FP7-ICT-2013- 10 (611146) **CONTREX**

Design of embedded mixed-criticality CONTRol systems under consideration of EXtra-functional properties

Project Duration 2013-10-01 – 2016-09-30 Type IP

WP no.	Deliverable no.	Lead participant
WP6	**D6.1.1**	**ECSI**

Plan on Training Activities

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History of Changes

ED.	REV.	DATE	PAGES	REASON FOR CHANGES
AM	0.1	2015-04-07	10	Initial version
SC	0.2	2015-05-04	16	Input integration
AM	1.0	2015-05-08	18	KTH/POLIMI/UC new input integration and final version production

Contents

1 Introduction

This deliverable describes the CONTREX consortium plan for training delivery. The consortium envisage to develop four types of training activities, they will be undertaken by a set of CONTREX partners or individually by some partners:

- Specific training on tools and methods (prepared and delivered by individual partners or set of partners)
- Tutorial material
- Web training material comprising e.g. videotaped tool demonstrations, tutorials
- Consortium training (at workshops and conferences)

The document is organised as follows: in the second section the target audience for training activities is discussed; in the section 3 currently planned training activities are described in the above discussed categories.

2 Scope and Target Audience

2.1 Target audience

For each training material and action the consortium will define the addressed target audience (initially planned and effectively participating in the training) according to the following classification:

Type	Domain	Main Targets
System Companies (Europe, WW)	Aeronautics / Aerospace	EADS / Airbus / Astrium / Thales / ThalesAlenia / Selex / GMV
	Automotive	OEMs
	Communication / Networking	Ericsson, NSN, Axis
Application developers	Aeronautics	Thales, ThalesAleniaSpace, Astrium
Subsystem Providers (Tier 1, Subsystems)	Aerospace	Thales Communication
	Automotive	Bosch, Continental, Valeo, Magneti Marelli, Melexis, …
Microelectronics	All domains	ST, Infineon, Intel, Freescale, Renesas
IP/VIP Providers	All domains	ARM, Imagination, Synopsys IP, Cadence IP
EDA / Tools	System / HW / SW	Magillem, Calypto, Agilent, NEC, Intel CoFluent, Big 3, Mirabilis, Wind River, Green Hills
Research	System / HW / SW	Relevant research / university (all Europe)

2.2 Measures of Efficiency

In order to estimate how useful the training actions were, the CONTREX consortium will provide some measures with each training activity:

Training Means	Measures of Success	Qualification
Training Sessions	# Participants Participant profile Follow-up	• Industry: management/engineering • Academia
Training Material (e.g. web courses, videos)	# Downloads Geographical regions Domains .com, .edu	
Hands-on Demos	# Participants Follow up	• Industry / Academia • Industry type, managment, engineering, research
• Cooperation in standardisation bodies • Workshops	# Proposals submitted # Proposals adopted Workshop success	Overall impact of proposal on final standard
Training	# Training visitors # Inquiries / maintenance / applications	• Usage: evaluation / production test / production, large deployment • Interactive / exchange

3 Training Material

3.1 Specific training on tools and methods (prepared and delivered by individual partners or set of partners)

3.1.1 ForSyDe Training for Intecs

KTH has trained Intecs in using the SystemC modelling libraries for ForSyDe to be able to model parts of their use case in SystemC ForSyDe. The training has been conducted in two training sessions online using a web conference system, and by self-studies of the Intecs employees using the online tutorials of ForSyDe (Section 3.3.1).

3.1.2 Training on the UML/MARTE modelling methodology

UC presented the modelling needs and the former version of the MARTE extension in the first MCS workshop of the project cluster in July, 2nd 2014 in Brussels.

UC also presented the UML/MARTE modelling methodology to the CONTREX partners in the Oldenburg technical meeting in December 2014, including the advances in CONTREX.

UC introduced OFFIS in a F2F meeting (Hipeac) and to GMV (via Telcos and offline via e-mail and modelling diagrams) further insights on how the use case models can be effectively captured relying on the UML/MARTE modelling methodology.

3.2 Tutorial material

3.3 Web training material comprising e.g. videotaped tool demonstrations, tutorials

3.3.1 Online Training Material ForSyDe

The ForSyDe web page offers training material for the ForSyDe modelling libraries, which are available for the languages SystemC and Haskell. In particular the following tutorials are relevant for CONTREX and have also been used by Intecs inside the CONTREX-project:

- Synchronous Dataflow MoC Tutorial (SystemC)
- Synchronous MoC Tutorial (SystemC)
- Getting Started with ForSyDe Tutorial (Haskell)

All tutorials are available via the ForSyDe web page: https://forsyde.ict.kth.se

3.3.2 Online Training Material for BBQ-RTRM

The BBQ web page offers training material for the usage and porting of BBQ run-time resource manager within applications and platforms. In particular the following tutorials are relevant for CONTREX:

- BBQ: A quick start from source code to build.
- Run-Time Adaptivity and Monitoring Library
- Using MOST-DSE tool to characterize applications for Run-Time Management
- Cross-compilation for ARM multicore architecture

3.3.3 Online Training Material for the UML/MARTE modelling methodology

UC already has a publically available a set of documentation in http://essyn.com/portfolio/ , which is background material. There, a UML/MARTE modelling methodology manual, an introductory short guide, and a flier are available. This documentation is a result of previous research an immediately available to partners. In deed, this modelling methodology documentation is within the site of the system-level synthesis framework called eSSYN (www.essyn.com). The enhancements and extensions done in CONTREX are being accompanied by an improved documentation and site infrastructure (both in content and structure). The plans for such an improvement are detailed in section 5.1.

4 Lectures & University Courses

4.1 Project Group Avionic Architecture

Course offered at: Carl von Ossietzky University Oldenburg
Course interval: It is offered every two years
Data of 1st pass: April 2014 – March 2015
Data of 2nd pass: To be planned
Link: http://www.uni-oldenburg.de/avionic-architecture/

Figure 4-1 Project Group Avionic Architecture 2014/15

Organization:
Wolfgang Nebel - Carl von Ossietzky University Oldenburg
Achim Rettberg - Carl von Ossietzky University Oldenburg
Malte Metzdorf – OFFIS
Henning Schlender - Carl von Ossietzky University Oldenburg
Sören Schreiner – OFFIS

Description:

The master degree program in computer science of the Carl von Ossietzky University Oldenburg contains the obligatory visiting of a project group. This university lecture gives 6-12 students over 12 month an overview of performing a task in a best practice, industrial way. It covers state-of-the-art methods for planning, implementing and testing today's systems. The range of the task and amount of overall work is chosen by the number of students who are signed on the lecture. The lecture covers the following topics in detail:

- Phases of an industrial workflow
- Project management techniques
- Requirements engineering
- Process models

- Testing methods
- Implementation of a prototype
- Documentation and presentation

CONTREX related contents:

In the project group Avionic Architecture 12 students developed an avionics for a multi-rotor system, which is based on a Xilinx ZYNQ Multiprocessor System-on-Chip (MPSoC). The postulated result of the course was to get a stable flying system, which uses the processing power of the MPSoC not only for the flight algorithms but also for another performance needing on-board task. The students decided to implement an on-board video processing task. With the use of a 3-axes camera gimbal the camera tracks a coloured football, while the multi-rotor is flying and piloted remotely. In that way the students implemented an architecture for the used MPSoC, which is able to serve a mixed-critical system. In summary, the lecture covers the following project related contents:

- Methods to build architectures which are capable to process tasks of mixed-criticality
- Building a flying demonstrator
- Model-driven development
- Handling with extra-functional properties

4.2 Low Energy System Design

Course offered at: Carl von Ossietzky University Oldenburg
Course interval: It is offered every winter semester.
Date of 1st pass: October 2013- February 2014
Link: http://www.uni-oldenburg.de/?id=35149

Organization:
Ralf Stemmer - Carl von Ossietzky University Oldenburg
Domenik Helms – OFFIS
Malte Metzdorf – OFFIS
Patrick Knocke – OFFIS
Lars Kosmann – OFFIS
Reef Eilers – OFFIS

Description:
This lecture gives an introduction to the topics of power estimation and power optimization for integrated circuits. During this course students will:

- get insight into the general problem of power dissipation (dynamic and static) and its main sources in today's transistor technology
- acquire a deep knowledge of requirements-driven design of embedded systems
- get knowledge of state-of-the-art power analysis and power optimization techniques
- get practical experience using design and analysis tools for power
- get practical experience with low power design flow

CONTREX related content:
Beside a general introduction of power estimation and optimization, the lecture presents CONTREX relevant topics:

- software-power estimation basics
- model generation and data abstraction techniques
- modelling and estimation of temperature for ICs
- modelling and estimation of reliability for ICs

4.3 System-Level Design

Course offered at: Carl von Ossietzky University Oldenburg
Course interval: It is offered every summer semester.
Date of 1st pass: April 2014 – July 2014
Date of 2nd pass: April 2015 – July 2015
Link: http://www.uni-oldenburg.de/?id=35150

Organization:
Kim Grüttner – OFFIS
Philipp A. Hartmann – OFFIS
Ralph Görgen – OFFIS
Daniel Lorenz – OFFIS
Philipp Ittershagen – OFFIS
Maher Fakih – OFFIS
Ralf Stemmer - Carl von Ossietzky University Oldenburg

Description:
This master course extends the basic courses on embedded system that give an overview on the design of hardware/software systems. It covers state-of-the-art methods and tools for the design of today's systems. In a practical part, an introduction to SystemC is given, which is otherwise not covered in depth at the University of Oldenburg. Based on SystemC, the modelling of virtual prototypes at Transaction-Level is given. The course covers the following topics in detail:

- Phases of a System-Level Design Flow
- Refinement and Transformation of an initial specification towards a real implementation
- Current design methods and tools
- (Formal) Models of Computation used for specification and analysis
- Partitioning and parallelization of applications
- Evaluation and exploration of design decisions
- Modelling if system components and architectures based on system-level design languages (SpecC, SystemC)

CONTREX related content:
Besides a general introduction to system-level design in general, the lecture presents CONTREX relevant topics. Furthermore, project results are directly integrated into the lecture. In summary, the lecture covers the following project related content:

- Transaction-level modelling of applications and architectures
- Modelling and abstraction of extra-functional properties of a system
- Design-Space Exploration techniques and tools
- Virtual prototyping in SystemC

4.4 IL2206 Embedded Systems

Course offered at: KTH Royal Institute of Technology

Course interval: It is offered every winter semester.
Credits: 7.5 ECTS credits
Number of students: 100
Link: https://www.kth.se/social/course/IL2206/

Organization:
Ingo Sander – KTH Royal Institute of Technology
Kathrin Rosvall – KTH Royal Institute of Technology
Hosein Attarzadeh – KTH Royal Institute of Technology
George Ungureanu – KTH Royal Institute of Technology

Description:
The course IL2206 Embedded Systems is given at master level at KTH Royal Institute of Technology. The course addresses the design of embedded systems with a focus on real-time. The course has the following main topics:

- Embedded computing platform
- Memory system
- Inter-process communication
- Introduction to real-time systems
- Software acceleration

CONTREX related content:
Although the main objective of the course is to give an introduction to embedded system design, the course aims to provide the necessary information, why it is so difficult to design real-time systems with guaranteed performance on state-of-the-art processors and multi-processor. Special focus is put on the sources for unpredictability in the memory system (cache) and communication architecture (shared bus and shared memory). Thus the course gives the foundation for a more elaborate discussion of real-time software design in the follow-up course IL2212 Embedded Software.

4.5 IL2212 Embedded Software

Course offered at: KTH Royal Institute of Technology
Course interval: It is offered every spring semester.
Credits: 7.5 ECTS credits
Number of students: 50
Link: https://www.kth.se/social/course/IL2212/

Organization:
Ingo Sander – KTH Royal Institute of Technology
Kathrin Rosvall – KTH Royal Institute of Technology
Hosein Attarzadeh – KTH Royal Institute of Technology
George Ungureanu – KTH Royal Institute of Technology

Description:
The course IL2212 Embedded Software is a follow up course of IL2206 Embedded Systems and given at master level at KTH Royal Institute of Technology. The course addresses the

design process of embedded software with a focus on real-time on multiprocessor architectures. The course has the following main topics:

- Classical real-time theory
- Models of computation
- Design space exploration for mixed-criticality systems
- Correct-by-construction software design

CONTREX related content:
The course IL2212 has a very strong relation to CONTREX and results of CONTREX are continuously integrated into the course. Currently the course contains lectures about the following CONTREX-related ongoing activities and results:

- Models of computation
- Analysis methods for synchronous data flow
- Design space exploration for mixed-criticality
- ForSyDe modelling
- Correct-by-construction software design based on ForSyDe

4.6 Advanced Operating Systems

Course offered at: Politecnico di Milano
Course interval: It is offered every winter semester.
Date of 1st pass: October 2013- January 2014
Level: MSc Level

Organization:
William Fornaciari – Politecnico di Milano

Description:
The goal of the course is to provide the necessary knowledge on design methodologies and tools necessary to develop system and application software for embedded applications. During the course some hands-on sessions will be to show how to put in practice the topics covered during the course. The goal is to make the students familiar with STM/ARM development boards provided by the lectures for the realization of small projects. Given their widespread availability, Linux and Android will be the reference for most of the examples. The course Advanced Operating Systems (AOS) focus on the development of the system and application software, including real-time aspects,

CONTREX related content:

- Application development for critical embedded systems
- Scheduling, Allocation and resource management
- Interfacing with sensors and accelerometers on STM/ARM platforms
- Usage of the POLINODE Wireless sensor, HANDS toolchain for extrafunctional property simulation and BBQ-RTRM

4.7 Embedded Systems

Course offered at: Politecnico di Milano
Course interval: It is offered every winter semester.
Date of 1st pass: October 2013- January 2014
Level: MSc Level

Organization:
William Fornaciari – Politecnico di Milano

Description:
The goal of the course is to provide competencies and design methodologies tailored to realize embedded applications including the management of the design flow and the selection of the toolchain.
Such applications range from Cyber Physical Systems to industrial control; in general any consumer electronics product is an embedded systems. Their design requires the coordination of cross competencies to identify the optimal solution under a number of aspects including flexibility, standardization, cost, size, energy and power, performance, etc.
The course will provide and enhance the competencies regarding: architectures for PCB and SoC based embedded systems which currently are many-core and integrate MEMS sensors; communication and interfacing standard popular in the embedded system market, energy aware design of software and hardware, including run-time management of the resources. Hands-on labs are proposed to the students (participation in optional) to show how to use STM/ARM development boards to interface external sensors and peripherals.

CONTREX related content:
- Building and using embedded HW platforms including extra-functional awareness
- Software Power Optimization for embedded systems
- Usage of HANDS toolchain for extrafunctional property simulation, BBQ-Run Time Resource Management, SWAT toolchain and MOST-DSE tool

4.8 Energy-Aware Computing

Course offered at: Politecnico di Milano
Course interval: It is offered every year.
Date of 1st pass: May-June 2014
Level: PhD Level

Organization:
William Fornaciari – Politecnico di Milano
Giovanni Agosta – Politecnico di Milano
Gianluca Palermo – Politecnico di Milano
Carlo Brandolese– Politecnico di Milano

The course covers topics in energy aware computing, from the architecture, application design methodology and system software points of view. It aims at providing an holistic view of energy efficiency across the computing continuum, from ultra-low power embedded systems to low-power servers and green computing. Popular tools and flows will be also presented. Syllabus: (1) Introduction: motivations and topics overview; (2) Architectures:

power/energy/thermal viewpoint; (3) Monitors and knobs, policies; (4) Software development; (5) Design Methodology; (6) RunTime adaptive management of resources; (7) Application case studies. The following in-house developed open source tools will be used: BBQ, SWAT, MOST, HANDS, PoliNode/Miosix, MEET, SDFA.

CONTREX related content:

- Energy-aware architecture design
- Energy-aware software development and optimization
- Energy-aware resource Management
- Usage of HANDS tool-chain for extra-functional property simulation, BBQ-Run Time Resource Management, SWAT tool-chain and MOST-DSE tool

5 Training Plans

5.1 Training material on UML/MARTE based modelling methodology

Training on UML/MARTE modelling is currently one of the main needs of related partners, e.g. OFFIS, for further development and refinement of the use case models. UC will provide early access to the partners to this material, and will tackle training activities, e.g. in next technical meetings or as bilateral meetings.

UC is enhancing the UML/MARTE modelling methodology manual. Specific content regarding the enhancements done in CONTREX will be included, i.e. modelling of mixed-criticalities, network, etc. Moreover, due to the extension of the documentation, an important effort into its structure is being done, so the modeller will have first at hand a core manual. Relying on this core manual, additional annexes will be facilitated. At least, the following ones:

- Connection to ForSyDe methodology,
- And the Network modelling

As well as these documents, a tutorial document for a fast first introduction into the methodology will be developed. A video-taped version of this document is planned. The tutorial will be based on a use case as long as IPR policy allows for it.

UC will create a website for the single-source UML/MARTE modelling methodology, which will integrate the material related to the modelling methodology. This will enable a better sites structure, centered on this site, (e.g. the modelling manual in its current state is in the eSSYN site, devoted to SW synthesis). The new site will server to link the tool/flow sites relying on the modelling methodology, including eSSYN site (www.essyn.com) itself.

UC will also build a website for the VIPPE simulation technology. There, the manual of the tool and examples will be accessible.

UC plans to present the UML/MARTE CONTREX modelling methodology either in the next MCS workshop of the project, in May 20th, in Milano, or, if not possible, in the next suitable workshop before the end of the 2016, e.g. Hi-MCM session in FDL2016.

5.2 Joint training material on “Joint Analytical and Simulation-Based Design Space Exploration”

KTH, UC and PoliMi have an extensive cooperation in WP2 on the development of a joint-analytical and simulation-based design space exploration for mixed-criticality systems. The academic partners aim to make the DSE-flow available to a wider audience by the preparation of online lecture material and tutorials covering the whole DSE-flow including also application and platform models. A possible set of lectures and tutorials is given below:

- Lecture set and tutorial on ForSyDe modelling framework (KTH)

- Lecture set and tutorial on UML MARTE modelling framework (mentioned in previous section) (UC)
- Lecture set on an overview of the joint-analytical design space exploration (UC, KTH, PoliMi)
- Lecture set and tutorial on analytical design space exploration framework (KTH)
- Lecture set and tutorial on simulation-based design space exploration framework (UC, PoliMi)

The lectures sets and tutorials will be made publicly available online at the end of the project.

5.3 Tutorial on "Joint Analytical and Simulation-Based Design Space Exploration"

KTH, UC and PoliMi will aim for a tutorial on the joint-analytical and simulation-based design space exploration for mixed-criticality systems at a relevant conference in the third year of the project.