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Optimising Research Sharing in the European Research Area: Cyberinfrastructure, Quality and Open Access from the Technological Perspective

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The aim of this paper is to address the issues raised by Jean-Claude Guédon's position paper about Research Sharing in the ERA¹ from the technological perspective (which is the one I am more familiar with).

Herbert Van de Sompel, few year ago, in his presentations of the Open Archive Initiative², was used to introduce scholarly communication as a process influenced by four main interrelated factors: *economy, sociology, law* and *technology*. This factors are not independent, rather they mutually influence each other. In particular, economy, sociology, and law at different levels influence technology by continuously posing new expectations and opening new opportunities. In the attempt to satisfy these expectations, technologists often introduce innovative solutions that may go far beyond what was originally required, thus creating new conditions that, in turn, stimulate evolution and changes with respect to the other factors acting on scholarly communication. Hence, in this continuous process, technology often acts as a main springboard for innovation in scholarly communication.

The evolution of digital information objects, which are at the core of the current scholarly communication, well exemplifies this particular role played by technology. In order to enable fast retrieval of scholarly communication physical products (e.g. books, journals, video-tapes, archive folders) libraries started several years ago dealing with digital representations of bibliographic records. Soon after, the diffusion of Internet and of technological tools for producing born digital objects, progressively stimulated a radical change in the way in which scholarly communication could be performed. In particular, the availability of this new technologies opened the way to the new models of publishing, mentioned in the Jean-Claude Guédon's position paper, able to better respond to pressing needs for less expensive solutions and for faster and wider dissemination of knowledge. The revolution induced by these technologies is still on-going. Information object

¹ Jean-Claude Guédon, "Optimising Research Sharing in the European Research Area: Cyberinfrastructure, Quality and Open Access", in this volume.

² Herbert Van de Sompel, "The OAI and OAI-PMH", www.oaforum.org/otherfiles/berl_desompel.ppt

managing technology is currently evolving beyond the mere provision of objects as digital alternatives to traditional publications. It is now clear that digital information objects have not necessarily to remain restricted to the digital counterpart of the physical objects. Information objects composed of multiple parts, organized according to semantically different structures, can now be created. Each part can have a different type (text, videos, 3D object, time series, image, etc), bring static information or being a placeholder for information that is dynamically calculated, whether periodically or when the information object is accessed. The availability of these new information objects opens the way to *new forms of scientific communication*, much richer and more effective than in the past. These are expected to largely facilitate scholarly communication and, ultimately, the performance of research.

The real impact that this specific technology will actually have, also largely depends on how the other factors influencing scholarly communication will evolve. The spreading of the Open Access, movement, for example, will definitively amplify the effects of this new technology. Pushed by social and, especially, economical considerations, Open Access is currently one of the main driving forces for the *sharing of research outputs*. Initially conceived for the open dissemination of articles, it is now more and more been promoted also for the sharing of any research results, including experimental data. The combination of Open Access, the diffusion of the Open Source software, and the availability of new information objects, leads the way to the future envisaged by ERA. In this future, researchers will be able to easily share information, analyze and process it to validate the results by colleagues, and generate new knowledge that can be immediately conveyed back to the scientific community.

This vision of the future is very attractive for each of us. However, in order to be fully implemented there are other challenges to be met. How can sharing be implemented? How can applications building be enabled? How can sustainability be guaranteed? Again, the technology can play an important role in responding to these questions. In particular, a lot can be done by new emerging *Cyberinfrastructures*.

Cyberinfrastructures, or e-Infrastructures how they are now usually named, have been initially introduced as basic frameworks for facilitating resource sharing. Third-party services can exploit the resources and services offered by an e-Infrastructure rather than implementing them by themselves. From its initial conception, over the time, the notion of e-Infrastructure has been evolving to include more and more capabilities. *Economy of scale* is certainly the major driving force driving for this increased demand. The outsourcing of specific functionality to specialized infrastructures is generally expected to result in less expensive and better quality services. Data aggregation, curation, preservation are typical examples of functionality that single providers require to progressively subcontract to infrastructures. Other examples are highly data and processing demanding applications, like simulations or processing of large corpus of data for information analysis and extraction, that characterize challenging research scenarios. These applications are hardly, or even impossible, to sustain if implemented with ad-hoc resources. To respond to the requirements imposed by these scenarios, new types of e-Infrastructures, able to support the on-demand construction and operation of Virtual Research Environments activated on shared resources, have been recently developed. If successful, they will offer much more efficacious instruments for research. Moreover, by largely facilitating access to resources and by reducing the cost of the research, they will create the conditions for the *"excellence of research"*, as defined by Jean-Claude Guèdon. More easily than in the past, scientists having access to the e-Infrastructures will be enabled to contribute to excellence, independently of the nation where they leave.

As any other major technological revolution, these new e-Infrastructures will definitely induce also changes in economy, sociology and law. Major open issues still to clarify about the future

scenarios in which e-Infrastructures will operate are: “Which organizations/institutions will operate scientific e-Infrastructures?”; “Who will coordinate them?”; “Which model will regulate their sustainability?” “Which policies will regulate their interoperability?” The answers that will be given to these questions will largely influence the shaping of the European Research Area of the future.