



SeaClouds Business Paper

Seamless Adaptive Multi-cloud
Management of Service-based
Applications

SeaClouds Consortium

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Executive summary

The commercial success widely demonstrated by cloud computing over the last decade has turned a promising trend into an undeniable reality. Far from stalling, this success will foreseeably continue in the near future. This assertion is supported by industry analyst firm IDC, which predicts that the global cloud market, including private, public and hybrid clouds, will hit **\$118 billion** by the end of this year and crest at **\$200 billion** by 2018 [1]. Reports from other leading firms like Gartner are in line with this, predicting that by 2016 Cloud growth will increase to become the bulk of new IT spend [2].

The problem of this rapid evolution over a short period of time is that it has led to a wide and **heterogeneous environment**. This rich ecosystem, formed by a plethora of different providers (grouped in different layers like IaaS, PaaS and SaaS) and even more cloud users, has transformed the cloud computing environment into a very complex and usually inflexible solution. Furthermore, this heterogeneous environment is monopolized by big companies like Amazon, Microsoft, Google or Salesforce, whose impose their own standards and formats. These impositions bind customers to their provider's API and SLAs, impeding the development of a collaborative cloud ecosystem. These limitations not only keep new users off the cloud market, but also avoid the already existing customers from taking full advantage of cloud computing potential.

Within the different layers of the cloud stack, **PaaS (Platform as a service)** is the one gathering more interest. According to **OVUM [3]**, "PaaS supports and/or delivers technology and ecosystem cloud services to help create, test, deploy, run, manage, maintain and/or monetize applications, APIs, and/or data assets". These technology services include infrastructure, development and runtime services, while ecosystems services include marketplace, business-enablement and community services.

One of the main advantages that PaaS offers to developers and/or software companies is that they can focus in developing their applications and forget about all the related expenses (hardware installations, configuring, patching, etc.) that regular companies have. Thus, PaaS has become a very appealing alternative for these companies and that's why SeaClouds has this layer on the spotlight. A clear example of this potential is stated by Technavio, the research firm, which predicts that the global PaaS market will top **\$6 billion by 2016 [4]**.

This development of the PaaS layer has directly affected the cloud's applications market, which has also experienced a boom in the last years. According to the report "**Worldwide Cloud Applications market forecast 2014-2018**", published by ARTC [5], backed by customer acceptance and investor support, the **\$30-billion Cloud applications market** is poised to rack up big gains over the next five years.

The combination of the exponential growth of the cloud (at all levels) with an increasingly pressing need for solving the vendor lock-in problem, together with the business potential it involves, becomes the ideal scenario for SeaClouds, which could become the so long yearned solution that would trigger a definitive change in the cloud computing panorama.

1- The problem

The rapid evolution of the cloud market and its huge business potential has turned the cloud ecosystem into a very complex environment.

The countless possibilities that cloud offers, has attracted many suppliers, each one of them providing their own platform, specific features, own development tools, infrastructures, etc.

The strong restrictions imposed by these providers, the lack of **interoperability** among them and the non-existence of application **portability**, has turned the vendor **lock-in** into one of the main concerns among potential adopters.

Interoperability, which allows developers to use different cloud services (regardless the provider of the service) to seamlessly communicate with each other, is needed in order to consolidate IT systems in the cloud.

Portability, which allows moving data and applications easily from one cloud platform to another, provides new and better alternatives in terms of QoS, reliability, performance, etc.

Thus, the lack of these two important features becomes a key factor when developers choose a specific environment, binding themselves to that given provider. From that specific moment, moving their applications to another platform becomes practically unfeasible, involving cumbersome processes with high complexity and elevated cost. Because of this, the deployment, management and reconfiguration of complex applications over multiple clouds is even harder.

Eradicating or at least mitigating vendor lock-in is then crucial in order to increase not only customer choice and competition, but also to foster innovation and to allow more players to jump into the cloud paradigm.

To overcome these problems, various standardization efforts such as **OASIS CAMP** (Cloud Applications Management for Platform) and **OASIS TOSCA** (Topology and Orchestration Specification for Cloud Applications) are currently ongoing. These two industry-led standards, abstract away low level cloud management functionalities, allowing providers a shortcut in developing IaaS and PaaS solutions, reducing the time to deploy applications in the market

Appearance of standards-based tools like **SeaClouds** provides a viable solution to the aforementioned problems. Furthermore, the open-source nature of this software enables reaching a wider audience, and increases the different exploitation alternatives for the SeaClouds platform.

2- SeaClouds: The solution

SeaClouds (Seamless Adaptive Multi-cloud Management of service-based applications) is a novel **open source** platform that performs **Seamless Adaptive Multi-cloud Management of Service-based applications**.

This platform is based on cloud standards and consists of an **Application Management System over Clouds (AMSoC)**, which helps developers by making more efficient the **design, development, planning and management of complex business applications** across multiple and heterogeneous clouds, something unfeasible hitherto.

Unlike the typical **Cloud Management Systems (CMS)**, which according to Gartner are integrated products that provide the management of public, private and hybrid cloud environments, Application Management Systems over Clouds, like **SeaClouds**, mainly focus on providing the tools for Modelling, Planning and Controlling cloud applications **regardless the underlying provider**, resulting on improved QoS and QoB, SLA compliance, optimization, agility, portability and interoperability.

This **AMSoC** works at different levels (IaaS and PaaS) and implements a DevOps approach for **continuous cloud-related software¹ delivery**. DevOps movement is a growing trend which addresses the typical disconnection problem of every IT department between Development and Operations teams. The goal of DevOps is to achieve a better delivery lifecycle by eliminating the silos and integrating “Dev” and “Ops” activities to be fully complimentary, with people sharing the same goals and working hand in hand with improved tools and collaborative processes.

SeaClouds can be seen as part of this **DevOps** movement as it provides a set of tools that facilitate adoption of **business and technical requirements** very early into the application lifecycle.

Moreover, SeaClouds enables operations, monitoring and portability capabilities to comply with expected operational quality levels.

Among the main advantages provided by SeaClouds, which can be noticed at both design time and runtime, we can highlight:

- Support for application deployment and migration to different providers.
- Management and monitoring of underlying providers.
- Increased availability and higher security.
- Performance and cost optimization.
- Low impact on the code and user-friendly interface.

3- How does it work?

Before describing the core components of the SeaClouds architecture, it is worth observing that the platform features a Graphical User Interface (GUI) for two user roles (Designers and Deployment Managers), and that Cloud Provider Systems are considered. Therefore, the main stakeholders for the SeaClouds platform are the following:

Application Designer (or Developer) exploits the GUI to provide a description of the topology of the application to be deployed together with a set of requirements. These requirements can include QoS properties and technology requirements for the application modules, and the maximum acceptable cost for the entire deployment.

Deployment Manager (or Application Manager) exploits the GUI through the Unified Dashboard that allows them to supervise the deployment and the monitoring of the application.

Cloud Providers offer Cloud Resources (which further offer some Cloud Capabilities). They do not necessarily interact directly with the SeaClouds platform, but the services offered are exploited by the platform to run service compositions.

The SeaClouds solution is composed by five major components. These components are all wrapped by a **RESTful harmonized and unified API** layer used for the deployment, management and monitoring of cloud-based applications. These five components are:

- Discoverer
- Planner
- Deployer
- Monitor
- SLA service

Additionally to these five components, the platform features a **Graphical User Interface (GUI)** located on the upper layer of the SeaClouds architecture providing an easy way to define the topology of a cloud application.

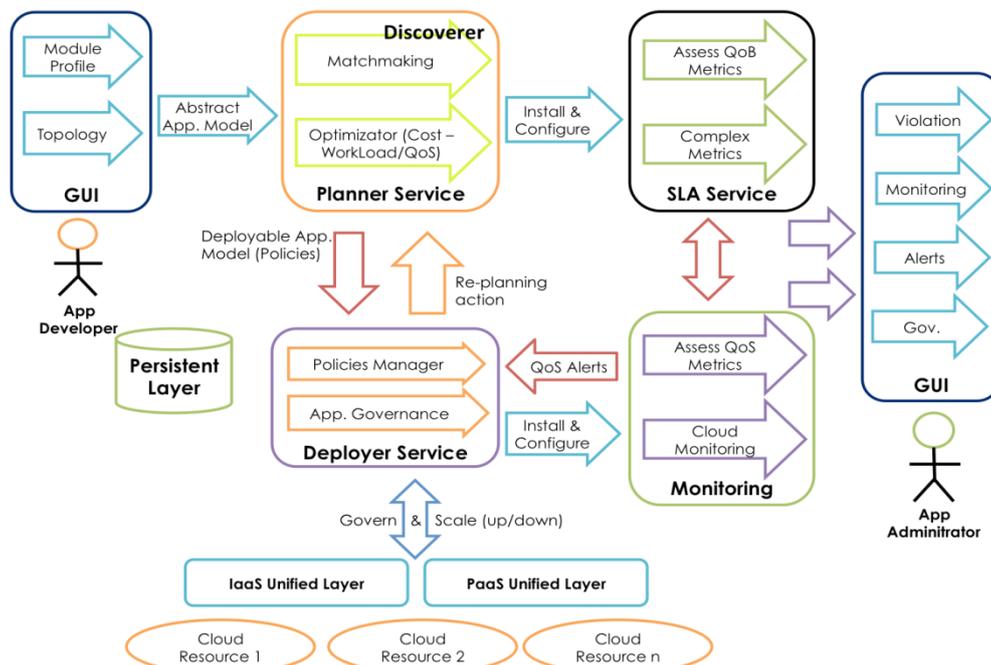


Figure 1: Interaction flow between SeaClouds components

The SeaClouds operation mode is the following:

First, the **application developer** provides the application with the corresponding modules to be deployed and specifying the **desired QoS** requirements and the properties to generate the SLA agreements of the whole application, as well as the technological requirements needed for individual application modules.

Then, **SeaClouds** will provide a feasible distribution of the application modules over available Clouds by means of the specification of an orchestration plan of the multi-cloud deployment. These clouds will be chosen using the so called **SeaClouds searching engine** which will return the **best-fit cloud** offering for each user requirement and will ease the deployment process of the whole application, considering the main dependencies among the application modules.

After the application is deployed, in case of violations of the defined requirements, a **reconfiguration** process will be initiated to (possibly) evolve the modules distribution, e.g. by migrating services to other providers. This reconfiguration process is applied over the system in execution providing mechanisms for rescheduling and re-execution of the modules, with the purpose of foreseeing the compliance of the properties and the soundness of the orchestration.

Finally, the application modules will be **effectively re-deployed** on the Clouds indicated in the distribution plan previously generated, and a run-time monitoring process will be initiated to guarantee that modules satisfy the SLAs and QoS properties specified.

4- Why SeaClouds?

SeaClouds offers seven main capabilities which turn it into a very appealing solution for different stakeholders:

Matchmaking: Based on the profile and specific requirements (location, QoS, cost, SLA, etc.) defined by the user for a given application, the matchmaking functionality provided by SeaClouds returns the best-fit option among the available cloud offerings (PaaS and IaaS) where that application can be deployed. This feature is very interesting for **application providers** (developers/designers) who ensure the optimal distribution of their applications among the available offerings, resulting on improved performance (QoS), reduced costs, etc.

Indirectly, **Cloud providers** would also benefit by this feature, since it represents an easy and powerful tool to increase their visibility among potential customers, thereby increasing their business opportunities.

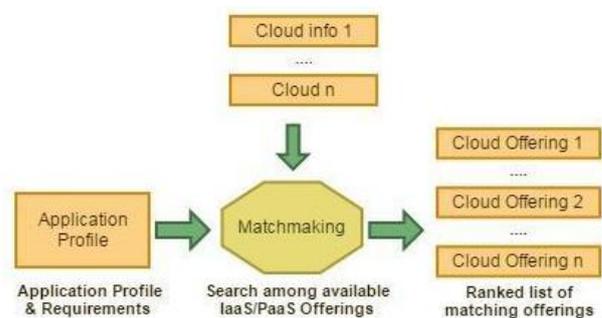


Figure 2: Matchmaking

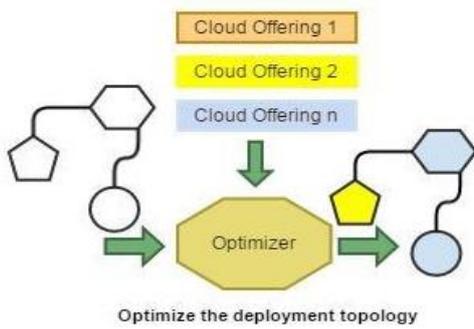


Figure 3: Cloud Service Optimizer

Cloud service optimizer: Thanks to this functionality, SeaClouds optimizes the deployment topology of applications across multiple clouds. This optimization can be performed according to different strategies like the maximization of the QoS, the minimization of costs, or following location policies like “follow the sun” or “follow the moon”.

The main beneficiaries of this functionality are **application providers** (administrators / designers / developers) who can use this to ensure an **optimal distribution** of their application in an automated way,

thereby saving time and improving the application development cycle.

Application Management (Application Deployment and Governance): Supporting efficiently the deployment and management / governance of multi-cloud applications across heterogeneous cloud offerings (IaaS and PaaS levels), leveraging cloud harmonized APIs and platform-specific adapters, is another functionality provided by SeaClouds.

This functionality is especially oriented towards **application providers** (designers, developers and administrators) who gain a powerful management tool to control their applications and streamlining their work.

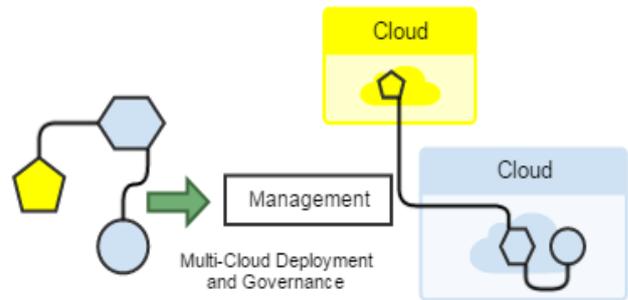


Figure 4: Application Management

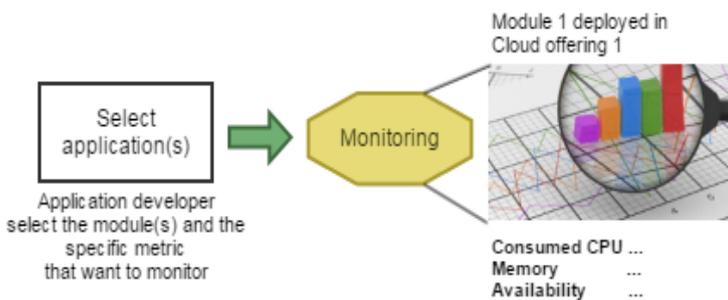


Figure 5: Monitoring & SLA enforcement

Monitoring and SLA enforcement: This feature provides an independent cloud monitoring functionality, based on unified “cloud offerings” independent metrics (like latency/response time, application status, etc.).

This functionality allows **application providers** to proactively monitor the health

and performance of business-critical applications hosted across multiple clouds,

easing their work and therefore ensuring the fulfillment of their QoS and SLA requirements.

Repairing actions: The repairing feature allows to horizontally and vertically scaling cloud resources to maximize the performance of each module of the application.

This is very valuable for **application providers** who can, a priori, define actions to benefit the agility after deployment, in order to fulfill QoS and SLAs, while minimizing operator's effort.

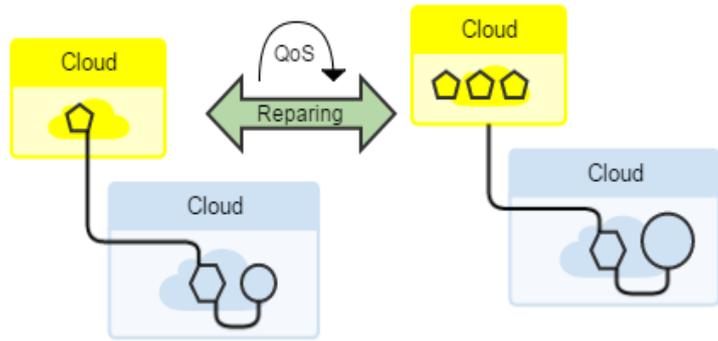


Figure 6: Repairing

Replanning and application migration: In case of any requirement's violation, SeaClouds provides a functionality that aims to support a seamless migration of the modules of an application between dissimilar (but compatible) clouds, dealing with the semantic interoperability conflicts, providing the full portability of an application.

This is extremely useful for **application providers**, who minimize their administration efforts (automated resolution of violations) while ensuring the maintenance of the minimum quality requirements. **Cloud providers** would also benefit from this migration by having a second chance to be

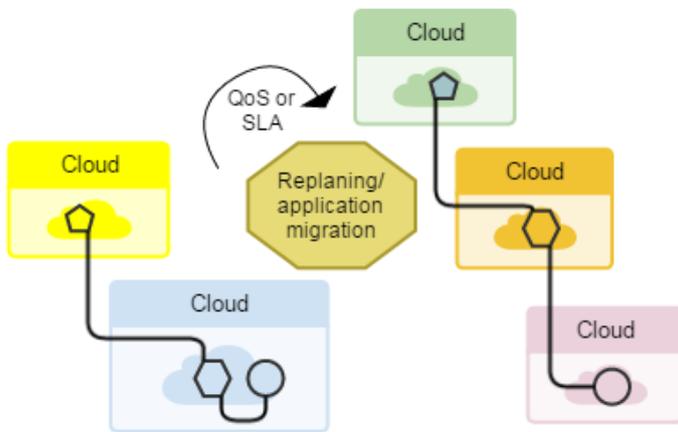


Figure 7: Replanning & Application

chosen from the list of best-fit available offerings.

Database migration and data synchronization: This feature enables the portability of data between databases (located on different clouds) in an automated way, so it minimizes the effort and time. This process guarantees that data are not lost or damages during the process and that the application using this data is not affected by the migration.

This benefit to **application developers** in tasks of setting up and processing critical data updates between different and in some cases dissimilar databases.

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As regards to **cloud providers**, they could benefit from the compatibility improvement offered by **SeaClouds**, allowing them to store data from other cloud providers and therefore, opening new business opportunities for them.

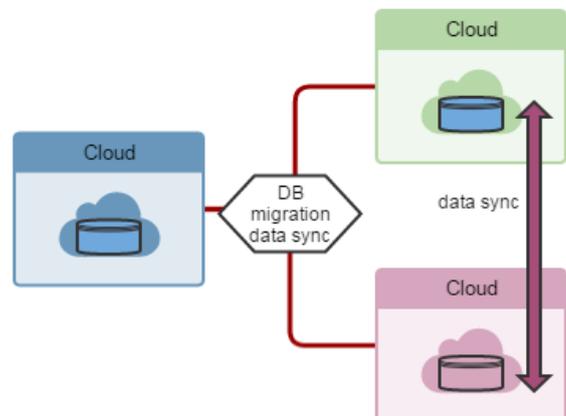


Figure 8: Database Migration

5- A real use case

NUROGAMES GmbH is a SMB company, developing high quality games and is partner in many research projects with focus on gamification, media and client/server based solutions.

Their server based games are using web techniques. The game client is developed with cross platform techniques in C++ and compiled for mobile or desktop devices. A wide range of other platforms are also possible by this technique.

The server component is a classical LAMP (Linux, Apache, MySQL and PHP) solution.

This is a proven reliable platform for rapid development with a minimal resources usage. PHP/MySQL applications are easy to deploy and there is a wide market with offerings for that platform.



Figure 9 NUROGAMES - server based games

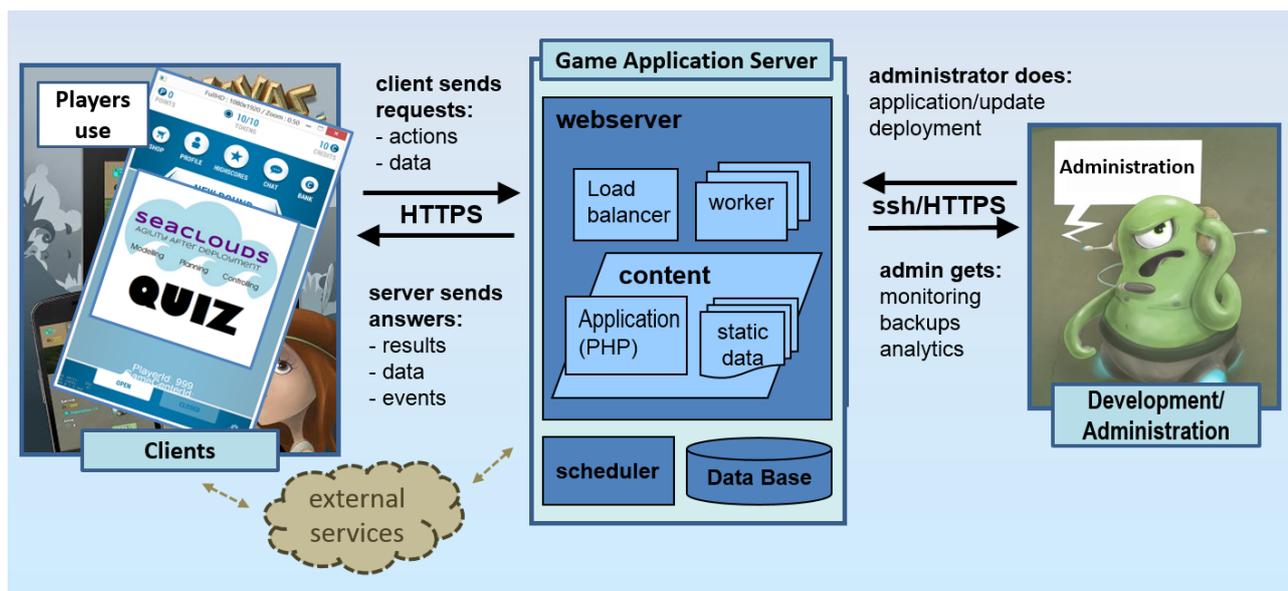


Figure 10 client server based gaming

The game clients perform actions and synchronize with the game application server by http or https requests with a JSON payload.

Situation before the project

On the start of the SeaClouds Project NURO has deployed 7 games with that technique on monolithic servers. They started to evaluate cloud based solutions to move to a future proofed, state of the art deployment.

NURO's games follow the "free to play, free to pay" principle thus the budgets for the technical infrastructure is very limited in the first phase on the market. If the game is accepted and there is a return of investment by paying users or by placed advertisement, the budgets can be extended.

Game servers are having a high volatile usage that is influenced by predictable factors as day time and planned marketing events on the one side and many random factors as whether, social events and unplanned featuring by third parties on the other.

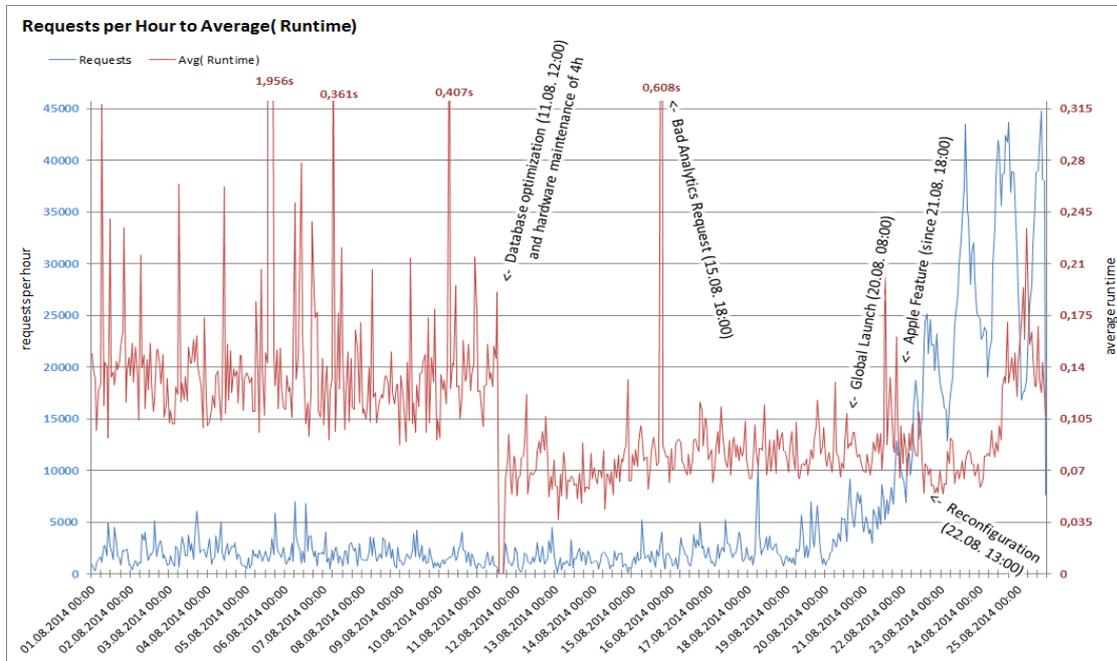


Figure 11 volatility of usage - average runtime vs requests per hour

It was realized the cloud market is a wide field of heterogeneous products, labeled as cloud solution, with very varying capabilities and pricing models. Cloud based deployments of some customer projects of NURO were administrated by partners. For the operative team it is a high need to get an easy and automated scaling orchestration of the game application server services with a fair pricing. With a small team, NURO was looking for a solution which will simplify the discovering, configuration and managing of their games application servers.

Benefits of the project

The SeaClouds project is a great boost in knowledge and experience to NURO. Combining NURO's expertise about real live server applications and application design with the various abilities in cloudification and orchestration of the partners has a high synergetic level.

Components which were developed with this project have been implemented into NURO's game servers and simplify some monitoring and operational tasks.

NURO is planning to use SeaClouds in a first step for the management of testing system. The system is expected to simplify the deployment, scaling and reconfiguration on various providers, including private systems. Thanks to the modular concept of SeaClouds, it is expected to also utilize components stand alone, e.g. monitoring and analytics components.

In a second step SeaClouds will be evaluated to be used for the staging and productive systems. Meanwhile one game, realized with a partner of the TV business is ready to be deployed with amazon.

After the project

With the expertise and techniques elaborated within the SeaClouds project NURO is able to manage and offer flexible cloud based solutions.

The collaboration with the partners is inspiring and successful. NURO expects to stay in touch with the partners and there are many opportunities for knowledge exchange and collaborated projects in the future.

The cloud market is highly under construction and NURO realized the result of SeaClouds will be an extended base technology for cloud application management which could be improved in follow-up projects focusing on aspects of SeaClouds and partner/parallel projects (MODAClouds, Brooklyn, Alien4cloud) that can be involved.

Possible objectives:

- Transparent metric collection
- Automated bottleneck analysis
- Optimized cross cloud synchronization
- Optimized transparent data migration
- Database agnostics
- Optimized automated discovery
- Optimized budget management

6- Business impact

We are expecting SeaClouds to impact the market mainly on three areas:

Business agility

A number of emerging technologies are useful in promoting business agility and we think that an open-source holistic solution like **SeaClouds** will provide the end-user of another powerful tool in this space. In fact, the advent of cloud and diminishing boundaries between staged software environments and application platforms the pressure on traditional development environments has increased, and the need for an integrated and pluggable solution like SeaClouds platform can be a great answer to many requirements.

Business agility is influenced by the theories pioneered in **agile project management**, in which project managers and their teams assess their priorities and progress frequently throughout the project lifecycle and make adjustments in an iterative manner, rather than at the end of a project. Business agility allows organizations to **adjust rapidly** to changing market conditions, capitalize on emergent business opportunities, adopt new distribution channels or supply chains and reduce costs or increase revenue streams in the process.

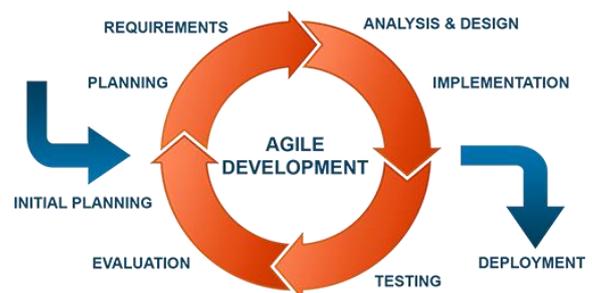


Figure 12: Agile Project Management

Open source first-strategy

"In this day and era, all businesses, no matter how large or small, have to view themselves as technology businesses first, focusing on their verticals second. Technology is no longer a nice to have, but a must have. At the heart of this new overriding need to get technology leverage is open source software, [...] **“Software is eating the world”** [...] it is a reference to how every business

needs to become a software (and data) business. After decades of acquiring and locking into proprietary software platforms, enterprises are looking at open source as a way to change the game and the nature of the relationship they have with their technology providers. [...] Unlike in the 1990s where one had to justify even a basic evaluation of an open source solution, now the reverse holds true. Using a proprietary software solution to solve a problem requires first proving that no existing open source software can resolve the situation.

Smart IT managers and teams would rather lock-in to a specific technology without locking into the vendor, which is only possible with open source software.

This results in the so-called “**comedy of the commons**” where everyone benefits from their own self-interests. [...]

Open source first strategies are leading to massive market momentum around open source projects, beginning in the early days with Linux, but now exploding out into a cornucopia of software that provides massive value including Hadoop for big data, OpenStack for cloud computing, Cassandra for modern databases, and Docker for containers" [6].

Maximizing cost efficiency

Cloud computing at its core is about provisioning resources on-demand. The most widely known aspect is IaaS (infrastructure-as-a-service): many solutions are able to work with a large number of such providers, however, higher up the stack, there is an increasingly diverse set of platform targets, from PaaS (platform-as-a-service) through to myriad containers and runtime fabrics and other backend-as-a-service environments. SeaClouds platform is highly influenced by **Apache Brooklyn [7]** which is based on the premise that applications may need to run in any or all of these, and the model must be flexible and open enough to support this.

Autonomic Computing, promise theory and **devops** are the main concepts that **SeaClouds** brings to **enterprise applications**. DevOps is increasingly seen as a key component for efficiency and reducing time-to-market. Tough economic conditions acted as a catalyst for the acceptance of cloud-based services and technologies. Devops movement was favored by start-ups which lacked the resources of larger IT firms. But today, enterprises are looking at that experience to set up business processes absolutely consistent and repeatable; they must also be fully audited and controlled so they can respond quickly to market conditions, possibly using open-source standard-based technologies like SeaClouds.

7- SeaClouds is already available!

The code of the **SeaClouds first integrated prototype**, together with the instructions for downloading and installing it, are already available at SeaClouds' Github repository located at <https://github.com/SeaCloudsEU/seaclouds-distribution>.

In order to perform a deployment of the SeaClouds solution, the use of Apache Brooklyn¹, Vagrant² and Virtual Box³ will be required.

Additionally, in case of needing only some components of the overall solution, all the binaries produced by each software components of SeaClouds can be downloaded by accessing

<https://oss.sonatype.org/content/groups/public/eu/seaclouds-project/>

This first version of the SeaClouds integrated platform includes the following components:

- Dashboard
- Planner (Matchmaker & Optimizer)
- Deployer
- Monitor
- SLA service

The definitive version of the integrated platform will include the discoverer component, which is not available on this first version.

Additionally, although the final version of the designer component will be fully automated, the current distribution requires certain level of human interaction.

In order to showcase SeaClouds and to demonstrate its benefits on a multi-cloud environment, an application example implementing a simple web chat room will be provided.

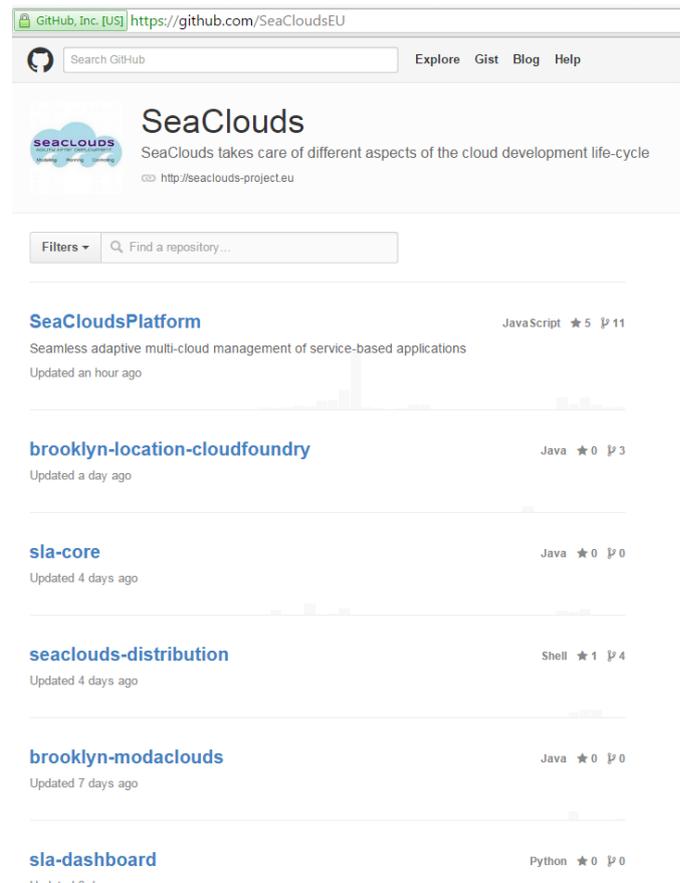


Figure 13: SeaClouds repository

¹ <https://brooklyn.incubator.apache.org/>

² <https://www.vagrantup.com/>

³ <https://www.virtualbox.org/>

8- Conclusions

The SeaClouds approach works towards achieving “**Agility After Deployment**” by tackling the problem from the **service orchestration perspective**, applying an agile execution approach, stressing both the design time with the development and planning, and the runtime with the deployment, monitoring and reconfiguration of cloud applications.

The advantages offered by the SeaClouds platform are multiple. The modularity of the solution is such that allows the exploitation of both the platform as a whole as well as its individual modules independently. This myriad of alternatives is quite beneficial for the sustainability of the project.

For instance, this flexibility allows the use of the design-time toolkit independently, whether this is to provide a specific functionality or to combine it with already existing solutions like Cloudify. The same applies for the SeaClouds’ Runtime Engine, which could be integrated with tools like Allien4Cloud to provide missing functionalities (smart monitoring, SLA enforcement and reconfiguration).

Thus, modularity will allow stakeholders to easily integrate specific modules of the solution with their existing applications, whether they are internal to the project or external, in order to improve them and to make them more competitive. Clear examples of this are CloudSoft and ATOS, who will use SeaClouds outcomes to integrate them into their existing portfolio.

These advantages are empowered by the use of renowned and successful applications like **Apache Brooklyn** which takes care of the SeaClouds’ deployment or FP7 project **MODAClouds**, used for QoS monitoring purposes.

Additionally, relying on the visibility provided by its open source nature with **Apache 2.0 license**, and its active support and contribution to important market-driven cloud standards, is another important hallmark of SeaClouds.

The combination of the current situation within the cloud environment and its ongoing trends, the increasing demand from the customer side, and the need to solve real problems affecting the market, become the ideal scenario for a solution like SeaClouds. Thus, **Cloud World Forum**, where **SeaClouds First Integrated Platform** will be presented, will mean a good test to evaluate the acceptance level of the SeaClouds solution.

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- **Universidad de Malaga:** Javier Cubo

References

- [1] **Computer world Magazine: “Hybrid adoption set for a big boost in 2015”.** December 18th, 2014. <http://www.computerworld.com/article/2860980/hybrid-cloud-adoption-set-for-a-big-boost-in-2015.html>
- [2] **Gartner says Cloud Computing will become the bulk of new IT spend by 2016.** October 2013, Gartner newsroom. <http://www.gartner.com/newsroom/id/2613015>.
- [3] **PaaS: a 360-Degree View.** Ovum. October 24th, 2013. <http://ovum.com/research/paas-a-360-degree-view/>
- [4] **Technavio, Global Platform-as-a-Service Market 2012-2016,** April 3rd, 2013. <http://www.technavio.com/report/global-platform-service-market-2012-2016>
- [5] **Apps Run the Cloud report.** September 1st, 2014. <https://www.appsruntimecloud.com/opinions/index/150>
- [6] **Randy Bias, Vice President, Technology, Emerging Technologies Division at EMC,** <http://reflectionsblog.emc.com/2015/04/open-source-first-strategy/>
- [7] **Apache Brooklyn Incubator.** <https://brooklyn.incubator.apache.org/>