Designing DCI

Professor Dr Dieter Kranzlmüller of Ludwig-Maximilians-Universität München on the importance of harnessing distributed computing infrastructure

The paramount importance of ICT in all aspects of life today introduces the need of assessment, control and aggregation of the underlying distributed computing infrastructure (DCI). Beyond the proliferation of IT services in commercial, governmental and educational sectors, the Exascale processing power required to support research in life-sciences forces a fresh view at the stance we take when designing DCI. On one hand, compliance and interoperability must be addressed, and on the other, the financial and energy economies of DCI must be taken into account. DCI can only grow and deliver value if its fundamental issues are understood and addressed in practice.

MNM TEAM
MUNICH NETWORK MANAGEMENT TEAM

THE MNM Team

The Munich Network Management Team (MNM Team) is a group of researchers at the Ludwig-Maximilians-Universität München (LMU), the Technische Universität München (TUM), the University of the Federal Armed Forces in Munich (UniBW) and the Leibniz Supercomputing Centre (LRZ).

The team, co-directed by Professor Dr Dieter Kranzlmüller and Professor Dr Heinz-Gerd Hegering (em), is one of the first groups in Germany to have addressed the research area of IT management – hence the name.

Presently, research interests revolve around large distributed systems and networks, including grid computing, virtualisation and cloud computing, high performance and exascale computing as well as visualisation.

The work of the MNM Team is based on practical experiences and knowledge gained from intensive co-operation with providers of large heterogeneous networks and software developers as well as scientific research in the individual institutions of the MNM Team. With the LRZ as the main IT provider for the Munich universities, the MNM Team has access to a world-leading IT-infrastructure including the energy-efficient petascale system SuperMUC. The MNM Team comprises around 30 researchers (about half of them pursue their PhD studies), as well as numerous students and administrative staff.

Accepting the challenge

The last years have seen an externalisation of computing resources into the cloud-based technologically on the virtualisation of DCI. While the technology has been available, its effective management is not. In particular, there is a need for the management of these virtualised DCI and facilities for quality assurance of cloud resources, in order to enable trading in such resources. The exchange of resources across administrative and national boundaries requires an adequate concept of trust between providers (as well as customers) and effective, open and auditable security measures.

Today's DCIs feature floor- or even building-filling computer clusters. As the energy demand of modern supercomputers ranges between that of towns with a couple of thousand inhabitants, stricter constraints on energy consumption and efficiency become necessary. It is therefore necessary to explore the strengths and weaknesses of varying computer architectures and cluster systems pertaining to energy efficient computing and Green IT.

When it comes to growth in performance, large scale computer systems develop in two dimensions: processors become faster and computer systems contain more processors. While computing applications implicitly benefit from faster computers, applications need to develop and evolve to optimally benefit from additional processors.

The MNM Team is conducting research and participating in several research projects with the goal of managing DCI to meet current and future demands of applications and make most use of scale out computing systems.

From roadmaps through standards to technology

The path to ubiquitous interoperable computing infrastructure is surrounded not only by technological issues, but also by the need of direction. The more technological building blocks become available, and the larger their domain of application becomes, the more importance must be given to the controlled development of this domain. First, strategic means are necessary to direct this development; second, a common understanding of the methods and tools to be employed; third specialised, concrete technology to fill remaining gaps.

The MNM Team has a track record of participation in projects funded at the European and national level, that constitute efforts to define roadmaps for the long-term view on infrastructure development, collaboration in the creation of standards to provide common methods, as well as supporting technologies. The following endeavours illustrate a selection of these projects.

EU project SIENA

SIENA, the Standards and Interoperability for e-infrastructure Implementation Initiative (2010-2012) contributed to defining a future e-infrastructures roadmap focusing on interoperability and standards, in close collaboration with the European Commission, DCI projects and Standard Development Organisations to gain an in-depth understanding of how distributed computing technology is being developed in this context. The MNM Team contributed to the efforts of the editorial board for the 'Roadmap on Distributed Computing Infrastructure for e-Science and Beyond in Europe'. The roadmap defines scenarios, identifies trends, investigates the innovation and impact sparked by cloud and grid computing, and delivers insight into how standards and the policy framework is defining and shaping current and future development and deployment in Europe and globally.

EU project gSLM

In the grid context, Service Level Management (SLM) is the base for a common understanding between service providers and customers. This is especially timely given recent structural changes to the academic e-infrastructure community, such as the launch of sustainable e-infrastructure services such as those from the European Grid Infrastructure and PRACE (the Partnership for Advanced Computing in Europe, that provides a European-scale High Performance Computing service), and the increasing coherency of user communities, such as the ESFRI research infrastructures.

The gSLM project produced a roadmap for future SLM efforts, that is directed towards efforts developing organisation models and frameworks for e-infrastructures so that SDM/SLM based on service level agreements between customers and e-infrastructures can be realised.

EU project MAPPER (Multiscale Applications on European e-Infrastructures)

Today scientists and engineers are commonly faced with the challenge of modelling, predicting and controlling multiscale systems which cross scientific disciplines and where several processes acting at different scales coexist and interact. Such multidisciplinary multiscale models, when simulated in three dimensions, require large scale, or even extreme scale, computing capabilities. The MAPPER project develops computational strategies, software and services for distributed multiscale simulations across disciplines, exploiting existing and evolving European e-infrastructure.

DFG project SPPEXA

Exascale systems are scheduled to become available in 2018-2022 and will be characterised by extreme scale and a multilevel hierarchical organisation. Efficient and productive programming of these systems will be a challenge, especially in the context of data-intensive applications. The MNM Team is leading the DFG-funded SPPEXA HA project to address the challenging problem of productive use of Exascale computing systems under a priority programme set up by DFG to fund software development for Exascale systems.

Adopting the promising notion of Partitioned Global Address Space (PGAS) programming the HA project develops a data-structure oriented C++ template library that provides hierarchical PGAS-like abstractions for important data containers (multidimensional arrays, lists, hash tables, etc.) and allows a developer to control and explicitly take advantage of the hierarchical data layout of global data structures.

EU project DRIHM

Within the EU-funded project 'Distributed Research Infrastructure for Hydro-Meteorology (DRIHM)', the MNM Team contributes expertise in developing and operating grid environments and high performance computing, to foster the development of new hydrometeorological research models and observational archives for the study of severe hydrometeorological events, to promote the execution and analysis of high-end simulations, and to support the dissemination of predictive models as decision analysis tools. Those resources and capabilities are employed to provide easy access to hydrometeorological data and models as well as to facilitate collaboration between meteorologists, hydrologists, and Earth science experts which is vital for predicting weather and climate and its impacts on the environment and for accelerating scientific advances in hydrometeorological research.

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