Why Use OPTIMIS?

Build and Run Services in the Most Suitable Cloud Venues

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Authors:
Csilla Zsigri (451 Research), Ana Juan Ferrer and Oliver Barreto (Atos), Raül Sirvent and Jordi Guitart (BSC), Srijith Nair (BT), Craig Sheridan (FLEXIANT), Karim Djemame (ULEEDS), Erik Elmroth and Johan Tordsson (UMU).
# Table of Contents

1. INTRODUCTION ........................................................................................................................................... 3

2. WHAT IS OPTIMIS? ........................................................................................................................................ 4
   2.1 OPTIMIS TARGET USERS ......................................................................................................................... 4
   2.2 POSITIONING OF THE OPTIMIS TOOLKIT ............................................................................................. 4
   2.3 THE OPTIMIS TOOLKIT .............................................................................................................................. 5

3. OPTIMIS VALUE ............................................................................................................................................... 7
   3.1 VALUE PROPOSITION ................................................................................................................................. 7
      3.1.1 For Developers .................................................................................................................................. 8
      3.1.2 For Service Providers ...................................................................................................................... 8
      3.1.3 For Infrastructure Providers ............................................................................................................ 8
      3.1.4 For End-Users .................................................................................................................................... 8
      3.1.5 For All .............................................................................................................................................. 8
   3.2 OPTIMIS VALUE IN ACTION .................................................................................................................. 9
      3.2.1 A Typical Use Case .......................................................................................................................... 9
      3.2.2 The Programming Model Use Case .................................................................................................. 9
      3.2.3 The Cloud Brokerage Use Case ...................................................................................................... 10
      3.2.4 The Cloud-Bursting Use Case ........................................................................................................ 11

4. ADOPTING THE OPTIMIS TOOLKIT ........................................................................................................ 12

5. TOOLKIT LAUNCH ...................................................................................................................................... 12
1 Introduction

Private clouds have moved very much to the foreground through 2011, and increasingly, hybrid strategies will be defining the supply side agenda as organizations seek to make the best use of existing resources and domain skills together with the new opportunities that Cloud brings.

While the economic model remains the number one driver for building a business case to get into the Cloud, we believe that operational benefits, flexibility, agility and quicker time to market are the key drivers of ongoing adoption and value. As cloud deployments are being built out, complexity of integration with existing systems has become a key barrier for enterprise end-users, alongside security and internal resistance.

As a consequence of recent outages and performance problems, the need for multi-clouds has become more inevitable as companies seek to insulate themselves against failure. At the same time, cloud offerings that enable organizations to extend their firewalls and networks directly into a hosted cloud are quickly coming to market. Altogether, these increase the requirement for 'Best Execution Venues' (BEV). End-user organizations are increasingly seeking ways to automate the delivery of workloads and applications to the most suitable cloud environments, be it internal or external, and whether that is determined by performance, risk, location and compliance or other SLA parameters.

OPTIMIS aims at optimizing IaaS cloud services by producing an architectural framework and a development toolkit. The optimization covers the full cloud service lifecycle (service construction, cloud deployment and operation). Optimis gives service providers the capability to easily orchestrate cloud services from scratch, run legacy apps on the cloud and make intelligent deployment decisions based on their preference regarding trust, risk, eco-efficiency and cost (TREC). It supports end-to-end security and compliance with data protection and green legislation. It also gives service providers the choice of developing once and deploying services across all types of cloud environments – private, hybrid, federated or multi-clouds.

OPTIMIS simplifies the management of infrastructures by automating most processes while retaining control over the decision-making. The various management features of the Optimis toolkit make infrastructures adaptable, reliable and scalable. These, altogether, lead to an efficient and optimized use of resources.

By using the OPTIMIS toolkit, organizations can easily provision on multi-cloud and federated cloud infrastructures and allows them to optimize the use of resources from multiple providers in a transparent, interoperable, and architecture-independent fashion.
2 What is OPTIMIS?

2.1 OPTIMIS Target Users

The OPTIMIS Toolkit comprises a set of tools to be used by Service Providers (SPs), Infrastructure Providers (IPs), Software Developers (SDs) and End-users to build and run cloud services in ‘Best Execution Venues’. A definition for each target user is provided below:

- **Infrastructure Provider (IP):** An organization that provides pooled computing and storage services, including outsourced servers, OS, storage, datacenter space, network equipment, etc. to end-users or other service providers. For Infrastructure Providers, the Toolkit provides tools for managing services in compliance with service level agreements with SPs while using the infrastructure according to the IP’s own policies regarding trust, risk, eco-efficiency and cost. The IP may use only its own infrastructure or subcontract resources from other IPs in a federation.

- **Service Provider (SP):** An organization that provides some kind of service or application to end-users or other service providers. It can be a Telco Provider, an Internet Service Provider, an Application Service Provider, or a Managed Service Provider, among others. For Service Providers, the toolkit provides tools for deploying and managing services on their own or external infrastructures provided by one or more IPs, possibly via a broker, based on parameters such as trust, risk, eco-efficiency and cost.

- **Application/Service Developer:** An individual or group of individuals developing applications or services for service providers or end-users, to be deployed on the infrastructure provider's infrastructure/resources. The Toolkit helps developers easily orchestrate cloud services from scratch and run legacy applications in the cloud.

- **End-user:** Person or organization that actually uses a product or service and does not resell it. OPTIMIS targets enterprises or organizations that want to deliver IT as a service to their own organizations using a combination of on-premise and hosted resources.

2.2 Positioning of the OPTIMIS Toolkit

Fundamentally, the OPTIMIS toolkit is a cloud enabling technology that ultimately helps end-users create a truly digital IT infrastructure, by adding an automation and orchestration layer to a virtualized infrastructure. The OPTIMIS components are deployed in the data center and are a complement to cloud management and orchestration platforms.

OPTIMIS enables users to schedule and automate the delivery of workloads to the most suitable clouds (internal/external) based on policies such as trust, risk, eco-efficiency and cost (TREC). This is what we call a true ‘best execution venue’ strategy.

OPTIMIS also supports end-to-end security, compliance with data protection and green legislation.

The key attribute of OPTIMIS, the TREC framework, is unique: none of the identified competitor products cover this full range of features or enable administrators to choose venues based on a balance of these factors. Along with the service orchestration features and the catalogue of deployment options, this provides the strongest selling point.
2.3 The OPTIMIS Toolkit

The OPTIMIS Toolkit can be broken down into three main groups of components: the **OPTIMIS Base Toolkit** with functionalities common to all components; the **OPTIMIS SP Tools** that enable service providers to implement, package, deploy and operate services, and finally the **OPTIMIS IP Tools** with functionality to manage the infrastructure (VMs, servers, data storage, etc.) required to operate services.

The **OPTIMIS Base toolkit** helps make optimal service deployment and operation decisions, and also provides fundamental services such as monitoring and security:

- The **Monitoring Infrastructure** gathers runtime information about physical hardware, virtualized hardware, energy consumption, and service performance. This information is aggregated and propagated to the TREC framework for analysis.
- The **Trust** framework allows IPs and SPs to determine each others’ reputation and level of trustworthiness. Historical information is used to determine the trust level among two providers. However, if there are no historical values, the trust can be determined by applying social networking mechanisms and using the opinion of all providers who have previously worked together.
- The **Risk** tools enable IPs and SPs to define, assess, and manage risk, for instance, the likelihood of an event and its impact on operation, regarding key aspects of service provisioning. They support SPs in making informed, risk-aware decisions at service deployment when pre-selecting IPs, and help IPs manage well-balanced infrastructures, so they can maximize the Quality of Service (QoS) and minimize the number of SLA violations during service operation.
- The **Eco-efficiency** tools provide assessments and forecasts of relevant energy-related metrics for Cloud providers such as Energy Efficiency (Performance/Watt) and Ecological Efficiency (Performance/Kg CO2).
- The **Cost** tools allow IPs to both assess their costs and predict future costs for the provisioning of a service or component through comprised cost models which allow for cost related alternative options and configurations to be evaluated. Options for pricing are also included on the IP side. On the SP side, quotes can be obtained for a service or component during at deployment time, and costs can be monitored during run time. Cost can be optimized with the other three TREC factors.
Build and Run Services in the Most Suitable Cloud Venues

- The **Security** services provide secure data communication and storage for the virtual machines constituting a cloud service, which may be deployed on multiple cloud providers. This is done by provisioning a virtual private network between the virtual machines, with the help of a peer-to-peer overlay network. The secure communication and storage of data is managed by the Cloud Broker or the Service Providers, by the administration of security agents deployed on the virtual machines whose behavior is controlled via security policies.

OPTIMIS allows IPs to effectively and efficiently manage infrastructure resources at a higher level of abstraction and enables SPs to create, deploy, and operate services with assessed and guaranteed TREC levels through the following tools:

- The **Programming Model** allows the creation of complex services by composing pieces of source code, licensed software, legacy applications and services. Although the composition is described as a sequential Java code, the programming model framework orchestrates the concurrent execution of its components on a pool of available resources which the programmer is not aware of.

- The **Integrated Development Environment** automates and simplifies the implementation of new complex services by providing a GUI where these can be programmed (directly by writing Java code, or by using wizards to ease the porting of legacy applications). It automatically generates the VM images (using the Image Creation Service component) and the service manifest needed for deploying a service. It also includes options for starting the deployment of the service, interfacing with the OPTIMIS Service Deployer.

- The **Image Creation Service** automates the generation of VMs by implementing services and software prerequisites.

- The **Virtual Machine Contextualizer** configures VM hardware at the Operating System level. It tailors the configuration of software within a VM image including other OPTIMIS components, dependencies of an application and applications themselves, for deployment into the IP's environment. This enables the dynamically changing environment of an IP to be abstracted away from the application deployed, enabling enhancements to scalability, performance, fault tolerance and other non-functional requirements such as security and license management.

- The **Service Deployer** manages the deployment of a new service, be it on private or multi-clouds. It also provides utility libraries that simplify bursting, federation, and cloud brokerage. For a service provider, the Service Deployer reduces the complexity of interacting with all these types of clouds to one simple call.

- The **Deployment Optimizer** is a decision-making tool used by the Service Deployer. It uses the TREC framework to negotiate with Infrastructure Providers in order to identify optimal execution venues for service deployment, for example by minimizing risk and/or service provisioning costs.
• The **License Manager** provides the mechanisms for using license protected software for cloud provisioned services while protecting the IPR of the software vendor.

• The **Service Manager** is used for service deployment and operation, and keeps track of all service runtime data. It also features functions for the automated management of service operation on the SP side (e.g. service redploy according to pre-defined rules).

• The **Admission Control** component decides whether or not it is worth to admit a set of services into the cloud, and in case of acceptance, obtains the optimum allocation for each of the VMs that comprise the services using TREC-driven policies.

• The **Data Manager** creates on demand ‘Data Analytics as a Service’ clusters, which can be used as simple storage or added value data processing tasks, while meeting legal constraints regarding location and handling of data in a federated environment. The management of the ‘DAaaS’ clusters may be used on parameters such as risk and workload forecasting.

• The **Cloud Optimizer** is a global decision and management entity for IPs that combines the monitoring and assessment tools in the OPTIMIS Base Toolkit with the above listed management engines in order to create a policy-driven, self-managed cloud driven by the IP’s overall business-level objectives.

• The **SLA Manager** negotiates, creates and monitors SLAs between SPs and IPs. It can also generate alerts in case some agreed terms are not fulfilled and evaluate the guarantees associated with the individual terms.

• The **VM Manager** provides basic plumbing mechanisms for starting/stopping/migrating VMs, and scheduling policies for the efficient allocation of VMs across the infrastructure and the management of physical hosts.

• The **Elasticity Engine** SLAs while reducing costs. It proactively allocates and de-allocates resources to a service. The number of provisioned VMs changes with changes in the service workload dynamics in terms of request arrival rate, and/or any other SLA metric of relevance for the service.

• The **Fault Tolerance Engine** ensures reliability by restarting failing VMs, recovering failures of physical hosts and initiating preventive actions when these failures are foreseen.

### 3 OPTIMIS Value

#### 3.1 Value Proposition

OPTIMIS addresses the scenario where most companies use on premise and hosted resources (private and public clouds) in combination. The cloud is becoming an element of a multi-pronged approach to service delivery within an enterprise’s broader digital infrastructure, which is heading towards a truly hybrid world. The digital infrastructure of the future will provide CIOs with an assortment of service delivery venues where users will be able to schedule and automate the delivery of workloads to the most suitable clouds (internal/external) depending on workload characteristics, SLAs and policies, such as risk, locality, latency, cost, etc. Most enterprises are stuck at the virtualization phase for different reasons. The last 2 stages of this internal cloud journey or IT transformation are automation and orchestration, and this is where OPTIMIS comes into play. OPTIMIS can help enterprises either directly or through service providers to get through these stages and transform their IT and enjoy the benefits of an agile, automated and adaptable IT infrastructure. More specifically, OPTIMIS has tools for construction, deployment, and operation of services.
3.1.1 For Developers

- Orchestrate value added composite cloud services.
- Run legacy applications in the cloud.
- Deploy individual service elements on different venues.
- Create VMs automatically.
- Do all the above without specific cloud expertise.

3.1.2 For Service Providers

- Make informed decisions and deploy workloads on the most suitable venues.
- Make deployment decisions based on policies such as trust, risk, eco-efficiency, and cost (TREC).
- Provide end-to-end security and compliance with data protection and green legislation.

3.1.3 For Infrastructure Providers

- Simplify and automate the management of your infrastructure based on policies such as trust, risk, eco-efficiency, and cost.
- Simplify and automate the management of your infrastructure even in complex scenarios, such as cloud federation.

3.1.4 For End-Users

- Become a cloud service provider and deliver IT as a service to your own organization using a combination of on-premise and hosted resources
- Make your IT infrastructure truly digital through orchestration and automation
- Make informed deployment decisions based on policies such as trust, risk, eco-efficiency, and cost

3.1.5 For All

- OPTIMIS enables vendor-neutral, hybrid cloud implementations.
- OPTIMIS allows for 'best execution venues' based on policies such as trust, risk, eco-efficiency and cost.
3.2 OPTIMIS Value in Action

3.2.1 A Typical Use Case

CRM software company ‘SOFT’ wants to become a SaaS provider. SOFT wants to move its CRM application to the cloud.

The programming component of the OPTIMIS toolkit allows the service developer at SOFT to define the service elements that include functionalities SOFT wants to provide to its clients. Once the elements are defined, the construction tools of the programming component create the service VMs and a ‘service manifest’ that will govern the deployment and operation of the created VMs/services.

Using the TREC optimization engine, the toolkit manages the deployment of the VMs to the service provider’s preferred infrastructure.

Another component, the OPTIMIS broker, manages the infrastructure selection and service deployment by automatically evaluating infrastructure providers based on the service provider’s TREC preference. These deployments can even occur across multiple cloud infrastructures if the TREC-based evaluation determines that would deliver the best result.

Once the service is live, OPTIMIS allows the service provider to continue to monitor, change and optimize the various configurations at runtime.

3.2.2 The Programming Model Use Case

Launching innovative applications requires significant investment of effort and money and their success on the market is uncertain. SMEs can’t dedicate unlimited resources to do research and innovation. This use case demonstrates how the service construction capabilities of the OPTIMIS Toolkit help SMEs enter the global SaaS marketplace more easily.

More specifically, this use case is meant to validate the service construction capabilities of the OPTIMIS Toolkit. The Programming Model use case shows how to use the OPTIMIS service construction capabilities to easily develop innovative, value-added services, by focusing on two specific scenarios:

- a Genomic Computation Service, which combines different genomic services offered by Genomic Institutions with resource-intensive calculations,
- a Retailer Service, centered on the combination of current business services for reselling products offered by manufacturers in the wholesale market.

The Genomic Computation Service scenario implies a complex service composition and it is resource-intensive. Efficient execution and resource management are crucial for delivering good quality of service without shooting up operational costs. The OPTIMIS construction tools hide all the complexity and allow the service developer to intuitively implement the service without any Cloud-specific programming expertise.
In the Retailer Service scenario, the developer wants to combine existing 3rd party software in order to offer value added services. The OPTIMIS construction tools give software developers the ability to leverage existing services and easily orchestrate new ones that offer value-added features.

3.2.3 The Cloud Brokerage Use Case

At its simplest, OPTIMIS components can be used to enable a multi-cloud deployment of a service including several IPs. This in itself allows for a more dynamic and competitive ecosystem by enabling the SP to choose different IPs for hosting various components of a service.

The OPTIMIS Cloud Broker service provides two capabilities that build on each other:

- Ability to approach the Broker with a set of physical requirements of the service components (like memory, CPU, network bandwidth, etc.) as well as a set of constraints (like cost, trust levels, risk level and eco-efficiency certification) and be provided back with the best possible venues the various components can be deployed on, using one or more IPs that provide compatible services.

- Further intermediation between the SP and the IPs by receiving the service details and the associated VMs, data storage, etc. and doing the complete onboarding of the service across multiple IPs, on behalf of the SP.

The Cloud Brokerage use case is expected to bring out the following innovations and value:

- Matching of requirements and functionalities: providing standards-based SLA negotiation and agreement mechanisms to allow the broker to match the requirements of the SP with the functionalities provided by the various IPs. This is something that is lacking in the current offerings and forms the basis of the broker functionality.

- TREC based decision-making: The OPTIMIS toolkit provides means to make decisions on which IP and SP to engage with based on trust, risk, eco-efficiency and cost parameters. The use of this functionality allows the broker to make SP-IP matches based on TREC. While the cost parameter might be an obvious functionality, the other three metrics are a definite value-add.

- Value-added services: the cloud broker feature will provide value-added services to the SP (and even the IP), making it easier for the parties involved to move services to the cloud. For example, the ability to enforce corporate IT policies in a cloud environment as effectively as in a corporate data center is a much sought after capability, along with seamless identity management capability, ability to provide end-to-end encryption support across multiple IPs, ability to provide access to secure storage capability, etc., and the broker is in a key position to provide some of these capabilities.

- Federation capabilities: In the current offerings, the IP is able to leverage only its dedicated infrastructure resources to provide a service to the SP. However, the OPTIMIS toolkit allows the IP to internally use the services of (federate to) other IPs to cope with scaling demands. This capability can be brought into the brokerage scenario, allowing for a more efficient and resilient working of the IPs.
3.2.4 The Cloud-Bursting Use Case

The inherent advantages of on-demand resources within a virtualized Cloud environment are well documented, however, the ability to cloud-burst takes this on demand concept to new levels allowing the ability to create a so called eco-system of resources across previously autonomous, independent systems.

The term ‘cloud-bursting’ has been coined to describe the ability for an IP to externalize computing resources when a given situation and user requirements dictate so. The ability to do this provides many advantages such as:

- A new form of redundancy, where services can be configured to automatically start on an alternative provider when required.
- Dynamic scalability of resources to match service requirements.
- Cost management where externalization is only used when required.
- Enhanced QoS guarantees where greater user expectations can be supplied.
- A more solid expectation of SLA fulfillment can be given.
- An optimal platform can be supplied for user needs.
- Dynamic decisions based on active monitoring maintain the optimization of resources.

By a service provider utilizing the OPTIMIS toolkit, one organization can break the boundaries and limitations of its favored public or private Cloud environment and effectively include the resources of another provider based on trust, risk, eco-efficiency and cost.

IPs can become part of a Cloud-bursting scenario in different ways. An IP could for example incorporate the full OPTIMIS toolkit allowing the full stack of advantages such as offering monitored resource data, historical performance data and cost parameters to external parties, encouraging the use of their platform and allowing a means for platform users to gain similar resources externally. These external resources can be automatically selected using the parameters set by the service provider to choose the most apt IP for their needs or indeed incorporate multiple IPs into the scenario such as placing more important services to a higher QoS offering and less important compute needs to the cheapest of the available IPs.

Alternatively, an IP could simply agree to be part of a scenario where they do not have to incorporate these tools to their platform by allowing external OPTIMIS tools to rent resource form their platform in a standard way using a standard API. Anything in between these scenarios is also possible, for instance, an IP only incorporating some of the OPTIMIS features. This way an IP can be slowly introduced to the OPTIMIS ecosystem and conform to more of the OPTIMIS features over time and at its own pace.
4 Adapting the OPTIMIS Toolkit

As previously stated, the OPTIMIS Toolkit comprises a set of tools to be used by Service Providers, Infrastructure Providers, Software Developers and End-users to easily orchestrate cloud services and run them on the most appropriate execution venues.

Software Development Tools consist of the OPTIMIS Programming Model and IDE, as well as, the Image Creation Service. These tools automatize code parallelization, packaging, installation of application and software dependencies and generation of VM images. The generated VM images can then be executed by the OPTIMIS Toolkit or any other Cloud fabric controller, VM Manager or hypervisor technology compatible with the hypervisor that generated the images. Consequently, Software Developers can adopt OPTIMIS Development tools independently of Service and Infrastructure Provider Tools, although in this case deployment and operational capabilities provided by the OPTIMIS Toolkit, such as BEV selection, Cloud self-management (automated elasticity and fault tolerance) and Data management (legal control on data placement), won’t be applicable.

Service Provider Tools enable SPs to deploy and operate services in multiple private and hybrid Cloud scenarios (bursting, federated and brokerage). It is able to interact both with OPTIMIS enabled providers and non-OPTIMIS providers by using a plug-ins developed for specific provider APIs. Therefore, the OPTIMIS Service Provider Tools are interoperable both with the OPTIMIS Infrastructure Provider’s Tools and other infrastructures through plug-ins.

The OPTIMIS Infrastructure Provider Tools are a layer on top of cloud fabric controllers and storage services such as, eMotiveCloud used by default in the OPTIMIS Toolkit and OPTIMIS Data Management, or others such OpenStack Compute and Storage, Open Nebula or VMWare vSphere. Adoption by infrastructure providers aims to offer two possibilities: “Full-OPTIMIS”, complete adoption of the Toolkit including eMotiveCloud and OPTIMIS Data Management; and the so-called “OPTIMIS-Enhanced” option, in which parts of the toolkit interact or are substituted by other existing tools. Examples of OPTIMIS-Enhanced adoption are infrastructures adopting the entire OPTIMIS Infrastructure toolset but changing the cloud fabric controller, or even, adoption of a reduced set of capabilities such as improved Fault Tolerance through Risk assessment tools.

5 Toolkit Launch

The OPTIMIS project released the first version of its open source Toolkit on 1 June 2012. It is available for download on the OPTIMIS website (http://www.optimis-project.eu/). Further versions have been released throughout 2012 and 2013.