Information Societies Technology (IST)

Advanced Research and Technology for Embedded Intelligence in Systems

WORKING DOCUMENT

Reference Designs and Architectures
-
Priorities Analysis

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7/7/2006	1.0		First draft – Results from the ARTEMIS Summer camp
18/7/2006	1.1	Alun Foster	Incorporation of first feedback, text augmentation and additional comments

Table of Contents

1 INTRODUCTION

The Strategic Research Agenda (SRA) developed, though open consultation, by the members of various ARTEMIS working groups, contains an extensive list of research topics that are felt to be the most important issues to be tackled in the short to medium term. As a refinement that will help guide proposers of projects in the short term that wish to refer to the ARTEMIS SRA, ARTEMIS members delegated experts to an extensive working session, during which the priorities for the short term were put forward and discussed for each of the major industrial SRA domains. The results of this workshop are documented in this and two accompanying documents.

The research topics identified as most urgent may be taken as a guide when proposing research projects for execution under the Framework Programme 7 of the European Commission, under the EURKA clusters ITEA-2 or MEDEA+, or indeed under locally focussed research projects. In all cases, the results will contribute to the long-term objectives of ARTEMIS.

2 RANKING OF THE PRIORITIES

The priorities have been ranked by the organizations represented at the Summer Camp as follows : (the left hand column shows the relevant paragraph(s) in the ARTEMS SRA. For Reference Designs and Architectures)

4.1	Composability	48
4.3	Architecture dependability	30
4.3 / 4.4	Design for Safety	23
4.3	Design for Manufacturing limitations	14
4.1	Reference architectures for Parallel systems	13
4.1 (*related to DM&T)*	Multi-aspect Trade-off in Designs	11
4.5	Resource management	11
4.2	Design for (Inherent) Security	10
4.7	Self Organisation	10
4.2	Networking	8
4.5	Resource Virtualisation	5
4.5	“Service Platform” concept	4
4.1 *(related to DM&T)*	Reference architectures supporting “X in the loop”	3

Priorities have been split into the following categories:

1. Highest priority
    - Composability
    - Architecture Dependability
    - Design for Safety
2. High priority
    - Design for Manufacturing limitations
    - Reference architectures for Parallel systems
    - Multi-aspect Trade-off in Designs
    - Resource management
    - Design for (Inherent) Security
    - Self Organisation of systems

Mapping these topics (and their sub-topics as discussed in the meeting) to the research priorities of the SRA shown below, we identify the following relations:

- Composability: directly addressed here for various topics; covers (in part) *Design-for-Safety*, *Multi-aspect Trade-off*, *Architectures for Parallel Systems*, *Service Platform Concept*, *Resource Virtualization*,
  X-in-the-Loop, *Design for Manufacturing Limitations*;
- Networking and Security: directly addressed here in two separated topics;
- Robustness: directly addressed in *Architecture Dependability*, together with fault handling, error containment, diagnosis, and maintenance; covers in part *Design-for-Safety*;
- Diagnosis and Maintenance: cfr Robustness
- Integrated Resource Management: directly addressed here; covers in part *Design-for-Safety*;
- Evolvability: included here as advanced topic in *Composability*;
- Self-Organization: directly addressed here;

Given this mapping, we see that the RDA SRA compiled a valid overview of the research deemed necessary by the contributing ARTEMIS partners. Additionally, we use the results of the summer camp to provide additional priorities and pointers to areas of interest, as laid out in the second section of this document.

It is also noteworthy that the interrelations between the topics as well as between architectural concerns and the areas of seamless connectivity and design methods and tools were stressed by several speakers. While some partners might accept improvements in regard to one topic on the expense of others, most will not and require more holistic approaches. In similar lines of thought, one might expect the integration of the three areas of the SRA to be an enabling approach to sustainable solutions of greater impact.

HIGHEST PRIORITY TOPICS FOR REFERENCE DESIGN AND ARCHITECTURES

Based on the presentations of industrial partners at the ARTEMIS Summer Camp 2006 and intensive discussions among the participants, the following research priorities have been identified. These priorities are felt to be the “most urgent”, meaning that research results in the fairly short term (timeframe <2010) are needed for the ARTEMIS goals to be met.

2.1 Composability

Composability, which was given the highest priority, is a concept that relates to the ease of building systems out of subsystems. A system, i.e., a composition of subsystems, is considered *composable with respect to a certain property* if this property, given that it has been established at the subsystem level, is not invalidated by the integration. Examples of such properties are *timeliness* or *certification.*

The composition of a system out of heterogeneous components that are interconnected by an appropriate interconnection structure requires e.g. the following enablers: scalable, network-centric architectures; integration of several programming models and languages; precise specification of interfaces of components and modules.
Additionally, advanced topics like reconfigurable components, or evolution of architectures are beneficial in this context. Composability on the architectural level requires supportive tools and methods such as Architecture Description Language and appropriate component models.

Chapter 4.1 of the ARTEMIS SRA / Reference Designs and Architectures (P20) gives full details of the research priorities addressing “composability”.

For the Nomadic application domain, the “Service Platform” concept, reference architectures for Parallel Systems and Resource Virtualisation were reported to be the most important issues under “Composability”.

2.2 Architecture dependability

At the next level of importance architectural dependability has been identified. Architectural concepts are needed that ensure the capability of a system to deliver an acceptable level of service despite the occurrence of transient and permanent hardware faults, design faults, imprecise specifications, and accidental operational faults. A system must be resilient with respect to unanticipated behaviour from the environment of the system or of sub-systems. In case such unanticipated behaviour occurs, the system should still exhibit some sensible behaviour, and not be completely unpredictable. Fault-handling, error-containment, and fault masking are suitable strategies to achieve these goals.

The architecture should support monitoring the functionality and performance of components for the diagnosis of faults. Reliable identification of failed subsystems can be used for the autonomous recovery of the system service in case a subsystem failure is transient, and support maintenance in case the failure is permanent.

Architecture dependability is a combined priority of the SRA chapters 4.3 on Robustness, and 4.4 on Diagnostics and Maintenance. Indeed, to quote the SRA “*the subsequent section on Diagnosis and Maintenance must thus be considered an integral part of the effort to achieve robustness”.*

The Nomadic application context identified these topics rather as medium priority, along with Diagnosis and Maintenance and Evolvability.

See also the Additional Note in section 2.4 below.

2.3 Design for Safety – Transportation Industry-driven: Safety-critical systems

The architecture shall enable the implementation of safety critical systems. In addition to the required dependability and functionality of the provided services this puts emphasises on architectural support for certification, and the establishment of a safety case. Since a safety-critical system cannot be tested to the required level of dependability, the safety argument is based on a combination of experimental evidence about the expected failure modes and failure rates of fault-containment regions and a formal dependability model that depicts the system structure from the point of view of dependability. The architecture must enable the construction of such a dependability model.

Safety is of course a critical implication of the use of embedded systems. While safety-critical system design has already a successful history, the existing techniques risk not being able to follow well the rapid evolution of markets and technology limitations presently seen. It therefore remains a high-profile area of research. Like “dependability”, it combines aspects of the chapters 4.3 (Robustness) and 4.4 (Diagnostics and Maintenance) of the ARTEMIS SRA for Reference Designs and Architectures.

2.4 Additional note on high-reliability systems

Sections 2.2 and (in particular) 2.3 both address the requirement for very high reliability systems. While it is true that much valuable research work and field application of high-reliability systems has already been achieved, it is commented that the techniques at today’s state-of-the-art do not necessarily map well to systems designed to meet newly emerging requirements (e.g. in application contexts other than the transportation industry). The new issues raised by the inherent unreliability of nano-meter silicon devices brings another dimension that must be taken into consideration. The increasing pressure to achieve levels of system robustness normally associated with very high-priced markets in products that must live in a consumer environment, with its very tough and elastic price structure, further emphasises the need to address these issues.

3 TOPICS WITH HIGH PRIORITY

At the next level of importance the following topics were identified:

- Design for Manufacturing limitations
- Reference architectures for Parallel systems
- Multi-aspect Trade-off in Designs
- Integrated Resource Management
- Design for (Inherent) Security
- Self Organisation of systems

In addition, the Nomadic application context identified Networking and Security as a high priority research topic.

The relevant chapter references in the ARTEMIS SRA for Reference Designs and Architectures can be found in the table in section 2.

4 RECOMMENDED APPLICATION DRIVERS

The following list captures application drivers that participants to the ARTEMIS Summer Camp felt important to target, for development and valorisation of the ARTEMIS developed technologies.

Note: These are SUGGESTED, NON-PRIORITISED APPLCATIONS which can serve to use/prove results of ARTEMIS developed technologies. This is NOT an exclusive list, and it does NOT represent a mandatory set of requirements for research projects.

4.1 Transportation

Safety and efficiency
Also covering systems for engine/motor control for fuel efficiency and reliability
Travel assistance

4.2 Production and logistics

Covering the integration of autonomous process controls, sensor arrays, RFID etc…

4.3 Social and Health solutions

Mobile, remote, stationary

4.4 Communication Networks

Autonomy, self-organisation, ubiquitesness, security

4.5 Smart Systems

Sensors and Actuators
Evolution of Smart Cards