Title: Network management in the Future Internet

Introduction

Future networks are expected to become even more complex and dynamic than today's networks. Different networks and technologies will interact in a global network of networks. Multiple access technologies will be simultaneously available. The choice of access network could depend on technical (achievable bitrate, maximum delay) or non-technical (cost) decision criterions.

Network elements and terminals will vary from the simplest (a sensor) to the most complex (a server, a mobile router). The role and capabilities of such devices in the management overlay will depend on its characteristics. Cooperation and delegation between nodes will be required.

The ability to adapt to changes will always be present without the need for human intervention. Changes can occur naturally as when a node arrives or departures a network, or can be caused by a malfunction somewhere in the network. There are similarities in the handling of both processes.

The vision of *Autonomic Network Management* is being pursuit by researchers as an answer to the previous problems. This is the capability of network entities to self-govern their behaviour within the constraints of business goals that the network as a whole seeks to achieve. In this paradigm each network element participates in a distributed management process. Cooperation between nodes is used to monitor, analyse, decide and act upon the network.

To address all these concepts, new Internet architectures need to be designed, following the GENI initiatives in the US of Clean Slate design approaches to re-build the Internet.

Objectives

The goal of this PhD Thesis is to achieve scalable, robust management systems with low complexity for large-scale, dynamic network environments. The guiding principles to achieve this goal are decentralization and self-organization, where the management capabilities are embebbed in the network elements (in-network management), which need to self-organize and cooperate to take decisions on the network operation.

The realization of the in-network management paradigm includes developing a network management plane that self-configures and dynamically adapts to changes in networking conditions. This plane provides communication and coordination primitives for a range of distributed management functions. The network, which now includes the management plane as a part, can execute end-to-end management functions on its own and perform, for instance, reconfigurations in an autonomous fashion. It reports results of management actions to an external management system, and it triggers alarms if intervention from outside is needed. Decision capability is added to each network element based on knowledge continuously acquired and shared. The In-Network paradigm can be interpreted as pushing management intelligence into the network, based on a distributed control mechanism. This mechanism provides continuous interactivity between nodes in order to exchange information about each node (and therefore the network). This information will allow it to make automatic decisions, reacting to network changes (such as link failures, load variations) and continuously optimizing the network resources (according to both physical and virtual networks, to users and services) according to optimization mechanisms.

The purpose of this PhD Thesis is to provide all the previous mentioned processes through distributed and in-network management capabilities. Evaluation of these paradigms when compared to the ones of current networks will be dealt with large importance.

Advisory

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Research Institution

The work will be integrated in the Institute of Telecommunications – Aveiro.

Research group and interests:

The Multimedia and Communications Scientific Area inside Institute of Telecommunications in Aveiro contains a sub-area, which is mainly centred on architectures for Heterogeneous Networks. The main interests of this group are in the areas of integration of heterogeneous networks, covering both infrastructure, ad-hoc and mesh networks, and covering technologies such as WLAN, WiMax, DVB and Ethernet. The main areas of research consider issues such as Quality of Service (QoS), mobility, multicast and broadcast, security and privacy, inter-domain, communities, mobile GRIDs and IMS/MBMS integration.

This group participates in national and european projects. In particular, its current involvements are in the FP6 and FP7 Projects ***Daidalos***, ***C-Cast***, ***WIP***, ***4WARD***.