Configuration Management for Networked Reconfigurable Embedded Devices

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Abstract. Distribution of product updates to embedded devices can increase product lifetimes for consumers whilst increasing revenues and brand loyalty for vendors. Dynamic provisioning of application solutions to embedded devices are complex due to their heterogeneous nature. This paper proposes a configuration management architectural framework which incorporates a mobile agent based push methodology for networked reconfigurable embedded devices. FPGAs (Field Programmable Gate Arrays) are hardware components within embedded systems that can be dynamically reconfigured. Product updates are composed of both software and reconfigurable hardware code which can be tailored to the physical constraints of the device. Push technology is a distribution mechanism initiated by the vendor enabling delivery of product updates. The proposed infrastructure is built upon the solid foundations of agent-based design patterns. Agent technology provides an ideal environment for embedded systems management. Mobile agents completely encapsulate hardware-software based solutions providing a coherent abstraction for their distribution. The paper also outlines an initial demonstrator system.

1 Introduction

Current and future generations of high performance embedded devices (e.g. PDAs) demand a broad range of end-user applications. Embedded system designers are responding to these consumer pressures with the development of networked reconfigurable embedded devices capable of providing a range of high-performance, compute-intensive applications. Each application is composed of a hardware-software mix configured to deliver optimum performance for the user whilst also respecting the physical constraints of the device. FPGAs are hardware components playing a key role in the construction of these embedded devices. They are a reconfigurable hardware technology with the ability to perform computations in hardware to increase performance whilst retaining much of the flexibility of a software solution [1].

Increasingly intense competition combined with time-to-market pressures compels embedded device manufacturers to release early product versions to guarantee adequate market share. Full-product functionality is then achieved in the market-place through a configuration management technique of distributing hardware-software based updates and patches. Push technology is a distribution mechanism initiated by the vendor enabling delivery of product updates to embedded devices.
Embedded systems are evolving and demand more proficient development methods and tools for their design, deployment and management [2]. A flexible, robust and proactive distribution framework is especially required to allow vendors confidently disseminate their updates and modifications to customers after initial product releases. All updates should interoperate seamlessly with the embedded device ensuring minimal disruption to the customer.

This paper builds upon our previous work [3] and proposes a configuration management architectural framework incorporating a mobile agent based push methodology for networked reconfigurable embedded devices. This innovative approach identifies agent technology as an ideal environment for embedded systems management. It asserts this approach is particularly suitable as a push-based distribution mechanism for embedded devices. A push strategy utilising agent technology allows for the coherent distribution of hardware-software application solutions to networked embedded devices. An agent-based middleware framework is efficient in its use of network bandwidth and is flexible in dealing with intermittent network connections. These characteristics are highly beneficial for mobile wireless embedded devices. Agent technology also encourages management decentralisation minimising the load on the network management centre and thus reducing points of failure within the network [4].

In the rest of this paper, an examination of related work in this area is presented (Section 2). The third section presents an overview of the configuration management distribution methodology proposed for networked reconfigurable embedded devices. This section highlights the architectural framework, explores the design patterns employed and describes the technologies utilised to realise the overall system. In section four an experimental prototype currently being constructed is depicted. Finally, section five concludes with remarks on future research.

2 Related Work

Push technology has been applied within various research communities as an architectural paradigm for data dissemination.

Telecommunications research has explored the push concept as a method for the provisioning of configuration settings to mobile phones [5]. The wireless application protocol (WAP) and the GSM short messaging system (SMS) are combined to provide the implementation framework. A beneficial scenario is highlighted whereby the hand-held devices belonging to selected personnel at a disaster site are automatically adapted for specifically directed emergency communications.

Parallel computing has also been exposed to the potential of push-based technology. In [6], a novel mobile agent-based push methodology is proposed within the supercomputing domain. This approach allows users to dispatch their jobs as agents who roam the network seeking servers on which they can execute their task. This is advantageous as it produces an adaptive and fault tolerant execution model.

Push-based technology also plays a key role within the configuration management community [7]. A push-based distribution strategy enabling software deployment utilising a mobile agent framework is presented. Key benefits of an agent-based ap-