JOINT REPORT ON

ANALYSIS OF EMERGING ICT TRENDS IN 2016: "INNOVATION IN ICT" AND "INNOVATION WITH ICT" & ANALYSIS OF MAJOR SOCIETAL CHALLENGES IN 2016

INNOVATIVE ICT SOLUTIONS FOR THE SOCIETAL CHALLEGES

INNOSOC ZAGREB 2016 MULTIPLIER EVENT

Prepared by:

InnoSoc
Innovative ICT Solutions for the Societal Challenges

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1. INTRODUCTION

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University of Zagreb Faculty of Electrical Engineering and Computing
INNOSOC Project Coordinator

Innovative ICT Solutions for the Societal Challenges (INNOSOC)

INNOSOC project URL: *http://sociallab.education/innosoc*

INNOSOC project at the official ERASMUS+ dissemination platform: *http://goo.gl/6Y67nW*

INNOSOC project Facebook page: *https://www.facebook.com/innosoc*

INNOSOC project Twitter page: *https://twitter.com/innosoc*

INNOSOC project duration: *1 September 2015 – 31 August 2017 (2 years)*

INNOSOC project budget: *203,389.00 EUR*

INNOSOC project team: *100+ lecturers and students from 11 universities from 8 EU countries*

INNOSOC logo

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Fast proliferation of **information and communication technology (ICT)** caused certain negative side effects for society (e.g., increased energy usage or CO_2 emissions). However, **"innovation in ICT"** and especially **"innovation with ICT"** offer potential solutions for some of the biggest societal challenges[1, 2]. These are reasons why it is of great importance that students understand **how ICT can be utilized to tackle societal challenges**. The *"Innovative ICT Solutions for the Societal Challenges (INNOSOC)"* project is a step forward in that direction, taken by consortium of 11 universities from 8 European Union (EU) countries.

The main objective of the INNOSOC project is to set up a **transnational multidisciplinary intensive study program in the field of innovations based on ICT** targeting societal challenges defined by Europe 2020[3] and Horizon 2020[4] programs.

The INNOSOC curricula, which will be available as a **multilingual open educational resource (OER)**, consist of four main topic groups:

- **"innovation"** as a core topic
- intercultural topics, with focus on **"multicultural teams"**
- ICT topics, with focus on **"innovative engineering based on ICT"**
- student projects, with focus on **"case studies on how ICT can contribute to innovative societal development"**

Innovation as a core topic of the INNOSOC curriculum follows **multidisciplinary approach** that includes innovation processes, intellectual property as well as technology policy issues.

Intercultural part of curriculum uses **interactive approach** and focusses on **multicultural teambuilding** through exchange of practices from different cultures and by analysing societal challenges from local, regional and global perspectives.

ICT part of the INNOSOC curriculum explains why **ICT is one of Key Enabling Technologies** and therefore horizontal technology enabling innovative solutions for societal challenges. It includes practical examples tailored specifically for INNOSOC providing knowledge/insights into hot ICT topics – "innovation in ICT" and "innovation with ICT" (e.g., "green", "smart", "inclusive" and "disruptive" ICT).

Student projects elaborate case studies related to the **role of ICT in responding to societal challenges (SCs)** defined by Europe 2020 and Horizon 2020 programs:

[1] Global e-Sustainability Initiative: Smart 2020 *(http://www.smart2020.org/_assets/files/03_Smart2020Report_lo_res.pdf)*

[2] Global e-Sustainability Initiative: Smarter 2020 *(http://gesi.org/SMARTer2020)*

[3] European Commission: Europa 2020 *(http://ec.europa.eu/europe2020)*

[4] European Commission: Horizon 2020 *(https://ec.europa.eu/programmes/horizon2020)*

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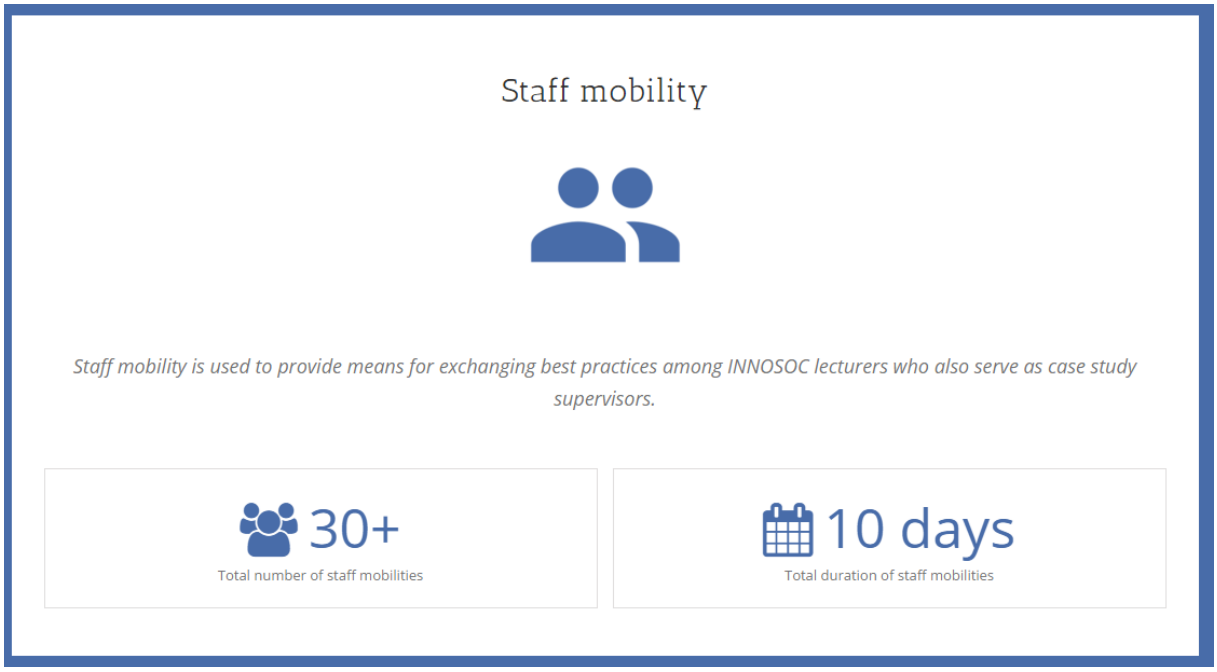
- Health, demographic change and wellbeing (**SC1 "Health & Ageing"**)
- Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the bio economy (**SC2 "Food"**)
- Secure, clean and efficient energy (**SC3 "Energy"**)
- Smart, green and integrated transport (**SC4 "Transport"**)
- Climate action, environment, resource efficiency and raw materials (**SC5 "Environment"**)
- Europe in a changing world – inclusive, innovative and reflective societies (**SC6 "Society"**)
- Secure societies – protecting freedom and security of Europe and its citizens (**SC7 "Security"**)



INNOSOC staff mobility for lecturers

Student projects will be based on the **"blended" mobility approach** and organized in two phases: (i) *preparatory phase* (virtual mobility); and (ii) *execution phase* (physical mobility). Physical mobility will be implemented through two **two-week intensive program workshops** hosted by partner universities in 2016 (Zagreb, Croatia) and 2017 (Valencia, Spain). Workshop participants will be lecturers and students from partner universities, as well as industry experts from workshop-hosting countries. **The first INNOSOC Intensive Program Workshop will be held 19-28 April 2016 in Zagreb.**

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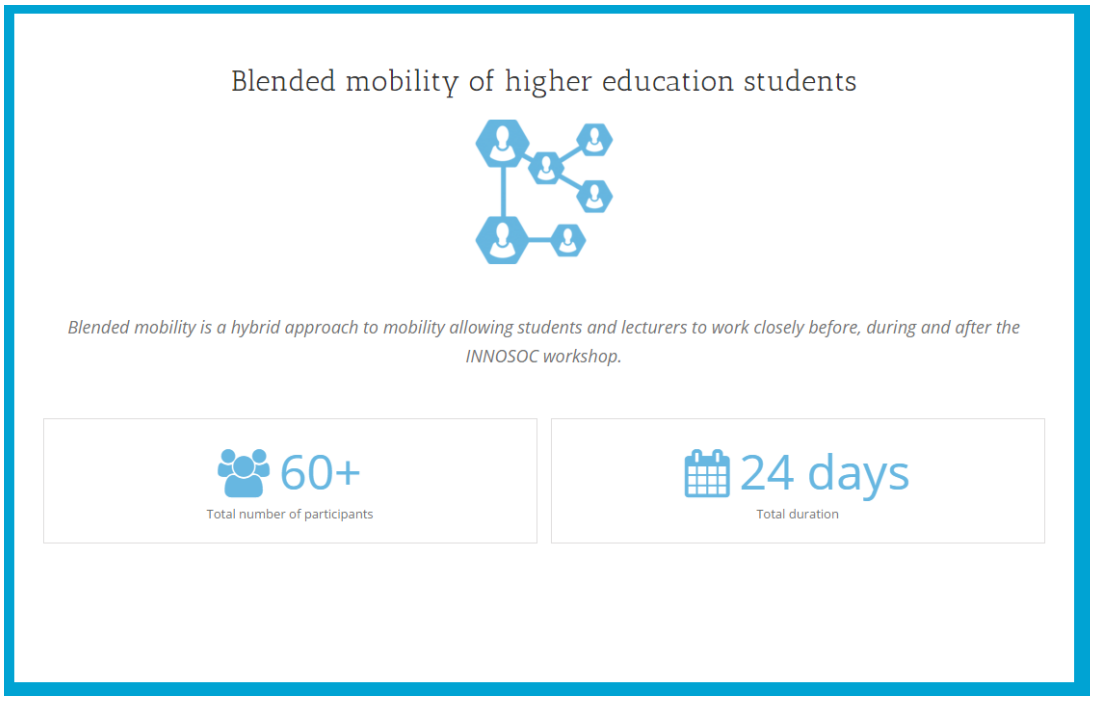

INNOSOC blended mobility for students – combining virtual and physical mobility

The INNOSOC project is funded through the **ERASMUS+ Key Action 2 Strategic Partnership Programme**[5]. ERASMUS+ is the **EU programme for education, training, youth and sport for 2014-2020**, which aims to **boost skills and employability**, as well as modernizing education, training and youth work. ERASMUS+ is based on **transnational partnerships** among education, training and youth institutions and organizations to foster cooperation and bridge the worlds of education and work in order to tackle the skills gaps we are facing in Europe. Specifically, **ERASMUS+ Key Action (KA) 2** is dedicated to **cooperation for innovation** and the exchange of good practices, where companies and higher education institutions work together to share knowledge. Priorities of the KA2 are to: (i) improve achievement in relevant and high-level basic and **transversal competence**; and (ii) develop **open and innovative education**, training and youth work, embedded in the digital era. **Diversity** should be woven into all ERASMUS+ KA2 activities, therefore motivating organisations from different participating countries work together to share and transfer best practices and innovative approaches in the fields of education, training and youth. Finally, specific ERASMUS+ KA2 sub-program – **Strategic Partnerships in Higher Education** – are aimed at supporting the **development, transfer and implementation of innovative practices** as well as the implementation of joint initiatives promoting

[5] European Commission: ERASMUS+ program (*http://ec.europa.eu/programmes/erasmus-plus/documents/erasmus-plus-programme-guide_en.pdf*)

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cooperation, peer learning and exchanges of experience at European level. The INNOSOC project aims to achieve the following general ERASMUS+ program objectives:

- **enhance student teaching practices**, especially for engineering students and especially in fields of transversal skills and entrepreneurial experiences
- **promote professional development** based on ICT
- **support the production and adoption of open educational resources (OER)** in diverse EU languages (partners from 8 EU countries will translate and adapt INNOSOC educational resources to their languages, digitalize it and make high-quality European OER visible and accessible to all citizens, in accordance with the "2013 Communication on Opening Up Education initiative"[6]
- **pursue priorities enlisted in general EU strategies** (**"Europa 2020, Innovation Union"** – *"smart, through more effective investments in education, research and innovation"*), as well as specific EU strategies (**"Horizon 2020"** – *"all societal challenges will be covered in INNOSOC case studies"* and **"Education and Training 2020"**[7] – *"enhancing creativity and innovation, including entrepreneurship"* and *"making lifelong learning and mobility a reality"*)

INNOSOC open educational resources will be available in 9 EU languages: English + 8 languages of INNOSOC partners

[6] European Commission: 2013 Communication on Opening Up Education initiative (*http://ec.europa.eu/education/policy/strategic-framework/education-technology_en.htm*)

[7] European Commission: Education and Training 2020 (*http://ec.europa.eu/education/policy/strategic-framework/index_en.htm*)

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Additionally, the INNOSOC project aims to achieve the **specific Croatian higher education objectives** as well:

- **internationalization** of higher education
- enhance **mobility** rates
- better **link of education with the labour market**

The first two specific objectives are achieved through enabling Croatian students to participate in the ERASMUS+ "blended mobility" as well by hosting the INNOSOC Intensive Program Workshop 2016 in Zagreb, while the third specific objective is targeted through the group of topics "Innovation" and entrepreneurial-oriented case studies.

Vedran Podobnik
University of Zagreb Faculty of Electrical Engineering and Computing
INNOSOC Project Coordinator

2. INNOSOC PARTNERS

INNOSOC is a truly international project!
Its consortium consists of 11 members from 8 countries.

University of Zagreb, Faculty of Electrical Engineering and Computing (UNIZG-FER)

University of Zagreb,
Faculty of Electrical Engineering and Computing

CROATIA, Zagreb

Project Coordinator, Steering Committee, Partner

The University of Zagreb (1669), which consists of 34 faculties and academies, is the oldest and biggest university in the South-Eastern Europe. With its comprehensive programmes and over 50,000 full-time students the University of Zagreb is the strongest educational institution in Croatia. Specifically, the Faculty of Electrical Engineering and Computing, through education and innovation in fields of electrical engineering, computer science and information and communication technology, prepares students for leading technological and societal development of Croatia.

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How do we innovate at the UNIZG-FER?

As Croatia's leading academic institution, we combine knowledge of our professors, curiosity of our researchers and open-mindedness of our students to foster innovation in our society and economy.

How do we use ICT to tackle societal challenges?

For example, we use ICT to develop innovative mobile applications for persons with complex communication needs (e.g., persons with Down syndrome). For more info check out our ICT-AAC project.

How do we promote intercultural environment?

Intercultural dialogue attracts a lot of attention in Croatia, the youngest member of the EU. This is why at our university we encourage interaction between different cultures, communities and people.

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Universitat Politecnica de Valencia (UPV)

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Universitat Politecnica de Valencia

SPAIN, Valencia

Steering Committee, Partner

UPV is a public Higher Education Institution actively involved in international cooperation and mobility projects. UPV hosts over 36,000 students and employs over 5,000 people (teaching, research, administrative, services staff). It is the first technological university in Spain according to international rankings (e.g. Shanghai Ranking of World Universities) and offers 33 undergraduate programmes, 73 official Master's degrees and 28 Doctorate programmes.

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How do we innovate at the UPV?

Technical University of Valencia ranks in the top 3 technical universities in Spainand Teelcommunication School provides around 25% of the research at UPV representing only 4% of the staff.

How do we use ICT to tackle societal challenges?

ICT is used widely at UPV, including teaching and reasearch applications, like Sakai facilities, remote teaching, etc.

How do we promote intercultural environment?

UPV is the second university in Spain that welcomes ERASMUS student which gives an idea of the intercultural and plurinational envinroment that the campus provides.

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Hochschule für Telekommunikation Leipzig (HfTL)

HfTL
Hochschule für Telekommunikation Leipzig
University of Applied Sciences

Hochschule fur
Telekommunikation
Leipzig

GERMANY, Leipzig

Steering Committee, Partner

HfTL is a private university under the patronage of the HfTL Trägergesellschaft mbH – a wholly owned subsidiary of Deutsche Telekom AG. It has full recognition by the Ministry of Science and Art of the federal State of Saxony, making it the only corporate-funded private university in Germany. HfTL specializes in academic teaching, research and training in the field of information and communications technologies (ICT) and management.

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How do we innovate at the HfTL?

HfTL is the only corporate German university which is specialized on ICT. The study programs are continuously brought in line with the technical and societal development.

How do we use ICT to tackle societal challenges?

As DT as one of the leading ICTelcos set & follows trends in order to facilitate and improve daily life with ICT products, HfTL plays an important role in the relevant field in both education&research.

How do we promote intercultural environment?

HfTL is a globally acknowledged specialized university, offers study programs in ICT for students from all over the world. It is a leading partner of the European network of comparable universities.

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Szechenyi Istvan University (SZE)

Szechenyi Istvan University

HUNGARY, Gyor

Steering Committee, Partner

The university serves and will serve the economy and society of the city and the area with the continuous expansion of the educational spectrum. At our university the students can choose subjects from other programmes and can study simultaneously two undergraduate programmes. An economics student can enrich his/her knowledge by listening in on law or engineering subjects. In addition to the twelve thousand students attending the university full time there are five thousand students learning in correspondence courses and distant learning courses. Most recently we have begun to offer e-distant learning courses.

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How do we innovate at the SZE?

The University provides a unique and innovative training students with high-level, valuable, professional, and practical education, in addition research activity in the region, which serves primarily the engineering focused production activities.

How do we use ICT to tackle societal challenges?

The University – in accordance with the traditions – pursues predominantly applied research. Particular attention is paid to ICT research activities that are multidisciplinary and interdisciplinary projects, which have a social and economic aspect to them and deal with critical problems.

How do we promote intercultural environment?

The university have established a working educational and research co-operation with more than 150 European institutions of higher education, and industrial partners and with numerous international partnerships outside Europe. The University welcomes cca. 500 foreign students.

Contact:
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SZE Team Leader
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University of Telecommunications and Post (UTP)

University of
Telecommunications and Post

BULGARIA, Sofia

Partner

The University of Telecommunications and Post (UTP), is among the oldest Bulgarian academic institutions, established from Knjaz Alexander I at 1881 for higher education in the area of telegraph and post services. After several transforms and change of the names nowadays UTP is a specialized university for higher education of students in the area of Computer and Telecommunication Technique and Technologies, Mobile Communications, Radio-communications and Broadcasting, Management of communication services. The Faculty of Telecommunications and Management through education and innovation in fields of ICT, computer science, information technologies and communication technologies, prepares students for leading technological and ICT practical development of Bulgaria.

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How do we innovate at the UTP?

The University of Telecommunications and Post (UTP) combine knowledge of academic staff and researchers for implementation of innovations in the area of telecommunications, ICT and service management.

How do we use ICT to tackle societal challenges?

UTP develop innovative mobile applications for disabled persons, for smart houses and future trends of implementation of sensor networks for automation and control of industrial processes.

How do we promote intercultural environment?

The University of Telecommunications and Post encourage interaction between different cultures and communities in the area of computer and communication technologies for better social life.

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University of Zilina (UNIZA)

University of Zilina

SLOVAKIA, Zilina

Partner

The University of Zilina was established as the Railway College on 1st September 1953 by the separation from the Czech Technical University in Prague. It has gone through numerous changes during its history. Finally, in 1996, it was renamed from the University of Transport and Communications to the University of Žilina in Žilina. The University as a public university provides education at all three levels of higher education (Bachelor's degree, Engineer/Master's degree and Doctoral degree) in both full-time and part-time forms. Approximately 11 000 students currently study in all forms of study. There are more than 1 500 employees and 650 of them are university teachers.

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How do we innovate at the UTP?

We are unique in Slovakia, offering education in transport and communications. Our faculty offers innovative study programs in ICT based on this tradition, but connected to industry requests too.

How do we use ICT to tackle societal challenges?

Our education and research are inter-disciplinary. We are developing apps, networks, hardware answering specific user demand – smart cities, urban transport, health, secure ICT.

How do we promote intercultural environment?

We finished project oriented to internationalization of our university one year before. We have active contact with non-European universities. In last semesters we had students from Taiwan and Brazil.

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Institut Mines Telecom – Telecom Bretagne (IMT-TB)

In the 30 years since its creation, Telecom Bretagne has affirmed itself as a pioneering "Grande École" in education, research and enterprise. It trains multi-discipline engineers able to assume important responsibilities. Recognised for its dynamism and its very substantial international dimension, Telecom Bretagne has partnerships with more than 100 establishments of higher education and research throughout the world. It collaborates with MIT and the Lausanne École Polytechnique Fédérale on the subject of pedagogic innovation. More than a thousand students, from 50 countries, follow engineering courses on two quite exceptional campuses situated at the heart of very active high-technology clusters.

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How do we innovate at the IMT-TB?

Founded in 1977, Telecom Bretagne is one of the most prestigious graduate engineering schools in France, at the cutting edge of the Information Technology sector in both research & teaching.

How do we use ICT to tackle societal challenges?

We innovate in all areas of Information Technology, including the Internet of Things, Domotics, Medical Imagery, Intelligent transport & Didactics.

How do we promote intercultural environment?

50% international students, study of two foreign languages; 6 months abroad. Intercultural Communication and Management courses: students and staff. Well-established research I/C programme.

Contact:
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Technical University of Kosice (TUKE)

TECHNICKÁ UNIVERZITA V KOŠICIACH

Technical University of Kosice

SLOVAKIA, Kosice

Partner

Technical University of Košice (TUKE) was established in 1952. The content of education and research at University includes the entire complex of sciences and economics. The TUKE seeks to maintain a cohesive and interdependent relationship between their teaching, research and service activities with accordance to European state of Art. The TUKE has 9 faculties with 17 030 students and 1880 staff. The TUKE has been the first and so far the only university in Slovakia to meet the criteria of the international standard EN ISO 9001:2000 and it received the quality certificate in the area of providing educational and research processes and enterprise activities within a public university (certification by TÜV SÜD Slovakia s.r.o.).

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How do we innovate at the TUKE?

TU support innovations in education (modern ICT infrastructure for students & staff, free wifi everywhere in the campus), excellent research centers. Special support for startups & innovative ideas.

How do we use ICT to tackle societal challenges?

TU have barrier free center for disadvantaged students, e-learning and online documents for students (exams, study results, application forms), internet in the dormitories.

How do we promote intercultural environment?

TU provide support for international students of all 3 levels of study. We have several student organizations: Best, ESN, IAESTE. We organize events for different cultures/nations.

Contact:
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University of Oradea (UO)

University of Oradea

ROMANIA, Oradea

Partner

The mission of the University of Oradea, is to promote knowledge, research and training through partnerships between teachers, students and community. In the last 22 years, the University answered the changes occurred within the national educational policy, demographic changes, requirements of the market economy, local and regional needs and new technologies. All these changes have led to new expectations from students, academic and administrative staff. University of Oradea offers to our students the necessary training to contribute to society development. This training is conducted in 15 faculties which offers a wide range of initial training and postgraduate courses.

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How do we innovate at the UO?

University of Oradea's mission, is to promote knowledge, research and training through partnerships between teachers, students and community.

How do we use ICT to tackle societal challenges?

UO is a creative,energetic,active and innovative university.Professors and researchers are very enthusiastic and determined to experience all the new opportunities offered by informational technology.

How do we promote intercultural environment?

UO promotes intercultural dialogue.The city of Oradea ever since the Middle Ages was a cosmopolitan city inhabited by several nationalities what assures a special diversity.

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University of Debrecen (UNIDEB)

University of Debrecen

HUNGARY, Debrecen

Partner

University of Debrecen is one of Hungary's five elite-research universities, offering the widest choice of majors in the country for over 29,000 students, including 3,741 international students. UD's 1500 lecturers of 14 faculties endeavour to live up to the elite university status and to provide high quality education. Our goal is to train professionals possessing all necessary skills and knowledge to enter the regional, national, or international labour market with a competitive degree. More than 1000 lecturers with doctoral degrees (PhD), 25 doctoral schools, and the volume of internationally renowned research publications and projects attest to the scientific dominance of the university. 139 of the lecturers and researchers are Doctors of the Hungarian Academy of Sciences and 27 are members of the Academy.

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How do we innovate at the UNIDEB?

Strong collaborations are established with companies committed for social challenges. Not only researchers but our students are involved in these activities implying the need of innovative thinking.

How do we use ICT to tackle societal challenges?

Several research groups work on how ICT can be applied in health care systems (e.g. devices and services for health monitoring and prevention, supporting older persons to remain active and healthy).

How do we promote intercultural environment?

Our faculty runs undergraduate and postgraduate programs in English for international students, where also exchange students are welcome. So, real intercultural environment is given for our students.

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Technical University – Sofia (TUS)

Technical University – Sofia

BULGARIA, Sofia

Partner

The Technical University of Sofia is the largest educational and scientific complex in Bulgaria in the field of technical and applied science with an institutional accreditation grade of 9.5 (on the scale of 10) for the period 2012 – 2018. As the first and largest polytechnic center, which supported the establishment of most of the higher technical colleges in the country, it sets the educational standards and national priorities for the development of engineering education and science.

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How do we innovate at the TUS?

We are introducing a system for promoting the students‘ active participation in research and project orientated training for master and PhD students.

How do we use ICT to tackle societal challenges?

Development of algorithms and methods for signal processing in biometric systems and systems using human-computer interface.

How do we promote intercultural environment?

There are three foreign language Faculties: German, French and English providing strong international student and teachers exchange and interaction.

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3. INNOSOC 2016 REPORTS

Ignac Lovrek
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INNOSOC Steering Committee member
Leader of the Working Group for Preparation of Croatian Science and Technology Strategy

Analysis of emerging ICT trends in 2016: "innovation in ICT" and "innovation with ICT"

The share of **information and communication technology (ICT)** in gross domestic product (GDP) as well as the contribution of ICT to productivity growth are significant indicators for the **economic impact of ICT**. The ICT sector, i.e., ICT manufacturing and service industry, achieves 4.8% of GDP in the European Union and generates 25% of total business expenditure in research and development (R&D)[8]. Further on, ICT sector contributes 20% directly to the overall productivity growth, and an additional 30% to overall investments in ICT in other sectors. Perceiving comprehensively not only economic, but also **social impact of ICT** requires taking into account research and innovation issues, and their roll in solving society's global challenges.

"Innovation in ICT" aspects refer to research and innovation that contribute to the overall development of ICT. ICT is present in all parts of the actual European research and innovation programme Horizon 2020. Let us list only a part of the activities in ICT as an enabling and industrial technology defined in "A guide to ICT-related activities in WP2016-17"[9]: *a new generation of components and systems*; *advanced computing and cloud computing*; *future Internet*; *content technologies and information management*; *robotics and autonomous systems*; *micro- and nano-electronic technologies*; and *photonics*. There are expected new features and capabilities, improved functionalities and performances, higher energy efficiency and lower energy consumption, better digital security and privacy protection, but also radically new possibilities as well.

"Innovation with ICT" aspects refer to the opportunities offered by ICT in enhancing and enriching the other sectors and contributing to the **global societal challenges (SCs)** that are defined in Horizon 2020 as follows:

- Health, demographic change and wellbeing (**SC1 "Health & Ageing"**)
- Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the bio economy (**SC2 "Food"**)
- Secure, clean and efficient energy (**SC3 "Energy"**)
- Smart, green and integrated transport (**SC4 "Transport"**)
- Climate action, environment, resource efficiency and raw materials (**SC5 "Environment"**)
- Europe in a changing world – inclusive, innovative and reflective societies (**SC6 "Society"**)
- Secure societies – protecting freedom and security of Europe and its citizens (**SC7 "Security"**)

[8] ICT Research & Innovation (*https://ec.europa.eu/programmes/horizon2020/en/area/ict-research-innovation*)

[9] A guide to ICT-related activities in WP2016-17 (*https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/Guide%20to%20ICT-related%20activities%20in%20WP2016-17%20A4%20v8.pdf*)

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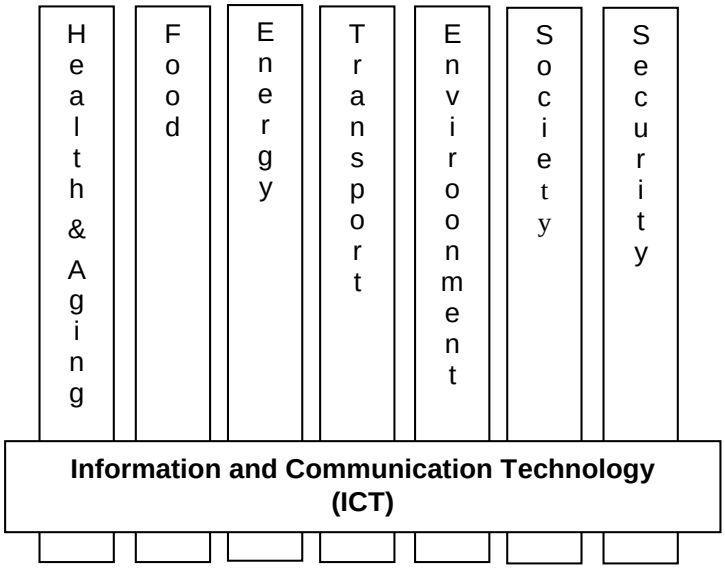
When talking about ICT and societal challenges, two following dimensions should be considered: a) **horizontal dimension** containing parts of ICT relevant to all (or more) challenges, and b) **vertical dimension** addressing topics for a specific challenge.

Horizontal dimension implies cross-cutting research and innovation activities that will produce system solutions and platforms able to adapt to specific requirements and support specific applications, i.e., "verticals". An excellent example of such a solution is *Internet of Things (IoT)* defined as *"A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies. With regard to the Internet of Things, this is an object of the physical world (physical things) or the information world (virtual things), which is capable of being identified and integrated into communication networks."*[10] IoT includes capabilities to connect cyber/information world and physical world in order to provide services for different application domains.



ICT and societal challenges

Besides technology oriented horizontal issues, **Horizon 2020** instruments support additional ones important for development of research and innovation infrastructures (e-infrastructures), innovation schemes and involvement of small and medium enterprises (SME).

[10] „Overview of the Internet of things", Y.2060 (06/2012), International Telecommunication Union (ITU), 2012

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Lack of skilled workforce is a particular problem facing Europe that will affect the European research and innovation potential. Part of the problem is insufficient focus on **education in the STEM fields (Science, Technology, Engineering and Mathematics)** and attracting young people to STEM. This is why STEM studies should be considered in the wider context of ICT and innovations.

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Analysis of global societal challenges 2016

ICT and all other technologies addressing global societal challenges are guided by a common vision of the **human-centric digital age**. Besides long-term goals related to the each of societal challenge (SC), targeted activities to be addressed by the new Horizon 2020 projects in the period 2016-2017 are defined as follows:

- **SC1 "Health & Ageing"**: Personalized medicine (active ageing and self-management of health)
- **SC2 "Food"**: Sustainable food security – Resilient and resource-efficient value chains
- **SC3 "Energy"**: Energy efficiency and Competitive low-carbon energy
- **SC4 "Transport"**: Mobility for growth, Automated road transport, and Green Vehicles
- **SC5 "Environment"**: Greening the economy
- **SC6 "Society"**: Co-creation for growth and inclusion, Reversing inequalities and promoting fairness, and Understanding Europe – promoting the European public and cultural space
- **SC7 "Security"**: Critical infrastructure protection and Digital security

Societal challenges wordle[11]

[11] European Science Fundation: „Responses to Environmental and Societal Challenges for our Unstable Earth (RESCUE)" (http://www.esf.org/index.php?id=6198)

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INNOSOC 2016 programme covers societal challenges with the following activities:

- **Case studies** related to a specific societal challenge or a horizontal activity
- **Horizontal activities** related to the development of face-to-face and distance communication skills, as well as promoting multicultural awareness
- **Visits to companies** providing industrial perspective

The activities included the INNOSOC 2016 programme follows.

SC1 "Health & Ageing":

- Innovative Solutions for Assistance of Active Daily Life at Home (*Case Study 6*)
- Recognition of Patterns of Maleficent Objects on Medical Images (*Case Study 8*)

SC2 "Food":

- Innovations in the food industry (Industrial perspective – *Visit to the company 1*: Kraš, Zagreb – the largest manufacturer of confectionery products in the South-Eastern Europe)

SC3 "Energy":

- Innovative Application of Electric Vehicles in Sustainable Energy Systems of the Future (*Case Study 1*)

SC4 "Transport":

- Intelligent Transport Systems and Vehicular Ad hoc Networks (*Case Study 4*)

SC5 "Environment":

- Microwave Sintering (*Case Study 7*)

SC6 "Society":

- Issues and Challenges of Corporate Social Responsibility and Sustainability in the ICT Sector (*Case Study 2*)
- Seamless Connectivity for a Digital Life (*Case Study 5*)
- Technology way towards networked society (Industrial perspective – *Visit to the company 2*: Ericsson Nikola Tesla, Zagreb)

Horizontal issues:

- Development of face-to-face and distance **communication skills**, as well as promoting **multicultural awareness**
- **Promoting STEM (Science, Technology, Engineering and Mathematics)** Studies among Young Students (*Case Study 3*)

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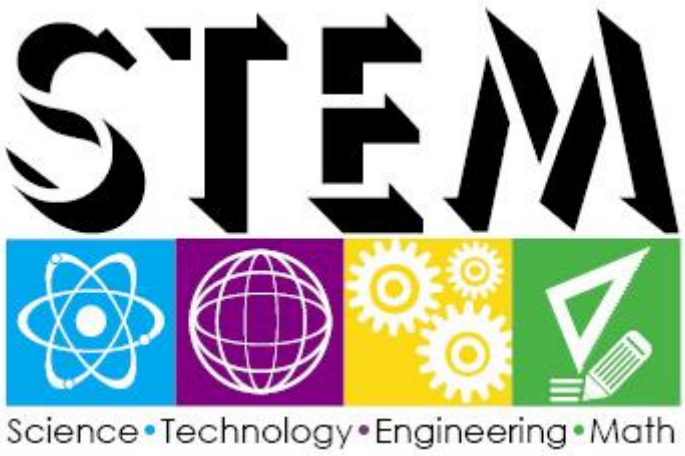

STEM = Science + Technology + Engineering + Math[12]

Lectures on selected innovation and ICT topics will complement teamwork-based case study development.

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[12] Success Strategies from Women in STEM (*http://www.universetoday.com/126551/book-review-success-strategies-from-women-in-stem*)

INNOSOC Case Study preparation process

INNOSOC Case Studies for the Zagreb 2016 Intensive Program Workshop were selected through the **three-step preparation process**. In the first step, which took place in the period November-December 2015, the *Call for Case Study Proposal* was sent to all 11 INNOSOC partners and each partner could propose up to two Case Studies tackling H2020 societal challenges. The proposals should have been done by filling the specially prepared template, which can be found on the following two pages of this document.

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InnoSoc
Innovative ICT Solutions for the Societal Challenges

INNOSOC Case Study topic proposal

Case Study topic title (*please insert title – max. 8 words*):

Case Study planned to be prepared for Zagreb (2016) or Valencia (2017) (*please choose a year*):

Choose a year

H2020 challenge addressed by the Case Study (*please choose from the drop-down list*):

Choose a H2020 challenge

Brief description of the problem addressed by the Case Study (*please insert 150-250 words*):

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Innovative ICT Solutions for the Societal Challenges

Brief description of the Case Study ***innovation aspect*** (*please insert 25-50 words*):

Brief description of the Case Study ***intercultural aspect*** (*please insert 25-50 words*):

Brief description of the ***role of ICT*** in the Case Study (*please insert 25-50 words*):

Key links and/or papers describing the Case Study (*please insert 2-3 links and/or papers*):

INNOSOC partner proposing the Case Study topic (*please choose from the drop-down list*):

Choose an INNOSOC partner

Primary contact at the INNOSOC partner proposing the Case Study (*please insert contact info*):

Name:
E-mail:

Lecturers from the INNOSOC partner which will coordinate the proposed Case Study development and come to give a lecture in Zagreb (2016) and/or Valencia (2017) (*please insert info*):

Lecturer name:
Lecturer e-mail:
Lecturer webpage:

After all Case Study proposals were collected, the INNOSOC Steering Committee analysed all received proposals and selected eight Case Studies for the Zagreb 2016 Intensive Program Workshop. Some of selected Case Studies were result of merging two related or complementary proposals received from INNOSOC lecturers from different universities.

In the second step (December 2015 – January 2016) of the INNOSOC Case Study preparation process, INNOSOC lecturers that proposed selected Case Studies were asked to extend their proposals by filling the specially prepared template, which can be found on the following four pages of this document.

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INNOSOC Case Study (selected for Zagreb 2016; extended version)

Case Study title (*please insert title – max. 8 words*):

Keywords (*please add 3-8 keywords separated by a semicolon*):

H2020 challenge addressed by the Case Study (*please choose from the drop-down list*):

Choose a H2020 challenge

Introduction to the Case Study (*please insert 200-300 words*):

Introduction should (in a catchy way) describe what is the main problem addressed by the Case Study and explain its relevance. Please do not use very technical vocabulary here but rather aim at a broader audience who are not experts in the field. Please give an example of the real-world problem which is not solved yet and this Case Study will develop a solution for it.

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How this Case Study is related to the selected ***H2020 challenge***? (*please insert 100-200 words*):

This section should explain how the Case Study addresses the specific H2020 challenge. You can use a bit more technical vocabulary here. Please use "official" H2020 wording (e.g., take a look here: https://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges).

How this Case Study is related to the ***INNOSOC project***? (*please insert 200-300 words*):

This section should explain how the Case Study fits in the INNOSOC project frame. You can use a bit more technical vocabulary here. Please use "official" INNOSOC wording (e.g., take a look at the brief project description http://goo.gl/D2INjR or http://sociallab.education/innosoc/about). You can also use ideas/text from the initial Case Study form where you described innovation, intercultural and ICT aspect of the Case Study.

Questions that need answers during the Case Study development (*please insert 5-10 questions*):

This section should present questions which will need to be answered by students in the process of the Case Study development. Example set of questions relevant for the Case Study "Innovative Application of Electric Vehicles in Sustainable Energy Systems of the Future" (Secure, clean and efficient energy) follows:

*****

Questions that need answers include but are not limited to the following:

- *Vehicle taxonomy: what types of vehicles are there? EV, BEV, ICV, FCV, PHEV, … Outline pros and cons (e.g., energy efficiency) for each of them.*
- *How do EVs affect three pillars of sustainable development: economy, environment and social community?*
- *What is the state of the global EV market? Sales, battery costs, incentives, popular cars ...*
- *How does an EV owner use its car? Demand (charging), typical traveling patterns …*
- *What is the state of the EV charging infrastructure? Types of chargers, number of chargers in popular countries…*
- *What is the role of ICT in EVs? In-car applications, communication with charging infrastructure…*
- How can we innovate with EVs? Integration with renewables as energy storage system, vehicle-to-home, vehicle-to-grid, electric charging lanes…

*****

References (key links and/or papers conneceted with the Case Study) (*please insert 5-10 references*):

This section should give main references connected to the Case Study. The role of these references is twofold: i) they support and or elaborate in more details statements given in the remainder of this document; and ii) they are initial reading list for students. Please provide citations according to the IEEE Citation Reference guidelines (http://www.ieee.org/documents/ieeecitationref.pdf). All references should be cited at least once in the text in the remainder of this document by inserting "[x]" mark in the text, where "x" is the number of the reference (same as when you write scientific papers).

[1] Reference 1
[2] Reference 2
…
[10] Reference 10

Knowledge and skills needed for developing the Case Study (please add 3-8 knowledge units and/or skills separated by a semicolon):

Five students (from different partner universities) will be allocated to the each Case Study. Students will bid for Case Studies in the process of student allocation. Students will rank their choices of Case Studies based on two criteria: i) interest for the Case Study topic (students will determine their interest for the topic based on the Case Study description given in this document); and ii) knowledge and skills needed for developing specific Case Study (students will determine their capability for working on the Case Study based on the list of knowledge and skills given in this section). We differentiate two categories of knowledge and skills: "prerequisite" (P) and "desirable, but not necessary" (D). Please mark each knowledge unit and skill with one of these categories (i.e., (P) or (D)).

Example of a knowledge unit: "TCP/IP protocol stack" (P); "wearables for e-health" (D)
Example of a skill: "statistical analysis in the language/tool R" (P); "web-page programming" (D)

Figures describing this Case Study (please insert 2-3 print quality figures; we are going to use these figures in our publications (web/brochures) so please be careful about copyright –insert only figures which are not copyrighted or provide us with source citation or whatever information which allows us to publish these photos (e.g. inserted photo is a photo taken by you and showing your lab); give a one line caption for every inserted figure)

INSERT FIGURE HERE
Figure 1. One line caption

INSERT FIGURE HERE
Figure 2. One line caption

INSERT FIGURE HERE
Figure 3. One line caption

In the last step (January-February 2016) of the INNOSOC Case Study preparation process, INNOSOC Steering Committee members finalized the preparation of each Case Study selected for the Zagreb 2016 Intensive Program Workshop.

Case Studies were published online and the process of INNOSOC 2016 students allocation to Case Studies has started. Four to five INNOSOC 2016 students will be grouped together to work on Case Study development through their INNOSOC blended mobility. Each student group will be supervised by two INNOSOC lecturers who are experts in the Case Study domain. Final results of student work will be presented during Zagreb 2016 Intensive Program Workshop in late April 2016.

The list of eight INNOSOC 2016 Case Studies is given on the page 36 of this report. Detailed description of each Case Study is given in the next section of this report, as well as it is available online (http://sociallab.education/innosoc/case-studies/zagreb-2016).

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4. INNOSOC 2016 CASE STUDIES

Case study is used and analysed in order to illustrate a thesis or principle in the area of innovation, intercultural and ICT.

Innovative Application of Electric Vehicles in Sustainable Energy Systems of the Future

Case Study URL: *http://goo.gl/7Bl4em*

Authors: Jurica Babic, Vedran Podobnik and Ignac Lovrek (*University of Zagreb, Croatia*)

Keywords: *Electric Vehicles; Sustainability; Innovation; Energy systems*

H2020 challenge addressed by the Case Study: *Secure, clean and efficient energy*

Electric vehicle "Concept_One" produced by a Croatian company "Rimac Automobile"

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Introduction

Nowadays, a term *sustainable development* is most often associated with a term *environmental sustainability*, whose goal is to conserve natural resources and to develop alternate sources of electricity while reducing pollution and harm to the environment [1]. In that respect, the undisputed truth is that *changes* are needed in the way people *produce* and *consume* energy. The lucrative amount of money EU offers through the HORIZON 2020 framework [3], as well as the latest Paris agreement on a climate change [2], communicates a clear strategic vision on **what to accomplish** but it provides **no clues on how to do so**.

An *electric vehicle* (EV) is a prime example of energy efficient and low carbon technology [4, 5, 6, 7]. Not only does an EV drive more *smoothly* and more *economically* than its internal combustion engine counterpart, but it also has a dedicated battery which can **store electricity**. In theory, this can be really exciting because the EV battery provides means to use EVs not only for traveling but also for **storing the excess electricity**, which typically happens when the wind turbine produces more electricity than users (e.g., industry and residential) currently need.

It *seems* an EV is a **clear winner** in all areas. In current practice, however, this may **not be the case**. Without serious incentives, **economical benefits** of EVs are still **doubtful**. Even though EVs have so-called **zero tailpipe emissions**, the electricity still largely comes from **fossil fuels**. Potential applications of EVs as energy storage are yet to be explored due to its **costly battery** and the overall **lack of charging infrastructure**. Thus, energy systems of the future need a lot of ICT-based innovation to tackle challenges imposed by EVs.

Five INNOSOC students, supervised by two INNOSOC lecturers, will collaborate on answering how innovative coupling of ICT and EVs can contribute to building sustainable energy systems of the future. These activities will be conducted as a part of the ERASMUS+ blended mobility and will be finalized during the INNOSOC Zagreb 2016 workshop in late April 2016.

Connection with the H2020 challenge „Secure, clean and efficient energy“

The so-called *Energy Challenge* is aimed at transforming traditional and aging energy systems towards reliable and competitive energy systems. This highly complex problem needs to cope with *increasingly scarce resources*, *growing energy needs* and *climate change*.

EVs are **strongly tied** to the specific objectives and research areas from the HORIZON 2020. In particular, EVs are highly efficient machines which **reduce energy consumption and carbon footprint**. Being **mobile energy sources**, EVs, along with appropriate policies and incentives, promote the inclusion of a **low-cost, low-carbon electricity supply**. Energy entrepreneurs interested in EV business (e.g., charging facilities) will need **robust decision-making** (e.g., pricing policies) as well as

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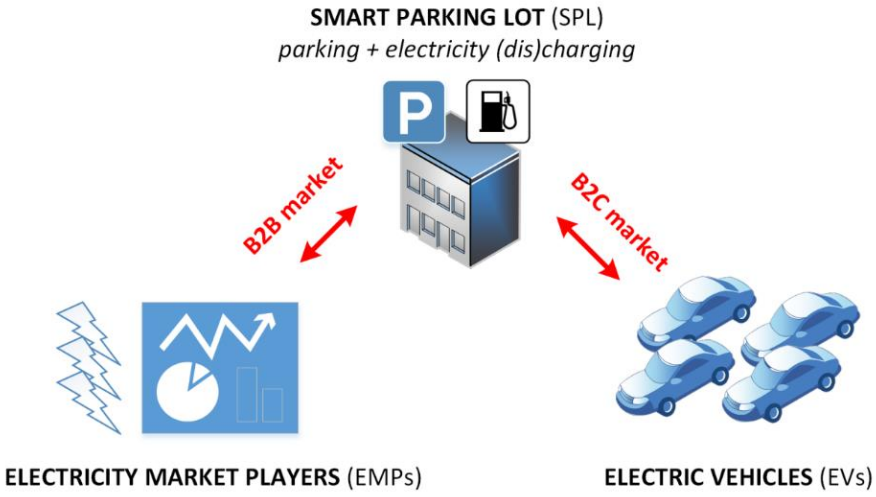
public engagement (e.g., EV owner charging flexibility) in order to achieve a **market uptake**. That being said, **new knowledge and technologies** are needed in the area of EVs to tackle wicked problems [8] in energy systems of the future.

Connection with the INNOSOC project

While conventional cars are used primarily for driving, EVs potentially have much more applications and consequently much broader positive impact on people's lives. For example, EVs, apart from being used for commuting to work or shopping mall, can potentially be used as power plants through vehicle-to-home technology [9]. Essentially, EVs act as both producers and consumers (i.e., prosumers) of energy. Indeed, the **innovation aspect** of EVs surpasses technical advancements. Energy entrepreneurs, along with a positive input from policy makers, are able to extend their businesses with charging infrastructures. In order to get there, however, there are years of a dedicated innovation ahead of us.

The Case Study eagerly awaits for participants from different countries and cultures. The **intercultural communication** is needed to discuss what people from different areas think and do about changing energy landscape. A bad reputation for nuclear power in Germany, lucrative incentives for buying an EV in Norway [10] and protests for coal-based power plant in Croatia are only few examples suggesting we are in the process of *emotionalization of energy*.



Smart parking lot as an example of innovation with EVs

Finally, today's EVs are *highly sophisticated* machines. It is expected that, in the near future, billions of machines will be connected by the means of ICT, EVs included. In contrast to the traditional energy

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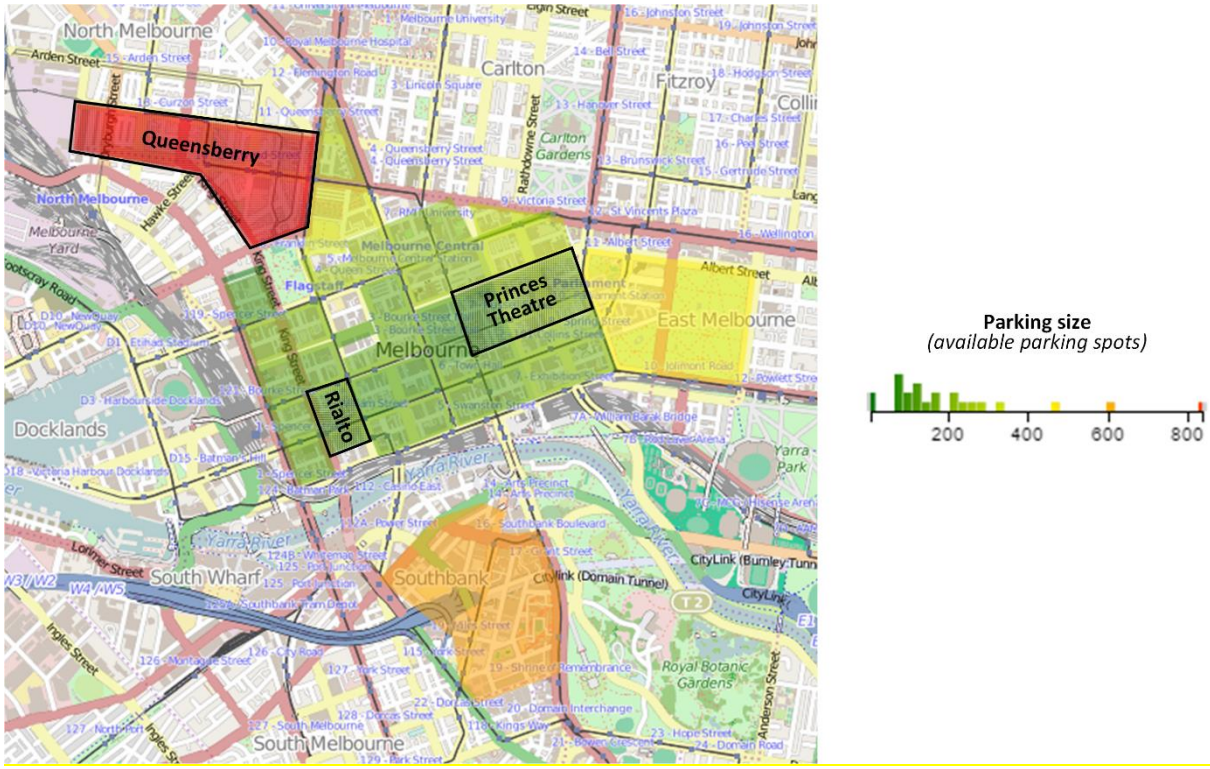
systems, the energy system of the future will require two-way flows of power and communication between producers and consumers. Smart in-vehicle applications, interaction with a charging infrastructure and many other innovative applications are just small examples which prove that an **ICT aspect** is a cornerstone for EV applications.



Parking lot size affects planning of a charging infrastructure

Questions that need answers

Questions that need answers include but are not limited to the following:

- Vehicle taxonomy: what types of vehicles are there (e.g., EV, BEV, ICV, FCV, PHEV, …)? Outline pros and cons (e.g., energy efficiency) for each of them.
- How do EVs affect three pillars of sustainable development: economy, environment and social community?
- What is the state of the global EV market (w.r.t., sales, battery costs, incentives, popular cars, ...)?
- How does an EV owner use its car (w.r.t., demand (charging), typical traveling patterns, …)?
- What is the state of the EV charging infrastructure (w.r.t., types of chargers, number of chargers in popular countries, …)?

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- What is the role of ICT in EVs (e.g., in-car applications, communication with charging infrastructure, …)?
- What my country and culture think and do about changing energy landscape (e.g., incentives for EVs and renewables, what kind of power plants are being used in my country, …)?
- How can we innovate with EVs (e.g., integration with renewables as energy storage system, smart parking lot [7], vehicle-to-home, vehicle-to-grid, electric charging lanes, …)?

Knowledge and skills needed for developing the Case Study

(P: prerequisite; D: desirable, but not necessary)

- to be familiar with newest trends in ICT (P)
- to have interest in Electric Vehicles (D)
- to care about sustainability (D)
- to be curious and prolific Internet researcher (D)
- to be familiar with Energy Systems (D)

References

[1] Circular Ecology, *Sustainability and sustainable development - What is sustainability and what is sustainable development?* – Available: http://www.circularecology.com/sustainability-and-sustainable-development.html#.VnfFNRUrJaQ

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[3] *HORIZON 2020 – Secrure, Clean and Efficient Energy* – Available: https://ec.europa.eu/programmes/horizon2020/en/h2020-section/secure-clean-and-efficient-energy

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[7] J. Babic; A. Carvalho; W. Ketter; V. Podobnik. "*Extending Parking Lots with Electricity Trading Agent Functionalities*," Proceedings of the Workshop on Agent-Mediated Electronic Commerce and Trading Agent Design and Analysis (AMEC/TADA 2015), May 2015 (request for a paper via e-mail)

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[8] W. Ketter; M. Peters; J. Collins; A. Gupta. "*Competitive Benchmarking: An IS Research Approach to Address Wicked Problems with Big Data and Analytics*," (December 7, 2015). MIS Quarterly; ERIM Report Series Reference No. ERS-2015-015-LIS. Available at SSRN: http://ssrn.com/abstract=2700333

[9] Philippe Crowe (January 8, 2014) - *Toyota's Fuel Cell Vehicle To Also Be A Back-Up Home Power Source* – Available: http://www.hybridcars.com/toyotas-fuel-cell-vehicle-to-also-be-a-back-up-home-power-source/

[10] *Overview of incentives for buying electric vehicles* (2015, March 27) – Available: http://www.acea.be/publications/article/overview-of-incentives-for-buying-electric-vehicles

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Issues and Challenges of Corporate Social Responsibility and Sustainability in the ICT Sector

Case Study URL: http://goo.gl/YyiZJp

Author: Lutz Buechner (*Hochschule fur Telekommunikation Leipzig*, Germany)

Keywords: *Corporate Social Responsibility; Sustainability; Innovation; Responsibility of the ICT Industry; Societal Responsibility; European Society*

H2020 challenge addressed by the Case Study: *Societal challenges – Europe in a changing world – inclusive, innovative and reflective society*

Three pillars of sustainability – People, Planet, Profit

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Introduction

Sustainable development *is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts [1]:*

- *the concept of* ***needs****, in particular the essential needs of the world's poor, to which overriding priority should be given; and*
- *the idea of* ***limitations*** *imposed by the state of technology and social organization on the environment's ability to meet present and future needs.*

The **ICT sector is a major driver for growth and innovation** in Europe. Around 5% of the total European GDP and 20% of productivity growth in the other sectors is related to the ICT sector. The share of ICT services is 80%, while 20% of the sector's turnover is caused by ICT manufacturing.

ICT is a young, complex, growing and dynamic sector. From the perspective of **sustainable development** there is less attention paid to this industry then there is to other manufacturing industries such as automotive, energy, transport. Research has revealed, that there are major problems in the production of ICT hardware and the development of ICT software [2].

Corporate Social Responsibility (CSR) and **Sustainability** are terms which are used around the globe but nobody really knows what it is about and how we are affected by them. Climate change, biodiversity, natural resources and many other topics can be subsumed under these terms.

To explain the dimension it is necessary to understand that both **vertically** (human beings, corporations, governments) and **horizontally** (family, community, region, state, global society) it is clear that "something" has to be done.

Five INNOSOC students, supervised by two INNOSOC lecturers, will collaborate on finding the relationships (e.g., from the perspective of challenges, chances and risks) between ICT as such and all relevant actors impacting the sustainable development, by analysing their responsibility towards individuals as well as regional and global societies [3]. These activities will be conducted as a part of the ERASMUS+ blended mobility and will be finalized during the INNOSOC Zagreb 2016 workshop in late April 2016.

Connection with the H2020 challenge „ Societal challenges – Europe in a changing world – inclusive, innovative and reflective society"

About 60 million people around the globe have actually the status of **refugees**. Europe is specially affected by the situation in the Near and Far East as well as Africa. Besides that millions of people are on their way because of economic reasons.

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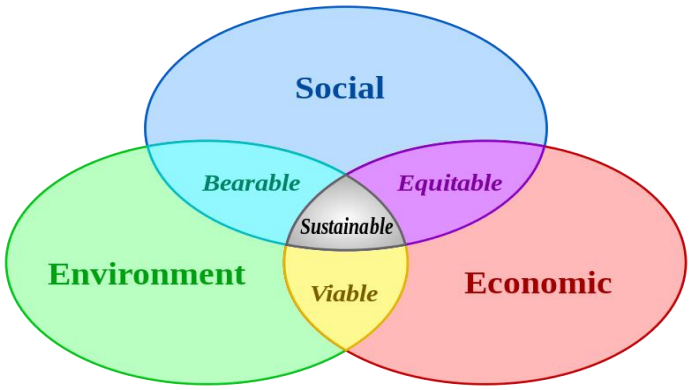
Not only Europe but Europe at its first faces huge challenges in **reducing inequality** and **social exclusion**. Around 80 million people are at **risk of poverty** and 14 million young people are not in education, employment or training. We have not yet overcome the economic crisis which has led to **unemployment rates** of 12% in general and 20% among the youth.

This is why Europe has not only to develop new ideas, strategies and governance structures for overcoming the **crisis in Europe**, but has to take the responsibility for other underdeveloped parts of the world as well. **Inequity** is not a European phenomenon but a global one. This is why Europe has a cross-border responsibility.

In order meet these challenges the actors of the ICT sector have to take responsibility for the natural resources, the climate, poverty, employment, education and training, living conditions and others. They have to build up a credible **social responsibility** and develop *Corporate Sustainability Management* systems.

Connection with the INNOSOC project

INNOSOC focuses on **innovation**. Innovation is more and more related to the idea of limitations imposed by the **state of technology** and **social organization** and neglects environment's ability to meet present and future needs. This means that ICT is a driver of innovative technical development but has to consider the principles of a **sustainable global development**. The overall aim is the elimination of inequity within Europe and worldwide, to improve living conditions by respecting that **we have "just one world"**.



Sustainability from three perspectives: Social, Environmental and Economic

This is why while studying innovative technical ideas and projects it is important to understand the general **theoretical background of innovative solutions**.

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Questions that need answers

Questions that need answers include but are not limited to the following:

- What is the meaning and the importance of ICT in today's world?
- Why is Sustainability a key issue in the ICT sector in general?
- Which key elements of ICT play which role in the sustainability debate?
- What are the challenges and risks of innovative ICT?
- Which role plays social responsibility for the actors involved in ICT?
- Which ICT tools can help to solve social problems in Europe and globally?
- Corporate Sustainable and social Responsibility of ICT companies – Sincerity or Greenwashing?

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Knowledge and skills needed for developing the Case Study

(P: prerequisite; D: desirable, but not necessary)

- interdisciplinary interest for economic issues (P)
- interest for general approach to innovative ICT (P)
- interest for development of the EU (D)
- interest for global correlations (D)
- being aware that the students are developing their future and are responsible for the next generations (P)

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Promoting STEM Studies among Young Students

Case Study URL: http://goo.gl/T9NnZJ

Author: Carmen Bachiller (*Universitat Politecnica de Valencia, Spain*)

Keywords: *Science, Technology, Engineering, Mathematics, Promotion, Young Students, Vocation*

H2020 challenge addressed by the Case Study: *Europe in a changing world - inclusive, innovative and reflective societies*

Young students in a demonstration of SoundCool http://soundcool.org, an application of electronic music developed in collaboration with the Technical University of Valencia (UPV).

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Introduction

The study of **Science, Technology, Engineering and Mathematics (STEM)** has suffered a strong decrease during the last decade in Western Countries [1]. Causes of this decrease are very diverse, but it seems necessary to take actions to improve the perception that future students have about these studies and to introduce technology to high school classrooms.

Despite that the number of ICT jobs decreased a 10% in Europe during the period 2006-2010, it is expected that Europe will require one million of ICT professionals in a short future. Moreover it is a fact that a good development in ICT is crucial to face economic or social crisis. Nevertheless, two main factors that contribute to maintaining, or even worsening, this situation are: i) setup of **high school studies**; and ii) perception pupils have regarding **technological studies** [2].

On the one hand, the balance among Arts, Humanities and Social Sciences, and Science and Technology in secondary studies and Baccalaureate is not uniform neither agreed in all European countries. In some high schools the **Science and Technology** Baccalaureate is not fully completed due to a lack of material resources (a science laboratory is far more expensive than a conventional classroom). Moreover, Technology and Computing syllabuses are sometimes optional and programs of Mathematics and Physics are less extensive than during the 90's and 2000's decades.

Additionally to this scenario, students have a negative perception of technological studies: **difficult** and **poorly paid**. Finally, but not less important, society perceives that ICT professionals are nerds and media presents them as funny strange people without glamour. This is completely obvious if we make the comparison between The Bing Bang Theory and CSI characters where both characters are supposedly scientists. It is even worse if compared with the image of other professionals as lawyers, doctors or brokers [4]. Moreover STEM studies are **less attractive to girls** – only a 10% to a 20% of ICT students are women, and those numbers are not increasing throughout the time [5].

Five INNOSOC students, supervised by two INNOSOC lecturers, will collaborate on answering how to reverse this situation by the promotion of STEM vocations among Secondary and High Schools students [3][6]. The key idea is that University students, who are closer to these young students in age and culture, develop **new strategies of promotion**. These activities will be conducted as a part of the ERASMUS+ blended mobility and will be finalized during the INNOSOC Zagreb 2016 workshop in late April 2016.

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Connection with the H2020 challenge „ Europe in a changing world - inclusive, innovative and reflective societies“

One challenge for Europe is to become an **international player** with a specific importance without losing the values that characterize our civilization [1]. These values will lead to **inclusive**, **innovative** and **reflective societies**.

In order to succeed in this field, it will be crucial that new generations, who are digital natives and users in European society, deeply dominate the technological languages as well. These technological skills will make European society independent of external factors and will allow us to develop **social policies, integration and international cooperation** which are our own. Giving young people skills in STEM disciplines will allow EU to tackle H2020 challenges, since most of them are connected with an advanced technology development. Access to STEM disciplines for the most disadvantaged groups of population should also be ensured, as a way to promote their development and integration, in that way actively working to eliminate the **digital gap** inside the EU. Finally, the **downward trend of girls** going for technological vocations should be reversed. Poor technological skills will take them to a worse professional and social development thus improving the **gender wage gap** and inequality level.

Young student using a Tenori-on app in an electronic music demonstration

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Connection with the INNOSOC project

"Innovation" as a core INNOSOC topic. STEM skills are tools for innovation. Anybody can have a very innovative idea than can improve people's life, but to develop and make this idea real a huge amount of knowledge and work is needed. In our time both knowledge and work will be related to STEM skills in one way or the other. The innovation perspective of this case study could be recognizes in focus on the technological culture that is needed to make innovation real.

Intercultural topics, with focus on "Multicultural teams". Different STEM students from different countries will discuss situations in their countries and ideas to promote the STEM studies. It is expected that they focus on: i) gender gap of these studies; and ii) access to the ICT resources in different communities.

ICT topics, with focus on "Innovative engineering based on ICT". ICT resources are crucial to promote STEM studies: audio visual information, social networks, open access platforms, information and courses, on-line studies, multiple platforms and non-traditional teaching and learning strategies.

Student projects, with focus on "Case studies on how ICT can contribute to innovative societal development". University students enrolled in STEM studies will raise ideas to encourage Secondary and High School students to follow the STEM-based careers. Their view is very valuable since they are closer in age and culture.

A class of (In)Security in wireless networks given by a Telecommunication Engineering student to High School students

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Questions that need answers

Questions that need answers include but are not limited to the following:

Knowing the State of the Art.

- Which is the current situation of STEM studies is your own country? Has it improved or decreased in the last 10 years?
- How is the access to STEM studies from Secondary/High School studies in your own country?
- What is the percentage of girls addressing these studies in your own country?
- What is the perception that young students have about scientists and engineers?

Designing strategies.

- How can STEM studies be more attractive to young students and girls in particular?
- What is the most appropriate age for the promotion actions?
- Which promotion actions are more effective?
- Are ICT tools effective for promotion?
-

Hands on.

- What problems (economic, temporal, logistic, social, personal resources, knowledge, skills…) occur during promotion actions?
- How can benefits of actions be measured?

Knowledge and skills needed for developing the Case Study

(P: prerequisite; D: desirable, but not necessary)

- to have a previous knowledge on the situation of STEM studies in the student country as well as interests and vocations of young students (P)
- to be sensitive to gender and socioeconomic inequality aspects
- to have a previous knowledge and skills on ICT resources (P)
- to be innovative, curious, proactive and open-minded (D)
- to be prepared to work in multidisciplinary and multicultural teams (D)

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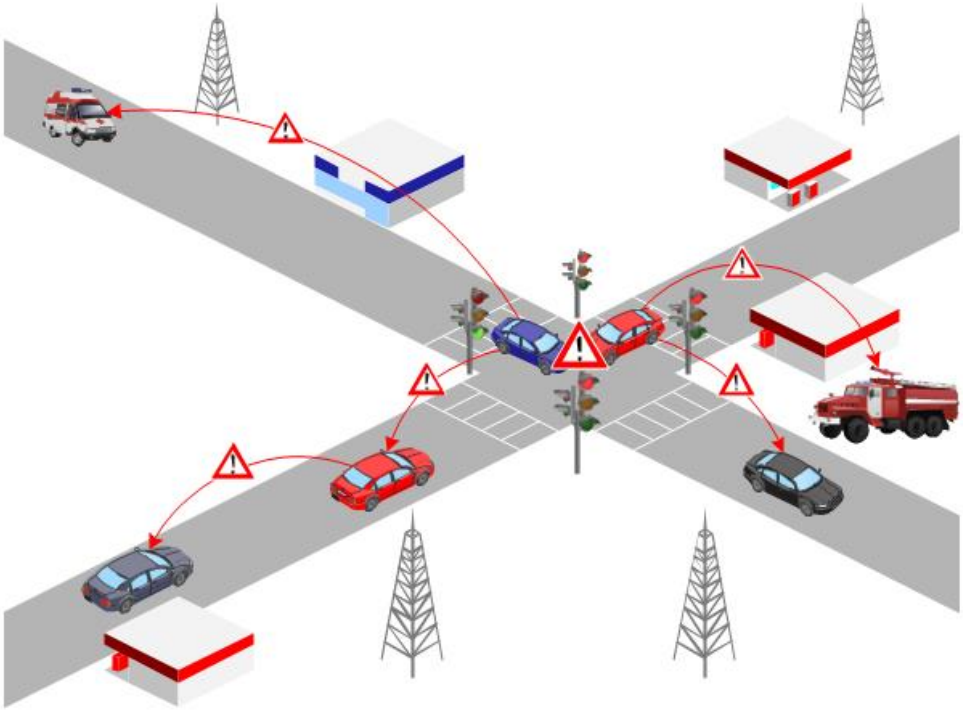
Intelligent Transport Systems and Vehicular Ad hoc Networks

Case Study URL: http://goo.gl/AMiQO7

Authors: Lubomir Dobos (*Technical University of Kosice, Slovakia*) and Tibor Kolos (*Szechenyi Istvan University, Hungary*)

Keywords: *Intelligent transport systems; Vehicular ad hoc networks; Car-to-car communications*

H2020 challenge addressed by the Case Study: *Smart, green and integrated transport*



Examples of Vehicular Ad-hoc Network (VANET) Applications

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Introduction

Increasing demands for different kind of **transportations** (road, railways, air) will generate higher density of vehicles, traffic jams, high number of fatal accidents and high level of environmental risks. The **Intelligent Transport Systems (ITS)** add information and communication technology (ICT) for elements of transportation systems to ensure new challenges in fields of **safety, economy, reliability and efficiency**.

In the near future the ITS will focus on the road transport, enabling introduction of different services from toll collection to driver assistant systems [2]. Subsystems of ITS will later act as the base of the autonomous car, or a "driverless car". The ITS communication system in case of road transport is based on wireless ad-hoc communication [1], called **vehicular ad hoc networks (VANETs)**.

The concept of leveraging wireless communication in vehicles has fascinated researchers since the 1980s. The last few years have witnessed a large increase in research and development in this area. Several factors have led to this development, including the wide adoption (and subsequent drop in cost) of IEEE 802.11 technologies, the embrace of vehicle manufactures of information technology to address **safety, environmental, and comfort issues** of their vehicles, and the commitment of large national and regional governments to allocate **wireless spectrum** for vehicular wireless communication. While cellular networks enable convenient voice communication and simple infotainment services to drivers and passengers, they are not well suited for certain direct **Vehicle-to-Vehicle** or **Vehicle-to-Infrastructure** communications. On the other hand VANETs, a direct communication between vehicles and to and from **roadside units** (RSU), can send and receive hazard warnings or information on the current traffic situation with minimal latency.

The major goals of these activities are to **increase road safety** and **transportation efficiency** as well as to **reduce the impact of transportation on the environment**. These three classes of applications of VANET technology are not completely orthogonal: for example, reducing the number of accidents can in turn reduce the number of traffic jams which could reduce the level of environmental impact. Due to the importance of these goals for both the individual and the nations, various projects are underway, or recently completed.

Five INNOSOC students, supervised by two INNOSOC lecturers, will collaborate on answering how intelligent transport systems and vehicular ad hoc networks can contribute to building sustainable transport systems of the future. These activities will be conducted as a part of the ERASMUS+ blended mobility and will be finalized during INNOSOC Zagreb 2016 workshop in late April 2016.

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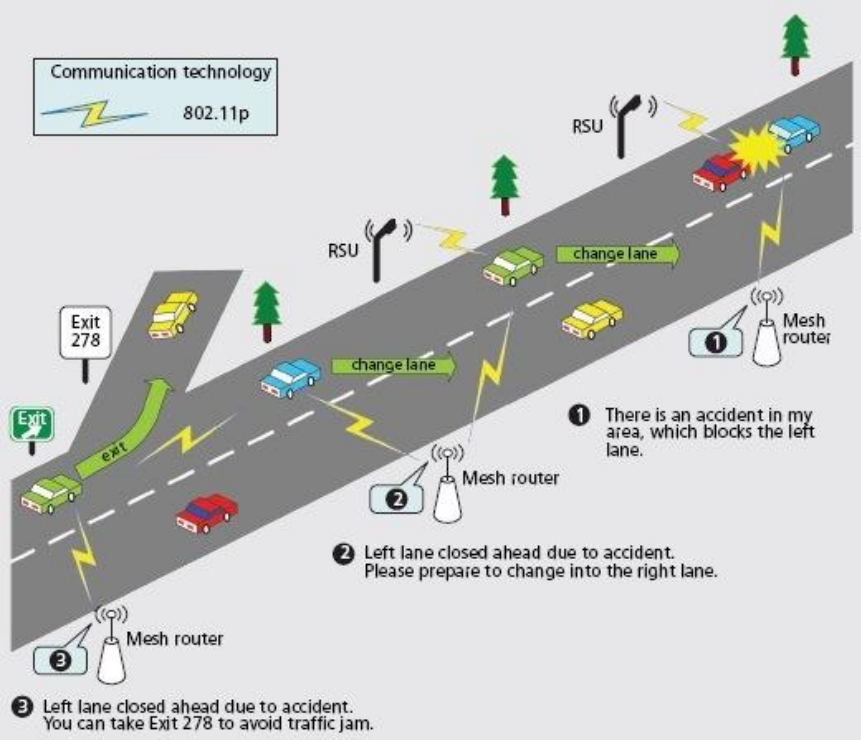
Connection with the H2020 challenge „Smart, green and integrated transport“

The future **smart, green and integrated transportation** is a very important challenge of the Horizon 2020, which reflects the policy priorities of the Europe 2020 strategy.

This Case Study deals with Intelligent Transportation Systems (ITS) and with Vehicular Ad-hoc Networks (VANET), which will be the technical background of the **green, safe and economical road traffic** in the future. Nevertheless, introducing elements of ITS requires international standardization, frequency management considerations and usage of interference resistant radio communication technologies.



Car-to-Infrastructure communications

The term VANET was originally adopted to reflect the “ad hoc” nature of these highly dynamic networks. However, since the term “ad hoc networks” has widely been associated with unicast routing related research, there is currently a debate among the pioneers of this field about redefining the acronym “VANET” to deemphasize ad hoc networking. Since this discussion is not yet reached consensus, we will continue to refer to **Vehicle-to-Vehicle** and **Vehicle-to-Roadside** communication based on wireless local area networking technology as a VANET.

Typically, applications are categorized as:

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1. **"safety" applications** (examples: traffic signal violation warning, curve speed warning, emergency electronic brake light, pre-crash sensing, cooperative forward collision warning, left-turn assistant, lane change warning and stop sign movement assistant);
2. **"transport efficiency" applications** (examples: enhanced route guidance and navigation, green light optimal speed advisory and lane merging assistants);
3. **"information/entertainment" applications** (examples: remote wireless diagnosis, tolling, point-of-interest notifications, fuel consumption management, podcasting and multi-hop wireless Internet access).

Connection with the INNOSOC project

Main goal of this Case Study is to give opportunity for students coming from different countries to work on an **innovative problem** and work together through the **blended mobility** teaching and learning instrument. The intercultural part of the project focuses on **multicultural team** building, teamwork using telecommunication facilities, presentation of results as well as **exchange of good practices** from different cultures.

While working on this Case Study students will get familiar with up to date radio communication technologies and their application in the road traffic. They will study advantages and disadvantages of wireless telecommunication technologies, impacts of Intelligent Transportation Systems (ITS) and with Vehicular Ad-hoc Networks (VANET) to road safety, economics and logistics. The Case Study will give a traffic coordination systems overview for students studying in different countries of the EU.

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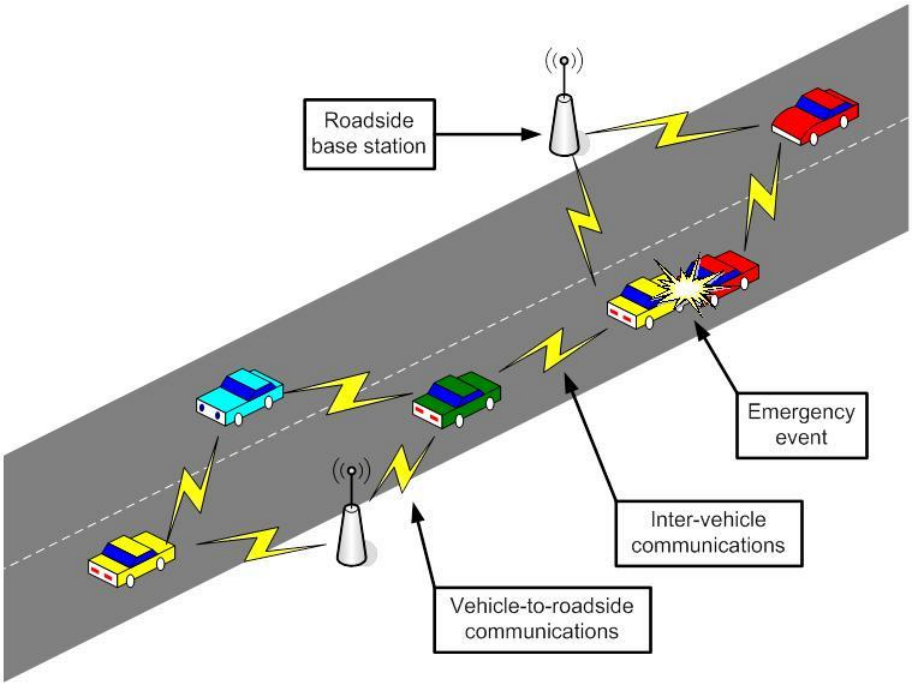

Vehicular Ad-Hoc Networks (Car-to-Car communications)

Questions that need answers

Questions that need answers include but are not limited to the following:

- Which kind of sensor and telecommunication networks we need for application of driverless car in the future?
- Which type of information we should transmit in the Intelligent Transport Systems? What is the needed bit rate for different services?
- Which propagation properties have frequency bands allocated to ITS systems? Which telecom technologies are deployed on these frequencies? [3]
- What are properties of wave propagation in the road environment with obstacles and/or reflection?
- How can we calculate interference in Car-to-Car communications?
- What are properties of the Cooperative Forward Collision Warning service?
- What are options for Internet access in vehicles?
- What are potential applications for the Vehicle-to-Infrastructure opportunistic communications?

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Knowledge and skills needed for developing the Case Study

(P: prerequisite; D: desirable, but not necessary)

- basic knowledge in field of radio communications (P)
- wireless communications basics (P)
- interest in smart car systems (D)
- mobile communications system basics (D)

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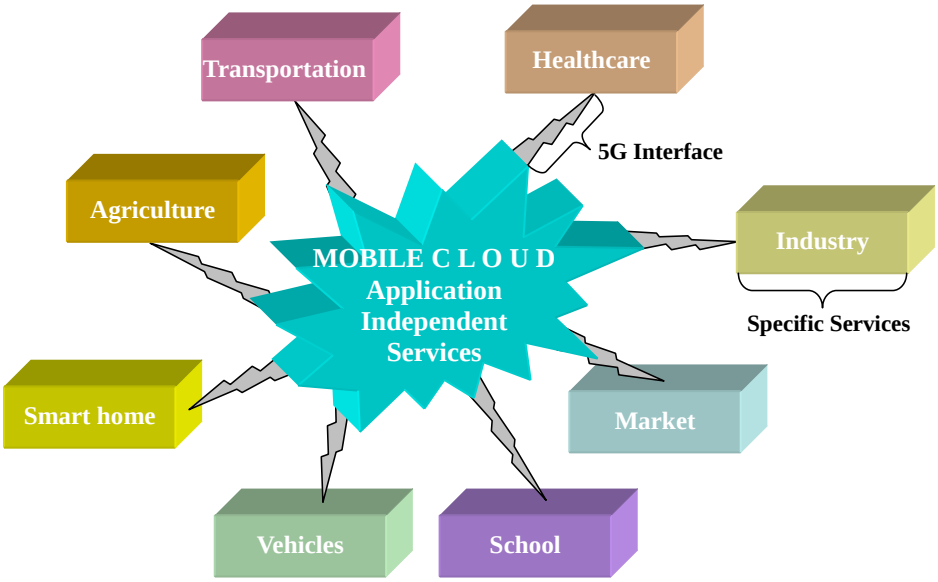
Seamless Connectivity for a Digital Life

Case Study URL: http://goo.gl/5LWsLu

Authors: Georgi Iliev (*Technical University – Sofia, Bulgaria*) and Christian Czarnecki (*Hochschule fur Telekommunikation Leipzig, Germany*)

Keywords: *5G networks; Internet of Things (IoT); sensor networks; enhanced Telecom Operations Map (eTOM), business processes*

H2020 challenge addressed by the Case Study: *Europe in a changing world - inclusive, innovative and reflective societies*



5G networks enabling the vision for IoT, IoNT and IoBNT

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Introduction

It is well known that **5G wireless networks** will bring solutions for many challenges which are typical for the recent mobile networks, such as constantly growing demands for **higher data rates**, tighter requirements for **quality** of the provided services, requirement for **everywhere and anytime coverage**, low **delay and latency**, need for low **energy consumption** as well as low **cost for a bit** of transmitted information. In order to address all these challenges 5G networks most probably will be implemented with multilayer and heterogenic structure consisting of macro-, micro- and femto-cells, relays and ad hoc subnetworks to communicate across different devices and users with diverse requirements for quality of service (QoS). Using such a complex infrastructure the main concern will be the problem for more effective intra- and inter-cell interference control. This problem is an integral part of a more general task for power control in wireless networks. The definition and solution of this task in the context of an optimization problem with specific cost function will result in the substantial increase of spectral and energy efficiency in 5G wireless networks.

In order to gain the full benefits of those **technical innovations**, telecommunication companies require flexible production models, streamlined operations and end-to-end management of customer requirements. There is a high risk that technical changes on the network layer result in silo-oriented processes and applications on the **business side** [4]. In this context, the industry organization TM Forum offers a reference model for standardized business processes that is called **"enhanced Telecom Operations Map" (eTOM)** [6]. The International Telecommunication Union (ITU) has confirmed eTOM as a *de facto standard* for business processes and the eTOM is used by most telecommunication companies worldwide. Applying the eTOM to 5G wireless networks is an important requirement.

Five INNOSOC students, supervised by two INNOSOC lecturers, will collaborate on answering how combining technical and business perspective of the design, launch, and operations of 5G wireless networks can provide seamless communication services to customers. These activities will be conducted as a part of the ERASMUS+ blended mobility and will be finalized during INNOSOC Zagreb 2016 workshop in late April 2016.

Connection with the H2020 challenge „Europe in a changing world - inclusive, innovative and reflective societies"

A great number of physical devices will be connected to 5G networks realizing the vision of the **Internet of Things (IoT)** [1], **Internet of Nano Things (IoNT**) [2] and even **Internet of Bio-Nano Things (IoBNT)** [3]. Monitoring and control systems that communicate through networks and enable smart homes are amongst the common examples.

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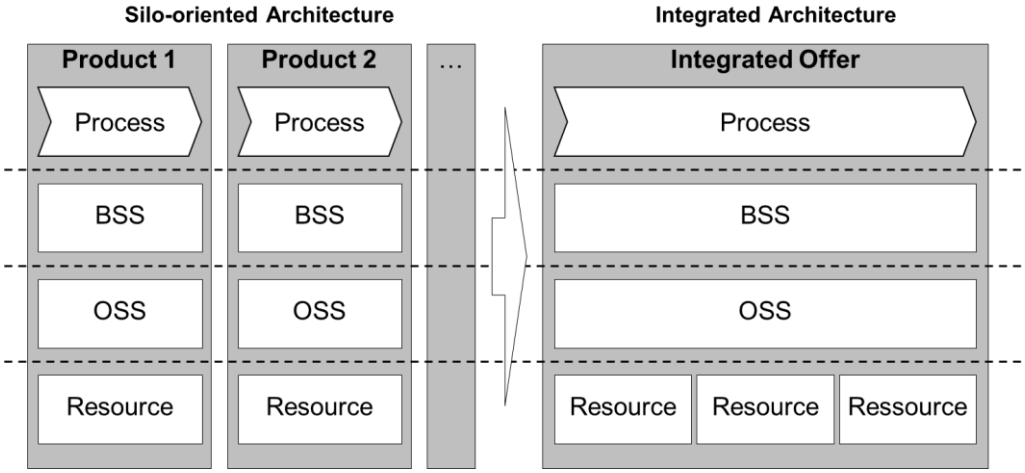
There are variety of areas and environments where IoT can play an important role and improve the **quality of human life**. These applications include transportation, healthcare, industrial automation, and emergency response to natural and man-made disasters. The IoT transforms the **connected objects** into **smart devices** by using ubiquitous and pervasive computing, cloud technology, routing protocols and cooperative transmission. In addition, management and operations of those communication services is a challenge for telecommunication companies. An important objective is to overcome silo-oriented structures in order to offer an end-to-end management of seamless communication services [4].



From a silo-oriented to an integrated architecture (according to [4])

Connection with the INNOSOC project

The key **innovations** expected in 5G wireless networks will be in several areas. First, the basic challenge of a **full duplex radio transmission** should be addressed. All recent standards for wireless networks work in half-duplex mode. The potential full-duplex radio systems can double the bandwidth and as a result can almost double the throughput. Alternatively, keeping the same throughput radio systems can save bandwidth which is crucial for applications where the frequency spectrum is scarce.

Next area for innovative solutions is the **inter-cell interference control**. Nowadays it is a common agreement that 5G networks will have a heavy heterogeneous structure. They will consist of macro-, micro- and femto-cells and will need an intensive coordination during data transmission. In such environments inter-cell interference control calls for new methods for coordination and interference cancelation. Most of recent approaches for inter-cell interference control exploit the spectral characteristics of transmitted signals and schedule different frequency ranges and time slots, in this way minimizing the interference. Basic problem for these approaches is how to manage the

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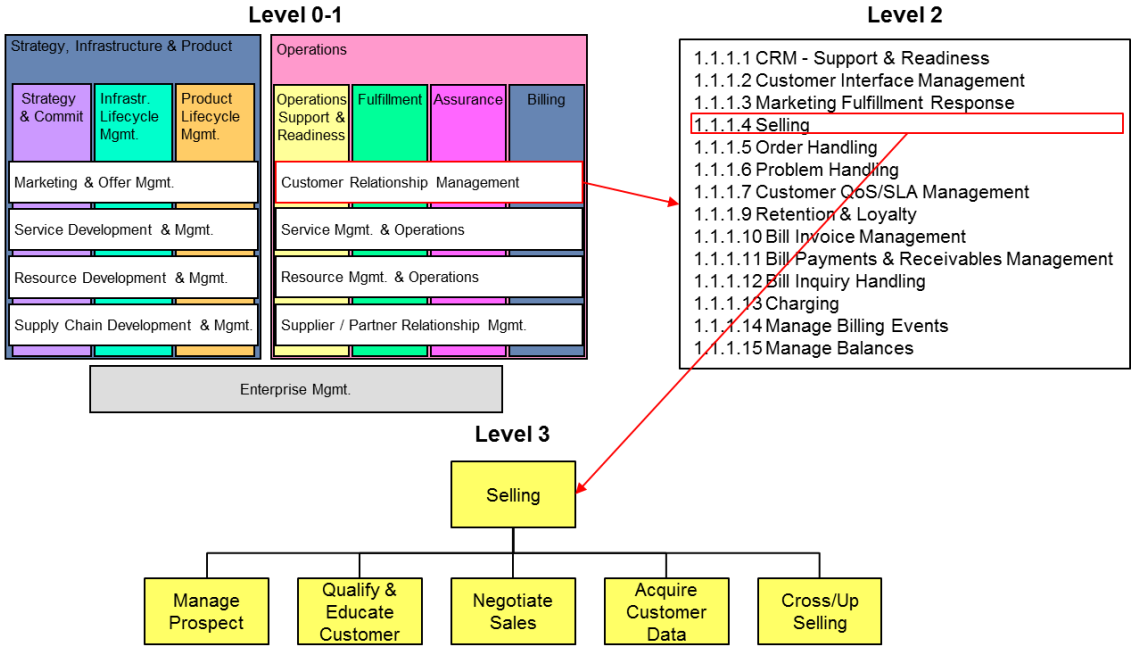
existing transmission resources in a fair manner according to the QoS requirements of each customer. Foreseen innovative solutions can be found in the field of Game Theory, Artificial Intelligence and Expert Systems.

Furthermore, **management of communication networks and services** and their impact on internal structures of telecommunication companies is an important question of information systems management. Solutions can be found in the field of reference modelling in general and specific work in the telecommunications industry.



The eTOM is a collection of processes that can be decomposed on different levels of detail [6]

Questions that need answers

Questions that need answers include but are not limited to the following:

- Which are the most popular methods for uplink and downlink transmission in current wireless networks?
- What are the new approaches enabling full-duplex radio transmission?
- Which are the most popular methods for the inter-cell interference control in current wireless networks?
- What are the new approaches enabling a fair resource management?
- What is the impact of these new technologies on the business processes and organizations?

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- What could be an end-to-end process (e.g., Order-to-Payment) for offering seamless connectivity services?
- How could a reference models like eTOM support this task? What are additional requirements that are not supported by this reference model?

Knowledge and skills needed for developing the Case Study

(P: prerequisite; D: desirable, but not necessary)

- basics of data transmission (P)
- optimization methods (D)
- basics of information systems design (D)
- business process management (D)

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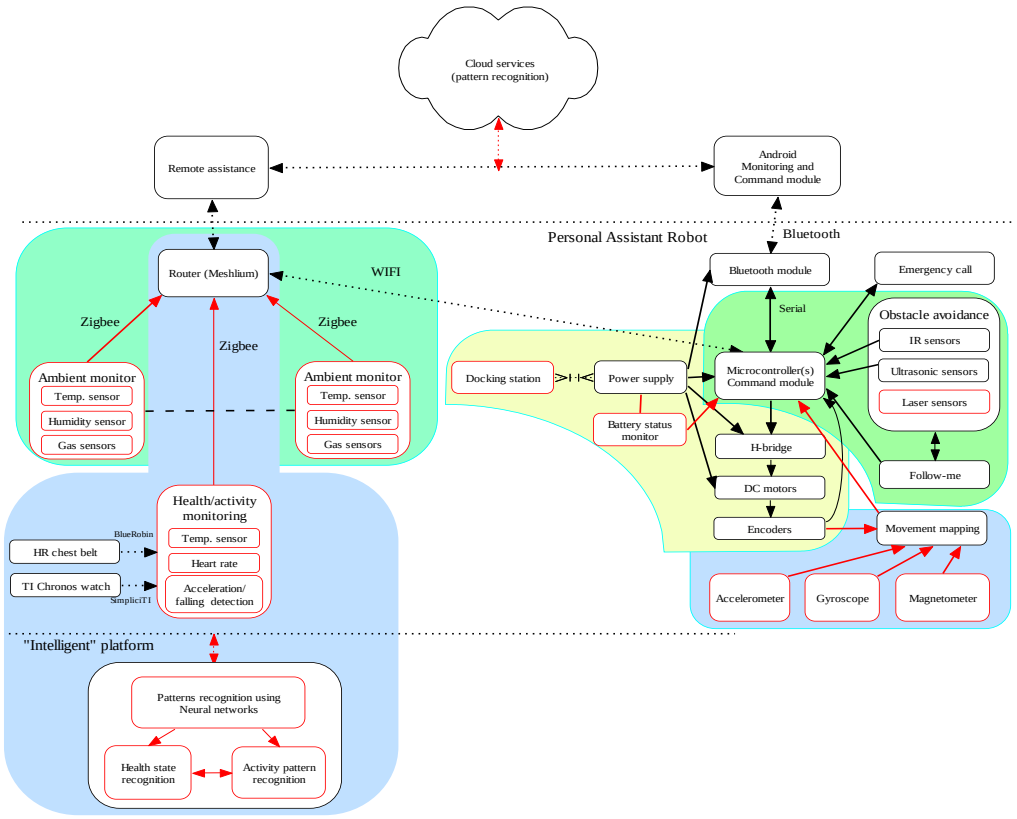
Innovative Solutions for Assistance of Active Daily Life at Home

Case Study URL: http://goo.gl/aHf5x8

Author: Istvan Oniga (*University of Debrecen, Hungary*)

Keywords: *Ambient assisted living; Human activity monitoring; Activity recognition; e-Health; Assistive robots*

H2020 challenge addressed by the Case Study: *Health, demographic change and wellbeing*



Possible architecture of the system for daily life assistance

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Introduction

Population ageing is a reality today and the concern about assisting active life of elderlies through ICT solutions is a priority of European Commission and one of the Societal Challenges that will be funded in Horizon 2020 programme will be the Health, demographic change and wellbeing [1][2]. The aim of this Case Study is to analyse the existing solutions to **assist elderly or sick people** in their everyday activities and propose innovative ideas using newest ICT. This Case Study should include (but will be not limited to):

- Study of **existing solutions** for (some of the) following topics [3-10]: intelligent assistive houses; assistive robots; human activity monitoring wearable devices; physiological parameters monitoring wearable devices; possibilities for data storage, visualization and analysis; pervasive and mobile applications for activity monitoring and daily life assistance.
- Study about **required** assisted living devices, services and user acceptance of existing ones. The above study and questionnaire should improve understanding of the possible improvements of devices and services for health monitoring and to prevent, detect, treat and manage disease and how to support older persons to remain active and healthy.
- Proposal of **new solutions** and ideas regarding the above topics. Tele-assistance, tele-medicine scenarios and mobile application development based on above studies may be developed. Characteristics of the proposed solutions should be cost-effectiveness, reliability, flexibility, applicability to realistic settings, safety and acceptability to end-users. The proposed solutions should be built on advances in ICT but should pay attention to multi-disciplinary aspects involving sociological, behavioural and other relevant disciplines. Gender and ethical issues must also be considered.

Five INNOSOC students, supervised by two INNOSOC lecturers, will collaborate on answering how innovative ICT solutions for assisting elderly or sick people in their everyday activities can improve their daily life at home. These activities will be conducted as a part of the ERASMUS+ blended mobility and will be finalized during INNOSOC Zagreb 2016 workshop in late April 2016.

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Connection with the H2020 challenge „Health, demographic change and wellbeing“

An important Societal Challenge addressed by the Horizon 2020 is **Health, demographic change and wellbeing**. For this reason EU have invested around €1,200 million in 2014/2015 in this Challenge. This Case Study will search answers for following two issues that are research and innovation topics under “*Personalising health and care”* project call in the Horizon 2020 programme:

- improve our ability to monitor health and to prevent, detect, treat and manage disease;
- support older persons to remain active and healthy.

Example of an ambient assisted living (AAL) system for improving daily life at home for elderly people (photo: Cibek)

Connection with the INNOSOC project

The INNOSOC project aim is to set up an **intensive study program in the field of innovations** based on ICT targeting Societal Challenges defined by **Europe 2020 and Horizon 2020 programmes**. The INNOSOC curricula will pay a special attention to the following aspects: "innovation" as a core topic; intercultural topics, with focus on "multicultural teams"; ICT topics, with focus on "innovative engineering based on ICT"; and student projects, with focus on "case studies on how ICT can contribute to innovative societal development". This Case Study will consider all these aspects.

First, the Case Study will cover new trends and technologies in **ambient assisted living (AAL)** trying to promote the usage of **innovative solutions for communication** (e.g., Bluetooth Low Energy and Zigbee), data storage and processing in cloud, visualization on mobile devices and smart TVs.

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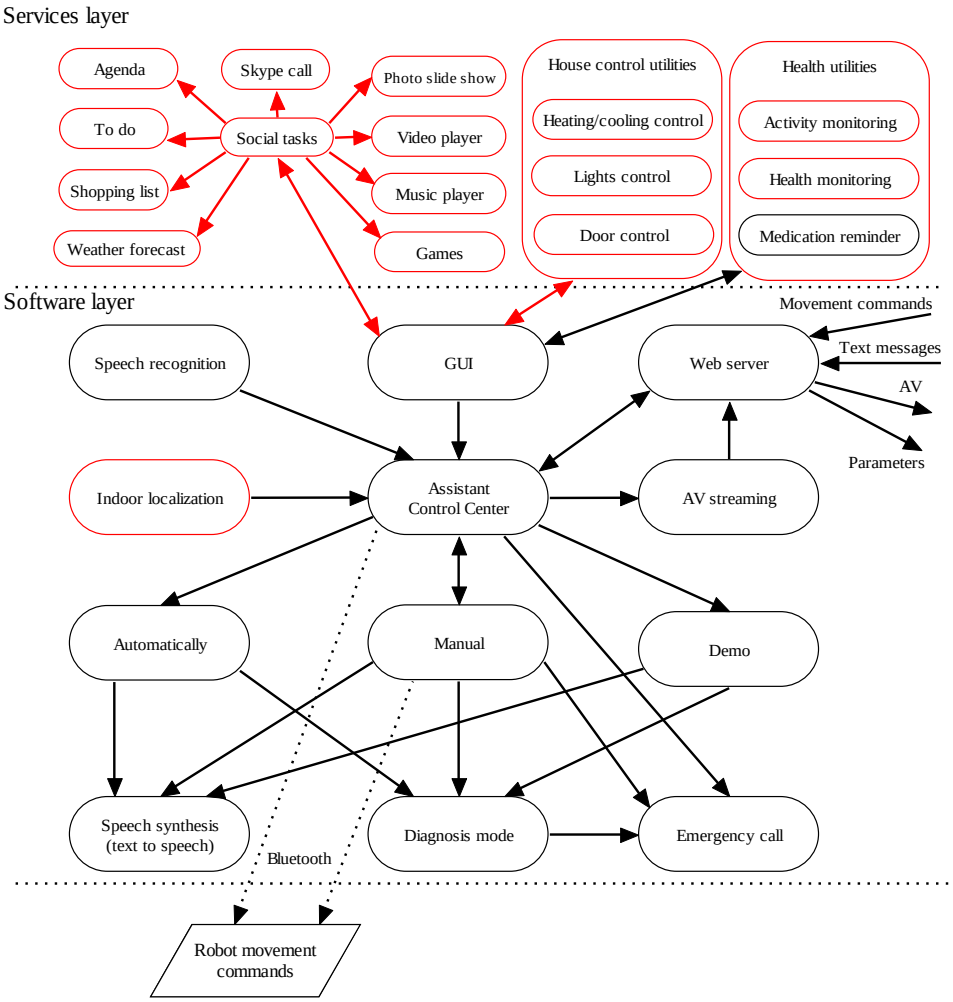
Second, the Case Study aims to find solutions regarding AAL, **activity and health monitoring systems** based on latest advances in ICT. ICT and web-based technologies create opportunities to help people in their daily life while monitoring them to promote their **independence, safety and social contact** through communication solutions offered by using ICT solutions.



Possible structure for Android App for daily life assistance

Third, **lifestyles in different countries are different**. Assisted living may have manifold interpretations depending on the nationality of elderly people. The teamwork, where members are from different countries, is a great opportunity to discover and identify the special characteristics of the demands arose across the countries the students are from.

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Questions that need answers

Questions that need answers include but are not limited to the following:

- What are the ambient assisted living (AAL) systems main features? What are the most desired features?
- What kind of hardware (processing units, sensors, I/O devices) and software can be used to monitor human activity in home environment and what are their characteristics?
- What type of communication protocols are used in AAL systems? Outline pros and cons (e.g., range, energy efficiency, cost-effectiveness, reliability, flexibility) for each of them.
- How could assistive robots improve everyday life of older people from point of view of personal assistance, active living, mental health and social inclusion? Describe some scenarios.
- What is the state of the global AAL systems market (sales, costs, reliability, flexibility, applicability to realistic settings, acceptability, popularity)?
- What kind of physiological parameters can be monitored at home and how can be used this data remotely? What are the security issues of people using the devices and data security?
- What are the most used human activity recognition methods, what are their computational requirements and where can be done this?
- What possibilities exist for data storage, visualization and analysis of human activity and health parameters? Outline pros and cons.
- How popular are pervasive and mobile applications for activity monitoring and daily life assistance and what is the state of tele-health or health-related services and information via telecommunications technologies?
- How can we innovate the AAL systems? Analyse devices and services for health monitoring to prevent, detect, treat and manage disease and how to support older persons to remain active and healthy?

Knowledge and skills needed for developing the Case Study

(P: prerequisite; D: desirable, but not necessary)

- general ICT knowledge (P)
- ambient assisted living (AAL) technologies (D)
- wearables for e-health (D)
- (assistive) robots (D)
- wireless data transmission technologies (D)
- data analysis and visualization techniques (D)
- android applications development (D)

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- cloud computing (D)
- web-page programming (D)

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Microwave Sintering

Case Study URL: http://goo.gl/TddawT

Author: Felipe Penaranda Foix (*Universitat Politecnica de Valencia, Spain*)

Keywords: *Microwave technology; Sintering; Microwave heating*

H2020 challenge addressed by the Case Study: *Climate action, environment, resource efficiency and raw materials*

Possible Uses of microwave energy

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Introduction

This Case Study implies the participation of **multidisciplinary groups** to join their knowledge to create a new tool for **sintering novel materials with new and improved physical properties**. This Case Study will consist of an active search of different microwave applicators to sinter materials, including rectangular or cylindrical applicators, solid state or classical tube amplifier as well as susceptors.

Active applicators, including tuning devices and automatic control (PID) to control the sintering process, will permit to control the speed of sintering to avoid problems like sample-breaks. All these possibilities give to **microwave energy** the possibility of create new materials for **innovative and added value applications**. The Case Study will consist of:

- Searching for bibliography that describes the benefits of the microwave energy;
- Summarizing different applications of microwave energy, with focus on its use for communication;
- Analysing security aspects of microwave radiation;
- Describing, based on references, the latest trends of the microwave energy in the field of new materials with new added values.

Five INNOSOC students, supervised by two INNOSOC lecturers, will collaborate on answering how novel materials with new and improved physical properties can be sintered. These activities will be conducted as a part of the ERASMUS+ blended mobility and will be finalized during INNOSOC Zagreb 2016 workshop in late April 2016.

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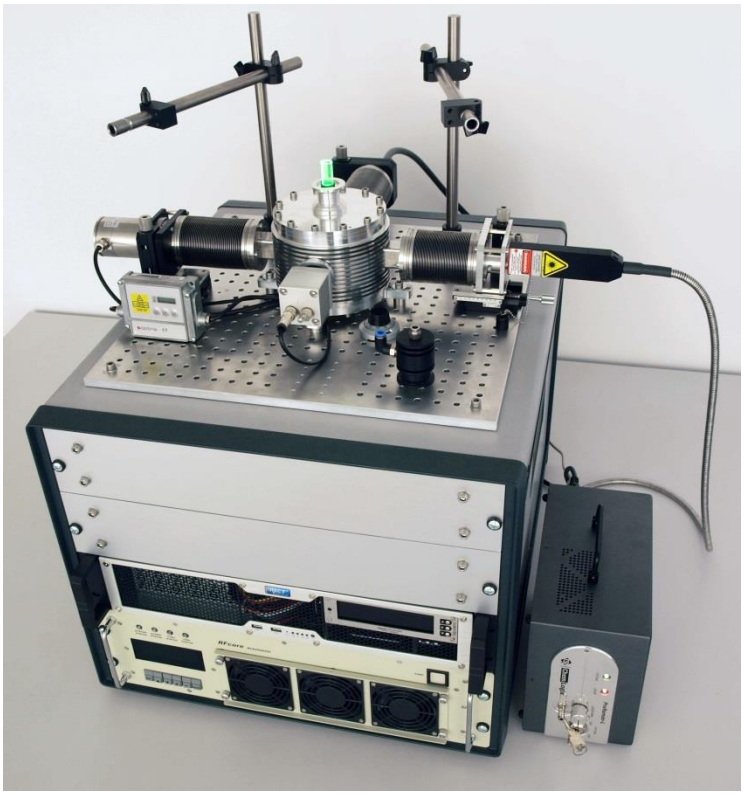
Connection with the H2020 challenge „Climate action, environment, resource efficiency and raw materials“

One of the H2020 challenges is the **“Climate action, environment, resource efficiency and raw materials”**, where the “design” of new materials is one of the main challenges in order to reduce the use of natural resources, to recycle the waste materials as well as to study the possibility of obtaining new materials with new characteristics in terms of speed of sintering, hardness and weight.

With this in mind, is quite clear that, apart from the traditional ways to sinter materials, new procedures are needed that can reduce the energy used to create it or to improve the mechanical properties acquired by traditional methods. This is where **microwave technology** can help.



Microwave device for material sintering

Connection with the INNOSOC project

The INNOSOC project involves four main topics in its aim: "innovation" as a core topic; intercultural topics, with focus on "multicultural teams"; ICT topics, with focus on "innovative engineering based on ICT"; and student projects, with focus on "case studies on how ICT can contribute to innovative societal development". This Case Study covers all of them.

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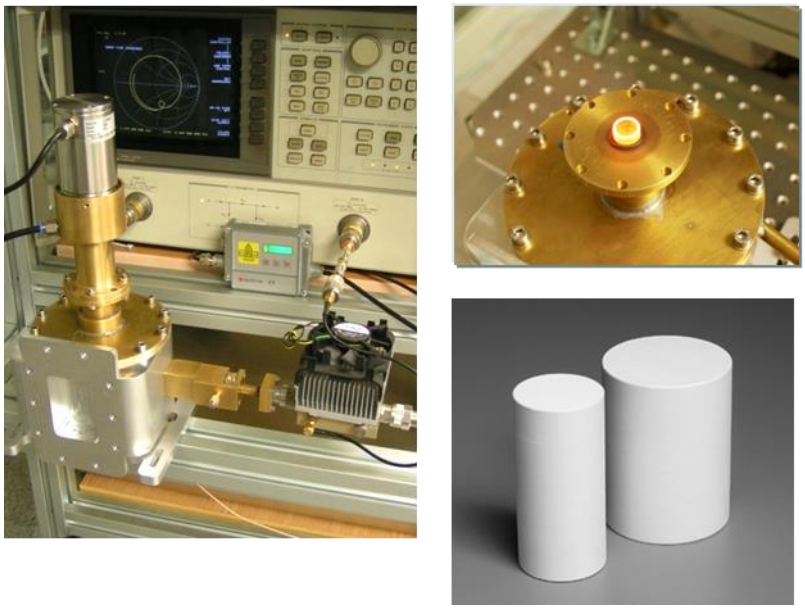
First, it is clear that this Case Study implies an **innovation** because not only it covers one of the H2020 main objectives but it is also using new technologies (like microwave heating) to design novel materials improving current properties as an alternative to the classical methods based, typically, on big ovens heated by traditional methods.

Multiculturalism is covered by the design of the working groups and a big number of partners participating in the INNOSOC project, coming from 11 universities from 8 different European countries, including former East and West countries that provide even more multiculturalism to the project.

Third, **ICT** is covered due to the proposed technology – microwave technology – that represents the basic technology for lots of ICT projects. While microwave technology is usually connected with spectrum used for communications other applications as the one proposed here are possible as well (more than 60 years ago the first microwave oven appeared).

And, finally, the **student project** is covered by this Case Study itself.



Materials sintered by microwave energy

Questions that need answers

Questions that need answers include but are not limited to the following:

- What does microwave technology mean for you?
- What are the traditional uses of microwave technology?

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- What is the history of the microwave heating?
- What are the main uses of microwave ovens (microwave heating engineering)?
- Which are new applications of microwave technology (including drying food)?
- What are new sintered materials developed by microwave energy?
- What are new and advanced properties obtained with this technology?

Knowledge and skills needed for developing the Case Study

(P: prerequisite; D: desirable, but not necessary)

- to have taken courses in microwave theory (P)
- to have taken courses in electromagnetics (P)
- to be able to summarize all technical information about the topic in a document with the minimum number of formulae and more description and basics for non-familiar people on microwave technology (D)

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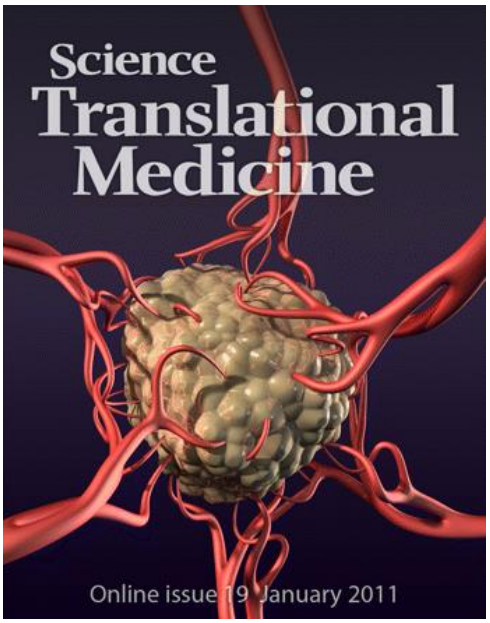
Recognition of Patterns of Maleficent Objects on Medical Images

Case Study URL: http://goo.gl/NVCftX

Authors: Szilvia Nagy (*Szechenyi Istvan University, Hungary*)

Keywords: *Medical image; Pattern recognition; Image processing; Colorectal tumor; Endoscopy; Blood vessels; Narrow band imaging*

H2020 challenge addressed by the Case Study: *Health, demographic change and wellbeing*



Blood vessels around a kidney cancer (from the online cover of Science Translational Medicine, Vol 3, Issue 66 – credit: C. Bickel / Science Translational Medicine)

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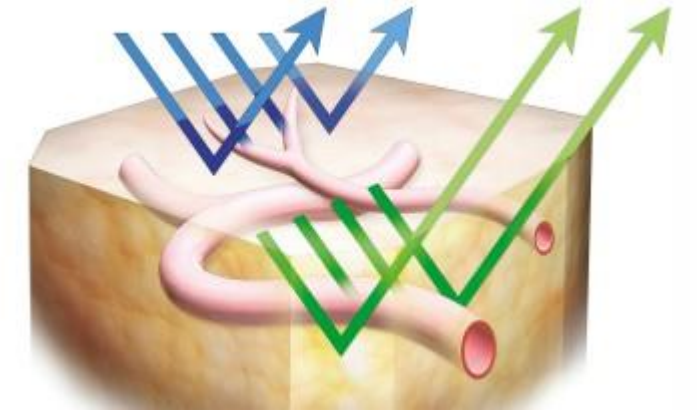
Introduction

Detecting maleficent medical conditions, especially cancers, is a costly and complicated task. Mostly only a biopsy can determine whether a tumour is cancerous, which causes the patient inconvenience and risk of the operation, as well as extra cost in the medical system. In case of many tumours a non-invasively taken image can also provide information on the nature of the formula, or at least a guidance whether to take biopsy, remove the tumour immediately, or leave it, because the removal is an unnecessary risk in case of a non-maleficent formula.



Narrow band imaging light absorption (from Olympus, http://www.olympus-europa.com/medical/en/medical_systems/applications/urology/bladder/narrow_band_imaging__nbi_/narrow_band_imaging__nbi_.html)

The **medical staff** is trained to identify maleficent tumours of their specialization field, but an **automatic image processing** can help their decision, moreover in some cases, like the skin cancers, it could add a tool into the hands of the not specialized persons as well. The non-invasive medical imaging [1][2] contains both the visible light techniques (like endoscopes and microscopes) as well as the higher and lower frequency electromagnetic field based imaging (like X-ray and ultrasound reflection based images). In case of tumours many tell-tale signs can be from the variation of the blood vessel structure around the formula [4-6] to the pattern and colour of the surface of the polyp itself [7-10].

Five INNOSOC students, supervised by two INNOSOC lecturers, will collaborate on answering how ICT can be used in image-based cancer detection. These activities will be conducted as a part of the ERASMUS+ blended mobility and will be finalized during INNOSOC Zagreb 2016 workshop in late April 2016.

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Connection with the H2020 challenge „Health, demographic change and wellbeing“

The Medical image processing is one of positive side effects of the **fast proliferation of the ICT into all domains of the society**. For example, it can decrease the workload put on medical staff and help them decide in problematic questions or draw attention to smaller details where problems might be present.

Cancer detection is still made by humans, and it will remain so, however, a visual aid can increase effectiveness, and a pre-screening can still be carried out by less qualified personnel and intelligent computer programmes instead of fully trained medical specialists.

The aim of this Case Study is to summarize the technologies used in **image-based cancer detection** for some types of cancer and compare the applicability of the techniques to the various cases. It is also necessary to determine whether new image processing methods could be used. In most cases the decision about a formula is taken in a crisp, yes or no way, however, many soft decision techniques can also be applied, completed with a learning algorithm, thus it is also necessary to map the applied training algorithms and their efficiency.

Therefore, this Case Study specifically addresses the **“Health, demographic change and wellbeing”** H2020 challenge.

Connection with the INNOSOC project

This Case Study is tightly connected with innovation, intercultural and ICT.

First, the **innovation** aspect emerges from comparing multiple types of image processing methods used for various purposes that can lead to a common method or a method applied for one type of problem to be applicable in other problems.

Second, although medical image processing is an **international** problem, acquiring images has different aspects in **different cultures**. Additionally, interpreting and communicating the results has various cultural aspects as well.

Third, medical images are processed by **IT devices**, and their transmission has multiple **ICT** tasks from coding, compressing to videoconferences about the results.

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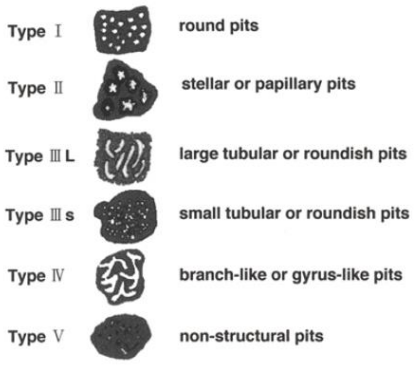

Colorectal polyp pit patterns (from: Nikolas Eleftheriadis, Haruhiro Inoue, Haruo Ikeda, Manabu Onimaru, Akira Yoshida, Roberta Maselli, Grace Santi, Shin-ei Kudo, "Definition and Staging of Early Esophageal, Gastric and Colorectal Cancer", Journal of Cancer, Vol. 2, pp. 161-178 (2014))

Questions that need answers

Questions that need answers include but are not limited to the following:

- What are image acquiring methods used in tumour classification?
- Are there specially developed imaging techniques for some aspects of tumour detection (e.g., for recognition of surfaces and interfaces of tumours or for enhancing the visibility of the blood vessels)?
- What are the most lethal cancer types in Europe and in the other continents?
- What is the usual diagnose method for the most lethal tumours?
- What type of image processing methods are used in detection or classification of the most dangerous tumour types?
- What type of soft or crisp decision techniques are used in tumour classification? What types of evolutionary or learning algorithms are applied?
- How the IT classification success rate is related to the human classification success rate or the biopsy results? What tumour types are well classifiable and what are hard to determine? Why (from image processing point of view)?

Knowledge and skills needed for developing the Case Study

(P: prerequisite; D: desirable, but not necessary)

- basic knowledge on image taking methods (P)
- basic knowledge on learning algorithms and soft decision techniques (D)
- basic image processing (D)
- basic knowledge on medical imaging (D)

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Innovative ICT Solutions for the Societal Challenges

Co-funded by the Erasmus+ Programme of the European Union