Universal, mobile-centric and opportunistic communications architecture

Paulo Mendes
SITI, COPELABS, University Lusófona
paulo.mendes@ulusofona.pt

Waldir Moreira
SITI, COPELABS, University Lusófona
waldir.moreira@ulusofona.pt

***Abstract*— Cars, sensors, home appliances, every device in the daily life of citizens is becoming a constituent in Future Internet, adding to the need to reconsider requirements and assumptions in terms of network availability and affordability to support the ever increasing traffic demand. Still, the current Internet can only evolve adequately, if its infrastructure can be devised to accommodate the emerging services, which is very expensive. Our goal is to make the Future Internet universally pervasive supporting a diverse set of services. To achieve this, we develop a universal mobile-centric and opportunistic communications architecture, which integrates the principles of Delay Tolerant Networking (DTN) and Information Centric Networking (ICN) in a common framework.**

Keywords—Data-centric networking; Delay-tolerant networking; mobile networks.

I. INTRODUCTION

The Internet has crossed new frontiers with access to it getting faster and cheaper. Considering the architectural foundations of today's Internet were laid more than three decades ago, the Internet has done remarkably well until today to cope with the growing demand.

However, the future Internet architecture is not only expected to support an ever growing number of users and devices, but also a diverse set of new applications and services. At one extreme, the future Internet is expected to transport applications such as tele-immersion and at the other extreme to connect vast numbers of tiny devices integrated into appliances, sensors, actuators, and a range of previously independent systems forming the notion of Internet of Things (IoT). The Future Internet is most importantly expected to support the ever-growing need of user mobility.

Now here lays the main obstacle: it is impossible to have 100% universal coverage. In what concerns populations living in physically remote locations, it is simply not cost effective for Internet Service Providers (ISPs) to install the required infrastructure for broadband Internet access. This problem is widely recognized: for example, in 2012, 9.1 million homes in Europe still did not have fixed broadband coverage, more than 90% of which located in rural areas. Achieving ubiquitous mobile broadband coverage is also currently seen as not feasible by major operators due to lack of incentives for direct investment in local infrastructure. For example in the UK, 3G coverage is mostly concentrated in major towns and cities.

One potential solution to this pertinent problem of improving pervasive Internet access is to change how users communicate and access information. This can be done by moving from the traditional host-centric access paradigm, where access to a desired content is mapped to its location, to a content-centric model where access to a desired content is mapped to the content itself irrespective of its location. Such a model when combined with the benefits of delay tolerant networking can support secure pervasive data exchange, agnostic of content location and tolerant to intermittent Internet connectivity. Decoupling communications from content location removes the need of being always connected to the Internet, due to content caching, either in the form of traditional caching, or in a more revolutionary diffusion-based form (e.g., store-carry-and-forward).

II. PROPOSED NODE ARCHITECTURE

The proposal developed by the UMOBILE consortium (**http://www.umobile-project.eu/),** is a mobile-centric service-oriented architecture, which integrates the core principles of Information Centric Networking (ICN) [1], Delay Tolerant Networking (DTN) [2], and IP together into one single architecture under a common service abstraction.

The proposed architecture, illustrated in Fig 1, exploits two major properties that are common to both ICN and DTN: (a) storage, which allows for storing data for as long as necessary until a communication link is established and (b) custody transfer, which allows for intermediate nodes to act as relays that surpass the communication limitations imposed by the end-to-end architecture of the Internet: hence, communication is possible even when the initial end-to-end path no longer exists. Moreover, the inherent ability of ICN to push content to

the edges provides more localized access to important content and enables a transmit-when-needed policy.

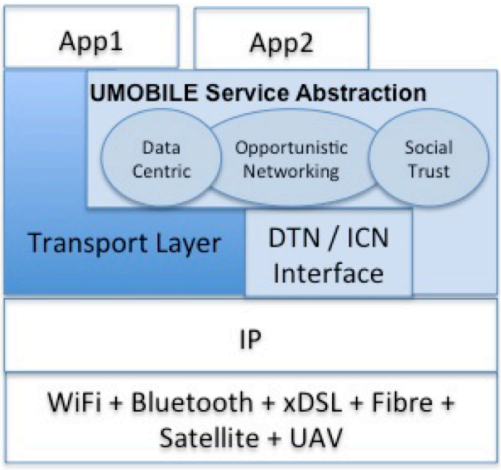

Fig. 1. UMOBILE Node Representation

The proposed architecture applies to a variety of devices, allowing a context-aware design of applications and communication flexibility. This architecture is developed to promote low cost inter-device communications that cope with different challenging conditions while following a social-driven design (e.g. communication within trust circles) [3].

UMOBILE will efficiently exploit all possible communication opportunities, while providing a unified abstraction to application developers for supporting current Internet-based services and enabling innovative future solutions. To make UMOBILE really pervasive, a smart routing approach will be developed, able to exploit social interactions and data interests [4,5,6].

III. Applicability

The proposed UMOBILE framework aims to enable services that fully exploit the inherent opportunistic nature of communications, without requiring constant Internet access while being agnostic of data location.

In this context, UMOBILE can be seen as an enabler for the easy development of future applications and services able of exploiting a low cost communication system (c.f. Fig 2).

Based on UMOBILE it is expected the creation of services and applications able to allow users to share their daily life experience within their trust circles (micro-blogging) and to use the shared information to improve their social routines, and consequently their well-being.

It is also expected UMOBILE to support the creation of civil protection services, as well as, applications able to alert citizens and communities about emergency situations. All this based on a low cost communication system able to operated independently of the presence of Internet access. These are the four use-cases that will be tackled in the UMOBILE project: Micro-blogging; Social Routines Improvement; Civil Protection; Emergency Situations.

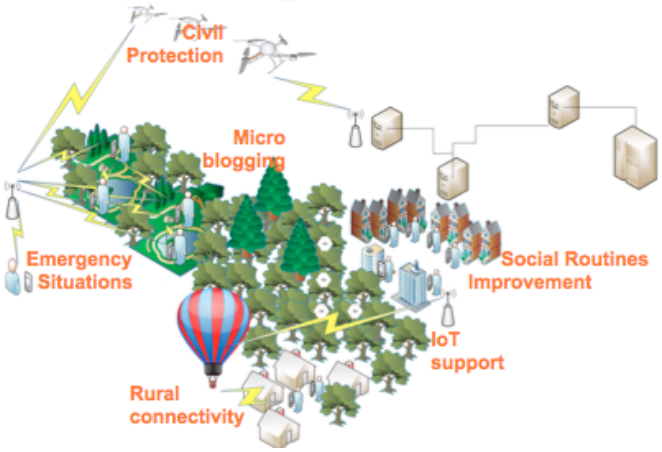

Fig. 2. Overall Applicability Scenario

The UMOBILE framework is expected to provide access to remote rural areas, but this scenario is not pointed out as central to boost innovation.

Acknowledgment

The Universal, Mobile-centric and Opportunistic Communications Architecture project (UMOBILE) - http://www.umobile-project.eu/ - has received funding from the European Union's (EU) Horizon 2020 research and innovation programme under grant agreement No 645124.

References

[1] V. Jacobson, K. Smetters, J. Thornton, M. Plass, N. Briggs, R. Braynard "Networking Named Content", in Proc. of ACM Conext, Rome, Italy, 2009

[2] V. Cerf, S. Burleigh, A. Hooke, L. Torgerson, R. Durst, K. Scott, K. Fall, H. Weiss, "Delay-Tolerant Networking Architecture", IETF RFC 4838, April 2007

[3] Rute Sofia, Paulo Mendes, Manuel José Damásio, Sara Henriques, Fabio Giglietto, Erica Giambitto, Alessandro Bogliolo, "Moving Towards a Socially-Driven Internet Architectural Design", in ACM CCR, Vol. 42, No. 3, July 2012

[4] Waldir Moreira, Paulo Mendes, Susana Sargento, "Social-aware Opportunistic Routing Protocol based on User's Interactions and Interests", in Proc. of AdhocNets, Barcelona, Spain, October 2013

[5] Waldir Moreira, Paulo Mendes, "Social-aware Forwarding in Opportunistic Wireless Networks: Content Awareness or Obliviousness?", in Proc. of IEEE WoWMoM workshop on autonomic and opportunistic communications, Sidney, Australia, June 2014

[6] Waldir Moreira, Manuel de Souza, Paulo Mendes, Susana Sargento, "Study on the Effect of Network Dynamics on Opportunistic Routing", in Proc. of AdhocNow, Belgrade, Serbia, July 2012