



Development Model for Research Infrastructures

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Research infrastructures (RIs) are platforms integrating facilities, resources and services used by the research communities to conduct research and foster innovation. RIs include scientific equipment, e.g., sensor platforms, satellites or other instruments, but also scientific data, sample repositories or archives. E-infrastructures on the other hand provide the technological substratum and middleware to interlink distributed RI components with computing systems and communication networks. The resulting platforms provide the foundation for the design and implementation of RIs and play an increasing role in the advancement and exploitation of knowledge and technology. RIs are regarded as essential to achieve and maintain excellence in research and innovation crucial for the European Research Area (ERA).

The implementation of RIs has to be considered as a long-term, complex development process often over a period of 10 or more years. The ongoing construction of Spatial Data Infrastructures (SDIs) provides a good example for the general complexity of infrastructure development processes especially in system-of-systems environments. A set of directives issued by the European Commission provided a framework of guidelines for the implementation processes addressing the relevant content and the encoding of data as well as the standards for service interfaces and the integration of these services into networks. Additionally, a time schedule for the overall construction process has been specified. As a result this process advances with a strong participation of member states and responsible organisations. Today, SDIs provide the operational basis for new digital business processes in both national and local authorities.

Currently, the development of integrated RIs in Earth and Environmental Sciences is characterised by the following properties:

- A high number of parallel activities on European and national levels with numerous institutes and organisations participating. The maturity of individual scientific domains differs considerably.
- Technologically and organisationally many different RI components have to be integrated. Individual systems are often complex and have a long-term history. Existing approaches are on different maturity levels, e.g. in relation to the standardisation of interfaces.
- The concrete implementation process consists of independent and often parallel development activities. In many cases no detailed architectural blue-print for the envisioned system exists.
- Most of the funding currently available for RI implementation is provided on a project basis.

To increase the synergies in infrastructure development the authors propose a specific RI Maturity Model (RIMM) that is specifically qualified for open system-of-system environments. RIMM is based on the concepts of Capability Maturity Models for organisational development, concretely the Levels of Conceptual Interoperability Model (LCIM) specifying the technical, syntactical, semantic, pragmatic, dynamic, and conceptual layers of interoperation [1]. The model is complemented by the identification and integration of growth factors (according to the Nolan Stages Theory [2]). These factors include supply and demand factors. Supply factors comprise available resources, e.g., data, services and IT-management capabilities including organisations and IT-personal. Demand factors are the overall application portfolio for RIs but also the skills and requirements of scientists and communities using the infrastructure. RIMM thus enables a balanced development process of RI and RI components by evaluating the status of the supply and demand factors in relation to specific levels of interoperability.

[1] Tolk, A., Diallo, A., Turnitsa, C. (2007): Applying the Levels of Conceptual Interoperability Model in Support of Integrability, Interoperability, and Composability for System-of-Systems Engineering. Systemics, Cybernetics and Informatics, Volume 5 - Number 5.

[2] Mutsaers, E.-J., van der Zee, H., and Giertz, H. (1998): The evolution of information technology. Information Management & Computer Security, Volume 6 - Issue 3.