Study of Mobility Control Functions in Ambient Networks

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1 Introduction

Ambient Networks (AN) [1] is a multi-national collaborative project within the European Sixth Framework Programmes, investigating networking aspects of mobile systems beyond today's 3rd generation standards. Ambient Networks is investigating how heterogeneous network configurations and diverse mobile user systems and applications with specific mobility requirements can be integrated into an internetworking architecture, which supports flexible plug & play and easy deployable network services at the same time. ANs can virtually compose and provide these network services based on a common control space (ACS), which can be distributed physically among different networks.

AN considers mobility as a fundamental part of its work, especially when considering novel challenges coming from the concept of network composition along with network heterogeneity and the need for integrated mobility [2], which are not yet handled by existing solutions. Consequently, a pure enhancement of existing solutions derived from the traditional, 3G oriented perspectives on mobility are not sufficient. We therefore recommend the definition of a new 'Mobility Architecture', which should not be considered in isolation but as a fundamental component of an overall AN approach. The following section gives a brief overview of the AN architectural approach especially from the viewpoint of mobility.

2 Ambient Network Architecture and Mobility Control Space

Ambient Networks project has proposed a scalable, flexible architecture, which entails three main components, as can be seen in Figure 1. The basic idea behind them is to provide an appropriate abstraction level, so that the actual functionalities can be used independently of the particular networking operations.

- The Ambient Connectivity abstracts existing network infrastructure to which the AN functionality is added.
- The Ambient Control Space gathers all the control functions that have been designed in order to cope with the aforementioned requirements, they are known as Functional Areas (FA), these can entail protocol-terminated entities or not (need to communicate with peer entities in other AN).

In addition, the AN architecture defines three well-defined interfaces, that interconnect the ACS components with other networking entities:

- The Ambient Network Interface (ANI) connects the components of the ACS belonging to different AN;
- The Ambient Service Interface (ASI) brings up the possibility that the different applications and services exploit the functionalities provided by the different FA.
- The Ambient Resource Interface (ARI) is established between the ACS and the underlying technologies, so that the ACS can manage the different resources independently of the actual technology.

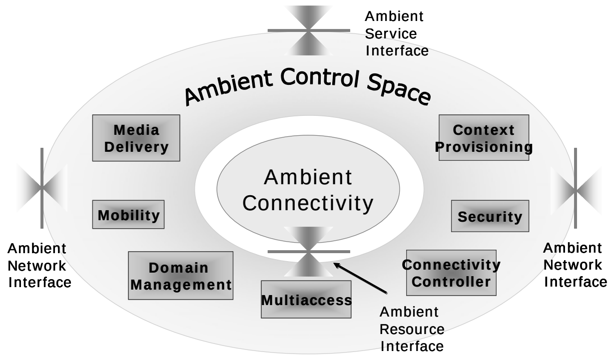

Figure 1: Ambient Networks Architecture

This work focuses on the FAs that are related to mobility operations; these are entailed within the Mobility Control Space (MCS). Its high level architecture is presented in Figure 2, and comprises the following components (they are also called Functional Areas, in order to maintain the coherence with the broader framework): (1) triggering, that collects, processes and filters all types of triggers or/and hints that can impact on mobility procedures, being in charge of delivering them to the corresponding entities; (2) handover and locator management, which enables the movement of mobile entities between different locations; (3) reachability management, that ensures that a correspondent node is always able to locate an AN node; and (4) moving network support, which is able to handle a group of nodes that move together as a single entity and therefore, benefit from this fact. The states in the figure refer to the current status of the end-point regarding mobility operations: reachability state is used for reaching AN nodes and usually imply the mapping of identifiers onto a meaningful locator; forwarding state determines the next hop within the route towards the current location of the node; mobile entity state gives some context information that has to be transferred upon the movement to/from another location; and application state allows to differentiate movement of either applications or flows from a more traditional view on mobility.

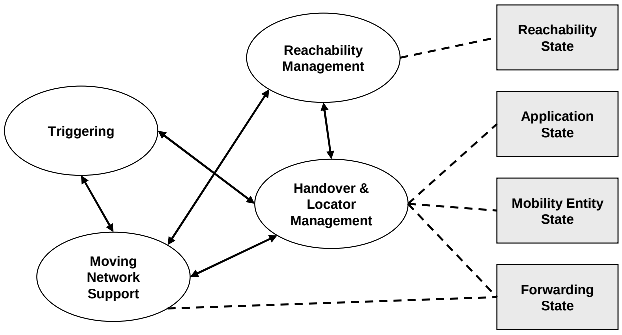

Figure 2: Mobility Control Space Architecture

3 Triggering

The triggering FA provides a generic mechanism for collecting and processing triggering events that may be considered useful mainly for mobility management but for other purposes as well. The functionality consists of three main functions. The first function comprises of collecting and identifying various events from different sources. These events may originate from any layer in protocol stack, from operating system and applications, as well as from network, operator or user preferences and context. The abundance of different events, possibly conflicting or inter-related, creates a challenge of processing all of them in order to identify, which events are actually to be used as triggers for mobility actions. This processing is the second function, which includes policy-driven mechanisms to classify triggers according to pre-defined criteria (currently we have identified six criteria: event source, type, frequency, persistence, time-constraint, and related mobility dimension) utilising various classification and filtering rules provided by system administration or the FA (e.g. handover management), which is interested in consuming the triggers. The third major function is responsible of keeping track of those consumer FAs, which want to receive processed triggers. It makes the triggers available for Handover and Locator Management FA, Routing Group Management FA and other functions either real-time or with an on-demand manner, depending on the preferences of the consumer and the time-constraint of the triggers.

4 Handover and Locator Management

The Handover (HO) Management functional area aggregates all the procedures needed to perform various types of handovers to support mobility in the ANs [3]. These include handovers between communication access points within a single radio network, between different access technologies, mobility between different IP address spaces, multiple service provider domains (i.e. network layer mobility), or session layer handovers between different terminals.

This FA has two main components: (1) the HO decision engine, which can be seen as the intelligence of the FA, as far as it received the classified triggers and using a set of policies, it decides on whether to execute the HO, and in which dimension(s), activating the appropriate tools; (2) the HO execution gathers the required mechanisms to maintain communication during and after a HO (context transfer, resource reservation, etc).

5 Reachability Management

This FA is responsible for enabling a CN to initiate communication with a mobile object regardless of its current location. This involves providing a mechanism to allow a CN to resolve an appropriate identifier onto the current topological location of a mobile object. Consequently Reachability management encompasses mechanisms that deal with the dynamic binding of objects with their identifiers that reflect the current location, route and the state of the object to be externally accessible. Two different aspects will be considered for this FA: (1) location registration and maintenance, which reflects how the different naming levels are registered within the network; and (2) reachability modes, which can be seen as an extension of the traditional paging procedures.

6 Moving Network Support

This FA copes with the formation, maintenance and management of Routing Groups (RG) and optimizations required for the mobility of such groups of nodes. Its main functionalities will be the collection of relevant inputs and hints that may be used for the formation of the RG; these should be processed in order to create the RG. Once the RG is already established, it needs to be maintained; e.g. new nodes may join, former members may leave, etc. In addition, the interconnection with external networks has to be provided by means of a Gateway that needs to be maintained continuously. All this information will be used by optimization processes, which will take advantage of the information so as to bring up improvements, both on an intra- and inter-RG level (i.e. communications inside the RG or to external entities), concerning the mobility-management related functionalities. An illustrative example of this last aspect is, e.g. merging/integration of signalling messages during a HO of the whole RG.

7 Conclusions

In this paper, we present one of the cornerstones of the Mobility Architecture, namely the consideration of modularity for the design of the Mobility Control Space (MCS) in AN project.

References

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