C O M B E S T

COMponent-Based Embedded Systems design Techniques

COMBEST will provide a formal framework for component based design of complex embedded systems: 1) formal integration of heterogeneous components; 2) encapsulation of components; 3) prediction of emergent key system characteristics; 4) corresponding certificates.

KEYWORDS: formal frameworks, component based design, complex embedded systems, formal integration, heterogeneous components, models of communication, models of execution, encapsulation functional properties, extra-functional properties, composability, compositionality, system characteristics, performance, robustness, distributed HW-architectures, design theory, heterogeneity, interface specifications, SPEEDS, rich components, compositional analysis

At A Glance: COMBEST

COMponent-Based Embedded Systems design Techniques

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Duration: *36 Months*
Start: 2008.01.01
EC Contribution: € 2.75 M€

Contract Number: STREP 215543

Main Objectives

COMBEST will provide a formal framework for component based design of complex embedded systems. This framework will:

1. Enable formal integration of heterogeneous components, such as with different models of communication or execution;
2. Provide complete encapsulation of components both for functional and extrafunctional properties and develop foundations and methods ensuring composability of components;
3. Enable prediction of emergent key system characteristics such as performance and robustness (timing, safety) from such characterizations of its subcomponents;
4. Provide certificates for guarantees of such key system characteristics when deployed on distributed HW-architectures

COMBEST will focus on formal integration of heterogeneous components.

To achieve these objectives, COMBEST will:

- Develop a design theory for complex embedded systems, fully covering heterogeneity, interface specifications, composability, compositionality, and refinement for functional and extra-functional properties
- Build on substantial highly recognized background results of the academic partners, partly carried out within the integrated project SPEEDS;
- Extend results of the Integrated Project SPEEDS, both regarding heterogeneous rich components and compositional analysis methods.
- Collaborate with the best US groups in embedded system design to build critical mass in a strategic area of vital interest to the European industrial ecosystem.

Technical Approach

The project pursues a dual approach, combining fundamental work with methods and tools for rigorous embedded systems design.

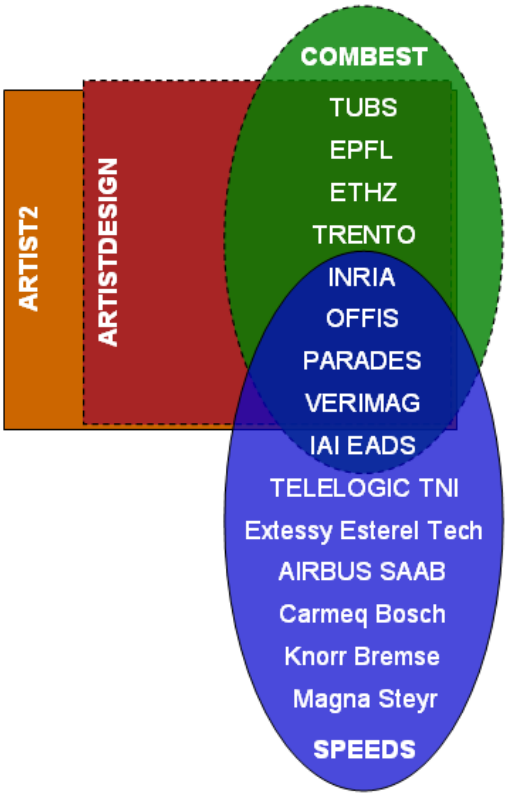
The fundamental work in COMBEST studies component-based design, by tackling two main problems:

- Developing frameworks for the composition of heterogeneous components.
- For such frameworks, develop theory allowing constructivity: inferring global properties of a system from the properties of its components.

The methods and tools developed use results of the theoretical work, to ensure a rigorous design for heterogeneous systems.

The tools cover modelling, verification, and performance analysis. Their use is supported by a global design methodology.

In addition, we use two case studies, provided by industrial partners, to evaluate the relevance and applicability of the tools.



Key Issues

For embedded systems, component-based design techniques should address both hardware and software components in a unified way. They should be able to handle hard constraints on performance and dependability as well as dissimilarities between levels of abstraction and communication primitives. The two main difficulties to handle are:

• The presence of *heterogeneous components*. In software engineering, components are mainly used for structuring functions and associated data. In contrast, hardware components are inherently parallel, and synchronous.

• *Predictability* of basic properties of the designed system. We argue in favour of constructivity, which is reasoning about global system properties based on properties of its individual components. Constructivity should allow satisfaction of essential properties by construction, to avoid costly a posteriori global system validation.

Providing formal frameworks which overcome these difficulties is only a first step towards disciplined system design. It is essential that theoretical results be integrated in coherent component-based design flows, validated through comparison with existing industrial practice. Furthermore, theoretical results should be implemented in scalable supporting methods and tools.

Expected Impacts

COMBEST will deliver significantly advanced technology for strengthening European excellence in embedded systems design. COMBEST will provide the basis for mastering holistic design methodologies, allowing European industries to maintain and even improve their technological leadership.

More specifically, we expect a positive impact for:

- **Component re-use and domain independence**. The emergence of component-based design as the primary design method for embedded system should allow component reuse across multiple domains. A concentration of the efforts in the European supplier industry will become possible due to emergence of cross-domain tools and methods. This reduction of fragmentation and the focused use of resources will speed up the development cycles in the supplier industry.
- **Decreased development cost**. Decreasing the development cost is of particular importance in Europe, which tends to have a competitive disadvantage due to high cost of labour.
- **Decreased time-to-market**. A shorter time to market will give the European industry is a decisive competitive advantage in today's fast paced business world.