Active Node support for Autonomic Communications supporting Pervasive Systems

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Abstract: In the past, pervasive systems have concentrated largely on integrating context-awareness for supporting application adaptations to suit user activities. However, with the increase complexity of pervasive computing applications and their requirements, there is also a need for more autonomic functionalities in the communication infrastructure to support this complexity. In this paper, we propose a hierarchical architecture based on active nodes, which maximizes the computational capabilities of various nodes within the pervasive computing environment, to support both pervasive user applications as well as autonomic functionalities within the communication infrastructures. The migratable active node architecture employs various decision-making processes for evaluating a rich set of context information.

1. Introduction

In recent years the Internet has witnessed tremendous growth from a small defence research network to global information exchange architecture. This architecture spans variety of network types (e.g. wireless, ad hoc, etc.) as well as device technologies. Parallel to this technological advancement, we are also witnessing advanced computing applications such as pervasive computing. The emerging pervasive computing technology aims to support user activities and perform tasks on behalf of the users, while adapting the application to changes in the computing environment. A key requirement towards achieving full-scale pervasive computing systems is the integration of context-awareness to various layers of the networking environment. These layers will consist of context support at user activities level (e.g. service composition) as well as to the communications infrastructure level (e.g. management of resources). The requirements at the communication infrastructure level have pushed for the need of autonomic communications. Autonomic communication is motivated by the need for self-adaptive functionalities, which will dynamically adapt and configure communication systems to meet the changes of the computing environment (e.g. network failures, Quality of Service (QoS) changes within the networks, etc.). The self-adaptive functionalities may include network elements having the capability to self-configure, self-organise [1], self-heal, etc. Such functionalities may be performed at the network elements, therefore, alleviating the computational stress on centralized systems and at the same time increasing system reliability.

2. Active node

In order to counter the drawbacks found in centralized architecture, we propose a hierarchical architecture that consists of an intelligent *Active Node (AN)* context gathering and evaluation system based on active network technologies. The proposed solution requires active nodes to be distributed through various regions of the

networking domain and self configure network elements cooperatively while supporting application level adaptations within the users computing environment (also known as Personal Computing Environment (PCE)). Each active node attaches itself to a network element in static network and at the same time provides active node hopping mechanism for dynamic network (e.g. ad hoc networks). Each node subscribes and evaluates the context information with regards to the network condition, user's activity and computing environment. The active node provides an efficient infrastructure for pervasive computing applications and employs the Redundant Positioning System [2] to accurately provide user location at the user application level. Example applications of AN at the user application level may include supporting seamless mobility (vertical handover) as users migrate from one network to another or provisioning service composition to suit user device or network environment.

3. Architecture

Our aim is to provide a scalable mechanism to acquire context information and to perform optimised context evaluation. The architecture for the proposed solution applied on various heterogeneous networks is illustrated in Fig. 1. It consists of a Central Context Repository (CCR), Active Node repository, Redundant Positioning System, QoS monitoring agents, and a filter repository. Each active node is responsible for context management, evaluation, and decision making process at both levels.

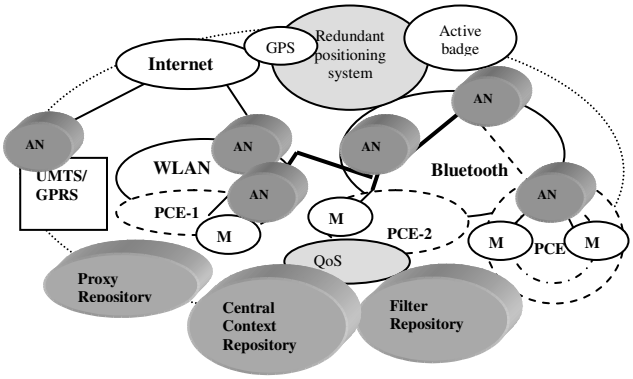

Fig. 1 Architecture of active node support for Pervasive computing environment

By providing decision process at both levels, more efficient optimisation techniques can be achieved through cooperative decision making (e.g. self configuration of network QoS can support optimised configuration of service composition).

2. Conclusion

This short paper has presented a migratable active node architecture for context gathering and evaluation for supporting user level pervasive application as well as autonomic functionalities at the communication infrastructure.

4. References

[1]C. Prehofer, C. Bettstetter, "Self-Organization in Communication Networks: Principles and Paradigms", IEEE Communication Magazine, July 2005.
[2] T. Pfeifer. Redundant Positioning, *Computer Communications* 28, (2005) 13.