Quality-oriented Mobility Control Architecture for ETArch Handover Optimization

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Abstract. *This paper presents a work in progress focused on improve the Clean Slate Future Internet Entity Title Architecture (ETArch) with quality-oriented mobility functions, by deploying mobility prediction, Point of Attachment (PoA) decision and handover setup meeting both session quality requirements and current quality wireless conditions.*

1. Introduction

Among the initiatives to enhance the Internet of today, known as Future Internet (FI), the *Entity Title Architecture* (ETArch) [Silva et al. 2012] is a promising FI clean-slate architecture that employs a new naming and addressing scheme based on the Title, and shares the vision of content-oriented paradigms. It is a realization of the Entity Title Model [Pereira et al. 2011], and consists of a vision of how the entities should be able to semantically specify their requirements and capabilities so that they can communicate with each other. ETArch can inherently support mobile group-communication based on the OpenFlow [McKeown et al. 2008] substrate within the Workspace, a channel that is able to gather two or more communicating participants.

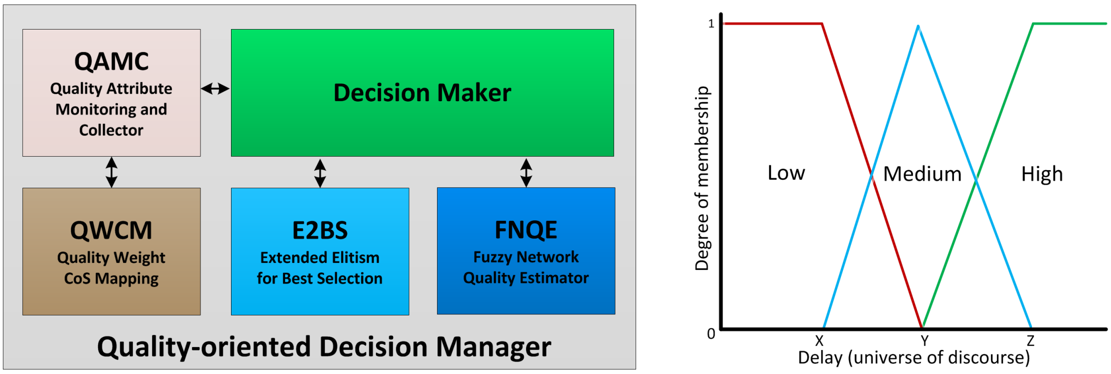
ETArch has been recently enhanced with seamless mobility optimization control capabilities, by being integrated with enhancements inspired by the IEEE 802.21 *Media Independent Handover* (MIH) Standard [Corujo et al. 2011]. As a result, despite being Media Independent in nature in terms of their ability to operate independently of the underlying access technology (both wired and wireless), the ETArch mobility control mechanisms [Silva et al. 2013], are currently only based on link layer features. Although the IEEE 802.21 Standard provides access to events associated with link quality, (such as its ability to indicate the support and characteristics of differentiable *Classes of Service* – CoS in the link, and minimum/maximum delay/jitter experience, among other factors), the ETArch mobility control currently triggers the handover process solely on the basis of the *Received Signal Strength* (RSS) of the candidate *Points of Attachment* (PoA), which will seriously restrict the scope of ETArch in future Internet scenarios (More information about ETArch components and their relationship can be found in [Silva et al. 2013][Silva et al. 2012]).

The limitations described above justify our work in the sense that there is a need to extend the mobility support of legacy ETArch with quality-oriented mechanisms for both prediction and handover control functions. In addition to the current RSS-based scheme, we will make use of the flexible nature of the ETArch framework, and empower its handover management scheme so that it can be applied not only to quality-oriented link layer parameters, but also to high level (e.g., application and user) parameters for enhanced handover decisions. Thus, we seek to maintain best connectivity over time, and be able to make decisions that go beyond those that are strictly guided by the motion events of MN.

Due to space limitation this paper focuses in provide only an overview of our work in progress, describing our proposal to improve ETArch mobility issues. The remainder of the document is structured as follows: Section 2 provides an overview of our proposal. And Section 3 outlines the next stages of this work.

2. Proposal Overview

The architecture presented in Fig. 1a represents the set of proposed extensions to the ETArch Mobility Manager mechanism, named QoDM (*Quality-oriented Decision Manager*) and consists of the following components:



(a) Proposed architecture

(b) Fuzzification example

Figure 1. Proposed architecture and attribute fuzzification example

2.1. QAMC

QAMC (*Quality Attribute Monitoring and Collector*) is responsible for identifying the modification of parameters that indicates the occurrence of mobility or quality degradation of current session and for obtaining the quality parameters of the entities. In case of occurrence of the first event, the QAMC can start the handover process (System Discovery) by asking the MN to scan networks in their coverage area. Collected data (with pre-determined frequency) will be sent to FNQE, to enable the handover prediction based on the quality of the active session.

2.2. QWCM

The QWCM (*Quality Weight CoS Mapping*) component is responsible to perform the mapping for the CoS to which a particular session (affected by the events identified in QAMC) belongs, and thus, determine the importance weights of attributes, through the AHP method [Dhar et al. 2010].

2.3. Decision Maker

This component works intermediating the different requests for the decision function (E2BS) and quality estimation (FNQE) subcomponents of the architecture.

2.4. E2BS

E2BS (*Extended Elitism for Best Selection*) is a handover decision method inspired in the Elitist Selection Strategy [Engelbrecht 2007], combined with MADM (*Multiple Attribute Decision Making*) [Dhar et al. 2010] features to enable quality-oriented mobility decisions efficiently. Its main goal is to meet both the quality requirements of active mobile session flows and to match the current quality standards of neighbouring PoA candidates. The elitism strategy employed by E2BS is based on a multi-attribute evaluation of the QoS candidate networks. In our model, the population is represented by a set of PoAs and their attributes. This technique is used to select the PoA which offers the best connection criteria. Assessing the QoS offered by the various PoA to select the best one is carried out by measuring the similarity between the attributes of the elite individual, represented by the reference PoA, and other candidates. The reference PoA is considered to be the one that have the ideal values, (i.e. attributes like delay and jitter should have values close to zero). The following steps are required to perform the calculating of the score of the candidate networks:

1. The QoS attributes of the candidate networks are joined to compose the decision matrix;
2. Since the data value of the attributes is expressed in different formats, there is a need for standardization;
3. Traffic class weight assignment is applied according to the respective traffic classes;
4. The final score is computed by calculating the Euclidean distance between the attributes of the reference PoA and other candidates. The selected network is that which has the highest final score;

2.5. FNQE

FNQE (*Fuzzy Network Quality Estimator*) is a quality estimator that makes use of fuzzy logic to assess the quality of active sessions, enabling the handover in situations where there is no explicit mobility. To accomplish this, it will check if the quality level provided by the network meets the needs of the application.

FNQE consists of n inputs and 1 output, being n the amount of attributes informed by the application at the time of its registration in DTSA [Silva et al. 2012], and the output the quality indicator, that will alert about the need for handover, according to the application preferences.

During the registration at DTSA, the application should inform your communication requirements, and through these data the FNQE will be able to model the fuzzification system by means of the CoS to which the application belongs. Through this process, the crisp input values will be represented by linguistic terms and associated with a given set according to their degree of membership, as shown in Fig. 1b, where delay is rated by three linguistic terms: low, medium and high. Each term represents the thresholds for certain application in its respective CoS.

The requirements of each attribute will, at first, go through the fuzzification process in order to identify which universe of discourse is associated to your needs. Then, the

QAMC will send to FNQE, with certain frequency, the data collected from the network to new fuzzification. Thus, according to the degree of membership, new results will be generated to be correlated in the inference process, where pre-defined rules for the respective CoS will be confronted with the linguistic terms which were derived from the previous step. The result of this process, known as defuzzification, corresponds to the stage where fuzzy values are converted to real numbers and are associated with the universe of discourse of the application preferences, represented by: Desirable, Good, Tolerable, Weak and Poor. In the cases where the conditions offered by the network does not meet the expectations of the applications, the FNQE will trigger the Decision Maker to start the System Discovery process.

3. Conclusion and Future Works

Although several studies have extensively explored the quality-oriented mobility control field, we believe that the benefits of our approach will contribute to compose a better and efficient mobility mechanism into ETArch framework. Finally, there is still a lack of studies that explores the mobility prediction by quality conditions of active session (i.e. if the network can meet the quality requirements of the applications satisfactorily).

Whereas this work is still in progress, the next step is to integrate our proposal into ETArch mobility manager mechanism and evaluate it at ETArch real testbed in order to assess our mobility prediction model by session quality requirements.

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