Cloud Computing in Europe

Appendix 10

Cloud Services Supply Landscape

15 July 2020

h-cloud.eu

Title	Cloud Computing in Europe. Appendix 10: Cloud Services Supply Landscape
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Version	0.7
Date	15 July 2020
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Important Notice: Working Document

This briefing is an annex to the Green Paper v 0.7. The Green Paper is an outcome of the H-CLOUD project, a Coordination and Support Action that has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement n. 871920.

CONTENTS

1 OVERALL CLOUD MARKET

(See Appendix 1 for a review of the technical definitions of different types of cloud service and deployment models).

There are three tiers of cloud service providers active in Europe:

- Tier 1 global cloud hyperscalers (operating in all European countries, at least through sales operations). Examples are AWS, Microsoft Azure, Google Cloud, Alibaba, IBM, Oracle.
- Tier 2 European cloud providers (operating in most European countries). These are typically the national telecom providers and large hosting or outsourcing providers. Examples include T-Systems, Orange Business Services, Telefonica, Telecom Italia, BT, OVH, etc.
- Tier 3 local cloud service providers (only operating in one or a few countries or even parts of a country).

Global public cloud vendors, also called "hyperscalers", have been recording the highest growth and largest volume of cloud business. Private cloud vendors and local public cloud vendors have been typically emerging from the ranks of traditional IT and telecom providers, and often their cloud business has related to enabling (e.g., re-hosting, re-platforming, cloudifying) and migrating non-cloud IT environments to the cloud and operating these new cloud environments for their customers; this category of vendors has been characterized by a moderate growth as opposed to exponential growth in the case of public cloud vendors.

In addition to the physical technology dimension of cloud services, there is a complex ecosystem of service organizations that are active in the cloud market, delivering services such as migration services, audits, advisory, SLA measurements, service monitoring, support, etc. that are essential to the provisioning of cloud services. These organizations also enable customers to design and operate hybrid cloud and multi cloud architectures.

1.1 The European cloud ecosystem

US-based vendors strongly dominate the public cloud market in Europe, with only 2 vendors in the top 10 in the region being headquartered in Europe. Furthermore, the US-based vendors have been consistently increasing their market share over the past years, according to IDC's 1H2019 semi-annual public cloud tracker[1].

Sector	Size & share *(H1 2019)*	Growth *(H2 2018)*	Concentration	EU players	Players tracked
IaaS	$4.1b (19%)	27%	Highly concentrated: AWS 48%, MS 7%, IBM 4%	4 in top 10: Orange, Vodafone, T-Systems, Atos with only 11% of market	29
PaaS	$3b, (14%)	37%	Moderately concentrated: Top 4 (MS, AWS, Salesforce, Google) have 46% of market. Next 7 have 22%.	2 in top 10: SAP & Siemens	115
SaaS	$14.4b, (67%)	25%	More fragmented: Top 3 (MS, Salesforce, SAP) have 21%. Next 7 have 17%.	2 in top 10: SAP & Visma	367

Table 1. Public Cloud Services Market in Europe

[1] IDC. Worldwide Semiannual Public Cloud Services Tracker. November 2019

- **Public IaaS market**: the top 3 vendors control 59% of the market, largely because of the massive footprint AWS holds in this space, where the vendor captured 48% of the market spend in 2019H1.Microsoft, as the second largest vendor in this market has 7% market share, followed by IBM at 4%. In the first half of 2019, the top 3 public IaaS vendors expanded their market share by 1.5 percentage points, while the remaining 7 vendors in the top 10 had their market share stagnating. This market segment has the highest number of European providers ranking within the top 10, i.e. Orange, Vodafone, T-Systems/Deutsche Telekom and Atos. However, their role and market power is reduced, as the fourth to the tenth vendors account for just 11% of the market spend. According to IDC's semi-annual public cloud services tracker 1H2019 release (November 2019), IDC is tracking 26 public cloud service providers in the European IaaS market. However, there might be many more providers not accounted for in the tracker.

- **Public PaaS market:** the top 4 vendors (Microsoft, AWS, Salesforce, Google) have 46% market share, expanding their footprint by 4 percentage points in 2019H1. In this market the concentration is less severe, with the fourth to the tenth vendors accounting for 22% market share. Despite the slightly lower market concentration relative to Public IaaS, there are only 2 European vendors (i.e. SAP and Siemens) in the top 10. IDC tracks 115 companies in this market, but that is not the totality of providers in this space.

- **Public SaaS market:** the top 3 vendors (Microsoft, Salesforce, SAP) have 21% market share, while the remaining seven vendors up to the tenth account for 17% market share. While the leading vendors are US-based, with only 2 European vendors in Top 10 (SAP and Visma), market power is better distributed and because of the massive variety of use cases European vendors are in a better position to compete. IDC tracks 367 providers in this space, but that is not the totality of the market. The SaaS market is very dynamic because many software vendors are transforming to become SaaS providers, and are looking for a partner in the IaaS and PaaS space to run on.

IT consulting services market: The provision of public cloud services (i.e. Public IaaS, Public PaaS and Public SaaS) cascades into a wide range of opportunities for IT services providers to deliver their services ranging from advisory and consulting to system integration and deployment services to managed and support services. Most public cloud services vendors maintain ecosystems of partners to deliver their services to the end customer. Fragmentation in the IT services provider landscape pertaining to professional and managed services associated with cloud is high, mapping largely the fragmentation found in the traditional IT services domain.

1.2 Market Share Differences by Country

The global cloud hyperscalers have customers across Europe, but they only have data centers in select European countries, as it requires a high level of capital investment to open up a cloud datacenter. They are planning to broaden their network of datacenters in Europe, but will likely not cover every single European country, as the market potential especially in smaller countries does not warrant the capital expenditure.

We also see country level differences in terms of the appetite for cloud adoption. The UK and Netherlands have embraced public cloud services early on, whereas Germany and France have been slower to adopt.

1.3 Market for edge & fog infrastructure

(See Appendix 1 for technical definitions of “edge” and “fog”.) The next wave of build outs is around distributed clouds and extending cloud services to the edge, requiring many local edge access points. According to IDC's 2019 European survey of 659 organizations, currently about 10% of their data resides on the edge, 18% in secondary datacenter locations, 36% in core data centers and 35% in the

public cloud. This is likely going to change significantly over the next 5 years, as 5G will be rolled out and a network of edge locations will be established. (See Appendix 11 for an extended analysis of edge technologies and markets.)

The edge technology domain is comprised of two components:

- Core computing infrastructure - describes all IoT/edge-related computing processes that occur inside an organization's IT datacenter (which can be housed inside an organization's premises, collocated off-premises, or off-premise on top of a public cloud infrastructure). This core, central infrastructure acts as aggregation and dissemination capability.
- Edge infrastructure – describes anything outside the datacenter, spanning the space between the endpoint and the core (depending on use case, the endpoint or sensors can sometimes be encapsulated in the edge)

Spending on edge infrastructure (i.e. specific compute, storage, networking) in Europe is less than $1 billion today, while the core edge computing platform infrastructure spend (i.e. specific compute, storage, networking) in Europe totals around $2-2.5 billion. Combined, the infrastructure spend for edge is under $3.5 billion, aggregating both the core computing platform and the outside the datacenter element[2]. By contrast, the public cloud spend in Europe is $47.7 billion, according to IDC[3].

Leading public IaaS and PaaS vendors have introduced offerings that extend their capabilities to the edge.

- AWS made its first move into edge computing back in 2017 when it launched its first edge offering, i.e. the GreenGrass portfolio. Since then, the company has been consistently enriching the offering (including capabilities related to messaging, data and state synchronization, event-driven and data streaming management, software development kit, container management) around the service suggesting ambitions to build an edge computing platform.
- Microsoft introduced Azure IoT Edge also in 2017 and has been consistently working to expand its edge capabilities. Microsoft's edge computing platform ambitions are also very clearly expressed, and in early 2018 Microsoft announced a $5 billion investment allocation over four years to build its edge computing portfolio.

Despite these new offerings, the philosophy of both AWS and Microsoft is to move edge data either all the way to the cloud for processing, or to intermediate “fog” computing facilities[4].

1.4 Other Initiatives of Large Cloud Providers

Large vendors are introducing new compute and/or IT management offerings, including:

- diversified forms of cloud computing: e.g. AWS enables customers to acquire AWS-built infrastructure and incorporate it into their data centers (via the AWS Outposts offering); AWS also announced Local Zones, which are smaller-scale AWS cloud operations brought closer to customer operations or important economic areas.
- application infrastructure management offerings aimed to become core architectural underpinnings for organizations that seek to centralize their IT and data operations. Such is the case of Google (via the push into the market of its infrastructure management offering Anthos), Microsoft (via its Azure Arc multi-cloud management offering) or VMware (via its Project Tanzu initiative)

These large public cloud providers want to help clients manage “all” of their cloud investments, not just those hosted on their own facilities. This approach makes hybrid cloud management easier for clients, but also increases CSP’s influence over and visibility into the growing hybrid cloud market and allows

[2] IDC. EMEA Edge and Core Internet-of-Things Infrastructure Forecast, 2019-2023. 2019.

[3] IDC. Worldwide Semiannual Public Cloud Services Tracker. November 2019

[4] LightKone Reference Architecture (LiRA)

them potentially to favour their own facilities when there is discretion over where workloads are launched.

1.5 Role of non-US players

The US-based public cloud vendors clearly dominate the top 20 positions in each of the 3 cloud market segments, and their positions are not likely to weaken over the medium term. Presence of non-US, non-European vendors within the ranks of public cloud services providers that can have a meaningful market role is currently low, as is the likelihood of China-based public cloud services vendors increasing their penetration of the space significantly.

Presence of Indian providers is felt, not in the direct provision of public cloud services, but in the ecosystem enabled by public cloud vendors. However, their role and market influence within the professional and managed services derived from public cloud are unlikely to exceed the role and market influence these providers have in traditional IT ecosystems.

1.6 Cloud technology suppliers

The structure of the cloud technology market comprises hardware vendors who supply the server, storage and networking systems necessary to build out the cloud datacenters. These are the traditional IT hardware vendors like Dell, HPE, Cisco, Huawei.

Then we have the software vendors, providing infrastructure and middleware software.

Firstly, we have virtualization vendors like VMware and Microsoft with their hyperV product. Increasingly, virtualization is being combined with or replaced with containers and Kubernetes, for example Red Hat Openshift.

On the next layer up, we have the system and service management vendors who provide software to manage heterogeneous hardware environments. Then we have the middleware layer with databases and integration software. Lastly, we have the application layer.

There is a large ecosystem of service providers in Europe, who are either selling their own hosting services, managed services or cloud services, or they are reselling other public cloud services.

Finally, there are service providers who help to architect the cloud solutions, migrate applications to the cloud and operate cloud environments.

2 TRENDS IN SUPPLY SIDE CLOUD

2.1 Evolution of the IaaS and PaaS cloud ecosystem

Looking at the past three to five years, one can project future trends in the public cloud services vendor landscape, where the most concentrated segments, Public IaaS and Public PaaS, are going to further experience higher levels of consolidation. For instance, between 2014 and 2018, the top 3 vendors in Public IaaS (all US-based) increased their EU market share by 17%, and the top 3 vendors in Public PaaS (again, all US based) increased their EU market share by 16%. Since the investment in IaaS and PaaS requires a very high level of capital and the space for business and technical differentiation is limited, the pace of market share expansion for the top 3-5 vendors in these segments will probably accelerate over the next couple of years. At the same time, because cloud service providers offer value directly to clients (i.e. as a final service) and compact a wide IT supply chain (e.g. hardware, whole infrastructure architectures, databases, data platforms, etc.) within their services, client bargaining power is likely to shrink.

Comments received in H-CLOUD's webinar of experts on supply side challenges indicated that European cloud providers may face difficulties in the market simply because they do have as strong a marketing presence as many of the larger US providers.

S-L Challenge 1: The top public IaaS and PaaS providers are non-EU and dominate the market. How can EU providers compete with US IaaS/PaaS providers with the same reliability, scale and become preferred providers? [Deployment]

As discussed in more detail in Appendix 12, the dominant cloud IaaS and PaaS providers offer their clients (and their IT service partners) attractive collections of proven, interoperable cloud-technologies, integrating physical infrastructure with a range of software-based capabilities that are easy to use and attractively priced (or free). Adopting and implementing cloud-based solutions with these tools creates "stickiness" and dependency on those providers' architectures and solution suites.

S-L Challenge 2: Today's cloud service providers (CSPs) have achieved market success through economies of scale, which have also funded the creation of proprietary, yet effective, cloud deployment tools. They have insulated the clients from uncertainty and change in the technology layers, and their clients have benefited from this. Proprietary solutions from large cloud providers are very appealing to clients -- their effectiveness and usability are more important to clients than the risk of "lock-in" and architectural dependency. This has created barriers to enter the IaaS and PaaS market segments. [Deployment]

S-L Recommendation 2.1: Support development of cloud-based solutions that can be provided/used by EU cloud providers and that offer as good or better ease of use and effectiveness compared to proprietary solutions.

S-L Recommendation 2.2: Evaluate how well "cloud switching" policies allow clients to migrate from proprietary platforms to other providers.

Potentially, the PaaS layer will be where most value will be created, because it enables the application software layer. The more robust and sophisticated the PaaS layer, the less users of more sophisticated applications or platforms need to worry about the infrastructure details. The simpler that layer is to use, the easier it is to create and exploit cloud applications.

The PaaS layer is a key enabler of both cloud computing applications, and edge computing deployment and applications. PaaS is also a good place to ensure a uniform data protection/security/privacy capability.

Clients will want to create applications in the cloud and therefore need the platforms that support their developments. IaaS providers are pushing up into the PaaS layer with their container and microservices functionality. Software suppliers (those who provide SaaS) create PaaS platforms to enable customers to create extensions to the SaaS services.

Both IaaS and SaaS providers are moving into the PaaS. IaaS players to extend their reach and serve a wider community. SaaS players need PaaS because it enables their software applications.

S-L Challenge 3: Most value will be created in the PaaS layer in the future. This requires a strategy to increase the competitiveness of EU providers in the PaaS Layer and increase their effectiveness as enablers of EU based applications.

S-L Recommendation 3: A "GDPR compliant" cloud abstraction layer for cloud deployments (that sits above the physical infrastructure) might be useful for both large and small organizations looking to deploy cloud technology. Other tools to increase competitiveness could include creation of a centrally managed service and tool catalogue, potentially by the EC or at least endorsed by the EC, substantial marketing support for products appearing in that catalogue, and strong governance and audits to make sure that the catalogue is up to date and that security standards are met.

2.2 Evolution of the SaaS cloud ecosystem

There is huge potential in the EU SaaS layer, as all industry specific solutions are undergoing the transformation from on-premise to SaaS provider. However for many providers that have only recently transformed to SaaS deployment, quality of service has been an issue.

Market power is more evenly distributed in the SaaS ecosystem, and, because of the massive variety of use cases, European vendors are better able to compete. Nevertheless the leading SaaS vendors are US-based, with only 2 European vendors in Top 10 (SAP and Visma). For example, between 2014 and 2018, the top 3 vendors in Public SaaS (all US) expanded their market share by only 2.5 percentage points. The public SaaS space should continue to see similar levels of fragmentation for some time. As more and more software vendors (ISVs), particularly mid-tier players, transform into SaaS providers, the market will remain very dynamic.

S-L Challenge 4: The SaaS market is the one with the largest in terms of EU participation, as independent software vendors (ISVs) are moving to the SaaS market.

S-L Recommendation 4.1: Strengthen competitiveness of EU SaaS providers.

S-L Recommendation 4.2: Supporting EU ISVs in a faster transition from old business models to SaaS provisioning is a priority.

2.3 Evolution of the IT services ecosystem

As in the Public SaaS market, the concentration levels in the cloud-related IT services ecosystem feeding into the public cloud market is not likely to experience major changes as entry barriers are surmountable while the market power of respective providers is distributed in a fashion that enables wide competitive participation. We expect to see more service providers to focus on helping customers to migrate to the cloud and operate cloud environments.

S-L Challenge 5: Although fragmented, the EU-based cloud-related IT services ecosystem can potentially act as a strong influencer on cloud adoption across the EU.

S-L Recommendation 5: Work with the EU-based cloud-related IT services ecosystem to reduce barriers to cloud adoption and identify tools that could maintain or increase the market share of EU-based cloud providers. Efforts could include support for accessing results and deliverables from EC-funded R&I projects, case studies and promotion of successful EU-based implementations.

2.4 Evolution of the edge ecosystem

In the short to medium term, the spend on edge infrastructure is forecast to grow faster than the spend on edge computing platform infrastructure in Europe, yet the difference will not be dramatic (21% vs 14.5% CAGR 2018-2023). This could allow large US cloud service providers to exert significant influence over the edge market in the near term.

At the same time, those large cloud service providers are struggling to build out datacenters in relevant European countries and are unlikely to increase their regional presence to support edge, even in larger countries. If edge computing becomes pervasive as projected, a wide number of market participants will have direct relationships with the end customer, bargaining power could remain balanced between end user organizations and their providers.

This could create an opportunity for Tier 2 providers, notably those associated with mobile networks, to take a more prominent role in edge infrastructure build out, leveraging their existing footprint of distributed facilities. However, there will still be competition over whose software will power that infrastructure, and there is a window for EU providers to establish a beachhead for market growth.

S-L Challenge 6: Uncertainty over who will invest in physical edge infrastructure.

S-L Challenge 7: Uncertainty over who will dominate the software stack that runs on edge infrastructure.

A more in depth discussion of edge challenges and related recommendations is included in Appendix 11.

3 CLOUD CODES OF CONDUCTS (COC) AND CLOUD STANDARDS

In Europe, we see at least two cloud codes of conduct emerging, CISPE and EUcloudCOC. They both provide guidance on how to implement GDPR when using cloud services. CISPE focuses mainly on the IaaS layer, while EUcloudCoC addresses all three layers (IaaS, PaaS and SaaS). In both cases, these processes clearly define the division of responsibility between the cloud provider and client in fulfilling EU regulations -- and the client clearly has ultimate responsibility for compliance.

3.1 EUcloudCoC

The EU Cloud Code of Conduct (source: https://eucoc.cloud/en/about/about-eu-cloud-coc.html)

- Covers the full spectrum of cloud services: software (SaaS) and platform (PaaS) as well as infrastructure (IaaS).
- Has an independent governance structure to deal with compliance as well as an independent monitoring body, SCOPE Europe, which scrutinizes cloud services which sign up to the Code and monitors services that are certified in the Code – a requirement of GDPR.
- Invites Cloud Service Providers of all sizes and from all cloud sectors to join: there are different membership options, depending on CSP's interests. Once a member, CSP's can declare Cloud Services adherent to the Code, committing to rigorous data protection safeguards
- Is the only Code drafted together with authorities of the European Union: the Code was developed by the Cloud Select Industry Group (Data Protection Code of Conduct Subgroup) convened by the European Commission under the auspices of DG Connect and with the involvement and advice of DG Justice. Development of the Code was further informed by input from the Article 29 Working Party.

As of April 15, 2020, a small number of IaaS and SaaS services have been reviewed and certified against the relevant provisions of the EU Cloud Code of Conduct.

The Gaia-X initiative indicates that the certification processes of the EU Cloud Code of Conduct would be a good model to manage certification against the wide range of standards being developed by Gaia-X.

3.2 CISPE

CISPE's Code of Conduct for data protection anticipates the enforcement of the European Union's General Data Protection Regulation (GDPR). (source: https://cispe.cloud/code-of-conduct/)

The code aligns with the strict requirements laid out in the GDPR framework to help cloud infrastructure (IaaS) providers comply and so avoid penalties while also offering a framework to help customers and end users to select cloud providers and trust their services.

The CISPE Code of Conduct:

- An effective, easily accessed framework for complying with the EU's GDPR
- Excludes the re-use of customer data
- Enables data storage and processing exclusively within the EU
- Identifies cloud infrastructure services suitable for different types of data processing
- Helps citizens to retain control of their personal and sensitive data

The CISPE Code of Conduct establishes clear limits to CSPs' responsibility for ensuring their clients comply with GDPR and related regulations and highlights the significant role of clients in properly designing their business applications to achieve full compliance.

Both CoC and CISPE have applied to become ISO standards.

S-L Challenge 8: 'Codes of conduct' and standards may not be helping EU clients adopt cloud solutions and at the same time maintain compliance with EC regulations such as GDPR.

S-L Recommendation 8: Evaluate the impact of ‘codes of conduct’ and standards on EU cloud adoption and identify mechanisms for improving adoption while maintaining GDPR compliance.