★ Technology plays such an integral role in our daily lives that many of us give barely a second thought to the underlying infrastructure on which it depends. **Professor Farid–Ould Saada** of NorduGrid explains how their work in improving Grid middleware will bring significant benefits to end users

The ARC solution for Grid middleware

The expectations of technology users seem to rise on a virtually continual basis. No sooner has an innovative, sophisticated product hit the market than demand is stimulated for newer, faster, more responsive technologies. The same holds true for Grid computing. Just as cluster computing was the next step for workstation-based computation, so the ongoing development of Grid technologies represents an important move forward in terms of computing for advanced research. "By making use of excellent wide-area networks Grid computing naturally extends the term 'distributed computing' from nodes in a cluster to clusters in a Grid," explains Professor Farid Ould-Saada, the chairman of NorduGrid, a collaboration working to advance Grid technologies.

"The main goal of NorduGrid is to develop, maintain and support a free open source Grid middleware, the Advanced Resource Connector (ARC)," he continues. "Although NorduGrid started as a project (2001-2002), it actually evolved into a long-term R & D collaboration based on a Memorandum of Understanding between the members. ARC is a result of the cooperation between several projects initiated and supported by NorduGrid: the EU-funded KnowARC project, the Nordic DataGrid Facility, and the Nordunet3-funded NGIn project that focuses on research and education (PhD programme, Grid school)."

With the effective operation of national Grid infrastructures reliant on their underlying infrastructures, the provision of reliable middleware takes on great importance. This is a role in which NorduGrid has been notably successful. "ARC has been facilitating the reliable implementation of fundamental Grid services and utilities since 2002," says
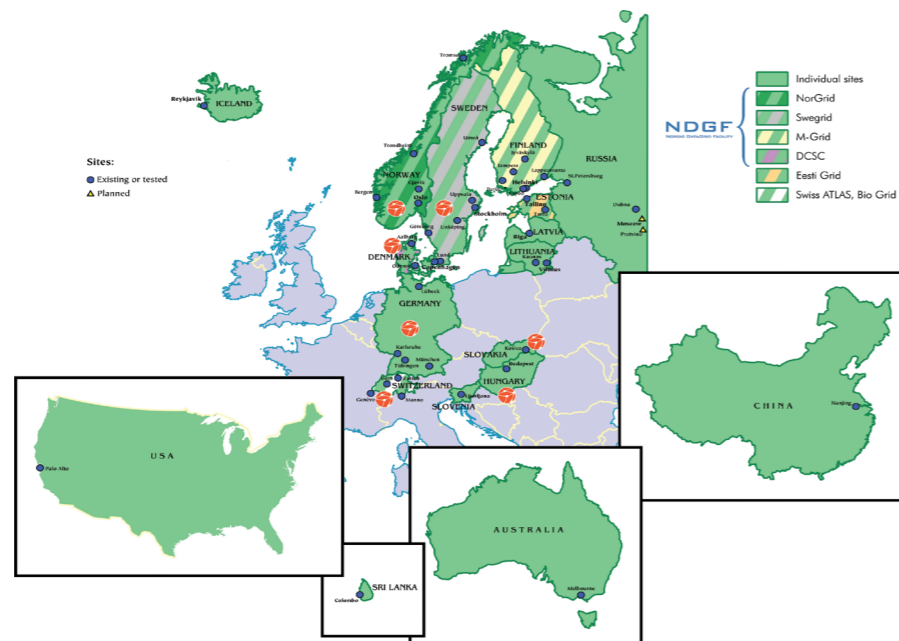
The ARC middleware is deployed all over the world

Ould-Saada. "A growing number of national and international infrastructure projects have chosen the non-intrusive, reliable, lightweight ARC as their middleware. Swegrid was the first, and the decision of a national Grid infrastructure to use ARC middleware was an important milestone for NorduGrid. Other Nordic countries quickly followed, including Norgrid in Norway, M-Grid in Finland and DCSC in Denmark – all of which rely on ARC. This ultimately led to the establishment of the NDGF, which set the goal of providing a distributed regional computing centre (Tier1) for CERN computing. Only ARC middleware can make this possible, there are no other comparable distributed centres."

Having set such ambitious objectives it is clear that NorduGrid must maintain a real focus on innovation if they are to be able to fulfil them. This is something of which Ould-Saada is well aware, indeed he points to NorduGrid's work in developing middleware capable of serving multiple platforms as an illustration of the project's forward-looking focus. "The ARC currently being deployed runs on most Linux distributions. One of the goals of the KnowARC project (the main NorduGrid-related R & D project funded by the EU) is to make ARC function on the Microsoft Windows and Mac OS platforms as well," he outlines. "The objectives of the KnowARC project are to create a novel, powerful Next Generation Grid middleware, to promote Grid standardisation and interoperability, and to increase the take-up of Grid technologies and thus bridge the gaps between business and academia in Grid development."

Innovation on solid grounds

NorduGrid's success has not been achieved through standing still. Change is ongoing in the technology sector, meaning there is a constant need to adapt to new demands and evolving concerns. This is something explicitly reflected in NorduGrid's overall philosophy, which marries solid technological foundations with a real commitment to meeting users needs. "The original ARC middleware was heavily reliant on some of the rather old technologies found in the Globus Toolkit. We then developed a number of innovative solutions which deviated significantly from Globus ones. The new generation of ARC middleware that is being developed with EU support through the KnowARC project is a completely new solution that has no parallels," says Ould-Saada. "However, we cannot really call it a radical departure as the most radical thing about this new middleware is that it complies with community Grid standards and is implemented in the Open Grid Services Architecture (OGSA). In the past not many Grid development projects relied on standards – for the simple reason that these standards did not really exist, indeed they have only started to emerge relatively recently. Contributing to standards development processes is one of the main objectives of NorduGrid and related projects."

The pursuit of such goals demands that the project collaborate closely with their European peers. This is something NorduGrid recognised at an early stage. "NorduGrid has historically cooperated closely with a number of European Grid initiatives. This started with the EU DataGrid (EDG, 2001-2004), where we were one of the associated partners and took an active part in middleware development and integration," says Ould-Saada. "We have established very close ties with a number of projects, especially in the area of interoperability. We are also very active in standardisation work and contribute to the Open Grid Forum (OGF), proof that we are collaborating not only on the European level but on a wider basis as well. We cooperate closely with the OMII-Europe and EGEE projects, and are actively involved in the EGI Design Study via the middleware task force. Not only do these projects influence NorduGrid strategic decisions, but we in turn have an effect on the development direction they take. The overall goal is to share knowledge and forces in order to converge towards interoperable Grid solutions. Standardisation is the key here."

This goal of enabling interoperability is yet to be fully achieved. However, there is

broad agreement amongst those in the field that collaboration and knowledge sharing bring the prospect of truly interoperable solutions closer. This brings more immediate benefits, particularly for open-source projects like NorduGrid. "Enhancements and new functionalities are being added gradually during the lifetime of the middleware," explains Ould-Saada. "Such development is usually triggered by user requests, and is often done in collaboration with other related projects, such as the NDGF or the 'Innovative Tools and Services for NorduGrid' project (NGin). Good examples of such cooperation are the accounting system developed by Swegrid, the Application Portal developed by Lund University and the security and data-management enhancements that are being developed by Finnish, Norwegian and Swedish students in the NGIn project."

Of course the needs of end users need to be kept firmly in mind when developing new technologies. Users typically only choose Grid computing over its conventional counterpart if it can bring significant added benefits. Ould-Saada says that the NorduGrid project have identified some key priorities in this area. "The primary benefit Grid technologies can offer is simple access to massive computing and storage resources," he explains. "The key word here is 'simple'. Users often have no opportunity to learn complicated procedures; neither can they easily change their working environment. Thus portability comes as a natural consequence of the simplicity requirement and vice-versa. If the middleware is simple enough and does not rely on a multitude of additional conditions then it will be pretty straightforward to deploy it on any underlying system. This is the main principle of NorduGrid: think simple."

This approach may come as a surprise to those who find the world of technology a daunting, disorienting place. However it is this focus on simplicity that, in large part, explains why the project has been able to make the advances that it has. "The success of ARC has been due to the fact that it has followed a bottom-up approach. We have been able to develop functional, non-invasive, cost-efficient, easy to install middleware and use it on existing heterogeneous computing and storage resources," says Ould-Saada. "The good contacts that have developed between developers, users and system administrators has been instrumental in this process. NorduGrid and its related projects cover the full research chain, from R&D, deployment and support right through to maintenance, application and education." ★

At a glance

Full Project Title
NorduGrid and related projects

Definition
NorduGrid is a Grid Research and Development collaboration which aims to develop, maintain and support the free Grid middleware.

Objectives
The aim of the NorduGrid collaboration is to deliver a robust, scalable, portable and fully featured solution for a global computational and data Grid system.

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Farid Ould-Saada works as a Professor in the Department of physics at the University of Oslo, a position he has held since 1999. He has extensive experience in different fields of particle and nuclear physics and takes a leading role in NorduGrid-related activities. In particular, he is chair of the NorduGrid collaboration and director of the Know ARC EU-project.