Networks for Reconfigurable Embedded Systems

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Activity on Dynamic and Pervasive Networks

Workshop report

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Motivation

Reconfigurability has long been recognized as a way to improve efficiency in the use of system resources, for example, when a system undergoes variable load situations, when it evolves during its lifetime or even when faults affect part of its structure. This means that reconfigurability, in a broad sense, may be beneficial to areas that range from Quality of Service (QoS), e.g., when the number of system users varies, to Dependability, e.g., through graceful degradation.

However, achieving reconfigurability may conflict with operational goals such as continued real-time and safe operation, and it becomes more difficult when the system is distributed, requiring adequate support from the network. Hence, whenever either of those two operational goals are relevant, the typical option has been to rely on a single static configuration. In some cases, reconfigurable solutions have been devised but limited to few predefined operational modes, thus still with reduced flexibility and efficiency. The use of more flexible mechanisms has been considered, mainly, when those goals were not critical, such as in non or soft real-time operational scenarios, only.

Therefore, more flexible approaches to reconfigurability are needed to improve resource efficiency in a vast range of applications, exploiting paradigms such as flexible modes, flexible scheduling, dynamic QoS management, stateful schedules, etc, particularly at the network level. This opens the way to keep costs low while improving dependability as the overall system complexity increases.

Finally, other domains exist, such as wireless sensor networks, mobile ad-hoc networks and ubiquitous computing, in which reconfigurations are unavoidable thus the problem is how to support real-time and dependable operation under changing topology, asymmetric links and openness to interference.

Goal

The goal of this workshop was to bring together people from industry and academia to:

- discuss the motivations, interest and challenges of reconfigurability in distributed real-time embedded systems;
- deduce the network requirements to support flexible reconfigurability under real-time and safe operation;
- discuss the adequacy of existing protocols and middlewares;
- discuss how to provide real-time communication in highly flexible networks and identify the potential of current protocols;
- deduce further network requirements to support real-time communication in highly flexible networks.

Format

The workshop was based on short presentations by the participants to encourage discussion. Papers were not required.

Attendance

The number of registered participants was 26, a number adequate to the proposed format (see annex A). The affiliation was mainly from academia or research institutions, with just one industry representative, namely from PT-Inovação, the research and development branch of Portugal Telecom. However, three of the academic participants brought to the workshop industrial case studies carried out in joint projects with industry. The countries of origin were 6, with most participants coming from Portugal (4 institutions) and Spain (5 institutions), but also with participation from Italy (2 institutions), Sweden (2 institutions), France (1 institution) and Mexico (1 institution). Their areas of interest ranged from automotive systems to industrial automation, telecommunication systems, cooperative mobile robotics, distributed control system and digital systems design.

Program

The workshop counted with 5 sessions and an opening address by Luis Almeida. The first two sessions were dedicated to flexible middleware, namely based on components, on resource contracts, on services and on the support for flexible scheduling, the following session was dedicated to diverse topics, from dependability to integration and wireless mobile ad-hoc networks for robot coordination, another session was devoted to industrial perspectives focusing on intelligent telecommunication networks, on industrial automation and on automotive systems, and finally the last session was devoted to control systems, including the presentation of one work in the scope of avionics systems.

Altogether there were 13 presentations (see annex B). The sessions included between 2 and 3 presentations and were separated by sufficiently large discussion periods. The discussions are summarized in the annex C.

Conclusion

The goals of the workshop were ambitious but the ample discussions fostered during the event were appreciated by the participants. In this respect, the workshop was rather successful. It also succeeded in bringing together people from industry and academia involved in different application areas to discuss issues related to dynamic reconfiguration in distributed embedded systems. In the large spectrum of application domains covered it was possible to identify difficulties, limitations and potential for the use of dynamic reconfiguration mechanisms in practice. In particular, it was referred that a taxonomy integrating all the different perspectives is still missing, so as appropriate metrics to evaluate the levels of reconfigurability. Moreover, the extra complexity added by dynamic reconfiguration mechanisms may impact negatively on the system fault-tolerance, on one hand, and on the willingness of end-users to deal with such systems, on the other. These aspects, however, do not seem to be fundamental obstacles and it seems that there are ways of circumventing them that need to be further explored.

Whilst there are still some problems to solve, as referred above, all participants agreed on the potential benefits of using dynamic reconfiguration, either for dynamic QoS management or to manage overloads, or even to provide adaptation to faulty scenarios. They also agreed on contributing to write down a draft on a possible taxonomy for Dynamic Reconfiguration, which we will try to coordinate, as a follow up of the workshop.

Annex A – Participants List

Annex B – Program

Annex C – Summary of the discussions