

CONTEXT AWARE SERVICES AS A STEP TO PERVASIVE COMPUTING

M. E. Anagnostou¹, A. Juhola², E. D. Sykas¹

¹ICCS, Institute of Communication and Computer Systems, Computer Networks Lab, Athens, Greece

²VTT, Technical Research Centre of Finland, Information Technology, Espoo, Finland

Introduction

The future of mobile computing after the death of WAP seems uncertain. WAP carried with itself an expectation that it would be an important driving force in areas ranging next generation mobile systems to microelectronics. The vacuum left behind by WAP and even a much greater space is now expected to be covered by the relative new buzzword of “pervasive computing” or its European version, namely “ambient intelligence”. Pervasive computing is about “the creation of environments saturated with computing and communication capability, yet gracefully integrated with human users”. It involves advances in a number of key areas, including sensors, interfaces, smart spaces, distributed and embedded computing technologies, service intelligence, and security.

Context aware service engineering can be seen as both the future trend in service engineering and an important aspect of pervasive computing. It has the additional advantage that it can be pursued today and thus provide one of the first steps towards pervasive computing. Context awareness in services is actually about closely and properly linking services, so that their user is relieved from submitting information that already exists in other parts of the global system. In this manner services are expected to act in a concerted mode, which finally add to user friendliness substantially.

Yet, context awareness cannot be achieved without an adequate methodology and a suitable infrastructure. The IST CONTEXT project deals with both. Regarding infrastructure, CONTEXT will rely on the capabilities of active networks. An active network contributes to the aims of this project in two ways: (a) by providing a network status awareness, which is part of the general context awareness, and (b) by allowing an improved network resource utilisation.

An essential aspect of CONTEXT work is the adoption of an end-to-end approach for service provisioning, from users to service providers and to the global Internet. A uniform way and underlying means for allowing the users to contract context-based services with service providers will be specified, complemented with the necessary intra- and inter-domain means for fulfilling and assuring the contracted service levels.

The CONTEXT project for context aware services

The *IST-CONTEXT* project (Active Creation, Delivery and Management of Efficient Context Aware Services, to begin Sept. 2002) [Context] main objective is to design, develop and assess innovative models and middleware solutions for an efficient provisioning of context-aware services making use of active systems technology on top of dynamically configurable Internet IP layer. This will allow the composability and dynamic adaptability of current and future context aware services for the benefit of the mobile user. There will be no need to develop services for “fixed” users specifically, since the “fixed” user can be considered to be a special case of the more general mobile one. From the technical point of view the CONTEXT solution will span into three domains, namely: the Service Layer (SL) domain, the Active Applications (AA) domain and the IPv6 domain. In the service layer domain, this project will deal with modelling of the information that expresses the context of services and establishing a framework for the creation of context aware services. The AA based solution, with appropriate APIs to control the IP domain, will allow the actual delivery of policy based context aware services.

In the Service Layer domain, CONTEXT aims

- to identify mechanisms for the definition, exchange and acquisition of contextual information
- to identify mechanisms for creating context sensitive services (binding of contextual information into services, thus creating context-sensitive services)
- to identify mechanisms for provisioning ‘contextualised’ services (based on the available provisioning means of the existing service infrastructure of the domain)
- to propose a policy-based framework for service management including configuration of the services according to the personalised user profiles
- to specify and implement the interactions with underlying (Active) Network Management Systems to facilitate personalised service delivery.
- to allow the enforcement of monitoring policies for Service Level Agreement management

In the Active Application Layer domain the CONTEXT aims

- to enhance active network technology in order to provide efficient delivery of context based services especially in the mobile network environment. This will be accomplished by specifying and developing an API on top of existing AN nodes to allow the following functionality:
- Provision of context information collected from the data plane (packet) and the management plane for the needs of context sensitive services and management. The information made available can include network characteristics, network policies to be made known to users/other networks, network charging principles/tariffs, network's current status and network resources available for the requestor.
- Utilisation of the context information for context sensitive (user) services
- Utilisation of the context information for policy-based active/programmable network and node management. For example, both the user and operator could place conditional actions (policy rules) for matching user applications with their immediate networking options.

Active networks as an enabling technology for context aware services

The network support for mobile users enjoying adaptive and context sensitive services places unprecedented demands for the network platform used. It is clearly unthinkable to statically configure every (access) node to support the individual service demands of every single mobile user, so the ability to dynamically instantiate personalised service functionality only when and where needed is a practical prerequisite. Currently there are not many networking paradigms daring to promise the fulfilment of this requirement: They are Active and Programmable Networking, including their derivatives. So the choice of the networking platform for our purposes can be narrowed down to the selection of the suitable form of active/programmable networking, with no viable alternative in sight.

The branch of programmable networking taken to a serious consideration in CONTEXT makes a separation between IP forwarding and control planes in an active node. This is in line with the IETF FORCES [FORCES] approach. The main idea is that the forwarding plane can be dynamically configured according to the instructions received from the control plane. The CONTEXT active node's control plane will support dynamically loaded code ("active code") that will indirectly use the control plane's power to configure the forwarding plane (within limits) and to extract context information from the network. Other options available for the active code will include the possibility to "grab" packets from the forwarding plane into the control plane for further examination, possibly triggering subsequent actions and/or packet content treatment. The packet, or a packet modified based on it, can also be sent back to network. The active code is the most important tool in implementing the context sensitive services, since the active code can be programmed to watch for context changes and to react on them. Say, to trigger forwarding plane configuring or other actions. The injection of the active code can be made subordinate to operator control, thus avoiding security problems that might otherwise arise.

Noteworthy other developments related to active/programmable networking include the recently developed paradigm of Mobile Agents (MAs). Although these concepts were introduced by different research communities to address different problems, they have started overlapping in focus and applicability. Next-generation service networks can benefit from active networking paradigm with the dynamic deployment of network services that can be tailored to the user's requirements using context. Besides, ANs distribute code to proxies at the edge of the network, as well as, to the mobile device, thus reducing the number of necessary network transactions to provide a service, by local processing and local service customisation.

The specific platforms currently under consideration are a variant of [ABLE] (The Active Bell-Labs Engine for Network Management) and LANE (Lightning Active Node Engine, VTT). Both have chosen a simple, practical minded approach to the programmable networking and support the general features as described earlier in this chapter. In addition, they have similarities in implementation. CONTEXT will deploy programmable network platforms in several member sites and implement the modifications and additions required for experimentation with context sensitive services to be defined based on the scenarios presented in the project's technical description.