Document name	Code	Segment	Created by
Ahmad2020-Cloud_Computing_Trends_and_Cloud_Migration_Tuple	CLOUD INFRAESTRUCTURE > Definition of cloud computing	These features characterize it to be platform-independent, portable, and ubiquitous. The definition of cloud computing given by the National Institute of Standards and Technology (NIST) of USA is most cited in the literature. It focuses on the key features of cloud computing such as opportune and	Ivon Miranda Santos
Ahmad2020-Cloud_Computing_Trends_and_Cloud_Migration_Tuple	CLOUD INFRAESTRUCTURE > Public cloud	Cloud computing is highly discussed agenda in the ICT circles of corporations and being adopted at a very rapid pace. The revenue for public cloud services is expected to rise at a staggering percentage of 17.3 in 2019 to reach up to USD 206.2 billion [3]. In order of highest revenue share, these services are cloud application services (SaaS), cloud business process services (BPaaS), cloud system infrastructure services (IaaS), cloud application infrastructure services (PaaS), and cloud management and security services.	Ivon Miranda Santos
Ahmad2020-Cloud_Computing_Trends_and_Cloud_Migration_Tuple	CLOUD INFRAESTRUCTURE > Public cloud	This section will illustrate upon basics of cloud computing, container technology, fog computing, and edge computing. Cloud computing is deployed through public clouds, private clouds, community clouds, and hybrid clouds. It is offered through majorly one of the service deliv-ery models such as infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS).	Ivon Miranda Santos
Ahmad2020-Cloud_Computing_Trends_and_Cloud_Migration_Tuple	CLOUD INFRAESTRUCTURE > Hybrid cloud	Cloud computing is deployed through public clouds, private clouds, community clouds, and hybrid clouds. It is offered through majorly one of the service deliv-ery models such as infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS).	Ivon Miranda Santos
Ahmad2020-Cloud_Computing_Trends_and_Cloud_Migration_Tuple	CLOUD INFRAESTRUCTURE > Elasticity	Cloud computing also provides a new approach to application development and deployment known as cloud native. Cloud native approach among others ensures the stateless computing so that elasticity of cloud can be achieved in real time and hence user traffic can be dynamically directed to any server regardless of their state of sessions. Cloud-native application (CNA) characterizes a distributed, elastic, and horizontal scalable system consisted of (micro) services that segregates state in a minimum of stateful components [14]. CNA may be developed with combination of best languages and managed through the DevOps processes.	Ivon Miranda Santos
Ahmad2020-Cloud_Computing_Trends_and_Cloud_Migration_Tuple	CLOUD INFRAESTRUCTURE > Definition of cloud computing	Virtual: This term is very integral of cloud computing as the whole technology works on virtualization of resources. Similarly, the virtual machine (VM)-related concepts and processes have also appeared in this cluster such as VM consolidation, migration, live migration, placement, provisioning, storage migration, scheduling, and security. Moreover, virtual network and virtual data center also happen to fall under this cluster	Ivon Miranda Santos
Ahmad2020-Cloud_Computing_Trends_and_Cloud_Migration_Tuple	CLOUD INFRAESTRUCTURE > Definition of cloud computing	Data centres (DC) are the basic infrastruc-tural component of cloud computing and related terms were DC networking and management.	Ivon Miranda Santos
Ahmad2020-Cloud_Computing_Trends_and_Cloud_Migration_Tuple	CLOUD INFRAESTRUCTURE > Definition of cloud computing	Multi: Multi-term has many-faceted implication in cloud computing. Most com-mon of all is multi-tenant environment. Multi-agent system (system of multiple interacting intelligent system) [25] has also become significant in the perspective of cloud computing. This term is also associated with replication and redundancy such as multicast, multi-cloud, and multi-gateway system.	Ivon Miranda Santos
Ahmad2020-Cloud_Computing_Trends_and_Cloud_Migration_Tuple	CLOUD INFRAESTRUCTURE > Elasticity	Dynamic: dynamic term is associated with real-time changes for instance cloud-native applications support dynamic resource allocation to ensure elasticity. This term is important for load balancing, consolidation, priority, resource migration, and scheduling. This term is also used as dynamic migration and consolidation of VMs, and dynamic structures.	Ivon Miranda Santos

Ahmad2020-Cloud_Computing_Trends_and_Cloud_Migration_Tuple	CLOUD INFRAESTRUCTURE > Public cloud	Cloud computing has become a norm of the day and all the leading organization com-mercial or government of different size and domain are adopting it, recent being the US Defense. Public cloud service revenue is expected to reach 206.3 billion in 2019. Cloud computing technology is maturing day by day with hypervisors, containers, cloud-native applications, flog computing, edge computing, and cloudlets to become a robust platform to host complete range of information technology services.	Ivon Miranda Santos
Alouffi2021-A_systematic_literature_review_on_cloud_computing_s	CLOUD INFRAESTRUCTURE > Public cloud	Existing literature on com-mercial service providers (CSPs) reveals that cloud service models are involved in hampering security concerns [55]. Therefore, it is users' workload based on the sensitive data that they do not need to outsource to a public cloud directly. Outsourcing the consumers' data and addressing the asso-ciated risks is challenging for both users and cloud service providers.	Ivon Miranda Santos
Ardagna2015-Cloud_and_multi-cloud_computing_Current_challenges_	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	Cloud computing is growing daily, providing a vibrant technical environment where innovative solutions and services can be created.	Ivon Miranda Santos
Ardagna2015-Cloud_and_multi-cloud_computing_Current_challenges_	CLOUD INFRAESTRUCTURE > Public cloud	, one of the most adopted framework to support large volume unstructured information processing) such as Google MapReduce framework, Microsoft HDinsight, and Amazon Elastic Compute Cloud. IDC estimates that by 2020, nearly 40% of Big Data analyses will be supported by public cloud. To support such challenges a Model-Driven Development (MDD) approach developed within the MODAClouds (www.	Ivon Miranda Santos
Asthana2021-Multi-cloud_Solution_Design_for_Migrating_a_Portfol	CLOUD INFRAESTRUCTURE > Elasticity	The use of cloud computing is increasing rapidly in many organizations [1]. Moving an application to the cloud enables organization to make use of the advantages of the cloud like elasticity [2], lower costs, and accessibility of data. To further utilize these advantages, achieve maximum flexibility, and avoid "concentration risk" (putting too many application eggs in one cloud basket), organizations recently tend to spread their applications across different cloud provider.	Ivon Miranda Santos
Asthana2021-Multi-cloud_Solution_Design_for_Migrating_a_Portfol	CLOUD INFRAESTRUCTURE > Hybrid cloud	Yang [12] shows a hybrid cloud solution design for genomics Next Generation Sequencing (NGS) service, which is streamlined for this particular service. Megahed et al. proposes an optimal approach for cloud solution design that satisfies client requirements and cloud offering constraints for an application in [13, 14], though they do not account for the different constraints of choosing different cloud providers in the solution.	Ivon Miranda Santos
Asthana2021-Multi-cloud_Solution_Design_for_Migrating_a_Portfol	CLOUD INFRAESTRUCTURE > Elasticity	Moreover, there is a numerous amount of prior art in applying analytical and opti-mization techniques to different cloud computing problems. For example, migrating vir-tual machines, applications to cloud environment have been discussed in [15–18]. Cloud elasticity optimization in software as a service cloud computing have been explored in [19–22]. Teyeb et al. [23] proposed another optimization model for dynamic placement of virtual machines in cloud data centers. Other works that provide other analytical approaches for different problems, though still in the cloud computing arena, are the ones in [24–26].	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	The purpose of this research was to determine the position of universities in Turkey within the context of cloud computing and to present an abstract hybrid cloud framework for these universities. Descriptive method and survey technique were used in the research. SPSS program was used to analyze the data.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	In this context, a hybrid framework for adopting cloud computing in universities for them to overcome their identified challenges was proposed. The results are primarily intended to provide a guideline to universities in cloud computing adoption.	Ivon Miranda Santos

Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	The purpose of this research is to determine the position of universities in Turkey within the context of cloud comput-ing and to present an abstract hybrid cloud framework for adopting cloud computing into universities to overcome the identified challenges of the universities.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	In the study, section “Literature Review” presents a literature review regarding the theoretical and conceptual background, and section “Purpose, Scope and Method of the Study” introduces the research model in detail. In section “Findings and Evaluation,” the findings of the study are evaluated. Section “An Abstract Hybrid Cloud Framework for Universities” describes the presented framework, while in the last section, conclusion and recommendations are listed.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Elasticity	Rapid Elasticity: Resources can be offered to users by cloud computing when they are needed the most. With this feature of cloud computing, users can use resources when they need and release them for other users when they are finished.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	The cloud conceptual reference model created by NIST contains elements that must be included in a cloud structure; these are “Cloud User,” “Cloud Controller,” “Cloud Service Provider,” “Cloud Agent,” and “Cloud Carrier” (Sevli, 2011). Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) are the service models. Public, private, community, and hybrid clouds are four deployment models of cloud computing (Goyal, 2014).	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Public cloud	Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) are the service models. Public, private, community, and hybrid clouds are four deployment models of cloud computing (Goyal, 2014). Cloud Computing and Universities	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Elasticity	Although personalized learning, being economic, elasticity, measurability, accessibility, low carbon emission, and standardization are shown as some benefits of cloud computing in the education field, security, compliance issue, lock-in, reliability, lack of skills, insufficient support of cloud service providers, policies on the cloud, privacy, and the complexity of cloud technologies are shown as some of its challenges (Njenga et al., 2019; Sabi et al., 2016).	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	The main contributions of this study are as follows: • Determination and evaluation of the current situation of universities and their opinions through the research questions determined within the scope of this study; • Presentation of an abstract hybrid cloud framework for the delivery of university information services such as SaaS, IaaS, and PaaS; • The literature review explaining cloud computing in universities and based on research questions;	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Definition of cloud computing	With the first (R1) question of the study, it was aimed to determine the awareness of the cloud computing service model.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	Cloud architecture status. Nearly half of the universities (43.5%) stated that they did not have a cloud architecture (Figure 5). Results showed that 21.2% of the participants had a private cloud architecture, 12.9% had a hybrid cloud archi-tecture, 11.8% had a community cloud architecture, and 10.6% had a public cloud architecture. In addition, the data obtained from the survey revealed that most of the respon-dents had no cloud architecture.	Ivon Miranda Santos

Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Public cloud	Nearly half of the universities (43.5%) stated that they did not have a cloud architecture (Figure 5). Results showed that 21.2% of the participants had a private cloud architecture, 12.9% had a hybrid cloud archi-tecture, 11.8% had a community cloud architecture, and 10.6% had a public cloud architecture. In addition, the data obtained from the survey revealed that most of the respon-dents had no cloud architecture.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	An Abstract Hybrid Cloud Framework for Universities Within the scope of the study, a literature review was made on how to create the conceptualization process of the model. There are currently four types of cloud models in the market:	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Public cloud	8 SAGE Open “Public Cloud Model,” “Private Cloud Model,” “Hybrid Cloud Model,” and “Community Cloud Model” (Goyal, 2014). Academicians and researchers have proposed different models for different cloud computing categories for the adop-tion of cloud computing.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Public cloud	Some of the critical success factors (CSFs) for the effective implementation of cloud-based e-learning at universities and institutes of higher education are Cloud Data Security, Availability and Reliability, Customizable Service Level Agreement, Network Bandwidth, Compatibility, Technical Support, Management Support, Human and Resource Readiness, Complexity, Cost Flexibility, Ease of Use, and Relative Advantage (Naveed & Ahmad, 2019). Hybrid clouds contain a combination of two or more pri-vate, community, or public cloud structures and therefore have a more complex structure (Goyal, 2014). In the study of K. E. Ali et al.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	Hybrid clouds contain a combination of two or more pri-vate, community, or public cloud structures and therefore have a more complex structure (Goyal, 2014). In the study of K. E	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Cloud computing architecture	Ali et al. (2018), an abstract hybrid model for adopting cloud computing in e-government to overcome the e-government’s challenges was proposed	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	(2018), an abstract hybrid model for adopting cloud computing in e-government to overcome the e-government’s challenges was proposed.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	In the study of Monsalve et al. (Alonso-Monsalve et al., 2018), the orchestration between the volunteer platform and the public, private, or hybrid clouds was described in the proposed hybrid cloud model. Juma and Tjahyanto (2019) proposed the ITOETAM model, which was the combination of the Technological, Organizational, Environmental (TOE), Technological Acceptance Model (TAM), and Internal, External (I-E) methods, to find challenges and suggest the solution to overcome those challenges (Juma & Tjahyanto, 2019). ITOETAM (the proposed model for cloud computing adoption challenges in Zanzibar’s Universities), TOE (the model used previously in cloud challenges), TAM (the model used to solve the challenges of cloud computing), and I-E (the model used to solve challenges in cloud comput-ing) are examples for some different models used in the litera-ture (Juma & Tjahyanto, 2019; Tashkandi & Al-Jabri, 2015). These studies show that cloud-based learning models are becoming widespread and their use is gradually increasing. Elhoseny et al. (2018) proposed a new hybrid cloud-IoT (Internet of Things) model which consists of four main compo-nents: stakeholders’ devices, stakeholders’ requests (tasks),	Ivon Miranda Santos

Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Public cloud	(Alonso-Monsalve et al., 2018), the orchestration between the volunteer platform and the public, private, or hybrid clouds was described in the proposed hybrid cloud model. Juma and Tjahyanto (2019) proposed the ITOETAM model, which was the combination of the Technological, Organizational, Environmental (TOE), Technological Acceptance Model (TAM), and Internal, External (I-E) methods, to find challenges and suggest the solution to overcome those challenges (Juma & Tjahyanto, 2019).	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Public cloud	cloud broker, and network administrator. A proposed architec-ture based on the hybrid cloud model which uses both the pub-lic and private clouds is simulated using CloudSim. It consists of two main parts, that is, the Cloud Management System and the Hybrid Cloud (Sqalli et al.,	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	A proposed architec-ture based on the hybrid cloud model which uses both the pub-lic and private clouds is simulated using CloudSim.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	It consists of two main parts, that is, the Cloud Management System and the Hybrid Cloud (Sqalli et al., 2012). In the cloud computing adoption model proposed by Okai et al. (2014), a roadmap for cloud computing adoption is proposed by universities to over-come the challenges faced	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	In this study, an abstract hybrid cloud framework was pre-sented (Figure 11). The framework consists of Private University Cloud (“PUC”) and Community University Cloud (“CUC”). The structure is a hybrid cloud because it includes both PUC and CUC. The purpose of the framework is to meet the expectations of universities in a cloud environ-ment in a cost-effective manner. The stakeholders of the framework are educational institutions, instructors, students, IT personnel, researchers, IT staff and administrators, learn-ers, educational practitioners, and so on. In the creation of the framework, existing studies in the literature on the sub-ject were examined. In the conceptualization process, both the information obtained from the literature and the results obtained as a result of the survey conducted within the scope of the research were used.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Public cloud	In the conceptualization process, both the information obtained from the literature and the results obtained as a result of the survey conducted within the scope of the research were used. In this structure, universities can use their own private or community cloud technologies in places where security and privacy are more important and precaution must be kept high, and public cloud technologies in areas where security measures can be kept at a lower level. PUC Implementation	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	There is a portal structure under the proposed model. Services/applications in PUC or CUC will be delivered via this portal structure. Information services in the model will be put into service through a single hybrid cloud platform. Information services to be provided through this model using a cloud model will be found in this portal.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	Services/Applications of the Proposed Hybrid Cloud Model The architecture of the proposed hybrid cloud includes SaaS, IaaS, and PaaS platform as shown in Figure 12. By combin-ing PUC and CUC environments, the model, which is a com-puting environment, allows data to move and to be shared seamlessly between these environments.	Ivon Miranda Santos

Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	These services can be catego-rized as secret services, dynamic services, and so on. When computing and processing demand fluctuates, hybrid cloud computing gives universities the ability to seamlessly scale their on-premises infrastructure. In the survey, 71.4% of IT departments stated that they did not think to apply cloud computing in their universities.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	Universities can gain the flexibility and computing power of the CUC cloud for their basic and non-sensitive computing tasks, while they can keep their criti-cal applications and data safely behind a university firewall via CUC. Each of the PUC and CUC environments that make up this hybrid cloud architecture has its own benefits and uses. By combining PUC and CUC into a single hybrid cloud, universi-ties can gain greater control over data safety, accessibility, Aydin 11 privacy, authenticity, and security for both their IT infrastruc-ture and their users' data, applications, and systems. The cloud users of the framework will be able to use both PUC and CUC services anytime from anywhere.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	In this study, literature studies focusing on cloud comput-ing in universities were reviewed based on the research ques-tions, and the position of universities in Turkey was determined. In the study, an abstract hybrid cloud framework that contains guidelines to overcome the major challenges identified was presented. Within this context, the existing conditions and problems in the use of the cloud service model in universities were tried to be identified and some recommendations for solving these problems were drawn up.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	This can be interpreted as an indicator of the need for cloud comput-ing in universities. Therefore, based on this result, an abstract hybrid cloud framework was presented. The fact that the vast majority of IT departments are seeing soft-ware costs as the highest expenditure item of their budget suggests that SaaS cloud services should be used first.	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Definition of cloud computing	In the chi-square test done in the study, no significant dif-ference was found between the state and private universi-ties in terms of knowledge level related to cloud computing	Ivon Miranda Santos
Aydin2021-A_Study_of_Cloud_Computing_Adoption_in_Universities_a	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	Cloud computing will enable these universi-ties, growing in number, to provide information services more cost-effectively.	Ivon Miranda Santos
Baby2015-Multicloud_architecture_for_augmenting_security_in_clo	CLOUD INFRAESTRUCTURE > Public cloud	As cloud computing service is a pay as you use service, it promises to reduce the initial capital investment as well as operational expenditures for hardware's and software's used in an organization [1]. Clouds can be classified based on the physical distance between the client and the cloud provider into public clouds, private clouds and hybrid clouds. If the cloud vendor is located far away from client it is termed as public cloud and if cloud vendor and client are in nearby premises it is termed as private cloud and if clients make use of both private and public clouds together are termed as hybrid clouds. There are three main service models for cloud computing [2]:	Ivon Miranda Santos

Baby2015-Multicloud_architecture_for_augmenting_security_in_clo	CLOUD INFRAESTRUCTURE > Hybrid cloud	As cloud computing service is a pay as you use service, it promises to reduce the initial capital investment as well as operational expenditures for hardware's and software's used in an organization [1]. Clouds can be classified based on the physical distance between the client and the cloud provider into public clouds, private clouds and hybrid clouds. If the cloud vendor is located far away from client it is termed as public cloud and if cloud vendor and client are in nearby premises it is termed as private cloud and if clients make use of both private and public clouds together are termed as hybrid clouds. There are three main service models for cloud computing [2]:	Ivon Miranda Santos
Baby2015-Multicloud_architecture_for_augmenting_security_in_clo	CLOUD INFRAESTRUCTURE > Public cloud	3.Two approaches are common in this method, first method involves a trusted private cloud taking a small share of critical computation and un-trusted public cloud takes most of the computational load [3]. The second method distributes computation among several un-trusted public clouds with the assumption that these clouds will not breach security [3]. Obfuscating Splitting is a special case of partition by application logic [6].	Ivon Miranda Santos
Baby2015-Multicloud_architecture_for_augmenting_security_in_clo	CLOUD INFRAESTRUCTURE > Public cloud	Block Level Diagram of Homomorphic Encryption Small trusted private clouds manage the keys and perform the encryption and decryption and massive computations on encrypted data are done by the un-trusted public clouds. A fully homomorphic encryption scheme allows for both additive and multiplicative operations while a partial homomorphic encryption supports either addition or multiplication operation.	Ivon Miranda Santos
Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	(1) Containerization and orchestration of applications, (2) Application placement and replication, (3) Portability and multi-cloud migration, (4) Resilience to network partitions and bandwidth constraints, (5) Automated service discovery and load balancing, (6) Localized image registry, and (7) Support for platform monitoring and management. We present an implementation and validation case study, Crane Cloud, an open source multi-cloud service abstraction layer built on-top of Kubernetes that is designed with inherent support for resilience to network partitions, microservice orchestration (deployment, scaling and management of containerized applications), a localized image registry, support for migration of services between private and public clouds to avoid vendor lock-in issues and platform monitoring. We evaluate the performance and user experience of Crane Cloud by implementing and deploying a computational and bandwidth intensive machine learning system. The results show lower response times of the system on Crane Cloud compared with hosting on other public clouds. The Crane Cloud platform is serving as a cloud-service for students and developers in low-resource settings and also as an education platform for cloud computing.	Ivon Miranda Santos
Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	4. Evaluation of performance and user experience of Crane Cloud platform by implementing and deploying a computational and bandwidth intensive machine learning system that shows lower response time compared when hosted on other public clouds. 2.	Ivon Miranda Santos

Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	The dataset is used for training and evaluation data for the machine learning models. The images are crowd-sourced from local farmers using mobile phones and can be stored on available public cloud platforms as well as on local storage to allow online training and evaluation of the machine learning models. The process flow typically involves uploading and downloading a huge datasets from the local storage and cloud systems. Such a dataset can take up to 24 h or so to upload to a public cloud service provider over slow intermittent connections that characterize many low-resource settings. 2.2.	Ivon Miranda Santos
Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	As can be observed from the above scenario, a developer uploading training dataset of 300 GB images to a cloud platform could easily take several days over a slow connection. The in-field data collection by farmers to a public cloud repository can be very slow because of sporadic Internet connectivity in rural areas. Access speed to cloud services would be faster if the cloud data centers were located near to the users, however, 98.4% of the data centers of popular cloud providers are located overseas (outside Africa) (Calandro et al.,	Ivon Miranda Santos
Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	However, it is important to note that these issues are similar in any other location with similar resource constraints. The design and setup of most public cloud platforms assume stable infrastructure across the users and leave the issues of connectivity challenges to the applica-tion developers. This shifts the burden and unnecessary complexity to the application developers who must consider offering different function-trimmed variations of their app services for users situated in low-resource settings, for instance, Facebook Lite app (Shankar, 2015), WhatsApp Lite (DigitBin, 2019), Uber Lite (Uber, 2021), Google Go (Google LLC, 2019) and Gmail Basic (Google LLC, 2021) for slow Internet connections and low-end devices.	Ivon Miranda Santos
Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	Countries have recently enacted laws that enforce data sovereignty and prevent data from leaving the country's boundaries. This becomes difficult to implement in regions where public clouds do not have physical presence. For instance, on the African continent where public cloud data centers are still sparse, it becomes almost impossible to comply with such policies. The microservice architecture and cloud orchestration platforms such as Kubernetes (Burns et al.,	Ivon Miranda Santos
Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	In the above scenario, the APDD system can be broken into independent microservices each with different data jurisdiction policies. For instance, the data storage and management microservice needs to be enforced to remain within the boundaries of the country while the plant disease prediction service can run in a public cloud without restrictions and benefit from the rich machine learning libraries and tools. Such a setup would require a multi-cloud environment that spawns boundaries with support for data jurisdiction policies specific to a microservice and use case.	Ivon Miranda Santos

Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	Other than vendor lock-in, there are other variations including product lock-in, version lock-in, architecture lock-in, platform lock-in, skills lock-in and mental lock-in (Hohpe, 2019). Public clouds offer provider-specific proprietary solutions to meet the market demands and this has resulted in an interoperability, integration and portability downside across the cloud divide. Consequently, the applications developed for a specific cloud provider such as Amazon Web Services (AWS) may not work out-of-the box with another cloud provider such as IBM cloud due to inherent de-pendencies of the underlying IT infrastructure (hardware and software), cloud semantics and non-standardized APIs (Opara-Martins et al.,	Ivon Miranda Santos
Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	New platforms and architectures such as Kubernetes (Burns et al., 2016) offer new possibilities to implement a vendor neutral layer on top of public and private clouds. However, the current offerings of managed Kubernetes layers assume migration of services in situations where there is stable connectivity and infrastructure and are not de-signed for data centers that may be characterized by frequent network partitions and bandwidth constraints.	Ivon Miranda Santos
Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	Coupled with high costs of Internet access, limited bandwidth and high latencies mainly introduced by distance, the content load times are high and this negatively impacts the user experience. Consider for example in the APDD case study where a cloud-based service for farmers is situated on a public cloud with a data center situated in the North America while the target farmers are located on the African continent. The longer the distance, the higher the number of intermediary links which can act as failure points (bottlenecks) and potentially introduce network packet losses.	Ivon Miranda Santos
Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	Furthermore, there are applications that are delay-sensitive and these require optimal and stringent quality of service parameter values such as low latency, low jitter and minimal or no packet loss for best performance. Currently, public cloud providers attempt to solve this challenge by moving services closer to the user. This approach however assumes presence of data centers closer to the user. Unfortunately this is not always the case for users located in regions where public cloud data centers are sparse. In the next section, we present the design options that need to be considered when developing a multi-cloud service abstraction layer to address the above challenges particularly in low resource settings.	Ivon Miranda Santos
Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Elasticity	Fully leveraging the elasticity of using container-based virtualiza-tion requires automated orchestration and cluster management tools such as Kubernetes,11 Nomad,12 Docker Swarm13 and DC/OS14 that provide an abstraction layer between computing resource pools and the appli-cations.	Ivon Miranda Santos

Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	The Crane Cloud software layer was conceived to address the key hurdles of operating a cloud-service platform in resource constrained environments characterized by challenges identified in Section 2.2. Its main ingredients include resilience to network partitions, support for microservice orchestration, support for migration of services between private and public clouds to avoid vendor lock-in issues, seamless downtime and network traf-fic load distribution, monitoring metrics, and tools for transforming existing non-cloud compliant services into compliant cloud services. The multi-cloud service layer has five components (managed portal, authentication and authorization, monitoring and billing, local registry and the backend service) purposely designed taking into consideration features described in Section 3 and are shown in Fig.	Ivon Miranda Santos
Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Public cloud	Experiment setup The purpose of the experiment was to evaluate the performance and user experience of mcrops when deployed on a public cloud (AWS) compared to the deployment on the Crane Cloud platform. We consider the response time metric as an important metric for the measurement of the quality service and user experience.	Ivon Miranda Santos
Bainomugisha2022-Crane_cloud_A_resilient_multicloud_service_abs	CLOUD INFRAESTRUCTURE > Hybrid cloud	IaaS (virtual machines) hybrid clouds using custom heuristics. Proper-ties such as high availability, scalability, fault-tolerance and monitoring are not discussed and the use of virtual machines may not be the most cost-effective approach to running application workloads. Filip et al. (2018) proposed a solution that considers a finite catalog of primitive microservices and designs a hybrid scheduling algorithm that matches tasks to resources based on task history and availability of resources. In addition to benefits of using a microservice architecture, the paper asserted that costs can further be reduced by placing data closer to processing points based on user density.	Ivon Miranda Santos
Belafia2021-From_monolithic_to_microservice_architecture_The_ca	CLOUD INFRAESTRUCTURE > Elasticity	This approach has the typical advantages of State-less architectures: the on-demand elasticity and the reliability through redundancy. Moreover, an AQL expression can be directly evaluated without the need for an initialization phase. However, this approach turns out to be very cumbersome for the rest of the application. Indeed, the Java services and additional packages must be carried between the components. If this can be handled in a monolithic approach, it can quickly become an issue in a microservice architecture.	Ivon Miranda Santos
Brogi2014-Seaclouds_Seamless_adaptive_multi-cloud_management_of	CLOUD INFRAESTRUCTURE > Public cloud	Due to its prospective benefits and potential, cloud computing is a hot research area. Many private and public clouds have emerged during the last years, offering a range of different services at SaaS, PaaS and IaaS levels aimed at matching different user requirements. To take full benefit of the flexibility provided by the cloud, modules of a complex application should be deployed on multiple clouds depending on their characteristics and strong points.	Ivon Miranda Santos
Brogi2014-Seaclouds_Seamless_adaptive_multi-cloud_management_of	CLOUD INFRAESTRUCTURE > Public cloud	– Unified management API for clouds. SeaClouds facilitates the access and the administration of both public and private cloud providers providing multi-cloud management tools as well as offering cloud providers and consumers a REST-based approach to cloud-based application management.	Ivon Miranda Santos

Brogi2015-Adaptive_management_of_applications_across_multiple_c	CLOUD INFRAESTRUCTURE > Public cloud	Cloud computing is a model for enabling convenient and on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction [1]. The cloud assists to reduce time-to-market and provides on-demand scalability at a low cost for the users. Due to its prospective benefits and potential, cloud computing is a hot research area. Many private and public clouds have emerged during the last years, offering a range of different services at SaaS, PaaS and IaaS levels aimed at matching different user requirements. To take full benefit of the flexibility provided by different clouds that offer different services, the modules of a complex application should be deployed on multiple clouds depending on their characteristics and strong points.	Ivon Miranda Santos
Caceres2022-State-of-the-art_architectures_for_interoperability	CLOUD INFRAESTRUCTURE > Definition of cloud computing	Since the early 2000s when the term "cloud computing" was introduced, the understanding of offered services and resources has been changing very fast.	Ivon Miranda Santos
Caceres2022-State-of-the-art_architectures_for_interoperability	CLOUD INFRAESTRUCTURE > Hybrid cloud	In this research, we will pay attention specifically to architectures which involve multi-cloud integration: Hybrid Cloud, Federated Cloud, Multi-Cloud, Ad-hoc Cloud and Micro Cloud. IV.	Ivon Miranda Santos
Caceres2022-State-of-the-art_architectures_for_interoperability	CLOUD INFRAESTRUCTURE > Hybrid cloud	Following subsections will describe emerging architecture solutions of different layers. A. Hybrid Cloud The simplest form of multi-cloud architecture is a Hybrid Cloud, which represents a consolidation of private and public clouds or a composition of private and public IT infrastructure [7]. Hybrid clouds are especially useful for handling spiking resource demands known in advance, and for working with sensitive data [8]. Most common problems arising for running a hybrid cloud system are related to network, such as problems with latency and connection bandwidth. Also, to access a public cloud from a private cloud there is a need in more complicated network topologies [9]. Limited network capabilities may result in a less effective hybrid cloud setup. A dedicated network linking clouds could power more productive infrastructure, however, this brings an overhead of additional private resources management. Hybrid clouds are typically connected on level from Middleware to Application, as shown on Figure 2. 705	Ivon Miranda Santos
Caceres2022-State-of-the-art_architectures_for_interoperability	CLOUD INFRAESTRUCTURE > Public cloud	A. Hybrid Cloud The simplest form of multi-cloud architecture is a Hybrid Cloud, which represents a consolidation of private and public clouds or a composition of private and public IT infrastructure [7].	Ivon Miranda Santos
Caceres2022-State-of-the-art_architectures_for_interoperability	CLOUD INFRAESTRUCTURE > Public cloud	Most common problems arising for running a hybrid cloud system are related to network, such as problems with latency and connection bandwidth. Also, to access a public cloud from a private cloud there is a need in more complicated network topologies [9]. Limited network capabilities may result in a less effective hybrid cloud setup.	Ivon Miranda Santos
Caceres2022-State-of-the-art_architectures_for_interoperability	CLOUD INFRAESTRUCTURE > Public cloud	Cloud federation enables end users to integrate segregated resources from different cloud systems [10]. The difference of this approach with Hybrid cloud is that Hybrid cloud is formed by different cloud models (private and public clouds), while Federated cloud is formed by different cloud models (private and public clouds) as well as the same clouds (joint private clouds). Both hybrid and federated cloud share the same concept.	Ivon Miranda Santos

Caceres2022-State-of-the-art_architectures_for_interoperability	CLOUD INFRAESTRUCTURE > Hybrid cloud	Cloud federation enables end users to integrate segregated resources from different cloud systems [10]. The difference of this approach with Hybrid cloud is that Hybrid cloud is formed by different cloud models (private and public clouds), while Federated cloud is formed by different cloud models (private and public clouds) as well as the same clouds (joint private clouds). Both hybrid and federated cloud share the same concept. Federated cloud would typically offer different services of different vendors.	Ivon Miranda Santos
Caceres2022-State-of-the-art_architectures_for_interoperability	CLOUD INFRAESTRUCTURE > Public cloud	By using cloud provider APIs, organizations can adjust their cloud plan using different service vendors, according to their needs. Federated clouds are connected on same layers as Hybrid clouds, having same difficulty of networking between private and public clouds. In addition, since Federated cloud can connect multiple services, another limiting factor is a need to manually implement APIs of every service of every cloud provider used.	Ivon Miranda Santos
Caceres2022-State-of-the-art_architectures_for_interoperability	CLOUD INFRAESTRUCTURE > Hybrid cloud	By using cloud provider APIs, organizations can adjust their cloud plan using different service vendors, according to their needs. Federated clouds are connected on same layers as Hybrid clouds, having same difficulty of networking between private and public clouds. In addition, since Federated cloud can connect multiple services, another limiting factor is a need to manually implement APIs of every service of every cloud provider used.	Ivon Miranda Santos
Caceres2022-State-of-the-art_architectures_for_interoperability	CLOUD INFRAESTRUCTURE > Public cloud	● 23%: Need to hire or train personnel for new skills, specific for public clouds support ● 23%: Complexity in environment management policies ● 23% Difficulties optimizing costs ● 25%:	Ivon Miranda Santos
Caceres2022-State-of-the-art_architectures_for_interoperability	CLOUD INFRAESTRUCTURE > Public cloud	However, there are products available that offer limited integration on IaaS level, like OpenStack, OpenNebula and Nimbus. OpenStack is a collection of open-source software packages designed for building public and private clouds, implemented as a set of Python services that communicate with each other via message queue and database. OpenStack implements two Cloud APIs: the Amazon Elastic Compute Cloud (EC2) API, and its own (OpenStack) API.	Ivon Miranda Santos
Caceres2022-State-of-the-art_architectures_for_interoperability	CLOUD INFRAESTRUCTURE > Public cloud	C. Limitations of existing implementations While aforementioned projects present impressive solutions to connect and manage VMs on the IaaS level, current usage of public clouds shifts more and more towards higher levels of the stack. Providers are implementing unique features to make own platforms more attractive, end users want to take advantage of those features.	Ivon Miranda Santos
daSilva2013-From_the_desktop_to_the_multi-clouds_The_case_of_mo	CLOUD INFRAESTRUCTURE > Public cloud	Our approach therefore relies on standard deployment artefacts and frameworks that can easily be moved from one provider to another. 3) Compatibility with public and private clouds We should be able to deploy the Project Management Server in public and private clouds to address specific client requirements. Rationale:	Ivon Miranda Santos
daSilva2013-From_the_desktop_to_the_multi-clouds_The_case_of_mo	CLOUD INFRAESTRUCTURE > Public cloud	Some of our customers are governmental entities or work in the defence sector. They cannot commit to public cloud offerings. We thus need a solution that can be deployed in a physical private infrastructure and that can also be provided as a public cloud service. 4) Security	Ivon Miranda Santos

daSilva2013-From_the_desktop_to_the_multi-clouds_The_case_of_mo	CLOUD INFRAESTRUCTURE > Public cloud	Rationale: This is a major concern of our clients when considering moving from a standard client server local architecture to public clouds. In this context, the Administration Service should be implemented following state of the practice security practices to avoid any data loss or leakage.	Ivon Miranda Santos
deCarvalho2018-Pacificclouds_A_flexible_microservices_based_arc	CLOUD INFRAESTRUCTURE > Elasticity	. For that matter, the applications are built with the focus on integration with the cloud model, to obtain full cloud advantages; it, also ensures other fe-atures labeled as IDEAL (Isolated state, Distribution, Elasticity, Automated management, Loose coupling). In this manner, the native cloud application can faci-litate the application deployment in multiple clouds, hence help treat interoperability and portability (Feh-ling et al., 2014).	Ivon Miranda Santos
deCarvalho2018-Pacificclouds_A_flexible_microservices_based_arc	CLOUD INFRAESTRUCTURE > Elasticity	The use of multiple clouds brings several advanta-ges, and through them, we can achieve the full bene-fits of cloud properties such as elasticity and pay-as-you-go (Mezg´ar and Rauschecker, 2014), (Silva et al., 2013). However, the multiple clouds bring several challenges, as well, e.g., interoperability and portabi-lity related to mitigating vendor lock-in. We consider portability the ability to allow customers to migrate data and systems from one cloud to another and inter-operability capacity to allow customers to use servi-ces across multiple clouds (Rezaei et al., 2014).	Ivon Miranda Santos
deCarvalho2018-Pacificclouds_A_flexible_microservices_based_arc	CLOUD INFRAESTRUCTURE > Public cloud	Two other solutions, Cloud4SOA and RASIC, address interoperability in only one of the service models. Cloud4SOA addres-ses interoperability at the PaaS level; it does not ad-dress any vertical and horizontal interoperability le-vels, and it uses the hybrid delivery model, which is a cloud federation that has a private cloud and at least one public cloud (Petcu, 2014a). RASIC treats inter-operability in the IaaS service model for multi-cloud	Ivon Miranda Santos
deCarvalho2018-Pacificclouds_A_flexible_microservices_based_arc	CLOUD INFRAESTRUCTURE > Hybrid cloud	Two other solutions, Cloud4SOA and RASIC, address interoperability in only one of the service models. Cloud4SOA addres-ses interoperability at the PaaS level; it does not ad-dress any vertical and horizontal interoperability le-vels, and it uses the hybrid delivery model, which is a cloud federation that has a private cloud and at least one public cloud (Petcu, 2014a). RASIC treats inter-operability in the IaaS service model for multi-cloud	Ivon Miranda Santos
dePaula2016-A_systematic_literature_review_on_cloud_computing_a	CLOUD INFRAESTRUCTURE > Public cloud	These three services described above are deployed following four different models: (i) Public cloud is available from a third party service provider via web and is a very cost effective option to deploy IT solutions [20]; (ii) Private cloud is managed within an organization and is suitable for large enterprises (managed within the walls of the enterprises). Private clouds provide the advantages of public clouds, but still incur capital expenditures [20]; (iii) Community cloud is used and controlled by a group of enterprises, which have shared interests [20]; (iv) Hybrid cloud is a combination of public and private cloud [20]. This paper focuses on public cloud providers and the three types of CC services: SaaS, PaaS and IaaS.	Ivon Miranda Santos

dePaula2016-A_systematic_literature_review_on_cloud_computing_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	These three services described above are deployed following four different models: (i) Public cloud is available from a third party service provider via web and is a very cost effective option to deploy IT solutions [20]; (ii) Private cloud is managed within an organization and is suitable for large enterprises (managed within the walls of the enterprises). Private clouds provide the advantages of public clouds, but still incur capital expenditures [20]; (iii) Community cloud is used and controlled by a group of enterprises, which have shared interests [20]; (iv) Hybrid cloud is a combination of public and private cloud [20]. This paper focuses on public cloud providers and the three types of CC services: SaaS, PaaS and IaaS.	Ivon Miranda Santos
dePaula2016-A_systematic_literature_review_on_cloud_computing_a	CLOUD INFRAESTRUCTURE > Public cloud	[S14] presented a step-by-step process to support cloud adoption and migration decisions in the enterprise. The authors demonstrated the use of cloudstep to support in the decision of business applications migration into the public cloud providers. In [S15], the authors explained the multi-dimensional decision-making process carried out to migrate applications to cloud environments and how to formalise its effects in the cloud migration criteria.	Ivon Miranda Santos
dePaula2016-A_systematic_literature_review_on_cloud_computing_a	CLOUD INFRAESTRUCTURE > Elasticity	Aware Mobile Cloud Services (CAMCS) cloud middle-ware and the Cloud Personal Assistant (CPA), the representative of the user within the middleware. In [S44], the authors discussed the cloud model in five perspectives: on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service.	Ivon Miranda Santos
dePaula2016-A_systematic_literature_review_on_cloud_computing_a	CLOUD INFRAESTRUCTURE > Elasticity	A spectrum of techniques and approaches has been identified that cope with vari-ous concerns, i.e., security and trustworthiness, elasticity, portability and inter-operability, and cloud resilience. In addition, many studies look into reference architectures and cloud-based architecture design methods as well.	Ivon Miranda Santos
Elmroth2011-Self-management_challenges_for_multi-cloud_architec	CLOUD INFRAESTRUCTURE > Elasticity	Abstract. Addressing the management challenges for a multitude of distributed cloud architectures, we focus on the three complementary cloud management problems of predictive elasticity, admission control, and placement (or scheduling) of virtual machines.	Ivon Miranda Santos
Elmroth2011-Self-management_challenges_for_multi-cloud_architec	CLOUD INFRAESTRUCTURE > Elasticity	Keywords: Autonomous cloud management, proactive elasticity con-trol, admission control, cloud governance, scheduling, placement, live virtual machine migration. 1 Introduction	Ivon Miranda Santos
Elmroth2011-Self-management_challenges_for_multi-cloud_architec	CLOUD INFRAESTRUCTURE > Elasticity	We are focusing on the three management problems of admission control (de-ciding whether to accept a new service request or not) for safe overbooking of elastic services and long-term capacity planning, placement (or scheduling) for optimal mapping of service components in cloud infrastructures comprised of many datacenters, and proactive elasticity to rapidly adjust capacity allocation to variations in demand.	Ivon Miranda Santos
Elmroth2011-Self-management_challenges_for_multi-cloud_architec	CLOUD INFRAESTRUCTURE > Elasticity	Figure 1 outlines a conceptual cloud architecture and illustrates the interac-tions between admission control, placement, and elasticity.	Ivon Miranda Santos
Elmroth2011-Self-management_challenges_for_multi-cloud_architec	CLOUD INFRAESTRUCTURE > Elasticity	2 Predictive Elasticity Control A key feature of cloud infrastructures is elasticity which is the ability of the cloud to automatically and rapidly scale up or down the resources allocated to a service according to the current demand on the service while enforcing the per-formance or capacity based Service Level Agreements (SLAs) specified. It should be possible to scale resources either by changing the number of VMs (horizontal elasticity) or by changing the size of the VMs (vertical elasticity) depending on the application's storage, memory, network bandwidth, and computate power requirements.	Ivon Miranda Santos

Elmroth2011-Self-management_challenges_for_multi-cloud_architec	CLOUD INFRAESTRUCTURE > Elasticity	The elasticity decisions should ideally be able to forecast in advance a change in the load of a service to be able to react to unexpected load changes faster than the rate of change of the load, i.e., in a few seconds. This requires fast and reliable algorithms for usage predictions. We propose a hierarchical control approach with a multi-tier elasticity manager where each tier has a controller composed of separate low-level controllers determining memory, bandwidth, storage and CPU requirements. Using the lower-level controllers' output as input to a higher level decision making component, the controller may issue elasticity decisions for each tier. Currently, there is no available elasticity technique that by far takes into account anything else than very basic parameters. Few current solutions actually go beyond simple reactive (non-predictive) threshold-based allocation adjustment [16,36,39].	Ivon Miranda Santos
Elmroth2011-Self-management_challenges_for_multi-cloud_architec	CLOUD INFRAESTRUCTURE > Elasticity	The decision to accept or reject a new elastic service request is one of the key decisions of an infrastructure provider as the services admitted will generate profit at the end or, in case too many or capacity demanding services are ad-mitted, cause loss of profit and bad reputation. Notably, at admission time it is not known how the elasticity requirements will affect future capacity needs. Based on an assumption that not all admitted services will have peaks in demand at the same time, infrastructure providers are expected to perform substantial overbooking w.r.t. the maximum expected capacity per service (e.g., similarly to how airline companies sell more tickets than they have seats and how net-work providers multiplex datalink bandwidth). Hence, the ability to determine optimal overbooking is crucial for using resources as efficiently as possible while not extensively breaking established SLAs. A unique characteristic of the in-frastructure provider admission control problem is that whereas network traffic oscillations are extensively studied and rather well understood [13,15,18,23] much less is known about the elasticity properties of service workloads.	Ivon Miranda Santos
Elmroth2011-Self-management_challenges_for_multi-cloud_architec	CLOUD INFRAESTRUCTURE > Elasticity	We propose that this problem is handled with two approaches ideally to be used in combination. The first approach, extending on results from statistical multiplexing of network bandwidth, is to make each admission control decision based on an elasticity analysis for the currently admitted services over a relevant set of time periods, in order to predict the future resource availability. The elasticity analysis includes calculation of probability distributions of load for each service over short to medium time and for the aggregated service workload per cloud over long term. An admission control decision will be made by combining these predictions with very short term ones obtained from elasticity and applying the overall provisioning (governance) policies with respect to risk level. Notably, profiling the new service with respect to elasticity is key for successful admission control.	Ivon Miranda Santos
Elmroth2011-Self-management_challenges_for_multi-cloud_architec	CLOUD INFRAESTRUCTURE > Elasticity	Given the dynamic nature of clouds, with significant changes over time both in demand (due to service admission or elasticity actions) and supply (resulting, e.g., from fluctuations in resource availability or off-hours discounts at external partners, etc.), VM place-ment decisions need to be renewed regularly. Since changes in placement requires migration of already running VMs, migration costs need to be part of the equa-tion, including overhead due to migration downtime, infrastructure capacity loss and monetary loss, etc.	Ivon Miranda Santos

Elmroth2011-Self-management_challenges_for_multi-cloud_architec	CLOUD INFRAESTRUCTURE > Elasticity	Cloud infrastructures are managed in order to achieve a specific high-level main objective (often referred to as the business-level objective (BLO)), e.g., maxi-mize resource utilization while maintaining fairness among users, or maximize profit without breaking more than a certain fraction of SLAs. In practice, there are a number of low-level management activities that need to be performed to adequately provision resources. These low-level management activities (e.g., ad-mission control, elasticity, and VM placement) can be addressed more or less independently as each one strives to achieve a specific goal related to its own domain. However, without having a global view of the problem, these low-level goals may be in conflict so that the combined effect of low-level managers action fails to optimize the BLO. For example, if too many SLAs are being broken due to lack of capacity for a specific service, it may be that the admission con-troller is allowing too much overprovisioning, that the elasticity engine is too restrictive, i.e., not requesting additional resources rapidly enough, or that the VM placement engine is packing to many or to few VMs per server. Without a global view, it is in such situations hard for the individual low-level managers to determine appropriate actions to optimize the overall system behavior.	Ivon Miranda Santos
Elmroth2011-Self-management_challenges_for_multi-cloud_architec	CLOUD INFRAESTRUCTURE > Elasticity	Enhancing the low-level managers to act according to higher-level objectives is important, but as an overall solution it is incomplete as the low-level compo-nents still operate independently of each other and the overall coordination of the system remains unsolved. Furthermore, optimizing a single low-level activ-ity, e.g., elasticity, is feasible but as more low-level activities are considered it becomes unmanageable to address the overall management as a single optimiza-tion problem. Autonomic management offers a more comprehensive approach. However, current solutions typically include all required decision making into the same process, increasing the complexity of optimizing each individual deci-sion making process and of adding additional decision making processes when required.	Ivon Miranda Santos
Elmroth2011-Self-management_challenges_for_multi-cloud_architec	CLOUD INFRAESTRUCTURE > Elasticity	We have presented a unified approach to key challenges for autonomous cloud management, including results from on-going work on the three topics of elas-ticity control, admission control, and VM scheduling and the topic of automatic cloud governance for management actions towards high-level management ob-jectives.	Ivon Miranda Santos
Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Elasticity	The complexity of migration is exacerbated by the fact that some legacy applications may have been developed without taking into account the unique requirements attributed to cloud environments such as elasticity, multi-tenancy, interoperability, and refactoring. Such requirements raise new challenges to the migration of applications to the cloud and hence needs improving conventional software development methodologies to address these specific requirements.	Ivon Miranda Santos

Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Elasticity	Moving applications to the cloud is similar to conventional legacy application re-engineering. However, cloud applications should also satisfy specific cloud environmental concerns. Drawing on the general literature on cloud computing (Fox et al., 2009, Brebner, 2012, Rimal et al., 2009, Guo et al., 2007, Nathuji et al., 2010, Toosi et al., 2014, Dalheimer and Pfreundt, 2009, Ristenpart et al., 2009), we identified six cloud intrinsic key concerns as follow: (i) resource elasticity, (ii) multi-tenancy, (iii) interoperability and migration over multiple-clouds, (iv) application licensing, (v) dynamicity and unpredictability, and (vi) legal issues. These concerns trigger considerations that an application owner should consider them in the migration process, though they might have been already automatically supported by cloud providers. The remainder of this section delineates these six concerns.	Ivon Miranda Santos
Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Elasticity	(i) Resource elasticity. Cloud environment can be viewed as an infinite pool of resources such as CPU, memory, storage, and network bandwidth in a way that resources can be acquired and released by applications based on demand (Fox et al., 2009, Brebner, 2012). Nevertheless, running an application on the cloud does not provide elasticity per se, rather applications need to optimise resource usage in the case of fluctuation in their workload in order to reduce infrastructure cost. Many legacy applications might not have been implemented with a support of dynamic scaling up/down of resources. They assume that elasticity is supported by providing more powerful physical servers. Inevitably, the architecture refactoring of these applications will not be easy and force many modifications in the application tiers. Addressing resource elasticity is concerned in migration types I, II, and V.	Ivon Miranda Santos
Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Elasticity	(iv) Application licensing. Taking advantage of elasticity for applications can raise application licensing issues. For example, assume an organisation that has contracted for K number of application licenses and pays a fixed annual fee. Once encapsulated into a virtual machine and run in the cloud, multiple instances of it are created by a server based on the workload. In such, the restriction on K instances is violated. It seems that traditional licensing model for commercial applications is not workable in cloud-based software. In some cases, a dynamic licensing mechanism is implemented in the application by its owner (Dalheimer and Pfreundt, 2009). However, dynamic licensing is not often addressable in the application and, instead a negotiation between the application owner and provider is required, in particular for migration types I, II, and V.	Ivon Miranda Santos

Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Elasticity	A criterion is included in the proposed framework if it had addressed at least one of the concerns stated in Section 2.2 and also sufficiently generic to cover a variety of migration scenarios regardless of a particular cloud platform. This resulted in defining 17 cloud-specific criteria including (1) Analysing Context, (2) Understanding Legacy Application, (3) Analysing Migration Requirements, (4) Planning Migration, (5) Cloud Service/Platform Selection, (6) Training, Re-Architecting Legacy Application (including (7) Incompatibility Resolution, (8) Enabling Multi-Tenancy, (9) Enabling Elasticity, (10) Cloud Architecture Model Definition, (11) Applying Architecture Design Principles), (12) Training, (13) Test and Continuous Integration, (14) Environment Configuration, (15) Continuous Monitoring, (16) Migration Type, (17) Unit of Migration. These criteria helped the study to contrast and compare cloud-centric aspects of existing approaches.	Ivon Miranda Santos
Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Elasticity	Common requirements engineering techniques (.e.g. interview, prototyping, and workshop) still are useable to elicit and analysis requirements from users, developers, and managers as it can be seen in approaches [S8] and [S26]. However, the requirement analysis in the context of cloud migration is with a specific focus on elasticity and scalability application requirements [S18], computing requirements [S19], inter-operability requirements for deployment in the cloud [S21], security and regulatory requirements [S23], and storage space requirements in the cloud [S33]. According to Table XVII, in 15 (35%) of reviewed approaches, it was found that they define related activities for the identification of expected requirements.	Ivon Miranda Santos
Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Elasticity	[S11] proposes a concrete technique for component selection and distribution in the cloud via transforming application architecture into a graph partitioning problem and using existing algorithms such as simulated annealing problem to optimise the distribution of components among different cloud nodes. (ii) Enabling Application Elasticity. Running applications in the cloud does not help to resource efficiency and scalability issues by itself.	Ivon Miranda Santos
Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Elasticity	, 2011). Elasticity is triggered via a set of rule/conditions related to specific workload or threshold, events, or metrics. Often legacy applications have not been designed with a support for dynamic resource provisioning in mind and hence adaptation is required to enable this feature. Elasticity can be 26 implemented by developing a new component either embedded in the application or separately hosted on a server node in order to continuously monitor the application/component resource usage variables and then performs appropriate action based on scaling rules. Only Ridha et. al.'s approach introduced in [S22] defines generic activities for deploying existing applications which assure elasticity. It consists of three activities:	Ivon Miranda Santos
Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Elasticity	Andrikopoulos et. al. [S35] point out aspects that needed to be considered during enabling elasticity in an application in terms of what to scale, how to scale, when to scale, which scaling strategy to be used, and scaling latency. Likewise, with respect to the approach of Maenhaut et al. [S29], to handle elasticity it is required that application components be decoupled and communicate in a-synchronised manner. (iii) Enabling Multi-Tenancy.	Ivon Miranda Santos

Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Public cloud	Given the above aspects of multi-tenancy, only the approach proposed by Maenhaut et. al. [S29] incorporates explicit activities to add customisability and security isolation to legacy applications are to move to a hybrid or public cloud environments. That is, enabling multi-tenancy requires the following steps: (i) decoupling databases, (ii) adding tenant configuration databases, (iii) providing tenant configuration interface, (iv) dynamic feature selection, (v) managing tenant data, users, and roles, and (vi) mitigating security risks.	Ivon Miranda Santos
Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Hybrid cloud	Given the above aspects of multi-tenancy, only the approach proposed by Maenhaut et. al. [S29] incorporates explicit activities to add customisability and security isolation to legacy applications are to move to a hybrid or public cloud environments. That is, enabling multi-tenancy requires the following steps: (i) decoupling databases, (ii) adding tenant configuration databases, (iii) providing tenant configuration interface, (iv) dynamic feature selection, (v) managing tenant data, users, and roles, and (vi) mitigating security risks.	Ivon Miranda Santos
Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Elasticity	We believe this kind of research can be applied in the field of cloud migration. — Lack of adequate support for multi-tenancy, elasticity, test and continuous integration. One interesting observation from reviewing 43 approaches is that only [S35] covers multi-tenancy merely from the customisation aspect. Elasticity has been also supported only by one approach [S22]. Continuous integration is partially supported by two approaches [S23] and [S32].	Ivon Miranda Santos
Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Elasticity	34 with relevant method fragments to the aspects multi-tenancy, elasticity, test, and continuous integration which have been weekly supported. Fourthly, the definition of new roles specific to cloud application development has not been explored in existing approaches.	Ivon Miranda Santos
Gholami2016-Cloud_migration_process—a_survey__evaluation_framew	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	In addition, journals, conference, workshop proceedings and technical reports attributed to Cloud Computing and SOA areas were sought. These included IEEE Transaction of Cloud Computing, IEEE Transaction of Service Computing, Software Engineering for Cloud Computing, Cloud Computing International Conference, Cloud and Service Computing International Conference, International Conference of Service-Oriented Computing, Maintenance and Evolution of Service-Oriented and Cloud-Based Systems, International Conference on Cloud, Service-Oriented Computing and Applications, and International Conference on High Performance Computing and Communications. Step 3 Defining Study Inclusion and Exclusion Criteria.	Ivon Miranda Santos
Gourisaria2020-An_Extensive_Review_on_Cloud_Computing	CLOUD INFRAESTRUCTURE > Public cloud	are mentioned as following in Table 1. Mobile computing is vastly relied on cloud to make its features work by storing the user data in a public or private cloud. Mobile Cloud Computing (MCC) brings mobile and cloud computing together with wireless networks to give rise to pow-erful resources in computing.	Ivon Miranda Santos
Gourisaria2020-An_Extensive_Review_on_Cloud_Computing	CLOUD INFRAESTRUCTURE > Public cloud	Some other examples are Simple Queuing Service (SQS), Relational Database (RDS), CloudFront and Elastic MapReduce. Google—The Google Cloud Platform (GCP) provides a wide domain of public cloud computing services. The core products include Google App Engine for access to software development kits, Google Compute Engine for accessing virtual machines, Google Container Engine and Google Cloud Storage.	Ivon Miranda Santos
Gourisaria2020-An_Extensive_Review_on_Cloud_Computing	CLOUD INFRAESTRUCTURE > Elasticity	Cloud technologies are scalable, as they possess the potential to flex with as per the interest of resources [11]. The work of elasticity is to enable the creation of virtual machines to cope up with “an expansion in the workload” (the growth of demand) [4].	Ivon Miranda Santos

Gourisaria2020-An_Extensive_Review_on_Cloud_Computing	CLOUD INFRAESTRUCTURE > Public cloud	4.1 Public Cloud A cloud is public when software and applications are being accessible publicly with anyone availing its utilities [10]. Schemes can be various, including pay per use or purchasing. Google App Engine and Amazon Elastic Compute Cloud (EC2) are important examples of public cloud [13]. The advantages of public cloud are inexpensive setup, scalability, seamless uptime and no wastage of resources. The principal concerns pertaining to public cloud are security threats. 4.2 Private Cloud	Ivon Miranda Santos
Gourisaria2020-An_Extensive_Review_on_Cloud_Computing	CLOUD INFRAESTRUCTURE > Public cloud	4.3 Hybrid Cloud Hybrid cloud uses the integrated facilities present in both public and private clouds [10, 14]. It is valued in places of fluctuating workloads.	Ivon Miranda Santos
Gourisaria2020-An_Extensive_Review_on_Cloud_Computing	CLOUD INFRAESTRUCTURE > Hybrid cloud	4.3 Hybrid Cloud Hybrid cloud uses the integrated facilities present in both public and private clouds [10, 14]. It is valued in places of fluctuating workloads. The scalability that hybrid cloud brings to the company workforce poses a significant reduction in its infras-tructural and managemental expenditure [15].	Ivon Miranda Santos
Gourisaria2020-An_Extensive_Review_on_Cloud_Computing	CLOUD INFRAESTRUCTURE > Public cloud	Businesses that work on similar projects fall back to community cloud. With the expenditure distributed over a less number of users than public cloud, community cloud provides a high level of security and privacy. An example of community cloud is Google's Gov .C	Ivon Miranda Santos
Gourisaria2020-An_Extensive_Review_on_Cloud_Computing	CLOUD INFRAESTRUCTURE > Public cloud	VM provisioning can be achieved in the following ways: • Procuring the machine in a public cloud service such as Amazon EC2. • Usage of private cloud management or a VM management present in the local data centre in order to procure the organization's virtual machine.	Ivon Miranda Santos
Gourisaria2020-An_Extensive_Review_on_Cloud_Computing	CLOUD INFRAESTRUCTURE > Public cloud	NIST plays a vital role in defining standards and conventions in cloud computing. The principal focus of NIST is to implement a synopsis on public cloud along with the involved security issues. The privacy and security issues diagnosed by NIST are as following:	Ivon Miranda Santos
Hajjat2010-Cloudward_bound_Planning_for_beneficial_migration_of	CLOUD INFRAESTRUCTURE > Hybrid cloud	ABSTRACT In this paper, we tackle challenges in migrating enterprise services into hybrid cloud-based deployments, where enterprise operations are partly hosted on-premise and partly in the cloud. Such hy-brid architectures enable enterprises to benefit from cloud-based ar-chitectures, while honoring application performance requirements, and privacy restrictions on what services may be migrated to the cloud. We make several contributions.	Ivon Miranda Santos
Hajjat2010-Cloudward_bound_Planning_for_beneficial_migration_of	CLOUD INFRAESTRUCTURE > Hybrid cloud	Users ex-ternal to the enterprise could be handled through servers deployed in the cloud, while internal users could be handled through servers located on premise. In this paper, we take a first step towards articulating and ad-dressing two challenges involved in enabling enterprises to move to such a hybrid cloud model, as we discuss below: Component placement:	Ivon Miranda Santos
Hajjat2010-Cloudward_bound_Planning_for_beneficial_migration_of	CLOUD INFRAESTRUCTURE > Hybrid cloud	The data center has over 40 firewall contexts, each context associated with a pair of ACLs, and with each ACL having several tens and sometimes hundreds of ACL rules. 2.3 Issues in migrating enterprise applications In this paper, we focus on hybrid cloud architectures, where in-dividual application components may be placed locally or in the cloud. Further, we allow for placement strategies where only a sub-set of servers in a component are placed remotely.	Ivon Miranda Santos

Hajjat2010-Cloudward_bound_Planning_for_beneficial_migration_of	CLOUD INFRAESTRUCTURE > Hybrid cloud	In particular, servers may be instantiated in the cloud when needed, while requests are in general served from the local data-center. In this paper, we address two key challenges associated with re-alizing hybrid cloud architectures: Planning which servers to migrate: Planning a hybrid cloud lay-out is a complex problem, where an application architect must take several factors into account. The key factors are (i) honoring pol-icy constraints regarding which components must be migrated; (ii) ensuring application response times continue to meet desired tar-gets; and (iii) ensuring the cost savings from migration are as high as possible.	Ivon Miranda Santos
Hajjat2010-Cloudward_bound_Planning_for_beneficial_migration_of	CLOUD INFRAESTRUCTURE > Hybrid cloud	For example, Fig. 6 shows the hy-brid cloud topology based on the migration scenario in Fig. 4.	Ivon Miranda Santos
Hajjat2010-Cloudward_bound_Planning_for_beneficial_migration_of	CLOUD INFRAESTRUCTURE > Hybrid cloud	5 Evaluation This section presents results evaluating the importance and effec-tiveness of our model in planning hybrid cloud layouts. Our eval-uations were conducted using (i) a real application made available as part of the Windows Azure SDK (§5.1), and (ii) a real Enterprise Resource Planning (ERP) application deployed in a large campus network (§5.2).	Ivon Miranda Santos
Hajjat2010-Cloudward_bound_Planning_for_beneficial_migration_of	CLOUD INFRAESTRUCTURE > Hybrid cloud	In this paper, we have made two contributions. First, we have shown (i) the potential benefits of hybrid cloud deployments of en-terprise applications compared to “all or nothing” migrations; and (ii) the importance and feasibility of a planned approach to making migration decisions. Second, we have shown the feasibility of au-tomatic and assurable reconfiguration of reachability policies as en-terprise applications are migrated to hybrid cloud models. We have validated our algorithms using a campus ERP application, Azure-based cloud deployments, and router configurations of a large cam-pus network.	Ivon Miranda Santos
Haugeland2021-Migrating_monoliths_to_microservices-based_custom	CLOUD INFRAESTRUCTURE > Elasticity	There are huge benefits for migrating to MSA such as maintainability and scalability in the long run [5], e.g., by adopting DevOps and benefiting from Cloud-native elasticity [6]. Microservices can be packaged and deployed in isolation from the main product, which is an important requirement for multi-tenant context.	Ivon Miranda Santos
Hwang2015-Computing_resource_transformation__consolidation_and_	CLOUD INFRAESTRUCTURE > Public cloud	ABSTRACT With the promise of providing flexible and elastic comput-ing resources on demand, the cloud computing has been at-tracting enterprises and individuals to migrate workloads in the legacy environment to the public/private/hybrid clouds. Also, cloud customers want to migrate between cloud providers with different requirements such as cost, performance, and manage-ability.	Ivon Miranda Santos
Hwang2015-Computing_resource_transformation__consolidation_and_	CLOUD INFRAESTRUCTURE > Hybrid cloud	ABSTRACT With the promise of providing flexible and elastic comput-ing resources on demand, the cloud computing has been at-tracting enterprises and individuals to migrate workloads in the legacy environment to the public/private/hybrid clouds. Also, cloud customers want to migrate between cloud providers with different requirements such as cost, performance, and manage-ability.	Ivon Miranda Santos
Hwang2015-Computing_resource_transformation__consolidation_and_	CLOUD INFRAESTRUCTURE > Hybrid cloud	Therefore, although the expectation has risen with various requirements on the target cloud platforms and environments, the cloud migration techniques have not provided enough options that can satisfy the various requirements. In this paper we propose a model to tackle the migration challenges that transform one resource into same or another resource in hybrid clouds. We formulate the problem as a constraint satisfaction problem, and iteratively decompose the server components and consolidate the servers.	Ivon Miranda Santos

Hwang2015-Computing_resource_transformation_ _consolidation_and_	CLOUD INFRAESTRUCTURE > Public cloud	Enterprises are increasingly migrating their existing IT infrastructure to the cloud, driven by the promise of low-cost access to elastic resources [1, 2]. Depending on the compliance and security requirements, as well as the business criticality of the business applications (often referred to as workloads), enterprises may choose one or more cloud environments, such as private cloud, 3rd party public cloud, traditional data center, resulting in hybrid cloud environments. Because the target environments are diversified and enterprises have a large num-ber of servers, the migration planning quickly becomes a in-tractable problem.	Ivon Miranda Santos
Hwang2015-Computing_resource_transformation_ _consolidation_and_	CLOUD INFRAESTRUCTURE > Hybrid cloud	Enterprises are increasingly migrating their existing IT infrastructure to the cloud, driven by the promise of low-cost access to elastic resources [1, 2]. Depending on the compliance and security requirements, as well as the business criticality of the business applications (often referred to as workloads), enterprises may choose one or more cloud environments, such as private cloud, 3rd party public cloud, traditional data center, resulting in hybrid cloud environments. Because the target environments are diversified and enterprises have a large num-ber of servers, the migration planning quickly becomes a in-tractable problem.	Ivon Miranda Santos
Hwang2015-Computing_resource_transformation_ _consolidation_and_	CLOUD INFRAESTRUCTURE > Hybrid cloud	It is the most of importance that many of these processes can be smoothly executed with well planned resource mappings between the source and the target upfront. In this paper, we propose a model to tackle the migration challenges that transform one resource into same or another resource in hybrid clouds based on source requirements and target availability. We investigate the tranformation metrics that need to be taken into consideration for the migration resource planning, server consolidation, and server decomposition.	Ivon Miranda Santos
Hwang2015-Computing_resource_transformation_ _consolidation_and_	CLOUD INFRAESTRUCTURE > Public cloud	As the target environment becomes more diversified, the complexity on deciding where to move rather than how to move renders migration analytics a harder problem. The pos-sible choices for target environments include container, (pub-lic/private) virtual machine, baremetal, POD (Performance Op-timized Data Center), datacenter, geo-location, cloud provider, service model. As shown in Figure 1 that illustrates selectable cloud model, this collection can be represented as a hierarchi-cal structure.	Ivon Miranda Santos
Hwang2015-Computing_resource_transformation_ _consolidation_and_	CLOUD INFRAESTRUCTURE > Hybrid cloud	Hajjat et al. [2] analyze the potential benefits of hybrid cloud deployments of enterprise applications, and the importance and feasibility of a planned approach to making migration decisions. Also, authors have shown the feasibility of automatic and assurable reconfiguration of reachability policies as enterprise applications are migrated to hybrid cloud models. Zhang et al.	Ivon Miranda Santos
Hwang2015-Computing_resource_transformation_ _consolidation_and_	CLOUD INFRAESTRUCTURE > Hybrid cloud	CONCLUSION The enterprise-scale migration analytics provides an ef-fective migration planning capability that can transform re-sources from on-premise data centers to target clouds. We have described a model to tackle the migration challenges that transform one resource type into same or another resource type in hybrid clouds. We formulate the problem as a constraint satisfaction problem, and iteratively decompose the server components and consolidate the servers.	Ivon Miranda Santos

Jambunathan2018-Architecture_decision_on_using_microservices_or	CLOUD INFRAESTRUCTURE > Public cloud	There are many containers available but docker is the most accepted one and are open source, have its own ecosystem to manage. Like VM, container also has its own life cycle to manage and every cloud service provider, be it a public cloud like AWS, Azure, Google or private cloud like OpenStack, VMware supports Docker containers. For example – AWS has elastic container service (ECS)[4] and Azure provides Azure container services.	Ivon Miranda Santos
Jambunathan2018-Architecture_decision_on_using_microservices_or	CLOUD INFRAESTRUCTURE > Definition of cloud computing	Microservices is a technical term and serverless computing is more a marketing term like the Cloud.	Ivon Miranda Santos
Jambunathan2018-Architecture_decision_on_using_microservices_or	CLOUD INFRAESTRUCTURE > Public cloud	It can run anywhere within the runtime environment. Because of its modular in nature, one can easily containerize the application, dockerize, and deploy it in both public and private cloud environment. With help of the native cloud services, one can avail the scalability, security, fault tolerant features and that makes microservices more appropriate technique to use in the containerized cloud environment.	Ivon Miranda Santos
Jamshidi2013-Cloud_migration_research_A_systematic_review	CLOUD INFRAESTRUCTURE > Elasticity	Crosscutting concerns. Some crosscutting tasks such as governance [S8], security analysis [S8] [S17] [S22], training [S6] [S7] [S16], effort estimation [S18], organiza-tional change [21], and multitenancy and elasticity analysis [S8] act as umbrella activities in the framework. JAMSHIDI ET AL.:	Ivon Miranda Santos
Jamshidi2013-Cloud_migration_research_A_systematic_review	CLOUD INFRAESTRUCTURE > Elasticity	The four different migration types also influence crosscutting concerns differ-ently [S8]. In terms of elasticity (cf. Cloud-RMM in Fig.	Ivon Miranda Santos
Jamshidi2015-Cloud_migration_patterns_A_multi-cloud_service_arc	CLOUD INFRAESTRUCTURE > Public cloud	, EU. • Circumstances where public clouds are used jointly with on-premises resources. • Cloud-based application must be resilient to the loss of a single data center.	Ivon Miranda Santos
Jamshidi2015-Cloud_migration_patterns_A_multi-cloud_service_arc	CLOUD INFRAESTRUCTURE > Public cloud	These can be coordination services that orchestrate different components in larger compartments or simply configurable IaaS resources providing required operating system or storage features. After migration, this component, instead of using on-premise platforms, uses public cloud platform services offered. Thus, the application component is re-deployed as-is on a cloud platform.	Ivon Miranda Santos
Jamshidi2015-Cloud_migration_patterns_A_multi-cloud_service_arc	CLOUD INFRAESTRUCTURE > Hybrid cloud	A multi-cloud is different from federation where, a set of cloud providers voluntarily interconnect their infrastructures to allow sharing of resources [10]. Hybrid deployment can be considered as a special case of multi-cloud where an application is deployed in both on-premise as well as cloud platforms. This deployment model is essential in cases where critical data needs to be kept in house in corporate data centers.	Ivon Miranda Santos
Jamshidi2015-Cloud_migration_patterns_A_multi-cloud_service_arc	CLOUD INFRAESTRUCTURE > Public cloud	This definition is based on the semantics of architectural schemas before and after migration. In some migration patterns, it may only be possible to deploy application components in a public cloud. However, for those patterns that consider re-architecting, the application can be deployed in hybrid public/private platforms.	Ivon Miranda Santos
Jamshidi2015-Cloud_migration_patterns_A_multi-cloud_service_arc	CLOUD INFRAESTRUCTURE > Hybrid cloud	• MP5 Multi-Cloud Refactoring: MP6 (hybrid refactoring), MP7 (hybrid refactor-ing with on-premise adaptation), MP8 (hybrid refactoring with cloud adaptation), MP9 (hybrid refactoring with hybrid adaptation) • MP10 Multi-Cloud Rebinding:	Ivon Miranda Santos
Jamshidi2015-Cloud_migration_patterns_A_multi-cloud_service_arc	CLOUD INFRAESTRUCTURE > Public cloud	A second objective is to expand ways to access applications. Applications located in the public cloud are available over the Internet, but authentication concerns exist. A third goal is portability, i.e.,	Ivon Miranda Santos

Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Public cloud	Mixing cloud architecture with private data centers adds operational efficiency for workload bursts while legacy systems on-premise still support core business services [3]. Instead of re-architecting applications, they can be re-hosted from on-premise to possibly multiple cloud offerings, either private or public ones. We are con-cerned with the migration of legacy on-premise software to multi-cloud architectures.	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Public cloud	Country regulations limit options for storing data in specific data centers. Circumstances which require public clouds to be used jointly with on-premises resources. Cloud-based applications must be resilient to the loss of a single data center or cloud provider.	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Hybrid cloud	A multi-cloud is different from a federation where a set of cloud providers voluntarily interconnect their infrastructures to allow sharing of resources among each other [25]. Hybrid deployments can be considered as a special case of multi-cloud where an applica-tion is deployed in both on premise infrastructure as well as on cloud platform(s). Such a deployment model is essential in cases where critical data needs to be kept in-house in corporate data cen-ters.	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Public cloud	Architecture and Platform. Circumstances require public clouds to be used jointly with on-premises resources. Copyright © 2016 John Wiley & Sons, Ltd.	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Elasticity	These models address a variety of concerns that we can categorize as follows: (i) QoS concerns (elasticity and availability), (ii) resource type (compute, storage, and network), (iii) architecture pat-terns (pipes and filters, cache, etc.) and (iv) platform provider (AWS, Azure, OpenStack, etc.)	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Elasticity	The external dimension includes availability as a quality concern, but also external resources such as network, storage and databases. The internal dimension focuses on the platform with its compute resources, for instance elasticity as a quality objective and architectural patterns as orchestration options. Table I illustrates three deployment configurations classified along the variability model.	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Public cloud	These can be coordination services that orchestrate different components in larger compartments or simply configurable IaaS resources providing required operating system or storage features. After migration, this component, instead of using on-premise platforms, uses ser-vices offered by a public cloud platform. Thus, the application component is re-deployed as-is on a cloud platform.	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Hybrid cloud	A multi-cloud is different from a cloud federation – for the latter a set of cloud providers voluntarily interconnect their services to allow sharing of resources [29]. Hybrid deployment is a special case of multi-cloud where an application is deployed in both on-premise as well as cloud platforms. Note that we primarily target Platform-as-a-Service (PaaS) clouds that provide middleware ser-vices to host and manage application services.	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Public cloud	Variants for the following core patterns can be found in [23]: Re-deployment (core pattern MP1): variant pattern MP2 (re-deployment in public cloud) Copyright © 2016 John Wiley & Sons, Ltd.	Ivon Miranda Santos

Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Hybrid cloud	Relocation (core pattern MP3): variant pattern MP4 (relocation for multi-clouds) Multi-Cloud Refactoring (core pattern MP5): variant patterns MP6 (hybrid refactoring), MP7 (hybrid refactoring with on-premise adaptation), MP8 (hybrid refactoring with cloud adaptation), MP9 (hybrid refactoring with hybrid adaptation) Multi-Cloud Rebinding (core pattern MP10): variant pattern MP11 (rebinding with cloud brokerage)	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Public cloud	It is difficult to deploy new applications with the required SLA to the existing hardware. Applications in a public cloud platform can take advantage of economies of scale and have automated processes for managing. Copyright © 2016 John Wiley & Sons, Ltd.	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Public cloud	An objective is to expand ways to access applications. Applications located in the public cloud are available over the Internet, but authentication concerns exist. Another goal is portability, that is, it can be moved between a public cloud platform and a private data center without modification to application code or operations. Furthermore, a tractable migration plan to the cloud platform is essential.	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Hybrid cloud	a document processing system that needs a multi-cloud integration with ERP system compo-nents, a financial services application with a hybrid on-premise/cloud architecture and the need for integrated security management, components of an ERP system with the need for mobile access,	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Public cloud	These migration projects cover a range of application types, giving us certainty that a variety of application areas can be successfully covered through the proposed patterns. Distribution: we considered single public cloud, hybrid on-premise/public cloud and heteroge-neous multi-cloud settings. Complexity: from cloud-based storage to multi-tier applications with 10 subsystems with more than 50 individual services.	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Hybrid cloud	These migration projects cover a range of application types, giving us certainty that a variety of application areas can be successfully covered through the proposed patterns. Distribution: we considered single public cloud, hybrid on-premise/public cloud and heteroge-neous multi-cloud settings. Complexity: from cloud-based storage to multi-tier applications with 10 subsystems with more than 50 individual services.	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	RELATED WORK We conducted a literature review [1] aiming to identify, taxonomically classify, and systematically compare the existing research focused on planning, executing, and validating migration of legacy systems towards cloud computing platforms based on earlier architecture evolution work [33]. We found a lack of repeatable and verifiable practices as one of the key reasons that cloud migration is not a fully mature domain.	Ivon Miranda Santos
Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Cloud computing architecture	RELATED WORK We conducted a literature review [1] aiming to identify, taxonomically classify, and systematically compare the existing research focused on planning, executing, and validating migration of legacy systems towards cloud computing platforms based on earlier architecture evolution work [33]. We found a lack of repeatable and verifiable practices as one of the key reasons that cloud migration is not a fully mature domain.	Ivon Miranda Santos

Jamshidi2017-Pattern-based_multicloud_architecture_migration	CLOUD INFRAESTRUCTURE > Elasticity	Architecture-oriented patterns for multi-cloud settings are important for two reasons. Firstly, architectures are often refactored to adapt an application to the cloud platform, to benefit more from cloud characteristics such as elasticity or simply to modernize a legacy application. Secondly, appli-cations often need to be integrated with other components as part of a larger business process in	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Public cloud	We summarize research focuses and trends dealing with cloud-native application engineering approaches. Furthermore, we provide a def-inition for the term “cloud-native application” which takes all findings, insights of analyzed publications and already existing and well-defined terminology into account. © 2017 Elsevier Inc.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Public cloud	Introduction The birthday of the cloud can be dated into the year 2006 – the first launch of a general purpose public cloud service (Simple Storage Service, S3 at 13th March 20061) by the currently most prominent public cloud service provider Amazon Web Services (AWS). Therefore, this study has not considered any papers dated before 2006.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Public cloud	All these cloud providers and their services forming nowadays our understanding of the term cloud computing. Al-though terms like public/private/hybrid cloud computing and acronyms like IaaS (Infrastructure as a Service), PaaS (Platform as a Service) or SaaS (Software as a Service) are frequently used, these terms are often understood in differing ways. Gladfully, the mentioned terms are defined precisely by the NIST definition of cloud computing (Mell and Grance, 2011).	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Hybrid cloud	All these cloud providers and their services forming nowadays our understanding of the term cloud computing. Al-though terms like public/private/hybrid cloud computing and acronyms like IaaS (Infrastructure as a Service), PaaS (Platform as a Service) or SaaS (Software as a Service) are frequently used, these terms are often understood in differing ways. Gladfully, the mentioned terms are defined precisely by the NIST definition of cloud computing (Mell and Grance, 2011).	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Definition of cloud computing	All these cloud providers and their services forming nowadays our understanding of the term cloud computing.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Definition of cloud computing	Al-though terms like public/private/hybrid cloud computing and acronyms like IaaS (Infrastructure as a Service), PaaS (Platform as a Service) or SaaS (Software as a Service) are frequently used, these terms are often understood in differing ways.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Definition of cloud computing	Gladfully, the mentioned terms are defined precisely by the NIST definition of cloud computing (Mell and Grance, 2011).	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Definition of cloud computing	But there remains confusion with more specific topics in cloud computing like cloud-	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	But cloud environments are elastic. Elasticity is understood as the degree to which a system adapts to workload changes by provisioning and de-provisioning resources automatically. Over the time system engineers under-stand the elasticity options of modern cloud environments better and they intentionally designed systems for such elastic cloud infrastructures. This intention is often expressed using the term	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	However, they show increas-ing momentum and are emerging from an evolutionary process starting with the service-oriented architecture approach, system virtualization, cloud computing, operating system virtualization (aka container) and ending in a recently most popular approach:	Ivon Miranda Santos

Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	CNA properties describe characteristics of CNA. Such character-istics dealing with consistency models, availability, partition tolerance (all strongly related to Brewer's CAP theorem (Brewer, 2012)), elasticity, resilience and service levels (SLA). This property combination seems to be very characteristic for CNA according to selected papers.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Public cloud	Further keywords dealt with use cases. These use cases can be categorized into the following domains: telecommunication, industrial processes, bioinformatics, videostreaming service providers, energy management and experiences with public cloud services. However, it is likely that there are a lot of other applicable use cases which did not turn up in our literature screening due to	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	CNAs looking back on 10 years of cloud computing history.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	PaaS framework that enables flexible definition, marketing, deploy-ment and management of Cloud-based services and applications. The major innovations proposed [...] are [...] lifecycle management, a one stop shop for Cloud services and a PaaS level resource management featuring elasticity, [...] a portfolio of ready to use cloud-native ser-vices and Cloud-aware immigrant technologies". The 4CaaST project was an EU funded project and the authors of the publication are from various academic and industrial research institutions:	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	7 shows the correlation on research topics. The reader sees that the research topic automation platform is intensively corre-lated to cloud-native architecture topics and cloud-native application properties like scalability, resilience and elasticity. The same is true for patterns which are intensively correlated to cloud-native appli-cation design topics.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	7, cloud-native applications (CNA) should be build according to corresponding CNA principles (being operated on automation platforms; using softwarization of infrastructure and network; having migration and interoperability across different cloud infrastructures and platforms in mind). Following these principles enable to build CNA architectures (mainly service-based and often with self-contained deployment units involved) with spe-cific and wishful CNA properties (horizontal scalability, elasticity, resiliency, isolated strict consistent or eventual consistent state) of resulting applications. To realize CNAs, there exist accompanying CNA methods which are often pattern based.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	Automation platforms are often mentioned beside architectural topics like mi-croservices, service composition, and deployment units. Furthermore, CNA properties like scalability, resiliency and elasticity are men-tioned very often in the same papers. So, automation platforms are seen by a lot of authors as an enabler to realize sustainable CNA architectures.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	The design of sustainable CNA architectures seems to be influenced deeply by pattern based approaches and relies on microservices being build on self-contained deployment units (containers). Furthermore, microservices and CNA properties like scalability, resiliency and elasticity are mentioned very often in the same papers. So, automation platforms, microservices and pattern based approaches seem to be seen as key enablers for cloud-native applications.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Hybrid cloud	, 2014). But interop-erability or portability in hybrid or multi-cloud scenarios (PRINC-2) seems to be only considered by single case or survey studies so far (Ben Belgacem et al.,	Ivon Miranda Santos

Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	However, systems of the past were seldom elastic systems. So, there might be the need for some CNA specific engineering methodologies (METH.2) covering CNA specific problems (namely elasticity). 4.3.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	According to our survey, a CNA shall have wishful CNA property combination of horizontal scalability (Cockcroft, 2015; Goldschmidt et al., 2014), elasticity (Moldovan et al., 2014; Inzinger et al.,	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	However, systematic evaluation and validation of postulated effects seems to be rare. Elasticity is often aligned to microservice based approaches. And microservices are relying heavily on stateless services.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	But stateless services can be scaled up and down easily from a dis-tributed systems conceptual point of view. We found only little research dealing with the elasticity of stateful CNA components (PROP-1) which is the much harder problem.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	Data coupling relies often on scalable but (mostly) eventual consistent storage solutions (which are often subsumed as NoSQL databases). Although, we did not investigate elasticity research in details, we got the impression that elasticity should be investigated on two layers. A platform (e.g.	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	Kubernetes) can be elastic, and a CNA being operated on a platform (e.g. on Kubernetes) can be elastic as well. But most of the times, elasticity seems to be investigated on an application level only. And to the best of our knowledge we do not know any study dealing the synchronization of both levels (PROP-2).	Ivon Miranda Santos
Kratzke2017-Understanding_cloud-native_applications_after_10_ye	CLOUD INFRAESTRUCTURE > Elasticity	Of course this definition can only be understood in a context of further terms already defined or characterized by other authors and standardizing initiatives: • Elasticity is “the degree to which a system is able to adapt to workload changes by provisioning and de-provisioning resources in 4 Except our own contribution (Kratzke and Peinl, 2016) which relies partly on this mapping study.	Ivon Miranda Santos
Lahmar2018-Multicloud_service_composition_A_survey_of_current_a	CLOUD INFRAESTRUCTURE > Cloud computing architecture	Finally, we summarize the challenges and requirements for an effective service reuse in the multicloud environment, and we conclude the paper with future directions. 2 CLOUD-COMPUTING ARCHITECTURE The cloud computing is described by the National Institute of Standards and Technology as a set of computing services (servers, storage, databases, networks, etc) accessible at any time and for ubiquitous use.	Ivon Miranda Santos

Lahmar2018-Multicloud_service_composition_A_survey_of_current_a	CLOUD INFRAESTRUCTURE > Public cloud	This model is beneficial in reducing the interactions' cost between service providers and the management effort.1 To cope with the heterogeneity of cloud users' profiles and requirements, 4 main types of cloud deployment models have emerged: public, private, hybrid, and community cloud.1 Figure 1 illustrates the layered model of cloud computing, as well as its corresponding service models. Among the existing cloud service–delivery models, we mention “software as a service” (SaaS) such as online word processing and spreadsheet tools, customer relationship management services and web content delivery services Salesforce customer relationship management, and Google Docs16; “platform as a service” (PaaS) such as Microsoft Azure and Google App engine16; and “infrastructure as a service” (IaaS) such as Amazon EC2 and S3, Terremark Enterprise Cloud, Windows Live Skydrive, and Rackspace Cloud,16 which provide cloud services to the user.	Ivon Miranda Santos
Lahmar2018-Multicloud_service_composition_A_survey_of_current_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	This model is beneficial in reducing the interactions' cost between service providers and the management effort.1 To cope with the heterogeneity of cloud users' profiles and requirements, 4 main types of cloud deployment models have emerged: public, private, hybrid, and community cloud.1 Figure 1 illustrates the layered model of cloud computing, as well as its corresponding service models. Among the existing cloud service–delivery models, we mention “software as a service” (SaaS) such as online word processing and spreadsheet tools, customer relationship management services and web content delivery services Salesforce customer relationship management, and Google Docs16; “platform as a service” (PaaS) such as Microsoft Azure and Google App engine16; and “infrastructure as a service” (IaaS) such as Amazon EC2 and S3, Terremark Enterprise Cloud, Windows Live Skydrive, and Rackspace Cloud,16 which provide cloud services to the user.	Ivon Miranda Santos
Lahmar2018-Multicloud_service_composition_A_survey_of_current_a	CLOUD INFRAESTRUCTURE > Public cloud	The cloud computing paradigm, as it was defined by the National Institute of Standards and Technology for the first time, consists in offering services deployed by 1 provider (eg, Nirvanix, Google Apps, and Amazon AWS), in a single datacenter. Therefore, only 1 availability zone hosts the services offered by either public or private clouds. The hybrid cloud could be also considered as a single-cloud environment if both the used public and private clouds are served by the same provider. In contrast, the multicloud is a distributed environment composed of several clouds, in which it is possible to use different cloud types in the same time.	Ivon Miranda Santos
Lahmar2018-Multicloud_service_composition_A_survey_of_current_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	Therefore, only 1 availability zone hosts the services offered by either public or private clouds. The hybrid cloud could be also considered as a single-cloud environment if both the used public and private clouds are served by the same provider. In contrast, the multicloud is a distributed environment composed of several clouds, in which it is possible to use different cloud types in the same time.	Ivon Miranda Santos

Lahmar2018-Multicloud_service_composition_A_survey_of_current_a	CLOUD INFRAESTRUCTURE > Public cloud	The intracloud environment is classified in some literature references as a cloud networking rather than multiple clouds.51 • Hybrid cloud is the composition of public and private cloud resources or capabilities for a certain period. The problem that exists, when using the hybrid cloud, is the possibility of disclosing of the private capabilities and exposing of the private resources to danger.51	Ivon Miranda Santos
Lahmar2018-Multicloud_service_composition_A_survey_of_current_a	CLOUD INFRAESTRUCTURE > Hybrid cloud	The intracloud environment is classified in some literature references as a cloud networking rather than multiple clouds.51 • Hybrid cloud is the composition of public and private cloud resources or capabilities for a certain period. The problem that exists, when using the hybrid cloud, is the possibility of disclosing of the private capabilities and exposing of the private resources to danger.51 • Crossclouds, in such environment, a series of steps consisting of matchmaking, resource discovery, and authentication, is followed by a federation of several cloud suppliers in order to offer/use resources.22	Ivon Miranda Santos
Lichtenthaler2019-Requirements_for_a_model-driven_cloud-native_	CLOUD INFRAESTRUCTURE > Cloud computing architecture	The characteristics of CNAs are the basis for deriving requirements for a structured migration approach. In this paper, the most important ones are the fine-grained architectures and the cloud computing paradigms. 2.2 Cloud migration	Ivon Miranda Santos
Lichtenthaler2019-Requirements_for_a_model-driven_cloud-native_	CLOUD INFRAESTRUCTURE > Elasticity	Components are the basic elements of the modeling approach which can be compute or storage components. This differentiation is important, because storage components are inherently state-ful and can not directly benefit from the elasticity of a cloud environment. This is in line with Levcovitz et al.	Ivon Miranda Santos
Mahmood2020-Erp_issues_and_challenges_a_research_synthesis	CLOUD INFRAESTRUCTURE > Public cloud	(2016) say that managing security-related issues in cloud ERP is a complex and challenging process. So, to tackle this problem cloud vendors offer service of private cloud, which is more secure as compare to the public cloud. This study supports the earlier findings in relevant research.	Ivon Miranda Santos
Mahmood2020-Erp_issues_and_challenges_a_research_synthesis	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	In the twenty-first century, today, businesses have to deal with technological advancements occurring at a pace never experienced before. New technologies such as cloud computing, IoT, Big data, among others provide revolutionary solutions to organizations. However, these technologies have different issues and challenges when enterprise systems are implemented using such technologies.	Ivon Miranda Santos
Maniah2022-A_systematic_literature_review_Risk_analysis_in_clou	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	The era of the industrial revolution 4.0 was an era marked by the transition of information and communication technology that was able to create new technology-based investments. Internet of things (IoT), Big Data, and Cloud Computing are the foundations that underlie this 4.0 industrial revolution. Cloud Computing is a service that provides network storage space and computer resources using an internet connection as a medium of access.	Ivon Miranda Santos

Maniah2022-A_systematic_literature_review_Risk_analysis_in_clou	CLOUD INFRAESTRUCTURE > Public cloud	Based on the type of service, the Cloud is divided into 4 (four), namely: Private Cloud, which is a Cloud service that is aimed at a group or group and limits access only to that group; Public Cloud, which is a Cloud service that can be accessed by any customer with an internet connection; Community Cloud, which is a Cloud service aimed at the commu-nity which can consist of two or more organizations that have sim-ilar Cloud requirements; and Hybrid Cloud, which is a Cloud service that combines at least two types of Cloud services from Pri-vate Cloud, Public Cloud or Community Cloud (Huth and Cebula, 2011). According to The National Institute of Standards and Tech-nology (NIST) - Reference Architecture, there are 5 (five) main actors in the Cloud ecosystem that describe their functions and roles, namely: consumers, providers, brokers, operators, and audi-tors (Iorga and Karmel, 2012).	Ivon Miranda Santos
Maniah2022-A_systematic_literature_review_Risk_analysis_in_clou	CLOUD INFRAESTRUCTURE > Hybrid cloud	Based on the type of service, the Cloud is divided into 4 (four), namely: Private Cloud, which is a Cloud service that is aimed at a group or group and limits access only to that group; Public Cloud, which is a Cloud service that can be accessed by any customer with an internet connection; Community Cloud, which is a Cloud service aimed at the commu-nity which can consist of two or more organizations that have sim-ilar Cloud requirements; and Hybrid Cloud, which is a Cloud service that combines at least two types of Cloud services from Pri-vate Cloud, Public Cloud or Community Cloud (Huth and Cebula, 2011). According to The National Institute of Standards and Tech-nology (NIST) - Reference Architecture, there are 5 (five) main actors in the Cloud ecosystem that describe their functions and roles, namely: consumers, providers, brokers, operators, and audi-tors (Iorga and Karmel, 2012).	Ivon Miranda Santos
Maniah2022-A_systematic_literature_review_Risk_analysis_in_clou	CLOUD INFRAESTRUCTURE > Public cloud	Search based on compatibility with given keywords, using ‘‘Boolean” ‘‘OR” and ‘‘AND”, where the keywords used are: ‘‘risk type” or ‘‘risk component” or ‘‘risk type on public cloud” or ‘‘risk component on public cloud” or [‘‘Risk type”] and [‘‘risk com-ponent”] and ‘‘cloud migration” or [‘‘risk type”] and [‘‘risk compo-nent”] and ‘‘cloud migration”. The literature search strategy is based on a meta-database (Fowley et al.,	Ivon Miranda Santos
Maniah2022-A_systematic_literature_review_Risk_analysis_in_clou	CLOUD INFRAESTRUCTURE > Public cloud	However, by migrating to the cloud, users cannot directly control the system that manages their data and applications, because data users and cloud servers are not in the same domain. Especially for public cloud service users who imple-ment a Shared Multi - tenant Environment. Multitenancy security and privacy are important challenges for cloud users, because multitenancy allows multiple users to run their applications	Ivon Miranda Santos
Maniah2022-A_systematic_literature_review_Risk_analysis_in_clou	CLOUD INFRAESTRUCTURE > Public cloud	State-of-the-art risk type and State-of-the-art risk component. Based on the a forementioned categories, the results can be briefly described through the distribution years of publica-tion and state-of-the-art analysis for types of risks and risk compo-nents in cloud migration. 4.1.	Ivon Miranda Santos
Maniah2022-A_systematic_literature_review_Risk_analysis_in_clou	CLOUD INFRAESTRUCTURE > Public cloud	, 2006; Abd Al Ghaffar, 2020). On the Infrastructure-as-a-Service (IaaS) cloud platform, it can pose a risk of losing the VM state (Rashid Dar and Ravindran, 2019), likewise for services on the public cloud the opportunity to threaten secu-rity due to shared servers (Masky et al., 2015; Shakeel and Sharma, 2017).	Ivon Miranda Santos

Mateen2021-A_dynamic_decision_support_system_for_selection_of_c	CLOUD INFRAESTRUCTURE > Public cloud	In recent years, the cloud computing model has gained increasing attention and popularity in the field of information technology. For this reason, people are migrating their applications to public, private, or hybrid cloud environments. Many cloud vendors offer similar features with varying costs, so an appropriate choice will be the key to guaranteeing comparatively low operational costs for an organization.	Ivon Miranda Santos
Mateen2021-A_dynamic_decision_support_system_for_selection_of_c	CLOUD INFRAESTRUCTURE > Hybrid cloud	In recent years, the cloud computing model has gained increasing attention and popularity in the field of information technology. For this reason, people are migrating their applications to public, private, or hybrid cloud environments. Many cloud vendors offer similar features with varying costs, so an appropriate choice will be the key to guaranteeing comparatively low operational costs for an organization.	Ivon Miranda Santos
Mateen2021-A_dynamic_decision_support_system_for_selection_of_c	CLOUD INFRAESTRUCTURE > Public cloud	The examples for IAAS include Microsoft Azure and Amazon Web Service (AWS) [2]. Cloud computing has three main types (public, private, and hybrid) with different benefits for each type. The public cloud is a standard cloud computing model in which resources, such as CPU, memory, a repository, and APIs, are available to all users. These services can be public websites like Daraz, or storage space like Dropbox and OneDrive.	Ivon Miranda Santos
Mateen2021-A_dynamic_decision_support_system_for_selection_of_c	CLOUD INFRAESTRUCTURE > Hybrid cloud	The examples for IAAS include Microsoft Azure and Amazon Web Service (AWS) [2]. Cloud computing has three main types (public, private, and hybrid) with different benefits for each type. The public cloud is a standard cloud computing model in which resources, such as CPU, memory, a repository, and APIs, are available to all users.	Ivon Miranda Santos
Mateen2021-A_dynamic_decision_support_system_for_selection_of_c	CLOUD INFRAESTRUCTURE > Hybrid cloud	, government ministry websites). In order to get the flavor of both public and private environments, there is a hybrid cloud. This type is not commonly used owing to some security concerns.	Ivon Miranda Santos
Mateen2021-A_dynamic_decision_support_system_for_selection_of_c	CLOUD INFRAESTRUCTURE > Public cloud	This type is not commonly used owing to some security concerns. Similarly, public users do not easily accept private cloud re-strictions. A community cloud is a variant of hybrid cloud that provides services within a community [3].	Ivon Miranda Santos
Mateen2021-A_dynamic_decision_support_system_for_selection_of_c	CLOUD INFRAESTRUCTURE > Hybrid cloud	Similarly, public users do not easily accept private cloud re-strictions. A community cloud is a variant of hybrid cloud that provides services within a community [3]. Figure 1 clearly shows that cloud services are dependent on the user's capability requirement and the openness of the membership.	Ivon Miranda Santos
Mateen2021-A_dynamic_decision_support_system_for_selection_of_c	CLOUD INFRAESTRUCTURE > Public cloud	The examples for IAAS include Microsoft Azure and Amazon Web Service (AWS) [2]. Cloud computing has three main types (public, private, and hybrid) with different benefits for each type. The public cloud is a standard cloud computing model in which resources, such as CPU, memory, a repository, and APIs, are available to all users.	Ivon Miranda Santos
Mateen2021-A_dynamic_decision_support_system_for_selection_of_c	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	Cloud computing adaptation has been growing in recent years due to its striking busi-ness framework established on the provision of unseen cloud computing resources, such as software, networks, servers, bandwidth, and data repositories	Ivon Miranda Santos
Mohamed2020-A_multicriteria_optimization_model_for_cloud_servic	CLOUD INFRAESTRUCTURE > Public cloud	four assumptions: (a) the deployment model is public cloud; (b) the service model is IaaS; (c) the pricing model is pay-as-you-go; and (d) each required service is rented from only one cloud service provider.	Ivon Miranda Santos

Opara-Martins2016-Critical_analysis_of_vendor_lock-in_and_its_i	CLOUD INFRAESTRUCTURE > Hybrid cloud	Moreover, more than half (50.9 %) of the organisations polled in the study are already using cloud services for at least one application domain within their organisa-tion. The higher majority (69 %) utilise a combination of cloud services and internally owned applications (i.e. hy-brid IT) for organisation's needs (Fig. 3).	Ivon Miranda Santos
Opara-Martins2016-Critical_analysis_of_vendor_lock-in_and_its_i	CLOUD INFRAESTRUCTURE > Hybrid cloud	Adoption of cloud computing by UK businesses The survey affirms that the concept of using cloud com-puting services to address the business IT needs has established a mainstream deployment across organisa-tions of various sizes. To further substantiate this matter, interestingly about 36 % of participants confirmed using a hybrid (public and private) cloud deployment model as opposed to a private cloud. Only 46 % of UK firms par-ticipated in the survey use public cloud services, in spite of the associated security risks (Fig. 4). The rate of adop-tion has been motivated by numerous indicators for effective cloud deployment decision. The most cited rea-sons for adopting cloud computing includes better scal-ability of IT resources (45.9 %), collaboration (40.5 %), cost savings (39.6 %) and increased flexibility (36.9 %). This suggests that organisations are allured to utilising cloud services due to the perceived business benefits of cost savings, IT flexibility and business agility.	Ivon Miranda Santos
Opara-Martins2016-Critical_analysis_of_vendor_lock-in_and_its_i	CLOUD INFRAESTRUCTURE > Public cloud	The survey affirms that the concept of using cloud com-puting services to address the business IT needs has established a mainstream deployment across organisa-tions of various sizes. To further substantiate this matter, interestingly about 36 % of participants confirmed using a hybrid (public and private) cloud deployment model as opposed to a private cloud. Only 46 % of UK firms par-ticipated in the survey use public cloud services, in spite of the associated security risks (Fig. 4).	Ivon Miranda Santos
Opara-Martins2016-Critical_analysis_of_vendor_lock-in_and_its_i	CLOUD INFRAESTRUCTURE > Elasticity	Managing cloud services requires extensive, mostly manual effort by the customers. Further, important cloud properties (such as self-service and rapid elasti-city) can only be realised if service management is auto-mated. In this aspect, TOSCA allows application developers and operators (DevOps) to model manage-ment best practices and reoccurring tasks explicitly into	Ivon Miranda Santos
Opara-Martins2016-Critical_analysis_of_vendor_lock-in_and_its_i	CLOUD INFRAESTRUCTURE > Hybrid cloud	Data synchronization is another concern, encountered in cloud interoperability and not in data portability [63]. To further substantiate this argument, we elucidate on the need for a portable hybrid environment by highlight-ing two main categories of portability scenarios encoun-tered in current cloud service market: 1) porting legacy applications or data; and 2) porting cloud native applica-tions or data.	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	abstract Despite the compelling case for moving towards cloud computing, the upstream oil & gas industry faces several technical challenges—most notably, a pronounced emphasis on data security, a reliance on extremely large data sets, and significant legacy investments in information technology infrastructure—that make a full migration to the public cloud difficult at present. Private and hybrid cloud solutions have consequently emerged within the industry to yield as much benefit from cloud-based technologies as possible while working within these constraints.	Ivon Miranda Santos

Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Hybrid cloud	Private and hybrid cloud solutions have consequently emerged within the industry to yield as much benefit from cloud-based technologies as possible while working within these constraints. This paper argues, however, that the move to private and hybrid clouds will very likely prove only to be a temporary stepping stone in the industry's technological evolution. By presenting evidence from other market sectors that have faced similar challenges in their journey to the cloud, we propose that enabling technologies and conditions will probably fall into place in a way that makes the public cloud a far more attractive option for the upstream oil & gas industry in the years ahead.	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	This paper argues, however, that the move to private and hybrid clouds will very likely prove only to be a temporary stepping stone in the industry's technological evolution. By presenting evidence from other market sectors that have faced similar challenges in their journey to the cloud, we propose that enabling technologies and conditions will probably fall into place in a way that makes the public cloud a far more attractive option for the upstream oil & gas industry in the years ahead. The paper concludes with a discussion about the implications of this projected shift towards the public cloud, and calls for more of the industry's services to be offered through cloud-based ''apps.'' & 2013 Elsevier Ltd.	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	The upstream oil & gas industry generally falls into the category of cautious adopters. Although there is considerable evidence that the upstream oil & gas sector has begun to move towards the cloud (Beckwith, 2011), this progress has typically been in the form of private clouds rather than public ones (Feblowitz, 2011), or hybridized solutions that mix cloud and existing non-cloud IT resources (Mathieson and Triplett, 2011). Therein lay the main objectives of this paper.	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Hybrid cloud	The upstream oil & gas industry generally falls into the category of cautious adopters. Although there is considerable evidence that the upstream oil & gas sector has begun to move towards the cloud (Beckwith, 2011), this progress has typically been in the form of private clouds rather than public ones (Feblowitz, 2011), or hybridized solutions that mix cloud and existing non-cloud IT resources (Mathieson and Triplett, 2011). Therein lay the main objectives of this paper.	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	We will then show how many of these challenges have also been encountered in other industries, and use these examples to shine light on how these problems might be overcome in the oil & gas sector. Next, we will consolidate these emerging trends from other industries into a prediction: whereas current cloud strategies in the oil & gas industry tend to be conservatively clustered around the concept of private clouds and hybridized cloud solutions, we believe that enabling technologies and conditions will fall into place in a way that makes the public cloud a far more attractive option for the upstream oil & gas industry in the years ahead. We will then conclude with a discussion about the implications of this projected shift towards the public cloud. 2.	Ivon Miranda Santos

Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Hybrid cloud	We will then show how many of these challenges have also been encountered in other industries, and use these examples to shine light on how these problems might be overcome in the oil & gas sector. Next, we will consolidate these emerging trends from other industries into a prediction: whereas current cloud strategies in the oil & gas industry tend to be conservatively clustered around the concept of private clouds and hybridized cloud solutions, we believe that enabling technologies and conditions will fall into place in a way that makes the public cloud a far more attractive option for the upstream oil & gas industry in the years ahead. We will then conclude with a discussion about the implications of this projected shift towards the public cloud.	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Hybrid cloud	These technical realities of the industry bring about an important question: how can the upstream oil & gas sector yield as much benefit as possible from cloud-based technologies while working within these constraints? Private and hybrid clouds have emerged as popular solutions. 4.	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	At a conceptual level, there are essentially three types of cloud architecture: public, private, and hybrid. Public clouds are typically set up by commercial providers that offer an Internet-accessible interface for creating and managing computing resources within their own physical domains (Sotomayor et al., 2009).	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	What is more, because of their highly virtual nature, these resources can be procured competitively from a broad array of specialized vendors and IT companies almost anywhere in the world. At the moment, however, the public cloud model sometimes comes with security risks. Private clouds are one alternative for managing and mitigating these kinds of threats.	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	The objective of private clouds is not ‘‘to sell capacity over the Internet through publicly accessible interfaces, but to give local users a flexible and agile private infrastructure to run service workloads within their administrative domains. Private clouds can also support a hybrid cloud model by supplementing local infrastructure and computing capacity from an external public cloud’’ (Sotomayor et al., 2009, p. 15). In this way, hybrid clouds offer the best of both worlds insofar as this approach makes it possible to manage security-related threats carefully while creating a secure conduit through which customers can selectively leverage the scalability of the public cloud whenever and however they want. Hybrid cloud solutions are a clever way to reap many of the benefits of the public cloud while maintaining a higher degree of control over data security, and they are therefore a very useful bridging technology that customers can use to move towards the public cloud while still hanging on to legacy systems or until software vendors can come up with cloud-friendly alternatives. But hybrid systems do come at a cost: they do not offer the near-infinite scalability, extremely high ‘‘outsourceability,’’ and cost efficiency that the totally public cloud does. It therefore follows that these mid-ground solutions do address some of the concerns and issues raised earlier about cloud computing—but they also curtail much of the additional value and functionality that these technologies could potentially deliver.	Ivon Miranda Santos

Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Hybrid cloud	Private clouds can also support a hybrid cloud model by supplementing local infrastructure and computing capacity from an external public cloud'' (Sotomayor et al., 2009, p. 15). In this way, hybrid clouds offer the best of both worlds insofar as this approach makes it possible to manage security-related threats carefully while creating a secure conduit through which customers can selectively leverage the scalability of the public cloud whenever and however they want. Hybrid cloud solutions are a clever way to reap many of the benefits of the public cloud while maintaining a higher degree of control over data security, and they are therefore a very useful bridging technology that customers can use to move towards the public cloud while still hanging on to legacy systems or until software vendors can come up with cloud-friendly alternatives.	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	For exam-ple, encrypting data3 before placing it in the cloud may even be more secure than unencrypted data in a local data center (p. 15). The TC3 example also sheds light on the jurisdictional dimen-sions of data management in the public cloud. Many types of data are subject to various controls, and several countries enforce laws that restrict attempts to transfer customer data, patient informa-tion, and copyrighted materials across international borders (Armbrust et al., 2009). It is therefore quite understandable that prospective users of the public cloud are sometimes hesitant to pursue this option precisely because it is difficult to ascertain exactly where one's data is being physically stored (Kamara and Lauter, 2010; Naone, 2011).4 Public cloud service providers are aware of these concerns, however, and have begun to offer servers and storage facilities in multiple legal jurisdictions. For example, both Amazon Web Services and Microsoft Azure have servers physically located in the United States and Europe, and both firms' customers are welcome to keep data in either region based upon their particular needs and circumstances (Armbrust et al.,	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	, Feblowitz, 2011; Yuan et al., 2011) and, in light of the considerable economic impact of the industry (Yergin, 1991) and the ''size of the prize'' that goes with this, someone in the market—perhaps an industry incumbent like an oilfield service company, or maybe a new entrant—may eventually rise to the challenge and offer solutions that reduce the barriers associated with sending this kind of sensitive data into increasingly public parts of the cloud. Data encryption protocols are a potentially promising way to address these types of issues. The same dynamic forces that re-shaped the retail sector may, with a bit of tweaking, be able to help the oil & gas industry get to the public cloud more quickly, too. Some data security experts even go so far as to suggest that data can be safer in the public cloud than in the privately managed facilities of companies that do not specialize in IT. Jeremy Grossman, a former information security officer at Yahoo!,	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	Scientific research A team of researchers at the Medical College of Wisconsin's Biotechnology and Bioengineering Center has made significant headway in an extremely data-intensive area of science by using the public cloud. The team collects vast amounts of data gener-ated by mass spectrometry instruments that determine the elemental composition and chemical structure of proteins expressed by organisms.	Ivon Miranda Santos

Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	Perrons, A. Hems / Energy Policy 56 (2013) 732–737 735team at the Medical College of Wisconsin developed a customized technical solution that made it possible to move enormous amounts of data and highly sophisticated computational tasks to the public cloud, and Yahoo! used Hadoop to a similar end. It therefore follows that such a bridge to the public cloud may not be out of the question for the upstream oil & gas industry. In addition to this, the efficiency and speeds available within off-the-shelf computing technologies have advanced at a remark-able rate over the years (Grove, 1996), and there is little evidence to suggest that this trend will abate anytime soon.	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	, 2009). Thus, even if no customized, industry-specific solutions are put forward in the marketplace that address the oil & gas sector's specific technical challenges, the macro-level evolutionary changes that will emerge throughout the entire IT landscape may at least partially lower the barriers that the industry is facing en route to the public cloud. 6.	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	Although there are many obvious differences between the upstream oil & gas industry and the three examples discussed here, a potentially useful theme emerges. In each instance, there were mitigating factors that initially made it difficult to move data and computational functions to the public cloud. The technical and logistical challenges facing each of these sectors were in many ways reminiscent of those currently facing the upstream oil & gas industry in its own journey towards cloud computing. But in each example, the problem was overcome by some kind of technological solution or a shift in the underpinning market conditions, and then each organization successfully moved mission-critical data and functions into the public cloud. Companies like Microsoft are beginning to hear anecdotal evidence from their clients that points in this same direction. Several firms within sectors that have been more aggressive in moving to cloud computing than the oil & gas industry have openly started to wonder if they should re-engineer their IT strategies away from mid-ground solutions like private or hybrid clouds in favor of designs that more fully leverage the public cloud. We therefore submit that the upstream oil & gas sector will probably arrive at a similar inflection point in its own collective thinking in the years ahead.	Ivon Miranda Santos
Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Public cloud	The evidence presented here therefore makes a strong case in support of highly modular IT architectures that will be relatively easy and inexpensive to change in the future. Although private and hybrid cloud architectures are popular within the industry at the moment because of existing constraints, the examples pre-sented in this paper point to a future that is increasingly predicated on the public cloud. We accordingly believe that companies within the upstream oil & gas industry—including international oil companies, national oil companies, service com-panies, and vendors—would be well advised to build into their systems enough flexibility and modularity to make this change when the time is right, thereby allowing them to take full advantage of the benefits that cloud computing can offer.	Ivon Miranda Santos

Perrons2013-Cloud_computing_in_the_upstream_oil_and_gas_industr	CLOUD INFRAESTRUCTURE > Hybrid cloud	The evidence presented here therefore makes a strong case in support of highly modular IT architectures that will be relatively easy and inexpensive to change in the future. Although private and hybrid cloud architectures are popular within the industry at the moment because of existing constraints, the examples pre-sented in this paper point to a future that is increasingly predicated on the public cloud. We accordingly believe that companies within the upstream oil & gas industry—including international oil companies, national oil companies, service companies, and vendors—would be well advised to build into their systems enough flexibility and modularity to make this change when the time is right, thereby allowing them to take full advantage of the benefits that cloud computing can offer.	Ivon Miranda Santos
Petcu2014-Portability_in_clouds_Approaches_and_research_opportu	CLOUD INFRAESTRUCTURE > Elasticity	1. Concept: to exploit the advantage of elasticity and pay-as-you concept; 2. Continuity: to ensure continuity in application and service functionality.	Ivon Miranda Santos
Petcu2014-Portability_in_clouds_Approaches_and_research_opportu	CLOUD INFRAESTRUCTURE > Public cloud	Continuity: to ensure continuity in application and service functionality. The portability between Private and Public Clouds is essential in realizing the vision of the Hybrid Cloud that handles the peaks in service and resource requests addressed to a Private Cloud using external resources of a Public Cloud. The porting process is usually triggered on demand basis.	Ivon Miranda Santos
Petcu2014-Portability_in_clouds_Approaches_and_research_opportu	CLOUD INFRAESTRUCTURE > Hybrid cloud	Continuity: to ensure continuity in application and service functionality. The portability between Private and Public Clouds is essential in realizing the vision of the Hybrid Cloud that handles the peaks in service and resource requests addressed to a Private Cloud using external resources of a Public Cloud. The porting process is usually triggered on demand basis.	Ivon Miranda Santos
Petcu2014-Portability_in_clouds_Approaches_and_research_opportu	CLOUD INFRAESTRUCTURE > Public cloud	1. Vertical portability as the capability of an application intended for a Private Cloud to be portable to a Public Cloud. The restriction is that the application runs on the same technology stack on both platforms.	Ivon Miranda Santos
Petcu2014-Portability_in_clouds_Approaches_and_research_opportu	CLOUD INFRAESTRUCTURE > Public cloud	Representative for the first category, AppScale is an open source software system implementing a PaaS. It is API-compatible with Google App Engine (GAE): it allows the execution of GAE applications on-premise or over public Cloud infrastructures, without any code modification [19]. The latest category (and most general) requires a large time investment by a developer to create the layers, and, later on, to maintain them as the APIs change.	Ivon Miranda Santos
Petcu2014-Portability_in_clouds_Approaches_and_research_opportu	CLOUD INFRAESTRUCTURE > Public cloud	Program to develop a set of Cloud computing standards. NIST' spe-cial publications are referring to Cloud architectures, Cloud security, Cloud deployment in the context of various strategies of USA federal government OASIS www.oasis-open.org/, Three important technical committees are activating: (1) SAF, referring to capacity, quality of service, and cost; (2) CAMP, Cloud ap-plication management for platforms, defining interfaces for self-service provisioning, monitoring, and control of Cloud platforms; (3) TOSCA OW2 www.ow2.org/view/ Cloud/	Ivon Miranda Santos

Petcu2014-Portability_in_clouds_Approaches_and_research_opportu	CLOUD INFRAESTRUCTURE > Public cloud	life-cycle of the application components, not on the management of Cloud resources. Adaptors are build for the major Public and Private Cloud technologies. The Personal Testbed Cluster (PTC) allows the development of the applications on a desktop and test on few virtual machines (as much as the desktop allows) and later on the seamless transfer of the applications into Private or Public Clouds. CompatibleOne is based on a platform and a model for the description, aggregation and integration of distributed resources provisioned by heterogeneous Cloud service providers.	Ivon Miranda Santos
Petcu2014-Portability_in_clouds_Approaches_and_research_opportu	CLOUD INFRAESTRUCTURE > Public cloud	The most significant initiatives are enumerated bellow in chronological order. CSAL, introduced by Hill and Humphrey [18], is a storage abstraction layer enabling applications to use scalable storage services provided by Public Clouds and also to be portable across platforms. It provides	Ivon Miranda Santos
Petcu2014-Portability_in_clouds_Approaches_and_research_opportu	CLOUD INFRAESTRUCTURE > Hybrid cloud	A roadmap for the Cloud software engineering was proposed by Da Silva and Lucredio [36]. The key-points of their roadmap are: solutions for avoidance of data lock-in; decision making about the migration towards the Cloud; legacy software migration; a re-engineering process for the Cloud migration; mechanisms to facilitate the hybrid Cloud; implementation of Modelling as a Service; Cloud service composition; case studies; open source platforms. 5.3.	Ivon Miranda Santos
Ranchal2020-Disrupting_healthcare_silos_Addressing_data_volume_	CLOUD INFRAESTRUCTURE > Elasticity	I. INTRODUCTION MODERN IT systems are increasingly adopting cloud computing and moving their workloads on cloud to take advantage of its various benefits such as economies of scale, energy efficiency, scalability, and elasticity. At the same time, the applications that run on cloud require their data to be available in cloud for adequate performance, accurate data processing, and operational efficiency.	Ivon Miranda Santos
Ravi2019-Emergence_of_middleware_to_mitigate_the_challenges_of_	CLOUD INFRAESTRUCTURE > Public cloud	Many large customers of Amazon such as Reddit and Quora were down for almost a day. The outage from a provider such as Ama-zon Web Services (AWS), that owns roughly a third of the global cloud market reignited debate on the risks of public cloud. However, Amazon's cloud outage was not the first, and it certainly would not be the last.	Ivon Miranda Santos
Ravi2019-Emergence_of_middleware_to_mitigate_the_challenges_of_	CLOUD INFRAESTRUCTURE > Definition of cloud computing	When we call the term Mobile Cloud computing, we are actually trying to empower mobile devices with massive capabilities from stationary data centers located all over the world.	Ivon Miranda Santos
Ravi2019-Emergence_of_middleware_to_mitigate_the_challenges_of_	CLOUD INFRAESTRUCTURE > Hybrid cloud	FUSION aims to fuse multiple cloud vendors with multi-ple handheld devices. From the cloud end, it acts as a solution to solve the cloud interoperability issue, and from the client end, it enables to access hybrid cloud ser-vices from mobile devices with less effort. This middleware includes its own unique stack of API set, designed with a protocol efficient for mobile or handheld devices.	Ivon Miranda Santos
Ravi2019-Emergence_of_middleware_to_mitigate_the_challenges_of_	CLOUD INFRAESTRUCTURE > Public cloud	After which, the addition of more nodes does not necessarily improve the performance. However, the cloud bursting capacity from Eucalyptus to a public cloud such as AWS can help in achieving higher scalability more quickly. 8.	Ivon Miranda Santos

Ravi2019-Emergence_of_middleware_to_mitigate_the_challenges_of_	CLOUD INFRAESTRUCTURE > Hybrid cloud	To support the above notion, this paper has done an extensive survey of the existing solutions that are offered in the market for both the cloud end and the mobile end, and then briefs about how a generic middleware should work and also outlines about the API heterogeneity with the existing vendors, and selects the suitable API technology that the middleware could hold. Developing such a framework would certainly decrease the effort and complexity of developing a mobile application that requires accessing distributed hybrid cloud architectures. References	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	Faculty of Computer Science and Information Technology University of Gujrat, Gujrat, Pakistan Abstract—The evolution of cloud infrastructures toward hybrid cloud models enables innovative business outcomes, twin turbo drivers by the requirement of greater IT agility and overall cost-containment pressures. Hybrid cloud solutions combine the capabilities of both public clouds along with those of on-premises private cloud environments. In order to key benefit with hybrid cloud model, there are different security issues that have been shown to address. In this paper, we explain security issues in detail such as to maintain trust and authenticity of information, Identity management and compliance which is influencing in enterprises due to migration of IT cloud technologies are increasingly turning to hybrid clouds. Here, work outcomes with comparative study of different existing solution and target the common problems domains and security threads. Keywords—Hybrid cloud; migration; security issues; security techniques I. INTRODUCTION	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Public cloud	Abstract—The evolution of cloud infrastructures toward hybrid cloud models enables innovative business outcomes, twin turbo drivers by the requirement of greater IT agility and overall cost-containment pressures. Hybrid cloud solutions combine the capabilities of both public clouds along with those of on-premises private cloud environments. In order to key benefit with hybrid cloud model, there are different security issues that have been shown to address.	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Elasticity	Cloud computing topic has lot of rapid innovation on Internet from cloud service provider such as Amazon, Open Stacks EC2, through different types of virtual data centers operate across different types of IT environments. Gaining the several benefits, cloud computing provides a more elasticity enabling the on demand approach to an elastic pool of shared computing [1], [2]. In the past few years, several business enterprises are go mainstream that by rapid provisioning the cloud resources and to leverage the scale inherent in IT Infrastructure to cut costs and modernize IT operational for service delivery requirements rather than need of purchasing their own expensive IT infrastructure.	Ivon Miranda Santos

Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Public cloud	In the past few years, several business enterprises are go mainstream that by rapid provisioning the cloud resources and to leverage the scale inherent in IT Infrastructure to cut costs and modernize IT operational for service delivery requirements rather than need of purchasing their own expensive IT infrastructure. Today many enterprises for cost savings IT cloud technologies are increasingly turning to hybrid clouds, allowing them to combine the benefits of building private and public clouds as well as to leverage the scale inherent in their existing IT Infra-structure to cut costs and modernize IT operational agility for service delivery requirements. Recently, survey covered that many enterprises are rapidly adopting a multi-cloud approach using different cloud service vendors to support their IT infrastructure [3].	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	In the past few years, several business enterprises are go mainstream that by rapid provisioning the cloud resources and to leverage the scale inherent in IT Infrastructure to cut costs and modernize IT operational for service delivery requirements rather than need of purchasing their own expensive IT infrastructure. Today many enterprises for cost savings IT cloud technologies are increasingly turning to hybrid clouds, allowing them to combine the benefits of building private and public clouds as well as to leverage the scale inherent in their existing IT Infra-structure to cut costs and modernize IT operational agility for service delivery requirements. Recently, survey covered that many enterprises are rapidly adopting a multi-cloud approach using different cloud service vendors to support their IT infrastructure [3].	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	Additionally, Google Cloud use 19%, Oracle Cloud use 9%, and RackSpace use 7.3%. Hybrid cloud computing is about aggregation and integration of computer, networking, applications, storage, security and management into unified, orchestrated management framework which enables enterprise IT and developers to leverage scale, flexibility and cost savings of existing in-house IT investment tools, systems and privacy policies scale to manage in the enterprise data center with their newly adopted cloud services[4], [5]. The IDC report predicts more than 80 per cent of IT enterprises will commit to hybrid architectures [6].	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	1. A Hybrid cloud includes a few addition features as discussed below. A. Integration of Infrastructure and the Application Environment Hybrid cloud platform is the capability spinning up workloads or virtual machines for infrastructure as a service same in both private and public clouds. B. Interconnectivity The parallel processes in which two coexisting environments communicate and interact facilitate the exchange of data, VMs and applications among individual clouds.	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Public cloud	A Hybrid cloud includes a few addition features as discussed below. A. Integration of Infrastructure and the Application Environment Hybrid cloud platform is the capability spinning up workloads or virtual machines for infrastructure as a service same in both private and public clouds. B. Interconnectivity The parallel processes in which two coexisting environments communicate and interact facilitate the exchange of data, VMs and applications among individual clouds.	Ivon Miranda Santos

Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	C. Portability of Applications Using cloud aware development builds systems from re-usable components that will work the same across cloud environments. D. Monitoring and Management across Cloud Environments In a Hybrid clouds, monitoring and management is essential for the health of the system, visibility into system health across clouds is crucial In spite of such significant benefits, migration of IT cloud technologies from enterprises have important aspect over privacy, integrity, security concerns and compliance considerations due to reliability on multi cloud vendors such as Microsoft, Amazon and Google [7]. The descriptive study in this paper is summarised with a view to discuss and different security issues that have been shown to address.	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	RELATED WORK Security in the hybrid cloud is still a major concern for many IT organizations. Undale et al. [10] describes comparison and performance review of AES, Blowfish and RC6 Symmetric cryptographic algorithm in hybrid cloud application with standard cryptographic techniques, such as Proxy encryption, ABE (Attribute based encryption)with its types. To make an efficient solution and to make an NP Complete solution of image encryption problem on hybrid cloud environment. Gharat et al.	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	With the encryption technique we have used steganography for text data storage. In this paper, our aim is to achieve the image and text data privacy using hybrid cloud. Sanjay et al. [13] focused on to identify the security threats in a hybrid cloud architectures for enterprises and suggested control method to access the data in Hybrid cloud approach using multi factor authentication from on-premises Active Directory. Federated Identities between on premises directory solution using Federated ID for the Identity infrastructure services is detailed.	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	Anukrati and Dubey et al. [14] address some challenges to consider when migrating to hybrid clouds and techniques can addressed in hybrid infrastructure securities can be provide to protect encryption and decryption communication, key based security algorithms which are countered authentication and authorization techniques secured over the intra cloud communication in which an automatic, intelligent migration service in hybrid cloud relay on agent technology. In this research paper major areas of focus on a group of unified Identity & Access Management and privacy frameworks across cloud computing applications or services.	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	Hardayal and Shekhawat et al. [15] mainly concern the security risks and solutions in hybrid cloud computing for electronic governance. This study summarizes major security issues based on a precise literature review.	Ivon Miranda Santos

Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	Patil et al. [16] introduce a secure Hybrid Cloud approach for encrypted deduplication of data using key generation. We propose secure hashing algorithm for avoiding deduplication, which generates a unique key for each file. The generated key is stored in private cloud and Key generation process involves inside the public cloud. For security consideration to encrypt the data before updating data into the cloud becomes necessary. For achieving authorized deduplication along with protect data security, hashing algorithm is used which makes technique very secure, to protect data from unauthorized access.	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Public cloud	We propose secure hashing algorithm for avoiding deduplication, which generates a unique key for each file. The generated key is stored in private cloud and Key generation process involves inside the public cloud. For security consideration to encrypt the data before updating data into the cloud becomes necessary.	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	Following major problems are observed during the study. In the Table I below a comparative study about security issues in Hybrid cloud:(IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 10, No. 3, 2019	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	□ Shared technology issues Working with hybrid cloud still requires implementing proper data security and Integrity among these main security issues. In fact, Identity and Access Management involved in data security issues [17].	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Public cloud	Data security refers to data confidentiality, integrity, authentication (CIA) in cloud [18]. A. Compliance with Regulatory and Policy Requirements Not only you have to compensate public cloud and private cloud provider are in compliance audit practices, but you also must demonstrate coordination of other third parties or open-source tools between both clouds is compliant [19]. B. Poorly Constructed SLAs Many cloud providers such as Amazon, Microsoft, Google and IBM support a large amount of customers by enhancing their web services. To make sure that public cloud provider can demonstrate the infrastructure meet those commitments, options and incentives detailed in the service level agreement (SLAs) [20]. To make trusted private cloud lives up to that similar to the SLA.	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Public cloud	356 | P a g e www.ijacsa.thesai.org C. Reconfiguration Issues Several issues are resulted due to migration of components from the private cloud to the public cloud due to reconfiguring components in hybrid cloud such as addressing, firewall and component placement [21]. D. Shared Technology Issues Virtualization technologies are mostly approach in hybird model [22].	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	356 | P a g e www.ijacsa.thesai.org C. Reconfiguration Issues Several issues are resulted due to migration of components from the private cloud to the public cloud due to reconfiguring components in hybrid cloud such as addressing, firewall and component placement [21]. D. Shared Technology Issues Virtualization technologies are mostly approach in hybird model [22].	Ivon Miranda Santos

Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	There is a more prone for accessing data in one virtual machine from another virtual machine on same physical server [23]. Demonstrating threats in hybrid cloud security to introduce a secure authentication framework for hybrid cloud services is required [24]. So we will target numerous threats is shown in Table II and are as follows:	Ivon Miranda Santos
Raza2019-A_review_on_security_issues_and_their_impact_on_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	CONCLUSION Hybrid cloud computing is inexorable paradigm where computing is on demand service of private and public both cloud. Emerging technologies related to any application should consider the several possible security threats. The various security issues presented would definitely useful the cloud users to suitable choice and hybrid cloud vendors to handle such kind of threats efficiently. Also, a study of hybrid model a framework of security and requirement of cloud security has been exploited and target with problem considerations.	Ivon Miranda Santos
Repschlaeger2012-Cloud_requirement_framework_Requirements_and_e	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	Due to the fast growth, Cloud Computing has become a non-transparent market with providers and customers willing to adopt it. Furthermore, many offers only partially meet customers' requirements and it is not clear how exactly Cloud Computing influences the IT.	Ivon Miranda Santos
Repschlaeger2012-Cloud_requirement_framework_Requirements_and_e	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	Recently, Cloud Computing has become a fast growing and non-transparent market with many providers, including heterogeneous service portfolios and models (Hoefer and Karagiannis, 2010; Martens et al., 2011a; Martens et al., 2011b).	Ivon Miranda Santos
Repschlaeger2012-Cloud_requirement_framework_Requirements_and_e	CLOUD INFRAESTRUCTURE > Definition of cloud computing	, 2011). Due to the lack of a universal definition and various perceptions of Cloud Computing, including the related benefits and challenges, many companies struggle to make use of the Cloud concept (Nuseibeh, 2011; Leavitt, 2009; Marston et al. 2011).	Ivon Miranda Santos
Repschlaeger2012-Cloud_requirement_framework_Requirements_and_e	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	Most researchers such as Briscoe and Marinos (2009) or Vaquero et al. (2009) and institutions like the National Institute of Standards and Technology (NIST) postulate three servcie models or service levels of Cloud Computing: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) (Grance and Mell, 2009; Koehler et al., 2010b). Most of the research work, prior to 2011, focused on various technical issues of Cloud Computing (Koehler et al., 2010b). Since 2011, the perceived importance of the business view has grown and Cloud Computing is becoming more than a technological enabler (Iyer and Henderson, 2010). Although, Cloud Computing is examined from several specific business perspectives, for instance, pricing models, resource allocation for IaaS, critical adoption capabilities, a comprehensive framework of requirements for all three service models (layers) remain unexplored.	Ivon Miranda Santos
Repschlaeger2012-Cloud_requirement_framework_Requirements_and_e	CLOUD INFRAESTRUCTURE > Public cloud	Also Martens et al. (2011a) identified only four scientific publications related to the field of business and management of Cloud Computing in 2010. Based on our literature review in 2011 we could detect over 61 publications focusing on business aspects of Cloud Computing. This growth of publications reflects the enthusiasm on the Cloud Computing paradigm and the increasing importance for practitioners and researchers (Yang and Tate, 2009; Son and Lee, 2011). In addition, Cloud Computing has become more mature and is perceived increasingly from a business perspective rather than only from a technological view (Iyer and Henderson, 2010).	Ivon Miranda Santos

Repschlaeger2012-Cloud_requirement_framework_Requirements_and_e	CLOUD INFRAESTRUCTURE > Public cloud	This analysis was based on an extensive internet research where the websites of relevant companies were examined regarding their pricing model, Cloud service offering, company data and customer segment. By means of market studies, business publications on the Cloud market and an extensive internet search we detected over 60 relevant providers for IaaS, 82 relevant providers for PaaS and over 1000 providers for SaaS, mostly located in the US. Due to essential differences on each service level we decided to draw a distinction between requirements specific to one or two service models and requirements valid for all three service models (independent of service model) (Weinhardt et al.,	Ivon Miranda Santos
Rosati2018-Making_the_cloud_work_for_software_producers_Linking	CLOUD INFRAESTRUCTURE > Elasticity	, 2012). Similarly, from a technical perspective, the benefits of the cloud are well documented including on-demand, self-service, resource pooling and rapid elasticity (Armbrust et al., 2010).	Ivon Miranda Santos
Rosati2018-Making_the_cloud_work_for_software_producers_Linking	CLOUD INFRAESTRUCTURE > Public cloud	Documents are classified under custom types, such as invoice or delivery docket, and specific metadata templates are used to store searchable tagged data against the documents for future retrieval and reporting. The application has been designed and coded specifically to run as a cloud application on the Microsoft Azure public cloud platform. 6.2 TCO Calculation	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	Therefore, to overcome this problem, there is a need to develop an elastic load balancing method to improve the performance of cloud systems. This paper proposed an autonomic CSO-ILB load balancer to ensure the elasticity of the cloud system and balance the user workload among the available containers in a multi-cloud environment. The concept of multi-loop has been uti-lized in our approach to enabling efcient self-management before load balancing.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	Moreover, adding these autonomic capabilities to the load balancer can efciently resolve the communication over-head and address the load redundancy problem, thus reducing the need to apply the load balancing algorithm [6]. Elasticity is a major feature of the cloud, as it enables the auto-scaling (add/ remove) of cloud resources based on the cloud applications' workload demands [7]. Cloud elasticity impacts the utilization of cloud resources, power consumption and SLA. Hence, it is highly remarkable [8]. However, ensuring the elas-ticity feature improves the cloud environment's reliability, which can deal with the dynamic workload of business processes. [9]. Generally, elasticity can be ensured vertically or horizontally: Vertical elasticity refers to resizing the capac-ity of cloud resources (VM/Container) such as memory, CPU cores, etc., whereas horizontal elasticity refers to replicating or consolidating the instances of cloud resources [10]. Considering both vertical and horizontal elasticity, the application can provide a fast response to small workloads through vertical scaling. It can respond to sudden workload peaks with the help of horizontal scaling [11].	Ivon Miranda Santos

Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	Since the execution of large business workloads and workfows in the cloud sys-tem is highly crucial, scaling strategies are mandatory to improve the capability of the cloud system [16, 17]. However, ensuring the cloud environment's elastic-ity helps address the uncertainty and heterogeneity issues of workload using auto-scaling strategies, which can increase the capacity of the cloud system by adding or removing containers based on demand. It efciently provides cloud resources to deal with large business processes [18, 19].	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	Workload prediction is a signifcant task as it is predominant in addressing issues such as over and under-provisioning [22, 23]. Accurate prediction of workload arrival rate and consumer request rate highly improves the efciency of the cloud in terms of elasticity [24]. Moreover, depending on the workload, assigning work-loads to the cloud containers may get overloaded or under-loaded.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	The reliability of cloud services is based on the number of resources available and the number of users requesting resources [26]. When the resources in the cloud cannot process the huge business processes, the cloud elastic-ity is declined, and the solutions become unfeasible [27]. Load balancing in a multi-cloud environment ofers performance improvement and elasticity to process huge business tasks within a minimum time. Also, the auto-scaling mechanisms improve the efciency of the cloud environment, thereby refecting the overall reputation [28, 29].	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	Addressing these issues is the motivation behind pro-posing this technique. The main objectives of this research are: to achieve elastic-ity by maintaining a proper balance between utilization and provisioning of cloud resources, to avoid overhead trafc in containers, to maintain SLA by reducing the response time and to fairly balance the load among the available containers ensuring efcient utilization. The proposed CSO-ILB algorithm selects the optimal container to which the tasks can be migrated from the overloaded containers to balance the load between the available containers.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	• To extend a dynamic scheduling strategy DCMM-MTS based on task ranking to dynamically schedule the tasks among available containers in multi-cloud. • To apply the autonomic multi-loop control in the self-adaptation system to ef-ciently monitor the load on containers and take decisions accordingly to main-tain the vertical and horizontal elasticity. • To propose the CSO-ILB load balancing algorithm for balancing the load among the available containers.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	2 Related works This section briefy describes some recent studies on loading balancing, which aim to ensure elasticity using autonomic computing concepts and auto-scaling strategies. However, in a cloud environment, numerous researchers have formulated load bal-ancing with auto-scaling mechanisms to improve the performance and efciency of the cloud system.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	To this extent, Ullah et al. [30] proposed a biologically inspired auto-scaling approach to address the horizontal elasticity problem from the service providers' perspective. They aim to attain the desired level of performance while minimizing computational costs.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	Khebbeb et al. [31] proposed a formal approach to quantitatively analyze the elasticity behaviour based on Bi-graphical Reactive Systems (BRS).	Ivon Miranda Santos

Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	CSO-ILB: chicken swarm optimized inter-cloud load balancer… were operated to describe the cross-layer elasticity strategies. Moreover, to improve the robustness of the cloud system, Singh et al.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	To improve the reliability, Shahidinejad et al. [33] proposed an elastic controller and queuing system to ensure the elasticity features in cloud infrastructures based on Coloured Petri Nets (CPN). The CPN approach surpassed resource utilization, response time and elasticity value compared with other approaches when evaluated under Yahoo cluster, Google cluster and Wikipedia workloads. Junaid et al.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	The technique resolved the problem of heavy load in the virtual machines and scheduled the tasks efectively. To improve the elasticity of the cloud environment, an auto-scaling based load balancing scheme was introduced by Arvindhan and Anand [36]. The approach reduced the response time in load balancing to attain high performance. Proactive auto-scaling was done to improve the overall resource elasticity. Unlike other strate-gies, Pourghafari et al.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Hybrid cloud	Gamal et al. [38] suggested a hybrid bio-inspired algo-rithm to ensure efcient load balancing in the cloud. The method integrated Ant Colony Optimization with an Artifcial Bee Colony algorithm to balance the load between the VMs in the cloud.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	Balancing the load in multi-cloud is challenging; Table 1 shows that the exist-ing load balancing strategies focus on balancing the load in a single cloud, but there is no work mainly focused on load balancing in containerized multi-cloud. Therefore, the proposed article attempts to maintain the load balancing and ensure the vertical and horizontal elasticity in containerized multi-cloud through autonomic computing. The existing ACO [48] takes much response time; hence SLA violation occurs, leading to performance loss.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	After task scheduling, the load in the containers is monitored and balanced with the help of a load balancer. The main aim is to achieve horizontal and vertical elasticity using load balancing. The cloud load balancer autonomously monitors the load of the available containers in the datacentres, and then it decides the migration of the	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	At the same time, the plan-ner takes decisions accordingly to balance the load among available containers. The following are the major modules involved in the autonomic cloud system for balanc-ing the load to maintain elasticity. (i) Automatic Adaptation module (ii) System Evaluation module (iii) Load Balancer module (iv) Controller module	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Hybrid cloud	The analyzer component is responsible for checking whether there is a need for auto-scaling. The hybrid auto-scaling is carried out to efectively scale the cloud resources to execute any number of tasks entering the cloud. The planner component is installed with a predictor to predict future workloads.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	The planner component is installed with a predictor to predict future workloads. Based on the prediction, the resources are scaled up or down to maintain elasticity. A threshold value is set for the CPU uti-lization and response time to scale the resources to minimize the response time and maximize the CPU utilization.	Ivon Miranda Santos

Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	The experiments proved that the proposed method could efciently balance the load among the available contain-ers by accurately choosing the optimal under-loaded container. Also, the proposed approach attains high performance in achieving horizontal and vertical elasticity through scaling options. The proposed CSO-ILB technique has been compared with the existing ACO, BCO, ASFLA and CSO algorithms.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	The overall observations show that the improvement rate of the pro-posed model is 61% in terms of response time, 59% in execution cost, 45% in task migration count, 45% in make-span, 38% in energy utilization, 42% in idle time, 35% in reliability, and 30% in CPU utilization. Thus, it can be concluded that the proposed approach outperformed the other approaches in all the considered param-eters, providing efcient load balancing, ensuing the vertical and horizontal elas-ticity in a multi-cloud environment, and satisfying both cloud user and provider objectives. Fig.	Ivon Miranda Santos
Saif2022-CSO-ILB_chicken_swarm_optimized_inter-cloud_load_balan	CLOUD INFRAESTRUCTURE > Elasticity	been built for monitoring the dynamic changes in the multi-cloud system to improve the efciency of the scaling decisions. Based on these decisions, vertical or horizontal scaling is performed to ensure the elasticity of the cloud environ-ment. The simulation is performed in the multi-cloud containerized environment using the ContainerCloudsim toolkit to prove the performance and efciency of the proposed approach.	Ivon Miranda Santos
Sailer2018-Healthcare_application_migration_in_compliant_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	Abstract. Key challenges in managing healthcare applications lie in the area of compliance of the deployment environments and the usage of hybrid clouds. Our approach, as reported in this paper, utilizes two innovative concepts: compliance conformance validation and environment reconstruction supported by a Platform as a Service (PaaS) environment performing healthcare applica-tion automated migrations in hybrid clouds. We show how the migration process is conducted with dynamic reconstruction of the application dependencies on the PaaS services.	Ivon Miranda Santos
Sailer2018-Healthcare_application_migration_in_compliant_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	Section 4 will detail the design of our Health Complaint Cloud services to natively support the HIPAA regulations. There is a rich body of literature that addresses the migration of legacy or enterprise applications to cloud [9–15] and its security and cloud hybrid aspects [12, 16–20]. Because migration to cloud is a major change for a service provider, carefully thought-out decisions factoring in technical, economical and compliance related aspects [16] need to be made and executed.	Ivon Miranda Santos
Sailer2018-Healthcare_application_migration_in_compliant_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	A survey on cloud migration decision making methodologies has been conducted in [13]. Migration to hybrid or federated clouds is another aspect addressed by current research. This type of migration requires partitioning of the application.	Ivon Miranda Santos
Sailer2018-Healthcare_application_migration_in_compliant_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	Moving to cloud remains a complex endeavor which requires planning and exe-cution of multiple steps and various vendors such as AWS [22] and Cisco [18] have published guides for the service providers illustrating the required processes on their respective platforms. Our intent in this paper is to contribute to the migration aspects in the context of HIPAA regulated hybrid cloud with a focus on providing or maintaining compliance. On an abstract level, some of the concepts used for this migration are similar to the existing migration technologies.	Ivon Miranda Santos

Sailer2018-Healthcare_application_migration_in_compliant_hybrid	CLOUD INFRAESTRUCTURE > Hybrid cloud	6 Conclusion Modern healthcare applications present particular challenges in cloud and hybrid cloud environments. Keeping these applications up-to-date in live cloud environments can be costly and time consuming.	Ivon Miranda Santos
Shirvani2018-An_iterative_mathematical_decision_model_for_cloud	CLOUD INFRAESTRUCTURE > Definition of cloud computing	A review The National Institute of Standards and Technology definition of cloud computing states that CC is “a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (eg, networks, servers, stor-age, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.”2 Researchers seem to agree. Hence, for our work, the National Institute of Standards and Technol-ogy definitions suffice.	Ivon Miranda Santos
Shirvani2018-An_iterative_mathematical_decision_model_for_cloud	CLOUD INFRAESTRUCTURE > Elasticity	Furthermore, it reduces OPEX for economies of scale and increases resource utilization for the sake of applying virtualization techniques and multitenancy. (4) Rapid elasticity: it can scale up/down the leased instances based on the status quo to keep uninter-rupted business units (BUs) and reduce losses, respectively. (5) Measured service: it causes customers to monitor their used services helping to take future suitable strategies.	Ivon Miranda Santos
Shirvani2018-An_iterative_mathematical_decision_model_for_cloud	CLOUD INFRAESTRUCTURE > Public cloud	Four service deployment types are private, public, hybrid, and community. Private cloud can be owned and managed by a single organization; public cloud is open for the general public to use at a low fee. It is owned and managed by a third party.	Ivon Miranda Santos
Shirvani2018-An_iterative_mathematical_decision_model_for_cloud	CLOUD INFRAESTRUCTURE > Public cloud	The community cloud is used for individuals and organizations with the same mission, policy, benefit, etc. Moreover, hybrid cloud includes composition of 2 or more clouds (private, commu-nity, or public) that are known unique entities. More generally, enterprises adopt the hybrid architecture in which some services are deployed in on-premises, whereas other services are placed on off-premises, public cloud. Note that a single cloud provider can only focus on bounded business domains and seldom provisions the full functional/nonfunctional customers’ requirements.48 We can enumerate several major cloud service providers such as Microsoft, Salesforce, Sky-tap, HP, IBM, Amazon, and Google.	Ivon Miranda Santos
Shirvani2018-An_iterative_mathematical_decision_model_for_cloud	CLOUD INFRAESTRUCTURE > Public cloud	Service deployment is typically available, which depends on the business and security requirement. Several service deployment types are private, public, community, hybrid cloud, and even a federated one. Users can deploy all of their needed services on-premises such as traditional IT or on-premises with cloud technology or the so-called private cloud.	Ivon Miranda Santos
Shirvani2018-An_iterative_mathematical_decision_model_for_cloud	CLOUD INFRAESTRUCTURE > Hybrid cloud	Service deployment is typically available, which depends on the business and security requirement. Several service deployment types are private, public, community, hybrid cloud, and even a federated one. Users can deploy all of their needed services on-premises such as traditional IT or on-premises with cloud technology or the so-called private cloud.	Ivon Miranda Santos
Shirvani2018-An_iterative_mathematical_decision_model_for_cloud	CLOUD INFRAESTRUCTURE > Public cloud	IT team. On the other hand, a radical shift toward public cloud is also available, where an organization delegates all of its BFs to be operated by a third-party datacenter. In this case, the term FC (T) as CAPEX can be ignored from TCO.	Ivon Miranda Santos

Shirvani2018-An_iterative_mathematical_decision_model_for_cloud	CLOUD INFRAESTRUCTURE > Public cloud	However, an organization suffers from a lack of IT governance; hence, the effect of security losses is highlighted. Then, a hybrid cloud is deployed when an organization uses its on-premises services and delegates new services over a public cloud as resource needs surge. Another scenario is contingent when an organization pins their critical data/services on-premises and delegates noncritical data/services over a public cloud. Finally, in multicloud, it is possible for an organization to split their service components and delegate them to different providers with different pricing schemes.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	School of Mathematics, Computer Science and Engineering City University London London, United Kingdom Email: r.muttukrishnan@city.ac.uk Abstract—A hybrid cloud is a cloud computing environment in which an organization provides and manages some internal resources (private cloud) while the other resources are provi-sioned externally (public cloud). Rapid deployment of hybrid clouds for utility, cost, effectiveness and flexibility has made it necessary to assure the security and privacy of hybrid clouds as it transcends different domains. Further, successful hybrid cloud implementation requires a well-structured architecture supporting the functionalities of both private and public clouds and the seamless transitions between them. One of the challenges in a hybrid cloud is securing resource access, in particular, enforcing that the owners policy never gets violated even when the data gets consumed and processed in multiple domains.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Hybrid cloud	School of Mathematics, Computer Science and Engineering City University London London, United Kingdom Email: r.muttukrishnan@city.ac.uk Abstract—A hybrid cloud is a cloud computing environment in which an organization provides and manages some internal resources (private cloud) while the other resources are provi-sioned externally (public cloud). Rapid deployment of hybrid clouds for utility, cost, effectiveness and flexibility has made it necessary to assure the security and privacy of hybrid clouds as it transcends different domains. Further, successful hybrid cloud implementation requires a well-structured architecture supporting the functionalities of both private and public clouds and the seamless transitions between them. One of the challenges in a hybrid cloud is securing resource access, in particular, enforcing that the owners policy never gets violated even when the data gets consumed and processed in multiple domains. Existing mechanisms for achieving this, including industry standards such as XACML, SAML, and OAuth, are vulnerable to indirect information leaks as they do not keep track of information flow.	Ivon Miranda Santos

Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Hybrid cloud	The Readers-Writers Flow Model (RWFM) is a novel security model with an intuitive security policy that tracks and controls the flow of information in a decentralized system. In this paper, we present an approach to building a hybrid cloud that preserves the given security and privacy policy by integrating an RWFM security module into a cloud service manager. An advantage of RWFM is that it provides a uniform solu-tion for securing various kinds of hybrid cloud architectures ranging from the simple pairwise federation to the complex interclouds, and supporting varying degrees of flexibility in workload placement ranging from a simple static placement to fully dynamic migration. Further, RWFM framework is forensic-ready by design, because the labels of data and services readily provide the necessary forensic information.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	the hardware and software is what is referred to as a cloud. When a cloud is made available in a pay-as-you-go manner to the general public, it is referred to as a public cloud – bringing clearly the underlying concept of utility computing. The term private cloud usually refers to the internal data centers of a business or other organization, not made available to the general public.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Hybrid cloud	The classic-information flow security models such as DIFC [5], suffer the problem of placing no constraints on the discretionary access by owners of objects/entities. In this paper, we describe an architecture for realizing a secure hybrid cloud using the RWFM model [7]. Our approach enables compliance checking even w.r.t a combination of multiple security policies including the Chinese-Wall model.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Hybrid cloud	The rest of the paper is organized as follows: a brief overview of the security model RWFM is presented in Section II, followed by a discussion on the security concerns in hybrid clouds in Section III. Section IV describes our approach to securing hybrid clouds, and the security guarantees it provides. Merits of our approach in comparison to some of the literature is discussed in Section IV-C, and conclusions and future directions are given in Section V. II.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	In fact, the latter possibility is attractive. 1) for organizations to build their cloud service manage-ment that uses the organizations local cloud storage along with other trusted public clouds with the stipulated security and privacy keeping in view the security and privacy laws of the public clouds. 2) for entrepreneurs, they can build a cloud service man-agement system that assures users to verify the influ-encers of the data and assure their final storage (and possibly the transitions of the data) in the internal cloud.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	For realizing such a verifiable system, the organization needs the following: (i) decide which data can safely be transferred to a public cloud for processing, and (ii) maintain accurate information about which data has been processed by which clouds - useful for forensics and audit. RWFM labels serve as a useful tool for achieving both: (i) readers component of the label of an object provides information to decide whether it is safe to be processed by a public cloud, and (ii) owner and writers components of the label of an object provide information about which cloud has created the data, and which were all the clouds that participated in the processing of data during its entire lifetime respectively. In a hybrid cloud computing environment, an organization provides and manages some of the internal resources and manages its interaction or flow of information between its'	Ivon Miranda Santos

Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Hybrid cloud	(i) readers component of the label of an object provides information to decide whether it is safe to be processed by a public cloud, and (ii) owner and writers components of the label of an object provide information about which cloud has created the data, and which were all the clouds that participated in the processing of data during its entire lifetime respectively. In a hybrid cloud computing environment, an organization provides and manages some of the internal resources and manages its interaction or flow of information between its' own and external resources.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	Figure 1 depicts varieties of cloud computing [12], [4]. In Figure 1, the structure Hybrid Cloud I, can be treated as an organization that uses a public cloud service such as Amazon's EC2 for general computing purposes while storing customers' data within its own data center in a private cloud. The hybrid clouds are being adopted for a variety of reasons like: (i) providing clients with the same features found in commercial public clouds, (ii) providing a uniform and homogeneous view of virtualized resources, and (iii) providing requirements of resources to meet the organization's highly elastic resource usage - thus, handling the dynamic scaling requirements. In the following section, we shall discuss an architecture that realizes the above properties.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Hybrid cloud	Figure 1 depicts varieties of cloud computing [12], [4]. In Figure 1, the structure Hybrid Cloud I, can be treated as an organization that uses a public cloud service such as Amazon's EC2 for general computing purposes while storing customers' data within its own data center in a private cloud. The hybrid clouds are being adopted for a variety of reasons like: (i) providing clients with the same features found in commercial public clouds, (ii) providing a uniform and homogeneous view of virtualized resources, and (iii) providing requirements of resources to meet the organization's highly elastic resource usage - thus, handling the dynamic scaling requirements.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Hybrid cloud	IV. A SECURE ARCHITECTURE FOR HYBRID CLOUD In this section, we provide a general approach for securing a hybrid cloud by integrating an RWFM monitor into the cloud service manager. Further, we also illustrate the working of the approach with a concrete example (no loss of generality), and compare the benefits of our approach with related works. A. A General Approach to Securing Hybrid Cloud Consider the architecture shown in Figure 2. In Figure 2 the cloud service manager (CSM) serves as the cloud manager for the organization that uses the internal cloud storage as well as interacts with public cloud providers.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	A. A General Approach to Securing Hybrid Cloud Consider the architecture shown in Figure 2. In Figure 2 the cloud service manager (CSM) serves as the cloud manager for the organization that uses the internal cloud storage as well as interacts with public cloud providers. From Fig.	Ivon Miranda Santos

Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	An example hybrid cloud architecture a security standpoint, the CSM is responsible for managing the placement of data and computations on various clouds based on the organization's security policy, and the service-level agreements (SLA) that the organization has with the public cloud providers. From the perspective of an audit, the CSM is also required to maintain provenance information, for which it needs to keep track of the set of influencers of incoming data, for example the results that are being returned by the public cloud providers. The CSM can in fact provide a complete multi-level secure platform for computations on the organization's private cloud as it has full control over the resources of the private cloud. However, the CSM has to consider the public cloud providers as blackboxes where trust is achieved through the SLAs. If the CSM is enhanced with an RWFM monitor for con-trolling information-flow among the stakeholders, information leaks can be prevented in the following sense:	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	It forwards the data and the request to the private cloud with the initial labeling as given. 2) The CSM passes the request (along with data) to the public cloud only if the label on the data allows reading by the public cloud. Further, the CSM also checks the compliance of data w.r.t. the SLA with the public cloud. 3) The CSM automatically labels the result returned by public cloud to reflect the fact that it has been influenced by the respective public cloud, before it is sent to the principal who submitted the request. 4) The CSM prevents information leaks in the inter-nal/private cloud by enforcing the RWFM rules on the flow of information among subjects and objects in the private cloud. a) The labels keep track of the influences from the public cloud. b) Assuming that the public clouds follow the SLA with the organization, the end-to-end information computation happens in a completely leak-free manner. 5) The CSM keeps track of the influencers and the readers	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	Consider the example scenario depicted in Figure 3, where an RWFM monitor is integrated in to the CSM - represented as a thin layer on top of the private cloud. For simplicity, the figure depicts a hybrid cloud with only one public cloud provider attached, but the methodology works even with multiple public cloud providers attached. A typical usage scenario in a hybrid cloud is described below using the notations of Figure 3:	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Hybrid cloud	Consider the example scenario depicted in Figure 3, where an RWFM monitor is integrated in to the CSM - represented as a thin layer on top of the private cloud. For simplicity, the figure depicts a hybrid cloud with only one public cloud provider attached, but the methodology works even with multiple public cloud providers attached. A typical usage scenario in a hybrid cloud is described below using the notations of Figure 3: • User (unaware of the security classification of data) submits a job (J) to the cloud.	Ivon Miranda Santos

Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	User also specifies the data (D) on which the computation is to be performed. • RWFM monitor intercepts the user submitted job, identifies the various classes of data (D1 is sensitive and trusted data and D2 is public and untrusted data) involved in the computation, and splits the user job into multiple jobs (job J1 for computing on the sensitive data D1, and J2 for computing on the public data D2) based on the sensitivities of input and submits these jobs to the appropriate (since sensitive data will be stored in the private cloud, J1 is submitted to it, while J2 is submitted to the public cloud on which public data resides) cloud providers. For simplicity, we assume that the organization stores in its private cloud all the sensitive data, and all public data is stored on a public cloud. Note that, this immediately also implies that the data stored on private cloud is more trustworthy than that on the public cloud. Further note that our method is generic and applies even in case of general lattice security policy. • Once the clouds complete their computation and return their results (private cloud returns R1 which is sensitive and trusted output, and the public cloud returns R2 which is public and untrusted data), the RWFM monitor automatically labels all the results.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	In our system, the set of subjects S is defined as {U, C1, C2}, where U, C1, and C2 stand for the user, private cloud and public cloud respectively. Initially the system con-tains objects D1 and D2 representing sensitive and public data respectively stored on the private cloud and the public cloud. Recollect that the initial label of a subject s is (s, S, {s}).	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	Label of D2 is (C2, {C1, C2}, {C1, C2}) and says that it is (i) owned by the public cloud, (ii) non-confidential, and hence readable by both the private and public clouds, and (iii) un-trustworthy since it can be influenced by the public cloud. These three subjects and two objects form the initial state for this system.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	(i) Req - stands for the job submitted by the user, (ii) R1 and R2 are results produced by the private and public clouds respectively, and (iii) R is the simplified final result produced by the private cloud. R has label (C1, {C1}, {C1, C2, U})	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	• D1 to R1 - R1 is the result of private cloud's processing on D1, • D2 to R2 - R2 is the result of public cloud's processing on D2, and • R1 and R2 to R - R is the result of combining the intermediate results R1 and R2.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Hybrid cloud	• R1 and R2 to R - R is the result of combining the intermediate results R1 and R2. The approach illustrated for the example above is general enough to be used for realizing the following properties in hybrid clouds: 1) Complete control of privacy and security in the private cloud.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	Lattice of objects in the example scenario of hybrid cloud 2) Assure desensitization of the data before the date leaves the private cloud into the public cloud. 3) The CSM is not over privileged, but just has the capa-bilities of reading the data that needs to go into public clouds. 4) The CSM keeps track of the provenance of the data that has flown among various public clouds. C. Discussion Zhu et al. [12] present a technique for scalable service and data migration in a collaborative cloud scenario where multiple public cloud providers store and maintain an organi-zations data. Their technique employs cryptographic schemes to achieve this.	Ivon Miranda Santos

Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	An advantage of our approach is that the label provides information not only about the current data possession, but also a succinct summary (high-level) of its entire transaction history. For example, whereas the method of [12] can only tell us that a given piece of data is currently residing in a particular public cloud, our approach can provide additional information about which all cloud providers have influenced it during the course of its computation and storage. We have developed a dynamic labelling approach for mapreduce computations using RWFM that complements the approach presented in this paper and provides an end-to-end security in a hybrid cloud.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Hybrid cloud	For example, whereas the method of [12] can only tell us that a given piece of data is currently residing in a particular public cloud, our approach can provide additional information about which all cloud providers have influenced it during the course of its computation and storage. We have developed a dynamic labelling approach for mapreduce computations using RWFM that complements the approach presented in this paper and provides an end-to-end security in a hybrid cloud. This work is currently under review and being considered for publication elsewhere.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Hybrid cloud	V. CONCLUSIONS In this paper, we have demonstrated that the RWFM model provides a secure architecture for a hybrid cloud assuring full security and privacy compliance in its private cloud and has the capability to keep track of the influences by the public cloud on the data entities. Such a capability establishes a sort of a provenance on the de-sensitised data flowing through the public clouds and thereby aids in non-repudiation of SLAs.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Public cloud	In this paper, we have demonstrated that the RWFM model provides a secure architecture for a hybrid cloud assuring full security and privacy compliance in its private cloud and has the capability to keep track of the influences by the public cloud on the data entities. Such a capability establishes a sort of a provenance on the de-sensitised data flowing through the public clouds and thereby aids in non-repudiation of SLAs. In a related work of ours [9] we have shown how the privacy infringements (note that due to the division of data in map-reduce, there is a possibility that the original privacy of the data may be compromised) that are possible in map-reduce frameworks can be overcome through the RWFM model.	Ivon Miranda Santos
Shyamasundar2017-Information_flow_control_for_building_security	CLOUD INFRAESTRUCTURE > Hybrid cloud	In a related work of ours [9] we have shown how the privacy infringements (note that due to the division of data in map-reduce, there is a possibility that the original privacy of the data may be compromised) that are possible in map-reduce frameworks can be overcome through the RWFM model. Work on integrating both these aspects for realizing an end-to-end security and privacy preserving hybrid cloud is in progress. REFERENCES	Ivon Miranda Santos
Sousa2016-Automated_Setup_of Multi-Cloud_Environments_for_Micro	CLOUD INFRAESTRUCTURE > Public cloud	It is up to the customer or a third-party to integrate services from different providers. Multi-cloud computing is a way to avoid vendor dependence and to better exploit offerings in the cloud market by employing a combination of public and private cloud resources. Customers can build configurations that better fit their needs while reducing their dependence on any given provider.	Ivon Miranda Santos

Sousa2016-Automated_Setup_of Multi-Cloud_Environments_for_Micro	CLOUD INFRAESTRUCTURE > Public cloud	Having independent well-isolated services facilitates this. On the other hand running microservices across private and public clouds from different providers allows for improved scalability and reliability. However, building a multi-cloud solution is complex.	Ivon Miranda Santos
Sousa2016-Automated_Setup_of Multi-Cloud_Environments_for_Micro	CLOUD INFRAESTRUCTURE > Public cloud	Microservices can be developed by different teams, relying on different technologies and methodologies and may therefore require functionalities at different levels of ab-straction. In a multi-cloud environment, microservices can be deployed across private and public clouds from different providers to implement scalability and redundancy mecha-nisms or to comply with location constraints. III.	Ivon Miranda Santos
Stavru2013-Challenges_for_migrating_to_the_service_cloud_paradi	CLOUD INFRAESTRUCTURE > Cloud computing architecture	61-62] Technical challenges T1 Addressing architectural and technical constraints Cloud Computing poses some architecture constraints on the way software systems are build, incl. decomposition, decoupling, componentization, etc. and some technical constraints as what should be the type of database, etc. [52]	Ivon Miranda Santos
Tona2020-DPS-AA_Intranet_migration_strategy_model_for_clouds	CLOUD INFRAESTRUCTURE > Hybrid cloud	The study deeply investigated and analyzed the issues, challenges and limitations i.e. features and performances of the current state of the art of the intranets in general and on-premise Intranet of AMU in specific. Finally, an Intranet Migration Strategy Model over Hybrid Cloud was designed and developed using SaaS (i.e. AMU CloudNet).	Ivon Miranda Santos
Tona2020-DPS-AA_Intranet_migration_strategy_model_for_clouds	CLOUD INFRAESTRUCTURE > Hybrid cloud	D. Prototype Designing In this research study, the Hybrid Cloud [9, 24] was proposed for deployment of the services of Intranet as the university functions consists of both the public and private of data and information. The AMU Cloud-Net prototype was designed and demonstrated over premium version of Interact Intranet technology platform for 45 days access	Ivon Miranda Santos
Weerasinghe2022-Taxonomical_classification_and_systematic_revie	CLOUD INFRAESTRUCTURE > Elasticity	According to the researchers, the best cloud-native software architecture is microservice architecture [9]. They comprise several non-functional requirements for the cloud-native applications such as elasticity, scalability, automated deployment, and vendor lock-in avoidance [10]. Docker the Rocket containerization concepts together with the Kubernetes.	Ivon Miranda Santos
Weerasinghe2022-Taxonomical_classification_and_systematic_revie	CLOUD INFRAESTRUCTURE > Hybrid cloud	Services in the microservice architecture are deployed in the distributed environment. This could be different networks, multi-cloud or hybrid clouds. Therefore, data needs to be transferred to each service to complete the business requirement, which ultimately leads to vulnerabilities in the entire software solution.	Ivon Miranda Santos
Weerasinghe2022-Taxonomical_classification_and_systematic_revie	CLOUD INFRAESTRUCTURE > Hybrid cloud	in-memory resources that conduct real-time analytics will be the trend in this concept. On the other hand, people try to deploy their solutions in hybrid cloud environments. The reason behind moving to hybrid cloud deployment is to minimize network latency based on geographical areas and to gain several cloud vendor services. The industry is rapidly moving to microservice architecture to associate with considerable challenges as well.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	{zhoubiyu, zhangfa, zyliu}@ict.ac.cn, jiewu@temple.edu Abstract—Hybrid cloud-based deployment is a trend in cloud computing which enables enterprise to benefit from cloud infras-tructures while honoring privacy restrictions on some services. Enterprise application migration is an effective way to improve the efficiency of using the cloud infrastructures.	Ivon Miranda Santos

Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	However, it is a challenging problem to decide which parts of the applications to migrate and where to migrate. In this paper, we focus on the problem of planning the migration of enterprise applications in hybrid cloud infrastructures. Unlike previous studies, we consider a general hybrid cloud architecture that involves multiple public clouds rather than only one. Our aim is to maximize the enterprise cost reduction under the constraint of user experience in terms of response time.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Public cloud	In this paper, we focus on the problem of planning the migration of enterprise applications in hybrid cloud infrastructures. Unlike previous studies, we consider a general hybrid cloud architecture that involves multiple public clouds rather than only one. Our aim is to maximize the enterprise cost reduction under the constraint of user experience in terms of response time.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Public cloud	This benefit mainly stems from the cloud's economies of scale and the buy-on-demand model of cloud computing. However, migrating the entire enterprise application to public cloud may introduce issues in security, performance and reliability [1]. In response to these concerns, several solutions based on hybrid cloud infrastructures, which involve both on-premise cloud and public cloud, have been proposed. A hybrid cloud based solution enables enterprise to find the right balance between costs, user experience and privacy considerations.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	However, migrating the entire enterprise application to public cloud may introduce issues in security, performance and reliability [1]. In response to these concerns, several solutions based on hybrid cloud infrastructures, which involve both on-premise cloud and public cloud, have been proposed. A hybrid cloud based solution enables enterprise to find the right balance between costs, user experience and privacy considerations. It is reported that about 60% of IT decision-makers in the US and UK choose to adopt hybrid cloud architecture to deploy their applications [2]. Typically, enterprise applications involve multi-tiers, in which each tier provides a different functionality and contains a certain amount of homogeneous servers [2].	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	Servers belong-ing to different tiers may communicate with each other. To deploy an enterprise application in a hybrid cloud environment, a key challenge is determining the location of each server. In order to solve this issue, both academia and industry have proposed solutions in recent years [1–8].	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	Several more sophisticated approaches in planning the placement of virtual machines that minimizes the financial cost while obeying the deadlines constraint are proposed in [4, 5, 7, 8]. In [3], the authors focus their attention on dynamic migration of content distribution services into hybrid cloud infrastructures. Their aim is to minimize operational costs with a service response time guaranteed at all times.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	They propose a solution that employs Lyapunov optimization techniques. Unfortunately, most previous studies on enterprise applica-tion migration to hybrid cloud infrastructure use a centralized optimization solver to obtain the optimal placement of each server. These methods are effective when the instance is small.	Ivon Miranda Santos

Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Public cloud	However, they are ineffective against typical medium-scale enterprise applications in which thousands of servers are involved. In addition, while existing works have done a good job exploring the benefits of deploying applications in the simple two clouds environment(which contains both a private and a public cloud), they seldom evaluate the benefits of employing a hybrid cloud architecture with a private cloud and multiple geographically distributed public clouds. In fact, many large cloud providers (e.g., Amazon Web Services [9] and Microsoft Azure [10]) enabled the placement of instances in multiple locations. In this paper, our objective is to explore the benefits of migrating medium- and large-scale enterprise applications to hybrid cloud infrastructures, in which a local cloud and multiple geographically distributed public clouds are involved. To solve this problem, we propose a simple but efficient three-stage framework:	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	However, they are ineffective against typical medium-scale enterprise applications in which thousands of servers are involved. In addition, while existing works have done a good job exploring the benefits of deploying applications in the simple two clouds environment(which contains both a private and a public cloud), they seldom evaluate the benefits of employing a hybrid cloud architecture with a private cloud and multiple geographically distributed public clouds. In fact, many large cloud providers (e.g., Amazon Web Services [9] and Microsoft Azure [10]) enabled the placement of instances in multiple locations. In this paper, our objective is to explore the benefits of migrating medium- and large-scale enterprise applications to hybrid cloud infrastructures, in which a local cloud and multiple geographically distributed public clouds are involved. To solve this problem, we propose a simple but efficient three-stage framework:	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	The main contributions of this paper are summarized as follows: 1) We tackle the issue of migrating enterprise applications in hybrid cloud infrastructures. Leveraging the characteristics of enterprise applications, we propose a three-stage framework to solve the problem.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Public cloud	We describe the Enterprise Application Migration (EAM) problem that maximizes the total cost reduction while ensuring the completion time constraint in this subsection. Mathemati-cally, we model a typical hybrid cloud architecture as a node set H = H ∪ h0, where h0 represents the on-premise data center and H represents M public cloud sites located in M geographic regions.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	We describe the Enterprise Application Migration (EAM) problem that maximizes the total cost reduction while ensuring the completion time constraint in this subsection. Mathemati-cally, we model a typical hybrid cloud architecture as a node set H = H ∪ h0, where h0 represents the on-premise data center and H represents M public cloud sites located in M geographic regions.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	We consider a static scenario in this paper, and thus, the values of ti and ti,j can both be precomputed. Let π(i) be a mapping of the hybrid clouds of vi. Let xi,π(i)	Ivon Miranda Santos

Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Public cloud	The goal is to de-termine a migration policy x = {xi,π(i)} which minimizes the total costs subjected to given transaction delay constraint. We adopt the application migration plan model provided by Hajjat in [1] and extend it to fit our hybrid cloud infrastructure– in which more than one public cloud site is involved–in the following. A. Cost Reduction Typically, possessing servers in public clouds is much cheaper than in small- or medium-sized data centers due to Economies of Scale. Some reports claim 80% savings using public clouds versus on-premise private data centers [11]. The actual savings for a specific server depend on the resource requirement of the server, the server renting price of the cloud provider and the operation condition of the on-premise data center. Since we consider a static scenario in this paper, the operation cost benefit of each server vi using each public cloud π(i) is assumed to be a constant, denoted by αi,π(i).	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	The goal is to de-termine a migration policy x = {xi,π(i)} which minimizes the total costs subjected to given transaction delay constraint. We adopt the application migration plan model provided by Hajjat in [1] and extend it to fit our hybrid cloud infrastructure– in which more than one public cloud site is involved–in the following. A. Cost Reduction Typically, possessing servers in public clouds is much cheaper than in small- or medium-sized data centers due to Economies of Scale.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	This cost mainly depends on the total communication traffic volume and the per-unit Internet communication cost of traffic from the cloud site. Deploying communicating servers to hybrid clouds will change the Internet communication cost. The reasons are twofold:	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Public cloud	The reasons are twofold: 1) when a server is migrated to a public cloud, the per-unit Internet communication cost will change; 2) when two communicating servers are migrated to two different cloud sites, they must use Internet to communicate, which will also increase the Internet communication cost.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	Obviously the value of γi,π(i) can also be pre-computed. Let H(x) denote the total benefits leveraging the hybrid cloud infrastructure; thus it can therefore be expressed as H(x) = vi∈V γi,π(i) −	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Public cloud	C. Motivation Example In order to describe the problem more clearly, we give a motivation example in this subsection. The hybrid cloud considered here involves an local cloud (h0) and two public clouds (h1, h2). The users are from three regions (R0, R1 and	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	C. Motivation Example In order to describe the problem more clearly, we give a motivation example in this subsection. The hybrid cloud considered here involves an local cloud (h0) and two public clouds (h1, h2). The users are from three regions (R0, R1 and	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Public cloud	It can be seen that neither plan 2 nor plan 3 are applicable (NA) due to the violation of the time constraint. When all servers are migrated to public clouds (plan 2 and plan 3), the enterprise achieves the maximum benefits, but its time costs are high (30 and 31 respectively).	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	This is the strategy adopted in this paper. C. Time Complexity The complexity of the Algo DP(Gq) is O(Nq ∗ D ∗ M), where Nq is the number of nodes of Gq, D is the time constraint, and M is the number of hybrid clouds. Note that when Gq is a tree, as in case 1, the algorithm will output the optimal solution.	Ivon Miranda Santos

Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	R1 and R2). The hybrid cloud considered in the simulation consists of one on-premise data center (h0) and two public cloud sites (h1 and h2). Note that h0 is located in region R0,	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Public cloud	The on-premise data center holds the entire application before migration. The capacity of both public clouds is assumed to be infinite (large enough to host the migrated applications). We adopt the Amazon EC2 cloud pricing [12] to calculate the cost of running a server in each cloud.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	Besides, the cost reduction obtained by our algorithm is close to that of the optimal solution solved by COMBSPO. Finally, our framework performs better in reducing enterprise costs leveraging the hybrid cloud architecture under controllable time overhead than the other two strategies. On average, EAM Algo reduces 27.80% and 12.74% more costs compared with ALL-In-Tokyo and All-In-NOVA, respectively.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Hybrid cloud	V. CONCLUSION In this paper, we study the problem of migrating enterprise applications to hybrid cloud for cost benefits maximization. Unlike previous works, this work considers a more general hy-brid cloud architecture involving multiple public clouds rather than one. By exploring the features of typical communicating applications, we propose a framework to derive an application migration plan for enterprises.	Ivon Miranda Santos
Zhou2017-Cost_reduction_in_hybrid_clouds_for_enterprise_computi	CLOUD INFRAESTRUCTURE > Public cloud	In this paper, we study the problem of migrating enterprise applications to hybrid cloud for cost benefits maximization. Unlike previous works, this work considers a more general hy-brid cloud architecture involving multiple public clouds rather than one. By exploring the features of typical communicating applications, we propose a framework to derive an application migration plan for enterprises.	Ivon Miranda Santos
Alonso2023-Understanding_the_challenges_and_novel_architectural	CLOUD INFRAESTRUCTURE > Evolution of cloud computing	The evolution of Cloud Computing into a service utility, along with the pervasive adoption of the IoT paradigm, has promoted a signifcant growth in the need of computational and storage services.	Ivon Miranda Santos