The delivery of software services over widely distributed systems provides far more dynamic and flexible ICT solutions for the user than ever before – but to maximise this potential, software development and maintenance has to radically change, something project **S-Cube** is ensuring. **Dr Andreas Metzger** explains

Working together to create a network of excellence

THE rapid evolution of information and communication technology (ICT) means that opportunities for new ways of computing and interacting are growing apace. One such opportunity is that of developing innovative systems by composing software services available over widely distributed infrastructures, providing utility to the users in a much more dynamic and flexible way than possible today. However, such service-based systems and their corresponding software services require fundamental changes to the way software is developed and maintained.

The use of software services implies that software is no longer owned by its users and that it is no longer running in the place where users are interacting with it.

This distributed ownership of the software opens up a whole range of research challenges, including its design, evolution, adaptation and quality assurance. But while many organisations across Europe are investigating some of those very challenges, so far there has been little or no concerted effort to explore challenges that cut across different research disciplines.

This is where the S-Cube project comes in. Coordinated by Paluno (The Ruhr Institute for Software Technology), based at the University of Duisburg-Essen in Germany, "S-Cube, as a European Network of Excellence, brings together researchers from various disciplines and ensures

there is a synergy and learning effect," said Dr Andreas Metzger, from S-Cube.

"As an example, the software engineering discipline has acquired a huge body of knowledge on how to design traditional software systems."

However, in the case of service-based systems much more decisions need to be taken during the systems' operation. This is due to the fact that the distributed ownership of the software implies that required information about the software services might not be available during design time.

This is where researchers working on computing infrastructures (such as Grids) bring in their expertise on how to design systems that are more dynamic and autonomous, such as self-adaptive infrastructures.

"Researchers from the business process management discipline bring in their understanding about how complex networks of organisations can work together to achieve joint goals via shared and distributed ownership and software systems. Finally, researchers from service-oriented computing are working on new languages and protocols to more dynamically and automatically compose and adapt software services."

To align the different disciplines and to cross-pollinate co-existing yet disparate research strands, S-Cube pursues dedicated integration activities within the project, not least to acknowledge and understand the differences in language and terminology used by the different scientific disciplines.

"What we did in S-Cube to address the diversity in terminology was to define and continuously update the S-Cube knowledge model. This is an on-line encyclopaedia and reference library for the Internet of Services, which is available via the S-Cube web portal.

"We realised that between the communities involved in S-Cube we will not always be able to agree on a common terminology, so we did not force it but instead interrelated the various definitions so that people can translate between the vocabularies of the various communities."

To organise the research activities in S-Cube, the network has defined an integrated research. "The S-Cube framework provides a clear separation of concerns and thus allows handling the complexity involved in aligning and integrating research activities of diverse disciplines. Specifically, the framework provides a clear distinction between service technology provided at different layers of a service-based system and cross-cutting principles and methods to utilise that technology in an integrated fashion.

"For example, in the 'Quality Definition, Negotiation and Assurance' building block of the framework, we investigate the novel facilities to predict a potential failure of a software service.

"This allows for an adaptation of the service-based system before a failure of a service can impact on the system's quality. To predict such failures different quality characteristics need to be measured and correlated across the technology layers."

S-Cube has just entered the second half of its four-year funding period. "Driven by S-Cube's research challenges and fostered by its research framework, researchers from various disciplines are now pursuing joint research activities and are intensively talking to each other.

"A very positive sign that shows the

> "The basic motivation for S-Cube is to create a network of excellence that will bring together researchers from various communities and ensure there is a synergy and learning effect between these various communities"

Prof. Klaus Pohl

is a member of the board of Paluno (the Ruhr Institute for Software Technology) and coordinator of S-Cube. He is a full professor for Software Systems Engineering at the Univ. of Duisburg-Essen and an adjunct professor at the Univ. of Limerick. His research interests include requirements engineering, service-based systems engineering, software quality assurance and software product lines. He serves as vice-chair of the steering committee and member of the executive board of the European Technology Platform NESSI.

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Prof. Michael Papazoglou

is the executive director of the European Research Institute in Services Science at the Univ. of Tilburg and the scientific director of S-Cube. He holds honorary professorships at the Universities of Trento (Italy), Lyon1 (France), New South Wales (Australia) and Universidad Rey Juan Carlos, Madrid (Spain). His research interest include service-oriented computing, web services, and service sciences.

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Dr. Andreas Metzger

is a senior researcher and leader of the service engineering research group at Paluno (the Ruhr Institute for Software Technology) at the University of Duisburg-Essen. He is activity and workpackage leader of S-Cube and member of the network management board. His research interests include software engineering and service-based systems engineering, and quality-assurance for variability-intensive and adaptive systems.

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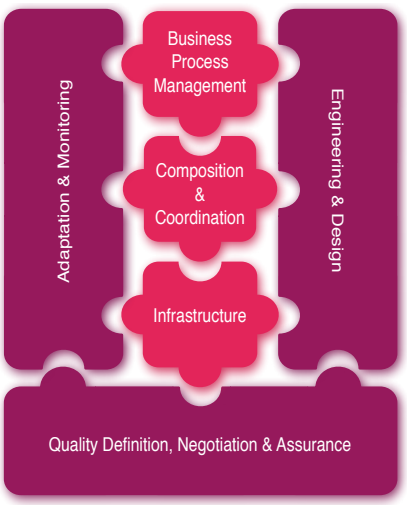
successful alignment of the various communities is conferences and workshops that S-Cube members have jointly organised, with contributions from all disciplines.

A prominent example is the ICSOC/ServiceWave conference series, which has attracted great interest from research and industry. ServiceWave has been launched in 2008 by S-Cube jointly with several European Technology Platforms and EU projects to serve as a European forum addressing software services and ICT technologies.

Each second year ServiceWave is collocated with the International Conference on Service-Oriented Computing (ICSOC) and thereby also attracts many participants outside Europe.

The challenges of cloud computing are now testing out the S-Cube team as they try to look ahead to a future which is changing so quickly in the present. "In addition to software that is provided as a service, processing and storage facilities will be made available as a service. This adds another level of flexibility and dynamicity, as it allows allocating and utilising computing resources per use," said Dr Metzger.



S-Cube's Integrated Research Framework

"So there is yet another dimension of shared ownership that has another potentially huge impact on research. The new ICT work-programme under the European Commission's Seventh Framework Programme is addressing these cloud computing issues and so this will also be a very interesting and relevant subject for S-Cube researchers to study beyond the scope and life-time of S-Cube." ★

At a glance

Project Information

Project Title: S-Cube: The Software Services and Systems Network

Project Objective:

S-Cube will create a unified, multidisciplinary, vibrant research community and will define a broader research vision and perspective to shape the "Internet of Services". Thereby, S-Cube will enable Europe to lead the software services revolution and help in building the foundations for our future interactive society.

Project Duration and Timing:

48 Months, running from 01.03.2008 to 29.02.2012

Project Funding:

Funded by the European Community's Seventh Framework Programme FP7/2007-2013 under the programme "Service and Software Architectures, Infrastructures and Engineering"

Amount: approx. 8.5 million EUR

Project Members:

Univ. of Duisburg-Essen / Paluno – Ruhr Institute for Software Technology (DE), Tilburg Univ. (NL), City Univ. London (UK), CNR (IT), FBK (IT), INRIA (FR), Lero (IE), PJIIT (PL), Politecnico di Milano (IT), MTA SZTAKI (HU), Vienna Univ. of Technology (AT), Univ. Claude Bernard Lyon (FR), Univ. of Crete (GR), Univ. Politécnica de Madrid (ES), Univ. of Stuttgart (DE)

Project Members:

CETIC (BE), Dortmund Univ. of Technology (DE), Karlsruhe Institute of Technology (DE), SINTEF (NO), South East Europ. Research Centre (GR), Tsinghua Univ. (CN), Univ. de Sevilla (ES), Univ. della Svizzera Italiana (CH), Univ. di Pisa (IT), Univ. Européenne de Bretagne / Univ. de Bretagne-Sud (FR), Univ. L'Aquila (IT), Univ. of Groningen (NL), Univ. of Innsbruck / Semantic Technology Institute (AT), Univ. of Manchester (UK), Univ. of Ménster (DE), Univ. of Southampton / IT Innovation (UK), Univ. Politécnica de Catalunya (ES) Univ. Politècnica de Catalunya (ES)

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