Adoption of Social Principles into a Dynamic Internet Design

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***Abstract*—This position paper aims to formulate our opinion concerning the need to approach a new research priority that can drive a more social oiented design of the Internet. Such opinion considers that the design of a Future Internet must integrate the investigation of a better intertwining between social, economic, and technological aspects.**

I. Introduction

In the most recent decade, the increasing adoption of Social Media (e.g. Online Social Networks, Flickr, or YouTube) provides the Internet user with new ways to express him/herself, and with new forms for knowledge exchange. Such exchange is growing and is an indicator that when addressing the Internet architectural design, it is necessary to consider the definition of a more symmetric Internet supply-chain model, e.g. by incorporating both economical and societal (interaction) aspects. Within this potential paradigm change is the need to develop tools that can assist in understanding the impact that social interaction and user engagement is having on the Internet structure and architectural design.

Beside the need to evolve the Internet to support a symmetric value-chain, which will create new economical sustainability and social dynamics, we need to consider that the evolutionary characteristics of the Internet become compromised when the architecture does not allow new functionality to be expressed after its original design. As a consequence, Internet stakeholders have been developing workarounds which often violate the original design principles. This problem lies deeply in the process used to design architectures. Much emphasis is placed on the design phase of the architecture, with requirements phases and use case definitions, accompanied by processes of standardization. This long process inevitably leads to an emphasis of the concerns that are important to the people/organizations who are deeply involved in the design phase, neglecting the concerns of future players, which will be the core of a more symmetric value-chain.

This position paper makes a statement on the potential technical challenges that should be addressed from a research roadmap perspective to drive such design paradigms, and has as background material from the Future Internet Research Roadmap version 1.2 (May 2012).

The paper is organized as follows. Section 2 addresses the technical challenges, while section 3 provides the mapping into the Future Internet Research Roadmap report version 1.2. Section 4 provides guidelines on how to approach this subject, while section 5 concludes the paper.

II. Technical Challenges to Address

In the most recent years there has been an increase in multidisciplinary work within the context of social networking and social interaction analysis, both emerging from two different fields: computer science, in particular in the context of pervasive networking; from social sciences, in regards to the impact that technology has on society. Until now there was an attempt to devise a more pervasive Internet by incorporating some networking social aspects, such as similarity metrics (e.g. degree, closeness, betweeness), and some form of user cooperation as occurs with User-centric Networks (UCNs), i.e., networking architectures which grow "virally" through user engagement, exchange of shared interests, and cooperation incentives. What we have been observing so far is that user engagement and empowerment seems to be a major contributing factor to the evolution of the Internet and yet, the impact of such engagement is still unclear, mostly due to the lack of a multidisciplinary approach (e.g. computer science and social sciences) to investigate an Internet architecture that is able to evolve by adapting to changes on society.

The major reason may be the lack of a deeper understanding of the social capital that such user empowerment bring to the Internet. Social capital is a concept that today is applied in a wide variety of fields, e.g. economy, media studies, sociology, and that can be defined as a set of features that assist in facilitating and coordinating actions in structures, such as the Internet. From a social networking perspective, examples of such features can be levels of trust, reciprocity, and affiliation. Recent conceptions of social capital perceive it as a metaphor about the advantage that is inherent to the strength of social relationships, and the access a person has to the resources available in a network.

Out of the computer and social sciences what stems is the need to consider also the impact that the societal aspects may have on Future Internet design and which can be formulated as:

- What is the impact that social interaction and engagement is having on the Internet structural/architectural design?
- How to quantify such impact in a way that allows the development of a socially-driven Internet design?

Even if we fully understand the best way to create a social-driven Internet design, we still face the problem of devising an Internet architecture that does allow new functionality to be expressed after its original design. Hence, the accommodation of any type of future requirement raises the need to define

and to use a more Darwinian approach to Internet design, where the Internet operational kernel becomes the design process itself, i.e., a process in which concerns of actors are incorporated into the system at run-time, recognizing the inability to cater to all possible requirements during design time.

This concept of system design has the ability to capture all relevant concerns at the time, and so to resolve the most probable run-time tussles at design time. However, the increasingly important role of the user in the creation of technology solutions, as well as the wide scope of the Internet beyond mere technology raises several questions about this design process.

Expectations are that such Darwinian design would assist Internet foundations in seamlessly incorporating prosumer requirements, and so to create the needed symmetric value-chain. However, such approach requires a set of formulations that need further investigation, such as:

- Reaching a clear understanding of what have been the advantages and the major limitation of the current Internet design. This requires to go beyond the pure technological perspective and to incorporate the social capital perspective.
- Although the Internet's hourglass model has been giving support to a significant set of innovations showing robustness and flexibility enough to comply with Internet changes, its limitations are close related with the limitations of the processes needed to describe new protocol flows. Hence, it is relevant to consider that the Internet foundations show be the design process itself, allowing the Internet to be defined by expressing the logic of computation/networking without describing its control flow.
- It must also be clear that it is not reasonable to assume that all of the previous architectural design advantages should be left aside. Hence, we must be open to understand how we can establish design processes that allow evolution towards the future requirements without delaying the progress of that Internet evolution unnecessarily. One first aspect related to this is the need to address the prosumer role in technology adoption modeling, and not only from a monetization perspective, but also from a social RoI perspective - RoI concerning knowledge exchange.

III. Mapping into the Future Internet Research Roadmap

Within the context of the report version 1.2, section 5 addresses three different aspects concerning the impact of Internet design towards people and society, business and economy, and technology. These different aspects reflect a vertical organization that has been in practice to define the research priorities for the design of a Future Internet able to achieve a better intertwining between social, economic and technological aspects.

For instance, in section 5.1 of the FIA Research Roadmap, knowledge management is approached in a business and economy perspective in the sense that in the future a supply chain or a virtual organization is more complex and challenging than for a single organization due to differences in business and cultural environments of the partners within the collaboration and the overall structure of the network. It is our opinion that the management of knowledge in an information society needs to be tackled with a wider spectrum, reaching all societal environments (e.g. office, home, public places) and not only is a well defined organization, independently of its size. Hence, it is our opinion that knowledge management needs to be tackled within a horizontal approach to all the enumerated aspects (business, economic, people, society, technology) centered in the only element that is common to all such aspects: the user.

Still in section 5.1, it is mentioned that the Internet is inducing deep socio-economic changes. People are empowered by the increasing tools and facilities to discover, connect, and exchange information and knowledge. Such toolsare giving rise to the development of advanced forms of work and to an increase in creativity, even remotely (with users far apart). Such an empowerment will be deployed in their role of citizens and entrepreneurs. While this statement is true, it is not restricted to the business and economic perspective of a future Internet. People empowerment will also have an impact on the social structures which will evolve based on the produced social capital, and well as the way technology will be adopted, having an impact on the Internet design.

In what concerns societal challenges, section 5.2 of the FIA Research Roadmap is mostly focused on the way vendors and operators may contribute to the creation of a more intelligent urban environment. While this is an aspect to have into account in the future, it still sees the citizen only as a consumer of smart services. It is our opinion that the evolution of the Internet to support the creation of smart infrastructures and services in a urban scenario should have into account the role that the end-user may have as a prosumer, creating new services and communication opportunities. How should the user be integrated as a player of a future Internet value chain is still an open question.

As mentioned in section 5.3 of the FIA Research Roadmap, one of technological challenges is the need for immediate followup of emerging trends. As said in section 5.3, "*we are facing a high speed of application development, combined with quick deployment. A consequence of this "rush" is that some parts of the systems involved in service delivery cannot keep track and turn into bottlenecks (such as the mobile networks when the smart phone avalanche happened)*". This means that we still face the problem of devising an Internet architecture that does allow new functionality to be expressed after its original design. Hence, the technological aspects of a future Internet must encompass the need to define and to use a more Darwinian approach to Internet design, where the Internet operational kernel becomes the design process itself, i.e., a process in which concerns of actors are incorporated into the system at run-time, recognizing the inability to cater to all possible requirements during design time.

In our opinion section 5 of the FIA Research Roadmap needs a new sub-section to address both the impact of social interaction and of user engagement in the Internet design. In other words, the relation currently formulated in the report

between society and the Internet (technology) is unidirectional, from technology to society. While what we are proposing is to drive the Internet architectural design by taking into consideration a formulation and integration of networking measurement metrics that can not only capture an economic perspective, but also a societal perspective. This new sub-section, which could be entitled "Socially-driven Internet Design", aims to complete the FIA research roadmap via the integration of social capital aspects in networking design. While all the current aspects mentioned in the FIA Research Roadmap focus on the impact that the Internet has on people, business and society, the proposed sub-section should define how could the Internet design adapt to the evolution of business, society and people behavior.

IV. Solutions/Research Needs

The inclusion of a new challenge tacking the dynamic design of the Internet driven by the evolution of social aspects, leads to several new research issues, some of which are technical and others are social or related to the study of human behavior. This means that the challenges raised by a socially-driven Internet design can only be pursuit with a multidisciplinary approach, encompassing the following major issues:

- Technical:
  - Symmetric Internet Value-Chain.
  - Trust management and Incentives for cooperation.
  - Declarative Networking.
  - Social Interaction Design.
  - Dynamic Services and software.
  - Technological adoption metrics.
- Social
  - Social Capital metrics.
  - Network Structures and Dynamics.
  - Privacy.
- Human
  - Reality mining.
  - Cooperative Sensing.
  - Affective Computing.

The pervasive adoption of Social Media is a strong indicator of the need to revisit the Internet supply chain to be able to truly take advantage of the prosumer model. Being capable of both integrating social metrics and technological adoption metrics into multi-objective utility functions is a requirement to further evolve the Internet supply-chain. Such a methodology requires as a first step to go beyond the pure technological perspective and to incorporate the social capital perspective in a multidisciplinary approach. Today, it is widely accepted that the Internet end-to-end design principle is hedged around with stronger caveats than before. Hence, we must be open to understand how we can establish design processes that allow evolution towards the future requirements without adding further entropy to the natural Internet evolution process. In order to allow the Internet design to be adjusted based on evolving social models, behavior of a node should express the logic of its computation without describing its control flow. The design of future Internet functionality should be based on an expressive language (e.g. declarative or functional programming) in order to accommodate a potentially more complex event structure and node operation.

Within the context of social capital, it is our belief that the social properties that are the most relevant to be applied to the Internet design are reach, engagement, and influence. Reach corresponds to the degree of effective dissemination of certain content or potential spread that a single actor or node (a profile) has in the network. Networking measurement metrics that can be applied to incorporate this property may be, for instance, rate of nodes reached; proximity; propagation speed. Engagement refers to the degree of participation and involvement of a specific actor or node. A profile in networking can be seen as e.g. a preferred location; an interest towards a node/cluster/location. Metrics that we can consider in Internet architectural design to define engagement can be, for instance, the growth of the direct neighbors (also known as followers) of nodes; time spent around a specific node (e.g. volume of inter-contact times). Reciprocity of contacts is also a metric that can assist in defining engagement. Influence refers to the degree of attention and mobilization that a certain actor can generate in other actors.

In addition to incorporating new metrics rooted on social science, it is also necessary to revise a few aspects concerning network centrality. Today, several notions of centrality are the basis for new concepts being addressed in the Internet, e.g. information-centric routing; opportunistic routing; self-organization based on small-world evolution. However, there are a few differences between the application of centrality as it is being done today in the context of networking, and within the social capital modeling context.

Summarizing, it is our belief that a starting point to address a socially-driven Internet design can simply start by addressing two simple aspects: i) integrate the notions of trust and influence in pervasive routing, by developing measurement metrics capable of sustaining such properties; ii) revise the notions of centrality that are being heavily applied today, ensuring that there is alignment between the definitions that are today applied in exclusivity within the context of social capital, and in pervasive networking.

V. Summary

This paper addresses the need to consider a real merging of social capital principles into technology adoption modeling as a way to assist future Internet architectures to naturally evolve beyond their role for service provisioning, thus enabling network prosumer models to be fully exploited as tools that can give rise to new business models and to both social and technological advances. Our belief is that this is a process that can be applied to the natural evolution of the network core, by removing artificial barriers related to Internet supply-chain management, as well as by incorporating a multidisciplinary perspective to the dynamics of social structures, through the integration of social capital models and metrics. To assist in such integration, we have provided a few design guidelines concerning how the implementation of such changes could be applied to the current Internet architecture.