User-centricity Impact on future Internet Architectures

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ABSTRACT

This position paper goes over the impact that user-centricity may have in terms of aspects that are fundamental to consider on future Internet architectures, namely, the end-to-end principle, routing, security and trust management, as well as mobility.

1. INTRODUCTION

The rise of *Wireless Fidelity (Wi-Fi)* as the de-facto complementary technology to Internet access introduced an unexpected flexibility, generating new opportunities in terms of the Internet value chain. Internet architectures where the end-user is an active stakeholder, i.e., *User-provided Networks (UPNs)*, are today starting to expand Internet access both at a faster pace and possibly at lower costs than what would be feasible if simply done by regular stakeholders, such as access providers. Current commercial examples of UPNs relate to the initiative of companies such as FON or WiFi.com. From a non-commercial perspective we assist to a number of community initiatives (e.g. Freifunk, CUWin) which aim to assist in the development of *Do-it-Yourself Networks (DYN)* based on Wi-Fi technology, always as a way to expand already existing/subscribed Internet connectivity at a low-cost and in a user-friendly way.

This position paper describes some aspects of user-centric networking that may impact future Internet architectures. The paper is organized as follows. Section 2 briefly goes over related work, while section 3 debates the impact of user-centricity on the Internet, focusing on the end-to-end principle, routing, security and trust management, as well as mobility impact. We conclude in section 4.

2. RELATED WORK

Cooperation is a concept that has been for long applied to several OSI Layers, being the main principle behind successful P2P applications. In more recent years, special focus has been put in systems and mechanisms that allow networks to self-organize and to automatically establish connectivity among involved entities, in order to accommodate future service needs. User-centricity has been addressed by several EU projects, being the most relevant to cite in relation to our work BIONETS [6], HAGGLE [7], SOCIALNETS [8]. ULOOP [5] is a recent proposal for an EU-funded project where the main aspect is to explore user-centric environments targeting three main aspects, namely, cooperation, resource management, and mobility aspects. User-centricity aspects are also addressed in the recent ESF Cost Action WiNeMo, which has as main goals to explore networking aspects involving large numbers of autonomous but owned and/or human-controlled wireless objects moving with different patterns and speeds.

3. IMPACT ON NETWORKING FUNDAMENTALS

3.1 End-to-end Principle

The end-to-end principle [2, 1] has evolved to address concerns of maintaining fundamental properties on the Internet: end-user choice and empowerment; support for trust and good-behaviour; protection of innovation; and provision of reliability [9]. Recognizing these properties when proposing modifications to the Internet is therefore significant, given that such modifications are needed to achieve greater functionality, lower costs, and increased adaptability for all types of social interaction [4].

Aiming at evolving the edge of the Internet (it is at the edge that we find the best economic conditions to favour innovation), user-centric architectures offer users and providers a way to augment connectivity models. Besides the essential principles of user empowerment and support for trust and good-behavior, user-centricity respects some of the requirements underlying the original Internet architecture [2], namely: i) internetworking, between spontaneous networks powered by users; ii) robustness of Internet connectivity, ensured by trust, incentive and credit-based cooperation; iii) heterogeneity, i.e. supporting end-user devices with different relaying/routing capabilities; iv) distributed management and easy attachment, by a self-organized control of connectivity; v) cost, by implementing an effective usage of shared Internet connections.

3.2 Routing

Within the context of the Internet, routing is based upon *store-and-forward* and dependent on the link cost definition, and where routing metrics were initially defined having in mind static topologies, fix end-nodes, and providing support to the client-server service models. Fixed networks are today mostly terminated (first-mile) by some form of Wi-Fi technology.

From an end-user perspective model, user-centric networks today rely on regular multihop routing. Such type of routing may, however, not always be necessary given that traces show us today that users tend to cluster and to prefer short distances than long distances, which implies shorter paths (few hops). Hence, throughput improvements may be achieved

using simple cooperative techniques, instead of the more complex techniques used in multihop ad-hoc networks.

The application of cooperative techniques increases the expected impact of user-spreadable networks on new wireless standards. Namely, on standards addressing architecture and information exchange models, allowing optimal decisions on the selection among available radio resources and among available relaying partners, leading to an improve of the connectivity and capacity of the composite network.

3.3 Security and Trust Management

From a networking perspective, user-centricity is today simply supported by the freebie roaming incentive. Security concerns are simply left aside and due to their autonomic nature, security becomes harder to implement: end-users roam frequently, detailed accountability and traceability are a hard problem to tackle. Therefore, the growing popularity for these architectures is trust management as humans perceive it in social networking: the growth of user-centric architectures is today just driven by the end-user's belief that the benefit of using them is higher than the risk incurred, and this is mostly due to naivety of the users involved. When there is some attempt to provide a sense of security, confidentially is only ensured partially based on the regular (wireless) mechanisms. A user can cope with this gap by relying on specific privacy mechanisms, e.g., using some specific application or establishing a tunnel to a specific, trusted entity (e.g. a VPN to an enterprise). The flip-side of this is the associated overhead both in terms of configuration/processing time, and in terms of data. We defend that in terms of user-centricity, future Internet architectures should tackle adequate trust modeling having as basis *grassroots* mechanisms, the foundation for social trust management.

3.4 Mobility

Current Internet models are lagging behind in what concerns mobility management and a highly end-user nomadic lifestyle, given that their design never had to cope with situations where the end-user moved (frequently or not) across different types of networks (multi-access networks). Future Internet models have to integrate properties that allow nomadic end-user experience for any application across multi-access or single-access networks, assuming that one or more operators are involved. Both nomadism and session continuity are essential from a user-centric perspective, being the reason for this must the fact that end-user mobility patterns are key to the autonomic behavior underlying to user-centricity. Moreover, currently the most popular solutions for global mobility management (SIP [10], MIP [3]) have in common a model where a *mobility anchor point* is in charge of keeping some form of association between previous and current identities for a mobile node that roams across different networks. While mechanisms derived from these two families can rely on some form of hierarchy to optimize different aspects of global mobility management (e.g., latency during handovers, signaling exchanged), they still rely on central entities as mobility anchor points. In user-spreadable networks, these models (as well as others) should rely on a distributed architecture which raises the need to develop efficient selection mechanisms based on reputation models. Nevertheless, the impact on seamless mobility depends considerable on mobility patterns of mobile users (e.g. mobile users may follow the same movement of their current mobility anchor), which by themselves are influenced by social interaction models.

4. SUMMARY AND CONCLUSIONS

This position paper addresses the need and relevance of considering user-centricity as a key aspect to tackle when addressing future Internet design. It provides a brief debate on some of the main aspects to address, and the impact that user-centric networking models are already starting to have. Such impact should not be ignored, given that from a global perspective, it is clear that user-centricity is already introducing a paradigm shift in Internet services and wholesale models, allowing the end-user to be at the same time a consumer and provider. It is therefore essential to adequately think about challenges and advantages they bring to the Internet in the future.

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