Chapter 10
Knowledge Sharing to Improve Routing and Future 4G Networks

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ABSTRACT

Current networking trends show a rapid convergence of several nestled networks as GSM/UMTS, WLAN, Bluetooth, wired networks among others. Nonetheless, such a complex environment raises new challenges including information routing, high dynamicity and possible disconnections. For such reasons, nontraditional routing paradigms have been put forward while adopting innovative ideas based on models from areas as diverse as biological, epidemic and social behavior. The reader will learn about new forms of routing being considered for integrating these future networks, based on the use of different metrics, such as shared network knowledge and willingness in taking and forwarding it. In this chapter an overview of traditional routing and the requirements for 4G systems are first made. New directions for routing based on policy and the identification of stimulus to control and improve the message forwarding in addition to their efficiency in the new context of 4G networks are presented.

INTRODUCTION

Despite rapidly advancing research related to building 4G systems, there is still an apparent lack of general consensus of how to view their scope (Szczodrak, Kim & Baek, 2007). Some works mainly look at 4G as a mere improvement of 3G cellular networks or emerging mobile WiMax 802.16 in terms of performance, mobility, capacity and new

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advanced services. Others consider a bigger picture that includes the convergence of several nestled networks including GPRS – 2.5G, GSM/UMTS – 3G, Wifi - WLAN, WiMax – 802.16, Bluetooth – short range, and also fixed networks. 3GPP calls its work in such context as the Long Term Evolution (LTE). A third view is that of an all-IP user centric approach where services may be developed on end systems independently of the network infrastructure. This is similar to the end-to-end argument adopted by the Internet where TCP/IP and P2P applications may be developed to use the network while seeing it as a simple pipe. The Android initiative from Google is an example of such user centric view. Note that the different approaches for the design of future networks, not only have technological differences, but are also motivated and driven by new business models. The reader may see that the Telecom industry, the Internet community, the information technology (IT) companies all, understandably, would like to see a future where control over the network services and resources is part of their responsibility. Trying to figure out who is right or wrong is a religious discussion at best as all sides present their supporting their views and business models for future networks such as 4G and the Internet as a whole. Only the future may tell who is going to win such debate.

Instead of discussing which scenario may prevail, let us look at a common concern, one that explores how to make use of such convergent scenario and more importantly it tries to enhance knowledge sharing in future 4G networks. The reader is shown how user mobility and network dynamicity may be valuable allies for this endeavor rather than limiting factors as often seen by traditional cellular systems. More specifically, it is the intent of this chapter to view the impact and analyze the behavior of knowledge (seen here as an important new network metric) sharing in a complex 4G environment where traditional services such as routing and locating information raise new challenges.

Initially we review the current experience gained in the area of routing into fixed and dynamic networks as well as describe some challenges for next generation systems. Unlike traditional work in the area of communication system architectural design, a number of innovative and research ideas are based on biological models which have extensively been used to model knowledge sharing and node reachability, as well as to provide adaptability, scalability and robustness for systems (Babaoglu, Canright, Deutsch, Di Caro, Ducatelle, Gambardella, Ganguly, Jelasity, Montemanni, Montresor & Urnes, 2006). For instance, a Wasp model provides an advanced scheduling scheme for satisfying robustness when submitted to unexpected events as well as having considerably high performance tasks (Song, Hu, Tian & Xu, 2005; Cao, Yang & Wang, 2008). Ant models have been used for optimized routing support, i.e. leading to increasing throughput and reducing network delay (Gutjahr, 2008; Dorigo & Blum, 2005).

Considerable work has also gone into partially connected networks (Vahdat & Becker, 2000; Lindgren, Doria & Schelén, 2003) and epidemic routing (Kenah & Robins, 2007). Such works introduce Epidemic Routing, where random pair-wise exchanges of messages among mobile hosts ensure eventual message delivery (Jindal & Psounis, 2006). Under this type of routing, probabilistic delivery may be used to lead with an important aspect of future 4G nodes, that of disconnected operation. Given that messages are delivered probabilistically in epidemic routing, the application may require the use of acknowledgments to ensure some level of reliability.

Relevant ideas may also come from recent work on social phenomena such as SOLAR (Ghosh, Philip & Oiao, 2007 and Ghosh, J., Ngo, H.Q., Yoon, S. & Qiao, C,2007), SimBet (Daly & Haahr, 2007) and Bubble (Hui, Crowcroft & Yoneki, 2008 and Hui, P. & Crowcroft, J., 2007) routing that will be discussed next. Bubble mimics the social communities way of life to create clusters and decreasing the number of routing messages.