continues to this day to steer the project and make the necessary decisions. Regular meetings are held with the main cloud computing providers.

[More information in the appendices]

Feedback from Air Liquide

In 2017, Air Liquide began to structure its then-decentralised teams, which led to the creation of the Global Infrastructure Office (GIO), which employs 200 people and manages outsourcing contracts for cloud computing. The GIO operates a large part of the infrastructure. The office manages a private cloud via an outsourcer with a variable costs approach and has adopted an initial public cloud computing strategy with a preferred partner (AWS). At the start of the transformation, Air Liquide also co-built a new operating model with an IT consultancy because the previous one was not suited to cloud computing and the "migration factory".

[More information in the appendices]

5.4 NEW SKILLS AND NEW JOBS

Here is a very brief summary of the new roles that are emerging with cloud computing:

- **DevOps**: plays a part in the continuous architecture chain, integrates the software and automates the deployment of the software from end to end.
- **Cloud Security Engineer** or **SecOps**: implements security measures in cloud computing environments.
- **FinOps**: aggregates and analyses the consumption information given by cloud computing providers and looks for ways to control costs.
- **"Infrastructure" developer** (Infrastructure as Code): codes the infrastructure and determines the architecture specifications and the technologies to be used.
- **DevSecOps engineer** (or SRE): integrates security into DevOps practices.
- **Cloud evangelist**: uses storytelling to explain cloud computing's complexity in a simple way, explains how it is used in the company, and plays an essential role at the start of the programme for adoption.
- **Cloud architect**: creates and integrates the cloud computing infrastructure, builds solutions in response to user needs, and manages migration to cloud computing solutions.
- **CloudOps**: coordinates the specificities of the various cloud computing providers, inspects how software functions on the different cloud computing systems, and facilitates the management of operations on the various cloud computing platforms.

Some of these new professions are explained in the Cigref's Nomenclature of information systems job profiles.[10]

5.5 DEVELOPMENT AND PRODUCTION TEAMS' ACCOUNTABILITY

Migrating to cloud computing has impacts on how development and production are organised. The concept of DevOps—a contraction of Development and Operations—consists in developing and integrating software and continuous operating measures, which has revolutionised organisations by eliminating silos and increasing team agility.

With cloud computing, software development teams have greater responsibilities. These have access to a set of tools that offers many possibilities. The IT department must define rules (patterns) in order to avoid having as many development models as there are projects and integrators, which would lead to a very heterogeneous environment that is not under control.

There are three objectives to consider when defining these rules: a high-performance and efficient software architecture, security to meet the company's requirements, and avoiding being locked in to one supplier and allow for software reversibility, or at least porting.

In order to promote the prototyping and deployment of new software, one company has created three types of accounts according to the development teams' needs:

"Sandbox" account: a sandbox server and an environment that are isolated from the corporate network and without corporate data, which can be created in just a few minutes.

"You build it, you run it" account: an environment managed by the development team itself is created, with supervision of the infrastructure service and an architecture framework. Some companies are adopting the logic: "You build it, you run it, you own it, you pay it".

"Managed" account: an environment is provided, fully operated by the infrastructure service or the cloud computing skills centre.

5.6 IN SEARCH OF AN OPTIMAL FINOPS ORGANISATION

Most companies are at the beginning of their FinOps organisation, and some plan to increase the team size according to its ability to offer optimisation and profitability. The teams are very motivated to optimise the software because there are real savings at stake.

The role of the FinOps team is at the junction of many projects, and it is difficult to find the optimal position, especially for scaling up. The FinOps team generally works transversally across infrastructure teams and cloud computing product teams. It is located at the margins of the domains of finance, purchasing, technology and business units.

The FinOps team is made up of employees coming most often from IT, with an appetite for finance subjects and who want to advance their careers. But it is also possible to find sharp management controllers with cloud computing skills. FinOps knowledge and training can also be organised into communities by creating a "FinOps guild".

[10] Cigref's Nomenclature of information systems job profiles: https://www.cigref.fr/wp/wp-content/uploads/2020/06/Cigref-Nomenclature-Information-Systems-Job-profiles-framework-update-2018-EN.pdf

However, these profiles are rare and difficult to find on the market. Most of the time, they are trained internally with support from specialised companies. Currently, there are few profiles on the market with both financial and IT skills capable of doing FinOps by design. FinOps is a promising career.

In addition, FinOps is a real opportunity to raise business units' awareness of the issues of cloud computing services, to help them understand their challenges and possibilities and, ultimately, to strengthen the company's digital transformation strategy.

6 INCREASINGLY COMPLEX SUPPLIER MANAGEMENT

Managing supplier relationships is acknowledged as increasingly complex, particularly with the move to cloud computing. Suppliers represent both cloud computing service providers - hosting and processing - and the entire ecosystem of software and IT components vendors.

Note that the organisational transformation and team training component is a prerequisite for choosing and managing cloud computing suppliers.

6.1 THE STRATEGIC CHOICE OF CLOUD COMPUTING PROVIDERS

As indicated previously in the report, migrating to cloud computing means choosing whether to be multicloud, and to apply your strategy to one or more cloud computing service providers. This choice is based on a number of criteria, starting with the strategic and sectoral position of the supplier and the company in question.

It seems that it is not so much the cloud computing services in themselves or their pricing policies that make suppliers' offerings stand out, particularly among hyperscalers, but other factors, such as business interests, especially their footprint on other sectors, their recognised abilities in one of the desired challenges, their ability to support companies, increasingly, their ability to respond to data protection issues, both in the security and legal aspects, and, finally, global coverage.

Choosing a supplier is a strategic and structural decision because of the consequences it has on the IT architecture over the long term, including the choice of technologies used, the skills developed internally, and the control over dependency.

If we consider the three big hyperscalers, Amazon Web Services, Google Cloud and Microsoft, it is interesting to know the suppliers' strengths and technical and non-technical specificities.[11]

Regarding these hyperscalers' market shares on the French market for public IaaS infrastructure services in 2020, the Gartner firm estimated that AWS held 51.3% of the market, Microsoft 23.2% and Google Cloud 9%, but with growth of 67.7%, the strongest in France over the 2019-2020 period.

It is widely recognised that Amazon Web Services (AWS) offers very interesting infrastructure services, but that its competitive positioning in many sectors immediately excludes it from the calls for tenders of certain large companies, for example in retail.

Microsoft knows how to distinguish itself with its strong foothold in the professional market in the software field and in office automation in particular for the past 40 years. This reinforces its notoriety, whether in terms of technology, its presence in the ecosystem, and its large and qualified workforce to support companies. Microsoft has announced strategic partnerships with Amadeus, Axa, and TotalEnergies.

For its part, Google Cloud is chosen in particular for its processing and data cross-referencing capabilities and its open-source approach that is better developed than the others'. Google is also proactive in strategic partnerships, as recent announcements with LVMH, Carrefour, and Renault have shown.

[11] See also: Public cloud "*Les points forts et les points faibles des principaux acteurs mondiaux*" - ZDNet, https://www.zdnet.fr/actualites/cloud-public-les-points-forts-et-les-points-faibles-des-principaux-acteurs-mondiaux-39927703.htm (in French)

In terms of data protection, trusted cloud offerings from European players and hyperscalers, whether the "Blue" offer from the trio Orange, Capgemini, Microsoft, the Google & OVH partnership or the very recent one from Google & Thales, will be of particular interest to large French companies (see Cigref's Trusted Cloud Reference Document[12]).

Feedback from Amadeus

In the summer of 2020, after a period of experimentation, Amadeus decided to migrate all of its IT to public cloud computing. In 2016, the IT department chose to set up private cloud computing and to experiment with the public cloud, to work on Kubernetes and prepare the software for the transition to cloud computing. By implementing a private cloud and using public cloud computing, Amadeus realised the sophistication of the three hyperscalers and their level of mastery over the technology, which was greater than many other companies. Three important challenges weighed on the choice of a hyperscaler: the location requirements for data processing, latency and response time, and maintaining their technological leadership over the competition.

[More information in the appendices]

Alongside multicloud, the concept of "CloudOps"—a contraction of cloud computing and operations—emerged, consisting of the management of operations through various cloud computing systems and obtaining a centralised and continuous view of all of them. Some platforms already offer to combine access to several cloud computing providers on request.

Companies will also make their choice according to their own capabilities and knowledge of certain suppliers previously selected for smaller scopes. Therefore, large strategic partnerships are often the continuation of previous agreements, although sometimes the choices do change.

The purpose is also to take into account the offer of the historical IT suppliers, almost all of whom have adopted a "cloud first" mentality, whatever their size. Publishers are currently investing in the development of new services in cloud computing environments, and it is commercially advantageous to bring their current customers along in migrating their products to the cloud.[13] We note that some small- or medium-sized publishers have not made their transformation to cloud computing, so their software solutions are unsuitable for the cloud.

Gaia-X: ensuring the free flow of data in a secure and trusted environment

Introducing Gaia-X

Gaia-X is an international non-profit association called the Gaia-X European Association for Data and Cloud. This association was born from a private initiative, but which is consistent with the European Community's data strategy. This association aims to create an open digital ecosystem in which data can be made available, collected and shared in complete security and confidence. The objective is to create, eventually with other EU Member States, a new type of networked collaborative infrastructure that serves the EU, its businesses, and its citizens, meeting the highest of requirements in digital trust and boosting innovation.

[12] Cigref's Trusted Cloud Reference Document, 2021: https://www.cigref.fr/cigref-publishes-its-trusted-cloud-reference-document

[13] These topics are the subject of regular meetings between Cigref members and publishers within the framework of the Cigref Supplier Relations Club.

Gaia-X's two goals

- Establish a framework of trust that respects European values and legislation and technically translate these values, which are contract transparency, data protection, portability of software and services, reversibility of infrastructures, interoperability between cloud computing systems, trust, energy efficiency within an architectural framework, according to technical standards, policy rules and certifications.
- Foster the emergence of services and use cases in an open digital ecosystem in which data can be made available, gathered, pooled and shared in total trust and security, which offers computation, analytics and AI capabilities and promotes innovation.

The French GAIA-X Hub

The mission of the French GAIA-X Hub is to make Gaia-X known in France, to bring together all interested stakeholders so that they can work collectively to develop functions that take advantage of Gaia-X. The French Hub also coordinates and dialogues with the Gaia-X association and the other national hubs. The French Gaia-X Hub is currently incubating 12 working groups, several of which are European data spaces that have already arrived at the first phase where the initial functions are implemented.

Cédric O, the French Secretary of State in charge of Digital Transition and Electronic Communications, has entrusted the management of the French Gaia-X Hub to Cigref and its partners Systematic Paris Region and the French National Academy of Technologies, joined by Inria, IMT and Numeum.

6.2 NEGOTIATIONS WITH HYPERSCALERS

Recognising that we are at a moment of major inflection and that the initial choice of supplier is crucial, suppliers and publishers are running significant campaigns to encourage migration to their cloud computing systems. There is a real market war. They are investing heavily in marketing and business proposals.

In the face of this, companies need to know their business model, the metrics used to measure their business objectives and the levers available in order to avoid too great an imbalance around the negotiating table. We have to set up multi-skilled teams to find the right levers for working with suppliers and learn about best practices.

Several 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 situation is particularly problematic when one of cloud computing's very advantages is its great flexibility that goes against the principle of commitment on reserved instances. When beginning the migration, two elements must be taken into account. The absence of a reliable estimate of the actual consumption of the service makes it difficult to project the number of instances to reserve. When adopting cloud computing services, companies often experience peaks in consumption that must be managed and then reduced. This is possible thanks to the use of FinOps tools (see dedicated section), hence the importance of initiating training from the start of the project.

Interoperability is also a major subject for user companies before migrating to cloud computing as well as during discussions with suppliers (see section on multicloud).

In the discussions with hyperscalers, integrators can bring significant added value by using negotiating leverage such as access to top executives and their previous experiences.

6.3 IMPLEMENTING WITH HYPERSCALERS AND INTEGRATORS

The members of the working group also shared their experiences on supporting and implementing their cloud transformation programme with suppliers.

Hyperscalers are not set up for the deployment of all their customers, with a very significant workforce differential, particularly for “pure players” such as AWS and Google Cloud.

The discussions revealed that companies are generally supported by integrators at the start of their programme to help develop the business case, change their operating model, reorganise teams and provide daily support. The integrator brings tips and their knowledge of the pitfalls. The integrator may also have a role in financing the programme. Some companies spoke of discussions where the integrator would purchase their data centre and then rent it back to the company so that they could use the money for their cloud computing investments.

However, it must be recognised that integrators and consulting firms also learn as they work with their clients on the field. In addition, a significant part of the workload for developing the migration roadmap rests on the internal teams given their knowledge of the software portfolio. The coordination between the integrator and the company and the strong support of the internal teams are also key factors here for a successful migration.

CONCLUSION AND OUTLOOK - OPEN QUESTIONS

The working group found that most businesses are still in the early stages of using cloud computing. The facilities offered by migrating to the cloud help to support business transformation and innovation. If the CIOs refuse to take an interest in it, there is a good chance that the business units will force their hand. This is why Cigref recommends that we collectively and proactively question ourselves on the issue and how it is implemented.

This working group was able to ask a large number of questions, be they economic, legal, security or technological in nature. It was able to partially answer some of them, but there are still many left unanswered. Extending the working group will allow certain subjects to be explored in greater depth.

Some questions remain open. These include questions about the funding and investment needed to set up a cloud computing migration programme. The companies have implemented or considered several solutions that they could share.

Furthermore, this is accompanied by a reflection on the management of the accounting and financial treatment of the transition to cloud computing, running costs and technical debt. The change in the financial model from CAPEX to OPEX is shaking up how IT expenses are managed. New regulations are also complicating certain internal mechanisms, which must be considered. In addition, there are the challenges of the FinOps tools and organisation within companies.

Migrating to the cloud and splitting the IT among many types of hosts challenges the notion of managing data in data lakes within a hybrid cloud and multicloud computing environment. The growing demand from business units who are gradually taking ownership of the possibilities offered by solutions around data is a good thing for organisations' innovation, but it must be managed at the highest level through responsible management of project portfolios.

There are also the issues of the training of development and production teams and, especially, their productivity and attractiveness.

Finally, to confront the risks of being locked in, it is possible, at the technological level, to use open-source software to maintain control over your software and its dependency on suppliers.

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Managing IT debt and obsolescence, 2021

Reference document Trusted Cloud, 2021

FEEDBACK

FEEDBACK FROM AMADEUS

Amadeus is a large European company of crucial importance in international trade. In 2019, it helped 2 billion passengers to travel, representing 50% of global traffic. Its core business is travel distribution thanks to 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), the hotel industry (reservation, reception) and airports (managing doors and passenger flow).

In the summer of 2020, after a period of experimentation, Amadeus decided to migrate all of its IT to the public cloud. In 2016, the IT department chose to set up private cloud computing and to experiment with the public cloud, to work on Kubernetes and prepare the software for the transition to cloud computing. By implementing a private cloud and using public cloud computing, Amadeus realised the sophistication of the three hyperscalers and their level of master over the technology, which was greater than many other companies. Three important challenges weighed on the choice of a hyperscaler: the location requirements for data processing, latency and response time, and maintaining their technological leadership over the competition.

The company stores and processes all of its clients' data at its data centre site in Bavaria, Germany. This situation is becoming complex to maintain as many customers are beginning to have location requirements for data processing, either because of national regulations or their own strategies. In terms of latency, customers often request a response time of less than 10 milliseconds. The company manages what is called "heavy transactional", i.e. around 100,000 user transactions per second (comparable to Google). Amadeus must manage very demanding SLAs with its customers in the order of 99.95%, sometimes even reaching 99.99% contractually, excluding planned maintenance. Service response time is a heavily differentiating aspect for their customers and can therefore translate into market share gains, but this requires global coverage, which only hyperscalers can offer. In terms of technological leadership, purchasing the hardware needed to maintain the data centre is becoming complicated. The large cloud computing providers are becoming increasingly efficient by using very high-level proprietary hardware (ARM processors offer performance gains of 30 to 40%, for example), combined with a technological gap at the network level, as well.

With this in mind, the company issued a call for tenders for a seven-year IaaS migration contract with three years of migration. It wants to entrust at least 50% of volumes to a single cloud supplier as part of a worldwide contract as a "partner". This is accompanied by a certain number of conditions to be negotiated concerning the Service-Level Agreement and Objectives (SLA / SLO), a guarantee on the location of the data, encryption mechanisms, jurisdiction, audit rights, compensation in the event of a problem, migration credits to compensate for temporary double hosting, dedicated support for the implementation without having to resort to an integrator, and the establishment of a real partnership to offer new services and offers together. Microsoft ultimately won the contract[14].

[14] 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 group's entire infrastructure. Supported by general management, this infrastructure globalisation program was presented as a factor in the company's competitiveness and agility.

The aim is to transform the perception of infrastructure from a cost centre into a value centre. Perpetual innovation makes infrastructure more resilient and improves the security of IT systems. Technical debt has not been the major driver of adopting cloud computing as the business tends to isolate legacy environments.

That year, the company began to structure its teams, which were very decentralised, leading to the creation of the Global Infrastructure Office (GIO), which employs 200 people and manages outsourcing contracts for the cloud. The GIO operates a large part of the infrastructure. The office manages a private cloud via an outsourcer with a variable costs approach and has adopted an initial public cloud computing strategy with a preferred partner (AWS). At the start of the transformation, Air Liquide also co-built a new operating model with an IT consultancy because the previous one was not suited to cloud computing and the "migration factory".

The GIO has chosen not to set up a Cloud Management Platform (CMP). The CMP offers business unit CIOs, who are less "knowledgeable" than the GIO, access to all services on a "self-service" basis. Nevertheless, the CMP's software overlay can slow down the use of services. Therefore, the GIO supervised the creation of a catalogue of services and set up a portal for CIOs in order to provision the desired infrastructure bricks, regardless of whether it concerns private or public cloud computing.

In 2017, Air Liquide decided to move more quickly to the public cloud after a major study on the advantages of public cloud computing, in particular AWS. The GIO took the decision to create a cloud expertise centre (centre of excellence) to have both the right intrinsic skills and the right mindset.

2018 saw the scaling up of the strategy with the migration of the legacy IT infrastructure in the Asia-Pacific region, then North America. As a first step, Air Liquide chose to do 95% lift and shift, but then understood that it had to transform software in order to find savings and improve performance.

The GIO has set up a migration factory with two options: either in the private cloud or in the public cloud. Gradually, adoption is spreading in the company thanks to the work of cloud evangelists: the benefits of cloud computing has been demonstrated and the total cost of ownership (TCO) has decreased, leading to emulation. In Europe, 30% of software in the public cloud has been reworked through re-platforming. This has helped to face the software transformation. About 5-6 applications have been redesigned to be cloud native out of more than 200 applications; the others are refactored instead.

Air Liquide has implemented FinOps best practices themselves, relying on the use of tools such as Aptio and reports such as Power BI to be in total control of costs with respect to cloud computing and business units. We must think about equipping ourselves to scale up, to automate the detection of compliance and non-compliance and to allow self-remediation.

The hybrid cloud strategy, combining the use of multiple types of cloud computing resources (private/public), will need to be maintained for some time yet, as some software cannot be ported. Often, it is possible to change suppliers by reopening competition, but sometimes this is still impossible. The company continues to explore all options to take full advantage of the possibilities that cloud computing offers in order to remain competitive.

FEEDBACK FROM SODEXO

Sodexo, a global leader in quality of life services, took its first steps in AWS cloud computing in 2014. Since 2018, the Move To Cloud programme has been structured around a major partnership contract with Azure.[15] Today, fairly sizeable software is hosted on Azure, which is also used for IoT, big data, and analytics. Cloud computing turns technologies in data centres into "commodities". This brings agility, speed, scalability, and true update automation (evergreen).

With more than 100 million consumers served daily in 64 countries and 420,000 employees, Sodexo has approximately 35,000 sites, most of which are customer sites. The company has the particularity of a history of multiple, diverse and autonomous entities, with a decentralised organisation. For several years, the IT department has aimed to consolidate local applications in 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 alongside the decision to centralise the budget. This made the total cost of ownership structure identical for all countries and offered economies of scale on the operations.

In the fall of 2018, the IT teams embarked on a software evaluation grid with several possible options for the applications: (1) migrate to the cloud at Azure, (2) migrate to a global data centre, (3) replace it with global software, (4) replace it with SaaS software, or (5) decommission. Above all, migrating to cloud computing has allowed for an inventory of the gigantic software base and an estimate of the number of applications to be decommissioned.

The other drivers are the speed of development and production, environment creation (time to market) and security. The positive impacts on IT security are very significant but very difficult to quantify.

Sodexo's IT teams have found that the lift and shift option is very difficult for certain software: there are network flow, architecture, security and environmental issues to consider. Sometimes the company only has one production environment, whereas migrating to the cloud necessarily creates several, which is more secure but also more expensive. Certain rules are required for a minimum of reengineering of all the software to make it "migratable". The IT department needed to define the "as is" architecture of the software even before migrating it. Therefore, they needed to recreate documentation and reassess the software's risk (risk of criticality for support as well as the rules towards Azure).

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

[15] *Sodexo et Microsoft annonce un partenariat mondial* - 2018 https://news.microsoft.com/fr-fr/2018/09/25/sodexo-et-microsoft-annoncent-un-partenariat-mondial-pour-ameliorer-la-gestion-du-facility-management/ (in French)

FEEDBACK FROM STELLANTIS*

In 2018, the former PSA Group chose to move to cloud computing for new software, first to gain agility, flexibility and time to market. The objective was also to benefit from new technologies, particularly data processing. The approach they chose was “PaaS first” in order to benefit from the advantages in terms of functional richness and productivity of the managed cloud computing services. Finally, the group wanted to benefit from cloud computing’s global coverage in order to deploy its own IT internationally.

After a slowdown in business in 2020 due to the COVID-19 crisis, they expect to speed up their adoption of cloud computing in 2021, notably by implementing a “cloud first” strategy for new development.

The Move to Cloud programme at the former PSA Group was set up in order to organise a global strategy and to frame the growing number of development and deployment initiatives in the public cloud. Its goal is to clarify the objectives and define the guidelines for using public cloud computing and to drive its adoption in all its components, be they technical, economic, organisational or skills related.

As part of this programme, the IT Department has set up a multidisciplinary team involving all the business units concerned to manage this change. A monthly committee with the CIO and their team was set up from the start and continues to this day to steer the project and make the necessary decisions. Regular meetings are held with the main cloud computing providers.

Cloud computing has many impacts that can vary in nature. One key impact concerns enterprise architecture, particularly data architecture. Like many others, the company had built a single, centralised vision of its data lake in order to develop data projects based on the cross-referencing of data from different domains, but cloud computing, through a centrifugal movement, entails a distribution of data among different cloud computing services and potentially distant locations.

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

(*) This feedback is from PSA Group when STELLANTIS was being created. STELLANTIS’s cloud computing policy is now built by actions to converge the strategies of ex-PSA and ex-FCA.

FEEDBACK FROM SYSTÈME U

Groupement U is a large-scale food distribution cooperative with deep regional roots and which is governed by three entities: U Cooperative brand, U Logistics, U IRIS. U IRIS is responsible for all IT resources, including design, development, integration, hosting, operation, infrastructure, security.

The goal of the IT transformation is to tackle future challenges with e-commerce, new modes of consumption, more personalised customer relations, changes in the distribution market, automated production methods, and prediction in supply systems, among others. The business units have drawn up a strategic plan to overhaul the software for central store and sales management, logistics and supply.

System U has adopted a cloud computing migration strategy quite recently, with a pragmatic approach to adopting SaaS solutions. The decisions of the IT department are guided by the value brought to the business units, responsiveness and time to market. The company has chosen to maximise its use of managed services with cloud first, SaaS and PaaS, and to offer them through a catalogue of cloud computing services. Therefore, they will not necessarily migrate all of their infrastructure to the cloud.

Thus, U IRIS is positioning itself as the company's provider of cloud computing services: a "cloud broker" for internal customers. By its nature, this is a hybrid cloud strategy, but it is also a deliberate choice because the current IT is resilient with a very good quality of service. The IT department will perform a functional breakdown of the IT with an opening by API and micro services, and will switch new software to cloud computing when there is a business interest by adding containerisation, including in data centres.

The company faces two major challenges: FinOps, on the one hand, which is seen as an additional cost and which has real difficulty in valuing the contribution of cloud computing and, on the other hand, reorganising teams to avoid a two-speed IT, which implies training teams from the start and finding a balance between having multidisciplinary skills in the teams but also disseminating them in the company.

U IRIS chose Google's cloud platform for several reasons: Google has a very good image in the company after the deployment of GSuite, the possible containerisation with automated releases through the Terraform tool, the implementation of a Kubernetes project associated with the cloud computing migration project, as well as the launch of a major data project. Since Google Cloud Platform is based on standards that are more open source, in particular PostgreSQL, we can consider possibilities of repositioning in the future.

As part of its data strategy, U IRIS wanted a central access point to carry out analytical, AI and other work by consolidating all the data processed and making them available to brands and business units to serve themselves without depending on the IT department. In 2016, the implementation of big data made it possible to open up raw data (with dedicated tools) to the business units. From 2019 to 2021, the business units successfully adopted the platform. But the current analytics platform is cumbersome due to an excessively rich ecosystem, excessive recovery times, a redundancy of SQL solutions, and costly data crossovers with decision-making IT.

At the end of 2020, U IRIS launched its Data.Next programme to migrate these two platforms to cloud computing, which made it possible to compare the Big Query and Snowflake solutions, both highly appreciated by their respective customers. Google has been proactive in presenting the Big Query roadmap with interesting key functions, and they also proposed a system for securing the build project, with a system for steering by the GCP board. The IT department chose to migrate the big data and then the decision-making IT the following year, relying on 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 companies 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.

Belonging

Cigref speaks with one voice on behalf of major French corporations and public administrations on the subject of digital technology. Its members share their experiences of the use of technology in working groups in order to elicit best practices.

Intelligence

Cigref takes part in group discussions of the economic and societal issues raised by information technologies. Founded nearly 50 years ago, making it one of the oldest digital associations in France, it draws its legitimacy from both its history and its understanding of technical topics, giving it a solid platform of skills and technical know-how, the foundation stones of digital technology.

Influence

Cigref ensures that its member companies' legitimate interests are known and respected. As an independent forum in which practitioners and actors can discuss and create, it is a benchmark recognised by its whole ecosystem.

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