Preliminary notices for applicants:

1. You must read and accept the *UKF Guidelines and Procedures 2007*, the respective *Call for Proposals* and the *Instructions for Applicants – Research Cooperability Program* before filling out this form.
2. Information on this form is collected in order to make recommendations to the Ministry of Science, Education and Sport represented by the Unity through Knowledge Fund's Approval Committee (Prof. Željko Bošnjak, Ph.D., Mr. Ivica Mudrinić, Prof. Ivan Pavić, Ph.D., Prof. Mladen Žinić, Ph.D. and the Minister Prof. Dragan Primorac, Ph.D. as the president of the Committee) on the allocation of financial support within Croatian Science and Technology Project under the Loan Agreement Nr. 7320-HR between Republic of Croatia and International Bank for Reconstruction and Development (Narodne Novine, Međunarodni ugovori br: 12, Loan Nr. 7320-HR).
3. The information collected may be passed to third parties for assessment purposes. In other instances, information contained in this Proposal can be disclosed without your consent where authorised or required by law.

A. Project proposal

1. Project info

a. Project title:
DICES - Distributed Component-based Embedded Software Systems

b. Duration of the project:
36 Months

c. Country(ies) where the research will be carried out (except Croatia):
Sweden

d. Organisation to administer funding (full name, address, web address and contact person details):
University of Zagreb, Faculty of Electrical Engineering and Computing
(In Croatian: Fakultet elektrotehnike i računarstva - FER)
Unska 3, 10000 Zagreb, Croatia
Web: http://www.fer.hr
Contact person: Dean, Prof.dr.sc. Vedran Mornar, tel. +385 1 6129642, Vedran.Mornar@fer.hr

e. Other organizations involved (full name, address, web address and contact person details):
University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture
(In Croatian: Fakultet elektrotehnike, strojarstva i brodogradnje - FESB), SPLIT
Ruđera Boškovića b.b., 21000 Split, Croatia
Web: http://www.fesb.hr
Contact person: Dean Prof. dr.sc. Dinko Begušić, tel:+385 21 305700, Dinko.Begusic@fesb.hr

Mälardalen University, Department of Computer Science and Electronics
Box 883,72173 Västerås, Sweden
Web: http://www.mrtc.mdh.se
Contact: Vice Dep. Chair Prof. Hans Hansson, tel: +46 21 103163, hans.hansson@mdh.se

f. Type of the grant:
Homeward Grant (1A)

2. Summary of the research project

Word count: ***392***

(*Max. 400 words, add word count)*

DICES (**Distributed Component-based Embedded Software Systems**) has a goal to advance development of distributed embedded software systems with emphasis on software reusability and predictability of software quality. The aim of the project is increasing the software development efficiency and quality by applying service-oriented and component-based approaches. The project will advance theories and methodologies for prediction of certain system properties, develop tools that will help in reusability of software components, and assure performance efficiency of the systems.

The overall presence of distributed embedded systems in the modern society is a fact. Examples of such systems are telecommunication systems, grid systems, control and information systems of vehicular systems (cars, trains), different monitoring environmental systems. Embedded systems development is one of the strategic research areas of EU-FP7 programmes. It is also of significant importance in Croatia, since many leading companies in Croatia either produce such systems (e.g. Končar, Ericsson Nikola Tesla) or use such systems (e.g. Pliva).

DICES will address efficient reusability of software components and prediction of the important properties for embedded systems: resource utilisation, and performance, by applying the service-oriented software engineering and component-based software engineering methods and technologies. The project will apply existing and develop new theories for predictability of certain quality attributes providing a) improved and more efficient software development b) optimal solutions of software architecture and components configurations for distributed systems.

The theories will be validated on a case – "iForestFire - Intelligent Forest Fire System" developed at FESB Split. This will enable a thorough validation of the approach and provide input for further development of this system and possible commercialisation of the improved product. Further, abilities of commercialisation, and possibilities of Open Source publicity will be investigated.

The additional goal of DICES is improving the structural research potential in the field of Software Engineering in Croatia. The project will contribute in establishment of network of excellence in software engineering in Croatia by performing DICES on two Croatian and one Swedish research centre and by connecting DICES to several projects performed in Sweden and EU. The project will also work on strategic planning for continuation of activities and building careers of young researchers to avoid "brain drain".

DICES have good assumptions for a successful performance since the participants have already established a successful cooperation, such as common work in education, organisation of some events, and submissions to Croatian and EU research proposals.

Sažetak

Ugrađeni sustavi i pripadna programska podrška su bitno drugačiji od "PC"-eva i njihove programske podrške koju kao korisnici lako prepoznajemo. Programska podrška za ugrađene sustave je skrivena unutar produkta, a zahtjevi na nju su specifični. Na primjer, zahtjev za pouzdanošću je izrazito velik – u takvim sustavima ne mogu se (ne smiju se) dozvoliti greške tipične za standardne računalne sustave (npr. da kočnica automobila trenutačno ne djeluje zbog preopterećenosti računalnog sustava ili da mobitel ne prihvati poziv zato što se na njemu u tom trenutku izvodi neka igrica). Takvi sustavi su obično zahtjevniji što se tiče resursa (memorije, energije i sl.), a istovremeno su ti resursi često ograničeni. Dakle s jedne strane postoje zahtjevi za visokom pouzdanošću, s druge za ograničenim korištenje resursa. Zato razvoj takve programske podrške traži specifične metode. Zbog velike brzine razvoja sklopovlja, mogućnosti razvoja programske podrške u ugrađenim sustavima su ogromne. Ipak, zbog relativno novog područja, još uvijek ne postoje etablirane metode za njezin efikasni i visoko kvalitetni razvoj. Jedan od značajnih problema je predvidjeti svojstva programske podrške u toku izvođenja i na taj način izbjeći greške i njihove neželjene posljedice.

Osnovni cilj projekta DICES je poboljšanje razvoja programske podrške za ugrađene sustave. Projekt koristi metode razvoja temeljene na komponentama, metode koje su se pokazale uspješnim u razvoju velikih raspodijeljenih sustava. Cilj takvih metoda je omogućiti ponovno korištenje programskih komponenata i na taj način povećati efikasnost razvoja i pouzdanost sustava. DICES također ima dodatni cilj razviti metode i tehnologije koje omogućuju predviđanje ponašanja sustava – posebno u korištenju resursa i dinamičkom (vremenskom) ponašanju. Uz razvoj metoda, projekt će razvijati i alate koji će omogućiti automatsku i efikasnu primjenu metoda. Razvijene teorije i metode bit će validirane na primjeru produkta "iForestFire - Intelligent Forest Fire System" – inteligentnog protupožarnog sustava. U daljem razvoju projekt predviđa proširenje studije, mogućnost primjene u drugim područjima ugrađenih sustava te kontakte s hrvatskim tvrtkama koje bi mogle koristiti razvojne metode.

Projekt DICES se izvodi u suradnji tri znanstvene institucije, FER i FESB u Hrvatskoj te MDH u Švedskoj pod vodstvom priznatih znanstvenika iz područja ugrađenih sustava, programskog inženjerstva te protupožarnih sustava.

3. Composition of the research group

a. Applicants

Main applicant – project leader		*Co-applicant*	
Family name:	Crnković	Family name:	Žagar
First name(s):	Ivica	First name(s):	Mario
Title(s):	Prof. dr sc.	Title(s):	Prof. dr sc.
Organization:	Mälardalen University	Organization:	FER
E-mail:	ivica.crnkovic@mdh.se	E-mail:	mario.zagar@fer.hr
Address:	Box 883 721 23 Västerås Sweden	Address:	Unska 3, 10000 Zagreb
Tel.:	+56 73 960 71 73	Tel.:	+385 1 612 96 17
Job description within the project	Project leader, PhD Advisor, research coordinator	Job description within the project	PhD Co-advisor, Senior researcher
Time to be spent (F.T.E.):	0,1	Time to be spent (F.T.E.):	0,1

b. Researchers and experts

Family name:	Stipaničev	Family name:	Štula
First name(s):	Darko	First name(s):	Maja
Title(s):	Prof. dr sc.	Title(s):	Doc. dr. sc.
University / Institute:	FESB	University / Institute:	FESB
E-mail:	dstip@fesb.hr	E-mail:	maja.stula@fesb.hr
Address:	R. Boškovića bb, Split	Address:	R. Boškovića bb, Split
Tel.:	+385 21 305 813	Tel.:	+385 21 305 700
Job description within the project	Senior researcher	Job description within the project	Senior researcher
Time to be spent (F.T.E.):	0,1	Time to be spent (F.T.E.):	0,3

Family name:	TBD	Family name:	TBD
First name(s):		First name(s):	
Title(s):	PhD Student	Title(s):	PhD Student
University / Institute:	FER	University / Institute:	FER
E-mail:		E-mail:	
Address:		Address:	
Tel.:		Tel.:	
Job description within the project		Job description within the project	
Time to be spent (F.T.E.):	0,5+1,0+1,0	Time to be spent (F.T.E.):	0,5+1,0+1,0

4. Description of the project

Word count: 2999

(Max. 3000 words, add word count)

a. Rationale and background of the project including the state of the art of the research field

The overall objectives of the project include modelling distributed embedded systems as component-based systems that will enable better reusability of software components. At the same time the goal is to provide methods and develop tools for prediction and optimisation of certain system properties (such as performance, and resource usage). A combination of reusability, efficiency and predictability is a novel part in the research and can lead to innovated results – new or adapted component models that enable predictability by construction. Some of existing component models and technologies will be used from Open source community and from MDH which is developing component models for research purpose. The methods and tools developed in the projects will be input for possible commercialisation and exploitation in companies that develop distributed embedded software systems.

To achieve the overall goals the following objectives will be addressed in the project:

- Provision of detailed state of the art of component models and service standards, including the challenges related to the predictability of the system properties, and a detailed state of the art of quality modelling, composition and analysis of quality attributes relevant for embedded systems.
- Adoption of some service-oriented and component-based technologies to improve the predictability. The significance of this is possible improvement of system qualities and increased development efficiency due to reusability and decreased requirements on exhausted testing.
- The adoption is tightly related to models of quality attributes and transformation between description of constructive parts, i.e. architecture and possibly detailed design, and elements in the theories of specification and composition of quality attributes.

The domains on which the results will have the most significant impacts are: Embedded systems with limited resources – for example automotive industry, consumer electronics, small embedded devices.

The approaches will be applied to real cases in which the metrics for the efficiency, reusability and quality will be defined and the measurements based on these metrics will be performed. This part is very important as it will demonstrate in a quantitative manner the feasibility of the approach. In particular the industrial case study *IForestFire* will be used as a demonstrator for improved characteristics. The system will be partially rebuilt using new technology and the following characteristics will be evaluated:

a. Predictability:
    i. Resource usage – by system construction it will be possible to calculate and optimise the use of memory, and measure the real use and compare it with the predicted values.
    ii. Software reliability – a model for calculating reliability of the installed software and possibilities for increasing reliability will be demonstrated.
    iii. Real-time characteristics – response time of computational units and communication units will be modelled, predicted by the theory and measured.
b. Reusability

A reusability model and measurements will be provided for different control stations (percentage of software reused and percentage of software modified). This will be compared with the old solutions

b. Overall objectives, significance and innovation of the research

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c. Proposed approach and methodology

The approach follows a research path characteristic for software engineering: It starts from recognition of problems relevant in an industrial context and identifying the final goal that leads to a problem solution. The real industrial problem is transformed into a research context in which the research questions, approaches and possible solutions to the research questions are provided. The research results are validated in the research context, and then in the real industrial context. This approach includes the following methodologies:

1. Analysis of an industrial case study to gathering the concrete and detailed requirements, constraints and concerns, and to understand the essence of the problem.
2. Building knowledge – studying state of the art and state of the practice in order o understand the theoretical bases of methods that might be utilised in the problems solution.
3. Creating theoretical models using basic theories in computer science, software engineering, component-based software engineering, web-based technologies to provide the theoretical and principle solutions.
4. Building tools prototypes for modelling components, their parameterisation and system configuration to achieve predictable behaviour of the systems.
5. Validation of the model and tool by applying on the existing real industrial case *iForestFire*, building a new version, comparing its properties with the old version and

providing directions for further improvements.

6. Generalisation, dissemination, and possible exploitation and commercialisation of the results in a broader industrial context –in this case application of component-based approach to increase reusability and development efficiency and enabling predictability of the system properties. Examples of the companies that can utilise the results are in Croatia Ericsson and Končar, or in Sweden ABB and CC-System (a car control-device development company)

d. Expected measurable results and their potential users

The following measurable results will be criteria for the success of the project:

- **Publications**. Published technical reports, conference papers on national and international prestigious conferences and international journals and magazines. Our expectation is to produce at least *20 papers* at prestigious international conferences in Software Engineering and *3 articles* in international journals of software engineering. The publications are means for communication with international researchers.
- **Tool**. A tool integrated into Development Environment Tools based on Eclipse or other integration platform will be built. In cooperation with research projects PROGRESS at MDH, EU ITEA2 FLEXI, an *optimisation tool prototype* for component and system configuration will be built. Potential users of the tool are the participants of these projects (32 companies from EU). Further a cooperation with new EU FP7 project Q-Impress in which Ericsson Nikola Tesla and MDH are partners.
- **Validation** in an industrial context. The tool built will be used for the specification, analysis and modelling of a case *iForestFire* and refectory of the existing system. Different cases of the systems will be modelled and analysed, implemented and measured in the real context. Further experimental building of an embedded system in at least one company in Croatia or in Sweden will be performed.
- **Releasing the tool**. In the first phase the tool will be released as freely available with the following potential users: research institutions, universities and selected (supported companies). In addition, potential users will be companies developing embedded systems.

The results of the dissemination and continuity of the group after the project will be visible trough the following results:

- Organisation of at least *two industrial seminars* in Software engineering and CBSE with Croatian Industry.
- Cooperation with TEMPUS KISEK project in which several industrial partners are involved.
- At least *two special sessions at Croatian conferences* and at leased one on an international conference or similar event.
- *Demonstration of the iForestFire* on at least one international event and one Croatian event will be organised.
- *A web site* showing the results and providing references to similar and related work will be developed.
- *Contacts with at least three international research groups* will be achieved.
- An extensive cooperation with MDH will be established, and a cooperation agreement will be signed.
- The group will *be involved in at least one EU project proposal.*
- A plan for further career of younger researcher in Croatia will be done (to avoid Brain drain)
- Analysis of possibility of commercialisation of the tool developed. In the third year in the project, possible partners for tool development will be contacted and possibilities for commercialisation of the tool will be investigated. Another possibility is that the young researchers start a new company with a goal to commercialise the tools.

e. Relevance and potential benefit of the project to the development of Croatia

Due to accelerating increase of software, Software Engineering is an increasingly important area, but with some exceptions not on the top excellence level in Croatia. Not only software development but also system development is heavily dependent on excellence in software engineering. The aim of the project is to improve state of the art of software engineering and for this reason highly relevant for development of Croatia.

Component-based and predictable development for embedded systems – the area that is a hot topic in EU research and as such brings Croatia's research close to the excellence research communities.

The inclusion of embedded software in any type of systems is inevitable process today, at the same time the embedded software development is not yet widely established in the EU and the world– this gives a chance for countries like Croatia to achieve world-recognised results with less efforts than in many other established engineering fields.

The need for the increase of software in different type of systems (and services) is rapidly increasing – even though many companies in Croatia are not aware of that. The efficiency and quality of software is essential for large companies, independent if they are owned by international companies or are Croatian companies.

The type of systems such as our case study *iForestFire* is of extremely importance for Croatia. Advanced systems for early detection of fire can by just a single prevention save at least one order of magnitude of money that covers the costs of this project., Bringing such system to a state for an easy adaptation provides assumptions for development of a technologically advanced product in Croatia that can also be exported to other countries.

f. Proposed communication and outreach of results

This strategy is that the project carries dissemination activities during the project, and also includes the post-project dissemination plan. This strategy has the following overall objectives:

- to establish awareness about the project at the European level;
- to disseminate the ideas and the research results of the project at both technical and business levels;
- to promote the tools developed among tool developers;
- to actively help some companies in adopting the DICES methods.

The above mentioned dissemination objectives will be supported by activities which may be divided into three categories: (i) creation of dissemination material, (ii) distribution of dissemination material, and (iii) organization of events. These activities will include:

- Create and maintain a website that will contain information about the project and its results. The website will clearly inform about UKF showing UKFs logo and providing references to UKF.
- Publish articles in books and book chapters, scientific prestigious conferences and journals.
- Publish and maintain an open-source library of the developed tools in the style of SourceForge to further disseminate the project results.
- Disseminate the results of the project in industry by organising industrial seminars, tutorials and demonstrations. In particular DICES will communicate with TEMPUS EU KISEK project (in which the DICES co-project leader is the coordinator), in which several important Croatian companies are involved (Ericsson Nikola Tesla, Koncar, Siemens, Ring ….). The industrial partners will be continuously informed about the project progress
- Contact and collaborate with other European projects, networks of excellence, and initiatives such as the European technology platforms NESSI and ARTEMIS, EU and other projects being performed at MDH.

The exploitation of the results will be initiated through the following activates:

- Exploitation in the case study "Intelligent Forest Fire System"
- Possible exploitation in open-source community
- The academic exploitation to allow project results to flow into and enrich the software

engineering lectures at the participating universities.
- Establishing contact with leading companies developing software-intensive systems in order to validate and exploit the results (tools and possible inclusion of component-based development)
- Providing a bases for possible commercialization of the tools developed in the project.

g. Management of the project

Key considerations when elaborating the organizational structure for DICES are to minimize management overheads and, at the same time, to guarantee very high scientific and technical quality. The project organisational structure is as follows.

- **Project leader** (Ivica Crnkovic) has overall responsibility for the project and he report to UKF.
- **Project Steering Committee** (Ivica Crnković, Mario Žagar, Darko Stipaničev). The Project Steering Committee is the main decision body within the project. It is in charge of all formal decision within the project regarding:
  - Scientific and technical direction of the project
  - Description of the work and proposal elaboration
  - Distribution of work
  - Performance of each partner with respect to its contractual obligations
  - Major conflict resolution
- **Advisory Board** consists of the representatives from the partners universities. They provide advices to the project scientific board in order to ensure the research quality and relevance, and a smooth cooperation between the universities.

The follow-up of the project takes place periodically – each half year the current project report will be produced. All project documentation will be placed on a common repository. The follow-up will also occur by personal meetings of all participants two times per year and combined with other events, such as seminars, or collocation of the meeting with a relevant conference.

In addition, the project management will work on the continuation of the group after the project end by establishing cooperation with existing international projects performing on MDH and the possible projects which proposals have already been submitted by the project members (currently a Croatian project, an EU Tempus and an EU project).

h. Literature references

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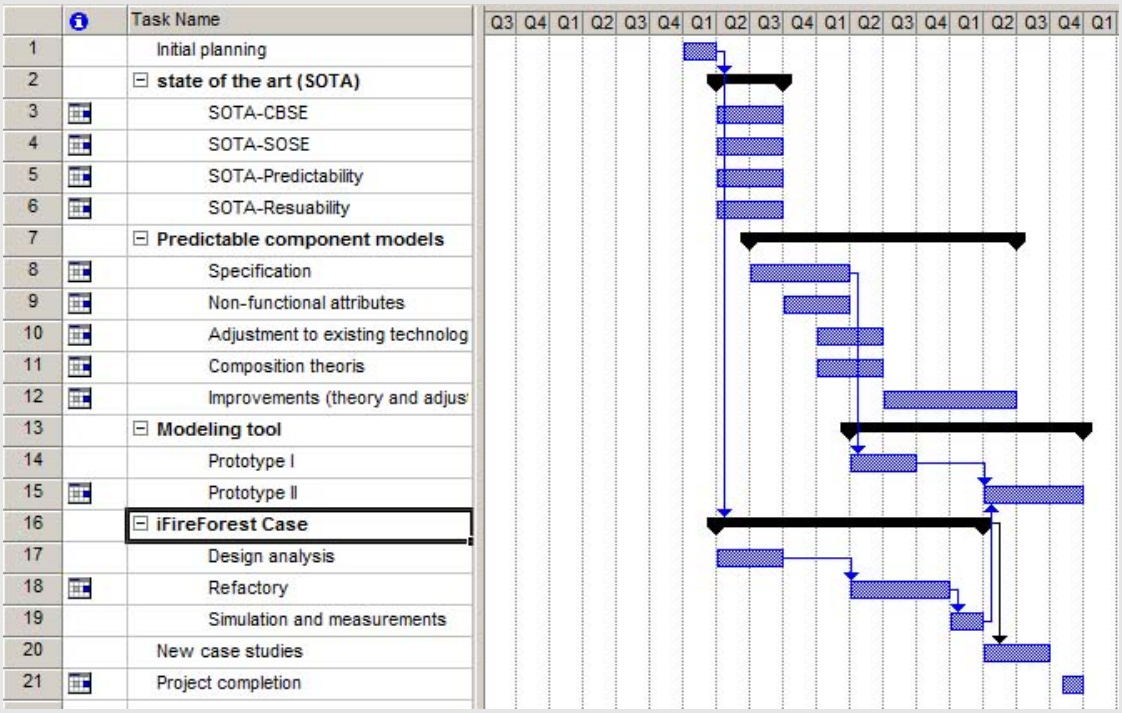
5. Work plan and timetable of the project

Word count: *600+figure*

(m*ax. 1500 words, add word count)*

a. Milestones (what and when is planned to be done)

The workplan is broken down in a set of grouped tasks as shown on the Gantt diagram below:



The following milestones are identified:

M1 - Planning workshop and provision of a detailed plan, month 1

M2 - New PhD students recruited, month 3

M3 - Current state identified, month 9 – The state of the art, state of the practice and analysis of the case completed

M4 - Component models and predictable attributed specified, month 15 - Specification of a "predictable component model" that can be applied on selected technologies and component models, and

M5 - Predictability and composition of quality attributes (performance and resource usage), month 18 - application of existing theories and their improvements for compositions of quality attributes for the developed "predictable component model"

M6 - Modelling tool for optimisation of the distributed embedded systems – version 1, month 21

M7 - re-design, refectory and re-implementation of parts of the "Intelligent Forest Fire System", month 24

M8 - Measurements of parameters for performance and utilisation of resources, month 27

M9 – Creation and validation system configurations and measurement of reusability, month 30

M10 - Completion: Improved theories, improved tools, preparation for further tool exploitation and possible commercialisation, completion of the project, month 36

b. Key performance indicators (quantitative development towards key project goals – quarterly achievements)

Key performance indicator	1st half-year	2nd half-year	3rd half-year	4th half-year	5th half-year	6th half-year
Technical reports	2	6	8	8	8	8
Scientific papers	0	2	4	7	10	12
Tool prototype	0	0	0	1	1	2
Evaluation and refectory	0	0	1	1	2	3
Events organised	0	0	1	1	2	2
Application for funding	0	0	1	1	2	2
Short visits	2	4	5	7	8	9
Long visits	0	0	1	2	3	4
Contacts with possible partners (about transfer of technology)	2	4	5	5	8	10

c. Assessment of the project risks

The methodology used for risk management consists of four steps:

- Identification concerned with identifying and classifying potential risks
- Quantification concerned with assessing the probability of occurrence and severity of the consequences
- Reaction concerned with elaborating contingency plans
- Control and reporting concerned with extracting and documenting the lessons learned.

Description	Probability	Severity	Contingency plan
R1 Disagreement or conflict within the project	Low	Medium	The minor conflicts are solved on a local level. More serious conflicts will be discussed and solved by the Project Steering Committee. If there is a disagreement at the project steering committee the project leader brings the decision about solving conflicts. All decisions follow strict the commitments defined by the contract.
R2 Delayed completion of project deliverables	Low	Medium	The scheduling was done based on the worst case estimates for task completions and as a result the project plan is already able to compensate for short delays. In case of longer delays, the project schedule will be adjusted along the way and steps will be taken, to mini-mize the overall delay - some parts less important (like refinement of the development tools) will be omitted.
R3 Loss of personnel or a drop-out	Medium	Medium	A replacement for her/him will be searched for. If necessary a re-plan of the project will be done.
R4	Low	High	In case of emerging discrepancies between anticipated

Discrepancies between the anticipated and the achieved results		h	and actual results, Project Steering Committee will inform the Advisory Board and the UKF Steering Committee and agree to which extend the project should be refined or adjusted.
R5 Problems with case study	Low	Low	If due to IPR or other conflicts work with the case study runs into problems, a new case study will be selected.

6. Partnership, owner structure, IPR and obligations

Word count: *197*

(m*ax. 500 words, add word count)*

a. Collaborations and partnership

DICES project will be realised in collaboration of researchers participating in this project.

The universities FER, FESB and MDH will sign an agreement in which they will regulate the cooperation in research and possible explanation. The agreement will be based on the rules valid at these universities, and on the previous cooperation agreement between FER and MDH, and with the agreement with UKF. According to the rules given by UKF, UKF has the priority right of the intellectual property.

b. Owner structure, obligations and intellectual property rights related to the project

"iForestFire - Intelligent Forest Fire Monitoring System" will be one of case studies in this project. It was developed as technological project financed by Croatian Ministry of science, education and sport and now is in commercialisation phase. The owners of the intellectual property rights related to this project are Darko Stipaničev, Maja Štula, Damir Krstinić and Ljiljana Bodrožić. Two of them are participants in this project, but all of them agree that the iForestFire could be used as a case study for exploration of the results obtained during work on DICES project. The written agreement is enclosed.

After finishing DICES project all participants and researchers in DICES project agree that the technical results of DICES project could be used in further versions of iForestFire without any limitations and obligations concerning iForestFire intellectual property rights.

The owners of iForestFire intellectual property rights - the main iForestFire functionality, detection algorithm, iForestFire structure functions (that are already developed) will remain today owners Darko Stipaničev, Maja Štula, Damir Krstinić and Ljiljana Bodrožić. UKF has rights for the intellectual property on the research results of this project (methodology and tools for component based embedded systems design according to the agreement between UKF and DICES. Personal participations in intellectual property rights of these technical results will be decided at the end of the DICES project according to the requirements provided by UKF.

The researchers participating in DICES project will be the owners of intellectual property rights of the technical results obtained by DICES project for all other applications. Personal participations in intellectual property rights of these technical results will be decided at the end of the DICES project.

In the case of further investment from the universes partners or other institutions (for example UKF), a possibility of sharing the intellectual properties with these institutions will be considered.