Input to Horizon 2020

Work Programme 2014

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Contents

Executive Summary

The objective of the paper is to provide DG CONNECT with a set of research recommendations identified by NESSI[1], the European Software and Services Technology Platform, as key for achieving the ambitious goals set out in Horizon 2020. As such, this paper aims at providing Software and Services input to the first Horizon 2020 Work Programme.

The content presented in this paper is the result of wide discussions within NESSI. It aggregates the input provided by NESSI Members through an online consultation, by the members of the NESSI Steering Committee and the recommendations of the NESSI Strategic Research Agenda.

NESSI has reviewed all activity lines described under specific objective Information and Communication Technologies of the Leadership in enabling and industrial technologies priority as presented in the proposal for a Council Decision establishing the Specific Programme Implementing Horizon 2020[2] and identified that Software and Services expertise is comprised mainly in two of these activity lines:

- Future Internet: Infrastructures, technologies and services;
- Content technologies and information management: ICT for digital content and creativity;

The NESSI paper is providing recommendations focusing on these two activity lines. The recommendations are structured around the seven following broader research areas for each of which a set of research priorities is suggested:

- Quality in cloud based heterogeneous service scenarios
- Service and software engineering
- Service usage in a fast changing business world
- New ways to increase software performance and energy-efficiency
- Software defined networking
- Security
- Big Data

The first 6 areas are addressing the activity line Future Internet whereas Big Data is mainly related to the activity line about Content and Information management. Further information is added for each of these areas in order to explain the assumptions and reasoning which led to the selection of each of these areas and what impacts their successful implementation would bring about for the sector as well as for the society.

1 Networked European Software and Services Initiative, www.nessi-europe.eu

2 European Commission, Council Decision establishing the Specific Programme Implementing Horizon 2020 - The Framework Programme for Research and Innovation (2014-2020), COM(2011) 811 final, 30.11.2102, Brussels.

Introduction

ICT including Software and Services is the central 'enabling technology that is referred to all across the Regulation establishing Horizon 2020 as well as the related Regulation establishing the Specific Programme Implementing Horizon 20203. Its presence all across the three priorities of Horizon 2020, the technology-driven Industrial Leadership priority, the application-driven Societal Challenges priority as well as its role in setting up a pan-European network of research infrastructures described in the Excellent Science priority, clearly demonstrates the enabling nature of the Software and Services industry both in other technology areas as well as in the applied areas. This reflects the fundamental importance of software as "the prime industrial differentiator and basis for innovation" as recognised in a report of the ISTAG4. NESSI welcomes this strong emphasis on Software and Services throughout all the three priorities of Horizon 2020.

One of NESSI's main objective as a European Technology Platform is to identify the research challenges that need to be addressed so that Europe can develop competitive advantages in the Software and Services area. In 2011, NESSI organised a consultation round asking its members to identify the main challenges as well as the main characteristics of future Software and Services. The results were presented in the 2011 update of the NESSI Strategic Research Agenda (SRA). At that time, NESSI members identified "the connected world", "faster business and technology cycles" as well as "the explosion of information" as the main challenges the software and services industry will face in the future. The main characteristics forecasted for the future of the sector were "interoperability", "security", "global access" and "adaptability".

These findings have been reviewed and updated in the light of Horizon 2020 and take into account the NESSI position papers on Cloud Computing and Big Data5.

"Cloud has reached virtually all areas of society and its impact on service development, production, provision and consumption is manifold and far-reaching. It lowers innovation barriers and thereby impacts industry, small and large businesses, governments and society and offers significant benefits for everyone6". However, properly preparing tomorrow's cloud challenges is crucial if one wants to unleash the full potential of the technology.

"The impact of Big Data gives not only a huge potential for competition and growth for individual companies, but the right use of Big Data also can increase productivity, innovation, and competitiveness for entire sectors and economies7." But in this area as well, one needs to prepare tomorrow's challenge in order to convert the huge potential of this technology into the real benefits for European businesses, citizens and the public sector.

3 http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=h2020-document

4 http://cordis.europa.eu/fp7/ict/docs/istag-soft-tech-wgreport2012.pdf

5 http://www.nessi-europe.eu/default.aspx?Page=position papers

6 NESSI, A Software & Service Perspective on the Future of Cloud in Europe, July 2012,

http://www.nessi-europe.eu/Files/Private/120718_NESSI_Cloud_WhitePaper_July.pdf

7 NESSI, draft white paper Big Data, a New World of Opportunities, to be published in January 2013.

Focus areas and research priorities recommended by NESSI

1. Quality in cloud-based heterogeneous service scenarios

Assumptions on technology level in 2015

In 2015, cloud-based service infrastructures will be well established and cloud services will be increasingly used by all sectors such as energy, health, or telecommunication. The global cloud market will have significantly grown (it is forecasted to reach a size of up to 250 billion €[8] in 2020) and SaaS will have by far the biggest share. However, improvements in terms of scalability, dependability and service quality in the broader sense will be required in order to consider cloud services a basic supply.

Objective

Investigate mechanisms, methods and tools to improve the quality offered by cloud-based heterogeneous service infrastructures. Quality aspects in terms of reliability, scalability or compliance with regulatory and legal frameworks have to be addressed. Sector-specific needs such as real-time and latency requirements or the protection of sensitive data must also be considered.

Research priorities

- Optimize SLA mechanisms by adopting an integrated end-to-end approach across different layers, including services, network infrastructures, devices and sensors;
- Adopt an extended view on handling SLAs, considering not only Quality of Service (QoS) related aspects, but also aspects such as compliance with regulatory and legal aspects, and interoperability, and investigate their impact on Quality of Experience (QoE);
- Investigate high-availability and recovery, including failover, backup, and disaster recovery mechanisms for complex service infrastructures;
- Advance standardized and open approaches for managing cloud resources, including computing, storage and network resources, in a coherent and automated way to improve efficiency and overall quality;
- Develop integrated, application-aware mechanisms able to address application-specific resource management and quality requirements.

Expected Impacts

- Increased awareness, trust and usage of cloud by European citizens, businesses and public actors up to a market size of 250 billion €9 in 2020 through improved reliability and quality of cloud-based service infrastructures.
- Full exploitation of cloud in tackling societal challenges through specialized and heterogeneous cloud service infrastructures with improved quality and adaptability to specific requirements of different sectors.

8 Quantitative Estimates of the Demand for Cloud Computing in Europe and the Likely Barriers to Up-take, IDC, 13/07/2012

9 Ibid.

2. Service and Software Engineering

Assumptions on Technology level in 2015

A new society and economy based on agile and dynamic collaboration between organisations, communities and individuals will shape Europe in 2020. Engineering tools for services and software development will be as common as word processing, spread sheets and presentation programs. Such tools will open up for massive production of in particular apps and alike.

Objective

The objective is to pursue the convergence between software, software-based services and data through a set of new technologies and approaches where also social sciences play an inherent role.

Research priorities

- Materialising Service Engineering: developing new ways for designing services through a multidisciplinary approach including management perspectives in addition to technical ones
- Community-based service engineering: Enabling communities and in general collaboration as the innovation engine of the next coming years through the study and development of technologies and approaches for building communities apps and supporting apps.
- User-centric, immersive and interactive environments: The goal is to directly involve end-users (professionals, administrative personals, individuals, and communities) in the creation of services and to support them in the evolution of their own models.
- Service development: designing fast and secure software development and deployment mechanisms in order to adapt known techniques to specific contexts, taking into account current developments (such as service-orientation, QoS, cloud-specific (quality) topics, IoT embodiment) as well as current and future trends which will add additional complexity to software development (performance engineering, adaptive systems) etc.
- Person-oriented interfaces and learning algorithms: integrate real time big data analysis as a mechanism to continuously adapt the behaviour of services to new circumstances of use (new location, long transaction, change of personal perspective).

Expected Impacts

- More easy-to-use services and more flexible software system by design through widening the scope of service engineering practices and the management of heterogeneous resources.
- Enabling innovation, invention, creation and deployment of new business models and jobs in all economic sectors and societal challenges through the creation of developer ecosystems and the empowerment of all kind of end-users.

3. Service usage in a fast changing business world

Assumptions on Technology level in 2015

In the upcoming years we will see an increasing number of businesses offering services in the Cloud on the IaaS, PaaS and SaaS layers. While standardization will occur more rapidly on the lower levels of the infrastructure, most of the growth in value creation will be happening in the PaaS and SaaS domain above the IaaS layer. This growth will be mainly driven by Big Data explosion that will provoke an increasing number of applications, being provided as business services in the so-called API[10] economy. Nevertheless, for saving storage and networking costs scalability issues will be crucial.

Objective

The objective is to address the growing needs of the society and various industry sectors towards the future architecture of the Cloud and its capabilities for continuous data and information processing. This has to be complemented by an appropriate platform strategy to build new and innovative (business) applications and services and to cultivate an ecosystem of innovative and agile companies providing these services.

Research priorities

- Federate platforms to virtualize from specific technical platforms (Web operating system)
- Federate heterogeneous data sources and real-time information streams
- Develop agent-oriented programming models for key users and end users to continuously aggregate and analyse (real-time) data and information from the IoT and Big Data
- Design contextualized information processing services and platforms bringing together information from various sources in real-time to provide the basis for a better user experience.
- Cultivate a European testbed bringing together platform technology and data to be leveraged by SMEs, prosumers, and citizens.

Expected Impacts

- Increased productivity for European businesses and their customers and improved support to users in managing previously complex tasks through access to services and information provided in an easy-to-consume form where contextual information will be seamlessly integrated into the user experience
- improved understanding by European businesses of their supply and demand service network through thorough analysis of (transactional) data,
- Access of European SMEs to new markets through deep and continuous customer insight by leveraging the platforms provided on the PaaS/SaaS layers.
- Sectors building upon the advances in the ICT sector such as healthcare, transportation, etc. will greatly benefit from the widely applicable technical advances in the services domain.

10 Application Programming Interface: an application in which a set of services are defined and reliably accessible.

4. New ways to increase software performance and energy-efficiency

Assumptions on Technology level in 2015

Green IT is a major differentiator especially for both mobile and IoT platforms to extend the battery life, and for data centres and communication networks to reduce operational cost. The increase in mobile computing and IoT as well as the growth in cloud computing and SaaS offerings will make energy-efficient and energy-aware software even more important.

Computational efficiency – i.e. getting computing tasks done quickly by applying for example more efficient algorithms and deploying concurrency – is one way to achieve higher energy efficiency. However, performance of software will play an important role not only for green IT, but also in solving complex computing problems, processing huge amounts of data, or meeting real-time requirements of software-based services.

Objective

The objective is to find new ways to improve the energy efficiency and to increase the performance of software and software-based services.

Research Priorities

- Develop new algorithms and programming paradigms resulting in better performance and higher energy-efficiency – for example by exploiting parallel processing capabilities, minimizing data movement, or providing virtualized real-time support;
- Design software models, languages, and tools to support parallel modelling and programming and enabling its widespread use within the software engineering community – for example to apply principles of data locality, and find new ways of synchronisation and scheduling.
- Engineer energy-aware software to improve power-efficiency of software systems and services – for example applying context information and pervasive computing in wide-scale scenarios, or developing scalable solutions.

Expected Impacts

- Improved take up of sectors such as cloud computing, Internet of Things or big data and improved competitiveness of the mobile computing industry through high performance and energy-efficiency of software and software-based services.
- Increased software performance will help solve complex problems related to societal challenges and will be a key differentiator for real-time services.

5. Software Defined Networking

Assumptions on Technology level in 2015

Software Defined Networking (SDN) is considered to be the key technology for turning the network into a service that enables to request network resources in a similar way as cloud computing allows on-demand requests for storage and computing power. This is achieved by the separation of control and forwarding plane of a network, by centralizing the management of network resources, and by programmable interfaces to access network capabilities at higher and more abstract levels. It is expected that in 2015 SDN concepts will be widely adopted in data centres and to some extent also in Wide Area Networks so that more flexible interconnections between data centres are possible and network capabilities will be controlled through extended cloud interfaces.

Objective

The goal is to fully implement the vision of a network as a service by applying SDN principles allowing innovative services by programmable access to network capabilities while keeping the network reliable and secure and improving its utilization and operational efficiency.

Research priorities

- Exploring the innovative power of an open and programmable network by developing added-value services on top of a centralized management intelligence provided by SDN. Possible services could address security issues or data synchronization between data centres (e.g. in distributed Big Data scenarios).
- Defining and unifying the right abstraction level for a programmable interface to network capabilities and its integration into a cloud environment as Network as a Service (NaaS) interface.

Expected Impacts

- Plethora of innovation opportunities comparable to the way how today's cloud provides an innovation platform especially for SaaS. Availability of SDN-based interfaces in wide area networks can support for example faster service introduction and their adaptation to changing quality requirements.
- Increased competitiveness for operating and using data centres, networks and cloud infrastructures together with mechanisms to avoid vendor lock-ins through unified management of network devices.
- Increased competitiveness for European businesses through the simplification and improved reliability of future networks architectures as well as the shortening of the development life-cycle of future network features and added-value services.

6. Security

Assumptions on technology level in 2015

By 2015 the proliferation of activities being developed through Internet both from local and mobile devices in every sector will end up with a tremendous amount of data generated and transmitted. These data contains sensible information (personal, health, financial, commercial) that are prone to misuse and consequently protocols for privacy preserving analysis, storage and modelling of the data would have been developed. Nevertheless, new ways of security monitoring and analysis would be required to increase the trust of every company (public or private sector) or individual user to make the Web a secure environment.

Objective

Prepare the new generation of trust and security mechanisms capable of taking up the challenges brought about by the future evolution of current technology trends such as Cloud Computing, Big Data, IoT and their gradual convergence.

Research Priorities

- Develop end to end privacy, anonymisation, new cryptographic technologies and context-based security in order to enable (big) data flows and scalable trusted identities federation;
- Foster cloud security with assurance levels through the development of hypervisors, virtual appliances and security abstraction layers for Infrastructure, Platform or Software as a Service multi-layer systems;
- Ensure digital and physical security convergence for the integration of real and virtual systems through sensors, IoT, embedded systems and by bringing “intelligence” within security procedures;
- Develop cybersecurity mechanisms for the detection of abnormal events (behaviour analysis, weak signals, analysis of heterogeneous information from multiple sources…), observation of attack patterns and creation of countermeasures stopping attack proliferation;
- Lay the foundations for the creation of a European Trust Label guaranteeing the trustworthiness of service-based systems.

Expected Impacts

- Mitigated impact of security threats for European citizens and businesses through improved awareness and understanding of existing and future solutions as well as easy-to-use and standardized tools.
- Strengthened European cybersecurity sector leading global understanding and handling of new security challenges imposed by the development and convergence of Cloud Computing, Big Data and IoT.

7. Big Data

Assumptions on Technology level in 2015

In 2015, the amount of data available is expected to be massive. Effectively managing, organizing, validating and analysing data constantly being generated, not only by use of internet, but also by companies generating big amounts of information coming from sensors, computers and automated processes will be one of the main challenges in this domain.

Advances in technology as well as new designs for databases and efficient ways to support massive parallel processing will help manage and store the data being generated. However, Big Data analytics solutions will be far from being integrated with hardware platforms and business processes.

Big Data analytics services impacting all types of organisations will have been recognized as a must for companies in every domain, public or private, nevertheless, the main challenge will still be to integrate the use of big data analytics processes as a basis for innovation and increasing productivity.

Objective

Investigate mechanisms, methods and tools to improve the quality offered by services to extract the hidden value from the massive amounts of data available and integrate it on the business chain for innovation. Aspects in terms of storage/processing/management not only of huge volumes of data and data streams but also of the models (knowledge) being generated have to be addressed. Context-awareness as well as mechanisms for integration of foreign data with own proprietary one and develop product services and processes will also be one priority. Sector-specific needs and protection of sensitive data and models must also be considered.

Research priorities

- Handle large amounts of streaming data, aligning the ability of data analysis algorithms towards the new constraints generated by the treatment of massive data collections (heterogeneity, multimodality, size, etc.).
- Develop analytics on mobile devices and the possibility of nearly real-time patterns discovery.
- Privacy and trust: develop methods and procedures for protecting sensitive data and models.
- Develop visual analytics, video and stream analysis
- Infer open data communities from evaluating both content and user relationships in social networks.

Expected Impacts

- Increased productivity as a consequence of data as a service integration as a basis for innovation supporting or even replacing human decision-making with automated algorithms.
- Easier development of applications that make use of massive data: making big data accessible to developers by developing easy-to-create applications out of pre-packaged modules tied to a big data backend in a cloud environment.
- More innovative business models and increased communication and collaboration producing innovative products and services.
- Increased visibility by ability to manage, search, analyse and reuse content and information.
- More effective public services by making use of web technology.
- Enhanced transparency and control of public services through the use of open data.
- Improved wellbeing of citizens by making use of ‘smart’ applications.