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Cloud computing and RESERVOIR project

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Summary. — The support for complex services delivery is becoming a key point in current internet technology. Current trends in internet applications are characterized by on demand delivery of ever growing amounts of content. The future internet of services will have to deliver content intensive applications to users with quality of service and security guarantees. This paper describes the RESERVOIR project and the challenge of a reliable and effective delivery of services as utilities in a commercial scenario. It starts by analyzing the needs of a future infrastructure provider and introducing the key concept of a service oriented architecture that combines virtualisation-aware grid with grid-aware virtualisation, while being driven by business service management. This article will then focus on the benefits and the innovations derived from the RESERVOIR approach. Eventually, a high level view of RESERVOIR general architecture is illustrated.

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PACS 89.20.Ff – Computer science and technology.
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1. – Introduction

Delivery of complex services, traditionally enhanced by service providers in a client/server architecture [1], has become a necessity of our society. One outstanding problem of this architectures is that the demand of services is very difficult to predict: for this reason resources are generally over provisioned in order to support peak demands. However, this implies high costs to both service providers and consumers. Besides, current adopted solutions still need to find new heuristics for the delivery of ubiquitous, continuous and reliable services.

For infrastructure providers to cost-efficiently deliver ICT capacity, they need an infrastructure that enables reliable and cost-efficient management of services, and that efficiently manage all phases of the service life cycle.

To simplify service deployment, an easy-to-use, yet comprehensive mechanism that allows the description, installation, and configuration of complex multi-tiered services is required.

Once services are deployed and running, an infrastructure provider must be able to monitor service execution and measure resource consumption. This service metering information is important both for accounting and billing against service providers, but also has a critical role in service placement decisions. By optimizing service placement, infrastructure providers can make efficient use of available hardware and minimize costs.

In order to cost-efficiently meet the SLAs agreed upon with the service providers, infrastructure providers need mechanisms to dynamically adjust resource allocation to services as load changes.

When the hardware resources of one infrastructure provider site is insufficient, the ability to federate resources from peer providers is key to SLA compliance. In such a federation of infrastructure providers, services can be placed close to their consumers for improved QoS.

Furthermore, migration of services enables efficient handling of scenarios such as planned or unplanned maintenance.

For infrastructure providers that host multiple services, potentially from competing businesses, service-level isolation becomes a critical security issue.

Finally, for the benefit of the service providers (and hence in the end also for the service consumers), the infrastructure provider market must be fair and free of monopolies and vendor lock-in situations.

This requires the future ICT infrastructure to have an open specification with standardized protocols and data formats.

2. – Key concepts

The RESERVOIR project is an aggressive research attempting to address the challenge of reducing software complexity and costs, expediting time-to-market, improving reliability and enhancing accessibility of consumers to government and business services. The basic concept under the RESERVOIR idea is the "Service Oriented Infrastructure (SOI) Equation", which brings together three technologies: virtualisation [2], grid computing [3, 4] and business service management (BSM) [5, 6], see fig. 1.

Grid Computing has established the feasibility and value of federated computing infrastructure in the form of large job scheduling systems which have been very successful in high performance scientific computing. However, algorithms for scheduling finite jobs

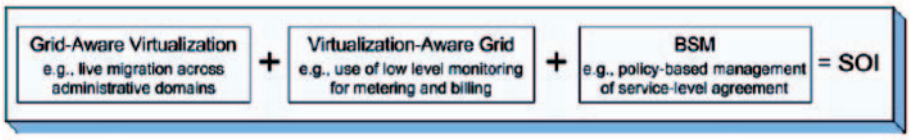

Fig. 1. – The Service Oriented Infrastructure (SOI) equation.

in many cases are not applicable to commercial applications, whereas the use of virtualisation technology has shown to be useful in overcoming some of the barriers to commercial adoption of grid concepts. RESERVOIR will add virtualisation awareness to grid computing, by shifting the focus from job scheduling to the creation and placement of general-purpose virtual computing resources.

Virtualisation has enabled the optimization of resource utilization. However, this optimization is confined to inflexible configurations within a single data center. RESERVOIR will extend contemporary virtualisation infrastructures to be grid-aware. At the same time, RESERVOIR aims at building an infrastructure in which virtual machines can be dynamically relocated to any node regardless of location, network and storage configurations and administrative domain.

Business Service Management (BSM) enables to fully benefit from dynamic nature of the RESERVOIR infrastructure. RESERVOIR will provides a uniform policy-driven management layer that automatically allocates resources to services and monitors execution and utilization to ensure compliance to SLAs by adjusting resource allocation level and location. The new capabilities of the infrastructure will enable us to explore new allocation policies, optimizing over a possibly huge number of parameters.

3. – Innovation and benefit

The innovative principles introduced by the RESERVOIR project are:

– Separation between infrastructure and services: RESERVOIR as a virtualization infrastructure for services enables a clear separation between service providers and infrastructure providers. A RESERVOIR infrastructure would own and manage the computational, networking and storage resources necessary to host arbitrary service applications. It would provide functions and management qualities, which allow dynamic mapping of service components to the physical computational, networking and storage resources. In particular, service components should be opaque to the infrastructure providers and could contain virtually arbitrary software stacks.

– Provisioning services as utilities: RESERVOIR aims to enable the delivery of services on an on-demand basis, at competitive costs, and without requiring a large capital investment in infrastructure; our research will also address many issues related to delivering services as utilities, such as security, performance, availability, etc.

– Service and resource migration without boundaries: RESERVOIR plans to enable the migration of the process from one physical environment to another without affecting the process nor imposing hard constraints on the configuration of the infrastructure. This approach points at allowing the migration of resources across

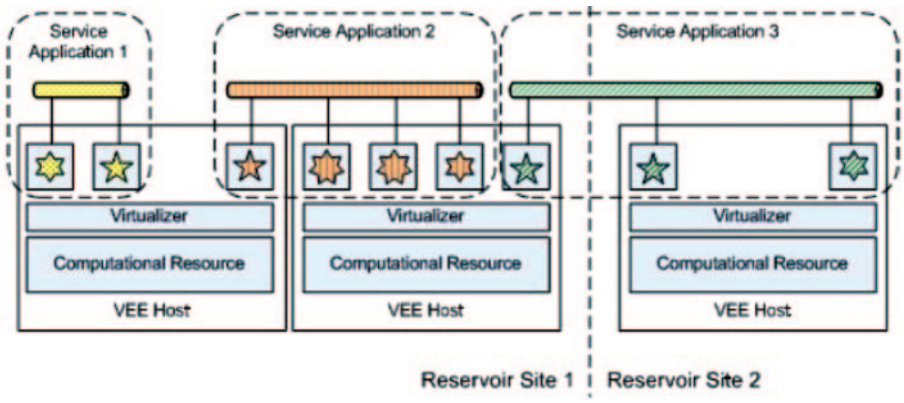

Fig. 2. – RESERVOIR model.

geographies and administrative domains, maximizing resource exploitation, and minimizing costs.

– Federated heterogeneous infrastructure and management commercial: RESERVOIR will introduce an abstraction layer that will allow the development of a set of high-level management components that are not tied to any specific environment; such component will use grid computing techniques to enable interaction.

– End-to-end support for service-oriented computing: RESERVOIR focus attention on fundamental technical issues deriving from the SOI ideas (end-to-end security, service deployment, orchestration, accounting and billing, alongside management of Service Level Agreements): the project has a clear determination on addressing such problems coherently.

– Security: RESERVOIR will provide a seamless, comprehensive, and flexible security scheme that operates consistently across dynamically changing layers.

4. – High-level model

In the RESERVOIR model, see fig. 2, there is a clear separation between the functional roles of service providers and infrastructure providers. Service providers are the entities that understand the needs of a particular business and offer service applications to address those needs. Service providers do not own the computational resources needed by these service applications, instead, they lease resources from infrastructure providers, which provide them with a seemingly infinite pool of computational, network and storage resources. Infrastructure providers operate RESERVOIR sites that own and manage the physical infrastructure on which service applications execute. The federation of collaborating sites forms a RESERVOIR cloud. To optimize resource utilization, the computational resources within a site are partitioned by a virtualization layer into virtual execution environments (VEEs) fully isolated runtime environments that abstract away the physical characteristics of the resource and enable sharing. The virtualized computational resources, alongside with the virtualization layer and all the management enablement components, are referred to as the VEE Host. A Service Application is a set of software components which work collectively to achieve a common goal. Each

component of such service application executes in a dedicated VEE. These VEEs are placed on the same or different VEE Hosts within the site, or even on different sites. The VEEs for a particular service application may all be co-located in the same VEEH, or may be distributed across VEEHs within the same site, or may even be distributed across sites. A service application is deployed on the RESERVOIR cloud using a service manifest that formally defines the contract and SLA between the service provider and the infrastructure provider. Within each RESERVOIR site, the resource utilization is monitored and the placement of VEEs is constantly updated to achieve optimal utilization with minimal cost. Similarly, the execution of the service applications is monitored and the capacity is constantly adjusted to meet the requirements and SLA specified in the manifest.

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