Chapter 86
Autonomic Cooperative Communications

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ABSTRACT

When perceived from the perspective of physical layer upwards, as it capitalizes on signal processing in both the spatial and temporal domains, the concept of link layer inherent distributed cooperative relaying based on virtual antenna arrays aims to improve the reliability of wireless communications through the exploitation of radio diversity provided by relay nodes. Given such a context, the inclusion of network layer routines of relevance may only further facilitate the orchestration of networked devices in terms of arranging for their pre-selection into cooperative groups. However, as the system becomes more and more complex, it appears of necessity to incorporate overlay elements of self-management-driven generic autonomic network architecture to allow simultaneous formation of numerous cooperative and non-cooperative set-ups. This is where the substantial role of autonomic system design comes into the global picture as the umbrella under which the concept of autonomic cooperative communications may be realized.

INTRODUCTION

Since the number of devices interconnected worldwide is growing at so unprecedented a pace, the orchestration of durable and resilient operation of networked systems becomes critically substantial. Especially when analysed in the context of network resiliency, such durability translates into the provision of key features of reliability, availability, safety, confidentiality, integrity, and maintainability. For this reason, it became highly valid to advocate for the integration of networking with the rationale behind autonomic computing in terms of self-configuration, self-optimisation, self-healing, and self-protection. This way the concept of Autonomic Cooperative Networking was proposed not only to integrate and capitalise on the above-mentioned building blocks, but, in particular, to incorporate the notion of Autonomic Cooperative Behaviour (Wódczak, 2014a). As such, stemming from and being triggered by the said Distributed Cooperative Relaying, the Autonomic Cooperative Behaviour intends to provide a mediation capability, not only aiming to facilitate cooperation among devices, but especially to integrate the relevant routines

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of the Optimised Link State Routing protocol. Consequently, the said devices are expected to share their computational capabilities and memory to perform joint data processing for the benefit of meeting the global performance indicators through increased resiliency.

As such, the paradigm of autonomic system design assumes that a networked system follow the operating principles of the Human Autonomic Nervous System and, thus, be able to self-manage without any external intervention. Yet, given the fact that autonomic designs are inherently characterised by their own field of applicability, by no means should they be confused with the notion of autonomous or automated operation. In other words, while an autonomous development may, on the one hand, pertain to being stand-alone, and, on the other hand, to being cognitive, the concept of being automated is solely rooted in the operation of scripting. The difference in meaning does not exclude, however, certain dose of synergy so that autonomics could be supported through the inclusion of autonomous and automated routines. Following, to provide more details, the concept of Cooperative Relaying will be described on the basis of Virtual Antenna Arrays to pave the ground for the incorporation of Network Layer routines with special emphasis on the Optimised Link State Routing Protocol and its inherent Multi-Point Relay station selection heuristics. This way, such a routing enabled cooperation will be translated into Autonomic Cooperative Behaviour and integrated with the entities of the Generic Autonomic Network Architecture under the umbrella of Autonomic Cooperative Networked System design (Wódczak, 2014).

BACKGROUND

As the number of globally interconnected devices is becoming substantially large, the resulting networked systems are getting prone to configuration issues and resiliency becomes one of their key characteristics. Following the rationale behind self-management of autonomic computing, the main trend in networking nowadays is to put emphasis on the ability of a networked system to self-configure, self-optimise, self-heal, and self-protect without any explicit need for external human intervention. This is crucial, for complexity reasons, as complete automation appears to be the only reasonable and justified way forward. In particular, devices may improve the related system robustness by sharing their computational resources through the application of cooperative schemes having been elevated to the level of Autonomic Cooperative Behaviour. For this reason the autonomic system design behind the Generic Autonomic Network Architecture was applied to synergise both the concept of Virtual Antenna Arrays and Multi-Point Relay station selection heuristics of the Optimised Link State Routing protocol, so that substantially large setups of devices could be considered to imitate the operation of Human Autonomic Nervous System. This was achieved with the aid of Autonomic Cooperative Networked System design allowing for the overall system to be controlled by Decision Making Entities within Autonomic Control Loops.

SYSTEM COMPONENTS

Cooperative Relaying

Cooperative relaying, also known as cooperative transmission, is undoubtedly one of the key advancements in the realm of mobile communications intended to facilitate the mitigation of the impairments induced and imposed by the characteristics of radio propagation (Pabst, Walke, Schultz, Herhold, Ya-

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