Standard-based Interoperability amongst Local, Grid and Cloud Resources to enable an Italian Distributed Computing Infrastructure

G. Andronico[1)], R. Barbera[1,2,*)], R. Bruno[1)], M. Fargetta[1)], A. Fornaia[3)], G. La Rocca[1)], S. Monforte[1)], R. Ricceri[1)], R. Rotondo[3)], D. Saitta[3)], D. Scardaci[1)]

[1)] INFN, Division of Catania, Via S. Sofia, 64, 95123 Catania – Italy
[2)] Department of Physics and Astronomy of the University of Catania, Viale A. Doria, 6, 95125 Catania – Italy
[3)] Consortium GARR, Via dei Tizii, 6, 00185 Rome – Italy

Abstract

The availability of powerful COTS (Commercial-Of-The-Shelf) computers and the decrease of costs of Local Area Network (LAN) components triggered in the first half of 90's, with the appearance of the first Beowulf systems, the emergence of cluster computing for High Throughput Computing (HTC) applications. "Farms" of computers with many-core processors, interconnected by very low latency networks (e.g., Infiniband), have become the norm also in the domain of High Performance Computing (HPC) and in the last five years about 80% of the machines included in the Top500 list are based on a distributed architecture.
The steep decrease of costs of large/huge-bandwidth Wide Area Networks at national, continental and intercontinental scale has fostered in the recent years the spread and the uptake of the grid computing paradigm both for HTC and HPC applications. Grid infrastructures are being built in several areas of the world but, despite the huge investments made by the European Commission and by other funding agencies, both at national and international level, the total number of users is in the order of magnitude $O(10^4)$ that is much less than $O(10^6)$, which is the order of magnitude of the number of EU researchers in the public sector, and $O(10^7)$, which is the number of users of the GÉANT network. The reasons for this have been investigated through studies promoted by the European Commission itself [1] and mostly reside in the complexity for non-IT-expert users of the Grid Security Infrastructure, based on a Public Key Infrastructure, in the little adoption of standards to let different middleware be interoperable among each other, and in the lack of general frameworks to build easily customizable and easy to use high-level user interfaces. On top of this, several, and quite different, middleware have been deployed on the grid infrastructures existing in the world with no (or very little) interoperability [2] amongst each other. This makes impossible for users belonging to Virtual Research Communities (VRCs) to exploit the power of worldwide e-infrastructures in a seamless way.
In the recent past, interesting developments have been independently carried out by the grid community with the Science Gateways and by the National Research and Education Networks with the Identity Federations to ease, from one side, the access and use of grid infrastructures and, from the other side, to increase the number of users authorised to access network-based services.
A Science Gateway is a *"community-developed set of tools, applications, and data that is integrated via a portal or a suite of applications, usually in a graphical user interface, that is further customized to meet the needs of a specific community"*. On the other hand, an Identity Federation is the ensemble of the *"[...] the agreements, standards, and technologies that make*

[*] Corresponding author. Email: roberto.barbera@ct.infn.it.

identity and entitlements portable across autonomous domains". They are already established in many countries and currently gather a number of people which is in the order of $O(10^7)$.
The distributed computing echo-system has become even more complex with the recent emergence, especially in the private sector, of cloud computing, i.e. the use of virtualised computing and storage resources (hardware and software) that are delivered "as a service" over the network (typically the Internet). Private cloud providers rely of course on "non-disclosed" architectures and have business models that leave very little (if any) room to interoperability and federability among services operated by different providers. Federated clouds for research, operated by public organisations and based on open standards, have started to be created in various European countries, also thanks to concrete investments made by the European Commission through the last FP7 calls, but they are still in an infancy state and the interaction between computing clouds and storage clouds is in many cases quite "fuzzy".
This complexity is reflected in the Italian context where many clusters of various sizes for HTC and HPC do exist inside universities, research organisations and national computing consortia. A fraction of those resources are integrated in geographically distributed infrastructures connected to continental services (such as EGI and PRACE) but interoperability (in the meaning defined in [2]) is basically missing, due to the middleware difference. This keeps away most of non-IT expert research communities and forces early adopters to have several accounts on several services.
Recently, the Grid team at INFN Catania has developed a framework to easily and quickly build Science Gateways which can be configured as Service Providers of Identity Federations and then potentially accessible by huge numbers of users. The framework makes use of the Simple API for Grid Applications (SAGA) standard, defined by the Open Grid Forum, to perform middleware-independent job and data management.
In this contribution we will present the recent results of the implementation of a Science-Gateway-enabled model to achieve standard-based interoperability amongst local (clustered), grid and cloud resources. Concrete use cases, belonging to different scientific and humanistic domains, will be presented and perspectives to use the model to enable a truly national distributed computing and storage infrastructure will be discussed.

References

[1] eResearch2020 Final Report, "The Role of e-Infrastructures in the Creation of Global Virtual Research Communities", www.eresearch2020.eu/eResearch%20Brochure%20EN.pdf.
[2] According to ISO/IEC 2382-01 (Information Technology Vocabulary, Fundamental Terms), interoperability is *"the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units"*.