

The Future Internet: A Services and Software Perspective Draft to be reviewed by a working group in Bled

Radical new patterns of Internet usage are beginning to transform the Internet itself: from a mechanism to exchange information to a “global” system composed not only of the required networking infrastructure, but also of all the ICT stakeholders around it. This new artefact is still evolving and soon will also encompass the context of use itself, i.e. the consumers and providers of services in a unique and full continuum where roles may continuously vary. We can regard this continuum as a complex interaction of billions of different devices, billions of actions, and billions of stakeholders communicating and operating in a highly unconstrained environment. The vision, for the next ten years, is that every single electronic device will incorporate interaction capabilities supporting the provision of services to both devices and people within continuously changing scenarios appropriate to specific business needs and situations in a continuum which *de-facto* defines the new global system. We emphasise that this new global system is no longer purely computer based nor fulfilling the role of an information exchange system as characterised above. Rather, the *raison d'être* for the new global system is to dynamically and proactively support the operations of businesses organisations and the everyday life of citizens and in a seamless and natural fashion. Technically, the system will be far more than the simple merger of the original ingredients: a simple network to exchange Morse code (i.e., communication); and punch cards which were invented to semi-automate the creation of textiles from yarn (i.e., computing); in essence a new quality of facilitating human cooperation through automatisisation. We call this new system the “**Future Internet**” the main peculiarities of which are:

- **openness**, to ensure that all organisations and individuals have the possibility to take full advantage of the available technologies related to the access and offering of services;
- **scalability**, to ensure that organisations and businesses of all sizes are able to create, manage and use a platform which integrates billions or trillions of entities;
- **dynamicity and proactiveness**, both services and service requesters may appear and disappear at any point in time and services should smoothly adapt to (potentially) constantly changing scenarios and contexts;
- **no central control and governance**, as the complexity, size, distributedness and heterogeneity of the system dramatically increases new approaches to management are required in order to extract business value from utilisation;
- **partial predictability**, the sheer multitude of items comprising this new perspective coupled with the dynamic nature of their interaction and the distributed nature of their coordination prohibits a predictable global behaviour for the overall system.

The **Future Internet** can be viewed from several perspectives, one of which, the focus of the discussion in this document is now commonly coined the “**Internet of services**”.

Internet of Services

In the context of the Future Internet, the key goal of the Internet of Services is to pursue the achievement of a “Continuity of services”. Continuity of services has two main perspectives, namely: the service consumer and the service provider perspectives.

- Service consumers look for “Perfect interactivity”. Where by “perfect” we mean permanent (i.e. interactivity at anytime), transparent (i.e. the service consumer need only concentrate on the benefits of the service he/she is using), seamless (i.e. the interaction is performed using “typical” devices appropriate to the current context), and trustworthy (e.g. secure, private, and safe).
- Service providers require new approaches to management where the complexity of the central control principle is shifted towards the simplicity of the approach to keep the consistency of each service.

Inline with the above the Internet of Services will support and stimulate creativity, community and commerce. It will feature semantically-enriched services centred on the user. Additionally, services will enable the deployment of the Internet of Things. The Future Internet will lead to demand for innovative services characterised by seamless access, personalised cross-media streaming, “software-as-a-service” (SaaS) and “resource-as-a-service” (RaaS). New revenue models will emerge enabling commercial usage and powerful personal and community spaces. Virtualisation will be used for increasing the efficiency of infrastructure use, extending the scalability of platforms and encouraging the widespread creation of organizations. Services will increasingly bridge real-virtual life. Also, issues such as interoperability will be treated like services.

Main Research Issues on Software and Service Platforms

New alliances amongst traditional IT industry, telecoms and mobile service providers, media corporations, suppliers of consumer electronics, search engine companies and other powerful players will drive the deployment of the Future Internet. To achieve this they will have to reach a series of deployment objectives:

- Service platforms will have to enable automatic service discovery, description, composition, and negotiation; SLA management and QoS; access rights and customer charging. Moreover, service aggregation platforms will be need to be capable of publishing 3rd party service provider services.
- Service engineering: Methods and tools will be required to enable faster development and support the evolution of higher-quality lower-cost services.
- Service Front Ends: Requirements here include high-level, functionality-aware, network-agnostic infrastructure; exposure of user session state information (including the provision of session management API); service brokering functions are required to allow the seamless blending of services.
- Virtualised service delivery platforms: Virtualisation of service platforms will allow the same service to be developed once and executed on top of different platforms and will need to support service access and delivery environments.
- Service platforms will need to manage opportunities for real-time multimedia.
- SOA-Grid coupling will extend SOA for enterprise, embedded, pervasive and real-time systems and provide technology-independent standards for interoperability.
- End-to-end solutions for instant, context-aware and personalised service creation will be necessary.

Cross domain Future of Internet Challenges (content, security, network infrastructure, etc.).

- **Scalability:** The increasing scale of the Internet brings new challenges in a number of areas. Examples of these challenges include: modelling, validation and the verification of business processes built on top of SOA; the flexible evolution and execution of business processes; data, process and service mediation; the reliable management of composed services; and brokering, aggregation and data management. Quality of software is an important factor in all of the above and will become essential to the smooth operation of the 'service universe'. Approaches to tackling scalability include *openness* - lowering the barriers to entry; and semantics – enabling the mechanisation of certain tasks currently carried out by IT developers.
- **Trust:** Creating trusted environments for the new service world will require: i) mechanisms to monitor, display and analyse information flows between nodes participating in complex collaborations in order to detect and assess security risks; and ii) mechanisms to ensure trust and confidence in services created by end-users themselves, i.e. built-in safeguards and guarantees to maximise the trustworthiness of the new services. In addition, it is necessary to bring about changes in perception. P2P services today are too often associated with activities of doubtful legality, such as the illegal trading of copyright-protected content. Technical and legal mechanisms which encourage law-abiding attitudes need to be developed. Additionally, languages and standards for representing and managing trust at scale are important here.
- **Interoperability:** This applies at many different levels: i) service interoperability to provide an automated capability to integrate stand-alone services with services which are similar or complementary, for instance from a related business domain; ii) data interoperability, so as to provide the automated understanding of the information exchanged and ensure the overall quality of the service; (iii) interoperability of the service layer with the network and application layers of different providers. Also, semantic interoperability is important from a quality of service perspective in order to facilitate composition and middleware support.
- **Pervasive Usability:** services will be exploited by end users through different devices in different contexts of use. This will require the development of flexible mechanisms for adapting the user interaction to the current context of use while providing consistent user interfaces. Moreover, it will require the maintenance of state within user sessions even when a change of device is involved. This feature will support users in seamlessly carry out their tasks through different devices in a manner more natural than possible presently.
- **Mobility:** Instant, on-the-go service creation and the provision of fixed-mobile service convergence in a wide sense, personal context efficient utilisation and discovery, ease of accessibility and mobile-to-mobile communication in a distributed, volatile platform are some of the issues to be analysed from a service perspective.

To achieve these Cross domain Future of Internet Challenges we need to align views, actions and strategy between the Telco, media and IT worlds to ensure that European players, existing and emerging, acquire a leading competitive position in future global markets.

Questions

- What will be in the network and what in the service layer? How will content and media impact be addressed?
- How do we address the likely architectural differences between Telecoms, Media and IT service platforms?
- What is the scope of an open service framework? What are the security and trust implications? How to best address standards issues?
- How will we personalise and contextualise applications for individuals and empower them to compose their own services?
- Do we need to rethink current business processes in light of the upcoming Internet of Things? What are the implications from a service architecture perspective?
- Will this lead to a lowering of the barriers for service development and a repositioning of the industrial players or opportunities for new players?

Actions

- Document to be reviewed by the Working Group members.
- Common deliverables to be defined.
- Define Format for working group.
- Select chairs of working group.