Trigger Management and Mobile Node Cooperation

Jukka Mäkelä, Kostas Pentikousis, Mikko Majanen, and Jyrki Huusko

VTT Technical Research Centre of Finland firstname.lastname@vtt.fi

Summary. This chapter addresses one of the challenges in cooperative networking, namely, mobility support in a heterogeneous ambient network environment. We motivate the need for efficient mechanisms for handling the large amount of network and channel state information required in assisting fast handovers and network and service adaptation strategies. Managing a variety of network and protocol events and triggering information is a challenging task even in a homogeneous networking environment when different mobility schemes (node, network, session) and application adaptation are considered and, not unexpectedly, the heterogeneity of access networks increases further the amount of such information. We present triggering management mechanisms which efficiently handle triggering information at node and network level, dealing with a greater variety of events originating from any component of the node’s protocol stack as well as mobility management entities within the network. We then discuss the benefits of arranging mobile nodes into specific mobile routing groups, and how such approaches can benefit from the availability of the triggering management mechanisms in an ambient network environment.

Key words: ambient connectivity; mobility management; routing group; event triggering; handover decision-making

10.1 Introduction

Today’s mobile devices are already capable of running demanding network applications and services, and the devices may also have multiple network interfaces for wireless and wired access networks and thus, they can provide a variety of connectivity options for users. Nevertheless, state-of-the-art mobile protocol stacks can only handle a small set of event notifications, typically related to radio access network (RAN) connectivity, user mobility, and load balancing. For example, signal strength deterioration generally leads to a base station handover in cellular voice; 2G/3G mobile phones typically opt for 3G connectivity when the user moves into a new area; and, sustained high data traffic loads may force the Universal Terrestrial Radio Access (UTRA) transport function to reallocate resources (and even perform a handover) in WCDMA 3G/UMTS networks [9].

In Section 10.2 we argue that we need a framework to handle a much larger set of notifications caused by events that originate not only from the lower layers of the protocol stack (physical, data link, and network), as in the examples, but from the upper layers (session, transport, and application) as well. Then, in Section 10.3, we present mechanisms that allow mobile devices to manage mobility events and the associated notifications, which we refer to as triggers in the remainder. These trigger management mechanisms lay the foundation upon which sophisticated handover operations can be performed, and establish an extensible framework where new sources of triggers can be included as necessary. For example, as we will see in Section 10.4, triggers can be very useful in forming routing groups in an ambient network setting. After introducing the routing group concept, for scenarios where a set of mobile nodes move in unison, we overview the gateway selection architecture in Section 10.4.3 and conclude the chapter summarizing the main points.

10.2 Mobility Triggers

Different kinds of events may trigger mobility management actions: traditional radio link specific conditions, context-dependent, security-related, upper-layer requirements and other system-, application- or user-dependent events. To cater for all these events, general and coherent mechanisms are needed to enable mobility triggering and to identify related events on different protocol layers in a distributed system. Trigger sources and trigger information will have to be included in the mobility architecture. We concur with Eisl et al. [4] that the decision process (arbitration between triggers, policies), and in particular the relative roles and cooperation of the involved networks and devices regarding mobility triggering and rule setting, needs to be handled by a generic and cohesive framework. Mobility actions should be executed based on unambiguous decisions, even if there were several conflicting triggers. Some of the events may be seen as forcing triggers, while some might be suggesting hints, either predicting or triggering. Eisl et al. [4] explain that the difference between triggering and predicting is that the latter enables anticipation of a seamless handover. The aim is that based on an analysis of different triggers, such general functionality can be developed for mobility management like deciding about handovers.

10.2.1 TRG Producers and Consumers

We defined a common triggering framework (TRG) [6] which receives “events” from the sources (TRG Producers), process them, and generates “triggers” which are then dispatched to interested parties, called TRG Consumers. In this framework, producers register with TRG before starting to send measurement and events. The registration can be seen as a form of contract between TRG and the producer. The latter affirms its commitment to report events it deems important for further propagation, while TRG guarantees that triggers based on these events will be delivered to interested consumers. Conventional event sources include, for example, different radio interfaces reporting events associated with radio access characteristics, such as, current or average network capacity load, signal-to-noise ratio (SNR), dropped frames ratio, received signal strength indication (RSSI), to name a few; the battery