Centre of Research Excellence for Advanced Cooperative Systems

SEVENTH FRAMEWORK PROGRAMME
THEME REGPOT-2011-1
Support actions

Project acronym: ACROSS
Project full title: Centre of Research Excellence for Advanced Cooperative Systems
Project reference: 285939
Start date: 1 October 2011
Duration: 42 months

Deliverable no.: 7.3
Title: Report on the workshop on evaluation results

Contractual date of delivery:	March 31, 2015
Actual date of delivery:	March 31, 2015
Lead beneficiary:	UNIZG-FER
Editor(s):	Ivan Petrović
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Reviewed by:	Project Management Team
Approved by:	Ivan Petrović, ACROSS Coordinator
Work package(s):	WP7: Evaluation of the UNIZG-FER by experts appointed by the EC
Nature:	R
Version:	1.1
Total number of pages:	14
Dissemination level:	PU

Summary:

This deliverable contains report on the workshop on evaluation results of the ACROSS project and its contribution to unlocking the research potential of the University of Zagreb, Faculty of Electrical Engineering and Computing (UNIZG-FER) in the area of advanced cooperative systems. At the workshop, four independent experts appointed by the European Commission (EC experts) presented their evaluation report (attached to this deliverable) based on their six-month evaluation of the ACROSS Centre and the UNIZG-FER. The workshop was held on March 23, 2015 at Grey Hall of the UNIZG-FER. The workshop attendees were EC experts, UNIZG-FER Management Team, ACROSS Team members, ACROSS Steering Committee members from Croatia, representatives of the Ministry of science, education and sports, City of Zagreb and University of Zagreb. The purpose of the workshop was to discuss the recommendations presented by the EC experts and to adopt the roadmap for sustainable operation of the ACROSS Centre of Research Excellence. The final conclusion of the EC experts was: "The ACROSS has accumulated all elements in order to achieve excellence at European level, both in scientific and in organizational matters."

ACROSS project has received funding from the Seventh Framework Programme of the European Union (Grant Agreement No. 285939 FP7-REGPOT-2011-1).

Document history

Version	Date	Comments
v1.0	March 27, 2015	First release
v1.1	March 31, 2015	Final release

ACROSS project has received funding from the Seventh Framework Programme of the European Union (Grant Agreement No. 285939 FP7-REGPOT-2011-1).

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1. Report from the workshop on the evaluation results

Workshop place, date, participants and purpose

Date:	March 23, 2015
Start time: End time	12:00 hrs 16:30 hrs
Attendees:	Evaluation Committee (international experts appointed by the EC; evaluators): 1. Prof. Anthimos Georgiadis, Leuphana Universität Lüneburg, Germany, Chair of the Evaluation Committee (EC) 2. Prof. Mihaela Albu, "Politehnica" University of Bucharest, Romania, EC member 3. Dr. Birgitte Lønvig, Care2Wear A/S, Denmark, EC member 4. Prof. Ulrich Berger, Die Brandenburgische Technische Universität Cottbus-Senftenberg, Germany, EC member Guests: 1. Prof. Ivan Pejić, Assistant Minister for Science, Ministry of Science, Education and Sports (MSES) 2. Prof. Adrijan Barić, Chair of the Technical Field Council, University of Zagreb (UNIZG) UNIZG-FER Management Team members: 1. Prof. Mislav Grgić, Dean, Croatia (also ACROSS SC member) 2. Prof. Gordan Gledec, Vice Dean, Croatia 3. Prof. Mario Vražić, Vice Dean, Croatia 4. Prof. Marko Delimar, Vice Dean, Croatia (also ACROSS Team member) ACROSS Steering Committee members: 1. Dr. Siniša Marijan, Končar- Electrical Engineering Institute Inc., Croatia 2. Dr. Darko Huljenić, Ericsson Nikola Tesla Inc., Croatia 3. Dr. Emira Bečić, MSES 4. Damir Lončarić on behalf of Marijan Maras, City of Zagreb, Croatia 5. Ivo Friganović, BICRO-HAMAG, Croatia 6. Prof. Nedjeljko Perić, UNIZG-FER, Croatia ACROSS Project Management members: 1. Ivan Petrović, UNIZG-FER, Croatia, ACROSS Coordinator 2. Mirjana Stjepanović, UNIZG-FER, Croatia, ACROSS Project Manager 3. Mato Baotić, UNIZG-FER, Croatia 4. Maja Matijašević, UNIZG-FER, Croatia 5. Stjepan Bogdan, UNIZG-FER, Croatia 6. Sven Lončarić, UNIZG-FER, Croatia 7. Vedran Bilas, UNIZG-FER, Croatia ACROSS Team members: 28 members
Apologies:	Vjekoslav Majetić, Dok-ing Zagreb, Croatia, SC member
Location	Grey Hall, UNIZG-FER, Zagreb, Croatia
Workshop purpose	To discuss the evaluation results and the recommendation presented by the EC experts and to adopt the roadmap for sustainable operation of the ACROSS Centre of Research Excellence.

Workshop Agenda

Time	Agenda Item
12:00-12:10	Opening and welcome address *Prof. Mislav Grgić, Dean of the UNIZG-FER* *Prof. Ivan Petrović, ACROSS Coordinator*
12:10-12:40	Presentation of evaluation results *Prof. Anthimos Georgiadis, Chair of the Evaluation Committee*
12:40-12:55	Discussion
12:55-13:00	Wrap-up of the workshop *Prof. Ivan Petrović, ACROSS Coordinator*
13:00-14:30	Lunch
14:30-16:30	Post workshop finalization of Evaluation Report

Minutes from the workshop

1. Opening and welcome address

Prof. Mislav Grgić, Dean of the UNIZG-FER, opened the workshop and welcomed all the attendees. He cordially greeted the Evaluation Committee members, Prof. Ivan Pejić, Assistant Minister for Science at MSES and representatives of the City of Zagreb, University of Zagreb and the ACROSS Steering Committee members, and thanked them for coming and for valuable support to the ACROSS project. In his welcome address, Prof. Grgić pointed out the important role the ACROSS project has had in unlocking the research and development potential of the UNIZG-FER.

Prof. Ivan Petrović briefly presented ACROSS objectives, and realised activities and accomplishments. He also presented the ex-post evaluation process of ACROSS and UNIZG-FER research potential by independent international experts appointed by the EC, and explained the reasons behind applying for the ex-post evaluation, although it was not obligatory. The reason was to get an independent assessment of the ACROSS project accomplishments and its impact on UNIZG-FER. We were of the opinion that positive assessment could have a strong long-term impact on: (1) better integration of the UNIZG-FER in the European Research Area, (2) increased participation in RTD projects at EU level, (3) establishing long-term sustainable partnership with Croatian industry and (4) Croatian economic and social development.

2. Presentation of evaluation results

The presentation of evaluation results was given by Prof. Anthimos Geogradis, Chair of the Evaluation Committee. He pointed out that the aim of the ex-post evaluation is an additional measure applied in project, in order to see the influence of the project in terms of unlocking the research and development potential. The scope of the call was unlocking the existing research and development potential which had not been utilized due to being locked into an environment or procedure hindering the potential to be involved in the European research area, or it was locked due to other reasons such as:

- lack of adequate research equipment,
- limitation of human resources,
- general frame where institutions is locked (administration, laws, government issues, etc).

For instance, one of the aims of ACROSS project was to convince the government that employment of additional personnel would create added value.

The Evaluation Committee's job was to see if sustainability after the project, i.e. unlocking of research potential, had taken place. In the process of ex-post evaluation, the evaluators did not have differing opinions, only discussion on issues under aspects of different topics took place.

In order to become acquainted about the ACROSS accomplishments, during the ex-post evaluation the evaluators visited the facilities of UNIZG-FER; in particular the laboratories directly involved in ACROSS where the use of acquired equipment was presented. During their first visit, the evaluators also participated in the ACROSS closing workshop, which took place in Dubrovnik in September 2014, where they met the international members of the ACROSS Steering Committee who are very well recognized in the ACROSS research domains. During the second visit in February, a discussion of the evaluators with the ACROSS Project Management team took place with the aim to define the strategic research plan for the next 5 years. The plan is included in the evaluation report.

In addition, the evaluators had separate meetings with the Assistant Minister for Science in MSES and with the Rector of the University of Zagreb at Rector's Palace. The future potential of ACROSS was discussed in both meetings.

Conclusion: According to the evaluators, the collaboration with all the involved parties was excellent. **All evaluators agreed that the ACROSS project had fulfilled in a very good way all planned tasks and that the project had accumulated all elements in order to achieve excellence at the European level, both in scientific and in organizational matters.** The influence of the ACROSS project was significant and made a great contribution to UNIZG-FER regarding the human resources and project was also a base for the future development in a five year period (long-term orientation). **The evaluators strongly believe that UNIZG-FER has reached the level of a center of excellence in advanced cooperative systems and a nomination as such at national level will contribute to the sustainable long-term development of the unit.**

Recommendations: In the evaluation report, the evaluators made fourteen recommendations for the future development of ACROSS, but they would emphasize the following three:

- try to integrate the ACROSS group into the European Research Area by further reinforcing the contacts with companies (industry),
- try to foster further development of internal communication and team work as well as better involvement of the young people; that could prove to be a valuable asset,
- MSES and UNIZG should continue to support the ACROSS group in order to establish its sustainable growth.

The final version of the full evaluation report would become publicly available by the end of March, after some minor editing is done by evaluators and the ACROSS Project Management team.

3. Discussion

The discussion was moderated by Prof. Ivan Petrović, the ACROSS coordinator. All participants were pleased with the evaluation results, and with the success of the ACROSS project. Hereafter is the summary of the discussion.

Prof. Ivan Pejić, Assistant Minister for Science at MSES, expressed his pleasure with very positive opinions of the evaluators and promised that MSES will support ACROSS in further development. His recommendation is that the ACROSS Team applies to the national call for centres of research excellence within the ERDF OP 2014-2020, which is expected to be open in a few months period.

Prof. Adrijan Barić, Chair of the Technical Field Council, University of Zagreb, also expressed his pleasure with what he heard at the workshop. He excused Prof. Damir Boras, Rector of the University of Zagreb, who was sorry for not being able to come. However, he could confirm that the Rector fully supports ACROSS as he has already expressed during the meeting with the evaluators on February 5, 2015.

Prof. Ulrich Berger, EC expert, would like to encourage the ACROSS Team to continue and further boost its participation in Horizon 2020 proposals. Although the competition is very high, the ACROSS Team can achieve great success due to close collaborations it has established with leading research groups across Europe.

Dr. Emira Bečić, ACROSS SC member from MSES, was very impressed with ACROSS achievements, in particular with procedures developed within ACROSS. She appreciated the recommendations of the Evaluation Committee, and would like to see more Croatian companies collaborating with the ACROSS Team on EU and other projects, but to foster such a collaboration, more active support is needed from MSES and RDI funding agencies in Croatia.

Dr. Siniša Marijan, ACROSS SC member from industry (Končar- Electrical Engineering Institute Inc.), emphasised positive side effects of the ACROSS to his company: one joint RDI project is running (funded by the European Regional Development Fund) and one join project proposal to a H2020 Call is in preparation.

Dr. Darko Huljenić, ACROSS SC member from industry (Ericsson Nikola Tesla Inc.), shared the same opinion as Dr. Marijan. From his point of view, ACROSS has really created a new environment for fruitful collaboration of UNIZG-FER with industry. His company also collaborates with UNIZG-FER on several projects, one of them being also funded by the European Regional Development Fund.

4. Wrap-up of the workshop

On behalf of the Evaluation Committee, Prof. Anthimos Georgiadis once more congratulated the ACROSS Team on a very successful project and expressed the wish of the Evaluation Committee that ACROSS gets financial support to continue its activities for the benefit of Croatian economic and social development.

Prof. Ivan Petrović concluded the workshop with sincere thanks to everyone who contributed to the success of ACROSS. He also expressed his hope that ACROSS will continue with its activities as a Centre of Research Excellence at the European level.

5. Post workshop finalization of Evaluation Report

EC experts and ACROSS Management Team members spent the two hours (from 14:30 to 16:30) on joint editing and polishing of the Evaluation Report. The final, signed, version of the Evaluation Report is attached (Attachment 2).

APPENDIX 1. Photographs from the Workshop

Prof. Mislav Grgić, Dean of the UNIZG-FER, gives the opening speech.

Prof. Ivan Petrović, ACROSS Coordinator, welcomes the workshop attendees. First row – Evaluation Committee members (from left to right): Prof. Ulrich Berger, EC expert; Prof. Mihaela Albu, EC Expert; Dr. Birgitte Lønvig, EC expert; Prof. Anthimos Georgiadis, EC expert and Chair of the Evaluation Committee. Third row (from left to right): Dr. Darko Huljenić and Dr. Siniša Marijan, SC members.

Prof. Ivan Petrović, ACROSS Coordinator, presents the ACROSS project and the evaluation process.

The audience. First row (from left to right): Dr. Emira Bečić, SC member; Prof. Ivan Pejić, Assistant Minister for Science; Prof. Nedjeljko Perić, SC member; Prof. Ulrich Berger, EC expert; Prof. Mihaela Albu, EC Expert; Dr. Birgitte Lønvig, EC expert; Prof. Anthimos Georgiadis, EC expert and Chair of the Evaluation Committee.

Prof. Anthimos Georgiadis, EC expert and Chair of the Evaluation Committee, presents the evaluation results.

Dr. Emira Bečić, SC member, discussing the evaluation results and ACROSS achievements.

Dr. Siniša Marijan, SC member, discussing the evaluation results and ACROSS achievements.

Prof. Anthimos Georgiadis, EC expert and Chair of the Evaluation Committee, and Prof. Ivan Petrović, ACROSS Coordinator, give closing remarks and wrap-up of the workshop.

APPENDIX 2. Evaluation Report for the ACROSS project

External evaluation report for the project with the acronym:

ACROSS

Project full title: **"Centre of Research Excellence for Advanced Cooperative Systems"**
Grant agreement no: 285939
Project home page: http://across.fer.hr/
Coordinating organisation:
Faculty of Electrical Engineering and Computing of the University of Zagreb (UNIZG-FER)

Organisation Legal name:

SVEUCILISTE U ZAGREBU FAKULTET ELEKTROTEHNIKE IRACUNARSTVA
Organisation short name:**UNIZG-FER**

Address:
Street name: UNSKA Number 3
City: ZAGREB
Postal Code / Cedex 10000
Country: Croatia
Internet homepage of the beneficiary organisation: www.fer.unizg.hr
Status: Non-profit organisation, Public body, Research organization, Higher or secondary education establishment
Main area of activity (NACE code) 80.3

Project Coordinator: Prof Ivan Petrović **Signature**

External evaluators Panel

Name	**Signature**
Prof Mihaela Albu	
Prof Ulrich Berger	
Dr. BirgitteLønvig	
Prof Anthimos Georgiadis (chair)	

Date of presentation: 23.03.2015

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1. Executive summary

This report has been prepared upon a request for external evaluation of the UNIZG-FER within the project: **ACROSS – "Centre of Research Excellence for Advanced Cooperative Systems",** Grant agreement no: 285939.

The evaluators have visited the facilities of UNIZG-FER as has been planned in the DoW. They have discussed with the members of UNIZG-FER (all statuses), with the steering committee in the Dubrovnik meeting and with the central administration of UNIZG-FER, up to the Ministry of Science, Education and Sports of Croatia about the relevant progress of the project and the potential for future development of it. Furthermore, two meetings have taken place dedicated for the definition of a strategic research plan for UNIZG-FER covering the next five years. All members of UNIZG-FER have collaborated in a very good way.

The evaluators discussed separately during every visit about the progress of the project, which has been very good at every stage of the project. **Finally, all evaluators agree that the ACROSS project has fulfilled in a very good way all planned tasks. The project has accumulated all elements in order to achieve excellence at European level, both in scientific and in organizational matters.** Moreover, the reinforcement of UNIZG-FER in terms of new researchers and new equipment due to the ACROSS project in combination with the presented strategic plan establish a sustainable basis for advanced research in advanced cooperative systems. The research of UNIZG-FER will focus according to the proposed plan on four selected topics presented in this report later.

ACROSS has covered successfully all its objectives. The recruitment has led to the reduction of the brain drain recruiting 26 researchers (4 of them returned from abroad) during the project execution and two permanent positions have been established. An additional permanent position is planned by autumn 2015. Based on it and because of the new equipment, there is a sustainable growth of the research potential. UNIZG-FER has successfully applied already during the ACROSS project for EU projects. UNIZG-FER established a wide network and managed to have an excellent track record of publishing. The institution has won on visibility and recognition. In terms of support to regional research activities with other stakeholders, meetings have taken place in order to identify the topics for common activities. However, the integration of SMEs into HORIZON 2020 is challenging. Further effort is needed in order to establish sustainable collaboration with the regional industry and enable common participation to European R&D projects.

The institution (UNIZG-FER) aims to apply becoming a center of excellence in advanced collaborative systems. **The evaluators strongly believe that UNIZG-FER has reached the level of a center of excellence in advanced cooperative systems and a nomination as such at national level will contribute to the sustainable long-term development of the unit.** Furthermore, UNIZG-FER is prepared due to ACROSS to be strongly integrated into the regional and national smart specialisation activities and contribute significantly to the socio – economic growth.

2. Today status of the Faculty of Electrical Engineering and Computing of the University of Zagreb (UNIZG-FER).

Additionally to the substantial strengthening of the research basis, ACROSS started and implemented a very positive structural and organizational paradigm shift at the faculty UNIZG-FER. During ACROSS, organizational and procedural limitations could be identified and subsequently maintained and optimized. The intra-organizational collaboration was strengthened due to newly developed and adopted methods and instruments of communication. Besides that positive effects, ACROSS generated also a sound environment of scientific motivation and exchange of values, creating a sustainable credit based research economy within the faculty. In consequence, the faculty adopted a new strategy paper and documented this in a data repository

http://www.fer.unizg.hr/_download/repository/Development_Strategy%2C_FER%2C_2013_-_2017.pdf

MISSION

The UNIZG-FER's mission is:

- to educate students capable of carrying out the technological and social development of Croatia through education and research in the field of electrical engineering, computing and information and communication technology, using scientific background from applied mathematics and applied physics;
- to create new knowledge by internationally acknowledged research and by development of new interdisciplinary areas;
- to innovatively develop the economy and public services, hence contributing to the overall development of the society;
- to be an institution of high academic values and ethical principles, a site of critical thinking and questioning, and of equality for all its members;
- to be a driving force in the Croatian society.

In fulfilling the mission of UNIZG-FER : «we rely on our core values that we continue to develop: we are the leading national and regional higher education and research institution with outstanding staff and students, closely connected with the economy, remarkably organised and internationally recognised».

VISION

As Croatia's leading academic and research institution in the field of electrical engineering, computing, and information and communication technology, UNIZG-FER wants *to be integrated and competitive in European higher education and research area*; it wants *to create new forms of knowledge transfer to the economy and to prompt economic and social activities of Croatia*.

RESEARCH AND INNOVATION AREAS/LABS in UNIZG-FER at the time of ACROSS proposal (2011) and now:

Laboratory for Robotics and Intelligent Control Systems - LARICS
Head of the laboratory: Professor Zdenko Kovačić
http://larics.rasip.fer.hr

Laboratory for Underwater Systems and Technologies - LABUST
Head of the laboratory: Professor Zoran Vukić
http://labust.fer.hr

Consumer Computing Laboratory - CCL
Head of the laboratory: Professor Siniša Srbljić
http://ccl.fer.hr

Laboratory for Electric Machines, Power Electronics and Drives - LEMPED
Head of the laboratory: Professor Damir Žarko

Laboratory for Pattern Recognition and Biometric Security Systems - RUBIOSS
Head of the laboratory: Professor Slobodan Ribarić
http://rubioss.zemris.fer.hr

Laboratory for mechatronic systems - LAMES
Head of the laboratory: Professor Fetah Kolonić

Human-Oriented Technologies Laboratory - HOTlab
Head of the laboratory: Professor Igor S. Pandžić
http://hotlab.fer.hr

Laboratory for Statistical Modeling and Optimization - SMOLab
Head of the laboratory: Nikica Hlupić

Applied Optics Laboratory - AOLab
Head of the laboratory: Professor Zvonimir Šipuš
http://www.fer.unizg.hr/zrk/aolab

Auralization Laboratory - AuraLab
Head of the laboratory: Professor Hrvoje Domitrović

Green Engineering Laboratory - GEL
Head of the laboratory: Professor Dina Šimunić

Integrated Circuits and Electromagnetic Compatibility Laboratory - IC & EMC
Head of the laboratory: Professor Adrijan Barić
http://www.fer.unizg.hr/icdt

Power System Protection Laboratory - PSP Lab
Head of the laboratory: Juraj Havelka

Smart Grid Laboratory - SGLab
Head of the laboratory: Igor Kuzle
https://www.fer.unizg.hr/zvne/znanost/research_labs/sglab

The organisational structure is preserved but the personnel have been reinforced due to ACROSS.

3. Contribution of ACROSS to UNIZG-FER

Reinforcement of Human Resources

The ACROSS project has contributed substantially to the reinforcement of the human resources at the faculty UNIZG-FER. Up to reporting stage, there have been established two permanent positions by the adoption of new Assistant Professors, namely Dr. Darko Vasic with the denomination of *Smart Sensing* and Dr. Ognjen Dobrijevic with the denomination of *Internet of Things*. Additionally, there is also planned and foreseen to establish an additional Assistant Professor with the denomination of *Autonomous Systems* with effect of autumn 2015.

The overall contribution of ACROSS in improving the human research basis at UNIZG-FER with respect to higher education, training of professionals and supporting also the regional and national industrial work force is very good. The figures below would indicate the reflect the positive effect on human resources.

ORGANISATION – UNIZG-FER (total / **ACROSS - related**):

Personnel	2011/09/30	2015/03/06
Total number:	505/**27**	521/**85**
*Researchers:	165/**27**	170/**29**
**PhD students:	93/0	128/**35**
Postdoctoral fellows:	66/0	69/**18**
Technical staff:	70/0	65/**2**
Administrative staff:	56/0	59/**2**
**Others:	55/0	30/**0**

* INCLUDES: ASSIST. PROF., ASSOC .PROF. and FULL PROF.

** In 2011 and before PhD students and Postdocs were mostly funded directly by the Ministry of Science, Education and Sports. That program was cancelled in 2011.

*** Employees on commercial projects with industry.

FINANCING

Project type	2011/09/30 (before ACROSS)			2014/09/30 (end ACROSS)			2015/03/06		
	Number	Financing		Number	Financing		Number*	Financing	
		(mil. €)	%		(mil. €)	%		(mil. €)	%
Financed from public resources	**4**	**0.3**	**8.75**	**47**	**9.16**	**78.49**	**48**	**10.29**	**82.72**
- international	4	0.3	8.75	14	2.78	23.82	16 (4*)	3.43 (1.14)	27.57
- national**	0	0	0.00	33	2.69	23.05	32	2.68	21.55
- other (pre-accession / structural funding)	0	0	0.00	12	3.69	31.62	13	4.18	33.60

Financed from private resources	**71**	**2.76**	**80.47**	**57**	**2.51**	**21.51**	**53**	**2.15**	**17.28**
- international	2	N/A		2	N/A		2	N/A	
- national	71	2.39	80.47	57	2.51	21.51	51 (2*)	2.15 (0.25)	17.28
Direct financing from the budget of the Ministry of Science, Education and Sports* **	**68**	**0.37**	**10.78**	**0**	**0**	**0**	**0**	**0**	**0.00**
Total	**143**	**3.43**	**100.00**	**101**	**11.67**	**100.00**	**101**	**12.44**	**100.00**

* Numbers in brackets correspond to contracts signed in 2015

** The Croatian Science Foundation was established in December 2011 and that is the reason why in 2011 there were no projects

*** Direct funding by Ministry was cancelled in 2011 and that is the reason why in 2014 and 2015 there were no projects

As a conclusion of this chapter, the results of hearings, interviews (Appendix B) and brain storming meeting, and in reflection of the upgraded SWOT analysis (Appendix A) the following documents have been additionally considered:

- Horizon 2020 EC Program
- Lisbon Strategy
- Bologna Process recommendations

In the following, a summary of the contributions to the current situation based on the ex post evaluation is presented.

Summary of ACROSS contributions to UNIZG-FER

The ACROSS project has successfully reinforced UNIZG-FER potential. Human resources have been attracted and qualified, material upgraded, important partnership with outstanding EU research entities and local industry has been established. The ACROSS project has successfully disseminated and promoted research results, and the project has raised awareness among various relevant stakeholders.

The ACROSS project main impacts are:

- Better integration of the UNIZG-FER in the European Research Area has been qualified and proved by an increasing number of FP7 and H2020 funded projects. The ACROSS strategic research domains are high on the agenda of H2020.

- The centre's future partnerships build on **strategic collaboration with 16 EU partnering organisations from 10 EU Members States and Switzerland** and with 3 partnering organisations from Croatia, which are leading Croatian industrial companies.

- New research directions, qualified by increased RTD capacity and capability as well as the quality of research carried out at the UNIZG-FER.

- Research management has been very qualified and showed the importance and high benefit of having good internal project management qualifications at research institutions such as the UNIZG-FER.

- Increased contribution to Croatian economic and social development. ACROSS has and will have strong impact on Croatian economic and social development by offering information and services to all interested stakeholders and general public.
    - Industry may embark on new production/services with the help of UNIZG-FER;
    - Governmental bodies may use expertise to prepare for the Technology Platforms for related domains in Croatia;
    - Students may embark on high quality R&D domains.

- Critical mass of researchers in the ACROSS focus areas delivering high quality research.

In conclusion, ACROSS projects has *significantly* contributed to achieving the goals announced by the UNIZG-FER vision, by addressing the excellence aim of several scientific teams grouped mainly according to the 4 research areas overarched by the *cooperative systems research paradigm*.

RA1. Cooperative Renewable Energy Systems

The research infrastructure (including personnel) has been built upon four research groups (EPSDAC, LARES, CADDiN and EAG) from three Departments. Main activities have been the short-term secondments of research staff and training in the following centres (excellently positioned in the ERA): Universidad de Sevilla, Spain; Politecnico di Milano, Italy; Politecnico di Bari, Italy; National Technical University of Athens, Greece. The cooperation with the four European teams has been enhanced by several seminars, on subjects related to wind energy, renewable energy systems and microgrids.

The expertise which has been acquired is demonstrated by the work presented during the ACROSS seminar and the participation in one FP7 project. Transfer of knowledge has been successfully done in the field of model predictive control and advanced control of renewable energy systems, advanced technological solutions for wind turbines control; dispersed generation, including industrial electronics applications to distributed power generation systems based on renewable energies and microgrids.

First investments in the initially planned hardware-in-the-loop (HIL) real-time test facility have been done, but still there is a long way to achieve the required simulation capacity for studying microgrids as a cooperative system. Excellent dissemination program – including publishing in highly prestigious journals and participation in relevant conferences (EWEA, EnergyCon etc.)

RA2. Cooperative Cognitive and Robotic Systems

The cooperative cognitive and robotic systems group *has reinforced research capacity significantly*. They contribute nowadays to a large platform of cooperating partners in Europe. They have successfully applied to various EC programs as e.g. FET (Future and Emerging Technologies). Their specialization is in the area of human and environmental services as e.g. social robotics, environmental surveillance and minefield excavation. A recent focus is based on the field of mobile autonomous systems, which fits in the larger area of service robotics. Due to the low performing industrial sector in Croatia, the group has not further elaborated on industrial robots.

The envisaged novel mobile robotic applications, the affiliated RTD methods and their implementation within the three pilot scenarios will contribute significantly for the future policy agenda of the European Union. In order to support the Manufacturing Development in Europe, which is a major strategic element of HORIZON2020, there has to be introduced multiple action lines, both on national and international level. The ACROSS project aims at the enhancement of innovative human capital within the industrial world and especially for research oriented companies and thus will contribute to the groundwork of a successful economic basis.

The group has purchased distinct new equipment with focus on two strategic areas: First a common research programming and application platform for mobile robotics in order to foster the basic sciences and education tasks in robotics and second an application oriented research platform focusing on marine and aerial robotics. The fast growing S&T development in autonomous robotics would, however, make it difficult to keep track in all possible technological niche areas. It is therefore recommended to focus the hardware/software lab equipment on long-term usage.

The group is member of EUrobotics AISBL, the European Platform for robotics research. This would lead to a stronger approach in acquiring RTD projects in Horizon2020.

RA3. Cooperative Networked Embedded Systems

The cooperative networked embedded systems group *has successfully reinforced research capacity* through collaborating partners with expertise in:

- low bit-rate image coding techniques for various applications, including telepresence and motion tracking.
- applications of instrumentation, tomography and imaging, and researching and applying novel tomographic systems to a diverse range of industrial and biomedical applications using a range of sensing modalities, especially electromagnetics.
- signal processing algorithms with applications in bioinformatics, telecommunications, and networked multimedia.
- architectures and protocols for the future Internet and in particular for wireless mesh and ad-hoc networks, transport layer performance, cross-layer interactions, Quality of Service management, and multimedia adaptation mechanisms open network architecture, software development methodologies and service oriented architecture.

New equipment underlining the capacity of the lab has been purchased within the budget of ACROSS: equipment for signal processing, development systems for embedded systems, equipment for wireless sensor networks, and equipment for smart networked environments.

There are appropriate plans presented for future research areas within human-centric

communications and services in future networks and ultra-low-power sensing and energy management of networked embedded sensors. One large promising national project has been successfully funded recently within the area of m/e-health and energy efficient communication networks in collaboration with national industry opening new perspectives for the group.

RA4. Cooperative Control Methods

The cooperative control methods group has established research capacity substantially. They have launched a sound proposal initiative, which was recently awarded with successful projects. The applicants could establish cloud oriented services for the manufacturing research community with focused RTD activities in advanced production. Valuable indicators and benchmarking criteria concerning the intended research objectives building have been presented, which support the overall scope of ACROSS. The establishment of an ACROSS cooperative control service center and its affiliated research scope and the contribution in the field of advanced production technologies is well described and relevant RTD collaboration contracts are already mentioned.

The strategic clarity and pertinence of the research group is good and the targeted focus of the proposed RTD strategy is well explained and the group follow a well thought S&T exploration strategy, embracing regional, national and international activities.

The research strategy is presented in a convincing way and the quality of the intended objectives is very well described. The proposed action line of the research group will be well implemented into the existing strategy of Horizon2020. The cooperative control method group follows a sound action plan in order to facilitate institutional resources and to foster excellent research, which is mainly led by the challenging technological developments in the field of control and manufacturing technologies.

The group has already achieved a highly scored European research reputation and elaborated a clear strategic view. Thus the quality of the proposed research and innovation measures is considered very well. The available and in purchase stage being research facilities are considered adequate. The applicants have already established numerous contacts to European research networks and have built up a sound interdisciplinary collaboration portfolio. The compliance of the research activities with Horizon2020 priorities is addressed well. The proposed objectives will foster also the research in cloud computing for manufacturing and will significantly improve the research performance in the area of development new control and production paradigm shifts. The cooperative control group has proposed appropriate ways to attract high quality of human resources and to achieve excellence on a sustainable basis. The presented scientific and research track records of the group members are fully convincing in order to form a coherent approach in modern control technologies. The envisaged research impact will create an enhanced capability to compete successfully for internationally competitive research funding in the field of control technology and manufacturing. There are several items mentioned, which will increase the research excellence of the institutions in the specific fields covered by the research group. The contribution to the objectives of regional or national smart specialization strategies, including increased interactions with economic and social actions, and complementing support provided under the European Structural and Investment Funds are well specified and explained. The measures to communicate the research results and to manage research data are on the regional and international level adequately described and justified.

4. Long-term research strategy

It was agreed between the external evaluator's board and the UNIZG-FER responsible staff to elaborate a systematic scheme for drawing a long-term research strategy following a time line of five years. In order to convey this scheme, there have been performed individual hearings and interviews and an additional brain storming meeting. It was agreed, that this results are valuable in order to identify the areas of interest and describe topics of future relevance. Furthermore, an upgraded SWOT analysis has been elaborated utilizing a scientific baseline for the future research strategy. Eventually, UNIZG-FER agreed to follow the proposed research scheme based on the Table 1 below.

Table 1: ACROSS (meeting 4 February 2015 Zagreb) – Long-term research strategy (methodology)

Research topic	Recent Accomplishments	Expected results in two to three years	Expected results in five years
Consensus strategy for cooperative control of multi-agent systems	Swarm robotics - how agent behaviour influence the stability of such systems. Exploration of unknown area with multi-agent systems; combine deterministic and random walks. Formation control of robots to keep particular formation in 2D - centralised and decentralised approaches. Formation in 3D space (aerial vehicles) by using potential functions. Consensus under intermittent communications (noised, delayed, outdated and partial information). Trust based consensus – stability conditions.	Trust based consensus under intermittent communication. Consensus under changing topology (e.g. due to communication failures). Consensus under two different graphs: communication graph and topology graph.	Heuristic approach to consensus problem. Extension of graph theory by inclusion of the properties of exchanged information. Scalability to multi-agent systems comprising thousands of entities.
Optimal predictive control for cyber-physical systems	Price-based Model Predictive Control of large scale systems. Parametric optimal control and distributed MPC of power systems. Coordinated control of wind farms. Stochastic MPC for Building HVAC Systems.	Stochastic MPC with smaller number of agents. Distributed MPC with smaller number of agents.	Stochastic MPC for cyber-physical systems. Distributed MPC for cyber-physical systems.

Research topic	Recent Accomplishments	Expected results in two to three years	Expected results in five years
Stochastic approach to autonomous systems navigation in complex highly dynamic environments	Motion planning, localization and mapping, and detection and tracking if moving objects in 3D: • Bayesian filter based localization and moving objects tracking. • Directional distributions based probabilistic data association and multiple target tracking. • Real-time motion planning for any-shape complex mobile robots. • Active SLAM (simultaneous localisation and mapping) from point clouds in indoor and urban environments. • Real-time robust stereo visual odometry in indoor and urban environments.	Stochastic estimation, planning and control of a single agent for autonomous long-term navigation in complex highly dynamic environments: • Random finite sets and probabilistic data association based multiple target tracking using directional distributions and Lie algebra. • Stochastic motion planning in dynamic uncertain environments. • Information theoretic long-term active SLAM from point clouds. • Real-time robust visual SLAM for autonomous robots.	Multi-agent stochastic estimation, planning and control for autonomous long-term navigation in complex highly dynamic environments: • Estimation and fusion methods for multi-agent systems in highly dynamic environments combining Euclidean and non-Euclidean spaces. • Stochastic motion planning of multi-agent systems coupled with stochastic obstacle tracking and negotiation in highly dynamic environments. • Long-term active SLAM in highly dynamic environments.
Real-time image processing and learning-based interpretation of static and dynamic scenes	Real-time image processing algorithms for colour correction and tone mapping of image sensor data. Learning-based methods for robust object detection and classification. Object recognition methods based on multiple classifiers and ensemble-based learning. Recognition and tracking of	Increased robustness of scene interpretation on larger datasets Improved real-time capability of scene interpretation methods. Algorithms for object recognition and tracking that are suitable to hardware. Implementation using the next generation of	Robust real-time image processing algorithms suitable for hardware implementation. Robust learning-based scene interpretation methods from multiple sensor data. Robust real-time object tracking

Research topic	Recent Accomplishments	Expected results in two to three years	Expected results in five years
	human faces in real-time. Motion estimation for object tracking and 3D object recognition based on stochastic optimization techniques.	FPGA technology. Learning-based methods for multi-sensors and video that can be used in real-time for object recognition and tracking.	methods.
Human-centric communications and services in future networks	Energy efficient and flexible data acquisition model in mobile crowd sensing applications: • Real-time data stream processing on mobile devices and in a cloud environment. • Quality-driven data acquisition models; • Contribution to open source OpenIoT software platform. Data traffic models and quality of experience for complex internet services: • User behaviour based data traffic models. • User quality of experience driven network resource allocation and optimization algorithms.	Smart services for Internet of Connected Objects: • Self-organized communication and cooperation mechanisms for mobile crowd sensing applications. • Modelling the dynamics of the sensed (big) data generated in smart environments. Optimization of resources and service configuration in the cloud: • Optimization algorithms for allocation of network resources and distribution of service components in the cloud. • Fair dynamic pricing schemes for context-based online charging.	Network management approach based on software-defined network paradigm: • Optimization of resources and service configuration in the cloud. • Distributed decision-making models and cooperation algorithms for IoT services. • IoT service composition.
Ultra-low-power sensing and energy management of networked embedded sensors	Holistic approach to power reduction on sensing, processing and communication level. Computational sensing for low-power operation of power-hungry sensors	Extension of the principle of wake-up radio communication to wake-up sensing: • Ultra-low-power smart electronic front ends (analog	Power reduction in networks of sensors combining wake-up schemes in sensing and communication: • Heuristic

Research topic	Recent Accomplishments	Expected results in two to three years	Expected results in five years
	(MoX). Compressive sensing of acoustic signals. Wake-up radio implementation and application in multi-tier wireless sensor networks. Optimization of cooperative network of complementary - low power and power hungry - sensors (e.g. PIR sensors and CMOS cameras) for optimal topology of sensors and optimal model of communication with the general goal to achieve required QoS minimal energy consumption. Low-power consensus strategy for resource sharing in co-located wireless sensor networks.	and digital) and signal processing. • Operational devices for biomedical, environmental and security applications.	approach to power management of the networked embedded systems. • Operational devices for biomedical, environmental and security applications processed on silicon chips.

5. Conclusions and Recommendations

After careful consideration of all aspects of the ex post evaluation task, this report is summarized with distinct recommendations. The recommendations are covering both, the sustainability and the dissemination activities.

In general, it is highlighted, that the ACROSS Centre of Excellence still owns the potential for further development and growth. Furthermore it has the capability to take international leadership in a selected number of research areas. The evaluators come to the following recommendations:

1) Sustain the high quality human resources from ACROSS at UNIZG-FER. The most important action to sustain ACROSS is to keep the high quality researchers working at UNIZG-FER. The group now *has attained the size to make an impact in the international field* and it also has the capacity to attract more qualified researchers as guest researchers, post docs/PhD or professors and the related funding.

2) Specify and make very visual a valid and up to date research area(s) strategy for UNIZG-FER; at each department, for each group and for current and future internal collaborations. It is recommended that the faculty organisation reflects the strategic research areas, and not the other way around.

3) Perform strategic networking for funding e.g. allocates resources to participate in relevant H2020 work programme, in future also during the definition phase, be aware on the roadmap for future strategic research areas in EU.

4) Offer administrative support for researchers in getting funding and running projects: e.g. by providing updated information on relevant published open calls, help with proposal writing, contracts and financial reporting, travel planning, project management among other things.

    a. Be properly informed about H2020 instruments and calls. There are many unexplored calls and instruments that could be relevant for the ACROSS centre and faculty e.g. ITN, different Marie Curie instruments, ERA chair, ERC starting grants among others.

5) Show international leadership e.g. by taking the coordinator role in more EU projects, creating new consortia and being the editor on new proposals based on the strategic research areas.

6) Stimulate a more international environment at UNIZG-FER. Aim for creating PhD and post-doc positions at UNIZG-FER that are advertised internationally and based on e.g. EU funding.

7) Create more awareness about the achievements and act more proactively and strategically in marketing your high expertise and “marketing value” towards relevant industry in Europe and internationally. Industrial collaboration with the ACROSS team in research projects getting public attention in television and other channels may be of very high “marketing value” for a company of any size.

a. Consider international industrial sponsors of e.g. equipment paid by branding and marketing from UNIZG-FER, e.g. naming of labs "Siemenslab" and normal marketing.

b. Consider international industrial sponsors of research PhD, post-doc, and professor fellowships at UNIZG-FER.

8) Continue supporting spin-off companies and industrial research collaboration in Croatia. Offer support on IPR and be clear on ownership of research invented at the faculty. Offer support and information to researchers on entrepreneurship and where/how to get funding for creating a company. Incubate with governmental and local funds (BICRO). Seek for international investors, e.g. for potential large expansions.

9) Boost the Centre premises and research capacities by applying for Structural Funds projects.

10) Continue the collaborative culture with colloquia bringing the research groups together.

11) The ACROSS team includes faculty members with a clear vision, skills and capabilities to manage engineering research and release roadmaps. However, the exploitation part for foreground technology was only at a basic threshold level hence requiring a re-editing of some strategic issues. The ACROSS group has successfully submitted a basic IPR strategy, but would *still need a significant upgrade in order to create a wider societal awareness*. It is recommended to define a more concise categorization of S&T results and elaborate on a storyline concerning cost/benefit analysis of the expected ACROSS findings. The definition of "ACROSS platform", "ACROSS system" and "ACROSS technologies" has to be better specified and explained in order to integrate further stakeholder outside of academic sector. It is recommended to split these more generic terms in a coherent way into building blocks and process parameters. It is therefore suggested to differentiate more precisely between envisaged methodologies, HW/SW tools and own developed or adopted gadgets. All results have to be earmarked with technology readiness levels in order to understand the gap between ACROSS results and market available solutions. *A clear roadmap including IPR strategies has to be defined*.

12) Today, the service, energy and security test beds are well sampled and equipped, yet not fully representative of the intended very large and complex mobile robotic ecosystem. There is still a remarkable distance between the elaborated theoretical framework and its practical piloting. The submitted compendium documents can now be used as a guiding documentation to clearly define needs of end users and state objectives, bearing in mind that energy and security scenarios, with evident gaps and distances from the standard mobile robotic approaches one to be clearly identified and managed.

    An improved attempt in order to disseminate ACROSS results as an important strategic approach within the worldwide upcoming Manufacturing

Development, addressing all kinds of manufacturing researchers in order to become more competitive keeping existing and creating new jobs. Especially, end users involved with complex work structure and products and end users involved with face-to-face customer relationships and short response times would benefit from the envisaged solutions.

13) The scientific, technical, commercial and social impact of ACROSS is in basic terms correctly identified and is supported by all faculty members. In the next phase *the societal impact has to be upgraded* in order to foster the instantiation of the tangible results. The results have to be better categorized (methods, tools, technical devices). Actually, the findings and results have to be better specified and highlighted. In consequence, the acceptance level of the novel methods and tools within the mobile robotic pilots could be higher. Furthermore, the consortium members have to continue in maintaining the thorough testing, evaluation and validation scheme concerning all necessary aspects of contribution to industrial standards and best-practice solutions. In the context of social robotics the handling of personal data (identification of workers within the workplace, automatic detection of workload and scheduling/capacity figures) has to be considered seriously.

14) European based customer oriented suppliers and producers will benefit from ACROSS results in a significant way, as they would obtain novel and innovative methods and tools in order to facilitate ad-hoc development and implementation of learning and training clusters in regional value chains and networks. Small and medium enterprises have typically a small share of technicians, which are capable to handle efficiently new media solutions and supporting ICT tools and gadgets. If the generic ACROSS methodologies and implementation roadmaps are validated, they could adopt the ACROSS findings and results. The participating faculty members would benefit in two ways. The researchers involved with the development and realization of the key enabling technologies would launch new products into the market such as sensor and visualization tools. The members participating as enablers would be the first to adopt the ACROSS methodologies in order to strengthen the competitiveness in a rapid changing but also growing market.

15) Energy – related research efforts should be not only aligned to the “hot topics” worldwide (and the microgrids laboratory is an excellent example to build on) but also to have critically integrated the solutions best adapted to the particularities and strategic goals of the Croatian power system. Efforts toward integrating renewable sources in the energy mix while keeping a sustainable and holistic approach should be made evident to the general public, by highlighting the long-term benefits at societal level.

APPENDIX A: SWOT ANALYSIS

The SWOT analysis, initially performed in 2011, was updated within the following three years and implementation of the ACROSS project and based on information obtained during the three visits of the expert evaluation team.

The major **STRENGTHS** of UNIZG-FER are as follows:

Category	Description of strengths 2011	Description of strengths 2015
Visibility:	*European and international level* S3. Positive reputation among research teams worldwide, proved by the large number of existing international collaborations and conference organisations. S4. Focus on excellence – already a partner in a number of international research projects and a significant number of specialisations of UNIZG-FER researchers in prestigious research centres abroad.	*European and international level* Excellent visibility following the cooperation and proven by the new FP7 and H2020 consortia. Ongoing FP7 and H2020 projects led by ACROSS Team members: Acronym: subCULTron Name: Submarine cultures perform long-term robotic exploration of unconventional environmental niches Project status: From: 2015-04-01 To: 2019-03-31 (Execution) Contract number: H2020-FETPROACT-2014, Project no. 640967. Acronym: ASSISI_bf Name: Animal and robot Societies Self-organise and Integrate by Social Interaction (bees and fish) Project status: From: 2013-02-01 To: 2018-01-31 (Execution) Contract number: FP7-ICT-2011-9 FET Proactive: FOCAS, Project no. 601074. Acronym: DYMASOS Name: Dynamic Management of Physically Coupled Systems of Systems Project status: From: 2013-10-01 To: 2016-09-30 (Execution) Contract number: FP7-ICT-2013-10, Project no. 611281 Acronym: OpenIoT Name: Open Source blueprint for large scale self-organizing cloud environments for IoT applications Project status: From: 2013-06-01 To: 2014-11-30 (Execution) Contract number: FP7-ICT-2011-7 CP, Project no. 287305

		Acronym: UrbanWater Name: Intelligent Urban Water Management System Project status: From: 2012-12-01 To: 2015-05-31 (Execution) Contract number: FP7-ICT-2011-8, Project no. 318602 Acronym: CADDY Name: Cognitive autonomous diving buddy Project status: From: 2014-01-01 To: 2016-12-31 (Execution) Contract number: FP7-ICT-2011-7, Project no. 611373 Acronym: EC-SAFEMOBIL Name: Estimation and Control for Safe Wireless High Mobility Cooperative Industrial Systems Project status: From: 2011-07-15 To: 2015-07-14 (Execution) Contract number: FP7-ICT-2011-7, Project no. 288082 Ongoing FP7 and H2020 projects of UNIZG-FER *not related* to ACROSS: Acronym: EUROFLEETS2 Name: New operational steps towards an alliance of European research fleets Project status: From: 2013-03-01 To: 2017-02-28 (Execution) Contract number: FP7-INFRASTRUCTURES-2012-1, Project no. 312762 Acronym: IMOLA Name: Intelligent light Management for OLED on foil Applications Project status: From: 2011-10-01 To: 2015-03-31 (Execution) Contract number: FP7- ICT-2011.3.6, Project no. 288377 Acronym: E2LP Name: Embedded Computer Engineering Learning Platform Project status: From: 2012-10-01 To: 2015-10-01 (Execution)

		Contract number: FP7-ICT-2011.8.1, Project no. 317882 Acronym: eWALL Name: eWall for Active Long Living Project status: From: 2013-11-01 To: 2015-10-31 (Execution) Contract number: FP7-ICT-2013-10, Project no. 610658 Acronym: MISW Name: Mitigation of space weather threats to GNSS services Project status: From: 2014-02-01 To: 2016-07-31(Execution) Contract number: FP7-SPACE-2013-1, Project no. 607081
	National level S8. Established cooperation with local industry R&D partners in ACROSS strategic research topics.	*National level* Good cooperation with local industry, proven by 1 ACROSS researcher going to SME and the white paper describing development platforms.
Staff:	S1. Experienced senior researchers – noteworthy number of research projects and publications. S2. Excellent junior research assistants and considerable number of motivated students.	Even better position, as long as by the end of the project, of 23 employed researchers, *19 research positions at UNIZGFER have been secured by new projects funding*, and only 4 have decided to leave UNIZG-FER At UNIZG-FER, 14 research groups from 7 departments were included in the project activities, and a total of 52 researchers were members of the project team at the end of the project (15 full professors, 10 associate professors, 4 assistant professors, and 23 recruited researchers), plus 3 who left. In addition, 19 international collaboration partners were involved.
Management:	S5. Capability to increase and strengthen internal and external collaboration due to already established informal links with many research groups worldwide. S6. Existing cooperation in SRDs - R&D and SMEs cooperation	Two (2) workshops for improvement of generic competences were organized by ACROSS: a Workshop on Management of Intellectual Property, and EU Grant Academy© 5-day in-house training programme. The whitepaper on technology platform preparation presents valid R&D collaboration with national industry and SME. There are evidently high political attention towards the importance of

		collaboration and growth in UNIZG-FER relevant market areas.
Technical support and infrastructure:	Modern **equipment**	**Laboratory for Cognitive and Robotics Systems has purchased:** - Complete robotic systems - 1. Aerial robot Asctec Pelican with accessories - 2. Helicopter Bergen Twin Observer with waypoint navigation system and ground control station - 3. Team of 5 aerial robots ArduCopter with ground control station - 4. Team of 10 aerial robots ARDrone Parrot with ground control station - 5. Team of 6 humanoid robots Aldebaran Nao - 6. Team of 4 all-terrain mobile platforms Clearpath Husky with base station - 7. High performance outdoor platform Robotnik Guardian - 8. Team of 4 holonomic mobile platforms AndyMark - 9. Pair of 7DOF robotic arms Schunk Powerball WSG50 - 10. Pair of 7DOF robotic arms Kinova Jaco - 11. Team of 20 mini robots Moway with ground control station - 12. Hornby system - High Performance Exteroceptive Sensors and Accessories **Laboratory for Cooperative Networked Embedded Systems has purchased**: Equipment for Signal Processing: - 1. Spectral/network analyzer Rhode & Schwarz ZVL - 2. Arbitrary waveform generator Agilent 33250A - 3. Logic analyzer Tektronix TLA6202 - 4. Digital oscilloscope LeCroy WaveRunner 640Zi Development Systems for Embedded Systems: - 5. FPGA Development system XILINX - 6. Software package XILINX ISE Foundation - 7. Software package Keil Development Tools for ARM controllers - 8. Xilinx Vivado design suite: system edition

		Equipment for Wireless Sensor Networks: - 9. Wireless sensor nodes with accessories - 10. Wireless sensor network energy harvesting equipment with transducers Equipment for Smart Networked Environments: - 11. High resolution CMOS digital single-lens reflex camera system Canon with tripods and accessories - 12. High performance infrared camera FLIR - 13. Network imaging system Axis - 14. Industrial digital video cameras Smartek with set of lenses - 15. Stereo camera pair GoPro HERO3+ Black Edition - 16. Colour calibration tool Datacolour - SpyderSTUDIO **Laboratory for Renewable Energy Systems has purchased**: Photovoltaic system: - 1. Photovoltaic panels Solvis with accessories Equipment for microgrid integration: - 2. Control and measurement Equipment for Photovoltaic System and Microgrid Kipp&Zonen - 3. Room acoustics modelling software Odeom Auditorium v11 with sound intensity probe GRAS - 4. Power converter equipment for batteries and fuel cells - 5. Meteorological station
	Modern **infrastructure**.	- High performance computer cluster upgrade was purchased.
Impact:	S7. Continuous improvement of research personnel know-how through workshops, conferences and summer schools.	In total *twenty-four (24) training visits of ACROSS researchers have been successfully completed*: - Five (5) training visits in the area of Cooperative Renewable Energy Systems (PoliMI, USE, ICCS-NTUA, PoliBa) - Eight (8) training visits in the area of Cooperative Cognitive and Robotic Systems (ALU-FR, KTH, TUW, TUC, LAGADIC) - Six (6) training visits in the area of Cooperative Networked Embedded

		Systems (LIU, DSP-TUT, KAU, SISP) - Five (5) training visits belonging to the field of Cooperative Control Methods (ETHZ, TUM, TUE-CS) - Fifteen research seminars at UNIZG-FER, given by recognized experts from EU partner institutions. - a weekly scheduled research seminar, termed ACROSS colloquium, has been established within the project, which brings together all ACROSS members. There were 55 research presentations within the ACROSS colloquium series (D3.3 for details). - sixty nine (69) active participations in international conferences were realised (D5.2 for details). - three (3) conferences were organized - five (5) international workshops were organised - three (3) invited session were organized

However, UNIZG-FER also faces difficulties, mostly due to internal or national reasons. Hereunder are presented UNIZG-FER major **WEAKNESSES**:

Category	Description of weaknesses 2011	Description of weaknesses 2015
Management & Internal organization	W7.Too few senior researchers to divide the load associated with big international research projects. W8.An overall lack of project managers with experience in large and international research projects.	An experienced Project Manager, Ms. Mirjana Stjepanović, was employed during 2011-2015. After ACROSS an Office for Projects Support with two permanent positions and three additional persons paid from overheads of the projects are successfully established. The ACROSS project manager attended 2 seminars/workshops: "Project Management for EU Funded Projects", 2012 & "H2020 and FP7 Financial Workshop", 2014 **High commitment of the Faculty management (Dean, vice-deans etc.) and the Ministry has mitigated this weakness**
Scientific strategy	W1.Research efforts fragmented between UNIZGFER's departments, laboratories and research groups.	The ACROSS colloquium has been established, and 55 research talks have been presented within the series → according to the interviews, **this action has substantially mitigated the weakness**.
Visibility	W6.Limited funding for UNIZG-FER researchers to travel professionally and have extended periods of study time to develop professionally.	This weakness has been fully addressed during ACROSS project: Short-term secondments from UNIZG-FER to EU partner institutions: - Autonomous Intelligent Systems Laboratory at Albert-Ludwigs-Universität Freiburg, Germany (ALU-FR) - Centre of Autonomous System at the Royal Institute of Technology Stockholm, Sweden (KTH) - Automation and Control Institute, and Vision for Robotics Laboratory at TU Vienna, Austria (TUW) - IRISA / INRIA Rennes, France (LAGADIC) - Linköping University, Information Coding Group, Sweden (LIU) - Universidad de Sevilla, School of Engineering/Department of systems and Automatic Control, Spain (USE) - Politecnico di Milano, Italy (PoliMI) - Department of Electrical Engineering,

		Laboratory for Power electronics, Politecnico di Bari, Italy (PoliBa) - Automatic Control Laboratory, Department of Information Technology and Electrical Engineering, ETH Zurich, Switzerland (ETHZ) - Institute of Automatic Control Engineering at TU München, Germany (TUM) - N.T.U.A. School of Electrical and Computer Engineering, Division of Electric Power, Greece (ICCS-NTUA) - University of Manchester , Sensing, Imaging and Signal processing Group, UK (SISP) - Technical University of Crete, Intelligent Systems and Robotics Lab, Greece (TUC) - Tampere University of Technology, Institute of Signal Processing, FinlanD (DSP-TUT) - Karlstad University, Computer Science Dept., Sweden, (KAU) - Technical University of Eindhoven, Control Systems Dept., Netherlands, (TUE-CS) - The recruited researchers were involved in submission of twenty (20) new project proposals, of which seventeen (17) were successfully submitted, and eleven (11) have been positively evaluated so far. **However, as the impact in the scientific area is well maintained, the impact in the societal sector (e.g. SME involvement, training of staff outside UNIZG-FER) is only marginally exploited, which is mainly due to low performing industrial sector in Croatia.**
Technical support	W3.Lack of adequate research equipment for reaching the next level of expertise for various applications. W4.Lack of a high technology infrastructure as it incurs high acquisition and maintenance costs.	The equipment purchased for the Laboratory for Cooperative Networked Embedded Systems has successfully reinforced the capacity of the lab for future research. The equipment for the robotics group has to be streamlined in order to keep international RTD standards. The ACROSS team has already established a solid ROS basis for the interdisciplinary research in robotics. However, it is recommended to enhance the already established ACROSS activities in ROS towards ROS-Industrial in order to foster the common industrial reflected research basis and open

		ways of industrial collaboration. This should be also considered when new equipment has to be purchased. http://rosindustrial.org/ ROS-Industrial was launched in 2012 as an open-source project that extends the advanced capabilities of ROS software to manufacturing. It was positioned originally as a one-way portal to make robot research results available for industrial applications. ROS-Industrial has already been quite successful since it was founded, with demonstrations of industrial application. It fosters interdisciplinary operations in order to make research results reliable, easy-to-use, and easy-to-find, and that these activities are strongly desired within the research community. It has further to be considered, that ROS is transitioning (expected in spring 2015 under the acronym ROS 2.0) toward a new middleware, namely the Data Distribution Service (DDS) which will be the worldwide standard for complex data communication systems with real-time capabilities as required for robotics. http://design.ros2.org/ Although this transition is motivated and coordinated from the Open Source Robotics Foundation in the US, the ACROSS members have to consider this movement in upgrading all ROS services accordingly and initiate new training and lecturing courses. http://www.osrfoundation.org/ As a result, the quality of the services provided by ROS, ROS-Industrial, and thus the ACROSS research results will improve significantly. Both ROS and ROS-Industrial have a worldwide presence, and they are the only platforms/communities that do. To strengthen and improve worldwide collaboration in robotics research, the only logical choice is to enhance the ROS-Industrial activities for quality assurance and easy-of-use amongst others. Robotics researchers have integrated access to all ROS-Industrial packages, communications, data, and networking facilities through the web portal at http://riceu. rosindustrial.org. The menu clearly shows that all services are readily accessible.

Staff and skills	W2.Difficult to compete internationally due to lack of human resources and research infrastructure.	Short-term secondments from EU partner institutions to UNIZG-FER contributed to diminish this weakness: - Autonomous Intelligent Systems Laboratory at Albert-Ludwigs-Universität Freiburg, Germany (ALU-FR) - Centre of Autonomous System at the Royal Institute of Technology Stockholm, Sweden (KTH) - Automation and Control Institute, and Vision for Robotics Laboratory at TU Vienna, Austria (TUW) - IRISA / INRIA Rennes, France (LAGADIC) - Linköping University, Information Coding Group, Sweden (LIU) - Universidad de Sevilla, School of Engineering/Department of systems and Automatic Control, Spain (USE) - Politecnico di Milano, Italy (PoliMI) - Department of Electrical Engineering, Laboratory for Power electronics, Politecnico di Bari, Italy (PoliBa) - Automatic Control Laboratory, Department of Information Technology and Electrical Engineering, ETH Zurich, Switzerland (ETHZ) - Institute of Automatic Control Engineering at TU München, Germany (TUM) - N.T.U.A. School of Electrical and Computer Engineering, Division of Electric Power, Greece (ICCS-NTUA) - University of Manchester , Sensing, Imaging and Signal processing Group, UK (SISP) - Technical University of Crete, Intelligent Systems and Robotics Lab, Greece (TUC) - Tampere University of Technology, Institute of Signal Processing, FinlanD (DSP-TUT) - Karlstad University, Computer Science Dept., Sweden, (KAU) - Universidad de Sevilla, School of Engineering/Department of systems and Automatic Control, Spain (USE)
	W5.Low number of junior researchers in the field	- This weakness has been significantly addressed. With more funding new

	compared to the outstanding EU research centres (limited national funding for entry level positions).	possibilities for PhDs fellowship are appearing in different ACROSS research areas.

OPPORTUNITIES

Category	Description of opportunities 2011	Description of opportunities 2015
Reliable partner for Croatian authorities and EC, complying with objectives in strategic national and European topics	O2. The market drivers (ICT industry, energy sector, security, ecology, etc.) are investing in this area. O3. UNIZG-FER specific knowledge could have good market opportunities (cooperation with industry and SMEs). O5. Ability to strengthen cooperation with SMEs and end users by means of clusters. O8. Building upon reputation of UNIZG-FER as a "brand" in the region. O9. Discovering potential applications of joint multidisciplinary research results outside of a particular domain	- The market drivers relevant for ACROSS research are still regarded as focus opportunities for investments. - There are a number of national clusters with participation from ACROSS. These could be further exploited strengthening the synergy of research, business and policy. Especially SME participation would strengthen opportunities of national exploitation of UNIZG-FER research. - The UNIZG-FER is definitely a brand that is exploitable in the region. - The multidisciplinarity is evident with good results in different domains e.g. the networked embedded system group has successfully been funded in the eHealth domain. - There are great perspectives of other collaborations e.g. creating synergies in the "unmanned vehicle area" looking for commonalities in systems used aerial, ground surface, and underwater. - The geographical conditions of Croatia are well-suited to demonstrate the success of new paradigm in power systems – the microgrids and microgrids clusters. The strategic partnership

		with the team at NTUA, one of the initiators of this research area, is likely to increase the chances of a fast track research path in this area.
Research funding programs	*National level* – O1. The growing interest for cooperative systems in various application domains (cognitive and robotic systems, networking, renewable energy) in Croatia and worldwide.	- The cooperative systems and the research areas followed are still at high interest in Croatia and worldwide.
	European level – O6. Capacity to attract more grants and contracts and to expand international links.	- The teams from ACROSS have proven their capability to attract funding from different sources: - Horizon 2020 - interstate bilateral R&D agreements - ERA-NET projects - trans-borders R&D programs
Cooperation opportunities	Free circulation of persons and information between EU states. O4. UNIZG-FER development costs in Croatia are highly competitive in a global economy due to specific expertise and relatively low costs of labour.	- UNIZG-FER remains to be competitive in a global economy due to expertise and relatively low cost of labour.
	Already existing partnerships within EU countries, USA, Canada, Japan etc. O7. Capacity to attract more high-quality students (undergraduate and graduate) toward multidisciplinary research in cooperative systems.	- The capacity to attract high-quality students nationally has increased with ACROSS. The next step would be to attract high-quality students from other countries. This would enhance future collaboration possibilities with more institutes worldwide.

THREATS

Category	Description of threats 2011	Description of threats 2015
Low-stimulating national environment	T2. New technologies, services, ideas cannot be tested without external financial help and external expertise in specific areas where we lack expertise. T3. Heavy teaching load for professors/researchers. T7. National financing of research project both by the governmental bodies and industry; governmental financing below 1% of GDP in the last two years. T8. Limited opportunities for career development for senior researchers.	24 training visits of ACROSS researchers have been successfully completed, leading to long-term collaborations with research groups from EU institutions on joint publications. Training of UNIZG-FER at EU Research Institutions (list of work in report). T3 and T8 remain unchanged, and unlikely to change in the future, considering the overall economic situation. T7 remains a threat- the level of investment in R&D remains between 0,7% and 0,8% of GDP since 2010, and it remains well below the EU average of 2,07%. Smart specialization strategy is still missing (as of March 2015) – Croatia has yet to adopt a Smart Specialization Strategy (S3), which is a precondition for gaining access to the European Structural and Investment Funds (ESIFs) for research and innovation.
Brain-drain	T6. "Brain drain" – without appropriate research infrastructure young researchers tend to leave the country in search of adequate job positions abroad; not many come back.	- this threat has been positively addressed and the brain-drain has diminished as a direct result of ACROSS: **26 researchers hired from the start of the project, and a total of three (3) who left.** 4 recognized Croatian experts have returned from abroad to join the ACROSS team; **(3) recognized Croatian experts have temporarily returned from abroad;** The development and introduction of dual study careers (industry and academia) would be beneficiary for a stronger interlinking between academic and industrial partners.
Economical crisis	T4. National economy that is very slowly recovering from the war effects in Croatia and is currently also facing the actual world economic crisis.	- the effects of the economical crisis are still evident - the contribution of ACROSS into the small but growing industrial sector in Croatia has to be further maintained.

	T1. Sustaining our internal capabilities without external help is critical. T5. Increased competition on the global market among research teams and providers.	- Continued funding of personnel and equipment is crucial for sustaining the ACROSS centre. - The level of capacity present in the ACROSS research areas is both competitive and envisaged to attract new funding and personnel on the global market.

APPENDIX B: Interviews (11&12 December 2014, Zagreb)

There have been performed several interviews in order to gain substantial information and relevant data from the working groups, covering also the individual work descriptions (professors, post-docs, administrative staff, PhD students, students). There have been performed meetings with the Deputy Science Minister of Croatia and the Rector of the University of Zagreb. The first interview round at UNIZG-FER was concerning the experience the groups gained through ACROSS. In order to reflect the in-situ characteristics of the interviews, the results are documented in a word protocol, which is enclosed.

Reflections of the ACROSS experience:

Part 1: (comments from ACROSS PhDs);
Questions: any long term strategy?--> what happens now after ACROSS ends? Do you feel mature enough? There is any career in industry foreseeable? Do you see relevant future places here? (i.e. Croatia)

1. the international dimension has been important;
2. collaboration/connection within the team here (in Zagreb) was very good;
3. one PhD worked in industry 10 years and then has been hired for taking care of experiments and in this way it became possible to have him "entered" in the "science experience"; still, this PhD has a different look to the things while developing a complementary view towards practical implementation of various solutions; ready to jump from ideas/software to reality/electronics etc.; it is a similar situation with working in industry and then moving to academia;
4. someone started only 1 year ago in ACROSS and acknowledged having the chance to speak with people working in different technologies while striving for achieving one single working system;
5. ACROSS has provided new equipment to work on;
6. Many events/workshops/ organized here have been attended by Croatians and people from abroad, resulting in an exchange of opinions and expertise; in the end this translates to "become educate" and achieve skills for writing proposals for H2020; the connection with the others via these colloquia organized Fridays has been very positive;
7. Seeds are there for future meetings.

Part 2: (comments from postdocs):
1. prior to ACROSS: obtained a PhD in applied mathematics, then returned from Vienna; opportunity for many professional connections and enjoyed the trans-disciplinary approach; he will continuing to work in the environmental group, enjoys the young-spirit environment;
3. went to France for PhD and postdoc then he returned in ACROSS (reason: family/girlfriend); he met people of quality; the computer vision field is well developed here; now there is a new project to work on; he works closely with the computer vision groups in Graz and Ljubljana;
4. a postdoc is hired now in a company (after being in ACROSS for 1 year); developed new equipment with FPGA in research (communication) projects; now successfully applies the acquired knowledge in industry;
5. 1 year postdoc in ACROSS allowed to another postdoc to bridge the gaps, now he is in a national project; he learned how to write proposals;

6. a postdoc with PhD in New Mexico returned to Croatia; now, because of being involved in ACROSS, one can say that "it is like there": you have no time; however, one can exploit (in the good sense) the work of others and set own experiments only in 5 days, which is remarkably fast;
7. someone who was not paid by ACROSS but had the benefit of attending a training session in Stockholm as a postdoc for 10 months; he entered in a new application field (unmanned vehicles) and had access to new equipment. This led to a lot of complementary work and increased the potential for new projects;
8. another postdoc one had benefit from training abroad: twice in Sweden, in a new scientific area which led to an increased expertise and good collaboration; money to give tutorials increased his visibility as a researcher;
9. in computer vision group: training abroad, enabling new professional connections and the opportunity to go to conferences made people in the department be well connected now;
10. *some common comments*: ACROSS gave the opportunity of having more time to dedicate to research; funding for going to conferences (very important), enabled many professional connections (including during the colloquium on Fridays!) and funding for going to meet people and write for new project proposals; long term network.

Part 3: (administrative staff):

Background in procurement and finance, worked for UN, other international organizations and several world bank projects; last job previous ACROSS: the ministry of education, science and sport; she joined this project (following recommendations by the colleagues) and it was the first time to be involved in an European project;

- she has been surprised about how the projects have been handled before (some missing info); it might have been a big challenge for the project coordinator; it was for the first time when approx. 50 people from the university are working together within the same project;
- another challenge was how to handle the complete administration because she is not the financial director of the entity! The financial admins are ready to help but the way they see their job, need to improve the organisation and administration;
- now there is a new organisation for managing the projects;
- a new job with the innovation centre (to take care of about 100 people);
- considering that ACROSS had approx. 30% infrastructure costs (equipment), the most difficult has been to procure equipment against the new public procurement law and it took time to adjust to the new rules;
- very good planning has been the key of success, despite constant effort to harmonize project activities with the national financial rules and regulations;
- such a work and achievements needs continuity!

Part 4: (meeting with the Deputy Science Minister of Croatia)

Governmental work focusing on creating Centres of Research Excellence in Croatia for structural funds is ongoing. The first call was in 2014, however UNIZG-FER did not get funding under this call. The money went to non-technical faculties. The minister is aware of the situation and asked for resubmission for the next call which should be in 2015.

A large investment project in a brand new innovation centre on premises close to UNIZG-FER is ongoing. Structural funds from EU will be needed and the project is on hold until further. The centre is planned to include new research lab facilities related to activities at UNIZG-FER and housing for start-ups.

Part 5: (Meeting with the Rector of the University of Zagreb):
Important comment during this meeting was for UNIZG-FER is that the next budget money allocated per student should reflect the costs of each faculty instead of equal budget per student for humanities and technical faculty.

Part 6: (Professors, individually divided into the four individual research group):

A. [Image Processing and Computer Vision Group]

- ACROSS helped to successfully align with the EU rules for procedures & process to comply with the requirements of EU projects; difficulties: the mechanism in the Faculty is already built-up;
- ACROSS centre was important: massive joining of researchers from different departments; this is sustainable (VISTA project on-going); industrial collaboration;
- *Any welcome package for the alumni returning in Croatia*? – yes!
- *What was your personal benefit from ACROSS*? - equipment's/ cameras for the laboratory; new opportunity to talk with industry in a better way; indirectly able to start the new projects VISTA, the spirit of the new centre transferred to;
- *Any further potential of growing the group of ACROSS*? - yes, there is a role model /he did the PhD in USA and knows what a role model is; however, there are 200 professors (lecturers) in the Faculty and the ACROSS core is 10%; There is no other group of this quality;
- *What courses are you teaching*? - image processing, stochastic systems, neural networks, information processing.

B: [Signal Processing Group]

- *highest benefit from ACROSS*: has strengthen links from different groups and opportunity to focus on certain area for a longer period (national funding being still scarce); they had a first occasion to talk about structural funds;
- we are/were all afraid of achieving sustainability (it is hard to synchronize our goals with external environment!) [especially when considering that robotics area is not a smart specialization topic]
- the group managed to keep its structure for next 15 months (4 projects with structural funds are going on); they have grant management people and strong international links;
- *Your personal benefits from the ACROSS program?* He had 2 researchers employed by ACROSS, boost the research significantly, we have funding for international cooperation and travelling;
- *Do you see potential of growing the ACROSS group*? – Not sure that we need to enlarge ACROSS, it is already large;
- *Any industrial collaboration and in what application areas*? Siemens lost 1000 jobs here; however, a lot of SMEs are working with some of the faculty members;
- *There is any organisation in the faculty who would support the interaction with the industrial sector (technology transfer)*?– there is a centre at university level / in the frame of ACROSS: 10 workshops have been organized with industrial partners – *could be these sustained*? Yes, but organized by the professors (in order to avoid to split again).

C: [Energy Wind Group]

- *What are your best collaborators and who are the competitors / before and after ACROSS*? - best collaborator was the ETH group; also Politecnico di Milano (bidirectional) and also TU Munich (2 postdocs moved to ABB //TU Munich); *competitors before?* - in Croatia we were in top and we are in better position now; worldwide: real competitors are the central European universities trying to gather/attract the same group of students, i.e. the universities in UK and in the US; moreover, the group in Vienna; the groups in Bratislava/Belgrade are competitors because there are on-going projects and actions in Serbia for innovation centres with support of government; helping reduce the brain drain; salaries lower than in western Europe and the need of innovation centre;
- *there is any local industrial collaboration*? - yes, for example Koncar: they are contributing to the proposals in the national funding and also for international projects – they are invited in the Advisory Board; also there is collaboration with a local DSO.
- *There is any program in Croatia to attract non-creation speaking people to learn Croatian and integrate*? (cultural skills); *any intercultural aspects arising from ACROSS*? – the exchange of people going abroad has been very beneficial (the environment is telling you to be "non-insured" of yourself, not competitive enough in research but soon you realize that "we can do");

D: [Communication Network Group]

- *The best and the worse of ACROSS for you*? – the best: the final workshop in Dubrovnik, the whole show in one place; before that people were not much aware of what the other groups have done; but now it was very nice: "one can say: wow!" – this was done in 3 years during crisis in Croatia! – seeing all in that place was impressive;
- Negative things: the general situation, when writing the final report: you are supposed to jump forward but the general situation/economic data shows not optimistic: since 2010 the Expenditure in research kept constant in Croatia (0.75% from GDP); therefore one cannot be optimist, i.e. the conditions are not better,
- *what are you personal benefits as a professor from ACROSS*? – she funded 3 people in total (one only for one month, at the end), those people have been exposed to European ways of running European projects/time sheets etc.;
- *do you see potential growth of the group*, *there is any potential to grow the ACROSS group?* - yes, the research potential is unlocked and the team is stronger and we remained together;
- *there are any other groups working in this field in Croatia*? – yes, the computer vision /multimedia communication but not collaborating yet;
- *Who are your most important collaborators (internationally)* ?- Uni Vienna (gaming); TU Berlin (quality experience); Karlstadt; Spain (Uni Zaragoza)
- About the research reports for 2012 - *the ministry does not follow the recommendations?! – there were a lot of instruments recommended there (45 different instruments) – there is anyone channelling this info to the faculty* - no (strategic limitation), everyone is gathering this info in particular; no systematic way of acting in this way; there is no liaison office in Brussels; they have a good NCP, but there is nothing done systematically; the university is loosely structured – and this is bad because the university is only an umbrella and not an efficient way to convey information on projects who can be done only at the university level;