UNIVERSITÄT SIEGEN

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Master of Cyber Physical Systems

International Master of Science on Cyber Physical Systems

Identification of the Current and Future Market Requirements

D1.2

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1 Introduction

During the last two months, the project has reviewed the existing computer science master courses and structures, as well as, possible standards and guidelines in the different countries where the partners exist. The analysis of the data collected and the exploration of similar programs worldwide have concluded with reaching an initial draft of the MS@CPS curriculum.

As a way forward to this step, partners in Jordan, Palestine, and Tunisia worked on involving the private sector and related university professors on reviewing the draft curriculum, capturing their feedback and establishing a base for further engagement in the development of the program curriculum and course content.

1.1 Scope

The scope of this deliverable is the private sector in partner countries. This deliverable explores their current and future needs from the CPS program and their opinion on the proposed courses found in D1.1. This will help to identify the core course in WP2.

1.2 Relation to deliverables

This deliverable will act as the initial phase of modules identification that will lead to D1.3 which will outline the capacity building needs assessment in partner countries as well D2.1, that will outline the set of modules, courses and related learning outcomes.

1.3 Relation to work packages

This deliverable will act as a milestone for WP2 that is concerned in the development of the program structure and modules. This deliverable will outline the initial requirement that provides basis for the CPS.

1.4 Terminology

CPS: Cyber Physical System

Modules/Courses: These two words are used interchangeably to indicate a unit of the program to be implemented.

Partner Countries: Countries where the program to be implemented (Palestine, Tunisia, Jordan)

Program Countries: EU partners (Germany, Sweden, UK)

Program: The master program (CPS) to be implemented

2 Methodology

In order to get the private sector involvement in the development of the MS@CPSP curriculum, partners invited relevant private sector companies along with key teaching professors for a number of workshops in the three countries. The workshop has four main parts, as the following:

- Part one: Presenting the program overview and objectives

A presentation was prepared for this purpose in order to properly introduce MS@CPSP to the participants. Most of the participants are not expected to be so familiar with the CPS concepts and emerging motivations. This part is critical for setting the stage and assuring quality participation in the workshop sessions.

- Part two: Reviewing CPS curriculum

For this session it is recommended to distribute the participants in small groups, 4 to 5 people each group. Having some diversity in the background of the participants in every group is important for the discussion quality. Later, the groups are introduced to the proposed CPSP curriculum and asked to discuss the following listed points among themselves. Each group summarizes their discussions and presents it to the other groups. Each group has 30 minutes for discussion and 10 minutes for presentation. To assure capturing the discussions properly, notes & feedback points were taken. The following were the main discussion points:

1. What are the main learning outcomes of the CPS?
2. What does each course is about? What it mainly covers?
3. Which are the most/ least relevant courses?
4. What changes you would suggest? What need to be added or removed?
5. Which courses should be “core /elective courses”?

- Part three: Exploring on CPSP local market requirements

Similar to the last session, the participants are requested to work with their group to discuss the following points and share their conclusions with the reset of the groups.

Discussion points:

1. What specialized skills the CPS program graduates will have?
2. How attractive would the MS Degree program be to potential students? How many students are expected to apply for the MS@CPSP yearly?
3. What is the demand to MS@CPS graduates at national level? What industries are relevant to CPS and related skills? How many graduates the local companies will hire yearly?
4. What job titles require CPS and related skills? How many new positions advertised/opened yearly?

- Part four: Next steps and wrap-up

At the last part of the workshop, the team reminded the participants of the objectives of the workshop and opened discussion on the following:

1. Summarize the main conclusions of the event.
2. Explore the possibilities to have further feedback from the companies or participants colleagues.
3. Acknowledge the participants' contributions and describe the process used to keep them informed and involved.

3 Workshops Results and Conclusions

This section provides the main conclusions of the workshop discussion. These were grouped according to the previously discussed methododology.

3.1 Name Changes

Table 1 shows the proposed changes in the titles of the courses by each partner.

Table 1: Proposed name changes for the program courses

AQU		**CU**		**PTC**	
Original	Modified	Original	Modified	Original	Modified
Real-Time Systems	Real-Time Systems Automation	Data Analytics for Engineers	Data Analytics	Data Analytics for Engineers	Data Analytics for CPS
Data Analytics for Engineers	Data Analytics for CPS			Image Processing	Image Processing and Computer Vision
Image Processing	Image Processing and Computer Vision			Optimization	Optimization for CPS
Optimization	Optimization for CPS				

3.2 Integration of Courses

Table 2 summarises the suggested integration of courses.

Table 2: Proposed integration of courses

AQU		**PTC**	
Original course	New course	Original course	New course
Intelligent Systems and Robotics Multiagent Systems	Artificial Intelligence and Multiagent Systems	Mobile Computing Ubiquitous Computing	Mobile and Ubiquitous Computing

3.3 Interchange of Core Courses and Electives

Table 3 summarises the suggested interchanges between the core courses and the elective ones.

Table 3: Proposed interchange of courses

AQU		**CU**		**PTC**	
Course name	Change	Original course	New course	Course name	Change
Knowledge Management	From core to Elective	Control Systems for Cyber-physical Systems	From elective to core	Knowledge Management	From core to Elective
Image Processing	From core to Elective	Sensors , Actuators And Sensor Networks	From elective to core	Image Processing	From core to Elective
Optimization	From core to Elective	Digital Systems Architecture	From elective to core	Optimization	From core to Elective
Control Systems for Cyber-physical Systems	From Elective to core	Image Processing (Traitement D'image	From core to elective	Control Systems for Cyber-physical Systems	From Elective to core

3.4 Addition/ deletion of courses

Table 4 summarises the proposed courses to be added and deleted.

Table 4: Proposed courses' additions and deletions

AQU		CU		PTC	
Course name	Change	Course name	Change	Course name	Change
Basics of SCADA Systems	Added to elective courses	Innovation management	Added to elective courses	Basics of SCADA Systems	Added to elective courses
		Knowledge management	Deleted	Estimation Theory	Added to elective courses
		Big Data	Added to core courses	Smart Grids	Added to elective courses
				Introduction to Robotics	Added to elective courses

3.5 Demand for the CPS Program

Table 5 summarises the demand of the CPS program in each program country as stated by the participants in the workshop.

Table 5: Courses' demands

AQU	PTC
The CPS specialization is new to the companies and the need for it is expected to increase overtime. The participants believe that offering this course as MA can be attractive to students but only if promoted in a proper way. Some students might find it risky to get specialized in CPS giving the low market demand at the moment. Students applying are pioneers who are aware of market and technology change. For the companies, CPS graduate can fit in different but limited positions, within their current structures. It is highly recommended to arrange further interviews with companies and use structured questionnaires for reliable conclusions on the demand part.	Same as AQU

4 Conclusion

After reviewing the results of the different workshops conducted at partner countries and analysing it, the findings were summarised in table 6 that shows the updated proposed curriculum by each partner country. The courses shaded in yellow are that agreed upon by all partner countries while the ones that are shaded by red are only proposed by part of the partners. The summary of the proposed core courses is shown in table 6 while the proposed elective courses by each partner are shown in table 7.

Table 6: Proposed core courses by each project country

Colour Codes: The courses shaded in yellow are that agreed upon by all partner countries

The courses that are shaded by red are only proposed by part of the partners.

AQU	CU	PTC	GJU
Internet Of Things	Internet Of Things	Internet Of Things	Real-Time Systems
Embedded Systems	Digital Systems Architecture	Embedded Systems	Real-Time Systems
Artificial Intelligence And Multiagent Systems	Intelligent Systems And Robotics	Artificial Intelligence And Multiagent Systems	Data Analytics for Cyber Security
Real-Time Systems Automation	Control Systems For Cyber Physical Systems	Real-Time Systems	Optimization
Cloud Computing And Semantic Web	Security And Privacy In Cps	Cloud Computing And Semantic Web	Control Systems for Cyber-physical Systems
Security & Privacy In Cps	Data Analytics	Security & Privacy In CPS	Intelligent Systems and Robotics
Data Analytics For Engineers	Multiagent Systems	Data Analytics For Engineers	Multi-agent Systems
Ubiquitous Computing	Ubiquitous Computing	Mobile And Ubiquitous Computing	Internet of Things
Control Systems For Cyber-Physical Systems	Sensors , Actuators And Sensor Networks	Control Systems For Cyber-Physical Systems	Embedded Systems
			Artificial Intelligence and Multi-agent Systems
			Real-Time Systems Automation
			Cloud Computing and Semantic Web
			Security & Privacy in CPS

			Data Analytics for Cyber Security Optimization Control Systems for Cyber-physical Systems Intelligent Systems and Robotics Multi-agent Systems Internet of Things Embedded Systems Artificial Intelligence and Multi-agent Systems Real-Time Systems Automation Cloud Computing and Semantic Web Security & Privacy in CPS

			Sensors, Actuators and Sensor Networks Mobile Computing Reliability and Risk Analysis Advanced Computational Modelling and Analysis System Theory Microelectronics Microcontrollers Control Theory Smart Health Technology Transportation System Design Nano Systems: Devices and Design Heterogeneous Multicore Architectures Digital Systems Architecture Virtual Reality/Augmented Reality Knowledge Management Image Processing and Computer Vision Optimization for CPS

			Basics of SCADA Systems

Table 7: Proposed elective courses m by each project country

AQU	CU	PTC	GJU
Sensors, Actuators and Sensor Networks Mobile Computing Reliability and Risk Analysis Advanced Computational Modelling and Analysis System Theory Microelectronics Microcontrollers Control Theory Smart Health Technology Transportation System Design Nano Systems: Devices and Design Heterogeneous Multicore Architectures Digital Systems Architecture Virtual Reality/Augmented Reality	CLOUD COMPUTING AND SEMENTIC WEB MOBILE COMPUTING RELIABILITY AND RISK ANALYSIS ADVANCED COMPUTATIONAL MODELING AND ANALYSIS SYSTEMS THEORY (THEORIE DES SYSTEMES) MICROCONTROLLERS MICROELECTRONICS SMART HEALTH TECHNOLOGY TRANSPORTATION SYSTEM DESIGN NANOSYSTEMS : DEVICES AND DESIGN) HETEROGENOUS MULTICORE ARCHITECTURES VIRTUAL REALITY /AUGMENTED REALITY	Sensors, Actuators and Sensor Networks Estimation Theory Reliability and Risk Analysis Advanced Computational Modelling and Analysis Systems Theory Microelectronics Microcontrollers Control Theory Smart Health Technology Transportation System Design Nano Systems: Devices and Design Heterogeneous Multicore Architectures Digital Systems Architecture Virtual Reality/Augmented Reality	Image Processing Risk Management Basics of SCADA Systems Data Analytics for Engineers Ubiquitous Computing Mobile Computing Reliability and Risk Analysis Advanced Computational Modelling and Analysis Smart Health Technology Nano Systems: Devices and Design Digital Systems Architecture Virtual Reality/Augmented Reality

Knowledge Management Image Processing and Computer Vision Optimization for CPS Basics of SCADA Systems		Knowledge Management Image Processing and Computer Vision Optimization for CPS Basics of SCADA Systems Smart Grids Introduction to Robotics	

Table 8: Summary of the proposed core courses

Common Core Courses
Internet Of Things
Artificial Intelligence And Multiagent Systems
Control Systems for Cyber-Physical Systems
Security & Privacy In Cps
Data Analytics For Engineers
Embedded Systems (3/4)
Real-Time Systems
Mobile and Ubiquitous Computing
Cloud Computing And Semantic Web
Intelligent Systems And Robotics

Table 9: Proposed elective courses

Elective Courses
Advanced Computational Modelling and Analysis
Basics Of SCADA Systems
Cloud Computing and Semantic Web
Control Theory
Data Analytics For Engineers
Digital Systems Architecture
Estimation Theory
Heterogeneous Multicore Architectures
Image Processing
Image Processing And Computer Vision
Introduction To Robotics
Knowledge Management
Microcontrollers
Microelectronics
Mobile Computing
Nano Systems: Devices And Design
Optimization For Cps
Reliability And Risk Analysis
Risk Management
Sensors, Actuators And Sensor Networks
Smart Grids
Smart Health Technology

Systems Theory
Transportation System Design
Ubiquitous Computing
Virtual Reality /Augmented Reality