# Future Internet Research: The EU framework

Dr. J. Schwarz da Silva
Director "Converged Networks and Services"
DG- Information Society and Media
European Commission

*The views expressed herewith are purely those of the author and may not necessarily be regarded as stating an official position of the European Commission*

## INTRODUCTION

The idea that today's Internet uses are pushing its original architecture and design philosophy into realms that were neither anticipated nor easily accommodated has been gaining momentum, the overriding concern being that the functioning of the global networked society and economies, is likely to be severely impaired.

There is no doubt a critical role to be played by countries and research funding agencies in this debate. However, the definition and correct positioning of these entities in the debate is closely related to basic underlying principles governmental institutions can agree to frame the developments of future network technologies and architectures. It is indeed clear that Internet architecture is today facing several challenges, many of them being related to scalability issues in view supporting an ever growing number of users, devices, service attributes, applications, contexts, environments, security, vulnerability, networking technologies to name a few. Still, existing architectures are based on a number of features and characteristics that have proved to be very valuable from an economic and policy perspective:

- The distributed architecture of the Internet, opposed to earlier star topologies such as those of public telephony networks or SNA/SDLC data networks has opened the possibility to a virtually unlimited number of actors to contribute as users and service developers, hence boosting innovation and economic growth;

- The end to end characteristics of the architecture has enabled to place intelligence at the periphery of the network, with the subsequent capability of making the Internet a neutral platform enabling any user to offer new content and new services thereby opening the way towards collaborative usages as currently developing under the "Web 2.0" wave;

- The open architecture of the Internet, based on standardised technologies has facilitated  large scale interoperability and early globalisation of services and applications;

- The "neutral" access characteristics have enabled various networking platforms and providers to offer competing access paths to the Internet, and contributed to the "infrastructure competition" objective that has been recognised by regulators (EU[1] and OECD[2]) as an important tool to catalyse the deployment of modern (e.g. mobile and broadband) networks;

- The clear layering from a network, service and content perspective[3] have enabled competition and innovation to flourish at different levels of the value chain whilst at the same time opening new opportunities for innovative business models;

- Even if security and resilience aspects have been questioned, today's Internet architecture has demonstrated a good level of resilience to physical network disruption (e.g. through build in alternate routing capabilities of packets). The recent incident in Taiwan is a good example of such resilience, as the subsequent disruption has been essentially limited to Asia.

The European Union has clearly outlined its adherence to the openness, interoperability and end to end principles, governing the Internet of today notably on the occasion of the recent World Summit on the Information Society held under ITU auspices[4]. From an EU perspective, it is hence deemed necessary that any further redesign of the architecture of global networks will have to respect these basic principles and characteristics. The adherence to such basic principles is clearly an area for international co-operation at both technological (saying what is possible) and policy (saying the requirements) levels.

On the other hand, it can be observed that many forces and interests are at work to modify the Internet architecture in a way that may not be fully compatible with these principles:

From an ***economic*** perspective, the move towards NGN by established constituencies represent an attempt to reinstate some form of centralised control within an inherently distributed architecture. The risk is not negligible that gatekeeper or lock-in situations may develop, the net neutrality debate being one particular illustration of the problem at hand. Whilst this issue is primarily of concern to national regulators[5], there is no doubt that international co-operation and partnership at both technological and regulatory levels will be beneficial;

From a ***technological*** perspective, approaches such as those discussed within the "autonomic communication" initiative may bring in additional complexity within the network that could

potentially damage the end to end characteristics of today's architectures.

From a ***political*** perspective, as the Internet is increasingly becoming a "critical infrastructure", security and robustness of the Internet are naturally becoming issues of major concern. These concerns may find their solutions in closed forms of Internet connectivity through the emergence of secure islands or of restricted connectivity, hence breaking the openness characteristics of the Internet.

## Key Concerns of European Commission

The European Commission has systematically called for the Internet to remain a vector of freedom of expression, to contribute to economic development policies, and to support multilingualism. This has notably been reiterated on the occasion of the first meeting of the Internet Governance Forum in Athens last October[6].

From an EU perspective, it is clear that these issues, when applied to future Internet architectures, can only be addressed in a multi lateral perspective combining at the same time the technological and the policy/regulatory perspective. The approach of systematically combining network technological development with policy issues has been and will continue to be systematically pursued by the technological R&D programmes sponsored by the European Union.

## Governance - Addressing, Indexing, Object Identifiers

An important aspect of multi lateral partnerships and cooperation is the one relating to governance of future architectures of global networks. The governance issue has crystallised around the DNS issue on the occasion of the WSIS discussions. DNS being one of the few centralised elements of the Internet it has become one of the major network services. The European Union has strongly supported a multi lateral, transparent and democratic framework for the supervision of such a critical infrastructure that might need to significantly evolve.

Addressing has for a long time been identified as a serious limitation of the Internet (with clear proposals being made by organised fora and the European Commission to move towards IPv6). The future may call upon additional work on addressing in light of the emerging requirement to consider different levels of addressing. While a network address is still required to reach the destination, such a network address may not be fully adequate at service and application levels. For example, a user may wish to gain access to information without being aware of the device or devices where the information is stored. A user may wish to locate objects by their name or a set of descriptors and act on them regardless of where they are located at any given time. Users may wish to address service elements to recompose novel dynamic services.

The current strong link between application/service level addressing and network addressing is already an inconvenience for both legacy applications and a hindrance to the development of new services including the generalization of innovative mobility concepts and dynamic service composition. The identities of users and objects (terminals, sensors, actuators, all types of electronic device), application identifiers, flows identifiers and network addresses (locations) may have to be defined independently within a global unified architectural approach. Such an address de-layering would also support a migration from *multi-service networks to multi-network services[7], with services composed from* external facilities, e.g. like time and position information obtained through the Galileo satellites.

The requirement towards new forms of addressing is already illustrated today with the emergence of object identifiers (RFID) and of the related governance structure materialized with the ONS[8]. Further evolution towards a multiplicity of identifiers for services, persons, flows, applications, and devices will only add to the complexity of finding an optimal globally acceptable governance structure.

As technology evolves, new forms of addressing and indexing content also emerge. Search engines are already today major economic and strategic constituents of the global network. Neutrality principles will also probably need to be addressed more globally, taking into account that search and page ranking algorithms are not necessarily "neutral". Content indexing tools and indexing strategies will hence get accrued importance in the search for a democratic and transparent handling of information, especially in an era likely to be dominated by user generated content. These technologies do potentially have a considerable impact on the way cultural and multi lingual content is handled and is made available as illustrated by the European "Digital Libraries"[9] project.

## The need for Multi Regional partnerships and cooperation

Multiple regional initiatives are currently emerging in view of defining future global networks. Japan and Korea have made public their ambitious u-Japan and u-Korea initiatives, China is supporting the domain through an ambitious and integrated industrial policy, in the US the GENI programme and facility is a key contributor to the debate on the future of the Internet. These initiatives are not all tackling the issue of the Internet evolution as part of their core objectives, but are certainly related to technological and socio-economic scenarios (ubiquity, connected devices) that will clearly need to be taken into account when addressing the Internet of Tomorrow.

Through its R&D Framework Programmes, the European Union has been for a long time an active supporter of R&D projects directly related to the evolution of future networks, and dealing with RFID/sensor networks, advanced mobile and broadband architectures, reconfigurable and ad-hoc network and service platforms, self configuring networks, context awareness to name a few.

From an EU perspective, it would be beneficial to build on these regional initiatives and create the conditions that would bring about a closer complementarity and cooperation between all actors associated to the definition, testing and validation work. Such co-operation have already been practiced under the EU Framework Programme, notably on issues such as 4G mobile, mobile TV, GRID, Open Source Software, or RFID applications. Under the upcoming 7th Framework Programme [10], additional opportunities will be opened to continue such international partnerships and co-operations.

One of the main objectives of multi lateral partnerships should be the emergence of global standards. Standards are indeed a key

element to achieve interoperability and openness, two of the essential Internet characteristics that have contributed to its success. The European Commission has in particular noted the need to foster the setting of open and interoperable global standards, and is committed to make proposals in that direction[11].

The ever growing multiplicity of players as well as the convergence of different sectors has lead to increased complexities in the standards making processes as illustrated by debates on IPR portfolios, as well as on the degree of openness, transparency and access. The European Commission supports the fair remuneration of R&D investments through IPR as one of the possible IPR models and is putting strong emphasis on improving IPR enforcement in key third countries[12]. Improvements of the framework for intellectual property protection are visibly on the agenda of the Commission[13]. Early co-operation and international partnerships on novel technologies are hence key to facilitate broader consensus, early agreements on standards by the key players while holding the promise to alleviate subsequent IPR disputes.

An important point to note is that the new economy created by the Internet is producing beyond a business revolution a unique opportunity to generate enormous environmental benefits, particularly if the right technological choices are made at the level of the infrastructure. In addition by reducing -often dramatically- the amount of energy and materials consumed by business and by increasing overall productivity, the new Internet holds the promise to revolutionize the relation between economic growth and the environment[14].

## What is the EU research approach to the Future of the Internet

As part of the process leading to the definition of the scope of activities to be launched in the context of the 7th Framework Programme of R&D, the European Commission has facilitated the creation of a "Future of the Internet - Think Tank" tasked to provide a position paper that could help framing future co-ordinated actions EU level, in view of developing a consistent programmatic approach for the coming years, both from technological and policy perspectives. While a significant part of the R&D activities of the 6th Framework Programme (2002-2006) already address issues directly relevant to the problematic of future global networks, it was indeed felt that future activities under FP7 would benefit from a more systematic and co-ordinated approach. As a result of this work, the "EIFFEL" white paper[15] identified the following drivers framing the future technological developments:

- The increasing pervasiveness of Mobility and Wireless technologies;

- The soaring number of connected devices, eventually leading to sensor networks and the "Internet of things";

- The insatiable demand for bandwidth, and underlying "unlimited capacity" core nets;

- The accelerated race for processing power and memory increase, continuing to support the trend of more and more intelligence at the network periphery;

- The expected heavy increase in digitized media, user generated content and associated critical requirement for data search, handling, and organisation.

- Location determination, as an important enabler for new categories of context aware services;

- End user provided infrastructure and services, possibly driving a "user generated" infrastructure, similarly to the trend towards "user generated" content;

- Security and resilience of the infrastructures, associated to growing concerns for privacy in an environment where users (or their attributes/avatars) will have multiple identities and identifiers;

- More and more intelligent devices with self adaptation/context awareness characteristics;

- Service adaptivity, and service configurability, with service platforms providing the agility for ad-hoc coalition of resources.

From an EU perspective, the approach taken from the outset was to encourage an academic-industry partnership leading to coherent industrial research roadmaps in partnership with university research[16]. Hence in complement to the work undertaken within the EIFFEL Think Tank, the four European Technology platforms active in the domain of networked systems and technologies (eMobility[17], NEM[18], NESSI[19], ISI[20]) were called upon to develop road maps and offer a coherent approach to the Future of the Internet.

## Evolution versus Revolution

Quite frequently the debate on the Future of the Internet is home to a confrontation between the "evolutionary approach" and the "clean slate approach". The EIFFEL think tank concluded that both approaches are probably needed. Still, the need for co-ordination between the various approaches and activities was identified, and and this is suggested to be the basis for future FP7 work. The intention is hence to open work in this field along several technological routes and (r)evolution strategies, but in a co-ordinated manner with "disruption" not being measured in technological terms, but rather from the point of view of business models, applications, and new industrial structures that may eventually emerge.

## Resources earmarked for the 7th Framework Programme of R&D

The tool to support this work will be the ICT programme, a Thematic Priority under the 7th Framework Programme which is planned to cover the 2007-2013 period. Over these 7 years, the ICT programme will work with a budget envelope of about 9 Bn€ with the first work programme covering the 2007-2008 period having been adopted end of 2006[21]. The structure of the work programme covers primarily 7 "Challenges" that have been identified as the key technological/socio economic priorities for Europe. Out of this budget, about 600 M€ have been earmarked for R&D in the field of networked systems, including explicitly the technologies for the Future Internet and also Experimental Facilities. .

This activity will be implemented under the "Challenge 1", whose generic focus relates to "Pervasive and trusted Network and

Service Infrastructures". Most of the Challenge 1 targeted R&D objectives (networks, services, security, networked media) will be open under the first call for proposals under the ICT programme, which has been officially published on 22 December 2006[22].

This R&D activity will be largely opened to international co-operation and partnerships. Whilst consortia are currently preparing for their first batch of proposal submissions, interested parties from all regions of the developed or developing world have an opportunity to join and participate towards the development of a common understanding of the future and global networked economy.

## REFERENCES

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[2] http://www.oecd.org/dataoecd/31/38/29892925.pdf

[3] Although it is recognised that over time, intermediate layers and protocols have appeared contributing to make the architecture more complex.

[4] EU contribution input at: http://www.itu.int/wsis/docs2/pc3/contributions/sca/EU-28.doc

[5] The current EU Regulatory Framework was set in 2002 to bring about effective competition in the provision of electronic communications and services across all European Member States. It was also designed to harmonise approaches to regulating communications providers with significant market power and to opening up markets to increased competition. A revision of the EU Regulatory Framework is expected to be tabled in 2007.

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