

When it comes to the development of European cloud computing, **Prof Dr Dieter Kranzlmüller** argues that the region can draw on diversity to ensure global leadership

Clouded diversity

European diversity is often seen as one of the roadblocks for many political issues, where interests of different countries or regions collide on seemingly easy questions, at least from the personal perspective of European individuals. Coincidentally, the diversity is prosperous when considering different approaches to solutions, as different viewpoints generate different ideas which lead to different results. On the technical front in general, and information and communication technology (ICT) in particular, we have seen numerous examples where European diversity has benefited its inhabitants, or sometimes even led to worldwide leadership. The strength of European researchers combined with their differences in working environment and culture, as well as the differences in their approach, has often initiated a competition, which fuelled technological advancement. The statement 'competition drives innovation' may be one of Europe's biggest assets.

At the same time, each individual research group is small enough to require collaboration across borders with experts from different regions across Europe and beyond. The expertise across Europe is rather diverse, stemming from different regional needs and viewpoints, but in total providing Europe with expertise in all areas. Whenever Europeans manage to combine these individual strengths into larger goals, great things may pay off.

Considering ICT, an on-going field of innovation is distributed systems. Here, the term 'grid computing' has often been referenced as an area where European leadership was unquestioned. While the 'grid' itself originated in the US, the necessity to use grid computing in different scientific areas across the European continent established a playground, where different ideas from different research groups were able to thrive and prosper. With the start of the first European Commission-funded EU project 'European Data Grid' at CERN and originally driven by the needs of the high-energy physics community, even US media accepted the European leadership in this technological domain. This situation has continued over the last couple of years with the Commission-funded EGEE project series (Enabling Grids for E-sciencE) trying to establish a pan-European grid infrastructure for all sciences, and at present the establishment of the European Grid Infrastructure (EGI) as a sustainable infrastructure independent of project life cycles.

Trough of disillusionment?

Throughout these projects, we have seen competing solutions flourish and vanish again, similar functionality addressed by different components or even middleware stacks from across Europe, and still today, we see many of these competing solutions being executed side-by-side. In fact, the EGI collaboration even addresses and encourages this competitive environment by establishing the Unified Middleware Distribution (UMD) as a catchment



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for middleware components instead of a single, monolithic, or monopolised approach.

The example of grid computing is only one domain where Europe managed to lead worldwide technological advancement. Today, we see cloud infrastructures coming up across the world and Gartner's well-known 'Hype Cycle on Cloud Computing' listed the general term 'cloud computing' as already beyond the peak of inflated expectations in the trough of disillusionment. As such, are we too late to attack for a European leadership in cloud computing? Or could clouds establish Europe as a market leader again, against today's big cloud providers from the US? And with respect to the European characteristics, will diversity provide new approaches and solutions in clouds, just as it did in grids?

To understand today's situation, we need to analyse the European situation and requirements with respect to cloud computing. What are the problems that European users have to tackle when utilising cloud computing? And where can we already see European excellence in cloud computing?

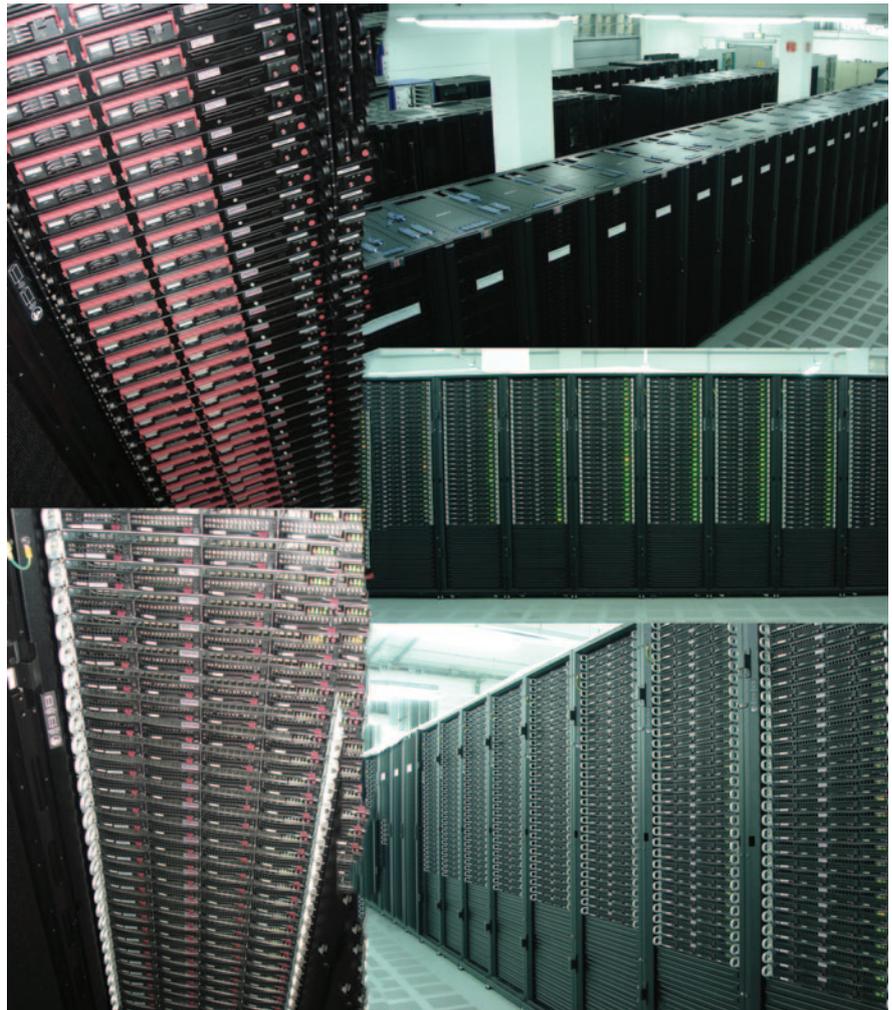
An initial problem stems from the differences in legal aspects, from different laws according to the respective nationality of providers and users, and from different interpretations of international law. Clearly, legal issues arising with cloud computing have only emerged with the adoption of cloud computing by the users. As seen in other cases, technological advances have taken legal experts by surprise, and currently, there are many efforts try to solve these issues, both nationally and internationally. Yet, at the moment, the legal situation when deploying cloud computing is often not clear, blocking some potential usage scenarios due to the confusion of its users. What cloud computing needs is a clear legal basis, where data can be processed, stored and transported into, inside, and between cloud infrastructures.

Trust needs to be built into the cloud offerings, and well-defined audits and certification processes are needed to guarantee that cloud services meet certain crucial criteria including legal issues in national and European law.

Security and trust

Another obvious area of European diversity and expertise is security, privacy, and data protection. Different countries have established different regulations for these aspects, and yet, the general problem is the same across all domains: the loss of control over your own data represents a serious threat to data integrity and confidentiality for cloud consumers. The legal framework required here to protect the consumers represents an important step towards a solution, but is certainly only one aspect in a series of issues, which must be addressed. The 2009 Madrid Resolution of the 31st International Conference of Data Protection and Privacy provides some guiding principles for a roadmap in this research area and demonstrates how important this area is. Each of the European member states has its own ideas and uses different means to guide citizens through the security issues of the technological equivalent of 'virgin soil'. For example, a recently published German book, *Innovativer Datenschutz*, by Falk Peters *et al*, describes the requirements on privacy with respect to IT systems, and derives all innovations needed to establish a future safe IT environment. The goal must be to make legally prohibited data processing also technically impossible, to protect the user from illegal operations and to obtain the user's trust in these operations.

But trust also requires a safe environment from the technical viewpoint, where clouds offer their functionality in a reliable, dependable and trustworthy way, such that cloud customers are able to perform their work in the same way as they would when trusting their own physical environment. This starts from guaranteeing Quality of Service (QoS) parameters and manageability across virtualised networks up to the situation, where different components in clouds can fail without affecting user operation. Again, we can easily see the potential of European competitiveness and collaboration, where diversity will benefit innovation and as a result will lead to novel approaches and solutions.



In fact, we already see these new ideas emerging with the German Deutsche Börse eagerly working on a cloud stock exchange, where cloud resources can be traded just as any other commodity; where users and providers can meet in the marketplace for cloud computing in a legally and technically secure environment with reliable solutions as a basis.

The Digital Agenda for Europe, published by the European Commission and endorsed by the European Council, seeks views on how to exploit cloud computing in the best way for business, government and science. The European Cloud Computing Strategy aims at enabling and facilitating faster adoption of cloud computing throughout all sectors of economy in order to boost productivity, growth and jobs, benefiting all of society.

The old Latin saying *divide et impera* is still true in Europe, but conquering the world requires not only the diversity of Europe, but also the collaboration across Europe and the combination of all European assets.

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