Strategic Research and Innovation Agenda

Version 2.0

Contents

Executive Summary

The objective of this paper is to provide DG CONNECT with a set of recommendations identified by NESSI[i], the European Software and Services Technology Platform, as key for achieving the ambitious goals set out in Horizon 2020. Recommendations are given with respect to research and innovation priorities for future activities launched in the context of Horizon 2020. Recommendations are also given with regard to the policies and instruments that should be applied for implementing and selecting projects. 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 former NESSI Strategic Research Agenda (2011).

NESSI has reviewed all activity lines described under the specific objective targeting the ICT industrial and technological leadership challenges and covering generic ICT research and innovation as presented in the proposal for a Council Decision establishing the Specific Programme Implementing Horizon 2020[ii] and identified that Software and Services expertise is comprised mainly in three of these activity lines:

- Next generation computing: Advanced computing systems and technologies;
- Future Internet: Infrastructures, technologies and services;
- Content technologies and information management: ICT for digital content and creativity;

The paper provides recommendations referring to these three activity lines. The recommendations are structured around the seven following focus areas for each of which a set of research and innovation priorities is suggested:

1. Quality in cloud-based heterogeneous service scenarios
2. Services benefiting from Programmable Networks
3. Service usage in a fast changing business world
4. Service and Software Engineering
5. New ways to increase software performance and energy-efficiency
6. Integration of Big Data Analytics into Business processes
7. Trust and security for global digital infrastructures and services

The first four areas are addressing the activity line Future Internet, the fifth one fits to the Next Generation Computing activity line and the sixth one is mainly related to the activity line about Content and Information management. Finally, the last area, trust and security, spans across all these topics. 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. These focus areas provide a certain structure of the identified research and innovation priorities, but should not be considered to be independent of each other. Actually they are interrelated – for example cloud computing heavily impacts the way how software and services are engineered and used, and security plays a role in almost all the other areas.

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 2020[iii]. 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 ISTAG[iv]. 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 and innovation 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 taking into account the NESSI position papers on Cloud Computing and Big Data[v].

"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 everyone[vi]". 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 economies[vii]." 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.

A. Focus areas and research priorities recommended by NESSI

This section presents the 7 main activity areas that NESSI has identified as necessary to research in the software and services sector in order for Horizon 2020 to achieve its ambitious goals in the ICT domain.

Each focus area is structured in the same manner. A first section outlines the technology outlook for 2015 in order to set the technology context in which most projects of Work Programme 2014 are likely to start their activities. The 'objective' sections outline the main goals to achieve in each given area while the research and innovation priorities outline what research or innovation activities have to be carried out in order to reach these objectives. Finally, the impact section draws up the main impacts that the different research and innovation priorities would have on the European citizens and economy as well as on the technology sector itself.

1. Quality in cloud-based heterogeneous service scenarios

Technology outlook for 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 € in 2020 – and SaaS will have by far the biggest share. However, scalability, dependability and service quality in the broader sense are still issues to be resolved in order to achieve the forecasted take-up of cloud services.

Objective

Investigate **Service Level Agreement (SLA) handling, resource management, and service development** mechanisms, methods and tools to improve the quality offered by heterogeneous cloud infrastructures in support of complex and mission-critical cloud-based service setups.

Quality aspects in terms of reliability, scalability, security, cost or compliance with regulatory and legal frameworks have to be taken into account as well as **sector-specific needs** such as real-time and latency requirements or the protection of sensitive data. Furthermore, advanced support for **agile development and deployment of dynamic applications and services** on heterogeneous clouds need to be investigated, in particular for optimizing the exploitation of cloud services in terms of quality and cost.

Research & Innovation priorities

Advanced SLA handling

- Develop machine-readable SLA's for more rapid discovery, comparison and monitoring of service capabilities facilitating the dynamic composition of services;
- Investigate fault and performance management, high-availability and recovery mechanisms, including failover, backup, and disaster handling for mission-critical services in the cloud;
- Take an end-to-end view across different layers – including services, network infrastructures, devices and sensors – and adopt an extended view on service level aspects to include not only quality of service, but also security, and compliance with regulatory and legal frameworks to improve quality of experience, interoperability and accountability in complex cloud service scenarios.

Integrated cloud resource management

- 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 and standardize integrated, application-aware management mechanisms able to address application-specific resource and quality requirements in heterogeneous cloud environments by applying intelligent monitoring, reasoning and self-learning, and dynamic adaptation methods.

Agile cloud service development and deployment

- Develop agile software engineering practices for efficient development and deployment of adaptive cloud applications and services on heterogeneous clouds supporting SLA compliance;
- Investigate and promote application software architectures that enable cloud deployments for industry verticals relying on mission critical applications.

Expected Impacts

- Resolving most critical issues around quality, security and compliance will help to increase exploitation of cloud services in Europe and thus will contribute to the growth of the European cloud market;
- Cloud services will be exploitable in tackling societal challenges through specialized and heterogeneous cloud infrastructures with improved quality and adaptability to specific requirements of different sectors.

2. Services benefiting from Programmable Networks

Technology outlook for 2015

Software Defined Networking (SDN) is considered to be a key technology for turning the network into a service that allows requesting network resources on demand via programmable interfaces. The integration of those interfaces into a cloud environment will add more flexibility and will provide new opportunities how applications can be provisioned in the cloud. It is expected that in 2015 SDN concepts will be widely adopted in data centres and to some extent also in Wide Area Networks (WAN). However, the full potential that programmable networks will provide to services needs still to be explored both in cloud environments as well as in WANs considering for example more flexible and service-oriented interconnections between clouds as well as optimized user access to cloud services.

Objective

The goal is to fully explore the benefits that services can gain by using programmable network interfaces allowing higher level access to network capabilities in cloud environments and in WANs.

Research & Innovation priorities

- Defining and unifying **appropriate abstraction levels and principles** (e.g. declarative, event-driven ...) for open programmable interfaces to network capabilities and their integration into a cloud environment; this will result into **common service models** allowing an **orchestrated and software defined access** to computing, storage, as well as networking resources in the cloud – this will allow for example higher degree of flexibility and consistency in configuring virtual networks especially for mission critical applications deployed in a cloud;
- Investigate **higher-level orchestration mechanisms** extending the usage of programmable network interfaces beyond a single cloud to enable **optimized service deployments in hybrid and heterogeneous cloud environments** and test these mechanisms in appropriate service scenarios – possible scenarios could be data synchronisation between clouds in case of Big Data services, the interworking of enterprise services across private and public clouds, or the implementation of redundancy concepts for high-availability services;
- Develop concepts combining cloud technologies with programmable networks to **optimize in particular mobile access to services and data** in the cloud – this will allow for better quality of experience in case of low-latency services.

Expected Impacts

- Open programmable networks will enable eco-systems offering a plethora of innovation opportunities for software industry as well as SMEs – new high-quality services and revenue streams can be introduced more quickly and at lower risk while keeping the network reliable and secure and improving its utilization and operational efficiency.

3. Service usage in a fast changing business world

Technology outlook for 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 further accelerated by the Big Data trend putting massive data and its real-time processing at the centre of many organizations. Furthermore, we expect that all of the aforementioned services will be provided as business services in the so-called API[viii] economy and realized the long-term vision of "software reuse" in the software industry.

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 and real-time data and information processing. This requires addressing the **scalability and elasticity** issues especially in **the PaaS and SaaS** layer. It has to be complemented by an appropriate **platform strategy** to build **new** and innovative (business) applications and **services**. Those technical objectives will only succeed if an **ecosystem** of **innovative** and agile **companies** providing these services is cultivated.

Research & Innovation priorities

Scalability and elasticity in the PaaS and SaaS layer

- Federate platforms to virtualize from specific technical platforms and thus allow a flexible integration of heterogeneous technical platforms
- Federate heterogeneous data sources and real-time information streams
- Utilize in-memory technology in appropriate PaaS services to address the needed scalability and performance requirements for massive data processing
- Address the convergence of high-performance computing and massive data processing for business and societal applications

Platform strategy for new business services

- 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
- Develop enhanced technical capabilities for advanced machine learning in the areas of Cloud management on PaaS/SaaS level and real-time event streaming and processing

Ecosystem of innovative companies

- Cultivate a European testbed bringing together platform technology vendors and data and information providers to be leveraged by SMEs, prosumers, and citizens.

Expected Impacts

- Core technical capabilities for the next generation of Cloud computing focussing on the real-time processing of massive amounts of data across various organizations and industries
- 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, energy, etc. will greatly benefit from the widely applicable technical advances in the services domain.

4. Collaborative Service Engineering based on convergence of software and data

Technology outlook for 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 processors, spread sheets and presentation tools. 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 for **collaboration**.

Research and Innovation priorities

- Materialise Service Engineering by developing new ways for designing services through a **multidisciplinary** approach **including management perspectives** in addition to technical ones
- Enable community-based service engineering via **collaboration** as the innovation engine and through the study and development of technologies and approaches for **building communities** and supporting apps.
- Create user-centric, immersive and interactive environments by **involving** directly **end-users** (professionals, administrative personals, individuals, and communities) in the **creation of services** and support them in the evolution of their own models.
- Design **fast and secure software development** and deploy 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.
- Realize **person-oriented interfaces** and learning algorithms by integrating 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.

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

Technology outlook for 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 and scalability – i.e. getting computing tasks done quickly by applying for example more efficient algorithms, deploying concurrency and scaling up and down services based on the actual usage – is one way to achieve higher energy efficiency. However, performance and scalability 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. Furthermore, novel CPU and memory architectures will have massive impact on future computing systems, their performance and energy-efficiency.

Objective

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

Research & Innovation priorities

- Develop method and tools to make it easier to get an **overview of the performance and scalability of complex systems**, so that performance and scalability refinement can be targeted at the weak spots and not on the whole system – this will balance development costs and other non-functional requirements like security on the one hand and performance, scalability and energy efficiency on the other hand;
- Develop new **algorithms and programming paradigms** resulting in better performance and higher energy-efficiency – for example by exploiting parallel processing capabilities, such as novel CPU architectures (e.g. built-ing FPGAs, GPUs) and novel memory architectures (e.g. non-volatile RAM or Phased-change Memory), 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, scalability 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.

6. Integration of Big Data Analytics into Business processes

Technology outlook for 2015

In 2015, the amount of data available from different sources (crowdsourcing, remote sensors, cameras, RFIDs, etc.) is expected to grow to 7.9 zettabytes, from 1.9 zettabytes in 2011. Effectively managing (classifying, validating and analysing) this data will be one of the main challenges in the coming years.

There are several open issues regarding the analysis of Big Data, from data acquisition and filtering, validation, privacy and security, near-real-time analysis, analytics on mobile devices, and database design for the facilitation of the analysis. Advances in technology relative to new designs for file storage and databases, and efficient ways to support massive parallel processing will help manage and store the data being generated. However, Big Data analytics solutions are still in their infancy, and there is no unified approach into the analysis required for each type of data, or how to embed the results of the analysis into business applications and processes.

By 2015, it is expected that Big Data analytics services will have been recognized as a must for companies in every domain, public or private. Given the advancement of technologies for managing Big Data, the main challenge will be to integrate the use of Big Data analytics processes as a basis for innovation and increase of productivity in all domains where they are to be applied.

Objective

The objective is to address the growing needs of storage, access and analysis of the amount of data and their integration in the business processes and associated value chains. This requires on the one hand developing methods for storage/processing/management/distribution not only of the data but also of the knowledge generated complemented with methodologies for systematization of the knowledge discovery process. Besides, implementation or adjustment of algorithms able to deal with context and resource constraints also forms part of this objective. Those technical objectives will only succeed if sector-specific needs and protection of sensitive and personal data are considered.

Research & Innovation priorities

Storage, processing, distribution

- Provisioning of Big Data warehouses where data providers and consumers can interact in new and innovative ways. Development of new methods for data warehouses so as to get full business intelligence value out of Big Data. New design methods will have to pay special attention to Big Data from a multitude of sources - from structured to semi-structured to unstructured - as well as to sources feeding data continuously in real time. Deployment of data marketplaces would be an example of applicability of such data warehouses.
- Data quality for Big Data – create models for validating data quality, introduce data validation tools to streaming and batch-oriented Big Data processing applications to provide data cleansing (down-sampling data/throwing away low quality data).
- Integration of contextual information and application of context and resource awareness techniques.
- Development of cross-platform components for large-scale data versioning and data access APIs.

Methodologies

- Development of methodologies supporting the complete process required to turn data (multimodal and heterogeneous) into knowledge, with emphasis on how to embed the resulting models into business applications and processes. Business cases should be developed for domains such as bio-medical, finance, industry, etc.

- Systematisation and automation of data pre-processing methods to facilitate the analysis (data filtering strategies, automatic metadata generation, validation strategies) so as to shorten processing time, and improve the possibility of near-real-time pattern discovery. This is also related to validation of data and removal or labelling of erroneous data sets.

Algorithms

- Development of novel algorithms and techniques to analyse in a timely manner massive multimodal and heterogeneous data collections (images, sensor-data, text from social media, etc.), shortening processing time and improving the possibility of near-real-time insights discovery. This will also aim at improving the analytical abilities of algorithms, and at handling constraints such as heterogeneity of data sources, multimodality, size, etc.
- Development of data mining and machine learning algorithms for predictive and prescriptive analysis (predictive models representing detected patterns, time series and relationships among sets of variables and metrics and prescriptive analytics being the chain of transformations whereby structured and unstructured Big Data is processed through intermediate representations to create a set of suggested future actions).
- Inference of open data communities from evaluating both content and user relationships in social networks and development of methods of analysis to integrate this knowledge with the one obtained from analysis of contextual and geographical information. Special attention will have to be paid to methods for user sentiment analysis.

Applications

- Development of analytics for Big Data-sets of video and images. Image and video analytics is the automatic algorithmic extraction and logical analysis of information found in image data using digital image and video processing techniques. The use of bar codes and QR codes are simple examples; more complex examples are facial recognition, position and movement analysis. Special attention should be paid to image and video analytics aiming at transforming big image and video data into higher-level constructs that can be analysed in progressive steps, each one adding value to the data. Examples are the analysis of medical images and integration with other health records, or in environmental studies, the integration of analysis from satellite images together with operational information for improvement of agriculture.
- Development of techniques to integrate biomedical records to give the capacity to store and process the vast amount of data (electronic health records, genome, pharmaceutical, clinical notes, …) to discover: i) biomarkers that help classify patients based on their response to existing treatments ; ii) biomarkers for early diagnoses (neurological diseases: Alzheimer, …), iii) patterns of patients to follow a particular protocol, treatment, … and pushing their results out to physicians in novel and creative ways.
- Development of methods for the interdisciplinary analysis of Big Data with input from areas like complex systems, game theory, evolutionary algorithms in order to understand/model the behaviour of complex systems (economics of a country, network of a CSP, a plant, a disease, an epidemics etc.).
- Software-as-a-Service systems providing deep text processing and integration with structured data (e.g. Linked Data) analytics.
- Efficient use of Big Data in Model-as-a-Service systems (e.g. in environmental prediction models, or large-scale simulation systems).

Personal data protection

- Privacy and trust: develop methods and procedures for protecting sensitive data at enterprise, government or national level. This includes guidelines for privacy respecting data mining algorithms.

Expected Impacts

- More effective and efficient approaches for producing and consuming large amounts of data.
- Faster and reliable integration of large data from structured, unstructured and real-time sources.

- Widespread use of Big Data and associated technologies in various decision-making domains, ranging from e.g. health to environmental to life sciences domains.
- Increased productivity as a consequence of the use of data analytics as a basis for innovation, supporting automated decision-making.
- 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 warehouse in a cloud environment.
- Increased communication and collaboration opportunities between collectors and consumers of data. Providing Big Data (raw or processed) via appropriate interfaces will mean that data collectors and consumers (analysers) do not have to belong to the same organisation or entity, and increase the opportunity for different parties to create value form data. In general, it will increase the visibility of information, which will lead to usage of information at a much higher frequency, outside the realm of a single enterprise.
- More effective public services and control mechanisms by making use of Big Data, in areas such as fraud detection and prevention, tax collection, economic forecasts and policy, monitoring of health care spending, security and threat identification, etc.
- Enhanced transparency of public services by making Big Data available to citizens.
- Improved wellbeing of citizens by making use of 'smart' applications. Personalized applications generating Big Data by monitoring health indices, sleep, sport and food habits in every detail, can help individuals create an environment and lifestyle promoting a healthy lifestyle, and provide early warnings of health hazards.

7. Trust and security for global digital infrastructures and services

Technology outlook for 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, transmitted and stored. These data contains sensitive 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 and solutions 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 & Innovation priorities

Research and develop core technologies to be used as foundations for secure-by-design systems

- End to end privacy, anonymisation and cryptographic technologies
- Software and hardware (processors, secured elements) based mechanisms able to implement different security levels by separated containers and sandboxing on end devices and IT equipment, to be used to develop end-to-end managed security environment (for applications such as payment, voting, dual use, bring-your-own-device policies, ...)
- Provable security development techniques that help reduce risk and protect individuals and organizations in the ever-changing technology landscape
- Mechanisms to allow the implementation and continuous evaluation of local and contextual Security Level Agreements), including guarantee that applications execute in a trusted environment (hardware, operating system, software layers) and ability for applications to adapt to the current security level at run-time

Design tools to ensure, validate, test, monitor and manage the security characteristics of large software based systems

- Basic research and tool development for testing and formal verification of SW, like code analysis, backdoor detection and runtime integrity protection
- Security modeling and analysis techniques and tools capable of efficiently tackling the complex interactions and dependencies in large complex digital systems, as well as the specific threats they face
- Cybersecurity mechanisms and tools for the detection of abnormal events (behaviour analysis, weak signals, analysis of heterogeneous information from multiple sources, observation of attack patterns …) - including advanced data mining and analytics or machine-learning techniques - and for the execution of countermeasures stopping attack proliferation and protecting infrastructures, data and services

Design and promote global solutions or frameworks for a secure services based economy

- Cloud security with assurance levels through the development of hypervisors, virtual appliances, solid trust anchors and security abstraction layers for Infrastructure, Platform or Software as a Service multi-layer systems
- Solutions to cope with the increasing threats (attacks, trap doors, malware, virus) on devices (currently mobile devices, possibly in machine-to-machine systems), including the development of

network based approaches moving the burden of detection and countermeasures from the end device towards the networks and servers

- Procedures and solutions supporting security related information exchange and collaboration between network or service operators, administrations and authorities, enterprises, end users (including automatic data anonymisation, security assessment and mitigation orchestration, trust enforcement, traceability)
- Research on the security impact of upcoming network architecture concepts, like SW defined networks, distributed core functionality, intelligent edge components and virtualized networks and on the solutions and standards for securing large digital infrastructures
- Solution to improve usability and context-awareness of security mechanisms in order to enable big data flows, seamless sessions between heterogeneous systems and services, scalable trusted identities federation, including adaptive and contextual security continuity for services
- 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

Launch initiatives to promote digital security awareness and maturity in Europe

- Lay the foundations for the creation of a European Trust Label guaranteeing the trustworthiness of service-based systems.
- Foster the development of security-as-a-service offerings that can complement the traditional on-premises or on-device security tools
- Foster the use of tools and services to empower end-users in managing their data and exercising their rights in the increasingly complex and information-rich digital environment
- Investigate how European businesses can efficiently implement upcoming cyber security directives, guidelines and standards and promote state-of-the-art solutions compliant with these directives, guidelines and standards

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.

B. Policies and Instruments

Recommendations:

Project Selection:

- **Open Calls**: Increase Open Calls based on idea and impact vs. constrained work program
- **Proposal Templates:** Strict, limited length, proposal templates to minimise proposal creation
- **Proposal Defaults:** Default proposal sections where only values or exception can be identified
- **SME Friendly Evaluation:** Evaluations/ors should be balanced towards business such as successful SMEs, Venture capitalists and web Entrepreneurs especially in SME areas
- **Anonymity:** Anonymous submission ensuring level field based on 'idea & delivery' not name.

Project Implementation:

- **Flexible Implementation**: Run-time easier reshaping of project DOWs and less "fear of change"
- **Mini-Projects:** Allow short time frame, limited budget, projects for fast-paced flexibility
- **Staged Projects**: Allow incremental(US SBIR) not only for SMEs but across all participants
- **2-Step**: Increase 2-Step instruments; Step I focusing on 'idea' and Step II implementation
- **Incremental Research**: Accept fusion of existing technologies for real use is a research goal

Project Instruments:

- **Innovation Prizes:** Provide innovation prizes based on reduced funding and rewards for solutions
- **Proposed Instruments:** NESSI Supports US SBIR-like and Eurostars enhancing instruments

As a complement to the input provided for the technical research areas presented in the previous section, NESSI supports several H2020 initiatives and proposes the following organisational and SME orientated instruments and policies to achieve the goals of Work Programme 2014. In summary NESSI propose concrete options for both simplification and SME inclusions which also take into consideration that Software and Services have a very different innovation cycle as opposed to the e.g. telecommunication network technology. The latter may take up to ten years for market introduction and broadly follows a waterfall approach whereas software today is based on agile, short and focused cycles in which prototyping, testing, validation and pilot activities constitute a large part of the process. Its user-oriented nature makes it particularly sensitive to market changes.

Therefore a Commission support programme for research and innovation for software and service technology needs to have a similar character and allow fast implementation and flexible adaptation of projects. NESSI thus believes that the existing instruments like STREPS and IPs need to be complemented by instruments and a selection processes that enables the European innovation intensive industry to become globally competitive.

High-tech research intensive SMEs (and web entrepreneurs) can be the essential bridge between novel ideas from science and industry on one hand, and marketable ideas on the other. As such, SMEs are instrumental in providing smart, easy-to-use, affordable technology but there are certain implicit barriers that minimise the uptake of SMEs into projects. By the Commissions own pronouncements it is estimated that 99% of organisations are SMEs, 65% of the work force are within SMEs, and the majority of Innovation comes from SMEs…but even in H2020s own communication it suggests that "15% of the total combined budget for all societal challenges and the enabling and industrial technologies will go to SMEs". Clearly there is a large discrepancy and a low ambition for SME inclusion which should be addressed. NESSIs SMEs have advised they do not fundamentally need specific SME instruments, although these surely help, but primarily advocate an approach which create a "level playing field" for SMEs throughout all instruments. Thus, the following is proposed:

1. Project Selection

Open Calls: While there is sense for structured programme setting there is also clear need for bottom up project definition (similar to FET) accompanied by fast proposal-to-contract-to-delivery cycles. This allows industry in particular to focus on the 'current' needs of the market rather than needs of past-years which take time to emerge in formalised work program setting where the call text and its wording is the main frame for the evaluation. This could be implemented through both specific open calls for innovation and allowance for specific objectives to be more open. This should then ideally be accompanied by a rapid proposal process that would make it possible to efficiently seize market opportunities since selection would be according to innovation potential and market prospect without having to wait for a hopefully adequate objective text.

Proposal template: In ICT Call 10, Objective 4.3, full STREP proposals were invited which would be a hard maximum of 20 pages with an understanding that any excess would not be read and would in fact cause the whole proposal to fail the eligibility criteria. This strict approach is similar to the successful character-limited approach of "Eurostars". The availability of such an approach is highly beneficial and is another way to ensure focus and to minimise proposal resources. NESSI highly encourages this approach to be adopted by all H2020 themes.

Proposal defaults: As an accompaniment to the aforementioned proposal template, NESSI would however suggest to go a stage further and allow some proposal sections to be standardised (defaulted) where only some property values or exceptions are filled in – for example the project management section and IPR sections are prime candidates.

SME-friendly evaluation: Evaluation procedures that accommodate the specific character of SMEs should be considered. Evaluation should focus more on idea (Criteria 1a) and impact (Criteria 3) and in particularly the state-of-the-art advancement may be reduced (Criteria 1b) along with possible the S/T methodology (Criteria 1c). Further, it should not be assumed that impact can only be made by large organisations when a bright idea by a small company can equally "change the world" if well implemented and nurtured. The criteria would thus be better as; 1:Idea, 2:Science, 3:Plan, 4:Management, 5:Impact and Dissemination and 6:Exploitation and where SME projects would focus more on items 1 and 6 and significantly less on 2. In conclusion evaluations and evaluators should be more balanced towards exploitation and business orientated needs including further promoting innovation orientated evaluations such as successful SMEs, Venture capitalists and web Entrepreneurs.

Anonymity: Regardless of a "bright, innovative idea", SMEs and web entrepreneurs are strongly hampered by an obvious "impact-doubt" since neither company names nor credibility are known, which favours the entrenched and larger players. Anonymity would allow all players to be treated on an equal and non-discriminatory basis. This can be well-coupled with the aforementioned 2-step process with Step I being the 'anonymous idea' and Step II being proof of achievability and impact.

2. Project Implementation

Flexible Implementation: Europe needs to speed-up and ensure flexibility in its research and innovation programme especially in the dynamic ICT sector related to NESSI. H2020 Instruments should allow beneficiaries to focus not only on the contractual achievement of results/deliverables, whilst assuring proven economic efficiency, but importantly allowing them to be responsive to technology developments and evolving market needs. In particular, SMEs should be allowed to be more business target-oriented in the execution of the project without changing its overall goals. This could be achieved by allowing the run-time re-shaping of research projects with significantly less bureaucracy than the current formal DOW changes and moreover also educate to remove the current

'fear' of changes to work plan. . Hence, a revision of a DOW under today's regime is a cumbersome process both for the Project Coordinator, and the Consortium, as it is for the Commission.

Mini-Projects: SMEs typically plan on shorter time frames than the research organisations of academic institutions and large industry. Thus, short time frame, limited budget projects should be accepted for fast-paced flexibility. There could be specific instruments for this but preferences is to allow, educate and integrate this as part of the 'normal' process versus the current assumption that if, e.g., a strep is not a standard "3 year, 3M€ and 7-8 partner" submission then somehow it is substandard.

Staged projects: It has been suggested that a new instrument will be adopted similar to the US SBIR mechanism (Small Business Innovation Research) where there is a call for ideas to resolve some specific research/technical/societal challenge, where some of these are then sponsored with seed corn funding, then the best ones from these are selected for further funding based on their results. Finally, in a final third stage, one (or few) projects get major funding for further development. A so-called: feasibility, grant, commercialisation model. NESSI very much encourages this idea since as per the options presented above, it reduces the amount of work, focuses on the innovation idea, and focuses on the exploitable outcome to resolve specific problem. NESSI would like to see this instrument fully deployed throughout the work program and not only for SMEs as is currently suggested.

2-step proposal: The amplification of use of 2-Step proposal instruments, typified currently in FET and also under other thematic programs of FP7, would spare considerable efforts invested in drafting proposals and allow focus on the "innovation idea." FP7 statistics show that 55% of proposals submitted under the ICT Theme (Call 1 to Call 9) did not even reach the threshold in their evaluation demonstrating such wasted resources. A 2-Step proposal would allow minimising these efforts and reinvesting them in the real economy. Step 1 would focus on the "idea", Step 2 would focus on the "implementation" through work plan, management and impact etc.

Incremental Research: Todays evaluations are focused on significant and future-looking progress in state-of-the art. However, there are many research challenges which need important incremental changes to make them marketable and/or where the challenge is in the "fusion of technologies for real use" and not so much specific research or deep technical advancement of use in a decade's time. This is valid for industry in general, and particularly for SMEs; since both need to ensure their research investment has close-to-the market outcome. Whilst such activity is valid in a generic context, often the 'use-case' element will be stronger to ensure wide applicability and market lead demands and in addition consideration should be given to allow more expansive paid trials without necessarily more beneficiaries (partners) being involved. Thus instruments/evaluations should be shaped to accept valid, incremental, impact-based research and ensure projects are not penalised by reduced future-looking scientific goals.

3. Project Instruments

Innovation Prizes: Innovation could be fostered in specific areas or on specific and precise topics identified by the European Commission, and representatives of relevant stakeholder communities or business sectors, as having high market potential but where certain inhibitors hinder usual market seizing mechanisms. The funding to achieve these solutions could be reduced or spread to many (small) consortia but matched by a reward for 'winners' who would be the most efficient in producing exploitable results that resolve the problem.

Proposed Instruments: NESSI, and its SMEs particular, welcome the "SBIR-like" new instrument mentioned above and also the suggestion to build upon the successful Eurostars program. In terms of the latter, it is important to keep Eurostars minimalistic administration and its impact related mission

but at the same time bring it under the same H2020 umbrella involving all countries and with relatively similar procedures during proposal time thus ensuring rule-simplification (one set of rules).

Kick-Starts: The "Fear of Failure" concept for new enterprise is well documented especially compared to the US entrepreneurial mentality. Europe has always had idea-generating people and skilled professionals but the actual enterprise formation and go-to-market has always proved difficult. Whilst the EU is putting great efforts of venture-capital-like financing instruments it is unlikely these will have big impact to start-up SMEs particularly web entrepreneurs. There are many ways to get start-up financing but in a lot of cases this financing is "only" a loan which needs to be paid back after a few years. Of course this is understandable from a tax payer perspective but it really hinders the foundation of start-ups because people always worry that they might end up significant debts in case that they fail. Yet Europe is prepared to handover significant amounts of money in research programs to existing companies. A proposed solution would be to offer easy access to financing WEs, including guidance from those professional that have completed their main business life and would like to invest in the future, and –if- they are successful, then they need to pay e.g. 50% back after 5 years plus a bonus to the investor. And if not then they do not need to pay it back. This would allow WEs to really kick-start without having to worry about financial debts in case that things do not work out and in terms of financial outcome would most likely increase start-ups and employment for significantly less money than the corresponding about if spent within pure RTD projects

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

ii 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.

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

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

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

vi 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

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

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