

**INRIA Position Paper**  
**PPP "R&D centres" Workshop**

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This document summarizes the INRIA contributions as well as its potential role within the PPP. INRIA will involve a set of its leading world-class researchers with the objective to carry out research activities aiming at developing new highly innovative technologies needed to deliver new services for the society at large and based on the next generation communication infrastructure. Shaping the future information and communication society will require achieving the development of a new communication infrastructure that is far more than the network we know today as the Internet. Indeed, as networks are becoming ubiquitous, more and more objects of our daily life are connected making the Internet of objects. People will thus face the challenge of interacting with these objects, as well with other people, both in the real world and the virtual ones through the Internet. The Web has thus to evolve to a Web of Objects and People.

**INRIA research contributions to the PPP** will be on the following topics covering both the development of the infrastructure as well as the design of new innovative services.

**New infrastructure**

*Network foundations, models and metrology* – New theories of network architectures must be devised to gain a better understanding of the communication infrastructure behavior leading thus to a new mechanisms to better control the network. Enhancing analytical models, building realistic network simulators for very complex networks (ad-hoc, self-organized and P2P networks) are required to make progress achieving a more appropriate communication infrastructure for high-level services.

*Overlay and virtualized networks* – Such networks connect logical entities on top of a physical infrastructure using an arbitrary structure well suited to the required functionalities or the nature of these entities as well as any constraint such as the geographic ones. They represent a crucial logical serverless infrastructure enabling efficient routing, navigation and storage while characterized by nice properties such as self-\*, decentralization and scalability. Distributed algorithms have to be studied in such a context.

*Green infrastructure* – The next ten years will see an escalation in electricity consumption to support the communication infrastructure, to store and to process data using large-scale data centers. In 2020, the annual electricity consumption of ICT will reach 400 TWh. In 2035, Internet will consume as much as electricity as humans consumes today. If nothing is done, humans will compete against computers to get access to the electricity. The infrastructure should be

designed to be energy-aware with self-adaptive energy efficient networks and computing resource management.

*Coding, compression and representation of 2D/3D visual and audio content* – the networking infrastructure will host an increasing number of different types of devices used to get access to multimedia contents. This device heterogeneity, in addition to the usage patterns, will clearly impact the coding, compression and representation of visual and audio content, which will have to comply with bandwidth constraints while offering an increased quality of experience.

*Security* – Malicious software or malware, viruses and worms have become a major security threat in the Internet. New protection mechanisms have to be explored that benefits not only to those who are protected but also to the whole network.

*Privacy* – with the advent of the Web 2.0, Internet has mutated to a huge read/write platform storing data provided by users. Accessibility and privacy are fundamental lacks of the today Internet. Keeping the control of data to maintain the right for a user to modify and to remove data is of prime importance to preserve privacy as well as providing up-to-date information. New protocols will have to be studied and their correctness has to be shown from their specification to their implementation.

## **Innovative services**

Thanks to the Internet, computing is turning into a utility just as electricity or banking did in the past. Processing information and performing computation to generate knowledge can be done somewhere in the Internet, *in the Cloud* as it is known today. The past decade has witnessed a dramatic evolution of the nature of content available on Internet as well as an increasing growth of large data sets such as structured and unstructured documents, images and video. This evolution leads to the development of new services such as virtual environment, VoD, social networks and versatile or specialized search engines. This is however just the infancy and it is foreseen a very fast growing and innovative service market. INRIA will contribute to the emergence of new innovative services in the following areas:

*Search engines* – Access to contents require powerful and more efficient search engines with enhanced capabilities for automatic content enrichment and exploiting semantic metadata. To be efficient, search engines should more and more incorporate multi-modal processing and access technologies. Special effort need to be dedicated to large scale search methodologies facing number of users' communities, heterogeneity and diversity of distributed information sources, number of data attributes and features dimension. "The user in the loop" issue, involving mechanisms such as feedback, personalization, recommendations, collaborative tagging, interaction and learning, is an important topic that needs to be more investigated.

*Social networks* – Social networks will play an increasing role to structure and get access to relevant information and knowledge. But their developments are still at an early stage and much has to be done to understand their dynamics, to capture

relevant items for given users to provide user-centric search and to ensure effective delivery of useful content.

*Infrastructure as a service* – Provisioning the infrastructure as a service has been popularized a couple of years ago by Amazon thanks to its EC2 and S3. However this approach promotes again the concept of mainframe (i.e. data center) that represents a single point of failure within the Internet as well as problems of security and privacy. These issues have to be addressed and INRIA has taken a leading position by developing a large-scale IaaS research platform (Grid'5000) since 2003.

*Platform as a service* – The concept of service relies on the ability to create new services based on the loose coupling composition of existing services available through the communication infrastructure. Business processes, safe composition, design of complex workflows as well as the supervision of their executions are examples of research topics that have to be studied.

As described above, most of the main topics to be addressed as far as Research is concerned are represented in the INRIA landscape. Of course, choices will be made in order to further focus our participation according to the priorities of the PPP.

In the early phase, **INRIA will participate in a prospective effort** for the definition of scientific and technological priorities.

Another important role of INRIA within the PPP will consist in **establishing strong connections with the Knowledge and Innovation Community, EIT ICT Labs**, which has just been launched by the EIT. INRIA together with major players in Europe (Alcatel-Lucent, Ericsson, Deutsche Telecom, Orange France-Telecom, Philips, ...) is playing a key role in this new long term action uniting Education, Research and Innovation. We propose to work with our partners and EIT ICT Labs in order to further strengthen Europe presence on Internet and Services for the Future Information and Communication Society in the context of the PPP.