Coverage and Capacity Optimization of Self-managed Future Internet Wireless Networks

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Abstract. Future Internet network management systems are expected to incorporate self-x capabilities in order to tackle the increased management needs that cannot be addressed through human intervention. Towards this end, Self-NET developed a self-management framework based on the introduction of cognitive capabilities in network elements. In this paper, the experimentation platform for "Coverage and Capacity Optimization of Self-managed Future Internet Wireless Network", incorporating the self-management framework of Self-NET, is presented.

Keywords: Self-Management, Self-Organization, Coverage and Capacity Optimization, Future Internet, Wireless Networks, Cognitive Cycle

1. Introduction

The management systems of Future Internet (FI) networks are expected to embed autonomic capabilities in order to face the increasing complexity of communication networks, reduce human intervention, and promote localized resource management. The Self-NET self-management framework is based on the Generic Cognitive Cycle, which consists of the Monitoring, Decision Making and Execution phases. The Network Element Cognitive Manager (NECM) implements the M-D-E cycle at the network element level, whilst the Network Domain Cognitive Manager (NDCM) manages a set of NECMs, implementing sophisticated M-D-E cycle features. In order to present and test the key functionalities of the proposed solution, we have addressed specific network management problems that lay under the umbrella of wireless networks coverage and capacity optimization family [1], [2].

2. Demonstration

In our testbed we have deployed a heterogeneous wireless network environment consisting of several IEEE 802.11 Soekris access points (AP, [4]) and an IEEE 802.16 base station (BS) [3], each embedding an NECM. Moreover, several single-RAT (i.e. WiFi) and multi-RAT (i.e. WiFi, WiMAX) terminals are located in the corresponding area, consuming a video service delivered by VLC-based service provider [5]. For the management of the underlying NECMs, an NDCMs is deployed. The cognitive network manager installed per network element undertakes a) the deductions about its operational status, b) the proactive preparation of solutions to face possible problems, and c) the fast reaction to any problem by enforcing the anticipated reconfiguration actions. The interaction of NECMs and NDCM enables the localized and distributed orchestration of the various network elements.

In this demonstration[1] we present the (re-)assignment of operating frequencies to wireless network elements and the vertical assisted handover of multi-RAT terminals. The demonstration scenario is divided into a) the optimal deployment of a new WiFi AP b) the Self-Optimization of the network topology through the assisted vertical handover of terminals from loaded to neighboring less loaded APs or BSs c) and the Self-Optimization of the network topology due to high interference situation. The M-D-E cycle is instantiated in both the NECM and the NDCM. The NECM periodically monitors its internal state and local environment by measuring specific parameters thus building its local view. All NECMs periodically transmit to the NDCM the collected information, which enables the latter to build the second level of situation awareness and have the domain level view.

The situation awareness inference engine is based on Fuzzy Logic Inference Systems (FIS). The latter consists of two parts: the "Fault and Optimization Opportunity Identification" and the "Configuration Action Selection". The first enables the identification of a symptom or an optimization opportunity by taking into account the monitored parameters, while the second uses the output of the first inference phase and deduces the most appropriate configuration action. When such a situation occurs the responsible cognitive manager proceeds to the Execution phase. In the presented scenario we implemented a channel (re-) allocation procedure, which triggered upon the deployment of an AP or in the case of high interference. Finally, the respective NECM undertakes to apply the configuration action.

3. Conclusion

The automation of network management systems and their ability to collectively address complex problems are key requirements for the FI networks. Self-NET proposes the software components (NECM, NDCM) for the engineering of an innovative self-managed FI system. Several benefits arise for both the Network Operator and the end user. This demonstration presented the software architecture for a realistic and implementable self-managed network system.

References

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[1] **The link for the video is:** http://www.youtube.com/watch?v=B0Pbj9iMdts