Integration, Service Orientation and Convergence – Advancing Research Information Management at the Karlsruhe Institute of Technology

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Summary

The analysts in their outlooks for 2012 identify as trends Social Media, Unified Communication & Collaboration (UCC), Next Generation Business Intelligence and Mobile IT. The paper by considering the impact of these innovations on Current Research Information Systems (CRIS) evolves a picture of the 'Next-Generation CRIS'. The future CRIS as a multifunctional platform will not only be deeply embedded in integrated and service-oriented architectures, but also comprise strong Social Media and UCC components, be graded up to a severe Business Intelligence tool and be accessible on all kinds of mobile devices anywhere and anytime. By these extensions of its range of functionalities the whole scientific and science management lifecycle will be supported. In the final chapter it is shown, to which extent the Karlsruhe Institute of Technology (KIT) in a strategic partnership with the AVEDAS AG is about to realize a Next-Generation CRIS within the running implementation project KIT-CRIS.

1 Cycle of Innovation

1.1 Trends

1.1.1 Overview

What we call Information Technology since the 1980's developed extremely fast. Companies in an ever-accelerating competition keep pushing new solutions and concepts in the market, with which they hope or in the ramp-up by elaborate marketing and branding made sure to succeed. This evolutionary process of innovation shows almost biological patterns, to which for example the well-known Gartner Hypecycle refers localizing important developments on a rising and declining line of birth, growth, trial, survival and death.

The analysts in their outlooks for 2012[1] identify as trends the inevitable Cloud Computing or other topics known from recent years like Software as a Service, Virtualization and Green IT or IT Security and Data Privacy. More important in this context are

[1] Evaluated were the rankings by Gartner, Forrester, Pierre Audoin Consultants (PAC), International Data Corporation (IDC) and Experton Group.

- Social Media,
- Unified Communication & Collaboration (UCC),
- Next Generation Business Intelligence, Next Generation Analytics, Big Data,
- Mobile IT.

Except UCC, which was hyped especially last year, these topics are all ranked highly and with no doubt will cause or already have caused sustainable effects. These trends are arched over by the mega-, or metatrend Convergence, which could be defined as the merging of formerly separated applications or functionalities into multifunctional hardware- and software-solutions.

1.1.2 Social Media, UCC, Virtual Research Environments

Social Media definitely is more than just a hype: users today spend more and more of their online-time in social networks, in which networking features have melted with communication and collaboration tools like messaging, file sharing or video conferencing. This is why Social Media and Unified Communication and Collaboration (UCC) are closely related. UCC aims to accelerate projects and innovation processes connecting people and information by a central solution that collects and shares information within the community and enables coordinated working on primary data or output of other kind. In science and research Virtual Research Environments provide comparable possibilities of collaboration and communication for intra- and inter-organizational scenarios. Depending on further developments, we can expect a new era of collaboration in research, triggered by a combination of Social Media, UCC-tools and Virtual Research Environments.

1.1.3 Business Intelligence

Concerning Business Intelligence, output oriented approaches on performance measurement in science in the meantime are to be seen as outdated, because facts and figures start talking to science managers to the extent, to which factors like results of time-line analysis, strategic objectives, benchmarks or resources are related to them. So the market and more and more the public sector requires intelligent and flexible Business Warehouse or Data Warehouse solutions capable of ‘making the numbers talk’ in the sense described above.

1.1.4 Mobile IT

Mobile devices like the ubiquitous smartphones and tablets could be considered as just another human-machine-interface providing access to a bundle of services in interaction with resources and systems in the backend anywhere and anytime. But the devices functional design and the use patterns with gesture or speech based control and a specific look-and-feel of graphical interfaces are remarkably different from what we had before. This is a challenge for usability design in general and will sustainably change the way we interact with hardware, systems and services.

1.2 Megatrend Convergence

The trends mentioned above are arched over by the mega-, or ‘metatrend’ Convergence, which could be defined as the merging of formerly separated applications or functionalities into multifunctional hardware- and software-solutions. In the hardware sector convergence led to spectacular technological innovations like smartphones and tablets. And also in software sector a

growing number of formerly separated applications are about to merge into multifunctional platforms like the Next-Generation CRIS that will combine and merge the functionalities or ‘features’ mentioned above.

2 Next Generation CRIS

2.1 Circle of Functionalities

2.1.1 Overview

The still very few companies setting out to conquer that growing market selling CRIS ’off the shelf‘ have to consider these newest technological developments, to make their products attractive for demanding consumers, whose expectations shaped both by the needs of everyday duty and the bundle of trends sketched above have to be met or – in best case – exceeded. So Next-Generation CRIS as a multifunctional platform that merges formerly separated applications, will be

- Deeply embedded in integrated and service-oriented architectures,
- Converged with strong Social Media and UCC functionalities,
- Graded up to a severe Business-Intelligence tool,
- Accessible on all kinds of mobile devices anywhere and anytime.

2.1.2 Integration and Service Orientation

Integrated information management and service orientation nowadays are accepted as important triggers for the performance of IT systems of every kind and are leading principles in most institutions IT-management-concepts. The advantages like improved efficiency, increased quality of data by eliminating redundancies and improvement of service level are evident. So Next-Generation CRIS will be deeply embedded in a local integrated architecture and intelligently interact with an identity management system and other relevant local applications like a campus management system, enterprise resource planning system or a business warehouse.

2.1.3 Social Media, UCC, Virtual Research Environments

Strong social media and UCC components will enable the scientist to act in a customized scientific network directly out of her CRIS user profile, where she or he can add other scientists inside and outside her or his organization as contacts, establish or join groups and communicate and collaborate with other researchers worldwide. The limits of social networks as we know them will be exceeded by the merging of social media with UCC and especially Virtual Research Environments that besides academic discourse enable sharing primary or raw data like results and objects of research with the community.

But to succeed, this model will have to ensure security and privacy, for Facebook’s and Google’s practices are stoking all kinds of fears that also CRIS-implementation projects can suffer from. For acceptance as one of the biggest risks for CRIS-implementation projects and possible strategies to overcome resistance see below (section 3.3.3).

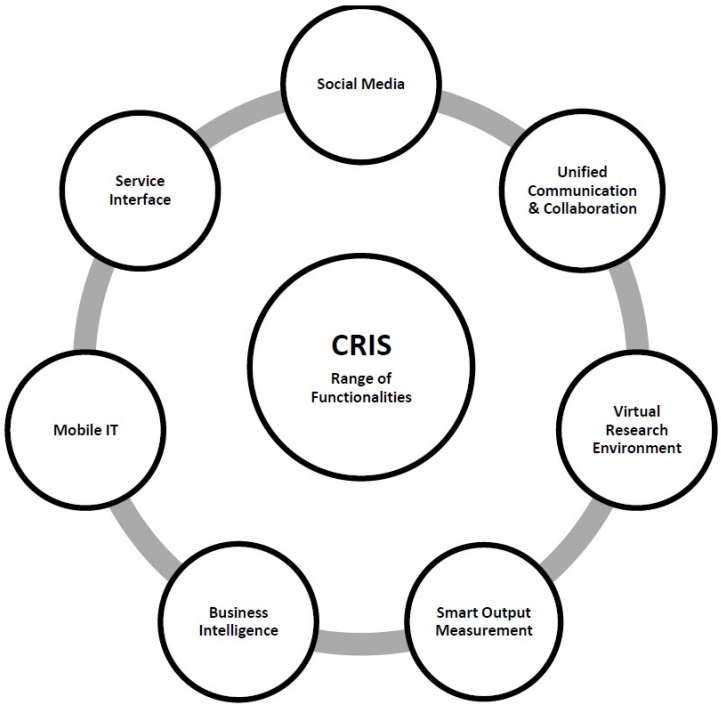

Figure 1: Next-Generation CRIS range of functionalities

2.1.4 Business Intelligence

Concerning Business Intelligence, CRIS today are partly very powerful concerning first the collection of output data from internal and external sources, second the mapping of this information to for instance persons, institutes, faculties, et cetera and third the visualization, sorting and filtering of this 3-dimensional structure. That is for sure an achievement and could be called 'Smart Output Measurement'. But, to make the Next-Generation CRIS an every-day tool for reporting, controlling and quality management, the systems we know today will either have to be graded up to a severe Business-Intelligence tool that relates reliable output-information to the results of time-line analysis, strategic objectives, benchmarks or resources, or must be enabled to interact with Data or Business Warehouse solutions in an appropriate way.

2.1.5 Mobile IT

The usability of the Next-Generation CRIS in all of the use cases mentioned has to meet the users expectations that are more and more shaped by mobile device use patterns. So it has to be accessible on all kinds of mobile devices anywhere and anytime fulfilling high-performance requirements.

2.2 Supporting the Science and Science Management Lifecycle

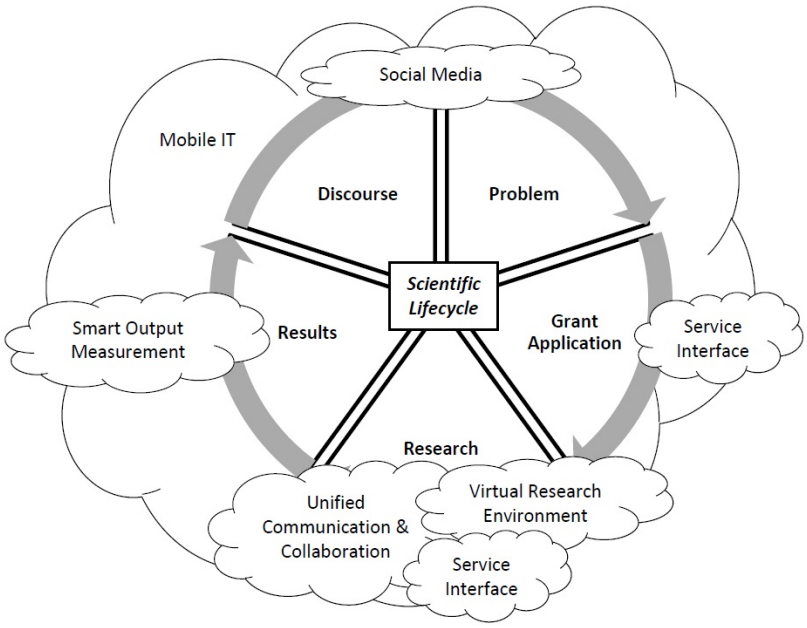

Figure 2: Next-Generation CRIS supporting and enabling the scientific lifecycle

While nowadays just a few steps or phases of the scientific lifecycle can be supported or enabled by a CRIS, the Next-Generation CRIS with its enhanced range of functionalities (Figure 1) will support or enable most of its phases (Figure 2). The Business-Intelligence component, which is not included in Figure 2, has to be seen as a part of the science-management lifecycle that can be depicted separately and consists of the 5 steps (1) Management Decision (2) Funding (3) Research (4) Results (5) Assessment.

3 Advancing Research Information Management at KIT

3.1 Karlsruhe Institute of Technology

The Karlsruhe Institute of Technology (KIT) is a German academic research and education institution resulting from a merger. In 2009 the University of Karlsruhe (TH) merged with the former National Nuclear Research Center Karlsruhe. With its 9000 employees on two major locations and an annual budget of 800 Mio Euro the KIT bundles two missions, for it is a University of the state of Baden-Wuerttemberg, awarded one of nine German Excellence Universities, and at the same time a large-scale research institution of the Helmholtz Association conducting program-oriented provident research on behalf of the federal republic of Germany.

3.2 Project KIT-CRIS

3.2.1 Requirements, Objectives, Tendering Process

KIT is about to position itself as an institution with excellent research in natural and engineering sciences on an international scale. But the overall 140 institutes of both missions over the years established different standards and practices in documentation of research activity and results and did not exchange data with one another or with the central administration, so an ambitious science management still is heavily constricted by the lack of knowledge about the strengths that must be strengthened, and the weaknesses that must be weakened. So to establish attractive services for scientists, to help science managers carry the burden of reporting and to enable them and the executive board to base decisions in science management on reliable facts on the institutions performance, in 2010 executive board and chief information officer decided to establish an integrated and service-oriented Current Research Information Management System.

In an 8 week tendering process KIT chose CONVERIS by AVEDAS AG as a platform. One of the major keys to the selection of CONVERIS was its full CERIF compliance. KIT not only wants to benefit from the mature and powerful CERIF data model, but in addition has specific requirements that CONVERIS fulfils: It both imports and exports valid CERIF XML files to facilitate CRIS interoperability, e.g. to be used to exchange research information between organizations in federated scenarios. Exemplary federated scenarios that are currently discussed are a collaboration with the Karlsruhe University of Applied Sciences and a CRIS for the federal state of Baden-Württemberg.

3.2.2 Project Structure, Software Development, Rollout Mode, Milestones

The team comprises about 20 employees from the stakeholder service units, the computing center, faculties and institutes that work part-time for the project and are coordinated by several part-time sub-project leaders and a full-time overall project leader. The project from the very beginning followed the principles of SCRUM. This agile software development method that instead of heavy specification sheets emphasizes a constant customer-provider dialogue driven by rapid prototyping and relatively short cycles of specification, development, delivery and evaluation, holds many advantages, in case the dialogue is held structured and focused. With this method KIT achieved high-speed implementation and hit the many ‘moving targets’.

Since January 2011 in the building blocks *Publications* and *Projects* (cp. Figure 3) data models and processes for the integrated and service-oriented management of bibliographical information and project information were specified and established. With these functionalities the system currently is rolled out at 3 of overall 140 institutes that we chose as ‘pilots’. If the system is accepted and successfully deployed, we expect an easier and faster rollout at the remaining 137 institutes in 2013 and 2014. As next steps in the building block *Innovation* the foundations for the management of the several revenues of the technology-transfer process like protection, licensing or commercialization will be built. In the building block *Higher Education* the system will be enabled to keep records of teaching activity and content as part of the academic profile of a scientist. A further building block for the management of *Doctoral Research Projects* is planned. While these building blocks can be called ‘vertical’, the one named *Controlling, Reporting & Quality Management* must be called ‘horizontal’. In this sub-project from the very beginning

certain informations and mechanisms have to be established that enable the KIT-CRIS to work as a Business-Intelligence Tool, like it is described above.

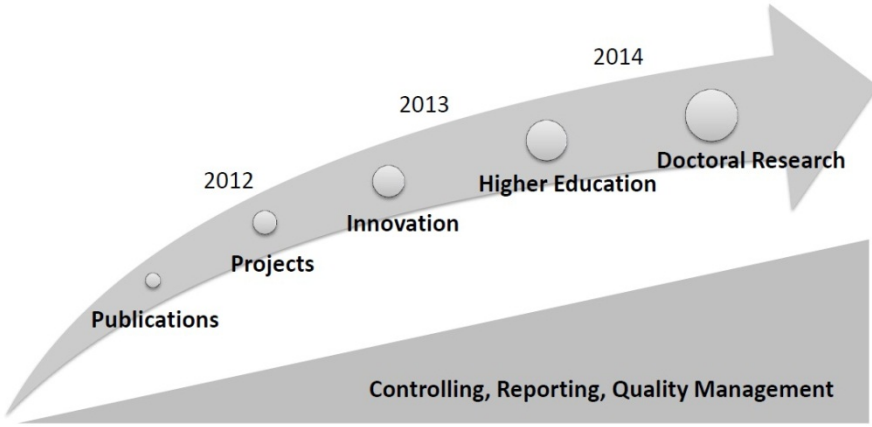

Figure 3: KIT-CRIS building blocks

3.3 System KIT-CRIS

3.3.1 Service for Science

The project – as already mentioned – aims to establish attractive services for scientists, to ease reporting and funding for science managers and to enable them and the executive board to base decisions in science management on facts. Accomplishing this mission, KIT-CRIS profits both from certain local preconditions, like a state-of-the-art enterprise IT architecture with a federated identity management system as the '*omphalos'*, and from a software product that provides a broad range of functionalities.

3.3.2 Integrated and Service-Oriented Architecture (KIM-iSOA)

Already in 2006 the KIT decided to consolidate IT services and infrastructure with the approach of the so-called Karlsruhe Integrated Information Management project (KIM) (Juling & Maurer 2005, Fondermann & Juling 2012). The project pursues the goal of increasing excellence in research and higher education and therefore strives for a continuous and sound integration of relevant legacy systems and data as well as for increasing the accessibility and transparency of related business processes.

The technical realization is based on a Service-Oriented Architecture (SOA) model, which was termed 'KIM integrated Service Oriented Architecture (KIM iSOA)'. As the center of this architecture the Steinbuch Centre for Computing (SCC) developed a federated identity management system (IDM). Due to the organizational structure of the KIT and based on the experience made in the course of the KIM project, the concept of federation presented a promising way to ease the establishment and operation of organizational and technical issues of Identity Management (Höllrigl et al. 2008). This concept fits well due to the fact that the organizational structure of common universities is resembled by 'realms', or 'satellites'. As

realms can be considered e.g. the computing center, university library, faculties and institutes. These organizational units had evolved separately over the years, establishing their own IT services, business processes and identity repositories. As a major benefit of the conceptual view 'university as a federation' the various realms still keep the data sovereignty and so there is no need to replicate the identity information in a central system. Also, the access control for the respective data remains at the satellites and there is no need for centralized access control permissions (Höllrigl et al. 2009, Höllrigl et al. 2008).

This architecture not only eases the provisioning of identities and organizational structures as the precondition for reliable mapping, but also allows appropriate interaction of a CRIS with e.g. the campus management system to keep records of teaching activity and content as part of the academic profile of a scientist (to be realized in 2013), the enterprise resource planning system to relate financial information to scientific output (to be realized in 2012) and a Data or Business Warehouse (to be realized in 2014).

3.3.3 Social Media, UCC, Virtual Research Environments

In KIT, scientists work in so-called 'fields of competence' depending on their expert know-how. Related fields of competence are bundled in 'competence areas'. Fields of competence and competence areas make up the competence portfolio of KIT, which is the basis of all research activities and provides a forum for inter- and trans-disciplinary scientific exchange within KIT. Thus, it is the breeding ground for new scientific ideas, projects, and networks, being either self-established or strategically planned.

The project Information Technology for Cooperation (IT4COOP), driven by the Steinbuch Center for Computing (SCC), will in 2012 and 2013 facilitate the linking of KIT scientists in the competence network by establishing suitable collaboration environments and interactive teaching, learning and working spaces. The KIT-CRIS plays a major role in this concept, for the newest version of the product we chose contains strong social media components enabling the scientist to communicate and collaborate in the competence network directly out of his CRIS user profile.

3.3.4 Smart Performance Measurement and Business Intelligence

Science needs management, and management needs measurement. To support our science managers by what above was termed Smart Performance Measurement and to provide them a severe Business-Intelligence tool one day, we first of all had to establish certain mapping mechanisms that relate all entities of the data model automatically and reliably to the objects of reporting according to the stakeholders needs. This for two reasons came out to be extraordinary challenging. Because of the KIT-merging process until the summer of 2012 the two institutions ran two separate ERP-systems containing HR-, finance- and organizational data in two different repositories. Furthermore the development of KIT triggered significant changes to the governance structures that in the next years will be developed further in order to bring together the pre-merger structures. Institutes make up the basic elements of this future organizational structure. Every institute will be assigned to one of the six new departments according to its main field of research. From there institutes of all departments contribute to research activities of KIT centers or focuses that strategically combine and support coordinated research activities such as collaborative research centers and Helmholtz programs.

So on the one hand we have to ensure a reliable mapping of scientific output, as known to the system, on the so-called vertical axis, thus, to for example departments, institutes, institute's sub-

structures and single scientists. This is ensured by the scientists affiliation delivered by the IDM from the authoritative HR-repository and both the current and historical organizational structure including 'parental' relationships between units also delivered from the KIT's ERP-system. On the other hand we have to enable the mapping on the horizontal axis, therefore, the dynamic matrix structures already mentioned like KIT centers and focuses. This came out to be extremely difficult, because the system knows a persons vertical affiliation, but can hardly know, in what horizontal structures he or she to what extent with which results is engaged. To avoid the enormous effort that would be caused by relating several context-flags to every entity managed in the system, we came out with identifying an institutes share in a center or focus activity on the basis of an index that is updated once a year in cooperation with the institute's heads and contains an average percentage, with which an institute participates in matrix-structures or activities.

The smart-measurement features of KIM-CRIS are determined by the requirements of several standard reports that both science managers and service providers on behalf of the executive board have to deliver. This comprises the large-scale evaluation exercise within the Helmholtz Association of Research Centers, the so-called Programme Oriented Funding (POF). Furthermore, we had to consider the data models of the most important rankings. To make the system the backbone for controlling and quality management, we will enable KIT-CRIS to interact with a business warehouse solution that collects and delivers facts and figures from the HR-, finance- and scientific dimension of the object of reporting, e.g. a project, in a single environment and provides the 'big picture'. In close cooperation with a running quality management project that develops intelligent up-to-date mechanisms for evaluating scientific performance, this information will be related to the results of time-line analysis, strategic objectives, benchmarks or resources.

3.3.5 Service Orientation and Process Optimization

The design of KIT-CRIS in every phase of the project was and is determined by the stakeholders needs and with its enhanced range of functionalities (Figure 1) strives to support or enable as many of the processes of the Science or Science Management lifecycle (Figure 2) as possible. Especially the system will allow a more immediate interaction between scientists and science managers as users and internal service providers that aim to increase their service level. To clarify matters just two examples shall be given:

Concerning publications, still every publication produced within the Helmholtz mission has to be announced to the institutes' head. This application for the permission to publish in the past had to be handed in on a paper form. After that the publication was announced to the library with a further paper form. In 2012 these two formerly unconnected processes were merged to one enabled and optimized by the KIT-CRIS. Concerning projects, we managed to cover the whole project-, or grant-application lifecycle and to enable users and internal service providers to interact with the KIT-CRIS. From the first step – the application for funding – to the last step – the grant of the project – a core set of project data is preserved and stays available for every service unit, so that – an advantage for instance for scientists – the information is given once, but used several times.

3.3.6 Risks, Acceptance and Outlook

Apart from the difficulties described above discussions with scientists showed that the end users appreciate by far not everything that providers and project managers are enthusiastic about.

Especially concerning Social Media, Smart Performance Measurement and Business Intelligence the biggest project-risk is the acceptance not so much of the science managers, but of the scientists. Fears are stoked first of all by social network-like GUI's that remind many users of Facebook, which in Germany currently is in a bad reputation. Furthermore the automation of mapping mechanisms evokes fears of the loss of control of personal data and a kind of 'tracking' in the sense of control of behavior that the employer plans to exercise hidden in a bunch of seductive services like poison in a bouquet of flowers. This impression is not overall wrong, because quantity and quality of data in a CRIS definitely depends on the extent, to which the scientists and science managers of an institution are brought to appreciate the provided services and to make use of them. But the loss of control of personal data and a 'tracking' of the activities of single employees is on the one hand not intended and on the other hand impossible because of the elaborate access-rights and roles the software provides and the IT Security and Data-privacy concept that KIT developed in cooperation with its specialists.

This besides the expected increase of service level is what the project management continues to emphasize avoiding a top-down approach by e.g. executive board enforcement in implementation, striving for a constant dialogue with the skeptics and trying to ensure a maximum of transparency and broad participation in all requirements-engineering processes. If KIT-CRIS has been successful at the 3 of overall 140 institutes chosen as 'pilots', we are very optimistic that the remaining 137 institutes won't hesitate to participate. If not, the strategy based on 'pull-mechanisms' will have to be reconsidered following the motto *fortiter in re, suaviter in modo*.

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