Grid4All, an IST project launched in June 2006 under the coordination of France Telecom's R&D, embraces the vision of a 'democratic' Grid as a utility where users draw on Internet resources without having to individually invest and manage computing and IT resources

Democratising the Grid for Internet users

The internet and its myriad of services are central to European life - at work and at home, in all situations. This is confirmed by recent statistics that show a 42 per cent penetration. Peer-to-peer services such as file sharing are highly popular and are considered a powerful incentive to the purchase of broadband access subscription. The next logical step is to securely extend personal computing capacity through the managed sharing of IT resources over the Internet.

The progress of high-speed WANs and high-performance PCs in recent years has made it possible to realise high-performance computing at low cost. Projects such as SETI@home and their recent successors achieve super computing capabilities with personal computational resources.

Generalising this concept to democratise the Grid and render it accessible to all requires incentives that go beyond voluntarism: as we know, not all users search for extra-terrestrial intelligence or sequence a new genome.

Utility centres proposing managed IT resources to large companies show a promising business model. So why not transpose the Utility computing model to small enterprises and even individual users?

Grid4All will help to bring global computing to the broader society by providing an opportunity to small organisations and individuals to reap the cost benefit of resource sharing, but without the burdens of management, security, and administration.

Figure 1: Democratic Grid scheme (payment and agreement are not represented)

This will enable Grid services to evolve from high-performance computing niche markets to a multipurpose service for anybody to access or propose IT resources. To this end, Grid4all tackles the issue of operating virtual marketplaces where computing resources and in general any Grid service may be traded.

We have chosen demonstrators in two different application domains:

- Collaborative tools for e-learning targeting schools.
- Digital content-processing applications targeting home users.

Besides France Telecom, the Grid4All consortium comprises seven partners: INRIA, KTH, SICS, ICCS, UPRC, UPC, Antares, from four countries (France, Greece, Spain and Sweden), and providing atypical expertise within many grid projects. This fresh approach should bring innovations in Grids particularly for large-scale and dynamic-community grids.

Scenarios and applications

The first scenario targets small institutions and focuses on the use of distributed computing and educational resources within an aggregated virtual e-learning environment.

Consider a virtual university operating higher-learning courses for working network engineers. The classroom execution may use resources brought in by the university and also from external providers. Computational resources on which students run applications such as network simulation software or play/edit documents may be leased and multimedia contents may be provided by partners (technical libraries, research institutions, industrial teaching partners).

The second addresses domestic users. Home movies are becoming popular. Encoding movies into an MPEG-4 format in a reasonable time requires computational power that may not be available at home. This need could be satisfied through the leased usage of idle computational and storage resources on the Internet in exchange for a small payment. Conversely, the same user should be able profitably to provide his/her idling resources. We use market mechanisms to achieve fair resource sharing among users where the prices of resources are decided by balancing demand and supply.

Democratic grids: the Grid4all approach

We address grids for collaborative and on-demand computing in the Internet, where communities appear in an ad-hoc way. The objectives are therefore to foster take-up for a Grid technology in society by reducing the complexity of Grid-based systems. Four aspects appear crucial:

- societal behaviours with churn and high volatility,
- non-professional users,
- the need to offer appropriate incentives to make the system spread and thrive,
- need for support for different styles of collaboration.

To address these aspects, Grid4all will develop/apply specific methods:

- Churn and volatility: ad-hoc, dynamic collaborative and social networks are built using self-configuring overlay services.
- Non-professional users: minimise manual intervention through an autonomic and self-managing middleware. We use the well known component model Fractal to implement self-managing services and applications.
- Incentives: pricing-based allocation of resources and services in an open marketplace.
- Collaboration and in particular address access to shared and mutable data in a volatile environment.

First results and achievements

The main focus so far has been on use scenarios, requirements, architecture and state of the art. From a DHT-based overlay called DKS (for Distributed K-ary System), brought in as background by SICS, we have released a prototype of new self-managing overlay services. INRIA has integrated its management architecture on the overlay and this framework provides three Grid-management functionalities: deployment, monitoring and discovery, essential for dealing with churn and volatility.

We have released a first prototype of the management framework for virtual organisations (VO) that can deploy and manage application components. A VO is mapped on an overlay. Application components are described using an extended version of the Fractal Architecture Description Language. This framework will be improved in order to provide policy-based management, enabling a rule-based decision control without requiring development of new code.

To address collaboration, the project has released a prototype of a VO-Aware distributed file system (DFS) that aggregates different types of storage providers through a common layer, the "Virtual Block Storage". This DFS implements a hierarchical and decentralised meta-data (directories and file systems) database providing information on the file objects that have been created or exported. It is built as a layer linking the file namespaces pooled into the virtual community. The advantages of this architecture are (a) separation between meta-data, access control and the consistent management of data itself, and (b) application-specific data-coherency control even in the face of volatility and disconnected operations.

P2P collaborative work is addressed through a novel middleware Telex that handles replication, consistency and conflicts. This takes application semantics into account and leverages on DFS for persistency. The first application using Telex, a shared calendar, is currently being evaluated for performance and behaviour in face of disconnected operations.

VOs are created on demand for a specific set of purposes. Resource requirements may vary over its lifetime. To address how to and from where to allocate resources, we design and develop tools for open resource market places to trade computational resources and services; supply and demand needs to be managed when there are fluctuations – this is addressed through pricing mechanisms.

Marketplaces serve to connect buyers and sellers and provide tools facilitating these actors: to create auction markets, to obtain information on the market situation etc. We have chosen a hybrid approach which lies between completely centralised and decentralised markets and are prototyping a layered market architecture that separates the economic mechanisms from platform-specific concerns to cope with heterogeneous environments.

One scheme offers generic support for auction-like negotiation mechanisms, on which specialised strategies and policies can be plugged in. For this purpose, we have used the Fractal component framework which is the basis for the implementation of self-management in all of Grid4All.

Applications interact with the marketplace in order to obtain the Grid services required to fulfil the application tasks. Such services may be software services (such as a media-processing service) or computational services. In fact, the former requires the latter for its implementation.

There is also an E-Tutor application. Antares, one of the Spanish partners, provides applications for a wide range of applications such as for distant learning and e-conferencing. One particularly important application is the e-Tutor/E-Meeting, a communicative application designed for face to face tutorials and virtual synchronous meetings through the Internet. It allows video, voice and data transmission simply by connecting to an URL, and includes tools such as slides, whiteboard, documents area, quick surveys, etc.

The challenge is the R&D applied to the adaptation of certain features to the decentralised grid4all environment. More information on this application is available at: www.antares/demos/etutor/video/ingles

Acronyms

VO: Virtual Organisation
DHT: Distributed Hash Table
DKS: Distributed K-ary System, a peer-to-peer middleware by SICS that is based on a DHT
DFS: Distributed File System
Fractal: Extensible and hierarchical language-agnostic component model

Prospects

At this stage the overall project goals are to realise proof-of-concept implementation in order to evaluate the system focusing on user and scenario requirements. With respect to the overall Grid4All vision, this particularly concerns schools, they are the primary targets as eventual end users.

Security and trust are crucial aspects before going towards pilot studies. It is enormously important that the providers of resources are assured their security is not being compromised, and correspondingly consumers that their applications execute in a secure environment. We will capitalise on work on the potential of virtual machine technology to preserve this isolation. Finally our ambitions are to:

1. set up a pilot test-grid for user trials in a real-world setting addressing the educational domain and in particular schools;
2. set up and operate a pilot marketplace to trade Grid resources and services, leveraging on ADSL and other broad-band clients as providers of resources;
3. and finally study the feasibility of offering a wide range of novel tools for collaboration that address online communities as part of the operator's services portfolio. ★

At a glance

Grid4All – Self-* Grid: Dynamic Virtual Organizations for families, schools, and all

Objectives

Grid4All aims to advance the pervasiveness of Grid computing across society by taking global computing beyond academia and large enterprises by providing an opportunity to small organisations and individuals to reap the cost benefit of resource sharing without however the burdens of management, security, and administration.
Reduction of management and administration complexity that are key hurdles that hamper adoption are addressed by pioneering the application of component-based architectures to self-organising peer-to-peer overlay services. Grid4All supports new styles of collaboration – a necessity to capture the needs of broader society.

Partners

France Telecom – Ruby Krishnaswamy (coordinator)
Institut National de Recherche en Informatique et en Automatique (INRIA), France – Marc Shapiro, Patrick Valduriez
The Royal Institute of Technology (KTH), Sweden – Vladimir Vlassov
Swedish Institute of Computer Science (SICS), Sweden – Per Brand
Institute of Communication and Computer Systems (ICCS), Greece – Nectarios Koziris
University of Piraeus (UPRC), Greece -- Symos Retalis
Universitat Politecnica de Catalunya (UPC), Spain -- Leandro Navarro
Antares S.A (Spain) – Sergio Lopez Borgonoz

Contact

t: +33 145296034

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