Report on an Exchange Visit Funded by PerAda

Between NXP Eindhoven and Edinburgh Napier University

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Background

A relationship between NXP, Eindhoven and Edinburgh Napier University has developed over a number of years. It started as a result of the research being undertaken in the School of Computing into parallel process based systems using communicating process architectures. The key novel element of the research is the capability for process mobility [Chalmers 2009]. This has the advantage that a system can move processes to processing nodes that are more appropriate for the task envisaged. Implicitly, this also requires the ability to either move communication channels or to create communication channels dynamically as the processes moves around the system. A capability was developed that could be used to create pervasive adaptive systems [Kerridge 2008]. An agreement was reached between Edinburgh Napier and NXP to fund a joint PhD research programme investigating the use of CSP based architectures [Hoare 1978] in pervasive adaptive systems. Anna Kosek was subsequently appointed to this position. Anna completed her first year of studies at Edinburgh Napier University from January 2008 to January 2009. From February 2009 she has been working on her project at NXP.

NXP has, from January 2009, been a member of the SOFIA[1] (Smart Objects For Intelligent Applications) EU ARTEMIS funded project which is investigating the creation of capability for smart environments. The project is investigating the use of pervasive systems in the application areas of Personal Spaces including mobility, Smart Indoor Spaces and Smart Cities. Integrative service components that cover User Interaction and Interfaces, Architecture and Application Development are also being undertaken. NXP's primary involvement is in the area of Architecture Development for Smart Indoor Spaces. The specific pilot application domain concerns the creation of smart lighting systems for indoor applications. Prior to joining NXP, Anna, had been working on architectures that could support pervasive applications for smart buildings, including lighting. These initial investigations showed that it is possible to create a system that allows dynamic addition of new capabilities and components by discovering existing services and augmenting them automatically. An overview of the architecture is presented in [Kosek 2009].

Discussions

One of the aims of the SOFIA project is to produce an ontology of smart devices that can be used over the full range of application environments. It will therefore provide a means for interoperation amongst such smart devices. The specific goal of the work based at NXP will be to determine how this ontology can be used to create a specific Knowledge Base in a smart device instance. This knowledge base can then be used to ensure that the device responds to any messages it receives in the most appropriate manner. Underpinning this capability is the desire to use a CSP based design methodology so that highly parallel scalable systems can be created. Perhaps, more importantly, the use of CSP means that we can build models of both the devices themselves and the control system with which they interact. These models can then be checked automatically to ensure deadlock and livelock freedom using model checkers such as SPIN [Holzmann 2003]. The requirement is to produce devices that can be simply

[1] www.sofia-project.eu

plugged into an existing infrastructure without the need of complex integration procedures involving a lot of human intervention. This means that a device has to be able to associate itself with the environment, determine its existing capabilities and then identify ways in which the new capability can be used by existing devices.

To achieve this requirement every device will need some form of processing capability. For simple devices such as lights and switches this processing capacity should be as lightweight as possible using mass produced silicon that does not required the use of a CPU, if at all possible. Some devices may need additional processing capability. In this case, the required process(es) will be contained within the hardware on the device but not executable by the device. As part of the introduction process, the device will download the required process into the associated control system environment, which is assumed to have sufficient processing capability available. The processes downloaded may include an agent that is able to interrogate the Knowledge Base of the existing devices to determine the current devices and their capabilities. In this manner, new devices are able to discover existing device services and, where appropriate, modify their Knowledge Base to add the new capability to the existing devices. Initially, some devices may not be able to use the new capability, but, when replaced, new devices may find they have the ability to use this service that is now part of the system. For example, a controller may be added that allows manipulation of the colour of lights. An existing light may not have this functionality. In due course, when this light is replaced, the new light may have this ability. Thus the new light can associate itself, using the mechanisms described above, with the colour controller so that it can respond to colour change messages. The project being undertaken by Anna Kosek is not formally part of the SOFIA project but is able to build upon outputs from SOFIA and also to generate inputs to SOFIA based on the research undertaken in her project.

It is proposed to use a staged development programme, which will also reflect the manner in which more sophisticated devices are likely to be created by device manufacturers. The smart device capability is one with which current device manufacturers are unfamiliar and it will take some time for them to become comfortable with the proposed smart device environment. Hence it is likely that more sophisticated devices will only become available after some initial confidence building activities. A staged development programme reflects this likely phenomenon. It will also demonstrate that functionality can be added to an existing system retrospectively.

Feedback to the SOFIA Project

This project will provide feedback to the SOFIA project in a number of ways. A non exhaustive list would include:

Commentary on the structure of the ontology and the ease with which ontological information can be extracted and used in the Knowledge Bases contained within the devices. This is particularly with respect to the ability of a knowledge base to be populated with data that can be interrogated by non-CPU based device hardware.

To identify device types that can utilise non-CPU based hardware to interact with the remainder of a pervasive system and hence to identify the hardware/software divide amongst device types.

The need for a Certification Authority may be indentified such that as manufacturers develop new devices then they have to submit the CSP / Spin model for checking and certification. Certification would guarantee that the implementation of the device would not cause an existing installation to fail in terms of deadlock and livelock.

Defining a Demonstration System

The project will use simulations of various devices to show the approach is feasible. Such software based simulations are inappropriate when trying to convince non-specialists of the feasibility of the approach. One of the outputs of the project shall be a specification of a demonstration system that can be constructed using real demonstration hardware, which while it does not contain the final target silicon, does have a hardware emulation of the target silicon.

References

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