Summary for C4SystemX EQUIPEX
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Research Centers: Orange Labs, CEA-List
Industry: Thales, Dassault, Bull
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Involved Competitive Cluster: is System@tic

The C4SystemX equipment of excellence initiative is meant to provide scientist from the public and private sectors in France and especially the IRT (Institut de Recherche Technologique) SystemX on complex systems with a cloud computing and networking experimental facility. C4SystemX stands for "Cloud for IRT SystemX" but will hopefully reach far beyond IRT SystemX by opening the facility to end users from the public and private sector and foster innovation, collaboration and technology transfer.

The facility offers cloud computing services, storage and communications services through advanced and programmable cloud networking and relies on federation principles for dedicated cloud provisioning. In essence it will offer cloud as a service so users can build or compose their own dedicated cloud infrastructure through the reservation of cloud resources, hosting platforms and software provided on demand through a common portal. Besides building their own cloud, scientists will also use the facility to design the next generation of open cloud architectures and remove current barriers such as cloud lock in that prevent transparent migration and portability of applications and information systems across clouds. Another objective is to merge clouds, telecommunications and computer networks into an overall cohesive architecture where all paradigms meet and blend while addressing security concerns raised by cloud computing and virtuaisation.

The most salient objective of C4SystemX remains to enable users to run experiments on the full cloud stack and to actually design it to support businesses, private enterprises and public organisations. These users and stakeholders would combine their own services and information systems with trusted cloud resources and services or even externalise securely and safely their services and information systems into the cloud. These are very challenging and unresolved problems that hamper wider adoption of the cloud paradigm across the globe. Users, companies and organisations require guarantees in the form of verification, auditing, reproducibility, reversibility (complete removal of applications and data from the loud) and traceability. The facility will focus on these issues and enable research on these essential topics.

C4SystemX high performance computing capabilities enable also an HPC service offer. Computation intensive and demanding applications are natural clients of the platform. Scientists working on HPC dedicated software parallel and distributed computing across multi-core and Hybrid HPC technologies will find in C4SystemX the experimental facility they need to derive adequate HPC architectures and algorithms.

C4SystemX will also serve as a front end to major cloud computing projects at the national level such as Andromede and Num-Innov. The first, (lead by Orange, Thales and Dassault) is a large scale trusted platform meant to support various business domains and fields with cloud services and resources supplemented by business and operating support systems. The second (lead by Bull) offers High Performance Computing as a Service (HPCaaS) along with the required dedicated software to support users of the HPC facility. These initiatives are on a different timing and national strategic agenda (called *"Grand Emprunt"),* expected later in the 2011-2014 time frames.

Among the available Future Internet and cloud computing facilities available today in the research community none provide the flexible, open, programmable and configurable cloud facilities needed to support the private and public segments. The frameworks are typically limited in flexibility, in diversity and in offered services often locking users in specific cloud architecture and hosting platforms. Migrating, porting or moving applications and services between clouds and business domains is not facilitated and sometimes even prevented.

At the experimental level there is a plethora of Future Internet platforms focussing on federation of networks and telecommunications resources such as PlanetLab, Onelab2, FEDERICA, G-Lab, F-Lab and Grid 5000. Le last is somehow the closest in structure as it provides access to grid and more that 5000 distributed cores across the nation and is gradually making an attempt to include the cloud paradigm in the framework. Except for GRID 5000 that is expected to extend the facility and continue to focus on middleware, all other facilities address either wireless and core networks (such as OneLab and F-Lab) or virtualisation and provisioning of broadband interconnections (in the case of FEDERICA). Other relevant projects (4WARD, SAIL, RESERVOIR) concentrate on R & D and less on the facility aspect and do not address clouds and cloud services in all their facets.

C4SytemX focuses on "cloud services" and aims at offering private and hybrid clouds as a service in the form of an experimental environment where scientists from the private and public sectors can compose their own dedicated cloud from the facility. They can conduct their investigations by deploying their own methods (protocols, algorithms, decision engines) and architectures in order to evaluate, test and validate them. A key feature of C4SystemX is its ability to offer dedicated compartments that users can customise via a unique portal and a configuration management interface. The compartments provide the flexibility not found today in other experimental facilities including those related to the FIRE initiative at the European level. The compartments can be composed of dedicated and isolated physical cloud resources and services, of virtual resources (ranging from virtual machines, virtual nodes and links to complete virtual networks), of high performance computing (ranging from standard HPC services to hybrid HPC) and any combination.

This diversity concerns also user rights and the type of experiments they can conduct on the facility. C4SystemX relies on isolation and compartmentalisation to achieve the flexibility seldom found in other experimental facilities. C4SystemX offers isolated compartments on demand with various degrees of openness and access to resources. Flexible and open compartments with extended access empower users with configuration, reset and modification rights to set up their dedicated cloud and experiments. Other compartments operate at higher levels of abstraction and virtualisation to hide details and complexity to applications and services developers. Often application and service developers are not interested in the underlying network services and bearers but require service level guarantees to concentrate on application development and service creation and put emphasis on interfaces and application programming interfaces. Cloud service providers and users can migrate and move transparently their applications across clouds within the C4SystemX experimental facility.

Users can reserve compute, storage and communications facilities and gain access to business and operation support tools to address the complete cloud stack. This includes the three well known levels of cloud architectures: IaaS, PaaS and SaaS supplemented with other essential subsystems: secure control and management subsystems and business and operating support systems. The availability of the full stack and tools for performance evaluation, monitoring, control, management, testing and validation experimentation enables in depth study of future generation cloud architecture free from any vendor and cloud services providers lock in.

The facility will also enable key stakeholders to experiment their support systems to facilitate hosting and migration of applications and complete information systems from public organisations and enterprises and start building national trusted and autonomous clouds as envisaged by Andromede and Num-Innov. C4SystemX will serve as a research facility for IRT SystemX and as front end to the much larger scale facilities Andromede and Num-Innov and in due time be integrated into a common and shared experimental facility by these key projects. Hopefully, C4SystemX will become a core element of a wider long term future cloud experimental research, development and innovation facility involving also third party clients from the public and the private sectors and organisations (education and research – e.g. scientists from FCS and plateau de Saclay and industry - small and medium enterprises, manufacturers and providers). The facility will also contribute to education and training of scientists and doctoral students on the plateau de Saclay.

As C4SystemX is led by the cloud computing activity of the IRT SystemX working group on algorithms, software and hardware for complex systems, it will naturally benefit from the unified governance and economic model adopted by the Institute. C4SystemX can rely on the IRT SystemX administrative and governance structure to ensure access to the facility and its maintenance and operation via the mutualisation of platform engineers and human resources.

C4SystemX will be distributed across 3 identified sites that have secured hosting premises (buildings with adequate cooling systems and energy provisioning and management system) and that will be interconnected through 10 Gbps dedicated links. The hosting sites (Télécom SudParis, X-Saphir and IRT SystemX premises) offer a combined air conditioned hosting space exceeding 250 m^2.

Two sites are on the plateau of Saclay and will be connected via available fiber and require only active routing and switching equipment to provide the desired facility open programmable broadband connectivity. The third site, located in Evry, at Télécom SudParis, is gaining access to Saclay and Bruyères-le-Châtel via 10 Gbps links and partial funding from Ile de France through a project known as Marguerite deploying interconnection infrastructures with X-Saphir as well as Cergy Pontoise. Links between Saclay, Bruyères-le-Châtel and Evry facilitate closer cooperation and provisioning of additional compute resources when needed from the CCRT and Terr@tec. The overall C4SystemX facility will provide around 1500 cores distributed over the three sites with half of them on the IRT SystemX premises so all involved partners and working groups and institutions in SystemX can benefit from the facility with even physical access to the facility to generate concrete and well identified faults and failures for fault tolerance and resilience studies. Cost assessment and energy efficiency studies are also planned to design more economically sustainable, energy efficient and cleaner clouds. The IRT SystemX site is expected to integrate these objectives at installation and set up time and pursue energy consumption reduction throughout the lifetime of the experimental facility.