European Commission

Cloud-TM

The Cloud-TM project developed a highly innovative data-centric middleware platform aimed at facilitating the development and at abating operational and administration costs of cloud applications. This is made possible thanks to the tight integration of i) innovative highly scalable data consistency protocols, ii) programming abstractions masking the complexity of coding for large scale cloud platforms, and iii) pervasive self-tuning mechanisms pursuing optimal efficiency in any operational condition.

AT A GLANCE

Project title
Cloud-TM: A novel programming paradigm for the Cloud

Project coordinator
Paolo Romano, INESC-ID (PT)
romano@inesc-id.pt

Partners
INESC-ID (PT)
Algorithmica (IT)
C.I.N.I. (IT)
Red Hat (IE)

Duration
June 2010 to Aug. 2013

Total cost/EC contribution
2.7M€ / 1.7M€

Programme
FP7-ICT-Call 5

Website
htttp://www.cloudtm.eu

Harnessing the Cloud

The promise of **infinite scalability** catalysing much of the recent interest about Cloud computing is, at current date, still menaced by one **major pitfall**: the **lack of programming paradigms and abstractions** enabling ordinary programmers to fully exploit the potentiality of cloud infrastructures.

The Cloud-TM project addressed precisely this issue by building a **highly innovative data-centric middleware platform**. Cloud-TM is designed from the grounds up to meet the **scalability** and **dynamicity** requirements of cloud infrastructures, while providing intuitive, yet **powerful abstractions** to spare programmers from the burden of coding for distribution, persistence and fault-tolerance, and let them focus on delivering differentiating business value.

Achievement and results

Figure 1 overviews the architecture of the Cloud-TM platform. At its backbone, lies an **elastic distributed transactional memory**, which employs novel data replication protocols designed to achieve **strong consistency** without hindering **scalability**.

Beyond **transactional consistency** - which spares programmers from coping with the idiosyncrasies of eventual/weak consistency models - Cloud-TM offers a

number of **abstractions** aimed at **masking complexity** and allowing ordinary programmers to unleash the potentiality of large-scale Cloud platforms. These include transparent support for **object orientation** and for various **query** types, **concurrency-friendly data structures** and frameworks to control **distributed execution** of tasks hiding issues such as fault-tolerance, load distribution and data placement.

Finally, Cloud-TM's Autonomic Manager supports **QoS-based provisioning** and **pervasive self-tuning schemes**, which guarantee **optimal efficiency at any scale, and for any workload**. The platform's adaptation is controlled via innovative **performance models** combining in a synergic way diverse methodologies like **analytical modelling, simulation and machine learning**.

Self-tuning at play

Figure 2 illustrates an example scenario highlighting the autonomic, self-optimizing capabilities of the Cloud-TM platform. Depending on the current workload characteristics, Cloud-TM can autonomously acquire or release resources from the Cloud, and adjust, in a transparent manner, its internal consistency mechanisms to maximize performance and efficiency

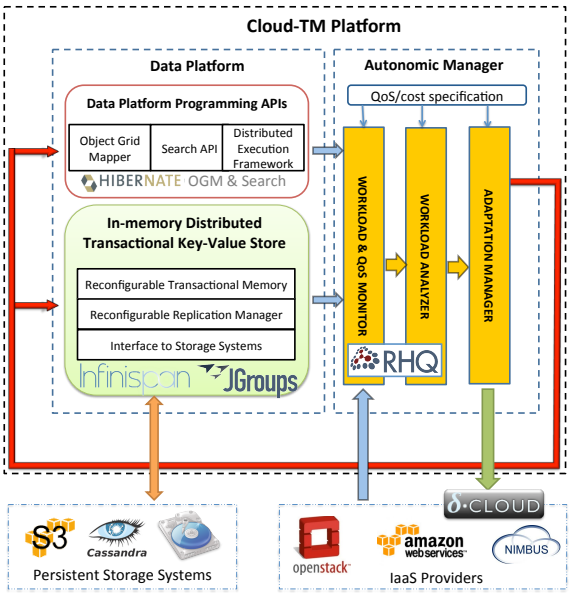

Figure 1 - Cloud-TM Architecture

The open source way

Since the early stages of the project, academic partners have worked in close collaboration with the leading company in the open-source software arena, **Red Hat**. This has allowed integrating a number of innovative solutions in highly visible Red Hat projects, like *Hibernate, Infinispan, JGroups, Delta Cloud* and *RHQ* (see Fig.1). The choice of embracing open source, and the integration of the best-of-breed research results in popular Red Hat projects, have strongly amplified the **impact and visibility** of the project's achievements, and paved the way for their immediate **industrial exploitation**.

Socio-economical benefits

Cloud-TM aims at abating several sources of costs associated with cloud computing:

- € **development costs**: via intuitive programming abstractions aimed at increasing productivity.
- € **operational costs**: via self-tuning mechanisms pursuing optimal efficiency.
- € **administration costs:** by fully automating the steering of the platform.

By abating these costs, Cloud-TM can increase significantly the speed of adoption of Cloud computing. This is a factor that, according to recent economical studies, can have a strong ***impact on the whole European Union economy*** in terms of creation of new jobs through the creation of SMEs.

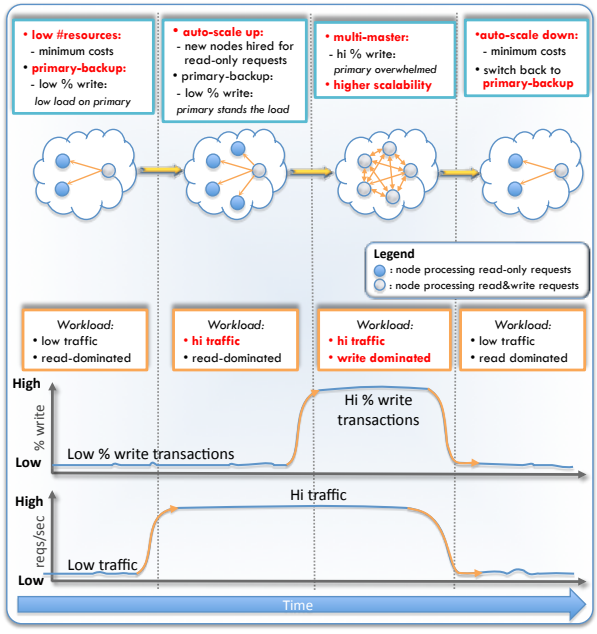

Figure 2 - Self-tuning capabilities of Cloud-TM