Research programme for years 2015-2020

Institute of Electronics and Computer Science

September 1, 2015

Contents

Glossary and abbreviations

[A] Knowledge Input - a new knowledge arrives at institute. This includes:

- [A1] Tacit knowledge in the form of previous experience by employees (either from past projects in institute or some other source);
- [A2] Explicit knowledge in the form of publications by external parties, such as journal articles, conference proceedings or some other kinds of technical or even popular publications.
- [A3] New tacit knowledge is born in the mind of a researcher as an idea at the moment, when existing tacit knowledge in the mind of the researcher combines with the newly acquired tacit knowledge (This usually happens during research, work in the research projects or tacit knowledge exchange such as internal seminars).
- [A4] Tacit knowledge in the form of exchange of experience (socializing) with other entities, such as universities, institutes and companies. This can take place as seminars, joint projects or knowledge exchange visits, where our researchers meet people from these entities and exchange their tacit knowledge, thus learning new knowledge and bringing it to the institute.

APL - Applications

- [APL1] Smart mobility;
- [APL2] Smart society;
- [APL3] Smart health;
- [APL4] Smart energy;
- [APL5] Smart production;
- [APL6] Security;
- [APL7] Space;

ARTEMIS - European Joint undertaking and industry association, now merged into ECSEL

[B] Knowledge Transformation - one type of knowledge is turned into another kind of knowledge:

[B1] Tacit knowledge is turned into Explicit knowledge by documentation - this includes writing of publications, reports, patents, internal articles, memos, etc. (Note: this process just prepares publications and patents not publishes them).

[B2] Explicit knowledge is turned into Tacit knowledge by reading publications and internalizing their contents.

[C] Knowledge spreading / Educating - when person who has some tacit knowledge spreads it to other people. This usually happens in form of internal seminars, briefings or just general socialization.

[D] Knowledge Output - the knowledge is made available to the external world to promote the goals of the institute:

[D1] Tacit knowledge is spread to external entities (companies, public administration, general public, students etc.) through external seminars, tours, presentations, speeches, lectures, etc. thus creating a knowledge network. This benefits the institute by exchanging knowledge for recognition, allowing to increase the influence institute has on external world, promoting its capabilities, finding new customers or research partners, lobbying for more beneficial laws or regulations, or educating potential future employees;

[D2] Explicit knowledge (technology) is patented and potentially sold in the form of intellectual property to existing or spin-off businesses making innovative products based on this technology. This benefits the institute by trading knowledge for funding, providing funds for future work;

[D3] Explicit knowledge (technology) in the form of know-how (intellectual property) is licensed to businesses or used in establishing spin-off companies, who then make innovative products based on this technology. This benefits the institute by trading knowledge for funding, providing funds for future work;

[D4] Tacit knowledge (experience) is sold to businesses in the form of contract research or consulting, allowing these businesses to make innovative products based on this experience. This benefits the institute by trading knowledge for funding, providing funds for future work;

[D5] Explicit knowledge is published in external media, such as scientific journals, conference proceedings etc. including providing access to the outcomes of the research for the general public (Open Access). This benefits the institute by trading knowledge for scientific recognition, thus allowing to find better research partners, attract more valuable employees as well as attract more research

funding by proving our experience and excellence in the scientific fields.

EC - European Commission

ECSEL - Electronic Components and Systems for European Leadership Joint Undertaking (Part of Framework programme)

ERC - European Research Council

ERDF - European Regional Development Fund

EU - European Union

Explicit knowledge - this is formal and systematic knowledge, usually stored as some kind of publication, written communication or information in IT systems. This kind of knowledge is easily accessible to others, but there is some effort involved to internalize and apply it in research.

F2F - Face to Face meetings

FSS - Field of smart specialization

[FSS1] knowledge–intensive bioeconomy;
[FSS2] biomedicine, medical technology, biopharmacy and biotechnology;
[FSS3] smart materials and technologies for engineering.
[FSS4] smart energy industry;
[FSS5] information and communication technologies;

GRD - General research direction

[GRD1] Data acquisition;
[GRD2] Multidimensional data (including big data) processing;
[GRD3] Algorithms for real-time embedded systems;
[GRD4] Data transmission;
[GRD5] Complex signal processing and Cyber-physical systems;

H2020 - European Framework programme Horizon 2020

HEI - Higher education institution

ICT - Internet and Communication Technologies

IECS - Institute of Electronics and Computer Science

IEEE - Institute of Electrical and Electronics Engineers

JSC - Joint stock company

JTI - Joint Technology Initiative (Framework programme)

LETERA - Latvian Electrical Engineering and Electronics Industry Association

LIKTA - Latvian Information and Communications Technology Association

LTG - Long term goal

[LTG1] Fill the gap in technology readiness levels between Universities and Industry;

[LTG2] Become a part of multidisciplinary Research and Technology Organization providing research in smart specialization fields;

[LTG3] Produce outcomes increasing the overall innovation capacity, thus contributing to moving Latvia forward from the group of Modest Innovators in the Innovation Union Scoreboard and providing great societal impact;

[LTG2.1] The funding from international joint research projects is forming about 1/3 of the whole IECS research budget;

[LTG3.1] Institute regularly attracts new talent ([A1]) as well as educates existing employees ([A4]) with tacit knowledge benefiting its long term goals;

[LTG3.2] Regular knowledge transfer among employees takes place in the institute facilitating more efficient knowledge utilization and generation of new ideas ([A3]);

[LTG3.3] IECS employees have access to important scientific and other types of publications ([A2]) relevant to their research, thus increasing efficiency of their scientific work;

[LTG3.4] IECS maximizes the benefit from publishing knowledge in external media ([D5]), by selecting the most appropriate publication for each piece of knowledge.

[LTG3.5] Institute develops its research results in such a way that they are ready for commercialization or technology transfer ([D2][D3][D4]) (with the exception of results published in scientific publications - [D5]);

[LTG3.6] Institute attracts potential customers, commercialization partners and inform public through such societal impact measures as external seminars, tours, presentations, speeches, lectures, etc. ([D1]) maximizing the market for technologies developed by IECS through recognition of them in industry and end-user communities, as well as using for that support from public administrations;

[LTG3.7] To contribute to total Latvian innovation level [LTG3] as well as to commercialization and technology transfer needs of the institute by supporting innovation beyond measures mentioned in [LTG3.5] and [LTG3.6], such as creation of spin-off companies etc.;

[LTG4.1] Buildings and surrounding territory infrastructure is renovated, be energy efficient and suitable for all IECS activities, such as everyday research, technology transfer and hosting of events;

[LTG4.2] Laboratory infrastructure is kept up to date, it is open to partners and is sufficient for achieving IECS research goals as laid out in the research program - all research and technical staff is equipped with necessary up-to-date laboratory equipment;

[LTG4.3] Support infrastructure (including prototyping and computing) is kept up to date and in sync with the research priorities of the institute, as well as ensure cooperation with partners from academia and industry on open access basis;

[LTG5.1] To have a "win-win" cooperation with both Latvian and international Higher education institutions (HEI);

[LTG5.2] To have a close partnership with other research institutions (RI).

[LTG5.3] To have a close cooperation with industry;

[LTG5.4] To lobby sustainable innovation development and IECS vision of the technology development [LTG1] in public administration, as well as in professional organizations (similar to [MTG3.15] but in a broader sense).

MTG - Medium term goal

[MTG1] Become a well recognized ICT research institution in EU;

[MTG2] Become the leading Information and Communication Technology Research Center in Latvia focusing on [TRL3]-[TRL5];

[MTG3] Develop appropriate innovation support infrastructure;

[MTG4] Develop a plan for becoming part of multidisciplinary RTO

[MTG2.1] IECS employees are regularly informed about relevant up-coming *H2020* and other research and innovation support programme and technology initiative calls and know all the specifics about these programmes

[MTG2.2] IECS employees are regularly informed and will take part in relevant up-coming conferences, exhibitions, information days, brokerage and F2F events and other meetings/events, where is possible to not only maintain a good relationship with the existing contacts from academia and industry in order to increase the number of reassert projects, but most importantly - acquire new and valuable contacts for future projects, thus creating knowledge network.

[MTG2.3] IECS researchers have established a) new national contacts from industry; and b) new international contacts from several top universities, RTOs and industry companies, and are able to use them for project writing purposes.

[MTG2.4] IECS researchers are highly motivated, have all the necessary infrastructure and are capable to write and coordinate project proposals for *H2020* and other research and innovation support programme and technology initiative calls;

[MTG3.1] Institute is (and is seen as) a desirable work place for potential future employees ([D1]) thus providing societal impact on students and pupils;

[MTG3.2] A motivation and opportunity for future education ([A4]) of existing research staff be provided;

[MTG3.3] Access to all valuable explicit (written) knowledge within the institute must be facilitated by storing it, and providing guidelines on how to generate and consume it;

[MTG3.4] All valuable tacit knowledge must be regularly distributed among employees through internal seminars etc.;

[MTG3.5] IECS always provides employees access to most popular scientific databases, where most of relevant publications are indexed and available;

[MTG3.6] In cases, when a specific publication is required, which is not part of the popular databases mentioned in [MTG3.5], IECS has a procedure known by all employees for accessing these publications on a case to case basis;

[MTG3.7] The number of publications in scientific journals with high impact (impact factor above 50% of the average in specific field), as well as access to the outcomes of the research for the general public (Open Access) by IECS researchers is increasing;

[MTG3.8] IECS has supporting measures in place assisting employees in publishing knowledge in the specific external media giving the most benefit of publishing the specific knowledge;

[MTG3.9] IECS supports publications with co-authors located in other regions, because they strengthen international collaboration;

[MTG3.10] Number of patents (fit for commercialization) held by IECS must be increased ([D2]) so that they can be sold or licensed for commercialization;

[MTG3.11] Knowledge that is not appropriate for patenting but has commercialization potential should be formed as know-how ([D3]) ready for commercialization/technology transfer;

[MTG3.12] Amount of contract contract research and consulting services by the institute should be increased ([D4]);

[MTG3.13] Organize seminars, tours, speeches etc. in the institute, and invite key representatives to these events;

[MTG3.14] Offer presentations, speeches, lectures etc. at key institutions and key events organized by other parties;

[MTG3.15] Develop innovation support infrastructure, allowing for more rapid technology transfer through spin-offs etc.;

[MTG3.16] Lobby sustainable innovation development and IECS vision of the technology development [LTG1] in public administration and regulatory institutions, as well as professional organizations

[MTG4.1] Building A satisfies requirements to fulfill the research program;

[MTG4.2] Building C satisfies requirements to fulfill the technology transfer activities of the research program;

[MTG4.3] Future utilizing of IECS premises is approved by Advisory board of the IECS;

[MTG4.4] Complementary to the recently established 25 modern researcher workplaces new workplaces are established and researchers are

provided with up-to-date conventional equipment and with development kits and environments;

[MTG4.5] Specialized equipment is completely sufficient for the purposes of the all selected fields of research;

[MTG4.6] Extended functionality of test-beds is offered to internal and external users and included in network of test-beds;

[MTG4.7] Prototyping equipment is updated to be sufficient to support research priorities and ensure cooperation with partners from industry;

[MTG4.8] Computing infrastructure is completely sufficient to support the purposes of the selected fields of research and maintained by sharing costs with partners who use it;

[MTG5.1] To increase the involvement of students from HEI in research;

[MTG5.2] To improve cross cooperation with Latvian and international HEI by involving their professors with IECS and IECS researchers with HEI;

[MTG5.3] To develop joint study programs for doctoral students;

[MTG5.4] To become a partner (leading for SECS, ICT) to other research institutions in consortia in national and international interdisciplinary R&D projects;

[MTG5.5] To exchange resources (to share infrastructure) with other RI outside of research projects;

[MTG5.6] To build general trust and cooperative environment with other research institutions;

[MTG5.7] To be a provider of new technologies for commercialization and high tech competence for business of high tech companies;

[MTG5.8] To exchange resources (including research and piloting infrastructure) with industry (e.g. KEPP EU Ltd., EuroLCDs Ltd., Lattelecom Ltd., Square Audio Ltd., XpressHD Ltd., JSC SAF Tehnika etc.);

[MTG5.9] To build general trust and mutually beneficial cooperation with industry;

[MTG5.10] To participate in international partnership networks, such as EMES European Research Network and participate in European Innovation Partnerships in order to build general trust and mutually beneficial cooperation with international research community;

[MTG5.11] Promote IECS research profile, to attract new potential partners as well as international researchers for work in IECS;

[MTG5.12] Establish an annual event, called "IECS day", inviting HEI, RI, industry and government partners for exchange of information. This will help both to market our competencies and projects and to find out partners interests and needs to establish trust, which is crucial to raise awareness that IECS can create a win-win situation for both sides.

NCP - National Contact Point

OO - Other organizations

PRD - Priority research direction

[PRD1] Extremely-high resolution event timing
[PRD2] Transformed time signal processing, UWB and SHF, EHF systems
[PRD3] Video analysis for safe and smart cities
[PRD4] Embedded and Cyber-physical systems for mobility
[PRD5] Bio-medical and biometry signal and image processing
[PRD6] Complex signal processing for industrial technologies
[PRD7] Remote sensing and space data processing
[PRD8] WSN hardware and software platform development and application (bioeconomy, medicine, environment monitoring etc.)

RI - Research institution

RIS3 - Latvian smart specialization strategy

RTO - Research Technology Organization

RTU - Riga Technical University

SCOPUS - Elsevier's largest abstract and citation database of peer-reviewed scientific literature

SECS - Smart Embedded Cooperative Systems

SME - Small and Medium Enterprise

STA - Short Term Action

SWOT - Analysis evaluating Strengths, Weaknesses, Opportunities and Threats

Tacit knowledge - this is the knowledge and experience possessed by individual people, which is not immediately accessible to others, because it might be hard do formalize and, therefore, communicate;

TRL - Technology Readiness Level

[TRL1] – basic principles observed
[TRL2] – technology concept formulated
[TRL3] – experimental proof of concept
[TRL4] – technology validated in lab
[TRL5] – technology validated in relevant environment
[TRL6] – technology demonstrated in relevant environment
[TRL7] – system prototype demonstration in operational environment
[TRL8] – system complete and qualified
[TRL9] – actual system proven in operational environment

Twinning - Cooperation actions targeted at reaching specific goals

UoL - University of Latvia

VUC - Ventspils University College

Chapter 1

Introduction

Institute of Electronics and Computer Science (IECS) in Riga, Latvia is a public research institute founded in 1960. IECS have more than 80 researchers working on innovative technologies in electronics and computer science. At the moment, main fields of competence includes signal and image processing, development of cyber-physical systems, hardware and software prototyping, wireless sensor networks, intelligent and embedded devices/systems, development of sensors, biometrics, wearables, precise timing, etc.

More specifically, IECS strengths are related to development of Smart Embedded Cooperative Systems (SECS) based on original and/or complex signal processing approaches.

Recently, in year 2013, during international assessment of Latvian research institutions[1], IECS was evaluated as one of the 15 best performing institutes in the Latvia and as a best in the field of Engineering and Computer Science. By score 4/5, IECS was described as a "Strong International Player", which is of high enough scientific level of excellence, importance and education to ensure critical mass for qualitative and outstanding results, and is a reference model for national collaborations and can increase its potential by leading a consolidation effort with other Latvian research units' experts in similar fields. This program was written while taking into account the suggestions in this assessment report.

The budget of the IECS is mainly formed from Latvian national research programs[2], grants from Latvian Council of Science[3], European Structural funds[4], International projects[5], Knowledge and Technology transfer[6], and

[1] http://www.izm.gov.lv/images/zinatne/ZISI/zisi_05.pdf

[2] List of national projects: http://edi.lv/en/projects/state-research-p-projects/

[3] http://edi.lv/en/projects/latvian-council-science-projects/

[4] List of current European structural funds projects: http://edi.lv/en/projects/ec-co-financed-projects/

[5] List of international projects: http://edi.lv/en/projects/international-projects/

[6] http://edi.lv/en/projects/contract-research/

partially from base funding, which, as indicated in Technoplis group external audit in 2015[7], is very low.

In the long term, international projects and knowledge and technology transfer should be two the most important sources of funding for development of the institute. IECS has years of experience in implementation of international projects, both as partner and coordinator. For example, currently IECS is involved in JTI ECSEL project „Integrated Components for Complexity Control in Affordable Electrified Cars" (3Ccar)[8], JTI ARTEMIS project: "Dependable Embedded Wireless Infrastructure" (DEWI)[9], EEA/Norway Grants project "Health and Social Indicators of Participation in Physical Activities for Children with Disabilities" (HIPPAC)[10] and others.

The most notable example of knowledge and technology transfer is spin-off company called Eventech[11], which, through licensing agreement, is commercializing IECS develop "extremely high resolution event timing" technology. At the moment, this technology is used in more then half of all NASA's International Laser Ranging Service stations[12] around the world. In addition, institute provides regular contract research for Eventech. Besides that, IECS is/was implementing research for several companies from industry, for example, "Research on development of mathematical model for silicon crystal growing technological process by using image processing methods" (SikA) for KEPP EU Ltd.[13], "Research on the reconstruction technology of the volumetric three-dimensional images for 3D spatial image display" for EuroLCDs Ltd.[14], "Data aggregation of multiple measurements, correlation analysis and real time extrapolation: modelling and piloting (TeleMed)" for Lattelecom Ltd.[15], "Research in construction of new electronic sound processing device for professional active acoustic system with megaphone type sound emitter, using multiple band high precision digital FIR filters and D-class amplifiers (SKANDA)" for Square Audio Ltd.[16], "Development of image processing algorithm for recognition of symbol combinations in video streams (KoDe)" for XpressHD Ltd.[17] and others.

This Research programme contains our vision (Sections 1.1, 1.2 and 1.3), which is based on our research strengths, available resources (both staff

[7] Technopolis, 27 July 2015, External audit of the IECS. Assessment of development potential and elaboration of recommendations for the strategy development.

[8] http://www.3ccar.eu/

[9] http://www.dewi-project.eu/

[10] http://edi.lv/lv/projekti/starptautiskie-projekti/hippac/

[11] http://eventechsite.com/

[12] http://ilrs.gsfc.nasa.gov/

[13] http://keppeu.lv/en/

[14] http://www.eurolcds.com/

[15] https://www.lattelecom.lv/en/

[16] http://www.square.audio/

[17] http://xpresshd.com/

and otherwise), SWOT analysis (section 1.1.3), results of international assessment of Latvian research institutions[18] and IECS functional audit performed by Technopolis group in 2015[19](suggesting increasing IECS international recognition - section 2 and 3.3.2, cooperate more with industry - section 3.3.3 and renewing infrastructure - sectioninfra) as well as points laid out in "Europe 2020: strategy for smart, sustainable and integrated growth", Guidelines for Science, Technology Development, and Innovation 2014-2020, including Latvian smart specialization strategy (RIS3)[20], smart specialization fields and growth priorities, Horizon 2020 work programme, ECSEL Multiannual strategic plan, criteria of innovation score board, research ethics, and other relevant strategic documents. In short, this vision describes how the institute plans to develop from leading SECS research in Latvia in short-term to leading ICT research center in medium term, to well recognized in Europe multidisciplinary Research and Technology Organization in long-term (see Figure 1.1).

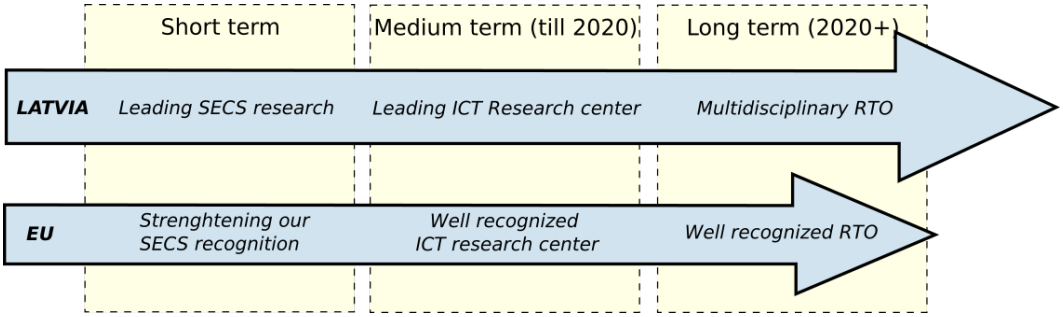

Figure 1.1: Vision of the institute in short, medium and long term

This research programme has been developed as a realistic and both financially and otherwise feasible plan for achieving scientific excellence and ensuring an improved efficiency of the scientific work, and to reach this goal it was coordinated with industry and international experts. It was discussed and approved in a board meeting[21] of Latvian Electrical Engineering and Electronics Industry Association (LETERA), which was attended by LETERA president Normunds Bergs (Bord member of JSC SAF Tehnika), and several LETERA board members, including Ilmars Osmanis (Board member of Hanzas Elektronika Ltd.[22], Ventspils Elektronikas

[18]http://www.izm.gov.lv/images/zinatne/ZISI/zisi_05.pdf

[19]Technopolis, 27 July 2015, External audit of the IECS. Assessment of development potential and elaboration of recommendations for the strategy development.

[20]http://www.ris3.lv/, based on Research and Innovation Strategy for Smart Specialization (S3)

[21]LETERA board meeting on 27.08.2015

[22]http://www.hansamatrix.com/mission-best-baltic-nordic-ems/

Fabrika Ltd.[23]), Janis Avens (JSC Latvenergo[24] IT and technical director), Janis Bikse (Vidzemes elektrotehnikas fabrika Ltd.[25]), Viktors Kononovs (director of Volburg Ltd.[26]), Oskars Krievs (dean of RTU faculty of power and electrical engineering[27]), Dzintars Zarins (board member of Dozimetrs Ltd.[28]). In addition to that the research programme was approved by the IECS scientific council[29] and in its creation IECS consultative board was involved, including experts from both Industry[30] and international research organizations[31].

Based on this vision, specific plans are devised to reach this vision:

- Plan for participation in *H2020* and other research and innovation support programme and technology initiative calls (Chapter 2), since, due to limited research funding in Latvia, it is crucial for IECS sustainability as well as for increasing the quality of research.

- Knowledge and Technology management (Chapter 3) - because creation of knowledge from funding and then managing this knowledge is the main goal of a research institute.

  - Plan for improvement of knowledge circulation and creation (Section 3.3.1) - To facilitate the growth of the institute it must be able to develop more new knowledge, and one of the ways to facilitate that is to circulate existing knowledge throughout the institute and between similar institutes in EU, providing a research friendly environment;
  - Plan for increasing the amount of international publications as well as access to scientific databases for increasing the efficiency of the scientific work (Section 3.3.2) - To attract better partners some of the knowledge produced in the institute must be published in quality scientific publications. To get such quality results it is necessary to have high level researchers, projects and quality access to existing scientific work;
  - Plan for improvement of knowledge and technology management to promote commercialization and technology transfer (including

[23] http://www.vatp.lv/en/ventspils-elektronikas-fabrika-ltd
[24] http://www.latvenergo.lv/eng/
[25] http://www.vefabrika.lv/
[26] http://www.volburg.lv/
[27] http://www.eef.rtu.lv/english.htm
[28] http://www.dozimetrs.lv/en/
[29] Council meeting on 28.08.2015
[30] Ilmars Osmanis - Hanzas Elektronika Ltd. and Ventspils Elektronikas Fabrika Ltd.
[31] Prof. Dr. Stefan Jahnichen - http://www.swt.tu-berlin.de/menue/ueber_uns/team/stefan_jaehnichen/, Arthur H.M. van Roermund - https://www.tue.nl/en/university/departments/electrical-engineering/department/staff/detail/ep/e/d/ep-uid/19992292/

spin-offs) of research results (Section 3.3.3) - knowledge must be turned into innovations to increase total value and close the cycle of money-knowledge-money through monetizing of intellectual property.

- Research infrastructure development plan (Chapter 4) - In order to be well recognized research center in Europe, IECS must have state-of-the art infrastructure so employees could perform high quality research.

- Plan for improvement of Twinning with academia and industry (Chapter 5) - to reach its long term goals IECS must build targeted cooperation with key institutions and form industry-academia partnerships.

In addition to measures described alongside the specific goals, to provide continuous improvement through monitoring, evaluation and performance each of the following plans and the matching staff performance will be regularly monitored and annually evaluated by a specifically designated responsible person for each of these plans and any implementation concerns and evaluation results will be brought to scientific council to decide on potential measures.

Human resources required for fulfilling this plan will be discussed in human resources development plan, which will be devised in later stage. For insight into this plan - the long term human resources goal of the institute is to reach reserch staff of 250 people, which should be.

1.1 Long term research vision and goals

For any institution to be successful at short and medium term planning it requires a long term vision of how the world will look in the future and how the institution will fit in this world. In the case of this research programme, long term vision concerns years 2020 and onward. The general long term vision revolves around the notion producing research outcomes, that generate a considerable positive impact on the IECS itself as well as society, fostering development of knowledge communities and integration in knowledge ecosystems.

The long term vision of the institute stems from two factors:

- Place in the scale of Technology Readiness Levels (TRL) - on what levels should the institute be working on to bring the most added value in form of money and kvowladge for society?

- Place in the spectrum of fields and applications - in what research topics and for which applications the institute can achieve excellence in the future?

Based on the analysis of these two factors (see Sections 1.1.1,1.1.2) and the long term interests of the society in Latvia as well as in EU, specific long term goals of the institute were determined:

[LTG1] Fill the gap in technology readiness levels between Universities and Industry;

[LTG2] Become a part of multidisciplinary Research and Technology Organization providing research in smart specialization fields[32], such as ICT, smart engineering systems and others;

[LTG3] Produce outcomes increasing the overall innovation capacity, thus contributing to moving Latvia forward from the group of Modest Innovators[33] in the Innovation Union Scoreboard[34] and providing great societal impact.

1.1.1 Place in the technology readiness levels

Technology life-cycle is the cycle of turning money into knowledge/technologies through research, and then back into more money and added value to the society through innovation leading to benefits, such as creating more jobs, building a greener society and improving the general quality of life.

This is the reason why strategies such as RIS3 and Europe 2020 focus on innovation, and why IECS as part of Latvia and European Union is interested in conforming to these strategies.

Technology Readiness Levels (TRL) are defined as:

[TRL1] – basic principles observed
[TRL2] – technology concept formulated
[TRL3] – experimental proof of concept
[TRL4] – technology validated in lab
[TRL5] – technology validated in relevant environment
[TRL6] – technology demonstrated in relevant environment
[TRL7] – system prototype demonstration in operational environment
[TRL8] – system complete and qualified
[TRL9] – actual system proven in operational environment

Although one entity could potentially be capable of taking on the full scale of Technology Readiness Levels, usually because of limited resources it is not the case. The lower TRLs are expensive and risky investments, which usually pay for themselves only in long run, and thus in most cases

[32] RIS3 - http://s3platform.jrc.ec.europa.eu/s3pguide
[33] Latvia was evaluated as Modest innovator in Innovation Union Scoreboard 2015
[34] http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards/index_en.htm

are publicly funded, while higher TRLs provide an easier to see business model for commercialization, thus attracting private funding.

Historically, Universities have taken on the fundamental research [TRL1] because it naturally stems out of their main mission of education and quest for knowledge. Later this range has been extended to more TRLs (usually [TRL2] and sometimes even [TRL3]+) taken care of inside Universities (depending on the situation in specific countries). This trend can also be seen in the high percentage of Universities among the recipients of ERC research grants for mostly lower TRL research[35].

On the other hand, businesses are mostly interested in innovation starting at approximately [TRL6], because at this level technology is partially validated for specific purpose and it is easier to see the return on investment. This is also recognized by EC through such tools as Horizon 2020 SME instrument, supporting only technologies of [TRL6]+[36].

This situation results in a gap at the region of [TRL3] - [TRL5] in the TRL scale, which all involved entities are interested in somehow bridging. Individual countries and European Union as a whole are developing support tools for bridging this gap in the form of research instruments and commercialization support instruments. In some cases Universities try to reach over this gap thus spreading their capacity for fundamental research and thus resulting in less resources spent on observing new basic principles, thus reducing the flow of innovations in the long run. In other cases businesses reach over this gap by investing in their own private research laboratories which is expensive and thus very hard to achieve for smaller companies and start-ups, also resulting in less innovation in the long run.

The third possible solution to this problem is bridging this gap with RTOs (e.g. VTT[37], TNO[38] or Fraunhofer[39]) consisting of research institutions, taking the fundamental results generated by universities and developing them into technologies ready for innovation by businesses. This solution allows less spreading of the resources by each institution involved, thus allowing to more concentrate and specialize on specific TRLs, resulting on higher total level of developed technologies.

In the case of Latvia where RTOs niche is not defined clearly enough, but is only partially covered by state research institutes, the resulting effort spent on TRLs by different entities are rather flat, resulting in lower total technology level, high competition for resources such as employees and funds, as well as low cooperation among entities involved and capacity bottlenecks because of missing previous research, resulting in fragmented technology capacity with less impact (Figure 1.2).

[35] http://erc.europa.eu/sites/default/files/document/file/erc_2014_adg_results_all_domains.pdf
[36] http://ec.europa.eu/easme/en/horizons-2020-sme-instrument
[37] http://www.vttresearch.com/
[38] https://www.tno.nl/en/
[39] https://www.fraunhofer.de/en.html

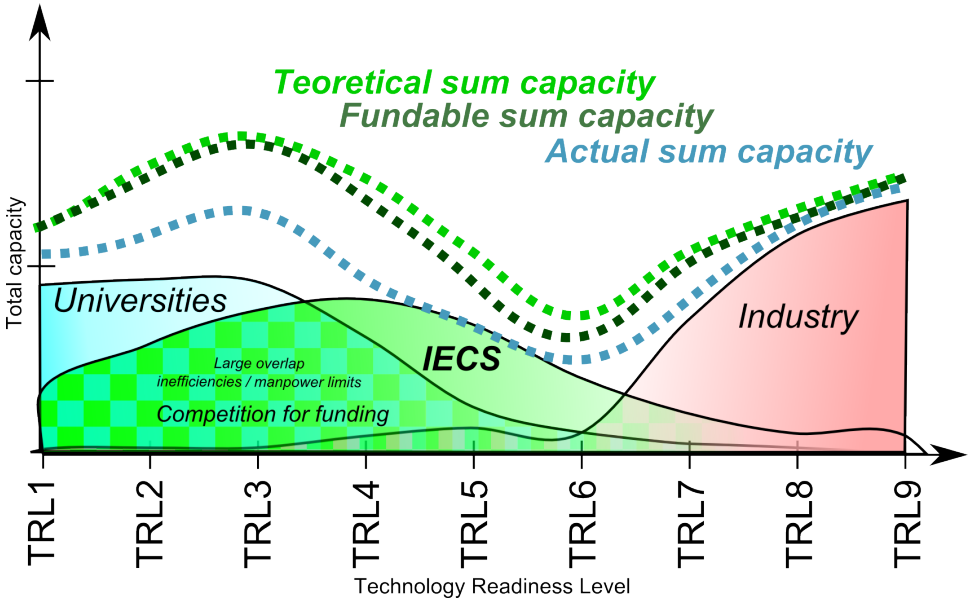

Figure 1.2: The current situation of technology readiness levels in Latvia

To achieve the long term innovation goals set out in such Latvian and European strategies as RIS3 and Europe 2020, it is important to increase the efficiency of the innovations, by concentrating the distribution of resources of involved parties, as seen in Figures 1.2, 1.3. This will result in higher total technological capacity and smaller overlap, increasing the potential of cooperation, and increasing overall efficiency of the system as a whole.

Thus our long term vision goal [LTG1] can be fulfilled if IECS in the short term and resulting RTO in the long term concentrates on [TRL3] - [TRL5] (this approach was also suggested by international reviewers[40]), with some effort in other TRLs for synergy/cooperation purposes. At the same time it is important to make universities understand the benefits of working mostly in [TRL1] - [TRL2], and to make businesses understand the benefits of working mostly in [TRL6] - [TRL9], as this will result in the benefits envisioned here. On the other hand, if universities and businesses continue to expand their capacity over the middle section of the technology readiness levels, it is a threat to the vision of a more efficient innovation chain and achievement of RIS3 goals in general because such strategy is not economically sound in the current situation of limited resources.

1.1.2 Place in the spectrum of fields and applications

To reach the long term goal of moving Latvia forward in the innovation capacity [LTG3], IECS not only needs to find its place in the technology

[40] in this years function and task external audit by Technopolis group

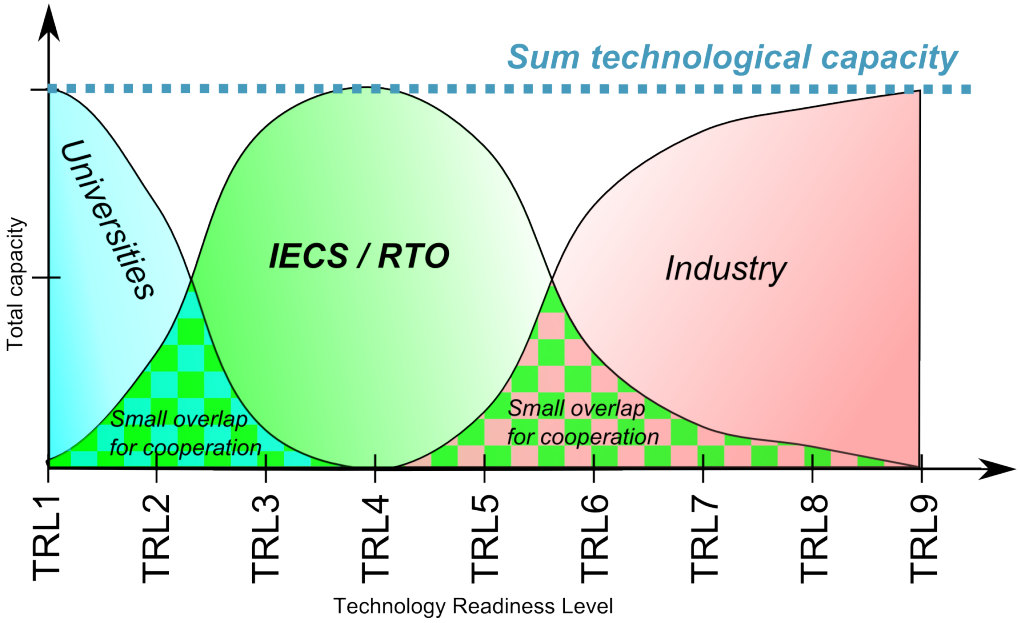

Figure 1.3: Vision of the place of the institute in the technology readiness levels in the future

readiness levels [LTG1], but also needs to be able to provide support to innovations in all the relevant fields and for all connected applications. According to vision described above, the institute must become a part of multidisciplinary Research and Technology Organization, by growing into an ICT research center, which covers smart engineering systems as well, and consolidate with other research institutions in all important research fields driving the innovations.

Without the limitations of time and resources it could be beneficial to consolidate all types of research institutions under such RTO. The limited scope of the real situation dictates some kind of specialization. In the case of Latvia, which is not rich in resources, this means smart specialization as described in Latvian Smart Specialization Strategy (RIS3). The fields of smart specialization described in RIS3 are:

[FSS1] knowledge–intensive bioeconomy;
[FSS2] biomedicine, medical technology, biopharmacy and biotechnology;
[FSS3] smart materials and technologies for engineering.
[FSS4] smart energy industry;
[FSS5] information and communication technologies;

These fields are in alignment with priorities of strategy Europe 2020, as well as general EC vision shown in *Horizon 2020* documentation. Each of these require signal processing (in some cases also SECS) as part of the

system in order to introduce smart and effective solutions. IECS has long experience in the field of signal processing and is contributing working for several fields of smart specialization. Since the last international review evaluated us as a "strong international player" which could be a center for consolidating research institutions of similar fields around it, the selection of these research fields and the idea of consolidating research institutions seems well founded. Thus, in the long run it seems appropriate, that the institute aims to become a part of a multidisciplinary RTO in the fields of smart specialization [LTG2] either through development or consolidation, while in the short and middle terms the vision is to strengthen the position of the institute as well recognized SECS/ICT research center in EU, as appropriate.

1.1.3 SWOT analysis

In order to ensure the viability of IECS through effective use of various resources, and sustainability through strategic planning, it is important to base the research programme on analysis of IECS strengths, weaknesses, opportunities, and threats.

Strengths

- Formidable experience and research opportunities in fields matching H2020 work programmes, RIS3 etc. with uses in medicine, transport systems, society safety solutions etc.;
- Modernized research infrastructure in the last few years (including buildings and laboratory equipment);
- Research partners from European Union, Eastern Europe and other countries;
- Active work in consolidating the respective research fields around IECS as the leading partner;
- Experience in internationally recognized projects (e.g. JTI ECSEL, JTI ARTEMIS);
- Active participation in the higher education processes (cooperation contracts with UoL, RTU, VUC as well as support for the doctoral programs of these higher education institutions, preparation and teaching of courses in higher education institutions);
- Publishing of scientific journal "Automatic Control and Computer Sciences", which is indexed by SCOPUS and distributed in cooperation with Springer;
- High percentage of publications (>70%), in the last few years, in publications indexed by SCOPUS and Web of Science data bases;

- Experience in commercialization of technologies, founding of spin-off companies, creation of support society for founding of high technology companies "Commercialization laboratory C-lab".

Weaknesses

- Comparably low number of publications in journals with high citation index;
- In knowledge transfer, there is insufficient cooperation with local and international partners and potential end-users;
- Insufficient activities in popularizing the know-how of the institute;
- Insufficient amount of leading scientists - team leaders with long professional experience.

Opportunities

- Active participation in defining of long term strategic plans of the state provide IECS with the opportunity to develop its strategy as part of the state planned scientific strategy;
- Active work in consolidation of respective research fields and investments centered around IECS provides an opportunity for the growth of ICT field (including electronics and telecommunications, computer science);
- The matching of research fields to the planned Horizon 2020 calls provides an opportunity to use the competences of IECS in Horizon 2020 projects and gain even more experience in these fields;
- Cooperation with the biggest universities of Latvia in the respective fields provides a lot of opportunities to attract students for specific tasks by offering an opportunity to them to work on their academic or qualification work in our institute, as well as to include our latest research results in the process of education;
- The close connection of research fields and competences to actual practical applications provide an opportunity to attract interest from industry, state an local organizations resulting in contracts for applied research in their behalf;
- The status of co-founder of "Commercialization laboratory C-lab" provides IECS with the opportunity to easily and effectively inform innovative business people of the latest research results with the potential for commercialization;
- There is no joint Research and Technology organization in Latvia, and the physical location in the "Teika" region scientific campus together with several other high level technology oriented institutions (e.g. Institute of Organic Synthesis, Institute of Wood chemistry) provides an

opportunity to develop synergy and move towards a creation of a joint research and technology organization.

Threats

- The low number of local industrial partners, having interest in development of high technologies threatens the institute with an ineffective commercialization of our competences and developed technologies;
- The large share of project related funding in the total budget leads to a threat of losing human resources in the situations between projects;
- An out of balance distribution of European Structural Funds between activities of research, technology development, innovations etc. provides a threat of specialists leaving to work in private companies, if they have easier access to European Structural Funds and have less obstacles on spending these funds;
- The threat of potential lack of Masters students, connected to the demographic situation in the country could lead to lower number of available young specialists in the future;
- The threat of Industry and Universities covering whole range of TRLs, thus settling on an ineffective system where there is no demand for applied research institutions.

1.2 Medium term research vision and goals

To reach the long term goals described in the previous section and determine medium term priority research directions, the current research specialization of the institute must be analyzed (see Subsection 1.2.1), so that medium term goals could be determined leading from the current situation to the long term vision. After that, out of these medium term goals, medium term priority research directions can be determined and short term activities can be set in the next section.

To reach the long term goal [LTG2] institute must expand the fields of research in such a way as to cover ICT and smart technologies for engineering of smart specialization fields ([FSS3] and [FSS5]). At the same time it is important to focus on the niche of TRLs between the Universities and Industry as described in the long term goal [LTG1]. In addition, to reach the long time goal [LTG3] the institute must support innovation in Latvia.

Based on the current situation of the institute and previously mentioned considerations for reaching the long term goals (which are described in detail in the subsections below) these medium term goals were determined for the time period till year 2020:

[MTG1] Become a well recognized ICT research institution in EU;

[MTG2] Become the leading Information and Communication Technology (ICT)[41] Research Center in Latvia focusing on [TRL3]-[TRL5];

[MTG3] Develop appropriate innovation support infrastructure;

[MTG4] Develop a plan for becoming part of multidisciplinary RTO

1.2.1 Current research specialization of the institute

At the time of writing this research programme, the institute specializes in complex and/or original signal and image processing for Smart Embedded Cooperative Systems (SECS). SECS consists of "Smart Systems", meaning strong signal processing component, "Embedded" meaning limited resources and "Cooperative" meaning networking.

Research is currently divided in five laboratories:

2.1 Signal processing laboratory[42],
2.2 Time-measurement laboratory[43],
2.3 Sampling signal conversion laboratory[44],
2.5 Embedded system laboratory[45],
2.6 Cyber-Physical Systems laboratory[46].

Currently, the existing research specialization is defined as follows:

- Novel information, communication and signal processing technology methods:
  - Original signal acquisition and processing methods;
  - Event timing and processing with extremely high resolution;
  - Development of platforms for sensor network architecture and sensor node software;
  - Signal processing in transformed time domain;
  - Image processing and pattern recognition.
- Smart integrated systems for data acquisition, processing and transmission:
  - Extremely precise event chronometric systems;
  - High efficiency and safety data transmission networks;
  - Safe and convenient multimodal biometrics technologies;
  - Multifunctional intelligent transport systems;

[41] Matching the field of smart specialization [FSS5]
[42] http://edi.lv/en/research-labs/laboratories/signal-processing-laboratory/
[43] http://edi.lv/en/research-labs/laboratories/time-measurement-laboratory/
[44] http://edi.lv/en/research-labs/laboratories/sampling-conversion-laboratory/
[45] http://edi.lv/en/research-labs/laboratories/embedded-system-laboratory/
[46] http://edi.lv/en/research-labs/laboratories/cyber-physical-systems-laboratory/

  - Technologies of ultra wide band high sensitivity location and data transmission;
  - Designing, prototyping and testing of electronic devices and special-purpose chips, including software-defined radio solutions.

- Perspective R&D directions:
  - Cyberphysical systems;
  - Acquisition and processing of biomedical signals;
  - Photonics;
  - Space data processing and satellite electronics.

These definitions match the existing strategy developed in 2010, and thus have not been updated for several years, and although the main research field of Signal and image processing for Smart Embedded Cooperative Systems is still up to date, some perspective sub-fields, such as Cyber-physical systems and Acquisition and processing of biomedical signals have moved from perspective research directions to fully fledged research directions. On the other hand, some less successful research areas with little or no future prospects are relinquished, as seen in the following sections.

As mentioned in the previous section, institute has already gained some recognition in the field of SECS as a strong international player. To facilitate long term goals [LTG2] and [LTG3] institute must be able to grow as a research institution. To do so, it must generate more knowledge and fund its research by attracting better international projects and experienced partners (as described in Chapter 2).

1.2.2 Description of medium term priority research directions

To define medium term priority research directions it is first required to review the potential for future development of the field to be sure, that it is likely, that the medium term priority research directions will still be viable when they are achieved.

The field of signal processing itself has great potential for future development, as more advanced signal processing methods are required by the growing number of applications as well as the increased level of complexity of different systems. Also, the fields of smart specialization, as mentioned in the Latvian Smart Specialization Strategy (RIS3), have a great potential to boost the future innovations in Latvia and EU. In addition, several other documents strengthen the belief, that these fields have high development potential:

- ECSEL[47] key applications include "Smart mobility" (matching [FSS3]-[FSS5]), "Smart society" (matching [FSS1]-[FSS5]), "Smart energy"

[47] http://ecsel.eu/web/downloads/Documents_GB/ecsel-gb-2014-22_masp_2015.pdf

(matching [FSS4][FSS5]), "Smart health" (matching [FSS2][FSS5]) and "Smart production" (matching [FSS3][FSS5]);

- European Space Agency is developing long term space capability of Europe, thus making research for Space applications (matching [FSS1][FSS3][FSS5]) viable in long term;
- Europe 2020 initiative goals include "Innovation union" (matching all fields of research producing knowledge for innovation), "Digital society" (matching [FSS5]), "Resource efficient Europe" (matching [FSS1][FSS4]), and also others which have connection to the fields of smart specialization;
- Big data, Open data, future internet, next generation ICT systems, robotics, data mining (matching [FSS5]) and advanced computing are priorities of Horizon 2020 ICT work programme[48];

Based on this review of the research fields potential for future development, as well as description of research specialization of the institute (Section 1.2.1), and plan for improvement of targeted co-operation (Chapter 5) medium term priority research directions were determined as follows:

1. Potential for future development - the key applications were selected in which research will have long term potential based on documents, such as RIS3, Europe 2020, Horizon 2020 work programme (including ECSEL) etc.:

[APL1] Smart mobility;
[APL2] Smart society;
[APL3] Smart health;
[APL4] Smart energy;
[APL5] Smart production;
[APL6] Security;
[APL7] Space;

2. Current research specialization of the institute as well as the previously mentioned reviewed documents - general SECS/ICT subfields were selected:

[GRD1] Data acquisition;
[GRD2] Multidimensional data (including big data) processing;
[GRD3] Algorithms for real-time embedded systems;
[GRD4] Data transmission;
[GRD5] Complex signal processing for Cyber-physical systems;

[48] http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/87-ict-15-2014.html

3. Applications and general research directions were matched to find priority research directions conforming to fields of smart specialization (Figure 1.4) with matching TRL levels on which IECS specializes:

[PRD1] Extremely-high resolution event timing [GRD6]+[APL7], matching [FSS3/5], [TRL2-9]

[PRD2] Equivalent time signal processing, UWB and SHF, EHF systems [GRD1/7]+[APL5/6], matching [FSS3/5], [TRL1-5];

[PRD3] Video analysis for safe and smart cities [GRD3-4]+[APL2/6], matching [FSS3/5], [TRL3-6];

[PRD4] Embedded and Cyber-physical systems for mobility [GRD6]+[APL1], matching [FSS5], [TRL3-6];

[PRD5] Bio-medical and biometry signal and image processing [GRD1-6]+[APL3/6], matching [FSS2/3/5], [TRL2-6];

[PRD6] Complex signal processing for industrial technologies [GRD1-6]+[APL5], matching [FSS1/4/5], [TRL2-7];

[PRD7] Remote sensing and space data processing [GRD4]+[APL7], matching [FSS5], [TRL3-5];

[PRD8] WSN hardware and software platform development and application (bioeconomy, medicine, environment monitoring etc.)[GRD2/5/6]+[APL1-7], matching [FSS1-5], [TRL2-8].

The determined medium term priority research directions were selected to cover more smart specialization fields in order to reach the long term goal [LTG2] and become an RTO in smart specialization fields. To reach this goal a medium term goal has been set, to become an ICT research center either by expanding the priority research directions to cover most of ICT fields, or to join forces with other research institutions in these fields ([MTG2]).

Also, a plan for achieving research capability in all other fields of smart specialization excluding those already achieved in [MTG1] and [MTG2] must be developed ([MTG4]) by searching for potential partners in these fields as well as research directions in which to expand the competences, thus moving towards the long term goal [LTG2].

1.2.3 Focusing the Technology Readiness Levels

In order to reach the long term goal [LTG1] of focusing on [TRL3]-[TRL5] of all the technology readiness levels, first a survey of capabilities and planned actions of our researchers was done in the priority research directions.As a result of this survey each priority research direction was paired with a set of TRLs in which the researchers of the institute see outcomes of its research work (Figure 1.5).

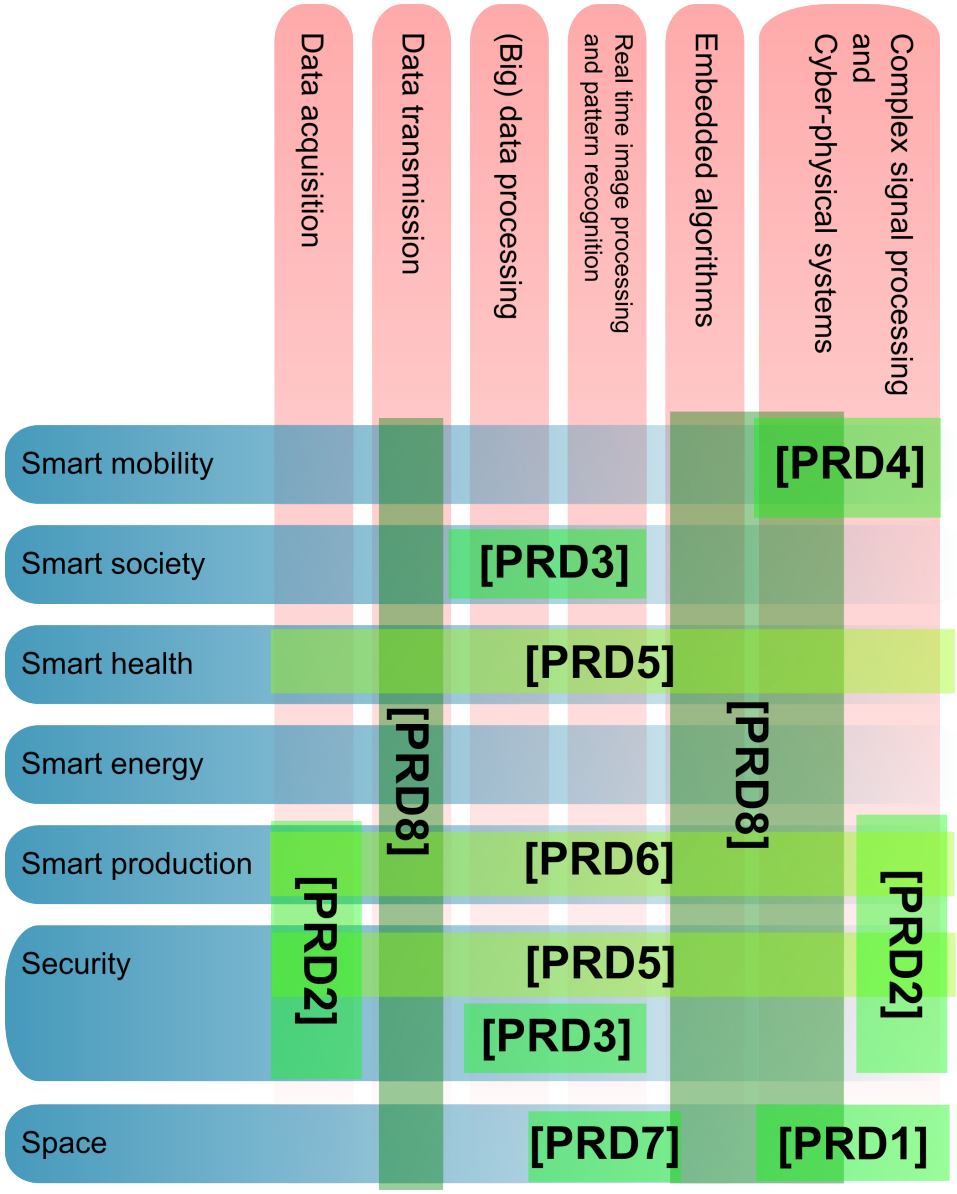

Figure 1.4: Priority research directions, based on applications and general research directions

From this figure it can be seen, that all of the research directions cover the planned [TRL3]-[TRL5] range, where some of the directions are close contacts with industry or even experience of small volume production (e.g. event timers) expands more to higher TRLs, while directions which are based on original theory expand to lower TRLs (e.g. transformed time signal processing). Covering the other TRLs is beneficial for cooperation

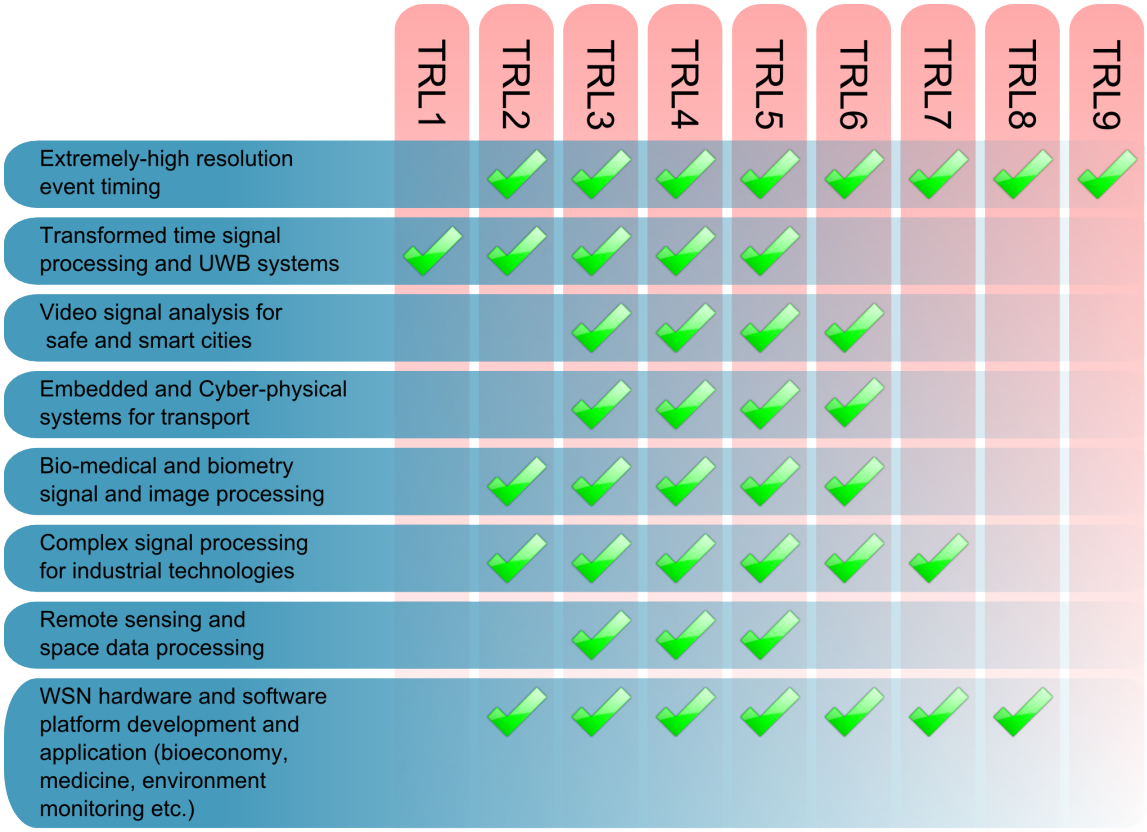

Figure 1.5: Priority research directions and corresponding TRLs

with universities and industry and complimentary contributes for reaching of [LTG1]. Because of this a medium term goal of focusing more on the [TRL3]-[TRL5] range was defined ([MTG2]).

1.2.4 Supporting innovation in Latvia

To reach the long term goal [LTG3] of moving Latvia forward from the group of Modest innovators, it is important to support innovation in Latvia.

In addition to distributing knowledge to support innovation in Latvia, as described in section 3 and improving targeted co-operation, as described in section 5, it is also important to develop innovation support infrastructure easily available in IECS ([MTG3]). This means, that in the medium term institute is planning to develop a technology transfer support infrastructure, such as office space for spin-off companies and companies with potential interest in commercializing research results of IECS and future RTO, as well as to develop open access innovation infrastructure (e.g. prototyping) and make it available to these companies. Also, previously founded "Commer-

cialization Laboratory Clab", which is partly founded by IECS, is planned to be incorporated in this structure in order to improve the effectiveness of its operation.

1.3 Specific short term actions and control mechanisms

For the short term (1-2 years) IECS has developed a short term plan based on the medium term goals.

To reach medium term goals [MTG1] and [MTG2] it is important to manage knowledge of the institute correctly as well as participate in ambitious projects with significant added value. Corresponding short term actions and metrics are described in sections 3.3.1 and 3.3.2.

To reach medium term goal [MTG3] of developing innovation support infrastructure (for both spin-off companies and cooperation with existing companies) a short term plan and metrics are described in section 3.3.3.

All three of these medium term goals [MTG1-3] require a corresponding infrastructure to support achievement of these goals. Medium term goals and short term actions and metrics regarding this infrastructure are described in section 4.2.

To reach the medium term goal [MTG4] these short term actions are required:

[STA1] Determine a list of new perspective research directions based on the fields of smart specialization, that the institute should work on, when it transforms into ICT research center and RTO in fields of smart specialization; (*Metrics: The list must contain potential research directions based on the fields of smart specialization, potential funding - next period ERDF for institutional development*)

[STA2] Determine a list of potential partner institutions which will complement and raise the research quality of the institute thus competitiveness within EU institutions. By joining forces it will be possible to cover more research directions; (*Metrics: How many potential research directions from fields of smart specialization strategy are covered by the list of potential partners*)

[STA3] Develop a plan of achieving research capability in these research direction either by joining the forces with specific other institutions or by developing the new potential research directions within the institute. (*Metrics: The plan is ready. potential funding - next period ERDF for institutional development*)

Chapter 2

Plan for participation in H2020 calls and other research and innovation support programmes and technology initiatives

2.1 Introduction and long term vision

As outlined in the introduction of IECS Research programme for years 2015-2020, IECS must increase its participation in *Horizon 2020* and other research and innovation support programmes and technology initiatives, since it is crucial for IECS sustainability. In order to do that and thereby increase the knowledge, skills, technical resources, scientific excellence and other resources of the institute, bringing IECS closer to the fulfilment of long term goals (see Section 1.1), IECS has developed a long term vision as well as mid-term and short-term plans (see Section 2.2) for participation in research and innovative support programmes and technology initiatives.

In order to reach long term goals ([LTG1]-[LTG3]), IECS long term vision (over year 2020) is to become one of the key partners in the consortium's and projects not only in the European Union level, but also, on global level, working together in projects with partners from USA, Japan and South-east Asia as well as from other regions. This includes strong and trustful collaboration with a) the most excellent universities, such as University of Edinburgh, Universität Wien, Imperial College London, Osaka University, University of Pittsburgh etc. b) top Research and Technology Organizations, such as, Infineon, VTT, TNO, IMEC, Fraunhofer, etc., and c) biggest industry *players*, such as Philips, Siemens, Daimler, STMicroelectronics,

NXP, etc.Furthermore, in long term, IECS must be capable of organizing and writing ambitious project proposals as a coordinator in consortium with above mentioned and other partners. Thereby, the main long-term goal is:

[LTG2.1] The funding from international joint research projects is forming about 1/3 of the whole IECS research budget.

2.2 Medium term goals and short term actions

IECS has already proved itself to many local and international partners as a reliable, trustworthy and capable partner through several successful projects. These partners includes such research intensive organizations as Imperial College London, Fraunhofer, AVL List, VTT, Infineon, Indra, Tecnalia, HI Iberia and many more.

But, to take one step further and fulfill the long-term vision (see [LTG2.1]) and meet the overall medium term goals ([MTG1]-[MTG4]), IECS has developed a medium term plan for next 5 years and short term plan for next 1-2 years on how to increase the collaboration with existing and new partners as well as on how to increase the participation of IECS in *Horizon 2020* and other research and innovation support programme and technology initiative projects. This includes following medium term goals and corresponding short term actions (with control mechanisms):

[MTG2.1] IECS employees are regularly informed about relevant (see relevant topics in Figure 1.4 and Figure 1.5) up-coming *H2020* and other research and innovation support programme and technology initiative calls and know all the specifics about these programmes. (*Metrics: How many informative e-mails/seminars about upcoming calls have been send/organized; Result: 6 e-mails per year, 2 seminars per year*) Reaching of this goal requires following short-term actions:

[STA2.1] IECS will continue to maintain contact with relevant National Contact Point (*NCP*) persons (e.g, for ICT, Health, Transport, Security and Space activities), in order to stay informed about latest news, calls, etc., as well as to have direct and fast access for consultations. This includes exchange of e-mail, direct visits and organization of seminars; (*Metrics: How often we receive information from NCP; Result: 12 e-mails per year, 1 seminar per year*)

[STA2.2] IECS assigned person will a) continue to follow-up on the relevant upcoming *H2020* (including *ERA-NET*, *ECSEL*, etc.) and other research and innovation support programme and technology initiative calls, such as *COST*, *EUREKA*, *BONUS*, *The EEA grants and Norway grants* etc.; b) collect information from NCPs; and

disseminate this information, through e-mails and seminars, to researchers on a regular basis; (*Metrics: How many informative e-mails/seminars about upcoming calls have been send/organized; Result: 6 e-mails per year, 1 seminars per year*)

[MTG2.2] IECS employees are regularly informed and will take part in relevant up-coming conferences, exhibitions, information days, brokerage and F2F events and other meetings/events, where is possible to not only maintain a good relationship with the existing contacts from academia and industry in order to increase the number of reassert projects, but most importantly - acquire new and valuable contacts for future projects, thus creating knowledge network. (*Metrics: How many events visited; How many new contacts established; How many reassert projects submitted; Result: 10 new contacts per event; 2 reassert projects submitted per year*)
Reaching of this goal requires following short-term actions:

[STA2.3] Assigned persons will continue to follow-up on the relevant upcoming conferences, exhibitions, information days, brokerage and F2F events and other meetings/events, and will inform other employees on a regular basis; (*Metrics: How many informative e-mail about upcoming events have been send to staff; Result: 24 per year*)

[STA2.4] IECS researchers will continue to disseminate their and also IECS overall research results in a) world's top conferences, b) exhibitions, c) EU organized information days, d) brokerage and F2F events and other meetings/events. For example, IECS researchers in the near future will take part in: 1) *ICT 2015 Innovate, Connect, Transform* event on 20-22 October 2015 in Lisbon, Portugal; 2) *Info Day, Horizon 2020 - 'Health, demographic change and wellbeing* event on 18 September 2015 in Brussels, Beligum; 3) *ICT, biotechnology and nanotechnology* EEN Brokerage Event on 15 October 2015 in Ostrava, Czech Republic. (*Metrics: In how many events participated; How many new contacts established; in how many consortium's IECS was invited; Result: 15 new contacts per event; involvement in 1 new project consortium after each event*)

[STA2.5] In order to inform IECS employees about all IECS research directions and progress in each of them, so every employee can properly present IECS competencies in different events, thereby increasing collaboration possibilities, IECS will continue to organize informative seminars and develop leaflets, which will present latest progress in one or more IECS research directions; (*Metrics: How many seminars organized; How many leaflets developed; Result:*

3 seminars per year; 1 new leaflet per year)

[MTG2.3] IECS researchers have established a) new national contacts from industry; and b) new international contacts from several top universities, RTOs and industry companies, and are able to use them for project writing purposes. (*Metrics: How many new contacts with different institutions established; How many joint projects submitted; Result: 5 cooperation agreements per year; 5 joint project proposals per year*)
Reaching of this goal requires following short-term actions:

[STA2.6] At least once a year, IECS will inform local industry, through associations which are in our field (e.g. LETERA, LIKTA), about their possibilities to participate in different EU research programs and how they can collaborate with IECS in joint projects. Besides that, IECS researchers will also inform local universities (UoL, RTU, etc.) about collaboration possibilities; (*Metrics: How many new SME's attracted to projects and how many joint projects submitted/implemented; Result: 2 per year*)

[STA2.7] IECS employees will actively use different partner search tools, such as *CORDIS*, *Ideal-ist*, *LinkedIn*, *NCP Networks*, etc., in order to find partners for our own consortium's as well as to join other consortium's; (*Metrics: How many partner search applications have been registered; on how many partner search applications we have responded; Result: IECS has registered or responded to 8 search applications per year*)

[STA2.8] Preparations will be made to start organizing an international brokerage event in IECS in a few years, bringing together researchers and representatives from industry from whole Europe with the aim of making IECS more visible and recognized in the international level. (*Metrics: Are preparations done; Result: Yes/No*)

[MTG2.4] IECS researchers are highly motivated, have all the necessary infrastructure and are capable to write and coordinate project proposals for *H2020* and other research and innovation support programme and technology initiative calls. (*Metrics: How many project proposals submitted; Result: in average, 10 per year*)
Reaching of this goal requires following short-term actions:

[STA2.9] IECS will organize educational seminars/workshops on how to write project proposals for different calls; (*Metrics: How many seminars/workshops have been organized; Result: 2 per year*)

[STA2.10] IECS will use possibilities to send employees to proposal witting courses. The gained knowledge will be shared with IECS staff af-

terwards; (*Metrics: How many courses have been visited; Result: 1 per year*)

[STA2.11] Employees with experience in proposal writing will consult, support and share their experience (success stories) to those, who are writing project proposal for the first time; (*Metrics: How many consultations were held; Result: 36 per year*)

[STA2.12] The rules of annual evaluation of researchers are supplemented with new section, which gives additional points for writing international projects (which are evaluated above threshold), thus motivate IECS researchers, since their base funding depends on the amount of gained points. (*Metrics: How many employees are involved in project writing; Result: 20*)

[STA2.13] Based on particular call topic, IECS will assign responsible persons, who will organize a work, with the aim - submit a proposal related to particular application area [APL1]-[APL7]. (*Metrics: How many calls have been released in particular topic and how many proposals were submitted by IECS in this application area Result: 1 project proposal per one relevant call*)

[STA2.14] An internal document repository is created. It consist of previously written project documents, general materials about IECS, templates, tips, etc; (*Metrics: Is document repository created? How often it is updated; Result: created: Yes/No; updated 4 times per year*)

Chapter 3

Knowledge and technology management

3.1 Introduction

The main role of any scientific institute is to research (create knowledge from money), and in the case of applied research institutes, such as IECS, it is to create knowledge and technologies useful for innovation (creating money from knowledge). This general cycle of money and knowledge is seen in figure 3.1. For an institute to be viable, in the long run it has to add value to this cycle. This value is added by efficiently managing the key resource of the institute - knowledge (including intellectual property), thus generating competitive advantages and substantially increasing effectiveness. Because of this, efficient knowledge and technology management is critical for the viability and long term sustainability of the institute.

Because technology itself can be thought of as information (knowledge) of how specific knowledge can be applied for practical purposes, in the context of this section, unless stated otherwise, statements which apply to knowledge management also apply to technology management.

3.2 Analysis of knowledge

Before a knowledge management plan can be devised, the knowledge itself and its interaction with the institute should be analyzed.

Knowledge within the institute can take one of two forms:

- Tacit knowledge - this is the knowledge and experience possessed by individual people, which is not immediately accessible to others, because it might be hard do formalize and, therefore, communicate;
- Explicit knowledge - this is formal and systematic knowledge, usually stored as some kind of publication, written communication or infor-

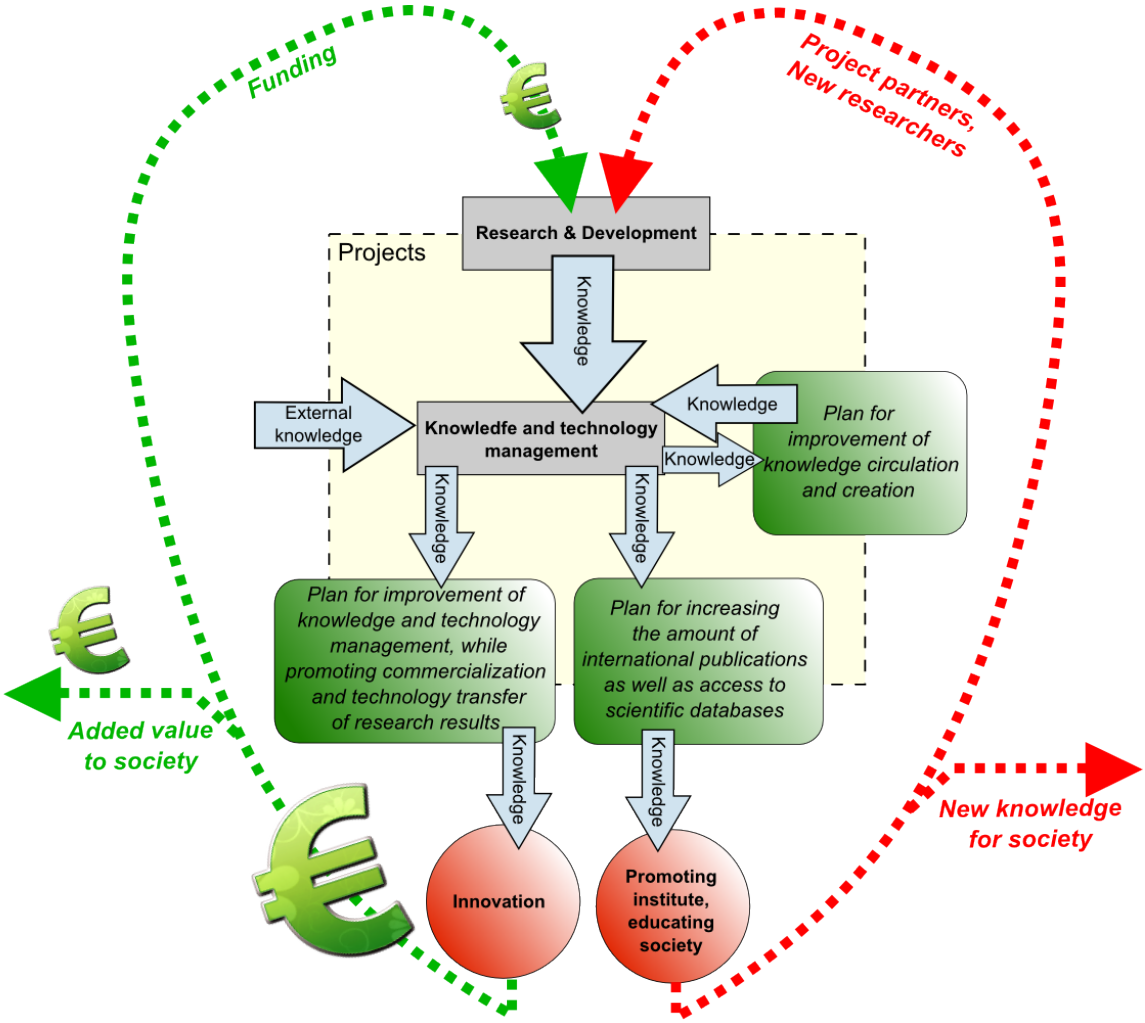

Figure 3.1: Schematic of finance and knowledge interaction with the institute

mation in IT systems. This kind of knowledge is easily accessible to others, but there is some effort involved to internalize and apply it in research.

Knowledge flow (as illustrated in figure 3.2) consists of four parts:

[A] Input - a new knowledge arrives at institute. This includes:

- [A1] Tacit knowledge in the form of previous experience by employees (either from past projects in institute or some other source);
- [A2] Explicit knowledge in the form of publications by external parties, such as journal articles, conference proceedings or some other

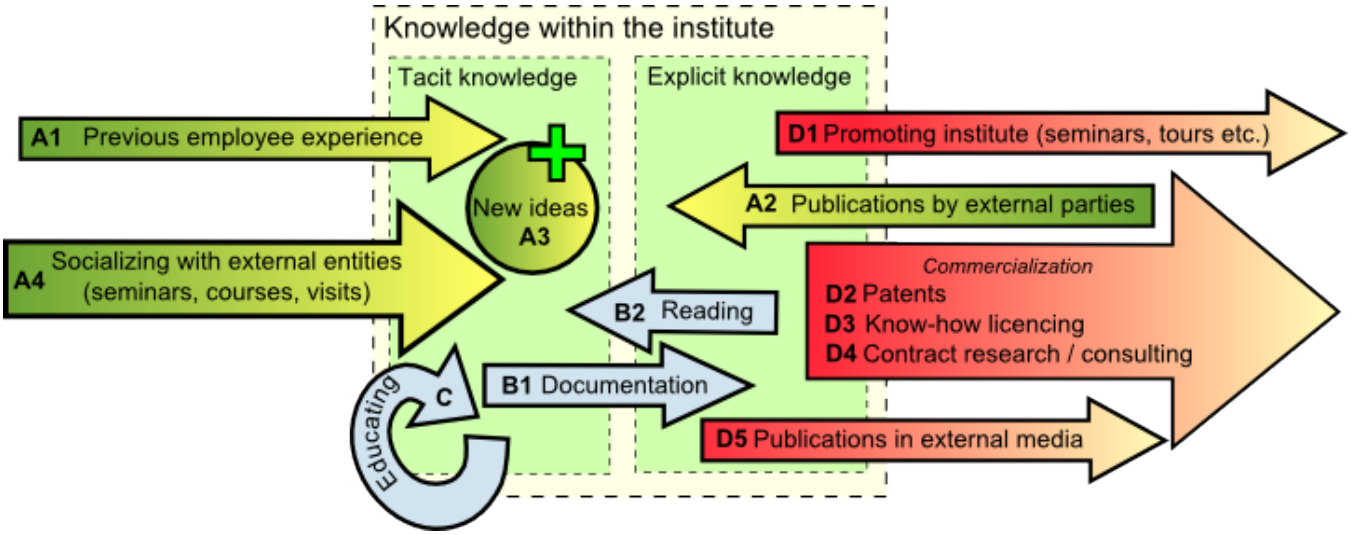

Figure 3.2: Schematic of knowledge flow within the institute

kinds of technical or even popular publications.

[A3] New tacit knowledge is born in the mind of a researcher as an idea at the moment, when existing tacit knowledge in the mind of the researcher combines with the newly acquired tacit knowledge (This usually happens during research, work in the research projects and/or tacit knowledge exchange such as internal seminars).

[A4] Tacit knowledge in the form of exchange of experience (socializing) with other entities, such as universities, institutes and/or companies. This can take place as seminars, joint projects or knowledge exchange visits, where our researchers meet people from these entities and exchange their tacit knowledge, thus learning new knowledge and bringing it to the institute.

[B] Transformation - one type of knowledge is turned into another kind of knowledge:

[B1] Tacit knowledge is turned into Explicit knowledge by documentation - this includes writing of publications, reports, patents, internal articles, memos, etc. (Note: this process just prepares publications and patents not publishes them).

[B2] Explicit knowledge is turned into Tacit knowledge by reading publications and internalizing their contents.

[C] Educating - when person who has some tacit knowledge spreads it to other people. This usually happens in form of internal seminars, briefings or just general socialization.

[D] Output - the knowledge is made available to the external world to promote the goals of the institute:

- [D1] Tacit knowledge is spread to external entities (companies, public administration, general public, students etc.) through external seminars, tours, presentations, speeches, lectures, etc. thus creating a knowledge network. This benefits the institute by exchanging knowledge for its recognition, allowing to increase the influence institute has, promoting its capabilities, finding new customers or research partners, lobbying for more beneficial laws or regulations, or educating potential future employees;
- [D2] Explicit knowledge (technology) is patented and potentially sold in the form of intellectual property to existing or spin-off businesses making innovative products based on this technology. This benefits the institute by trading knowledge for funding, providing funds for future work;
- [D3] Explicit knowledge (technology) in the form of know-how (intellectual property) is licensed to businesses or used in establishing spin-off companies, who then make innovative products based on this technology. This benefits the institute by trading knowledge for funding, providing funds for future work;
- [D4] Tacit knowledge (experience) is sold to businesses in the form of contract research or consulting, allowing these businesses to make innovative products based on this experience. This benefits the institute by trading knowledge for funding, providing funds for future work;
- [D5] Explicit knowledge is published in external media, such as scientific journals, conference proceedings etc. including providing access to the outcomes of the research for the general public (Open Access). This benefits the institute by trading knowledge for scientific recognition, thus allowing to find better research partners, attract more valuable employees as well as attract more research funding by proving our experience and excellence in the scientific fields.

For the institute to function properly each of these knowledge flows must be managed, and this management should be based on specific plans, so that the knowledge management can be monitored and mindfully improved according to priorities. Further subsections of this document will contain specific plans addressing important parts of these knowledge flows comprising the core of knowledge and technology management plan.

3.3 Plans for management of knowledge and technologies

3.3.1 Plan for improvement of knowledge circulation and creation

Introduction and long term vision

One of the most valuable types of knowledge for the institute is the tacit knowledge of individual researchers, because it can be directly applied to research problems. This plan is concerned with generating and circulating this tacit knowledge in a way beneficial to the institute as well as attracting people from the outside with additional tacit knowledge.

To generate, circulate and attract tacit knowledge in the long term it is important to work towards these long-term goals:

[LTG3.1] Institute regularly attracts new talent ([A1]) as well as educates existing employees ([A4]) with tacit knowledge benefiting its long term goals;

[LTG3.2] Regular knowledge transfer among employees takes place in the institute facilitating more efficient knowledge utilization and generation of new ideas ([A3]).

Medium term goals and short term actions

In order to reach long term goals of knowledge circulation ([LTG3.2]) and creation ([LTG3.1]) specific medium term goals and short term actions (with control mechanisms) were developed:

[MTG3.1] Institute is (and is seen as) a desirable work place for potential future employees ([D1]) thus providing societal impact on students and pupils (*Metrics: How many students are attracted to work in the institute, how many public events and mass media appearances IECS participates in and how many visitors/followers are recorded on IECS online presence tools; Result: Number of new employees supports 10% annual expansion rate of research staff, 2 public events per year, 3 mass media appearances per year, 10% annual increase in online visitors*)
Reaching of this goal requires following short-term actions:

[STA3.1] Develop and attract students from universities through targeted co-operation measures described in Chapter 5;

[STA3.2] Regularly organize or participate in public events, such as Researcher nights, annual IECS day, exhibitions, seminars, sports and entertainment events etc. showing institute as an attractive workplace for young researchers with potential to grow thus providing societal impact;

[STA3.3] Cooperate with mass media on regular basis to provide societal impact both by popularizing IECS itself and science and engineering as a whole;

[STA3.4] Keep institute online presence up to date allowing for greater societal impact, with regular information about latest achievements and research life in general. This includes updating IECS social media accounts (Facebook, Twitter) and IECS web page (www.edi.lv) including web pages of specific projects.

[MTG3.2] A motivation and opportunity for future education ([A4]) of existing research staff be provided. (*Metrics: How many external knowledge exchange/socializing events have research staff participated in, how many scientific events have research staff participated in; Result: 25% of researchers annually participate in external knowledge exchange events; 50% of researchers annually participate in scientific events*)
Reaching of this goal requires following short-term actions:

[STA3.5] Regularly send employees to other institutions for knowledge exchange/socializing activities ([A4]), as described in targeted cooperation measures in Chapter 5;

[STA3.6] Regularly send employees to symposiums, conferences, seminars, workshops, exhibitions and courses ([A4]). Some of these activities are described in section 3.3.2 and section 2.

[MTG3.3] Access to all valuable explicit (written) knowledge within the institute must be facilitated by storing it, and providing guidelines on how to generate and consume it (*Metrics: An online system is upgraded and accessible to all employees, How many items of information are documented and stored in the knowledge storage system; Result: A system is developed, at least 2 fully formatted knowledge units per researcher annually*)
Reaching of this goal requires following short-term actions:

[STA3.7] An online system for storing and accessing knowledge, such as publications, source code, schematics and other documentation will be upgraded and accessible for all IECS employees thus promoting reading of written information ([B2]);

[STA3.8] Employees will be encouraged to document their knowledge and store it in the online knowledge system, both by motivating them through the rules of annual evaluation of researchers and educating them on how to best format and document their knowledge, so that it is easy to access by other employees, thus promoting documenting of experience ([B1]).

[MTG3.4] All valuable tacit knowledge must be regularly distributed among employees through internal seminars etc. (*Metrics: How many internal seminars are held; Result: at least 1 seminar per project annually*) Reaching of this goal requires following short-term actions:

[STA3.9] Regular internal seminars will be organized whenever there are major steps achieved in research projects as well as for general education of other employees in fields they might not be familiar with, but which could become handy in their research work. Also regular informal events encouraging general socialization will be held and encouraged ([C]).

All of these measures will allow generation of even more new knowledge inside of institute, because whenever new knowledge arrives, there is a chance, that it can be combined with some of existing knowledge and result in creation of some completely new insights. Most of this knowledge "genesis" happens within projects through research, and projects themselves often support many of these goals, such as seminars for presenting project results.

3.3.2 Plan for increasing the amount of international publications in highly rated journals as well as access to scientific databases for increasing the efficiency of the scientific work

Introduction and long term vision

In order to reach the long term goals of the institute defined in this document it is important to disseminate and acquire knowledge through scientific publications. This section is concerned with access to existing scientific publications allowing to acquire more scientific knowledge, as well as publishing existing knowledge in highly rated scientific journals (including Open Access) promoting the scientific competence of the institute and thus attracting more high quality potential cooperation partners allowing to work on prestigious international projects.

To acquire access to the important scientific publications as well as to publish existing knowledge in highly rated scientific journals these long term goals were determined:

[LTG3.3] IECS employees have access to important scientific and other types of publications ([A2]) relevant to their research, thus increasing efficiency of their scientific work;

[LTG3.4] IECS maximizes the benefit from publishing knowledge in external media ([D5]), by selecting the most appropriate publication for each piece of knowledge.

Medium term goals and short term actions

In order to reach the long term goals of providing researchers access to publications relevant to their research ([LTG3.3]), and maximizing benefit from publishing knowledge in external media ([LTG3.4]) these medium term goals and short term actions (with control mechanisms) were determined:

[MTG3.5] IECS always provides employees access to most popular scientific databases, where most of relevant publications are indexed and available (*Metrics: How many relevant and used scientific databases are accessible to IECS researchers, A survey of required databases is held each year; Result: Researchers have access to all relevant scientific databases determined from survey, a survey is held every year*)
Reaching of this goal requires following short-term actions:

[STA3.10] the access to most popular scientific databases e.g. Science Direct, SCOPUS, IEEExplore will be continued;

[STA3.11] Each year an employee survey is held to determine the list of scientific databases that employees require access to and, this list is evaluated, to accordingly update list of databases provided in [STA3.10].

[MTG3.6] In cases, when a specific publication is required, which is not part of the popular databases mentioned in [MTG3.5], IECS has a procedure known by all employees for accessing these publications on a case to case basis (*Metrics: Guidelines for accessing required publications are available, Amount of funds spent on buying access to specific publications; Result: Researchers have access to guidelines on accessing required publications, amount spent on individual publications is managed so as not to surpass access cost to whole database containing such publications*)
Reaching of this goal requires following short-term actions:

[STA3.12] Guidelines for accessing required publications will be written and published in IECS internal network;

[STA3.13] In cases where it is impossible to acquire the specific publication without spending additional funds, scientific director of the institute will decide if and how IECS should allocate funds for paying for specific publication on case to case basis.

[MTG3.7] The number of publications in scientific journals with high impact (impact factor above 50% of the average in specific field), as well as access to the outcomes of the research for the general public (Open Access) by IECS researchers is increasing (*Metrics: Percentage of high impact publications and open access publications from all publications,*

updated rules of annual evaluation of researchers, number of employees informed on guidelines of producing high quality research publications; Result: on year 2020 percentages grow to 10% on average of all publications are in high impact journals and 20% on average of all publications are open access publications (at the moment IECS has 0.66 annual publications per full-time equivalent researcher and this number matches that required by long term goals[1] *but the percentage of high impact publications should be increased), rules of annual evaluation are updated, all researchers working in IECS for more than a year are educated on preparing high quality publications*)
Reaching of this goal requires following short-term actions:

[STA3.14] To increase the number of high quality research papers published in high impact journals, the research must be conducted in high quality international projects, acquired through measures described in Chapter 2;

[STA3.15] Employees are motivated to publish in journals with high impact and Open Access publications by giving additional points for such publications in the rules of annual evaluation of researchers;

[STA3.16] Employees will be educated on guidelines of preparing scientific publications which are of sufficient quality to be accepted for publishing in journals with high impact factor.

[MTG3.8] IECS has supporting measures in place assisting employees in publishing knowledge in the specific external media giving the most benefit of publishing the specific knowledge (*Metrics: How many internal seminars are held, list of preferred places of publication is available and up to date; Result: Internal seminars are held at least 10 times annually, list of preferred places of publication is available and updated annually*)
Reaching of this goal requires following short-term actions:

[STA3.17] regular internal seminars are held to discuss prospective publications with researchers, thus allowing others to suggest the appropriate place of publishing and give comments of content ([B1]) to improve chances of acceptance for publishing;

[STA3.18] A list of journals and conference proceedings recommended by the institute for publishing will be regularly updated. This list will be divided by fields of research and may include not only scientific journals and conference proceedings, but also other types of technical or even popular publications for publishing of certain types of information. At the moment recommended are IEEE Transactions on Signal Processing, and other IEEE Transactions

[1] Other RTO have similar amount of publications e.g. VTT has 2000 publications per 3000 researchers annually

on relevant topics to IECS, Elsevier Signal Processing, as well as such conferences as EUSIPCO, ICASSP, ICB, ICPR, IEEE ICIP, CPS Week etc.

[MTG3.9] IECS supports publications with co-authors located in other regions, because they strengthen international collaboration (*Metrics: How many publications of total publications are with co-authors located in other regions; Result: 10% of publications have co-authors located in other regions*)
Reaching of this goal requires following short-term actions:

[STA3.19] To increase the amount of co-authors from other regions it is important to work on international Twinning (Section 5) and international projects (Section 2) and work on publications together with these partners.

Publishing knowledge generated by the institute in an efficient and beneficial manner is important to find better research partners, attract more valuable employees, have greater societal impact as well as attract more research funding by proving our experience and excellence in the scientific fields.

Unrestricted access to relevant external publications is important for scientific work, because in all research state-of-the-art must be considered, so as not to spend valuable resources on reaching research results already reached by others.

3.3.3 Plan for improvement of knowledge and technology management to promote commercialization and technology transfer of research results

Introduction and long term vision

For long term development of the institute it is critical to acquire sufficient funding. This means promoting innovation, commercialization and gaining of economic benefit. The most sustainable form of funding in the long run is funding from commercialization and technology transfer. This section is concerned with improvements of knowledge and technology management to facilitate this form of funding research.

To support achievement of long term goals of the institute through funding from commercialization and technology transfer, as well as to increase the innovation capability of the Latvia [LTG3] the following long term goals were determined:

[LTG3.5] Institute develops its research results in such a way that they are ready for commercialization or technology transfer ([D2][D3][D4]) (with the exception of results published in scientific publications - [D5]);

[LTG3.6] Institute attracts potential customers, commercialization partners and inform public through such societal impact measures as external seminars, tours, presentations, speeches, lectures, etc. ([D1]) maximizing the market for technologies developed by IECS through recognition of them in industry and end-user communities, as well as using for that support from public administrations;

[LTG3.7] To contribute to total Latvian innovation level [LTG3] as well as to commercialization and technology transfer needs of the institute by supporting innovation beyond measures mentioned in [LTG3.5] and [LTG3.6], such as creation of spin-off companies etc.;

Medium term goals and short term actions

In order to reach the long term goals of preparing research results for commercialization [LTG3.5], informing potential partners and society in general [LTG3.6], rising overall innovation level of Latvia [LTG3.7] these medium term goals and short term actions (with control mechanisms) were determined:

[MTG3.10] Number of patents (fit for commercialization) held by IECS must be increased ([D2]) so that they can be sold or licensed for commercialization (*Metrics: How many patents are held by IECS; how many researchers are comfortable writing patents, rules of annual evaluation of researchers benefit writing patents; Result: 0.1 patent per full time equivalent annually, every researcher employed for more than a year is comfortable writing patents, rules of annual evaluation of researchers favor writing patents.*)
Reaching of this goal requires following short-term actions:

[STA3.20] Educate IECS employees on benefits and key elements of development of patents - how to do a patent search, how to write ([B1]) and prepare patent and how to submit different level patents;

[STA3.21] Continue to motivate employees to patent their research results by giving additional points for patents in the rules of annual evaluation of researchers.

[MTG3.11] Knowledge that is not appropriate for patenting but has commercialization potential should be formed as know-how ([D3]) ready for commercialization/technology transfer (*Metrics: Number of technologies prepared in the form of know-how for commercialization and technology transfer, rules of annual evaluation of researchers benefit well prepared know-how; Result: Each project not resulting in a patent results in at least one well formulated know-how, rules of annual evaluation of researchers benefit well prepared know-how.*)
Reaching of this goal requires following short-term actions:

[STA3.22] Educate researchers on benefits and key elements of preparing know-how for commercialization and technology transfer - preparing a document and prototype (if applicable) ([B1]), separate the know-how for commercialization from knowledge for scientific publishing etc.;

[STA3.23] Motivate employees to prepare their research results as know-how for commercialization and technology transfer through spin-offs and other companies by giving additional points for such prepared know-how in the rules of annual evaluation of researchers.

[MTG3.12] Amount of contract contract research and consulting services by the institute should be increased ([D4]) (*Metrics: The amount of contract research and consulting projects, are internal guidelines developed; Result: at least 2 contract research and consulting projects annually reaching approximately 20% of total IECS finances, Internal guidelines for providing contract research and consulting services are developed*)
Reaching of this goal requires following short-term actions:

[STA3.24] Contract research and consulting capabilities of institute must be promoted to potential customers through events described in [MTG3.13] and [MTG3.14] as well as targeted co-operation measures described in Chapter 5;

[STA3.25] Develop internal guidelines for providing contract research and consulting services, describing procedure, pricing etc. thus allowing employees faster access to this information in cases where opportunity for such projects arises.

[MTG3.13] Organize seminars, tours, speeches etc. in the institute, and invite key representatives to these events (*Metrics: How many key persons and/or institutions are identified, how many such events are organized; Result: at least 10 key research institutions and 10 industry representatives should be identified, at least 5 such events annually must be organized*)
Reaching of this goal requires following short-term actions:

[STA3.26] Organize internal discussion to identify key persons and/or institutions that should be targeted through social events. Some of the most important key institutions are identified in Chapter 5 about targeted co-operation;

[STA3.27] Organize seminars, tours, speeches, similar to those in [STA3.2] but targeted at key persons/organizations identified in [STA3.25]. Specific examples of these events are discussed in the Chapter 5 about targeted co-operation.

[MTG3.14] Offer presentations, speeches, lectures etc. at key institutions and key events organized by other parties (*Metrics: How many key events are identified, how many such talks are given; Result: at least 3 key events every year, at least 5 such talks are held annually*)
Reaching of this goal requires following short-term actions:

[STA3.28] Organize internal discussion to identify key events in which presentations, speeches, lectures etc. should be held by IECS employees to promote the institute as a potential partner;

[STA3.29] Offer to hold presentations, speeches, lectures at key institutions identified in [STA3.25] and key events identified in [STA3.27]. Some specific examples of such targeted informing are discussed in the Chapter 5 about targeted co-operation.

[MTG3.15] Develop innovation support infrastructure, allowing for more rapid technology transfer through spin-offs etc. (*Metrics: Progress of development of technology transfer facilities, how much space is planned for situating start-ups and spin-offs in the facilities of the institute, how many companies are identified as potential candidates for locating their divisions in the territory of IECS; Result: Technology transfer facilities are developed, at least one floor of building C is dedicated to placement of spin-offs and start-ups, at least 3 companies are identified*)
Reaching of this goal requires following short-term actions:

[STA3.30] start preparation work for development of technology transfer facilities, planning renovation of infrastructure required (see Chapter 4), as well as potential structure and working guidelines;

[STA3.31] start preparation work for development of space for start-up and spin-off companies, planning renovation of infrastructure required (see Chapter 4);

[STA3.32] lay groundwork for attracting R&D sections (or parts of them) from key innovative companies to the facilities of IECS, in the long term allowing for better cooperation and faster technology transfer. First step is to identify these potential companies. (see Chapter 4);

[MTG3.16] Lobby sustainable innovation development and IECS vision of the technology development [LTG1] in public administration and regulatory institutions, as well as professional organizations (*Metrics: How many key groups are identified, how many such groups are in regular communication with IECS employees; Result: at least 3 key groups are identified, IECS employees are in regular contact with all identified key groups*)
Reaching of this goal requires following short-term actions:

[STA3.33] Organize internal discussion to identify key groups capable of changing laws, regulations and general innovation landscape in the direction envisioned in IECS long term vision;

[STA3.34] Lobby sustainable innovation development and IECS vision of the technology development [LTG1] in key groups identified in [STA3.32] either through visits or participation in the work of these groups. Some specific examples of such targeted informing are discussed in the Chapter 5 about targeted co-operation;

As commercialization and technology transfer is key to reaching long term goals of the institute, this problem must be approached with serious measures and from several directions. In addition to measures described in this section, also measures described in other sections about knowledge management and section about targeted co-operation contribute to this goal, thus allowing to increase the influence institute has on external world, promoting itself, finding new customers or research partners, lobbying for more beneficial laws or regulations, or educating potential future employees - resulting in greater research and innovation capability overall.

Chapter 4

Research infrastructure development plan

4.1 Introduction and long term vision

During the last several years the infrastructure of the institute is considerably upgraded, thus basically the equipment is of high standard. International experts evaluated[1] "State of the art equipment is available for fast data acquisitions, analysis and computing at the Institute". However, there are some complaints about shortages or missing components. Therefore the first aspect related to research infrastructure development plan is the continuous renewal of equipment that is required due to the rapid development of technologies. This is especially important for computing equipment and thus, it has to be foreseen that all computing equipment has to be renewed approximately every 5 years. This applies to hardware and software. Having in mind limited financial resources, Research infrastructure development plan is based on definition of certain limited priorities, reflected by the strategic directions chosen, and well balanced with other strategic activities.

In general, infrastructure development is divided in 3 categories:

- Buildings infrastructure;
- Laboratory infrastructure including measurement and test equipment;
- Support infrastructure including prototyping and computing facilities.

Each of these categories correspond to a long term goal:

[LTG4.1] Buildings and surrounding territory infrastructure is renovated, be energy efficient and suitable for all IECS activities, such as everyday research, technology transfer and hosting of events;

[1] http://www.izm.gov.lv/images/zinatne/ZISI/zisi_05.pdf

[LTG4.2] Laboratory infrastructure is kept up to date, it is open to partners and is sufficient for achieving IECS research goals as laid out in the research program - all research and technical staff is equipped with necessary up-to-date laboratory equipment;

[LTG4.3] Support infrastructure (including prototyping and computing) is kept up to date and in sync with the research priorities of the institute, as well as ensure cooperation with partners from academia and industry on open access basis.

4.2 Medium term plan and short term activities

4.2.1 Buildings infrastructure

Regarding the [LTG1] and buildings and surrounding territory, the Institute has a campus of four connected buildings (A, B, C and D) as seen in Figure 4.1.

The building B, where research laboratories and technical staff are located, is fully renovated. The research groups and technical staff have currently enough space (about 25 sq.m. per person) and therefore personal could still grow up to 1.5 times without the need for new renovated space. The building A, where administrative and publishing staff is located as well as meetings and representative events are held, is only partially renovated. International experts suggested that this is the next building that should be renovated. The most urgent work is thermal insulation and repairs for representative purposes. At the moment some of the rooms have been renovated including auditorium for approximately 60 people with all necessary equipment. This provides an excellent place for meetings and videoconferences and is important for seminars and workshops. To completely satisfy requirements for organization of events described in the research program which are important for building up knowledge network of the Institute, the conference hall with up to 250 participants and surrounding facilities have to be renovated. This includes following medium term goal and corresponding short term activities:

[MTG4.1] Building A satisfies requirements to fulfill the research program; Reaching of this goal requires following short term actions:

- [STA4.1] Complete renovation and equip the conference hall and surrounding facilities. (Financial source: ongoing projects; indicator: conference hall and surrounding facilities are completed);
- [STA4.2] Thermal insulation of building A and renovation of administrative facilities. (Potential financing sources: ERDF 2014-2020 activities “R&D infrastructure” and “Improvement of institutional

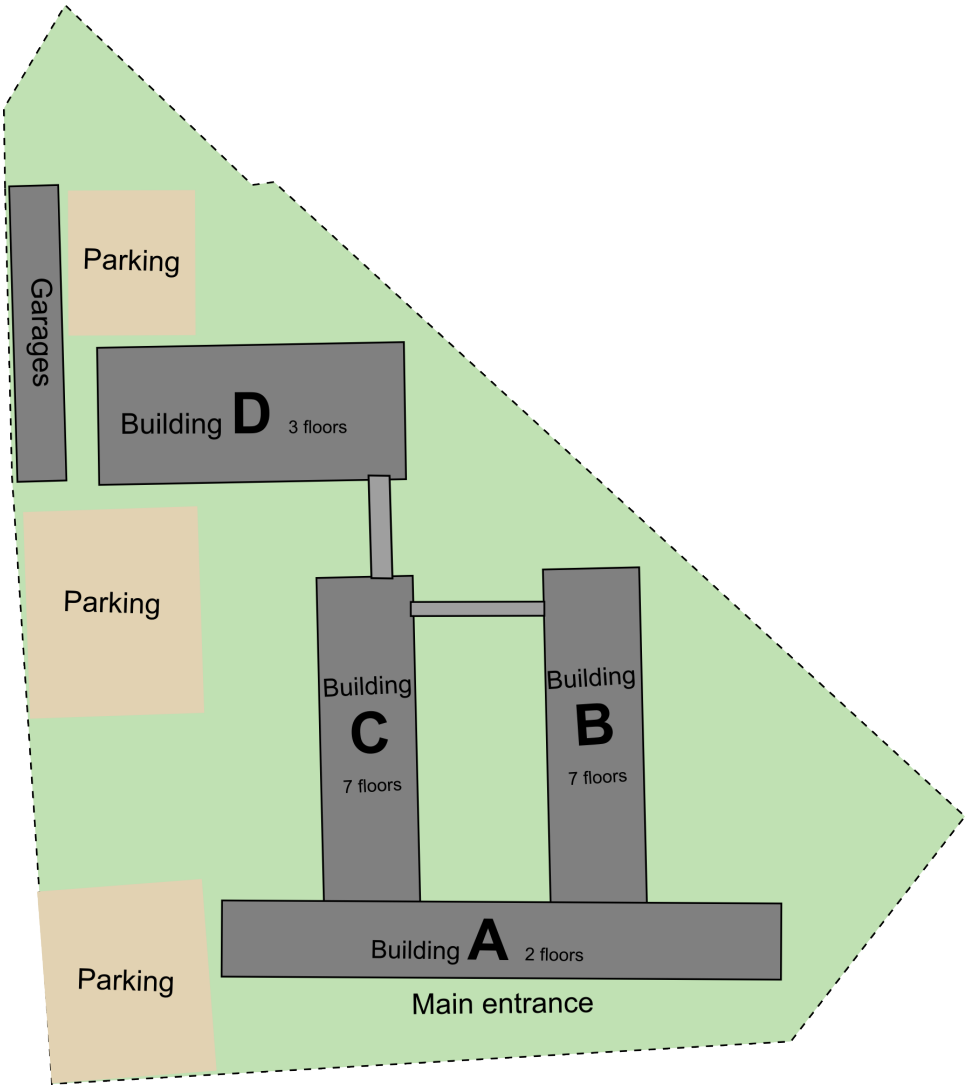

Figure 4.1: Schematic of the buildings and territory infrastructure of the IECS

excellence" with co-financing from the Institute; indicator: building A is renovated and energy efficient).

In the second floor of the C building, which is directly connected to the administrative facilities in building A, it is planned to house technology transfer facilities including space for spin-offs as described in section 3.3.3, thus these facilities have to be renovated in the medium term. In addition whole building C requires improvement in thermal insulation. The similar situation is with the building D, which is built for a piloting, and now requires a considerable renovation and vision for further utilization. In the

long term it is planned establish facilities for prototyping and small volume production of developments of the institute in the building D.

This includes following medium term goals and corresponding short term actions:

[MTG4.2] Building C satisfies requirements to fulfill the technology transfer activities of the research program. Short term action is:

[STA4.3] Renovation of second floor of building C. (Potential financing source: ERDF 2014-2020 activity "Technology transfer" with co-financing from the Institute; indicator: Second floor of building C is renovated and energy efficient);

[MTG4.3] Future utilizing of IECS premises is approved by Advisory board of the IECS. Short term action is:

[STA4.4] Plan for renovating, thermal insulating and utilizing of buildings C and D. (Potential financing source: ERDF 2014-2020 activities "R&D infrastructure" and "Improvement of institutional excellence", indicator: prepared, discussed and accepted plan.).

4.2.2 Laboratory infrastructure

Regarding the [LTG4.2], laboratory infrastructure is reasonable to divide between workplace, standard test and measurement equipment and specialized (and high cost) equipment.

For the standard infrastructure the equipment should cover the conventional equipment ranges, like a frequency range up to 1GHz. However, specialized measurement equipment is far more expensive, and a clear strategic choice has to be made taking into account priority research directions selected in Section 1.2.2. Equipment has to fulfill the needs and ambitions expressed in the research program. Taking into account limited financial sources and that existing equipment mostly is sufficient for the purposes of the selected research fields, only two priorities are selected for specialized infrastructure - 60GHz frequency range equipment (in possible cooperation with industry) to ensure [PRD2] goals and development platform for electrical vehicles to ensure [PRD4] goals.

A special attention is planned for further development of wireless sensor and Wi-Fi network, ITS and security solution video surveillance test-beds located in the buildings and surrounding territory of the institute. In the short and middle terms, there is no necessity to purchase new equipment for this, while in long term maintenance of the test-beds should be covered by the revenue from their services. Taking into account above mentioned the following medium term goals and corresponding short term actions are defined:

[MTG4.4] Complementary to the recently established 25 modern researcher workplaces new workplaces are established and researchers are provided with up-to-date conventional equipment and with development kits and environments.

[STA4.5] Preparation and implementation of R&D infrastructure improvement project, which provides new researcher workplaces (furniture, PC, power supply, soldering station, tool kit etc.), conventional equipment (oscilloscopes, generators, analyzers etc.), development kits (for embedded system design based on FPGA, SoC, microprocessor etc.) (Potential financing sources: ERDF 2014-2020 activity "R&D infrastructure" and research projects (H2020, National research program etc.); indicators: at least 25 a newly created researcher workplaces, at least 45 new devices of conventional measurement equipment, at least 10 new development kits).

[MTG4.5] Specialized equipment is completely sufficient for the purposes of the all selected fields of research.

[STA4.6] Project preparation and implementation for specialized equipment modernization, including 60GHz equipment and development platform for electrical vehicle (Potential financing source: ERDF 2014-2020 activities "R&D infrastructure" and "Competence centers"; indicator: sufficient equipment for [PRD2] and [PRD4] needs).

[MTG4.6] Extended functionality of test-beds is offered to internal and external users and included in network of test-beds

[STA4.7] Development, validation and demonstration of test-beds use-cases for WSN applications (FP7 project DEWI and national research programs SOPHIS and EVIDENT), for ITS V2V and V2I applications (program SOPHIS, H2020 project 3Ccar), video security solutions (program SOPHIS) (Financing sources: research projects, indicator: at least 4 use-cases are demonstrated and offered for users).

4.2.3 Support infrastructure

Regarding the [LTG4.3], two main groups are support infrastructure for prototyping and computing needs. Taking into account the vision of the institute to play a crucial role for an industrial growth towards a high-tech society in Latvia [LTG3] and provide the high tech competence that is lacking in the industry, particular attention needs to be paid to further development of prototyping and piloting infrastructure. Development of

this infrastructure is planned in coordination with co-working place ("hackerspace") MakeRiga[2], which is located in the premises of the institute.

For an institute with ambition to be well recognized as ICT center, the availability of computing power is a must. Recently in the IECS is established data center which includes access point of Latvian NREN 10Gbps core network, HPC with 12x16 CPU cores and 12 Tesla K40c cards each with 2880 GPU cores as well as virtualization and other servers. Computing infrastructure also includes necessary software packages (MATLAB, SIMULINK, ArcGIS, SolidWorks etc.). At the moment computing power and functionality is already sufficient to support all priority research direction, however it needs to be up-to-date in the long term as well.

Based on this information the following medium term goals and corresponding short term actions are defined:

[MTG4.7] Prototyping equipment is updated to be sufficient to support research priorities and ensure cooperation with partners from industry. Short term action is:

- [STA4.8] Preparation and implementation of the project (in possible cooperation with industry) for modernization of prototyping infrastructure such as equipment for Prototype stamping, Laser cutting, CNC Machining, Assembly, CMM inspection (Financial sources: ERDF 2014-2020 activities "R&D infrastructure", "Technology transfer" and "Competence centers"; indicator: at least 5 new prototyping devices).

[MTG4.8] Computing infrastructure is completely sufficient to support the purposes of the selected fields of research and maintained by sharing costs with partners who use it. Short term action is:

- [STA4.9] Development of plan for strategic and a financially healthy basis for the future of data center located in the premises of the institute by sharing costs with other research institutions (already are agreements with research institutes from "Teika" campus) and users outside the Institute. (Financing source: financing from the IECS; indicator: Established model for covering long term maintenance and renewal costs).

[2] makeriga.org

Chapter 5

Plan for cooperation with academia and industry (twinning plan)

5.1 Introduction and long term vision

According to the IECS long term vision the institute plays a crucial role in an industrial growth towards a high-tech society in Latvia [LTG3]. From one side it provides the high-tech competence that is lacking in the industry, but from other side it boosts the quality of the education of specialists in high-tech fields. In order to fill the gap between universities and industry (as shown in Figure 1.3), which is crucial for a sustainable growth and fulfillment of our long term goals [LTG1], it is necessary to form industry-academia partnerships to cooperate with all identified key institutions, such as higher education institutions (HEI), research institutions (RI), industry, public administration and other organizations (OO). A twinning plan is needed to manage these relationships efficiently, leading to fulfillment of the long term goals of IECS (note: some twinning actions are already described in other sections and will not be repeated here). Taking into account previously mentioned, several long term goals were determined:

[LTG5.1] To have a "win-win" cooperation with both Latvian and international Higher education institutions (HEI).

[LTG5.2] To have a close partnership with other research institutions (RI) in order to use research capacity more synergetic and efficiently.

[LTG5.3] To have a close cooperation with industry for facilitating the transfer of knowledge and developing of sustainable innovative technologies.

5.2 Medium term goals and short term actions

In order to reach the long term goals [LTG5.1] - [LTG5.3], the corresponding medium term goals (MTG) and short term actions (STA) and control metrics are determined:

[MTG5.1] To increase the involvement of students from HEI in research (*Metrics: How many visits to HEI are done, how many HEI students are employed in IECS projects, how many students develop their academic work at IECS, how many HEI students participate in IECS internships; Result: at least one visit a year to each of key HEI, at least 20 students are employed in IECS projects, at least 10 students work on their academic work, at least 3 interns annually*)
Reaching of this goal requires following short-term actions:

[STA5.1] At least once a year continue to visit local HEI (e.g. University of Latvia[1] (UoL), Riga Technical University[2] (RTU), Transport and Telecommunication Institute[3] (TSI), Ventspils University College[4] (VUC) etc.) and inform students about the opportunity to participate in IECS research, internship and development of their graduate theses;

[STA5.2] Promote employment of students for research in IECS by uniting their studies in HEI with scientific work in IECS, while planning finances that are required to support it in projects (Currently 20 PhD students are employed in IECS, approximately half of which are from UoL and half from RTU);

[STA5.3] Regularly update and distribute information in local HEI (such as UoL, RTU, VUC etc.) about subjects of graduate theses which are offered to students for development in IECS (Currently 10 masters/bachelor works are being developed by UoL, RTU and VUC students in IECS and these works are usually among the top ranked);

[STA5.4] Continue to organize and offer internships to students;

[MTG5.2] To improve cross cooperation with Latvian and international HEI by involving their professors with IECS and IECS researchers with HEI (*Metrics: How many HEI professors are involved in IECS consultative board, how many IECS researchers are involved with HEI study program boards and promotion boards, how many HEI key groups are identified and met on a regular basis, how many courses are red by*

[1] http://www.lu.lv/eng/
[2] http://www.rtu.lv/en/
[3] http://www.tsi.lv/en
[4] http://venta.lv/en/vuc/

IECS researchers; how many cooperation agreements with HEI involve joint study programs for doctoral students; Result: two professors from international HEI and two professors from Latvian HEI are involved in the work of IECS consultative board, at least one researcher in each of HEI, at least one group from each HEI, at least 5 courses annually, agreements with all of key Latvian HEI include joint study programs for doctoral students)
Reaching of this goal requires following short-term actions:

[STA5.5] Involve HEI professors in the work of IECS consultative board and in the work of IECS scientific council;

[STA5.6] Promote IECS employees in the work of HEI study program boards and promotion boards;

[STA5.7] Define which are the most relevant and potent groups and persons in HEI for the various fields of interest. Visit and invite these persons regularly to build up long-term relationships and find out their interests and needs. Offer them support with courses and internships by using research project funding from the Institute to support and attract PhD students. Also, establish practical cooperation by co-publications;

[STA5.8] Promote the capacity of IECS employees to deliver courses in HEI by gathering information about such potential courses and courses already red by IECS employees and distributing information about them on a regular basis. Once a week, organize and deliver study courses to HEI students in the premises of IECS;

[STA5.9] Develop joint study programs for doctoral students, fulfill and upgrade the cooperation agreements with UoL, RTU, VUC, TSI. (IECS currently has cooperation agreements with both local[5] and international[6] HEI).

[MTG5.3] To become a partner (leading for SECS, ICT) to other research institutions in consortia in national and international interdisciplinary R&D projects (*Metrics: How many partners have agreed to participate in consortia after invitation by IECS, does IECS manage national research programme, in how many research projects IECS participates as a partner;Result: more than 30% agree to participate after invitation by IECS, IECS manages national research programme, see chapter 2*)
Reaching of this goal requires following short-term actions:

[STA5.10] When writing Framework Programme and other project proposals (Chapter 2), invite other Latvian and international research

[5] e.g. UoL, RTU, VUC etc.

[6] e.g. Donbass State Technical University (Ukraine), Univeriste Joseph Fourier (France), Virginia University (USA), Aalesund University (Norway) etc.

institutions of appropriate profile to participate (especially if coordinating);

[STA5.11] Manage National research program in "Next generation ICT systems" (Currently IECS is leading National research program SOPHIS[7] and partnered with highly evaluated research groups from UoL faculty of computing and Institute of Atomic Physics and Spectroscopy, as well as groups from RTU such as faculty of computer science and information technology, institute of telecommunications and water research laboratory);

[STA5.12] Participate in multidisciplinary research projects as partner providing SECS and ICT competences, cooperate within the European Innovation Partnership on Smart Cities and Communities (Currently IECS participates in several international multidisciplinary research projects, examples of which are described in the section 1. Also local multidisciplinary project State research program EVIDENT[8] must be mentioned).

[MTG5.4] To exchange resources (to share infrastructure) with other RI outside of research projects (*Metrics: How many research institutions have used IECS research infrastructure, How many IECS staff members are currently in employee exchange programs with other research institutes; Result: The number of research institutions using IECS research infrastructure grows by 10% annually, at least one researcher at any given time participates in employee exchange programs*)
Reaching of this goal requires following short-term actions:

[STA5.13] Manage usage of IECS research infrastructure by offering it to other research institutions (see [LTG4.3] and section 4.2.3 in Chapter 4);

[STA5.14] Facilitate exchange of staff with other research institutions both for short term experience exchange or long term positions ;

[MTG5.5] To build general trust and cooperative environment with other research institutions (*Metrics: How many RI have agreed or are considering joining IECS in building RTO in smart specialization fields, how many RI have visited IECS organized events, how many cooperation agreements with other RI are signed, how many international RI researchers are in IECS consultative board; Result: 1 institution per smart specialization field not covered by IECS, at least 10 annually, at least one new every year, at least 3*)
Reaching of this goal requires following short-term actions:

[7] http://www.edi.lv/en/projects/state-research-p-projects/vpp-sophis/
[8] http://edi.lv/en/projects/state-research-p-projects/

[STA5.15] Work on strengthening cooperation with RI which could potentially together with IECS establish an RTO in smart specialization fields [LTG2] and start discussions about this prospect;

[STA5.16] Invite RI representatives to IECS organized events, such as project seminars, conferences etc.;

[STA5.17] Sign additional cooperation agreements with key RI, both Latvian and international, including placing their researchers in IECS consultative board (Currently IECS has signed cooperation agreements with both local[9] and international research institutions[10]).

[MTG5.6] To be a provider of new technologies for commercialization and high tech competence for business of high tech companies (*Metrics: How many industry partners have agreed to participate in consortia after invitation by IECS, how many IECS knowledge units have been commercialized; how many new high-tech companies have been founded based on effort by C-Lab or IECS; Result: at least 30% of industry partners invited by IECS are interested in participating in consortia, at least 1 new knowledge unit annually, at least 1 every two years*) Reaching of this goal requires following short-term actions:

[STA5.18] When writing FP and other project proposals (Chapter 2), invite other Latvian and international companies of appropriate profile to participate (especially if coordinating);

[STA5.19] Provide IECS knowledge to industry as described in section 3.3.3 (commercialization and technology transfer);

[STA5.20] Actively work in motivating high-tech industry growth [LTG3] - such as Commercialization laboratory C-lab events or building of innovation support infrastructure as described in section 3.3.3;

[MTG5.7] To exchange resources (including research and piloting infrastructure) with industry (e.g. KEPP EU Ltd.[11], EuroLCDs Ltd.[12], Lattelecom Ltd.[13], Square Audio Ltd.[14], XpressHD Ltd.[15], JSC SAF Tehnika[16] etc.) (*Metrics: How many industry partners have used IECS research*

[9] e.g. institutes from UoL, RTU, VUC, as well as independent institutes such as Latvian Institute of Organic Synthesis, Institute of Physical Energetics etc.

[10] e.g. Chinese academy of sciences, Grenoble Institute of Technology, Daegu Gyeongbuk Institute, Marine systems institute (Tallin), Center for Wireless Health (Virginia, USA) etc.

[11] http://keppeu.lv/en/

[12] http://www.eurolcds.com/

[13] https://www.lattelecom.lv/en/

[14] http://www.square.audio/

[15] http://xpresshd.com/

[16] http://www.saftehnika.com/en/

infrastructure, how many industry representatives are located in IECS buildings, How many IECS staff members are in employee exchange programs with industry; Result: all key industry partners, at least 1 till year 2020, at least 1 every year)
Reaching of this goal requires following short-term actions:

[STA5.21] Manage the usage of IECS dual-use research infrastructure by offering it for use to industry;

[STA5.22] Provide unused space in the IECS buildings for rent to industry representatives, preferring new spin-offs and start-ups based on technology transfer from IECS and companies working in the field of ICT;

[STA5.23] Facilitate exchange of staff with industry representatives both for short term experience exchange and long term positions;

[MTG5.8] To build general trust and mutually beneficial cooperation with industry (*Metrics: In how many industry associations and clusters IECS is actively participating, how many industry organization events have IECS representatives participated in, how many industry representatives are involved in IECS consultative board, how many industry representative have visited IECS organized events, how many long-term trust relationships (and cooperation agreements) with industry partners are active at the moment; Result: at least 2, at least 1 event per organization annually, at least 2 representatives, at least 1 from each key industry partner, one trust relationship with each key industry partner*)
Reaching of this goal requires following short-term actions:

[STA5.24] Actively participate in industry associations and clusters, including projects they are managing (Currently IECS is participating in both of the relevant industry associations - LETERA and LIKTA, and in two of the three technology clusters - Electronics cluster and Satellite technology cluster. IECS also has a close cooperation with the third - IT cluster);

[STA5.25] Participate in industry association (e.g. LETERA, LIKTA etc.) and other organization events (e.g. annual general meetings) to introduce industry representatives with information about IECS (e.g. participate in IT Demo Center initiative);

[STA5.26] Involve key industry representatives from individual companies or industry associations in consultative board of the institute. ;

[STA5.27] Invite industry representatives to IECS organized events, such as project seminars, conferences etc.;

[STA5.28] Work on building up long-term relations with industry and potentially sign cooperation agreements with key industry partners, both Latvian and international.

[MTG5.9] To participate in international partnership networks, such as EMES European Research Network and participate in European Innovation Partnerships in order to build general trust and mutually beneficial cooperation with international research community (*Metrics: In how many such institutions IECS plan to participate in, Result: at least three till 2020, (at the moment IECS test-bed is part of FIRE/Xipi network*[17]*)*)
Reaching of this goal requires following short-term actions:

[STA5.29] Evaluate participation in European Innovation partnerships and EMES European Research network as well as similar networks and determine a list of organizations IECS will participate in.

[MTG5.10] To promote IECS research profile, to attract new potential partners as well as international researchers for work in IECS. (*Metrics: How many new partners are interested to cooperate with IECS, how many international researchers are interested in work in IECS; Result: at least 10 new partners annually, at least 1 international researcher annually*)
Reaching of this goal requires following short-term actions:

[STA5.30] Participate in international conferences, publish in international journals, take part in international program and editorial committees and otherwise promote IECS research profile.

[MTG5.11] To establish an annual event, called "IECS day", inviting HEI, RI, industry and government partners for exchange of information. This will help both to market our competencies and projects and to find out partners interests and needs to establish trust, which is crucial to raise awareness that IECS can create a win-win situation for both sides. (*Metrics: How many participants are in IECS day; Result: 200 participants annually*)
Reaching of this goal requires following short-term actions:

[STA5.31] Decide on program and organizing of the new "IECS day".

[17] http://www.xipi.eu/infrastructure/-/infrastructure/view/4497

Chapter 6

Risk management

To ensure successful implementation of this research programme, it is important to sufficiently analyze risks, that may undermine successful completion of the programme and put in place contingency plans in the event these risks come true. This section describes the main risks to the implementation of research programme and IECS plans on mitigating them.

Risk	**Probability**	**Mitigation measures**
Other Latvian institutes are not interested to join forces and build ICT center in medium term and RTO in long term	High	IECS will motivate other institutes to join forces by showing several advantages of such collaboration
Companies are not interested to commercialize IECS inventions	High	IECS will focus on developing market demand products
Financial issues	Low	IECS will actively search for all possible financial instruments to ensure IECS sustainability
Staffing & recruitment problems. New talents are not interested to join IECS team; Besides that, here is a tendency for our current stuff to be recruited by companies in the industry	Medium	IECS will improve its PR. Will visit HEI and motivate new talents as well as motivate current researchers

Uninformed staff about different activities in IECS due to communication issues	Low	IECS is already using different tools for communication and will explore more in order to reduce communication issues
There are no financial resources for participation in different events, highlighted in [MTG2.2]	Low	IECS has successfully implemented two projects[12], which support such actions and will continue to search for similar financial intruments
The submitted international projects are not funded	High	In order to avoid low performing project proposals, IECS researchers will strongly consider all the aspects before joining the consortium. Also, in order to submit high quality proposals, IECS researchers will be well educated about project writing specifics (see [MTG2.4])
Researchers are not motivated to write or coordinate project proposals	Low	Different instruments, such as described in [STA2.11],[STA2.12], will be used to motivate researchers
HEI are not interested to collaborate with IECS	Low	IECS already has a strong collaboration with all biggest universities in Latvia and will expend its network by using different tools (see [MTG2.2],[MTG2.3],[MTG5.1]-[MTG5.3]) to European level
RI are not interested to collaborate with IECS	Low	IECS will use different tools to establish strong collaboration with RI (see [MTG2.2],[MTG2.3],[MTG5.4]-[MTG5.6])
Companies from industry are not interested to collaborate with IECS	Medium	IECS will use different approaches to convince industry, that collaboration is beneficial to them (see [MTG2.2],[MTG2.3],[MTG5.7]-[MTG5.9])
IECS researchers don't have access to important scientific papers	Low	IECS will ensure that all necessary papers are delivered to researchers (see [MTG3.5],[MTG3.6])
The funding for building renovation, laboratory equipment and support infrastructure is not found	Medium	IECS will use ERDF 2014-2020 activities to develop all the infrastructure