Science Foundation Ireland
Strategic Partnership Programme
Full Proposal

Proposal Summary

Proposal Title

R@ISE: Research at ISE - Immersive Software Engineering

Proposal ID

21/SPP/9979

Total funding request amount (in €)

€2,050,000.01

Duration of Grant requested (in months)

60

Requested start date

31/12/2022

Co-funding Partner(s)

John and Patrick Collison/Stripe
Analog Devices International
Tines
Trackworx
Johnson & Johnson
Limerick City and County Council

Co-funding partner(s) Cash Contribution

€2,050,000.00

Co-funding partner(s) In-Kind Contribution

€1,520,000.00

Is this a second-term funding application?

No

Research Alignment

Primary Priority Area

Other - Area under SFI's Legal remit where there is convincing evidence that there be significant potential for economic, and/or societal impact

Secondary Priority Area

Priority Area A - Future Networks, Communications and Internet of Things, Priority Area B - Data Analytics, Management, Security, Privacy, Robotics and Artificial Intelligence (including Machine Learning), Priority Area C - Digital Platforms, Content and Applications, and Augmented Reality and Virtual Reality, Priority Area N - Innovation in Services and Business Processes

Research Area - Primary

Computer and Information Sciences

Research Area - Secondary

Software Engineering

Please describe how your proposal is aligned with SFI's legal remit

R@ISE espouses the dual SFI strategic objectives of "Delivering today" and "Preparing for tomorrow" by a research program co-designed with our partners that will help make Low-Code/No-Code software development efficient, high quality assurance, and offer 4 Postdoctoral researchers and 22 PhD students the
Besides doing excellent research, due to R@ISE's commitment to equality, diversity, and inclusion, already evident from the composition of the core research team, it will contribute significantly to the goals of reaching 35% women leaders in research and 65% of postgraduate and postdoctoral researchers departing to positions outside academia after 6 years. It surely addresses the SPP objectives, to "Build stronger, more direct relationships with co-funding partners from industry, charity and academia"," Maximise the state investment in research through leveraging of non-exchequer funding, including funding available through philanthropic and charitable sources", and "Enable alliances with industry/charity/philanthropy that enhance competitiveness in securing European funding".
We have already seen how ISE has profoundly and dramatically changed the discourse on Software Engineering education in UL, in Ireland, and beyond. Driven by the same key actors, R@ISE is best poised to double down on the transformational impact of the perception and culture relative to applied embedded research, becoming a lighthouse example for the level of ambition, of skills, and of speed that Ireland can bring to the table in a global context.

Lead Applicant Details

Full Name:	Prof. Tiziana Margaria
Organisation:	University of Limerick (UL)
Department:	Lero, and CSIS, Computer Science and Information Systems
Job Title:	Professor
Year of PhD:	1993
ORCiD:	0000-0002-5547-9739

Location of Applicant at time of Submission

Ireland

Lead Applicant % Commitment

30%

Co-Applicant Details

Full Name:	Prof. Michael Hinchey
Organisation:	University of Limerick Lero-the Irish Software Engineering Research Centre
Department:	Computer Science and Information Systems
Job Title:	Professor of Software Engineering
Year of PhD:	1995
ORCiD:	0000-0001-5110-561X
% Commitment:	25
Full Name:	Prof. Stephen Kinsella
Organisation:	University of Limerick (UL)
Department:	Economics
Job Title:	Professor of Economics

Year of PhD: 2007

ORCiD: 0000-0002-7943-4797

% Commitment: 50

Supervisory Details

	Masters Students graduated	PhD Students graduated	Masters Students Currently supervising	PhD Students Currently supervising	Other staff being supervised
Tiziana Margaria	45	9	4	10	3
Michael Hinchey (Co-App 1)	85	5	4	0	65
Stephen Kinsella (Co-App 2)	60	10	4	10	32

Research Funding

Funding Diversification

Current								
Added by	**Role on Award**	**Funding Body**	**Funding Programme**	**Title of Proposal**	**Amount of Funding**	**Amount of Funding Allocated to PI (€)**	**% Commitment**	**Start Date**	**End Date**
Tiziana Margaria	PI	Science Foundation Ireland (SFI)	Confirm - Smart Manufacturing Centre	Confirm RC	€47,358,586.00	€4,049,365.00	10	01/10/2017	30/09/2023
Tiziana Margaria	PI	Science Foundation Ireland (SFI)	SFI CRTs	Centre for Research Training on Artificial Intelligence and Data Analytics	€14,069,144.00	€1,406,900.00	5	01/04/2019	30/09/2026
Tiziana Margaria	Co-PI	Science Foundation Ireland (SFI)	Research Centres Phase 2	Lero Phase 2	€29,000,000.00	€2,070,000.00	10	01/01/2020	31/12/2025
Tiziana Margaria	Co-PI	European Union - Horizon 2020 (Marie Curie)	Smart 4.0	Smart Manufacturing Advanced Research Training for Industry 4.0	€2,901,504.00	€128,421.00		01/06/2019	30/05/2024
Tiziana Margaria	Co-PI	Other Source (please describe)	UL-HRI	ULCaN - University of Limerick Cancer Research Network:	€234,585.00	€35,000.00		01/03/2019	01/03/2023
Tiziana Margaria	Co-PI	Higher Education Authority Ireland (HEA)	HEA North-South Strand 2	eHealth-Hub: All Island Research Hub for Federated Analysis of Cancer Data	€3,995,801.00	€250,000.00	5	01/09/2022	01/09/2026
Tiziana Margaria	Co-PI	European Union - Other (Please describe)	COOPERATION PARTNERSHIPS IN SCHOOL EDUCATION (KEY ACTION 2)	Blockchain for the Environment: Open Interdisciplinary Education on Generating Disruptive Change through Impactful DLT Applications (BC4ECO)	€276,449.00	€49,899.00	2	01/09/2022	31/01/2025
Expired									
Added by	**Role on Award**	**Funding Body**	**Funding Programme**	**Title of Proposal**	**Amount of Funding**	**Amount of Funding Allocated to PI (€)**	**% Commitment**	**Start Date**	**End Date**
Tiziana Margaria	PI	Other Irish Government Source (please describe)	Failte Ireland	Conference support for ETAPS 2020 bid	€10,710.00	€10,710.00		01/03/2018	31/08/2020
Tiziana Margaria	Co-PI	European Union - Horizon 2020 (Marie Curie)	MRC Cofund	ALECS	€3,681,600.00	€283,200.00		01/11/2017	31/10/2021

Co-Applicant Funding Diversification

Current									
Added by	Role on Award	Funding Body	Funding Programme	Title of Proposal	Amount of Funding	Amount of Funding Allocated to PI (€)	% Commitment	Start Date	End Date
Stephen Kinsella	Co-PI	European Union - Horizon 2020 (Societal Challenges)	+CityXChange	+CityXChange: Moving	€21,000,000.00	€1,250,000.00	15	01/01/2018	01/12/2023
Stephen Kinsella	PI	Other Source (please describe)	National Energy Research Development and Demonstration (RD&D) Funding Programme	SMARTLAB: Prototyping a Digital Sustainable Future	€647,949.00	€647,949.00	10	01/01/2022	31/12/2023
Stephen Kinsella	PI	Other International Government Source (please describe)	New Foundations	Rebuilding Macroeconomics	€4,800,000.00	€1,200,000.00	10	01/01/2017	01/12/2023
Stephen Kinsella	Co-PI	Environmental Protection Agency (EPA)	EPA Research	INCASE: Irish National Capital Accounting for Sustainable Environments	€847,000.00	€365,000.00	10	01/12/2019	01/09/2023

For each current and pending grant listed above, clearly indicate any scientific overlap with this application, referring only to overlap in content

The research projects of the above listed grants are distinct.
The R@ISE proposal has an own research program that is distinct from the research programs of Lero, Confirm, and the CRT-AI, the other major research activities. There is no overlap with the current objectives in Lero, but the outcomes of WP1 could in future find application in the Governance space Lero addresses in the current phase. Similarly, the insights and outcomes of WP2 could inform in the future Mission 4 of the Confirm phase 2, that Tiziana Margaria co-leads. As the Confirm Phase2 proposal is under review, it is not clear at this point that this opportunity may be realized. While ADI and J&J are part of Confirm, Tiziana Margaria has no own ongoing funded projects with those companies. There is no connection with the topics dealt with in the CRT-AI. It is however possible that CRT-AI PhD students may benefit of the existence of R@ISE, e.g. finding case studies for their independent research, as well as placements in the R@ISE partner organizations.
The MSCA Co-fund Smart 4.0 is terminating: the last postdoctoral fellowship, in co-supervision, will finish in March 2023.
The ULCaN grant is terminating in early 2023.
The eHealth-Hub is just starting, there are no overlaps in projects. It could become a further future application domain for a strong, reliable and scalable Digital Thread platform.

The grants managed by Stephen Kinsella terminate in 2023.
The +CityXChange and SMARTLAB are central in the relationship with the Limerick City and County Council and are enablers of correspondent R@ISE activities.

The other two projects are not directly related, but witness the economics competences and the engagment in sustainability.

Management of More Than One Major SFI Award
For all three PIs, R@ISE will become their main research activity.
The involvement of Tiziana Margaria as PI of Lero and Confirm (on the Executive Committee of both) and of Mike Hinchey in Lero (past director and Executive Committee member) is helpful to R@ISE as it is conducive to synergies, e.g. through activity coordination especially concerning EPE and potential jooint applications, e.g. to EU MSCA Co-fund.
The CRT-AI is largely managed centrally in UCC by dedicated staff.
Beyond 2023, Stephen Kinsella will be focused principally on R@ISE.

Research Funding section completed

Yes - section is completed

Collaborator Details

Full Name:	Dr. Salim Saay
Organisation:	University of Limerick (UL)
Job Title:	Lecturer
Collaborator Type:	Funded Investigator
Full Name:	Dr. Roisin Lyons
Organisation:	University of Limerick (UL)
Job Title:	Lecturer of Entrepreneurship and Innovation
Collaborator Type:	Funded Investigator
Full Name:	Dr. Katie Crowley
Organisation:	University of Limerick (UL)
Job Title:	Lecturer
Collaborator Type:	Funded Investigator

Main Body of Proposal

Keywords

Low-code/No-code, Software development platforms, Digital Thread, Sustainability

Scientific Abstract

The R@ISE project aims to augment the global low-code/no-code revolution, arming key corporate stakeholders and citizen developers with a robust, research-led platform and advanced toolkit. Supported by eminent scholars, domain experts and corporate partners, this multi-dimensional and visionary project will leverage international academic and industrial knowledge in LC/NC to focus on low-code development platforms, their use and evaluation.
R@ISE will provide a coherent, holistic and robust platform –offering both generic and customisable LC modelling environments, as well as the development of a superior Digital Thread platform which integrates the provision of meta-tooling support, enhanced formal developer support, with languages and tooling congruous to those known by industry collaborators and domain experts.

Entrenched into the strategy of the R@ISE project is a commitment to stakeholder collaboration, as well as continuous platform iteration and research/educational dissemination. This is facilitated using a 360o approach spanning tool and platform development (WP1), adoption, validation and stress test (WP2), dissemination (WP3) to adopters of many different backgrounds and the empirical evaluation and feedback from multiple user types.
Our R@ISE SPP application, if successful, will deliver an ambitious research program scaling the ecosystem research component to 24 PhD students and 6 Postdoctoral fellows over its 5 years.

Lay Abstract

The R@ISE project aims to augment the global low-code/no-code revolution, by creating a robust and research-led developer platform and advanced toolkit. Supported by eminent scholars, domain experts and corporate partners, this multi-dimensional and visionary project will leverage international academic and industrial knowledge in LC/NC to focus on low-code development platforms, their use and evaluation. The project boasts unprecedented collaboration between esteemed scholars in the field of LC/NC and corporate partners. It combines platform iteration and development with continuous validation and testing to ensure its superiority and relevance in the area, augmented by top-class research and multi-modal research dissemination.

Ethical Issues

Does your research involve the use of animals?	No
Does your research involve human participants, human biological material, or identifiable/potentially identifiable data?	Yes
Does your research involve Human Embryonic Stem Cells (hESCs)? Research using human embryonic stem cells or tissues will not be supported by SFI.	No
Does your research involve human participants?	Yes
Are they vulnerable individuals or groups, patients or persons unable to give informed consent (including children/minors)?	Yes
In the course of your research programme, do you propose to use Clinical Research Facility/Centre (CRF/C) facilities?	No
Is a formal sponsor required for the research programme?	No
Does your research involve physical interventions on the study participants?	No
Does your research involve a clinical trial or investigation?	No
Is the clinical trial or investigation covered by the EU Clinical Trials Directive?	N/A
If yes please confirm that HPRA approval will be obtained prior to study commencement.	N/A
Will an independent Trial Steering Committee (TSC) be established?	N/A
Will the trial or investigation be registered in a publicly available, free to access, searchable clinical trial or investigation registry?	N/A
Will the requisite Insurance cover be sought for the clinical trial or investigation and evidence of cover submitted to SFI prior to trial initiation?	N/A
Does this clinical trial or investigation involve activities outside of the Republic Of Ireland or partnerships with international collaborators?	N/A
Does your research involve human cells or tissues?	N/A
Does your application include an element of biobanking?	N/A
Does your research involve personal data collection and/or processing?	No
If any potential commercially exploitable results may be based upon tissues or samples derived from human participants, will appropriate informed consent for such use be sought?	N/A

Sex/Gender Dimension in Research

In accordance with the SFI Gender Strategy (Strand 3: Integrating Gender in Research and Innovation), all applicants must complete a statement articulating the consideration of biological sex and/or social gender variables in their research programme.
Applicants must consider how the sex and/or gender dimension impacts your research. Please consult the Guidance for Applicants on Ethical and Scientific Issues for resources on how to address the sex and/or gender dimension of research in your grant.

Do not include information on how you have addressed gender equality, diversity and inclusion in your research team/environment; this should be addressed in your CV, should you choose to highlight.

To complete this section, please consider the following questions:
1. Is sex as a biological variable taken into account in the research design, methods, analysis and interpretation, and/or dissemination of findings?
2. Is gender as a socio-cultural factor taken into account in the research design, methods, analysis and interpretation, and/or dissemination of findings?

If the answer is yes, please describe how sex and/or gender considerations will be integrated into your research proposal. If no, please explain why sex and/or gender are not applicable to your research proposal.

Is there a sex and/or gender dimension to be considered in your research proposal?

Yes

Please describe how sex and/or gender considerations will be integrated into your research proposal.

The tech industry as a whole has a gender problem, and the developer role is no exception: according to last year's FRG Technology Consulting Java and PHP Salary Survey, only one in every 10 developers is a woman. The low-code/no-code method has the potential to democratise app development, addressing inclusivity, one of the most urgent issues in the tech industry. LC/NC platforms bring new opportunities to women because they change the community around programming rather than changing the programming itself. By advancing LC/NC platforms R@ISE will encourage democratic development, a vital step in achieving gender parity in STEM. The R@ISE team is passionate about gender balance, as evidenced by the female representation on the programme, and our programme partners.

Sex as a biological variable, and gender as a socio-cultural factor, will be taken into account in the research design, methods, analysis and dissemination of findings for all work packages.

Curriculum Vitae

TIziana Margaria

SECTION 1 – Applicant Details (max. 3 pages)

NAME AND CONTACT DETAILS

Name: Tiziana MARGARIA
Address: Univ. of Limerick, Tierney Building, T2-024, Limerick
Email: tiziana.margaria@ul.ie
W: https://lero.ie/people/tiziana-margaria , LinkedIn, DBLP

CAREER PROFILE (Education and Employment)

Education

PhD (1993)	Politecnico di Torino, Italy, Computer and Systems Engineering
Laurea (1988)	Politecnico di Torino, Italy, Ingegneria Elettronica

Employment

2014-	Full Professor, Chair of Software Systems, Department of Computer Science and Information Systems (CSIS)
2015-2021	Head of Department, Computer Science and Information Systems, University of Limerick, member of the Faculty Management Board, Academic Council (Senate) and UL Management Council.
2006-2014	Full Professor, Chair Service and Software Engineering, Faculty of Mathematics and Natural Sciences, University Potsdam (D)
2010-2014	co-affiliation at Faculty of Economy and Social Sciences, Univ. Potsdam (D)
2004-2006	Associate Professor, Head of the Service Engineering for Distributed Systems Group, Faculty of Mathematics, University Göttingen (D)
2000-2004	Oberingenieur (Senior Lecturer), Faculty of CS, Univ. Dortmund (D)

KEY ACHIEVEMENTS IN RESEARCH EXCELLENCE & IMPACT

A. Key Achievements in the Generation of Knowledge

1) Foundations of efficient automata learning: with the **LearnLib**, https://learnlib.de, now the defacto standard open access tool for automatic generation of models for legacy and black box systems. – This stems from the needs of a project with Siemens in Witten (Germany) I led in my company in 2000-2001, published in ENTCS in 2002[1]. With its various variants (NGLL, LearnLIb Studio, ALEX tool, and more) it has been used in research and education. It led to a US Patent with NASA (https://portal.unifiedpatents.com/patents/patent/US-7668796-B2). It is now used to automatically derive Digital Twins of cyberphysical systems amenable to formal verification[2]

2) The efficient representation of aggregated, situative knowledge using ADDs (Algebraic Decision Diagrams). It started in 2000-2003 with the miAamics company I co-founded (CEO) after having won the McKinsey Business Plan competition Start2 Grow in Dortmund in 2001. The technique is optimal. It led in the following years to a further US patent (US Patent # 9,141,708), to the CeBIT Innovation Award 2003, and it is now at the core of the open source tools ADD-Lib (https://add-lib.scce.info), and its derivative for random forest Forest GUMP, with optimal representation and explainable causality for each individual result, In collaboration with F. Gossen, who recently

[1] T. Margaria, B. Steffen. Scalable System-level CTI Testing through Lightweight Coarse-grained Coordination. Electronic Notes in Theoretical Computer Science 66 No. 2 (2002)
URL: http://www.elsevier.nl/locate/entcs/volume66.html

[2] Margaria, T., Schieweck, A. (2021). Towards Engineering Digital Twins by Active Behaviour Mining. In: Model Checking, Synthesis, and Learning. Lect, vol 13030. Springer, Cham. https://doi.org/10.1007/978-3-030-91384-7_8

sustained his viva voce PhD examination in UL. Most recently, two contributions appeared in IEEE Professional[3] and a follow-up paper on the enhanced efficiency in 2022.

3) The link of problem shaping and solving through computational thinking and model driven approaches footing on formal methods, see

Margaria T. (2018) From Computational Thinking to Constructive Design with Simple Models. In: ISoLA 2018. LNCS 11244. Springer, Cham.

This is my personal passion in applied research and education, as it promotes a mindset of accessibility of IT and Software Engineering beyond the programmers' elite. This approach is central to the approach we will take in the envisaged R@ISE LC/NC platform in Pillar 1.

B. Key Achievements in the Development of Individuals and Collaborations

The most recent achievement in CS Education as researcher and Head of Department of CSIS was the establishment of the **interfaculty BSc in "Education in Computer Science and Mathematics"** (a collaboration of the Faculty of Science and Engineering and Faculty of Education and Health Sciences), aimed at forming teachers in CS - a discipline that only entered the high school curriculum in 2020. The challenge here was the co-creation with the Teacher Council of an accreditation path for Teachers in CS, which did not yet exist, in parallel with the new course. We recently achieved full accreditation.

As co-director, I am proud of the establishment of the SFI funded **Centre of Research Training in AI**, (2019-2027) with over 120 PhD students over 4 cohorts and 5 Irish universities. The CRT-AI is co-funded with 20% industry cash contribution. I am a Principal Investigator, the UL Centre Director and a member of the Executive Committee. We are currently in the cohort building process for the fourth cohort: 27 students in total, 6 of which will be in UL.

C. Key Achievements Supporting Broader Society & the Economy

I have broad experience in the use of formal methods for high assurance systems, focussing on functional verification, reliability, and compliance of complex heterogeneous systems. My experience was gained through major industrial projects, including one where I won the **European IT Award** in 1996 with the GAIN/INXpress project with Siemens, another where I won a McKinsey **start-up competition** in 2001, through numerous consulting engagements, and through my activities as **founder and CEO of three startup companies**. In terms of economic impact, the GAIN/INXpress software was the first time that Siemens (Public Networks) sold software to Telecommunication operators (for several million Euros). In terms of process improvement, the turn-around time was cut from months to a few days while achieving better quality. Both spin off companies (METAFrame Technologies GmbH, since 1997, and miAamics GmbH (2001-2003)) have worked in the applied R&D and innovation domain. The key relevance to R@ISE is that the technology developed back then is the ancestor of today's low-code, MDD , LDE and generative approaches at the core of R@ISE's Pilllar1.

I proactively support **research and new practices in CS Education**. Besides publishing in this area, I am since 2017 founder and Co-chair of CELT, the IEEE COMPSAC Symposium on Computing Education and Learning Technologies. I co-edited of the special issue in the IEEE Transactions on Emerging Topics in Computing (Volume: 6, Issue: 1, Jan.-March 1 2018). Additionally, I served repeatedly on the Program Committee of SEET, the Software Engineering Education and Training track of ICSE. In 2015, I co-organized a girl's camp within the Google RISE award won by Lero. In 2016-2018 I taught the Introduction to Model Driven Design module, the very first module for our BSc and Higher Diploma students, in a **bootcamp** fashion. This was an essential experience to shape ISE. I am also involved in the OER initiative about Open Education Resources and the OER workshop at COMPSAC, with own

[3] F. Gossen, T. Margaria, B. Steffen: Towards Explainability in Machine Learning: The Formal Methods Way. IT Prof. 22(4): 8-12 (2020)

papers in collaboration with the History Dept in UL (Digital Humanities), where we regularly organize profession-building **IT-supported transcribathons**.

Since 2019 I am the CS expert crafting the traits of the disruptive **Immersive Software Engineering integrated BSc/MSc** (LM173/LM815) that constitutes the substrate of R@ISE. ISE is born from my experimentation in Potsdam within the Informatik-degree, with PBL embedded along the 2nd year Software Engineering modules I taught and new, cohort-overarching project management practice: 3rd year students practicing PM as project managers of two 2nd year Software Engineering project groups. This continued in Limerick with the "1st semester bootcamp" for problem solving through computational thinking applied to Model Driven Development. The Membership Model now set up with the over 50 ISE Residency Partnership companies stems from my experience as co-director of the CRT-AI, that practices a similar model for their co-funding. The Residency approach to in-company education, with 5 discipline-specific internships with a set content profile and fully assessed goals, stems from my years of intensive collaboration with DGINA (German Society for Emergency Medicine, 20029-2015) and then EUSEM (European Society for Emergency Medicine): there I learned the practice of training on the ground for their Young Professionals. The ISE Young Advisory Board idea (YAB) stems from my own mentorship in the YEMD, the Young Emergency Medicine Doctor branch of EUSEM, and the associated young role models ("like me") for the ISE students.
The impact of ISE in the CSIS Department, in the Faculty, in UL, in the national awareness and discourse about new approaches to Software Engineering and tech, as well as internationally (calls in the night from Silicon Valley about how to apply) has been truly transformative. A huge corollary achievement has been to raise in a few months over 2 Mio Euro from companies that are now the partners of the R@ISE SPP. The passion of these companies for the core topics (low code development and the digital thread), and their trust in the UL team and in the Irish research support are unprecedented.

D. Key Achievements Supporting the Research Community

Most recently I have been the **General Chair of ETAPS 2020 in Dublin** (which had to take place virtually), **Program Chair of ISoLA 2020** in Rhodes, Oct 2022, where I co-organize a Special track on *Digital Twin Engineering* and a Special track on *Digital Thread in Smart Manufacturing*, and I **co-chaired the CELT Symposium of IEEE COMPSAC 2022** (Torino, Italy). In terms of long-term impact on forming new nurturing research communities, I am

- Ideator and General/Program Chair of **ISoLA**, the series of biannual International Symposia on Leveraging Applications of Formal Methods, Verification and Validation (since 2004),
- co-founder of the **Int. Journal on Software Tools for Technology Transfer** (STTT, Springer, 1997),
- **Founding editor of the Transactions on Foundations for Mastering Change** (Springer 2016).
- General Chair and organizer of **SOFSEM 2017**, brought for the first time to Western Europe.
- Founding editor of NASA's Innovations in Systems and Software Engineering (Springer, 2005),

In terms of **open source journals**, I am **founding editor of EC-EASST**, which I established when I was President of EASST (European Association of Software Science and Technology), and I am also **founding editor of the open source Int. Journal of Critical Computer-Based System**s (IJCCBS, 2008).

I was recently **reviewer** of the SIRIUS Norwegian **research centre** (2019), of the German DFG Sonderforschungbereich HAEC at TU Dresden, Vice-chair of the Swedish VR (Vetenskapråden) national panel in 2019, and currently reviewer of the Austrian WWTF. I recently served on several **appointment panels of professors** at DTU in Odense (DK), of a prestigious Wallenberg professorship in Umea University (S), at Université Catholique de Louvain (B), and currently in UCC and Trinity College.
I was recently on **PhD dissertation panels** at TU Dresden (D) and LTU (S), and currently in Verona (I).

I will be Co-Chair of ECBS 2023 (Engineering of Computer-based Systems conference), and asked by the ETAPS Steering Committee (to which I belong) to bringing ETAPS, the top EU conference on Theory and Practice of Software, back to Ireland in 2025. Similarly, I am asked to organize VLSI-SoC in 2025, as I am Vice-chair of the IFIP WG 10.5 on "Design and Engineering of Electronic Systems".

SECTION 2 – Publication Details (max. 2 pages)

A. SELECTED SENIOR-AUTHOR PUBLICATIONS

1. **Margaria T**. (2016) Knowledge Management for Inclusive System Evolution. In: Transactions on Foundations for Mastering Change I. Lecture Notes in Computer Science, vol 9960. Springer, Cham. https://doi.org/10.1007/978-3-319-46508-1_2

   The paper addresses knowledge management in the design and evolution of complex IT systems and how to manage the link between domain knowledge (e.g. Cyberphysical systems) and System design and evolution in a collaborative and inclusive approach are directly relevant to the co-design approach in this initiative. In R@ISE we will leverage these principles as a core philosophy of the ethical (even frugal) use of complexity and redundancy, aiming to a fundamental simplification of the design, models, implemented artefacts, and then runtime resource consumption.

2. **Tiziana Margaria**, Bernhard Steffen, Christian Kubczak*:*
   Evolution support in heterogeneous service-oriented landscapes. J. Braz. Comput. Soc. 16(1)*: 35-47 (2010)*

   Significant work to explain how to use declarative descriptions of components and declarative high level properties to adapt complex service-based systems in a context of complex enterprise infrastructure. In this case it was SAP ERP, and an evolution monitored and checked by means of various formal methods.

   In R@ISE, we will use a similar mindset in approaching the complex infrastructural components brought by ADI, J&J, and Tines.

3. Stefan Naujokat, Johannes Neubauer, Anna-Lena Lamprecht, Bernhard Steffen, Sven Jörges, **Tiziana Margaria**:
   Simplicity-first model-based plug-in development. Softw. Pract. Exp. 44(3): 277-297 (2014)

   This contribution stresses the importance of simplicity as a guiding principle in design and any choices. Well before the UN Sustainable Development goals and the current attempt to consider parameters like e.g. energy, this paper summarizes the experiences over a decade of strict simplicity orientation in the development and evolution of plug-ins. The approach pre-empts the creation of waste, for example through production of incorrect software that costs when writing, testing and disposing of it.

   In R@ISE, we will embrace prevention and pre-emption by early detection at the model level of many categories of defects, thus adopting this mindset and the Formal Methods based techniques and tools that can deliver it.

B. OTHER PUBLICATIONS

1. **Margaria T.** (2019) Making Sense of Complex Applications: Constructive Design, Features, and Questions. In: Models, Mindsets, Meta: The What, the How, and the Why Not?. Lecture Notes in Computer Science, vol 11200. Springer, Cham. https://doi.org/10.1007/978-3-030-22348-9_9

   How to co-design robust, agile yet understandable applications in a constructive design approach that considers overlapping domains of responsibility and autonomy (through features and feature interaction).

2. **Margaria T**., Steffen B. (2008) Agile IT: Thinking in User-Centric Models. In: Leveraging Applications of Formal Methods, Verification and Validation. ISoLA 2008. Communications in

Computer and Information Science, vol 17. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-88479-8_35

This is the **seminal paper** about eXtreme Model Driven Development, that led to the corresponding methodology and the development of the toolset based on Cinco and DIME.

3. **Margaria T.**, Steffen B. (2020) eXtreme Model-Driven Development (XMDD) Technologies as a Hands-On Approach to Software Development Without Coding. In: Tatnall A. (eds) Encyclopedia of Education and Information Technologies. Springer, Cham. https://doi.org/10.1007/978-3-030-10576-1_208

   and

4. Lamprecht AL., **Margaria T.** (2020) Modeling of Scientific Workflows. In: Tatnall A. (eds) Encyclopedia of Education and Information Technologies. Springer, Cham. https://doi.org/10.1007/978-3-030-10576-1_210

These are 2 invited chapters in the recent Encyclopaedia of Education and IT (Springer): the central aspect of the methodology and tools is the ability to involve subject areas experts who do not code in a precise system development process that delivers running systems. The approach was already validated in the classrooms and in case studies in the following Textbook:

5. **Textbook:** A.-L. Lamprecht, **T. Margaria**: Process Design for Natural Scientists - An Agile Model-Driven Approach. Communications in Computer and Information Science 500, Springer2014, ISBN 978-3-662-45005-5

This is a textbook comprising theory and practice of advanced scientific workflow design with XMDD. It includes a collection of case studies in bioinformatics.

6. Gossen, **T. Margaria,** J. Neubauer, B. Steffen (2019). A Model-Driven and Generative Approach to Holistic Security. In: Resilience of Cyber-Physical Systems 2019: 123-147.

How to consider security aspects at the model level and automatically weave the security-providing aspect in (web)-applications in a holistic (and not layered) approach: this is an essential capability for any secure platform.

7. **Margaria T**. (2018) From Computational Thinking to Constructive Design with Simple Models. In: ISoLA 2018. LNCS 11244. Springer, Cham

The link of problem shaping and solving through computational thinking and model driven approaches footing on formal methods is central to the approach we will take in the envisaged IT platform.

NAME AND CONTACT DETAILS

Professor Mike Hinchey
Lero, the Science Foundation Ireland Research Centre for Software
University of Limerick
Limerick
mike.hinchey@lero.ie
+353 86 0495075

CAREER PROFILE (Education and Employment)

- B.Sc. in Computer Systems, University of Limerick, Ireland (1987-1991)
- M.Sc. in Computation, University of Oxford, England (1991-1992)
- Ph.D. in Computer Science, University of Cambridge, England (1992-1995)
- Chartered Mathematician (CMath)
- Chartered Engineer (CEng), UK and Ireland
- Chartered Professional Engineer (CPEng), Australia
- Chartered Information Technology Professional (CITP), UK
- Computer Society of India, Honorary Fellow (HonFCSI)
- Academia Europaea, Member (MAE)
- Institute of Mathematics and Its Applications, Fellow (FIMA, CMath)
- Institute of Engineering Technology (formerly Institution of Electrical Engineers), Fellow (FIET, CEng)
- Institution of Engineers, Australia, Fellow (FIEAust, CPEng)
- British Computer Society, Fellow (FBCS, CEng, CITP)
- Engineers Ireland, Fellow (FIEI, CEng)
- Irish Computer Society, Fellow (FICS)
- Association for Computing Machinery, Member (MACM)
- American Institute of Aeronautics and Astronautics, Associate Fellow (AFAIAA)
- Institution of Electrical and Electronics Engineers, Senior Member (SMIEEE)

- Head of Department, Department of Computer Science & Information Systems, University of Limerick, Ireland (2021 -)
- University Advocate, University of Limerick, Ireland (2021 -)
- President, IFIP (International Federation for Information Processing) (2016-2022)
- Director, Lero–the Irish Software Research Centre (June 2010 – December 2016)
- Professor of Software Engineering, University of Limerick, Ireland (June 2008 -)
- Member, Technical Advisory Board of Financial Services Roundtable
- Editor-in-Chief and Founding Editor, *Innovations in Systems and Software Engineering: A NASA Journal,* Springer-Verlag, London (2005 -)
- Editor-in-Chief, *NASA Monographs in Systems and Software Engineering*, Book series, Springer- Verlag, London (2005 -)
- Associate Editor, ACM Computing Surveys (2020 -)
- NASA Expert (2007-2014)
- Director, Software Engineering Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD (2001 – 2007)
- Editor-in-Chief, AIAA (American Institute of Aeronautics and Astronautics) *Journal of Aerospace Computing, Information and Communication* (2006 - 2011)
- Scientific Director, Lero-the Irish Software Engineering Research Centre, Limerick, Ireland (June 2008-June 2010)
- Professor of Computer Science and Director of the Graduate Program, Loyola College in Maryland, Baltimore, MD (July 2006 – June 2008)
- Visiting Professor, University of Potsdam, Germany, 2012-2015
- Visiting Professor, Pontifícia Universidade Católica do Rio de Janeiro, Brazil, 2005
- Visiting Professor, Loyola College in Maryland, Baltimore, MD (2005-2006)
- Research Professor (half time) Virginia Tech, Alexandria, VA, USA (2003-2005)
- Research Associate Professor, George Mason University, Fairfax, VA, USA (2001-2003)
- Visiting Professor of Computer Science, The Queen's University of Belfast, Northern

Ireland (1999-2003)
- Professorial Research Fellow, Grade G (Research Full Professor) and Director (Head of School) Software Verification Research Centre, University of Queensland, Brisbane, Australia (Oct 2000 – Sept 2002)
- Chair of Software Engineering, University of Skövde, Sweden (1998-2000)
- University of Nebraska Foundation Associate Professor of Computer Science (sponsored chair), University of Nebraska at Omaha, NE, USA (1998-2000)
- Assistant Professor, New Jersey Institute of Technology, NJ, USA (1995-1998)
- Visiting Professor, Hiroshima University, Japan (1996)
- ASEE/NASA Fellow (1996-1998)
- Adjunct Professor of Computer Science, University of Limerick, Ireland (1996-1999)

KEY ACHIEVEMENTS IN RESEARCH EXCELLENCE & IMPACT

A. Key Achievements in the Generation of Knowledge
- Innovations and developments in mathematical correctness of autonomous software, resulting in 26 issued United States Patents (of which the applicant is inventor or co- inventor) several of which are used in the Mars Rovers and in other NASA space exploration missions.
- Several of these patents have been licenced in other industries.
- Co-author of a report for the European Commission on the role of software in innovation.

B. Key Achievements in the Development of Individuals and Collaborations
- Grew Lero from a research centre in (then) 4 universities to being based in 8 universities with a 400% growth.
- Lead the NASA Software Engineering Laboratory for almost 15 years leading to new technologies for autonomous systems and supporting hundreds of civil service and contract staff.

C. Key Achievements Supporting Broader Society & the Economy
- 26 United States Patents were generated from my prior research work and several are now licenced by various companies for use in other domains.
- Contributed to the public understanding of the role and importance of software as a results of many international public presentations and engagements.

D. Key Achievements Supporting the Research Community
- Editor-in-chief of several respected international journals.
- Served on the selection committees for several international funding bodies, most notably NSERC where I have been instrumental in selecting candidates for funding.
- Long-time contributions to professional bodies, e.g., 3 terms as President of Irish Computer Society, 2 terms as President of IFIP, recently elected to Board of Governors of IEEE Computer Society, Chair of IEEE Global Public Policy Committee.

SECTION 2 – Publication Details (max. 2 pages)

*Please **do not** exceed the maximum number of publications requested. Deviating from these instructions may result in the redaction of these details or make your application ineligible for review. Please briefly describe the importance/impact[1] of your publication and whether these publications are openly available.*

A. SELECTED SENIOR-AUTHOR PUBLICATIONS

*Detail 3 peer-reviewed, senior-author (that is, first, joint-first or last author) primary-research publications, which will confirm, **where relevant**, that you meet the eligibility requirements for publications for this programme. Refer to the appropriate section of this call document for details on senior-authorship requirements. Preprints may*

only be included where a Digital Object Identifier (DOI) is quoted. ***Note that publications where the applicant claims joint-first authorship will only be accepted as senior-author publications where the article clearly verifies this***.

1. Emil Vassev and Mike Hinchey, *Autonomy Requirements Engineering for Space Exploration Missions*, Springer, NASA Monographs in Systems and Software Engineering, 2014.
2. Walter F. Truszkowski, Christopher A. Rouff, Lou Hallock, Jay Karlin, James L. Rash, Michael G. Hinchey and Roy Sterritt, *Autonomous and Autonomic Systems: with application to NASA intelligent space exploration missions*, Springer, NASA Monographs in Systems and Software Engineering, 2009. Republished in Chinese.
3. Simon Dobson, Roy Sterritt, Paddy Nixon and Mike Hinchey, Fulfilling the vision of autonomic computing, *IEEE Computer,* 43(1):35-41.

B. OTHER PUBLICATIONS

1. Michael G. Hinchey and Stephen A. Jarvis, *Concurrent Systems: Formal Development in CSP*, McGraw-Hill International Series in Software Engineering, London and New York, 1995.
2. Mike Hinchey, Jonathan Bowen and E.-R. Olderog, editors, *Provably Correct Systems,* Springer, London, 2017.
3. Mike Hinchey and Lorcan Coyle, editors, *Conquering Complexity*, 2012, Springer *with a foreword by Sir Roger Penrose.*
4. Chris Rouff and Mike Hinchey, editors, *Experiences from the DARPA Grand Challenge*, 2012, Springer *with a foreword by Dr. T. Tether, DARPA Director.*
5. Christopher A. Rouff, Michael G. Hinchey, Walter F. Truszkowski, Diana Spears, editors, *Agent Technology from a Formal Perspective*, Springer Verlag NASA Monographs in Systems and Software Engineering, September 2005.

[1] Number of citations is appropriate in this instance.

SFI Industry RD&I Fellowship Programme

APPLICANT DORA-COMPLIANT CV TEMPLATE

SECTION 1 – Applicant Details (max. 3 pages)

NAME AND CONTACT DETAILS

Professor Stephen Kinsella, Department of Economics, University of Limerick. Stephen.Kinsella@ul.ie, twitter @stephenkinsella, ph: 061233611.

CAREER PROFILE (Education and employment)

I am currently Head of Department of the Department of Economics at the Kemmy Business School, University of Limerick, and co-Director of Immersive Software Engineering. I have been on the faculty for 16 years and hold the rank of Professor of Economics. I have two PhDs in Economics, one from the New School for Social Research, the other from NUI, Galway. I have three master's degrees and a BA in economics also. I am a regular visiting Professor at both Brown University, USA and the University of Melbourne, Australia.

KEY ACHIEVEMENTS IN RESEARCH EXCELLENCE & IMPACT

A. Key achievements in the generation of knowledge

1. ABM-SFC Modelling

I invented the field of agent-based stock flow consistent macroeconomic modelling (Kinsella, 2011). My development of empirical stock flow modelling as a Consultant to the Bank of England is now being used by central banks in Italy, Australia, Iceland, and the Netherlands. An example of the Bank of England's model is here. Kinsella et al (2011) is acknowledged as the first paper in this new field. Caiani et al (2016) is an elaboration on this basic model, bringing with it an entire agent-based software platform, which has now been used as the baseline for dozens of other papers. This 2016 paper has 300+ citations now, a large number in economics. Beginning as a niche area of heterodox economics, agent-based stock flow consistent macroeconomics is becoming mainstream thanks in part to the funded projects I have led, my work at the Bank of England, which now has an agent-based model it runs and the European network I have grown. Recently for example an agent-based stock flow model based on my work by Botta et al (2021) was published in the elite journal, *Research Policy.* A review of Stock-Flow consistent Macroeconomic Modelling (Zezza et al, 2017, Journal of Economic Surveys) cites my work 13 times. Another review article, Caverzasi et al, (2015, Cambridge Journal of Economics) placed my contributions in the network of papers on the subject on a graph of influential studies.

2. The New Economics of Austerity

I am acknowledged as a key scholar in the economics of austerity, particularly on the Irish economy (Kinsella, 2012, 2014, 2016). Minister for Finance Paschal Donohoe TD reviewed the key book on the Irish experience of Austerity in the Irish Times on February 18th, 2017. He described my chapter in it as an "authoritative analysis". The Financial Times podcast Alphachat interviewed me on the Irish experience of the 2008 crisis and described my contribution as "the best concise explanation of the macroeconomic forces at work throughout Ireland's experience of crisis, austerity, and unexpectedly quick recovery."

3. New Economics of Innovation

Together with Prof. Neave O'Clery from Oxford University and Michael McMahon from the CSO, I am building an evidence base around the knowledge spillovers and innovation for UK and Irish companies published in some of the top journals in the world, notably Research Policy and the Journal of Technology Transfer as well as some OECD working papers looking at scale and markups in digital firms. This work relates directly to digital enterprises like those impacted by R@ISE.

B. Key achievements in the development of individuals and collaborations

I have supervised 12 PhD theses to completion and mentored 10 post-doctoral fellows. I have created research partnerships and groupings since coming to UL in 2006. Here are three examples of my academic leadership in research.

1. S120 Research Group at UL (2013-2017)

In 2013, I won $460,000 for a project entitled 'debt and demography in the European Periphery' This led me to set up a research group, S120, named after the room we were located, and led to a series of other grants from INET, the IRC, FP7, and the ESRC. This group consisted of five postdoctoral fellows, 3 PHD students, and 6 Research Assistants, with me as the leader of the group. We worked with Nobel Laureate Prof. Joseph Stiglitz and Ancona University's Prof. Mauro Gallegati and produced three new software platforms (all available at www.github.com/S120). Each of these platforms is now used by universities across the world, from South Africa (Wits) to Brazil (Sao Paulo) to Italy (Catholica Milan).

2. Globalisation Hub Leader, Rebuilding Macroeconomics Project (2017-present)

Rebuilding Macroeonomics is a 4-year project funded by the UK's Economic and Social Research Council. I am a co-investigator on this €5.2 million grant. Rebuilding Macroeconomics is a research network structured around a concept of Research Hubs. Each Hub addresses a specific "real world" macroeconomic issue and aims to ask relevant questions, chosen after extensive consultation with academics and the public. Hubs are settings for scholars and practitioners to explore and learn from each other, and to consider possible new methods of investigation. I am the leader for the 'Can Globalisation Benefit All?' Hub. I lead an interdisciplinary team of anthropologists, psychologists, policy makers, and macroeconomic modelers. The hub is there first to stimulate ideas and second, to provoke responses from different disciplines to the important question of 'can globalization benefit all?' The hub does this by creating spaces in which these ideas and disciplines can engage one another. These spaces can and must be online, they must be physical, and they must be able to grow themselves.

+CityXChange (2017 – present)

I am UL lead and workpackage lead for the +CityXChange project, an initiative with Limerick City and County Council designing positive energy districts. Limerick is a lighthouse city for Europe and will continue our work post the project through the creation of the citizen innovation lab in the new UL campus in Limerick City. My work on stock flow consistent systems has changed with the climate agenda. I now apply the models I have developed since 2010 in my second PhD to climate-related topics, through the +CityxChange project, where I am Principal Investigator, to the EPA-funded INCASE, project which is measuring and valuing natural capital, and adding those measurements in a stock-

flow consistent manner to the existing Irish national accounts to inform policy makers and guide their decision-making. A new project called SMARTLAB building on +CityXChange funded by SEAI launched in September 2022.

C. Key achievements supporting broader society & the economy

I have spent 15 years doing research to inform and impact policy. My goal as an academic is to spark meaningful and important conversations. I'm proud to say I have brought my academic research to the real world across multiple areas, from central banks to childcare to SME development, to the health service, to the creation of policies for new artists. Economics provides a powerful toolset, but the real world always requires more. Learning from others, incorporating their knowledge, and moving forward to make things better is always the objective. My work has direct impact on policy. I contribute to policy in three main ways.

First, my research is presented to, read by, and cited by, policy makers. Here are three

examples.

1. My 2016 report for the Health Research Board on strategic workforce planning has been referenced by the HSE, Department of Health, and World Health Organisation in developing their policies.

2. My 2015 report on financing early childhood education, Footsteps for the Future, was presented to the Department of Children and Minister James Reilly and informed his evolution of the nascent Early Childhood Education scheme.

3. My work with the School of Architecture's Intelligence Unit helped develop a policy for supporting artists currently being trialled by the Department of Social Protection. This work was published in Kinsella et al (2017). I also presented Limerick's European City of Culture bid in 2016.

Second, I participate more directly in the policy-making process as an office holder and as an informal advisor to Ministers and Secretaries-General, and as an independent expert advisory group member of bodies like the National Public Health Emergency Team (NPHET), the government's annual spending review, the Parliamentary Budget Office, the National Economic Dialogue, National Risk Assessment, the Higher Education Authority, and the Bank of England. I currently Chair the Expert Advisory Group of the Irish Government Evaluation Service.

Third, my work has a public impact, with keynote lectures, in 2021 alone for conferences for civil servants at the Departments of Finance and Social Protection, to organising events with the Central Bank of Ireland and European Investment Bank, to appearances before the Boards of Enterprise Ireland and the National Competitiveness and Productivity Council, to the general public at events like the MacGill Summer School (2021, 2020, 2016, 2014, 2013) and the Seán Mac Diarmada Summer School (2016), as well as events for the general public like Electric Picnic, Kilkenomics, and many more. I give public talks about once a month.

D. Key achievements supporting the research community

I regularly review articles for publication in the Economic and Social Review, where I am Associate Editor. I also review grants for the EU, Irish Research Council, and other bodies. I served on the research expert advisory group to NPHET with Prof. Mark Ferguson of SFI, and as Acting Chair of the HEA worked to improve connections between the research and policy communities. As Chair of the Irish

Government Economic Evaluation Service, and the only external member of the government spending review, I am committed to increasing the rigour with which public policy is conducted.

SECTION 2 – Publication Details (max. 2 pages)

A. SELECTED SENIOR-AUTHOR PUBLICATIONS

1. O'Clery, N. and Kinsella, S. (2022) Modular structure in labour networks reveals skill basins, Research Policy.Volume 51, Issue 5,
2. Caiani, Alessandro, Antoine Godin, Eugenio Caverzasi, Mauro Gallegati, Stephen Kinsella,
3. and Joseph E. Stiglitz. "Agent based-stock flow consistent macroeconomics: Towards a benchmark model." Journal of Economic Dynamics and Control 69 (2016): 375-408.
   Kinsella, Stephen. "Is Ireland really the role model for austerity?." Cambridge Journal of Economics 36, no. 1 (2012): 223-235.
4. Kinsella, Stephen, Matthias Greiff, and Edward J. Nell. "Income distribution in a stock-flow consistent model with education and technological change." Eastern Economic Journal 37, no. 1 (2011): 134-149.

B. OTHER PUBLICATIONS

1. Kinsella, Stephen. "Visualising economic crises using accounting models." Accounting, Organizations and Society75 (2019): 1-16.
2. Schasfoort, Joeri, Antoine Godin, Dirk Bezemer, Alessandro Caiani, and Stephen Kinsella. "Monetary policy transmission in a macroeconomic agent-based model." Advances in Complex Systems 20, no. 08 (2017): 1850003.
3. Schneider, Markus, Stephen Kinsella, and Antoine Godin. "Redistribution in the age of austerity: Evidence from Europe, 2006-13." Applied Economics Letters 24 (2017): 10
4. Xiong, Hang, Diane Payne, and Stephen Kinsella. "Peer effects in the diffusion of innovations: Theory and simulation." Journal of Behavioral and Experimental Economics 63 (2016): 1-13.
5. Raza, Hamid, Gylfi Zoega, and Stephen Kinsella. "Capital inflows, crisis and recovery in small open economies." Finance Research Letters 27 (2018): 273-282.

C. Kinsella, Stephen. "Remember: A Country Is Not a Company." Harvard Business Review 25(2013).

D. Kinsella, Stephen, Niamh NicGhabhann, and Annmarie Ryan. "Designing policy: collaborative policy development within the context of the European capital of culture bid process." Cultural Trends 26, no. 3 (2017): 233-248.

Applicant/Co-applicant/Funded Investigator CV Template

SECTION 1 – Applicant Details (max. 3 pages)

NAME AND CONTACT DETAILS

Name: Dr. Salim Saay
Dept of Computer Science and Information Systems
University of Limerick
Limerick, V94 T9PX, Ireland
Email: Salim.Saay@ul.ie

CAREER PROFILE (Education and Employment)

Currently, I am a Lecturer at the Department of Computer Science &Information Systems, teaching in the Immersive Software Engineering (ISE) course, course director of DevOps and Data Analytics at the University of Limerick, FI and a researcher with Lero, the SFI Research Centre for Software and Academic Collaborator in Confirm SFI project. I am a graduate of Computer Science (B.Sc Kabul University, M.Sc – the University of the Western Cape in South Africa and PhD- Tallinn University of Estonia.

Prior to my current role at the University of Limerick, I worked as Assistant Lecturer at Athlone Institute of Technology (AIT), and as a research fellow at Lero, I worked for 14 years as an Assistant, Associate professor at Kabul University in Afghanistan. Parallel to lecturing at the university I also worked in the government and different industries, during 2017- 2018 I worked as an IT and Research Network Advisor with the Army Institutional Advisory Team, NATO. From 2008 to 2014 I worked as Director of IT and Manager of AfgREN-Afghanistan Research and Education Network at the Ministry of Higher Education of Afghanistan. In 2014 we established a new technical University, and I worked as Acting chancellor of Ghazni Technical University, Afghanistan. I also worked with the United Nation Development Program (UNDP) from 2006 -2008 as Cisco lead Instructor and from 2004-2005 I worked with the GSI- Globecomm Systems Inc.

KEY ACHIEVEMENTS IN RESEARCH EXCELLENCE & IMPACT

A. Key Achievements in the Generation of Knowledge

Research: I completed my post-doctoral research fellowship, worked with Professor Tiziana Margaria in Lero- the SFI Research Centre for Software at the University of Limerick(UL) investigated "Application of XMDD as a key enabling technology to the interoperability of large-scale e-learning systems. We prototyped an e-learning broker for the data integration of e-learning systems that exist in a National Research and Education Network (NREN). This research was a future work for my PhD study. During my Ph.D. study, I developed an e_learning reference architecture based on national network infrastructure under the supervision of Prof Alex Norta at Tallinn University in Estonia. The reference architecture is designed based on broker technology for cross-organization collaboration, it is easily adaptable for cross-border organization collaboration and in different application domains. I was a member of the Bridging Application and Network Gap (BANG) research group at the University of the Western Cape in South Africa and we worked with several telecom companies, specifically I worked on the security of wireless mesh networks.

Industry/Government: The goal of my research is to solve a real problem that I found during my work as the manager of the Afghanistan Research and Education Network (AfgREN) which is funded by NATO, the European Commission, the US embassy, and the World bank. After

successfully connecting 31 public Universities in a single national network and connecting these universities to the GÉANT-the pan-European data network for research and education, I found that the data integration and interoperability problem exists in the e-learning systems and it is the same problem worldwide.

Funding awards: I have secured international funding for my study, and research as well as for developing the research infrastructure for the Universities and research organizations.
In 2018 we secured a fund for curriculum development of TVET(Technical and Vocational Education and Training), from the world bank we developed the curriculum and I wrote a textbook on IT Project Management, for the TVETs. I also secured another fund for the Analysis of University entrance exam for the graduates of TVET from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). In 2014 I succeed in a PhD scholarship funded by the Ministry of Foreign Affair of Estonia.
In 2010 I designed the network architecture of Afghanistan Research and Education and developed a strategic plan based on that strategy in 2013 we secured the amount 13Milion euros for the Implementation of AfgREN from NATO and the US embassy, Kabul.
before this fund, we secured the Nangarhar University Network Infrastructure Grant (NATO NIG Ref 985427). In 2012 we secured the Network Infrastructure grant for 7 Universities under the AfgREN project funded by the US Embassy, in 2011 the Kandhar University Network Infrastructure project was funded by NATO (NATO NIG 984349). In 2010 the Network expansion and Information security of Kabul-based Universities(NATO SPS.OPS NIG 984436). In 2009 the Managing academic Network Infrastructure training at the University of Groningen, Netherlands. Funded by the NATO. Additionally, In 2008 the CCNP: Building Scalable Internetworks training in Higher Colleges of Technology Abu Dhabi, was funded by the UNDP. In 2007 the Wireless Network and Network Security training at National Telecommunication Institute Cario, Egypt funded by UNDP. In 2006 my Master's degree scholarship in South Africa was funded by the United States Agency for International Development (USAID).

B. Key Achievements in the Development of Individuals and Collaborations

During my career to date, I have gained extensive experience both working in and leading teams. I led the teams in research and development and I have been a team member in multi-disciplinary projects co-funded by industry, national and international funding bodies.
Software Development (leading the team): from 2008-2012 we Developed the Higher Education Management Information System (HEMIS) with several modules including a student management system, HR management system, and hostel management system, I led the project and it was funded by the world bank. In 2008-2009 we Developed the University Entrance Exam, at the national examination organization, I was leading the project and the project was funded by USAID. From 2010-To to 2013 we developed 31 University websites that and the project was funded by USAID, as well as we during 2012-2013 we developed library management systems.

Conferences/Workshops (co-organizer): During my work in industry and academic organizations we organized a huge number of conferences and workshops, I categorized them and list those conferences that I worked as co-organizer on them**.**
From 2008 to 2014 we Organized annual National IT conferences in different fields of IT at the Ministry of Higher Education of Afghanistan, the university professors, IT companies and governmental organizations were invited to those conferences, and I secured the fund for these national conferences from DAAD- The German Academic Exchange Service. We also organized 8 international workshops for the National Research and Educational Network (NREN) in Dubai, Istanbul, and Kabul. The experts from NATO, European Commission, USAID, UNDP, and experts from the GÉANT-the pan-European data network for research and education and Asi@Connect was participating in these workshops, the workshops funded by NATO.

C. Key Achievements Supporting Broader Society & the Economy

I have a passion for sharing knowledge and experience through teaching and training. I have extensive experience in teaching technical material to non-technical users, both in academia and industry. Following are my efforts for supporting society and the economy.

- I am a strong advocate of education and research, and regularly collaborate with learners and researchers at varying levels. In 2017 I Established the Strategic Research Organization for Contemporary Science (SROCS) and gathered around 100 university professors and researchers to present their research our goal was to implement their research outcome. in 2010 I Established the Afghanistan Research and Education Network (AfgREN), and currently, around 186,000 students and around 5,876 academic staff use this network. In 2014 we Established, Ghazni Technical University, which currently has 50 buildings, two faculties, and around 1000 students, in the beginning before I move to Estonia I worked as acting chancellor of this new university. In 2011 I established the Irshad private school and currently it has around 600 students and 30 teachers that is one of the best schools in Kabul.

- **Volunteering:** during 2012 to 2014 I worked as a member of the DAWE- the E-government project at the Ministry of Communications and IT, Afghanistan. From 2011 to 2015 I was the Representative of the Virtual Silk Highway project to NATO/ EC. From 2010 to 2015 I worked as a representative of Afghanistan in the Trans-Eurasia Information Network (TEIN) project funded by the European Commission.
-

D. Key Achievements Supporting the Research Community

I have held several research roles, at different universities including the University of western cape south Africa, Kabul University, Tallinn University in Estonia, and the University of Limerick.

- Currently, I am the Co-Applicant of the Erasmus project Title: Blockchain for the Environment: Open Interdisciplinary Education on Generating Disruptive Change through Impactful DLT Applications, duration of the project is 01 February 2022 - 31 January 2025, and the partner of the project is researchers from the Tallinn University of Technology Estonia, Aalborg University Denmark and SUE (Netherlands) and University of Limerick.
- I am an AC of the AI-Driven Cooperating Behaviour to Enable True Collaboration in Human-Robot Interaction (CO-OP) in Confirm, the partner of the project is researchers from Tyndall National Institute, University College Cork, Insight Centre for Data Analytics and the University of Limerick.
- I am a Journal Reviewer of Advances in Science, Technology and Engineering Systems Journal (ASTESJ).
- In 2020 I contributed as a Program Committee Member of the 29th ACM international conference on information and knowledge management.
- From 2017 to 2019 I was a Member of the Kabul University research board and from 2016 to 2019 I worked as the head of the Computer Science Faculty research board at Kabul University.
- I contributed as a second reader to more than 10 master's degree dissertations and supervised five MSc dissertations at the University of Limerick and at Athlone Institute of Technology.
- I also contributed to the master's thesis review at Tallinn University in Estonia. Additionally, from 2016 to 2018 I supervised more than 20 master's degree projects in the area of software architecture, cloud computing and e-learning at Kabul University and Tallinn University.

SECTION 2 – Publication Details (max. 2 pages)

*Please **do not** exceed the maximum number of publications requested. Deviating from these instructions may result in the redaction of these details or make your application ineligible for review. Please briefly describe the importance/impact[1] of your publication and whether these publications are openly available*

A. SELECTED SENIOR-AUTHOR PUBLICATIONS

*Detail 3 peer-reviewed, senior-author (that is, first, joint-first or last author) primary-research publications, which will confirm, **where relevant**, that you meet the eligibility requirements for publications for this programme. Refer to the appropriate section of this call document for details on senior-authorship requirements. Preprints may only be included where a Digital Object Identifier (DOI) is quoted. **Note that publications where the applicant claims joint-first authorship will only be accepted as senior-author publications where the article clearly verifies this**.*

1. Saay, Salim and Tiziana Margaria, "XMDD as Key Enabling Technology for Integration and Organizational Collaboration: Application to E-Learning Based on NRENs," ASTES Journal. Learn., vol. 6, no. 6, pp. 54–75, 2021. DOI: 10.25046/aj060324

2. Saay, Salim, and Tiziana Margaria. "Model-Driven-Design of NREn Bridging Application: Case Study AfgREN." In 2020 IEEE 44th Annual Computers, Software, and Applications Conference (COMPSAC), pp. 1522-1527. IEEE, 2020. DOI: 10.1109/COMPSAC48688.2020.00-39

3. S. Saay and A. Norta, "An architecture for e-Learning Infrastructures on a National Level: a Case Study of the Afghanistan Research and Education Network," Int. J. Innovation. Learn., vol. 21, no. 1, pp. 54–75, 2018. DOI: 10.1504/IJIL.2018.088790

These three papers address system collaboration and data integration at the national level and cross-national levels. We designed the architecture, and we did the modelling and prototyping based on a Broker Technology. eLearning is the case study in these three papers, but the concept is not limited only to eLearning it can be adapted for organizational collaboration and data integration in different domains including health care, smart home and smart city, manufacturing and research.

B. OTHER PUBLICATIONS

You should list up to 7 other publications (where you are a senior author or otherwise) that you wish to be considered in the assessment of this application. You should ensure that your primary research outputs are prioritised; however, reviews, essays and any other secondary-research articles relevant to this application may also be listed.

1. Saay, S., & Margaria, T. (2020). XMDD as Key Enabling Technology for Integration of Large scale eLearning Based on NRENs. International Conference on Advanced Learning Technologies and Technology-enhanced Learning. IEEE Computer Society.
2. Saay, S., & Norta, A. (2018). Designing a Scalable Socio-Technical Method for Evaluating Large e-Governance Systems. In Advanced Computational and Communication Paradigms (pp. 571-580). Springer, Singapore.

[1] Number of citations is appropriate in this instance.

3. S. Saay, “a reference architecture for a national e-learning infrastructure,” Tallinn University, 2018.https://www.etera.ee/zoom/41462/view?page=3&p=separate&search=Salim%20AND%20Salim%20Saay&tool=search&view=0,0,2067,2834

4. S. Saay, M. Laanpere, and A. Norta, “Requirements for e-testing services in the AfgREN cloud-based e-learning system,” in Technology-Enhanced Assessment, 2017, pp. 142–146.

5. S. Saay, A. Norta, and M. Laanpere, “Towards an Architecture for e-Learning Infrastructures on a National Level: A Case Study of AfgREN,” in Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 2016, vol. 9584, pp. 13–22.

6. S. Saay and A. Norta, “A Reference Architecture for a National e-Learning Infrastructure,” in IEEE/ACM 9th International Conference on Utility and Cloud Computing, 2016, pp. 404–409.

7. S. Saay, “Toward authentication mechanisms for Wi-Fi mesh networks,” Computer, Science, vol. MSc, no. May 2011. https://etd.uwc.ac.za/xmlui/handle/11394/5275

Applicant/Co-applicant/Funded Investigator CV Template

SECTION 1 – Applicant Details (max. 3 pages)

NAME AND CONTACT DETAILS

Name: Roisin Lyons
Contact: roisin.lyons@ul.ie
Socials: @rolyonz; Linkedin
Academic: ResearchGate; Google Scholar

CAREER PROFILE (Education and Employment)

- **Education:** B.Sc in Chemistry & Biology (UL); Higher Diploma in Ed. (UL); M.Sc. Business Management class (DCU, 1st in class); Ph.D in Entrepreneurship Education (DCU).
- **Current Position:** Lecturer of Entrepreneurship and Innovation, University of Limerick (Kemmy Business School).
- **Past Employment of Note:** *(Note – there are no periods of leave from employment or research)*
    - Assistant Professor of Entrepreneurship and Innovation, Dublin City University Business School (2016 - 2021)
    - Lecturer (Marketing & Innovation/Management Communications), Princess Nora University (DCU@PNU) (Jan 2014-June 2015), Riyadh, Saudi Arabia.
    - Lecturer (New Enterprise Development; DICE), Dublin City University (Sept 2011-2016); multiple subjects, Dublin Business School (2012-2014).
    - Course Developer, Teaching Assistant (2010-2011).
    - Secondary School Science (Biology/Chemistry) teacher, Coláiste Choilm Ballincollig

- **International Experience:** 8+ involvement in the DCU@PNU partnership with Princess Noura University (Saudi Arabia). I was on the original team to travel to KSA in 2013, and have since created and delivered numerous modules including Communications; Marketing of High Technology; Entrepreneurship; Business and Society, and New Enterprise Development.

KEY ACHIEVEMENTS IN RESEARCH EXCELLENCE & IMPACT

A. Key Achievements in the Generation of Knowledge

- Research (quantitative) focuses on development of entrepreneurial tendencies (entrepreneurial self-efficacy, intentionality, passion etc.), and the impact that factors such as education, teamwork, and more recently, the start-up workplace, has on the nascent or evolving entrepreneur. PhD research and publications provide much needed discussion on resources needed to develop entrepreneurial talent within education, and in the start-up environment. In particular, a recent publication in Small Business Economics examines the role of social sexual behavior in the start-up workplace, noting the need to investigate human resource and workplace norms in fast-growing entrepreneurial firms.
- Specialist in the area of innovation pedagogies. Much scholarly research and teaching centres on the development and testing of robust pedagogies to stimulate innovative thinking. These include novel teaching methods such as hackathons and online interventions, which are of value to wider education and industry.
- National lead for the Global University Entrepreneurial Students Spirit Study (GUESSS), which requires that I disseminate the survey to multiple Irish HEI's, and create a national report biannually. This project and report offers enables me to position myself as a thought-leader in the area of entrepreneurial education in Ireland, and provides access to use and analyse the entire global dataset (which in 2018 > 208k student responses, 2021 >250k) which can be used to create many paper collaborations and benefits.
- Currently compiling longitudinal research database on the efficacy of hackathons – considered to be the most robust to date in the research field.

B. Key Achievements in the Development of Individuals and Collaborations

- Module developer of over 10+ new modules to date. The LIFE (Learning Innovation for Enterprise) module which I developed in 2019 for all Business students in DCU, has won numerous awards including the 'AACSB Innovations that Inspire' award.
- Creator of the DCU Hack4Change Social Innovation Hackathon series. Developed and ran a series of 5 daylong hackathons involving over 600 students and 100 industry experts in 2020 and 2021 (Mental Health), Tues (Fast Fashion); Wed (Smarter Travel), Thurs (Climate Action, Fri (Diversity & Inclusivity). I handled all sponsorship, marketing, resources, planning, and management.
- BTSYE Young Scientist Judge (2018- current).
- Enactus Social Entrepreneurship student faculty advisor
- Student Entrepreneurship support. Have mentored a number of student entrepreneurs on a continual basis, and have acted as mentor and judge in over 30+ start-up events. As part of the DCU-PNU partnership, I created an annual Shark Tank/Dragons Den event, attended by key Saudi investors and government officials. In addition, I worked closely with Saudi staff to help transform their courses to include sustainability and social enterprise topics.
- Thesis Supervision: Have supervised multiple Postgraduate Thesis and Group Thesis (Applied Practicum) projects (DCU, Dublin and DCU, Saudi Arabia. 2017-Present).
- Created a partnership with 'Teach a Man to Fish' non-profit, facilitating the use of postgraduate DCU students as junior judges for enterprise competition in the developing world (2014-2020).
- Annually run pedagogy and assessment workshops for new teaching staff. Have also been an active member of many diverse working groups including the national CSR policy group, curriculum development initiatives, DCU community garden, building enterprise into engineering education and more.
- Group member on numerous international projects including:
    - GCSO Capacities Project: Examining the use of gamification and serious games to encourage stakeholder participation for sustainable development. International project led by Arizona State University
    - GETM3 Interdisciplinary research and innovation project funded by the EU's Horizon 2020 (https://getm3.eu/). Visited Korea and Newcastle as part of research secondment and sandpit events. Multiple research outputs.

C. Key Achievements Supporting Broader Society & the Economy

- During the Covid-19 lockdown, I co-founded a voluntary organisation (teamosv.com) as an online open innovation platform and community (+3000 members internationally). This community ideated and developed many solutions for emergency needs during the crisis, and served to unite innovators across the country and world. I was awarded funding (DCU Covid Hub) to study the efficacy of such open-innovation online communities during times of crisis and am collaborating with international experts in the field and the SFI funded engineering team (I-Form).
- I spearheaded the integration of a student component to StartUp Week Dublin in 2019 as University Track Captain, overseeing the creation of 9 events across 3 Dublin HEI's, and which saw an attendance of over 900 students to these external entrepreneurship seminars and events.
- European Commission's - European Social Economy Regions (ESER) project: (Reviewer and Researcher) Piloting and providing feedback to a new 'Social Economy (SE) Canvas'. Talks underway to lead academic research into action research process of tool development and testing. Piloted early test of tool at Social Innovation hackathons (March, 2020). Presenting at the European Commission ESER online seminar "Social economy and importance of educational dimension" (11 September 2020).

- Enterprise Ireland Innovation Voucher – funded projects (PI)
    - 2021: [€5000] Lyons, R. & Robbins, P. Future of Work. Study and Report for WorkJuggle
    - 2019: [€5000] Lyons, R. & Robbins, P. Design Thinking for the Flexible Professional Workforce. Design Thinking Workshop conducted and Research Report submitted to 'Talentforce Recruitment'.
    - 2015: Enterprise Ireland Innovation Voucher [€5000]. Lyons, R. & Hunt, G. Step down care: Developing an Innovative Approach. Research Report submitted to 'Codládh Samh', research conducted with multiple nursing homes to create a new business module for step-down care.

D. Key Achievements Supporting the Research Community

- Creator and Organiser of **'DCU and the SDG's'** Research Day 2019. Received DCU funding to encourage research activity relating to the SDG's in the University. Ran an academic collaborative event attended by over 350 individuals.
- 'GET' conferences – Have assisted in the co-ordination and running of over 16 conferences in the Helix, Dublin which are usually attended by over 600 guests.
- Accreditation/Interview panel member: National College of Ireland (2020); Trinity College Dublin (2020); Atlantic Technological University (2022); Dublin Business School (2022).
- External Examiner: Cork Institute of Technology – Entrepreneurship (2020- Current)
- Mendeley Support Advisor – Ireland (Referencing Software) 2013-2017
- I have held numerous roles within academic conferences including participating as a moderator and facilitator of workshop sessions (Entrepreneurship Summer University 2013-date), chairing events (3E Conference 2019, IAM 2020), and organising sessions (doctoral colloquium AIS International Conference on Information Systems (ICIS) 2016).
- I have acted as reviewer for multiple publications in the entrepreneurship field. These include American Journal of Entrepreneurship (International); IJEBR; RENT Anthology 2019: Frontiers in European Entrepreneurship Research (International); Sustainability; Journal of Product Development; APIR; IJGE; IJM; JSBM.

SECTION 2 – Publication Details (max. 2 pages)

*Please **do not** exceed the maximum number of publications requested. Deviating from these instructions may result in the redaction of these details or make your application ineligible for review. Please briefly describe the importance/impact[1] of your publication and whether these publications are openly available.*

A. SELECTED SENIOR-AUTHOR PUBLICATIONS

*Detail 3 peer-reviewed, senior-author (that is, first, joint-first or last author) primary-research publications, which will confirm, **where relevant**, that you meet the eligibility requirements for publications for this programme. Refer to the appropriate section of this call document for details on senior-authorship requirements. Preprints may only be included where a Digital Object Identifier (DOI) is quoted. **Note that publications where the applicant claims joint-first authorship will only be accepted as senior-author publications where the article clearly verifies this**.*

1. Lyons, R. and Buckley, K. (2020). Stakeholder Engagement in a Large Enterprise Class Showcase. *Journal of Management Education*, 45(3), pp.404–437. https://doi.org/10.1177/1052562920969908

2. Lyons, R., Brown, M. & Donlon, E. (2021). Moving the Hackathon online: reimagining pedagogy for the Digital Age. *Distance Education in China*, 8, 60-70. DOI:10.13541/j.cnki.chinade.2021.08.007

3. Lyons, R., Lynch, C & McConalogue, E. (2022). Looping Everyone into the Conversation: The Use of Eportfolio as a Multistakeholder Feedback Tool, *Irish Journal of Technology Enhanced Learning* *6*(1), 174–185. https://doi.org/10.22554/ijtel.v6i1.85

B. OTHER PUBLICATIONS

1. Belchoir, R., & Lyons, R. (2022). An exploration of changing student entrepreneurial motivators – A longitudinal analysis, *International Journal of Entrepreneurial Behavior & Research* 28(1):151-181. https://doi.org/: 10.1108/IJEBR-05-2021-0417

2. Gillanders, R., Lyons, R., and van der Werff, L. (2021). Social sexual behaviour and co-worker trust in start-up enterprises. *Small Business Economics*, 57(2), pp.765–780. https://doi.org/10.1007/s11187-020-00381-5

3. Belchior, R.F. & Lyons, R. (2021). Explaining entrepreneurial intentions, nascent entrepreneurial behavior and new business creation with social cognitive career theory – a 5-year longitudinal analysis. *International Entrepreneurship and Management Journal*. https://doi.org/10.1007/s11365-021-00745-7

4. Lyons, R., Lynn, T., & Mac an Bhaird, C. (2015). Individual Level Assessment in Entrepreneurship Education: An Investigation of Theories and Techniques. *Journal of Entrepreneurship Education, 18 (1)*, 136-156.

5. Stephens, S., Lyons, R. & Cunningham, I. (2021) The decision-making environment for the entrepreneurial student. Journal of Enterprising Culture, 29*(1),* 65-78. https://doi.org/10.1142/S0218495821500047

[1] Number of citations is appropriate in this instance.

6. Bi, T., Lyons, R., Fox, G. & Muntean, G. (2020). Improving Student Learning Satisfaction by using an Innovative DASH-based Multiple Sensorial Media Delivery Solution. *IEEE Transactions on Multimedia.* https://doi: 10.1109/TMM.2020.3025669.

7. Lynn, T., Lyons, R., & Kenny, G. (2017). Don't Make the Player, Make the Game: Exploring the Potential of Gamification in IS Education. *23rd Americas Conference on Information Systems (AMCIS 2017)*.

Applicant/Co-applicant/Funded Investigator CV Template

Please note that your full research funding track record and supervisory details should be uploaded via SESAME and should **not** be included in this CV. Please **do not** include any type of journal or publication metrics, e.g. impact factor and h-index[1], or refer to the total number of papers you have authored or co-authored. Deviating from these instructions may result in the redaction of these details or make your application ineligible for review.

SECTION 1 – Applicant Details (max. 3 pages)

NAME AND CONTACT DETAILS

Name: Dr Katie Crowley
Email: katie.crowley@ul.ie

CAREER PROFILE (Education and Employment)

I am currently a Lecturer in Computer Science at the University of Limerick, FI and researcher with Lero, the SFI Research Centre for Software and a visiting fellow with the Centre for Innovative Human Systems in Trinity College Dublin. I am a graduate of Computer Science (B.Sc and Ph.D), University College Cork, (M.Sc - University of Limerick) with interdisciplinary research, teaching and project management experience across multiple domains and institutions.

Prior to my role at the University of Limerick I was a project lead with the IMaR research group, Munster Technological University Tralee, on an industry partnered SFI CONFIRM program of research. In Trinity College Dublin I worked with the Centre for Innovative Human Systems, in partnership with Lero, focusing on the support and management of national and international research proposals and submissions, and with SFI ADAPT as part of a multidisciplinary team on a global industry partnered research program in the automotive space.

I led an Enterprise Ireland Industry Partnership Program between Trinity College Institute of Neuroscience and a marketing company, and held an SFI Industry Fellowship where I worked with Logitech. Cork. I have extensive research and teaching experience, and I have worked in, and with, many of the key academic institutions in Ireland, including TCD, UCC, UL and MTU. I also have experience working in, and with industry, including for a number of tech and software start-ups.

KEY ACHIEVEMENTS IN RESEARCH EXCELLENCE & IMPACT

A. Key Achievements in the Generation of Knowledge

My research area is interdisciplinary, encompassing Affective Computing, Human Computer Interaction, and Digital Health, equipping me with transferable and scalable expertise. I have secured national funding for my own research as well as being actively involved in international research with academic and industry partners.

- I secured funding from the Irish Research Council (IRCSET – Science, Engineering & Technology) to carry out research on the elicitation and measurement of stress using wearable technology. I was an early adopted of Brain Controller Interfaces and developed

[1] Examples include, but are not limited to, H-index, i10-index, G-index, H(2)-index, HG-index, Q2-index, AR-index, M-quotient, M-index, W-index, Hw-index, E-index, A-index, R-index, W-index, J-index

an analysis technique for the raw data output that led to the device manufacturer publishing a white paper and guidelines based on my research (Crowley et al 2010; NeuroSky). I also developed a framework for the elicitation of speech under stress as part of this research.

- I held an SFI Industry Fellowship award where I worked with Logitech working on affective computing and AR/VR technologies. As part of this work, I was instrumental in the research and design phases of a new keyboard for virtual reality (Bovet et al 2018; 2019), which was later patented by the company (Patent #10817128) (I was not listed on the patent as a non-employee).

B. Key Achievements in the Development of Individuals and Collaborations

During my career to date I have gained extensive experience both working in and leading teams. I have been a team member in multi-disciplinary international research projects co-funded by industry and national funding bodies.

- External Funding Consultant, *IMaR, MTU Tralee*: I was hired as an external consultant to co-author a successful funding proposal for the Human Capital Initiative Pillar 3, Innovation and Agility call, *Rethinking Engineering Education in Ireland (REEdI)*, funded for €8.95m. REEdI, aligned with R@ISE, will transform the way we deliver undergraduate engineering education in Ireland. The project is innovative, drawing on international best practice in the field of engineering education which will enable a student centred, project centric and technologically innovative approach to course provision, equipping graduates with the skills and knowledge required to ensure they industry ready.
- Research Coordinator, *Centre for Innovative Human Systems, TCD*: In partnership with ADAPT and Lero, I worked with interdisciplinary teams on Non-Exchequer, Non-Commercial funding proposals with diverse stakeholders from academia to industry, forging strategic alliances and multi-disciplinary partnerships, and building effective research consortia. In this role I coordinated research proposals and mentored colleagues working on the full lifecycle of proposals from definition, to development, and to submission.
- I am currently the UL lead on WiSTEM2D. The Johnson & Johnson WiSTEM2D Programme aims to fuel development of the female STEM2D talent pipeline by awarding and sponsoring women at critical points in their careers, in each of the STEM2D disciplines: Science, Technology, Engineering, Math, Manufacturing and Design. As a female in Computer Science I am extremely passionate about this programme. I have also completed programmes for *Supporting Women in Academia*, and *Universal Design for* Learning, to support equality, diversity and inclusion in my teams and mentoring. I am part of a mentoring network for all these programmes where I continue to work closely with my colleagues to promote these values in our work.

C. Key Achievements Supporting Broader Society & the Economy

I have a passion for sharing knowledge and an enthusiasm for teaching and training. Contributing to, and nurturing the mind-set of a student is profoundly satisfying. I have extensive experience teaching technical material to non-technical users, both in academic and industry settings.

- I am a strong advocate of 'education for all' and 'lifelong learning', and regularly work with learners at varying levels and abilities including Disability Support Services and Access

programmes. I have completed a course in *Universal Design for Learning (UDL).* The overarching aim of UDL is to create expert learners by developing a mastery of learning itself, which they can use successfully in future learning settings and in the world of work. Providing learners with scaffolds in more than one format and with multiple ways of engaging gives them a reason to want to continue learning, and to connect their previous experiences in a meaningful way.

- I am regularly involved in outreach programmes, educating and engaging the community about technology and computer science, including second-level students. I have gained valuable insights into the expectations and needs of these students and believe that the *Immersive Software Engineering* course will deliver a truly unique and transformative learning pathway. I have a particular interest in encouraging women in STEM, as part of the WiSTEM2D programme outlined above.
- I have worked on a number of industry partnerships collaborating with the public and private sector on research projects. I have held a Science Foundation Ireland Industry Fellowship (PI) grant, and led an Enterprise Ireland Innovation Partnership Programme where I was responsible for directing and conducting applied research; stakeholder engagement; grant management; project management and supervision of research assistants and students. I also secured an Enterprise Ireland Innovation Partnership Feasibility grant for a collaboration with an industry partner.

D. Key Achievements Supporting the Research Community

I have held a number of research roles, working with interdisciplinary teams, in a number of Irish universities including University College Cork, Trinity College Dublin, Munster Technological University, and currently, the University of Limerick. I have experience working with, and in industry, including roles where my duties included identifying and pursuing funding opportunities that aligned with the specific research capabilities of my team through extensive networking.

- Research Coordinator (TCD)/Research Support Officer (UCC): In my role with CIHS, TCD I coordinated research proposals and mentored colleagues working on funding calls, with a particular focus on Non-Exchequer, Non-Commercial funding calls. I edited, reviewed and evaluated funding proposals for my colleagues and helped them to identify suitable consortia members and grow their research networks. As a Research Support Officer in UCC I worked with undergraduate and postgraduate students assisting them with the preparation of scholarship proposals and funding calls. As part of this role I ran workshops for students on ethics and research integrity. I also supported staff with funding applications.
- I currently supervise 6 Masters students (4 taught/2 by research) and 1 PhD student. I have received funding for a second PhD student that I am currently recruiting. I regularly support research activities within my department and university including volunteering for internal progression boards, participating in vivas and mock-vivas, and reviewing draft publications and funding proposals for colleagues. I am a reviewer on a number of journals in my field including Springer, Wiley, and IEEE publications.
- I am a member of a support network for female academics that was formed as part of a programme on *Supporting Women in Academia*. This is an all-female multi-disciplinary network established to support and mentor one another in our teaching and research roles. I currently lead the UL WiSTEM2D programme in collaboration with Johnson & Johnson.

SECTION 2 – Publication Details (max. 2 pages)

*Please **do not** exceed the maximum number of publications requested. Deviating from these instructions may result in the redaction of these details or make your application ineligible for review. Please briefly describe the importance/impact[2] of your publication and whether these publications are openly available.*

A. SELECTED SENIOR-AUTHOR PUBLICATIONS

*Detail 3 peer-reviewed, senior-author (that is, first, joint-first or last author) primary-research publications, which will confirm, **where relevant**, that you meet the eligibility requirements for publications for this programme. Refer to the appropriate section of this call document for details on senior-authorship requirements. Preprints may only be included where a Digital Object Identifier (DOI) is quoted. **Note that publications where the applicant claims joint-first authorship will only be accepted as senior-author publications where the article clearly verifies this**.*

1. Crowley, K., Sliney, A., Pitt, I., & Murphy, D. (2010, July). Evaluating a brain-computer interface to categorise human emotional response. In *2010 10th IEEE International Conference on Advanced Learning Technologies* (pp. 276-278). IEEE. DOI: 10.1109/ICALT.2010.81

   This paper investigated the suitability of off-the-shelf wireless brain controller interfaces to detect physiological markers of and attention and stress. This paper is referenced in Section A above.

2. Crowley, K., & Balfe, N. (2018, July). Investigation of train driver physiological responses. In *Proceedings of the 32nd International BCS Human Computer Interaction Conference 32* (pp. 1-9). http://dx.doi.org/10.14236/ewic/HCI2018.5

   This paper investigated the suitability of wearable devices to detect physiological markers of stress in an ambulatory environment.

3. Pitt, I., Mehigan, T., & Crowley, K. (2016, July). Using biometrics to support affective eLearning for users with special needs. In *International Conference on Computers Helping People with Special Needs* (pp. 487-490). Springer, Cham.

   This paper concerns the use of biometric technology as a means to improve delivery of eLearning material to learners with special needs.

[2] Number of citations is appropriate in this instance.

B. OTHER PUBLICATIONS

You should list up to 7 other publications (where you are a senior author or otherwise) that you wish to be considered in the assessment of this application. You should ensure that your primary research outputs are prioritised; however, reviews, essays and any other secondary-research articles relevant to this application may also be listed.

1. Cahill, J., Crowley, K., Cromie, S., Kay, A., Gormley, M., Kenny, E., ... & Ross, R. (2020, July). Driver Persistence, Safety and Older Adult Self-efficacy: Addressing Driving Challenges Using Innovative Multimodal Communication Concepts. In *International Conference on Applied Human Factors and Ergonomics* (pp. 313-319). Springer, Cham.

2. Cahill, J., Crowley, K., Cromie, S., Doyle, C., Kenny, E., Kay, A., ... & Ross, R. (2020, July). Advancing a 'Human Factors & Ethics Canvas' for New Driver Assistance Technologies Targeted at Older Adults. In *International Conference on Human-Computer Interaction* (pp. 503-520). Springer, Cham.

3. Cahill, J., Crowley, K., Cromie, S., Kay, A., Gormley, M., Kenny, E., ... & Ross, R. (2020). Ethical Issues in the New Digital Era: The Case of Assisting Driving. *Security and Privacy From a Legal, Ethical, and Technical Perspective*.

4. Bovet, S., Kehoe, A., Crowley, K., Curran, N., Gutierrez, M., Meisser, M., ... & Rouvinez, T. (2018, August). Using traditional keyboards in vr: Steamvr developer kit and pilot game user study. In *2018 IEEE Games, Entertainment, Media Conference (GEM)* (pp. 1-9). IEEE.

5. Balfe, N., Crowley, K., Smith, B., & Longo, L. (2017, June). Estimation of train driver workload: extracting taskload measures from on-train-data-recorders. In *International Symposium on Human Mental Workload: Models and Applications* (pp. 106-119). Springer, Cham.

6. Crowley, K., Sliney, A., Pitt, I., & Murphy, D. (2011, July). Capturing and using emotion-based BCI signals in experiments; how subject's effort can influence results. In *Proceedings of HCI 2011 The 25th BCS Conference on Human Computer Interaction 25* (pp. 132-138).

7. Crowley, K., & Pitt, I. (2013). Monitoring User's Emotions Using Brain Computer Interfaces. In *Tools for Mobile Multimedia Programming and Development* (pp. 151-167). IGI Global.

Programme Documents

[ISE]

UNIVERSITY OF LIMERICK
OLLSCOIL LUIMNIGH

R@ISE | Research at ISE

Consortium:

University of Limerick
Prof. Tiziana Margaria (applicant, PI)
Prof. Stephen Kinsella (co-PI)
Prof. Mike Hinchey (co-PI)
Dr. Katie Crowley (FI)
Dr. Salim Saay (FI)
Dr. Roisin Lyons (FI)

Collaborators:

JJ Collins (UL)
Dr. Victor Cionca (MTU)
Prof. Bernhard Steffen (TU Dortmund, D)
Prof. Arend Rensink (TU Enschede, NL)
Prof. Axel Legay (UC Louvain, B)
Prof. Wang Yi (U. Uppsala, S)
Prof. Cristina Seceleanu (MTH, Västerås, S)
Prof. David Fisher (Rose-Hulman Inst. of Techn., Indiana, USA)
Prof. Gabriel Miro-Muntean (DCU)
Prof. Gerardo Schneider (Chalmers, S)
Prof. Graziano Pravadelli (Verona, I)

Co-funding partners:

stripe ANALOG DEVICES tines TRACWORX Johnson&Johnson Comhairle Cathrach & Contae Luimnigh Limerick City & County Council

software-engineering.ie

Appendix III: TEMPLATE A (For SFI Budget request of less than €2.5M)

i. Goals of the partnership

R@ISE: The catalyst Ireland needs to develop its high-assurance low-code/no-code capability

Software increasingly pervades every aspect of our society and economy. Software development has never been more important, and yet organizations are struggling to find enough skilled developers. Businesses have an unmet need for code that works. Low-code is a new way for developers of all skill levels to design applications quickly and with minimum hand-coding[1]. No-code is a way to help those who may not know how to program but want to develop an application for their specific use case[2]. Low-code and no-code (LC/NC) development tools enable the rapid deployment of powerful computerized functionalities without the need for a developer to have deep knowledge of the underlying platform or of computer science. LC/NC development tools speed up the delivery of applications. LC/NC tools have been used by governments around the world to handle the spread of COVID-19[3].

LC/NC can meet the unmet needs of government and business. Digital businesses' demand for ever-more software ever-more-quickly is the big driver of LC/NC adoption. In an influential report, Gartner[4] predicted in 2019 that **by 2023, over 50% of medium to large enterprises will have adopted low-code or no-code** as one of their strategic application platforms. In 2021, Gartner forecasted that by 2025, the value of these technologies will reach $29 billion, with a compound annual growth rate of over 20%[5]. Gartner also predict that by 2025, 70% of new applications developed within enterprises will use no-code or low-code technologies[6].

Given these trends and the national importance of software and AI, **the goal of the Research at Immersive Software Engineering (R@ISE) programme is to act as a catalyst for the development of a strong research and application LC/NC capability for Ireland.** R@ISE is uniquely placed to accelerate this development into the future of LC/NC with industry partners like Tines, ADI, Stripe, J&J, and Tracworx who are already constructing that future with the Immersive Software Engineering (ISE) degree at UL. We will also partner with Limerick City and County Council to embed LC/NC approach within a public policy context.

We propose **R@ISE** as the research catalyst platform of a unique industry partnership supporting the development and adoption of technologies, methodologies and test beds of national strategic importance that harnesses national and international academic knowledge with industrial know-how and experience in LC/NC.

R@ISE's impact will be

1. A comprehensive platform for LC/NC development for Ireland.
2. A shared cohesive vision and strategy for the growth of LC/NC research, education and tool development
3. An unprecedented level of participation and partnership of academic and industry partners committed to the LC/NC vision.
4. The extended dissemination of high-calibre and research-led insights relating to the evolving LC/NC field.
   The exponential growth of high-class LC/NC deployment by small and large actors, furthering increased corporate automation and revenue generation on a national scale.

ii. Background and significance of the research question

Background

Low-code/No-code today.

Both industry and research are trying to democratize high quality software development, making it more manageable and less wasteful of human time and resources.

The current state-of-the-art in the area is that industry is proceeding at high speed to create, acquire and adopt LC/NC platforms. The Gartner Magic Quadrant 2020 report for Enterprise Low-Code Application Platforms (LCAP)[7] lists Microsoft, Oracle, Salesforce, Appian, and Mendix (acquired by Siemens) as global players that are heavily invested in LCAP. The domain is evolving rapidly, see the 2019/2020 Magic Quadrants comparison.

As Tarun Xathri, head of the Appian practices and co-founder at Xebia, recently stated, "*Software may be eating the world, but low code could eat software*"[8].

Sites popular in the developer community list over 150 LC/NC tools. Most of these platforms a) are application specific, b) their graphical models lack a mathematical underpinning, therefore c) do not provide analysis mechanisms beyond what we know from traditional coding: execution-based breakpoint placement and testing on the generated, deployed

application. They feature the same produce, deploy, wait and see approach as in traditional systems, as the quality assurance happens almost entirely at runtime, at the code level.

LC/NC tools **do not leverage the model for early correctness and quality**. Surprisingly, even tools with these shortcomings have **huge benefits for the adopters**. For example, the Microsoft Low code Trend Report 2022[9] provides quantitative analyses for the Microsoft Power Platform that show a substantial improvement compared with the data we see in customary empirical software engineering studies about developer satisfaction with specific technologies. In the report, "*Of those surveyed in a recent Microsoft study**, 82 percent of low- or no-code users agree that the technology helps provide an opportunity for software users to improve their development knowledge and technical skills**. In addition, the use of no-code or low-code platforms or apps is shown to have led to an **83 percent positive impact on work satisfaction and workload** by users, and an **80 percent positive impact on morale** by users*."

While we do not think that LC/NC is the silver bullet, and we are aware that LC/NC has limits, these numbers witness the high level of inefficiency and frustration developers and users feel with the traditional high-code software development process. "*Embracing low-code or no-code platforms can also help combat the IT industry's gender disparity. Currently, fewer than 20 percent of cloud computing professionals are women. In addition to filling the aforementioned skills gap, gender-diverse businesses are shown to perform better*[10]*, and advancing gender equality could add up to $13 trillion to global GDP in 2030*.[11]"

Low-code tools are synonyms for quick prototyping to design and develop digital products, freeing designers to focus on look and feel and content. A significant challenge exists in merging this new product category with key differentiator concepts such as user experience (UX). The value of UX in the design process has significantly increased in the last 10 years. In their 2018 "*The business value of design*" report, McKinsey reported a two-to-one improvement in revenue, and a 21% increase to shareholders for companies that are strong in UX practice vs. companies that are not. LC/NC uses strict rules, or guardrails that a user must follow to achieve their result. UX can be lost in this process. In an interview with Acceleration Economy, Jason Beres, Head of Indigo.Design, believes that many low-code tools don't offer much for interaction and usability testing. "*So many applications today fail because the developer just starts building*," he said. Bringing in more stakeholders from day one and involving iterative user testing throughout the design process is crucial for creating functional, pleasant app experiences.

The convenience of low-code shouldn't come with a UX sacrifice, and R@ISE will address this. The startup field in this area is growing rapidly: a May 2021 study by two VC funders[12] discussed 145 newcomer companies, showcasing their enormous transformational potential for the "***democratisation of software development**, unlocking the potential that digitisation brings to anyone that has access to a computer or a phone & the internet*", as well as the **economic potential for entrepreneurs and investors** alike: "*The momentum is so strong that some see it as a craze, comparable to the chatbots-, ICOs-, and cannabis-related explosions we saw in recent years…*" They distinguish twelve categories, from Form, website and app builders to workflow automation, but there is no general-purpose category.

This is where the R@ISE platform belongs.

*In the R@ISE context, **J&J** and **ADI** are large multinational companies interested to adopt low-code technologies, but the question is which low-code platform, and how to ensure that the products have the same or ideally even better characteristics than their current (often safety or business critical) software artefacts. **Tines** is a successful provider of their own automation software, their keen interest is in the evaluation of the effects of LC/NC on productivity and satisfaction of all the stakeholders, as well as in the improvement of the quality of the platform and its products. Adding FM in that context seems a natural next step. **Stripe** and **Tracworx** are providers of external capabilities (payments, asset tracking) and potential testers/adopters of the new technologies, and the LCCC is eager to test and evaluate the new technology in the context of their own digital transformation and smart city initiatives.*

Key to our language- and model-driven approach to LC/NC development and engineering is the interplay of two aspects: Low-Code as means of expression for non-programmers, and Language Workbenches. We turn to these aspects now.

Low-Code: Languages for Non-Programmers

Fowler characterizes in [22, p.34] the role of – in his case, textual – DSLs: "it's not that domain experts will write the DSLs themselves; but they can read them and thus understand what the system thinks it's doing". In contrast, several (graphical) DSLs used by non-programmers became successful in dedicated application domains, like MatLab/Simulink [37], ladder diagrams [28], and Modelica [23]. The understanding that one should address application experts with graphical notations is also shared by the developers of the KIELER framework [24], which has meanwhile evolved into the Eclipse incubation project Eclipse Layout Kernel (ELK) [1]. KIELER provides means to automatically generate domain-specific graphical views for textual DSLs realized in the Eclipse modelling context. However, they follow Fowler's point of view: KIELER's primary goal is to provide views to better communicate with non-programmers, but creating the actual (textual) models still requires programmers or highly technical experienced domain experts. Graphical models seem more

appealing to non-programmers. For over two decades, generating executable code from graphical process models has been the underlying basis for the jABC framework [46].

More recently, DIME's [16] process models are heavily inspired by jABC's Service Logic Graphs, and it is more flexible, as it builds on top of a language workbench. Full code generation from graphical languages is also key concept of domain-specific modelling (DSM) [31], which originated around the same time as jABC . It adopts a Language Driven Engineering approach (LDE)[45,34] that allows tailoring the graphical representation and of the semantics of the language to the specific needs of the domain and their concerns, Capabilities (called mindset) of the target users.

Prominent current low-code development platforms like Mendix [39], Bubble [17], or Salesforce Lightning [43] also focus on (graphical) specifications of workflows. They do it in a process model or flow graph-style using manually programmed, application-specific activity blocks. These approaches address situations where a process-oriented combination of predefined building blocks is adequate. This strongly depends on a good fit of such a mindset with the mindset inherent in the addressed application.

Larger software companies have invested heavily in developing low-code platforms, e.g., Google with AppSheet [15] or Microsoft with Power Apps [40]. While not focusing on graphical languages, their table-centered structure works well for domain experts already used to spreadsheet office applications.

Concerning model-driven web application development, the research presented in [16] explores how model-driven approaches can support the transition to the Web 2.0. It uses models to capture important social and technological aspects that arose with that transition. The beContent project [19] designs a programming system where graphical models and textual programming of a web application are synchronized with a round-tripping process. In contrast, DIME eliminates the round-tripping process by implementing full code generation.

The Language-Oriented Programming (LOP) approach of the Racket team [21] is very similar to LDE concerning the explicit support of multi-DSLs. In fact, LOP advocates multiple cooperating languages for a project, has a feature called FFI (foreign-function interface) similar to the notion of native services in DIME, and uses a meta language 'syntax parse' to define languages.

There are clear conceptual differences which limit the cooperation with non-programmers: LOP uses internal DSLs (called embedded Domain- Specific Languages (eDSLs)) based on a single host language: Racket [10], one of the successors to Lisp [51] which in [14] received an additional (manually drawn) graphical notation for readability, next to the exemplary DSL code, as an add-on. The members of the Racket team do not consider their DSLs as an adequate vehicle for communication with non-programmers.

The Lowcomote [49] MSCA ETN is a EU-Funded research training network started in 2019, exploring current challenges in low-code development platforms. Leveraging model-driven engineering, machine learning and cloud computing, An explicit goal is the integration of heterogeneous models from different disciplines. However, the 15 PhD students are working on separate projects across 5 institutions and many industrial partners, it is unlikely to produce a coherent development platform with its application and evaluation as we are proposing in R@ISE.

Tiziana Margaria and Bernhard Steffen have developed the vision of LDE for over two decades, with a comprehensive metamodeling framework for graphical DSLs, including model validation, full code generation, and language implementations for many domains. The current generation is now centred on Cinco as a metalevel LDE platform, and DIME as the main Integrated Modelling Environment generated from Cinco following the LDE and eXtreme Model Driven Development (XMDD)[13] approaches. This long experience and maturity led to a holistic toolsuite that does not only support a generic low code development as in DIME, but also the generation of new, domain-specific low code modelling environments that are tailored to the mindsets of the addressed stakeholders [55, 48, 52].

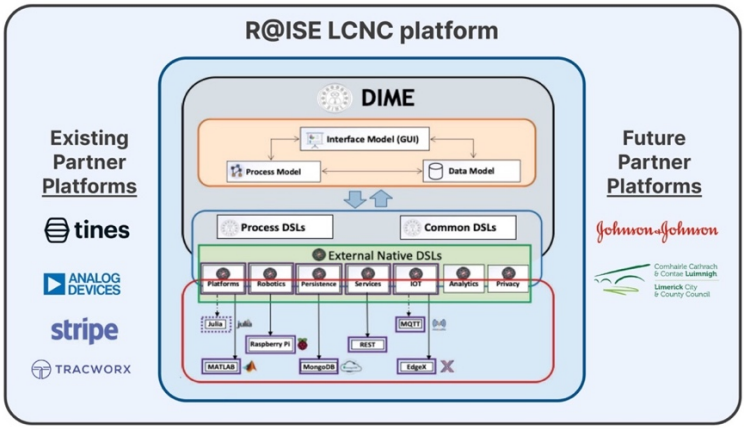

Figure 1. R@ISE LCNC platform architecture.

The R@ISE LC/NC platform will build upon the LDE approach, the Cinco metaIDE and the DIME and Pyrus platforms as the core of the integrated development environment. The existing LC/NC workflow automation platform by Tines will be connected to DIME at the modelling and process level. There is a preliminary understanding of how to connect also the platforms of Stripe and the Tracworx applications, especially using ADI's unique Catalyst collaboration Hub and LCCC's Digital Quartet and Citizen Innovation Lab as experimentation grounds. J&J has a special role, as their interest is in scouting technologies and opportunities for LC/NC innovation and adoption.

Language Workbenches

A LC/NC-style platform can be realized with any language workbench, if it supports the kind of languages required for the targeted mindsets (e.g., graphical and/or textual) and it provides dedicated support for building model structures stemming from multiple languages. Often the development effort outweighs the gain. On the scale from general-purpose to highly domain-specific, it pays off to support a spectrum of general to specialistic developed solutions, with simplicity as a core value. Cinco [41] achieves simplicity by sacrificing some of the generality provided by other language workbenches in order to elegantly support the interplay of various languages. It also supports code generation by providing a dedicated tool-specific model API that is more powerful than the underlying generic Ecore API of Eclipse. For example, DIME is a tool generated from Cinco specifications, and its GUI profits of this bespoke model API generation. Other prominent frameworks for the development of graphical modelling languages are MetaEdit+ [30, 8] (the reference implementation for DSM [31]), GME [35, 36, 11], Pounamu/Marama [26, 7, 53], Sirius [2], and DeVIL [29, 44].

The powerful frameworks described above are designed for developing graphical IDEs for a specified graphical DSL, including corresponding code generators. The aspect of coordinating stakeholders with different capabilities and mindsets in a cooperative fashion is not explicitly addressed. The same also applies to the more traditional Eclipse modelling ecosystem [25] with the RCP [38] and the Eclipse Modeling Framework (EMF) [47]. While there is good support for textual DSLs in Eclipse (e.g., using the Xtext [12] framework), building graphical DSLs with GMF [5], Graphiti [6], or even the Epsilon project [32, 3, 4, 33] is very tedious. [41] contains a detailed discussion on how Cinco compares to Epsilon, Spray, Sirius, MetaEdit+, GME, Marama, and DEViL, also regarding the simplicity of modeling tool specification. Thanks to its support for integrating arbitrary EMF-based languages into one modeling solution, Cinco supports both textual DSLs (as we regularly do with Xtext) and any other graphical editor developed in the Eclipse modelling ecosystem: e.g., use Sirius to include table-based editors, as Cinco purely focuses on graph diagrams with nodes and edges.

Projectional editing [50] is another approach to language-driven development, as most prominently provided by JetBrains' Meta Programming System (MPS) [27]. However, this approach clearly addresses programmers, as using languages developed with MPS often feel like (guided or constrained) programming in an IDE. The support in MPS for graphical editors has improved but developing languages with MPS is widely known to be very complex. It has an extremely steep learning curve, which directly counters our goal of simplicity. Cost-effectively building good LDE solutions with MPS is probably limited to a very few experts who are really well-versed with all the intricate details of the framework.

As software is currently shifting towards the web as an application platform, the Pyro project [54] ported to Web a significant subset of the Cinco graphical modelling so that Pyro users have no installation. As with Pyrus [55], all Pyro-products support collaborative modeling in a Google Docs fashion. Not all the features of the Eclipse-based generator are realised yet in Pyro and this is ongoing work. The ROCCO tool [42] has similar aims as it makes graphical modeling languages based on Eclipse EuGENia [20] accessible in a web-based low-code development platform. ROCCO performs the corresponding migration by generating diagram models for evaluation in the Psi Engine [18], a web-based low-code environment. Compared to Pyro, ROCCO does not offer collaborative editing of the diagram models. Furthermore, as ROCCO (in contrast to Pyro) is not available to the public, it is difficult to compare Pyro and ROCCO at a language feature level.

Our prior research covers covers the platform development technologies as described (T. Margaria, M. Hinchey), adoption in education (T. Margaria, S. Saay, R. Lyons) and in industrial projects (T. Margaria, M. Hinchey). It also covers reference architectures for data integration and organisation (S. Saay), user experience (K. Crowley) and evaluation from the economic (S. Kinsella) and pedagogic (R. Lyons) point of view. The reference architecture for data integration has been proven in proofs of concepts of the Digital Thread, and it has been applied to organisation collaboration at the national level and cross-national level. We prototyped applications for different domains including education, health, and manufacturing.

Our next step in this project will be the full functional low-cod/no-code platform that will be adaptable for different domains.

The proposed research **advances the described state-of-the-art** in these **four main dimensions**:

1. Conceptually, we aim for enabling **all the stakeholders** to co-develop software without programming by providing various specialized (potentially graphical) modeling and specification languages close to those already known to the domain experts, and fully generate complete applications from a one-thing model structure comprised of these model types.
2. Technologically, this requires appropriate meta tooling support, so that highly specialized low-code development environments can be developed **cost-effectively**.
3. We embed **formal methods** in this environment, for developer support, high quality products and user comfort. They cover the language design time, the application design, the implementation through model-to-model and model-to-code transformations and the runtime analysis support.
4. In this partner collaboration, we will address **case studies from different domains and evaluate the platform and its adoption over 5 years**. This will happen in at least four real industrial ecosystems (connected with ADI, Stripe, J&J and Tines and their customers) as well as citizen engagement with the LCCC.

To our knowledge, these four aspects are rarely covered at the same time in a proposal of this size, with this top-level engagement with world-leading companies. Our team includes three founders or CEOs, the Director of ADI's Catalyst Centre, Limerick City's Head of Digital Services & Strategy, and others.

Significance

From the focused attention paid to this topic by both established and new entrant players in the software development tool market, this is **clearly a vitally important problem**, of strategic importance to any company and organization relying on software, it therefore deserves research attention.

Next to the foundational contents and the unprecedented level of commitment to work together, the other unique and innovative aspect of this research program is the ability to design and carry out **a 360° approach** spanning tool and platform development (WP1), the adoption, validation and stress test (WP2), the dissemination (WP3) to adopters of many different backgrounds and the empirical evaluation and feedback from the practice in the industrial educational and broader adoption. In decades of experience in large scale projects, consortia, with own companies and in university teaching, even much larger projects, like FIWARE, Gaia-X and others, did not have this complete set of experts, the resources, the embedding in industry, organization and education and outreach, with partners that have already committed nearly 2 million Euro of cash funding and in-kind resources upfront, to do this anyway. This is truly unique.

In terms of **market opportunities** enabled by our success, our partner companies are core actors in the new software economy enabled by LC/NC: Gartner research says, "*on average, 41% of employees outside of IT – or business technologists – customize or build data or technology solutions. Gartner predicts that half of all new low-code clients will come from business buyers that are outside the IT organization by year-end 2025, too.*" For companies, especially a software platform companies, a trustable, secure, high assurance, easy to use LC/NC platform able to connect and interoperate the Digital Thread with other actors will be vital to manage the new norm of cost, speed, and quality induced by the transition to the LC/NC economy.

In fact, *"The economic consequences of the COVID-19 pandemic have validated the low-code value proposition,"* said Mr. Biscotti. *"Low-code capabilities that support remote work function, such as digital forms and workflow automation, will be offered with more elastic pricing since they will be required to keep the lights running."*[13] This is in **alignment with SFI's remit** of core and applied software engineering in STEM: the R@ISE research program addresses prevalently "oriented basic research" in WP1, and "applied research" in WP2.[14]

The R@ISE research program is also aligned with the Irish Government's national **Refreshed Priority Areas 2018 – 2023**[15] Through its core Software Engineering research R@ISE aligns with the National strategic research priority areas 1 (ICT) and 2 (Services and business processes).

In **ICT**

- *"A further key market is Anything-as-a-Service (XaaS) consisting of ST(orage)aaS, SEC(urity)aaS, U(nified) C(ommunications)aaS, N(etwork)aaS, D(ata)B(ase)aaS, and B(ackend)aaS, or, typically, back-end platform development."* The R@ISE platform architecture addresses explicitly in WP1.2 the backend, and the concept of External DSLs embodies the XaaS concept (all WP2),
- It also addresses the "*Security and semantic technologies*" through WP1.3 (security, privacy) and the formal methods integration in WP1.

- The Augmented Reality and Virtual Reality are of keen interest to ADI and J&J. The introduction of new immersive technologies such as VR/AR transform how we develop and learn with digital content. Irelands Technology Skills Plan to 2022, DT-AIOIW and The Disruptive Technologies Innovations fund, all reference ICT-priority areas for all sectors- innovation accelerators such as Robotics, AI, Machine Learning Data analytics & AR/VR.
- "*Ireland is ideally positioned to realise opportunities in the manufacturing and distribution of Application Development.*" R@ISE is entirely devoted to a new, highly attractive technology that addresses this recognised opportunity.

In Services and Business Processes:

- R@ISE' addresses through the LC/NC approach a faster and more widespread set of developers directly responds to the call to "*enabling both the manufacturing and service sectors to innovate their service offerings, service delivery, and business processes. Examples include servitisation of manufacturing, smarter commerce, business model innovation, risk governance, and sustainability*", *as well as the* "*potential for this priority area to enable other priority areas, helping maximise the impact of the overall prioritisation initiative*."

Through the applications in the Pillar 2 projects we see contributions to the area **Manufacturing**, a vital part of the Irish Economy (Irelands Industry 4.0 Strategy 2022-2025). Future Skills Requirements of the Manufacturing Sector (FSRMS) 2020 outlines that industry requires flexible means for continuous professional development (CPD) and upskilling (Future Jobs 2019, Ireland's National Skills Strategy 2025 (NSS). We see also indirect contributions to the area of **Energy, Climate Action and Sustainability**: the energy crisis has brought the country and every company to leap forward here. our understanding under energy efficiency and sustainability fits the consideration of system performance in our research, and the quest to avoid repeated extensive testing and computations. In fact, R@ISE **promotes and delivers sustainability** in four main dimensions:

1. Sustainability of **software and IT systems** as a goal,
2. Sustainable **computation** as a means,
3. Sustainable **design and engineering as a culture of building**, and
4. Sustainability in **mastering change**. It directly addresses the needs of industry, society and education to promote a more responsible approach to technology production and use.

UL's strategic commitment to sustainability is central to every aspect of R@ISE's research and operations. R@ISE contributes directly to the **UN SDGs** 4, 5, 8, 9, 10 and 17, as well as indirectly to others, through the specific application projects. Truly transformational is the depth of commitment and investment by startups like Tines and Tracworx, who could be the next Stripe.

iii. Scientific/Technical Aims and Objectives of the Research Programme

R@ISE will define and carry out a research and dissemination program in both core (LC/NC development platforms) and applied Software Engineering (Digital Thread), collaborating with five companies (3 MNCs and 2 startups), the Limerick City and County Council. With three national and eight international senior specialist experts the R@ISE research program addresses SFI's remit of core and applied software engineering in STEM.

The purpose of the project is to conduct an important research programme, which in turn requires the budget requested, combining SFI and donor contributions. This collaborative research program will enable a truly transformational impact in the partner companies and the rich environment that we address in outreach and EPE. The impact of the grant in terms of headcount is shown below.

Our Pillars: What we are going to do in R@ISE

R@ISE will bring into being the future of high-quality software, designed by non-programmers with LC/NC platforms that embed both *extreme model driven development* (XMDD) and *formal methods*, easily evolvable through *built-in DevOps*, based on the existence, adoption and diffusion of advanced low-code and no-code development environments that use intuitive (yet formal and thus automatically analysable) models as the means of expression for software "*stories*", and embed a strong capacity to *analyse*, *(auto)complete*, *optimize*, *compile, validate* and *deploy* the software on all the current platforms: on premise, as services, in the cloud, on mobile, and more.

Pillar 1 conducts research in advanced LC/NC development environments. It **provides the new kind of methods, tools and development frameworks** that enable a different, much more **efficient and sustainable implementation of Digital Thread applications** in Pillar 2.

Pillar 2 establishes a coherent Digital Thread of interoperability within and across integrated Software and Systems ecosystems, in a deep university-industry collaboration. Together, both pillars will deliver **new technologies, application examples** and **educational components** that make the rapid development of software and systems much more sustainable, understandable, its design and implementation faster and more efficient, and better equipped to face the frequent changes, adaptation and evolution the modern business needs and IT landscapes continuously mandate.

Pillar 3 concerns the global tasks of management and Education and Public Outreach (EPE)

Pillar 1: Advanced Low-code Development Environments

<table>
<tr><td colspan="4">WP 1.1 Application development in a low-code and no-code platform</td></tr>
<tr><td>Leader: UL (T. Margaria)
Vice-leader:
Tines (B. Long)</td><td>Participants: UL (T. Margaria, S. Saay, K. Crowley, R. Lyons), Tines (B. Long), ADI (L. Keane), Stripe (R. Heaton), J&J (J. Meaney, M. Finnan)</td><td>Funded Resources:
4 PhDs,
1 post doc fellow</td><td>Duration:
60 months
(M1-M60)</td></tr>
<tr><td colspan="4">This WP addresses the front end and user view of the platform, the full development lifecycle (conception to deployment and evolution), including the integration (low code) and orchestration (no-code) support using Integrated Modelling Environments (IMEs) within LC/NC platforms that embed both extreme model driven development (XMDD) and formal methods.
We start with the DIME, Pyrus and Tines platform, and will progress with their integration, their extension at the modelling level along the LDE paradigm and make them easily evolvable through built-in DevOps. This WP covers the architecture, the development of the interface and the enabling features for extending the model types presented to the users.
Formal Methods will include dataflow analysis, model checking, property checking, workflows synthesis and runtime verification for applications. The user interface will be developed using user-centered design principles ensuring the front end is accessible, usable and learnable. Co-design methodologies will be deployed involving diverse stakeholder engagement with the companies, their customers, students and other potential end-users. A usability assessment of existing development environments such as those based on Eclipse will be undertaken to ensure the individual IMEs and the R@ISE LC/NC platform maintain consistency and deliver optimal user experience (UX).
Key collaborators: Prof B. Steffen (TU Dortmund, D), Prof A. Rensink (U. Twente, NL), Prof G. Pravadelli (U Verona, I)</td></tr>
<tr><td colspan="2">Outputs: Low/No-code platform with increasing and increasingly tested features</td><td colspan="2">Impacts: New knowledge, new software, journal articles, conference papers.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">WP1.2: Back-end automation and integration</td></tr>
<tr><td>Leader: Tines (E. Hinchy)
Vice-leader:
J&J (G. Madden)</td><td>Participants: UL (T. Margaria, S. Saay, M Hinchey, S. Kinsella) Tines (E. Hinchy, C. O'Neill) Tracworx (C. Kelly), Stripe (R. Heaton, E. O'Meara)</td><td>Funded Resources:
4 PhDs,
1 post doc fellow</td><td>Duration:
60 months
(M1-M60)</td></tr>
<tr><td colspan="4">This WP addresses the back-end automation and integration with low code approaches, to support server side the infrastructure layers of a modern complex software stack.
In particular, it addresses questions like a) how to reuse or integrate existing connectors from other platforms, like EdgeX middleware, AWS storage and AI/ML services, Tine's security, MongoDB storage, GAIA-X data exchange, FIWARE components, Stripe payment and more, b) how to efficiently integrate and orchestrate existing APIs/services, like e.g. Stripe's payment services, which follow different standards in different technologies, and c) how to make them easily maintainable, decoupling them as much as possible from the application layer.
Here we plan to initially adopt the External Native DSL concept of DIME and extend it through abstraction layers in order to make it more flexible and evolvable. We intend to use FMs to analyze the adaptation/mediation needs and potentially automatically synthesize the necessary adapters. Domain semantics and mechanisms to adequately express and manage it will be investigated, as well as how best to interface with the middleware, communication and scheduling layers. We expect to consider concept graphs and GraphQL as starting points, but technologies are likely to evolve during R@ISE.
Key collaborators: Prof. Wang Yi (U. Uppsala, S), Prof B. Steffen (TU Dortmund, D), Prof C. Seceleanu (MDU, S), Prof G. Pravadelli (U Verona, I), JJ Collins (UL).</td></tr>
<tr><td colspan="2">Outputs: New integration and runtime application management layer, new analysis methods</td><td colspan="2">Impacts: New use-cases in companies, publications</td></tr>
<tr><td colspan="4"></td></tr>
</table>

WP1.3: Embedded Data management, Privacy and Security			
Leader: UL (M. Hinchey) Vice-leader: Tines (B. Long)	**Participants:** UL (M. Hinchey, T. Margaria, S. Saay, J.J. Collins), ADI (L. Keane), Tines (B. Long), Stripe (S. Marigny)	**Funded Resources:** 3 PhDs	**Duration:** 60 months (M1-M60)
This WP addresses Data management, Privacy and Security in the overarching platform of WPs 1.1 & 1.2. We propose an aspect-oriented approach with broker-style federated architectural solutions, in order to flexibly manage the level of coupling. This WP considers data- and process-related management aspects, in particular under FAIR data, GDPR and other regulated industries laws and standards, as about financial data and personal/patient data. While we do not have health applications lined up at proposal time, several partners work in a health-related domain (J&J, Tracworx), or have connections with that sector (ADI, Stripe), therefore readiness for this and Industry Critical Systems is important. Health-related data is particularly sensitive and will require strict governance and security protocols. We will consider here mechanisms for trust, security, and privacy from the point of view of their robustness and ease of change/evolution, especially in connection with federated vs. decentralized approaches (e.g., broker vs. DAOs). Examples are encryption on a declarative, attribute-based basis; Zero-Trust mechanisms; and alternative forms of blockchains, in particular those accommodating legal smart contracts. The international collaborators are experts in the use of statistical methods, property checking and validation mechanisms in these areas. They need to be loosely or tightly integrated with the features of the platform and the applications, but without interfering in a too rigid and prescriptive fashion as we need a range of solutions for the Digital Thread (WP2). **Key collaborators:** Prof A. Legay (UC Louvain, B), Prof G. Schneider (Chalmers, S), Prof. A. Norta (Dymaxion OU, EST)		
Outputs: Low/No-code platform with increasing and increasingly tested features	**Impacts:** New features in the platform, publications		

Pillar 2: Digital Thread in Integrated Software and System Ecosystems

Pillar 2 will evaluate various IT ecosystems from the point of view of theory, practice, and pragmatics of integration in a reuse- and sharing perspective, as needed to implement a full-stack end-to-end Digital Thread platform. It will test, adopt and extend the platform produced in Pillar1.

WP 2.1 Digital Thread in the ADI Catalyst ecosystem			
Leader: ADI (M. Morrissey) Vice-leader: UL (T. Margaria)	**Participants:** ADI (M. Morrissey, R. Ryan), UL (T. Margaria, M. Hinchey, J.J. Collins, K. Crowley, S. Saay), Stripe (R. Heaton), Tines (E. Hinchy), Tracworx (C. Kelly, E. Walsh), J&J (M. Finnan, E. Henchion)	**Funded Resources:** 4 PhDs, 1 post doc fellow	**Duration:** 57 months (M4-M60)
In this WP we implement and evolve the Digital Thread in the context of the ADI Catalyst in Raheen, Limerick. The ADI Catalyst embodies a system of systems approach to wide range system design. Its layered system of specialized platforms addresses different concerns, that cooperate and interoperate to deliver end-to-end services to a multitude of experiments, prototypes, case studies and products. Here the ADI Catalyst platform is seen from ● the project hosts and service providers (south interface) perspective, and ● the users' perspective (north interface), as beneficiaries of the shared infrastructure and capabilities Working with ADI, 5 core projects will serve as collaborative application benchmarks of the Pillar 1 technologies. They cover 5 distinct domains of hot relevance to industry well beyond ADI and R@ISE: 1) ROS integration and mobile robotic subsystems, incl. cobots; 2) edge computing, sensor fusion and edge monitoring; 3) NextGen connectivity using 5G and beyond; 4) enhanced interoperability through uDOS (Universal Dataset Open Standard), 5) green digital factory. In these projects, successive prototypes will adopt, test and validate increasingly advanced capabilities of the Digital Thread platform. We envisage also here a systematic evaluation of the usability, effectiveness and productivity it enables, in particular in comparison with the current in-house methodologies and data. **Key collaborators:** Prof D. Fisher (Rose-Hulman Inst. of Techn., USA), Prof. Cristina Seceleanu (MDU, S), B. Steffen (TU Dortmund, D), Prof G. Pravadelli (U Verona, I).			
Outputs: Successive versions of case studies implementing the Digital Thread in the respective domains. They use the LC/NC platform of Pillar 1, and/or contribute new features/DSLs to it.		**Impacts:** Case studies, new business processes, new business cases, new applications, publications	
WP2.2: Integration for mobility and supply chains			
Leader: Tracworx (E. O'Brien) Vice-leader:	**Participants:** Tracworx (E. O'Brien, C. Kelly, N. Gleeson) UL (T. Margaria, K. Crowley, S.Saay, R.	**Funded Resources:** 4 PhDs,	**Duration:** 57 months

UL (S. Saay)	Lyons) ADI (M. Morrissey, F. Treacy), Stripe (E. O'Meara), Tines (E. Hinchy), J&J (E. Henchion), LCCC (N. Gallagher)	1 post doc fellow	(M4-M60)
In this WP, in cooperation with Tracworx, ADI, Stripe and Tines, we will consider end-to-end applications and integrations that include integrated and optimized logistics, asset tracking and payment. The evident challenge here is the high-level design of high assurance applications, as they involve potentially privacy (personal data on assets or shipments) as well as financial aspects (payments). Relevant data protection standards will be applied, and prototypes will be tested with potential end-users to ensure user trust in the system is achieved. Concurrency aspects may be central here, as well as data management, federation and security. **Key collaborators:** Prof. Wang Yi (U. Uppsala, S), Prof. D. Fisher (Rose-Hulman Inst. of Techn., USA), Prof C. Seceleanu (MDU, S), Prof G. Pravadelli (U Verona, I), JJ Collins (UL), Dr. V. Cionca (MTU).			
Outputs: High level design of high assurance applications.		**Impacts:** Case studies, new applications, publications	
WP2.3: Integration in the civil and cultural space.			
Leader: UL (S. Kinsella) Vice-leader: LCCC (A. Dooley)	**Participants:** UL (S. Kinsella, T. Margaria, K. Crowley, R. Lyons) ADI (E. English), Stripe (All), Tines (M. Dillon), Tracworx (F. Blackburn), J&J (All), LCCC (A. Dooley, N. Gallagher)	**Funded Resources:** 3 PhDs	**Duration:** 57 months (M4-M60)
Jointly with ADI, LCCC and Tracworx, this WP will consider accurate occupancy analytics in buildings and delimited indoor/outdoor areas, advanced use of 5G, including mmwave mesh technology. The aim is to connect in real time collaborative spaces (e.g. cultural venues in the city and county), or buildings and warehouses, or mobile locations (trucks, drones, mobile components of art installations) that need to exchange reliably broadband information under performance, reliability and security conditions. **Key collaborators:** Prof C. Seceleanu (MDU, S), Dr. V. Cionca (MTU), Prof G. Miro-Muntean (DCU).			
Outputs: Case studies of technological adoption, co- development.		Impacts: Hackathons, Case Studies, Citizen Innovation Lab Demos.	

WP3: R@ISE Operations

WP3 Operations and Education and Public Engagement (EPE) will cover **management, finances, reporting, EPE and dissemination**. R@ISE is large and complex, so we request a Project Manager (at Senior Executive Administrator level) for the 60 months of the project. Concerning EPE, many initiatives will be coordinated with the core ISE teaching and outreach teams. ISE has a dedicated 2nd level officer and a marketing and communications role. EPE will be carried out by the PhD students, post-doctoral fellows, and the supervisors to conserve funds and increase EPE requirements of partners such as Lero. Concerning dissemination, we foresee publishing in Q1 journals and high-ranked conferences, organizing workshops in Limerick or abroad, e.g., at ETAPS, and special sessions or tracks at conferences like IEEE COMPSAC, ISoLA, and others.

Postdocs and PhD students will be supervised by an academic team and will each have one or more industrial mentors. At least half of the students will complete a **secondment in industry or to an international research partner**. The table below details partners, resources, outputs, and impacts.

R@ISE Operations					
WP	**Description**	**Institution (Work Package Leads)**	**Resources**	**Outputs**	**Impacts**
3.1	Management	UL (T. Margaria, S. Kinsella) ADI (M. Morrissey), Stripe (R. Hierons), Tines (E. Hinchy), Tracworx (E. O'Brien), J&J (G. Madden), LCCC (A. Dooley)	Program Manager, Administrator, Technical Officer	Excellent management	Maximal, optimized Impacts
3.2	EPE	UL (K. Crowley, R. Lyons, All) ADI (F. Treacy, All), Stripe (R.	Technical Officer,	Online fora, school visits, webinars,	Visibility for outputs, impact

		Heaton, All), Tines (F. Blackburn, All) Tracworx (M. Dillon, All), J&J (J. Meaney, All), LCCC (N. Gleeson, All)	Administrator	competitions, public events.	on education, research and society

Governance: R@ISE will be led by Prof Tiziana Margaria, who has experience of Executive Committees in Lero, Confirm, and the CRT-AI, plus 8 years of experience as Head of Department (in Potsdam and Limerick), on the Faculty Management Committee, Academic Council, and as a CEO. The Co-PIs Prof Stephen Kinsella and Prof Mike Hinchey have extensive management experience: for example, Mike Hinchey is the past Centre Director of Lero and past Director of the Software Engineering Laboratory at NASA Goddard Space Flight Centre. All the 3 PIs have extensive experience of UL's management and administration, and are already familiar with the structures, mechanisms, requirements and key objectives connected with running a research initiative of this size with SFI. The **R@ISE management and governance** structure guarantees the connection with UL and Lero, but also sufficient independent oversight. The figure below shows the map of relationships with respect to governance, and this relates to the section below looking at the national landscape.

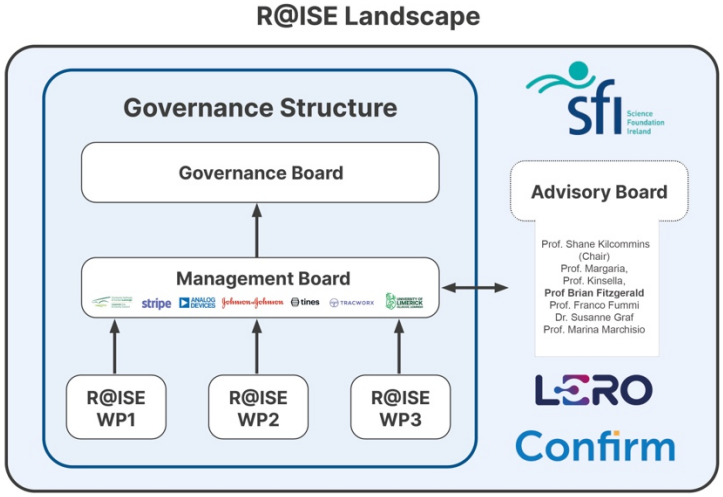

Figure 2. R@ISE Landscape: Governance Structure

The **Management Board** is chaired by T. Margaria as the R@ISE coordinator and includes all the leaders of the Partner teams and the R@ISE Project Manager. It oversees the project, in particular the progress, finances and risks, and communicates with the SFI Project Officer. It meets bi-monthly. The Management Board will also include a representative from the Postdoctoral Fellows and initially 1, later 2 representatives of the PhD students when dealing with the aspects that specifically concern the progress of the recruits. It meets bi-monthly with the Management Board (as a standing agenda point) and implements our co-design and co-decision philosophy, as R@ISE is de facto also an Early Career Researcher initiative.

The R@ISE **Advisory Board** monitors and assures, by means of external experts, the high-quality scientific output and the widest **impact** of R@ISE. It meets at least once every 6 months, in person or hybrid/remotely. It is chaired by Prof. Shane Kilcommins (Deputy President UL) or a nominee, its members are Prof. Margaria, Prof. Kinsella, Prof Brian Fitzgerald (Director Lero, UL), Prof. Franco Fummi (Full professor Computer Architectures, Director ICE Lab, Univ. Verona, I), Dr. Susanne Graf (CNRS Research professor (Directeur de Recherche) Verimag, Grenoble F), Prof. Marina Marchisio (Department of Molecular Biotechnology and Health Sciences, Univ.Torino, I).

The R@ISE **Governance Board** is chaired by Prof. Kerstin Mey (President, UL) or nominee, and comprises Prof. T. Margaria (R@ISE project coordinator), John Collison (R@ISE philanthropic donor), Prof. Paul Pettersson (ex Vice-Chancellor MDU, S - the title is equivalent to Rektor), and one representative of IDA and/or EI. The Governance Board oversees the project, in particular the progress, finances and risks, meeting at least once per year, in person or hybrid/remotely.

Importantly, throughout the selection of specific individuals to participate in these bodies and coherently with the Athena Swan Charter, R@ISE will **balance each body and group with respect to background and gende**r, thanks to the many **female senior participants** and to the specific attention to Equality, Diversity and Inclusion in recruitment (UN SDGs 5&10).

Lero's headquarters at the University of Limerick (UL), jointly with the UL Department of Computer Science and Information Systems where R@ISE is primarily located received an Athena SWAN Department Bronze Award in 2020. Lero members are committed to gender equality. Every Lero academic partners has attained Athena SWAN Bronze awards, or have committed to submitting for awards. For a number of years, UL, through Lero, has partnered with Johnson & Johnson on

their WISTEM2D Awards Programme. The Johnson & Johnson Scholars Award Program aims to fuel the development of female women leaders in STEM and feed the talent pipeline by awarding and sponsoring women at critical points in their careers.

iv. Approach/methodology

R@ISE is designed around an **action research method**. In this approach the researchers work closely with the companies and partners who act as problem givers and who often act as providers of test beds for validation and feedback. These partners operate in frequent communication with the researchers, supervisors and other mentors. Each project topic follows a similar **problem posing and solving approach** with **iterative yearly analysis, solution, and validation cycles**. This approach ensures that the researchers have continuous communication, feedback, and support by the supervisors and partners. Key to handling technology initiatives within modern ICT, all technical platforms and applications will be created using **agile development** connected with **continuous integration** of individual contributions. Contributions will be evaluated and tested by tech and non-tech participant and partners according to a **dev-ops teams approach**, created and practiced in Lero[16] [17] by T. Margaria, B. Fitzgerald and I. Richardson.

Concretely, the research will follow an adapted **design science, action research, agile approach**[18], as depicted in the Figure. The three cycles will also couple the WPs in the evaluation and in the rigor cycle, where we re-examine the multidisciplinary foundations of our research. Communication with all the stakeholders, including industry, will be frequent and prototypes will be successively designed, implemented and handed over to the users for feedback and adoption in **cycles of 3 to 6 months**, where WP1 and WP2 are interleaved.

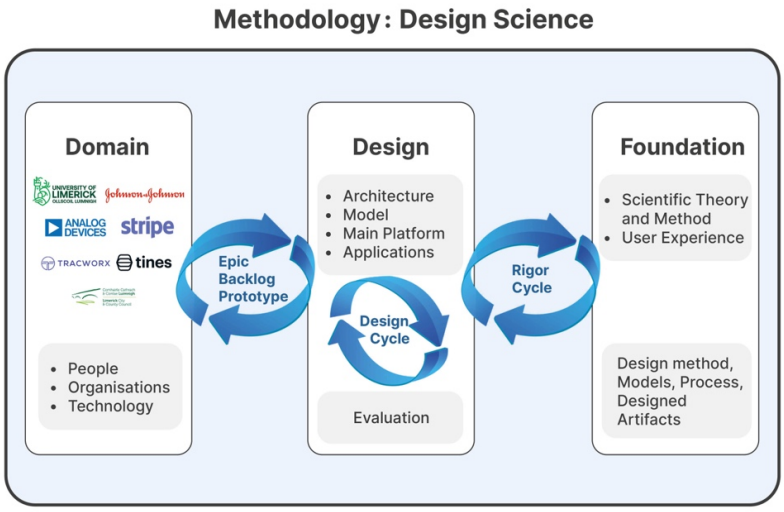

Figure 3. Methodology: Design Science

Within the research teams, it is planned to pursue a much more frequent feedback pulse to take advantage of the co-location of all the research staff in one lo cation, thus permitting the full utilisation of agile development methods. As per Cohen and Thias[20] (2009), "By applying these principles [...] it is possible to create small, powerful, adaptive, sustainable software teams that far out perform any off-shore or distributed development team."

This, along with the continuity provided by the long tenure of the research staff, is a key benefit of the centralised nature of the research proposal. According to Cockburn and Highsmith[21], p.132, "*people working together with good communication and interaction can operate at a noticeably higher level than when they use their individual talents*".

In both WPs we start from the current prototypes of the Digital Thread platform and with preliminary small Proof of Concepts, bootstrapping this way the R@ISE initial platform. In terms of hiring and of progress cycles, WP1 and WP3 will start at Month 1 but WP2 at Month 4, in order to respect the natural precedence of platform w.r.t. applications. This way, we have an interleaving of the ca.6 months cycles of the platform (WP1) with Milestones at M6, M18, M30, M45 and M60, and the Digital Thread applications which follow at M12, M24, M38, M52 and M60.

As evident from the research topic and WPs, the team members co-define, co-produce and co-manage the research program. For example, Tines' expertise in top level security will benefit not only the single project but all R@ISE through the platform, the repeated adoption milestones in WP2, and the EPE activities in WP3.

The **collaboration partners** were chosen based on their status as **internationally leading experts** in their subject domain, with proven success in collaboration between academia and industry, strength of their involvement in cutting edge

European research projects and initiatives (e.g., Wang Yi: ERC Advanced grant), excellence in education and training (e.g., David Fisher). Prof. Bernhard Steffen (TU Dortmund, D) and Prof. Arend Rensink (TU Enschede, NL) are renowned experts in programming languages and programming platform design as well as formal methods, Prof. Cristina Seceleanu (Mälardalen University, S) and Prof. Graziano Pravadelli (Univ. Verona, I) are experts in Embedded and Cyberphysical systems, Prof. Axel Legay (Univ. Catholique de Louvain, B) is expert in formal methods and statistical model construction, Prof. Gerardo Schneider (Chalmers, S) and Prof. Alex Norta (Dymaxion OU, EST) are experts in secure legal contracts based on formal models and blockchain, and Prof. Gabriel Miro-Muntean (Dublin City University, IE) and Dr. Victor Cionca (Munster Technical University, IE) are expert in various aspects of simulation and telecommunication networks. The tight relationship among the partners shows their will or proven ability to work together. This group is an excellent consortium for R@ISE: within our respective networks, this is a carefully chosen and balanced mix of partners and collaborators. Synergy and complementarities are consistently demonstrated at the **global level** in shaping R@ISE this way, and at the **thematic research level** in WPs 1 and 2, where each WP is interdisciplinary and intersectoral. The chosen co-leaders for every management task ensure optimal synergy exploitation.

Ethics process management will follow a demand driven model as the studies will be developed in response to the requirements suggested through collaboration with the research partners. The project team have a strong track record of submitting successful Ethics proposals (for example the Eirenteering study – https://eirenteering.lero.ie/). The Science and Engineering – Research Ethics committee examines t ethics applications every month, thus facilitating an on-demand approach that aligns strongly with the agile methodologies adopted in the R@ISE proposal.

v. Role in the National Research Landscape

In this section we provide an overview of the current national research landscape, describe relevant research activities and this proposal relates to them, and describes the relevant national infrastructure available to support R@ISE. We also highlight how R@ISE will interact with LERO to ensure a cohesive and collaborative ecosystem. The governance of R@ISE is described on pages 15 and 16 of this application, and includes key inputs from the LERO Director.

The figure below shows the pertinent landscape of funded research and shows R@ISE's connections through individuals and through centres such as CONFIRM and LERO, the connection to international centres of best practice, with the internal governance of R@ISE itself being described above. Concretely, in terms of functions R@ISE will leverage and enhance LERO's EPE and Outreach functions, and will have opportunity to draw upon CONFIRM's testbed resources.

Figure 4. R@ISE Participants

R@ISE espouses the dual SFI strategic objectives of Delivering today and Preparing for tomorrow by embedding research-related or inspired projects/challenges in the ISE integrated BSc/MSc, so that every year about 300 students will experience research-inspired education.

Besides doing excellent research, due to R@ISE's commitment to equality, diversity, and inclusion, already evident from the composition of the core research team, it will contribute significantly to the goals of reaching *35% women leaders in research and 65% of postgraduate and postdoctoral researchers departing to positions outside academia after 6 years*. The R@ISE team and partners are committed to support women in STEM as evidenced by the existing partnership with J&J and UL on the WiSTEM2D programme. Katie Crowley currently heads the programme from UL, further strengthening

the relationship with J&J, and directly with R@ISE. Building on these partnerships R@ISE addresses the SPP objectives, to "*Build stronger, more direct relationships with co-funding partners from industry, charity and academia, Maximise the state investment in research through leveraging of non-exchequer funding, including funding available through philanthropic and charitable sources, and Enable alliances with industry/charity/philanthropy that enhance competitiveness in securing European funding*".

As Lero in Phase 2 increasingly addresses the societal dimensions of IT, core Software Engineering research is currently not funded at the scale addressed in R@ISE. Both in Lero (Software Platforms, Pillar 1) and in Confirm (Digital Thread, Pillar2) it has been observed that the fragmentation of funding on a large number of independent projects does not allow the concentration of effort and the sheer development scale needed to create a platform of this ambition and quality, nor this coherence of interrelated case studies. We are also not aware of any similar funding initiative elsewhere globally. R@ISE will deliver a lighthouse project to become an enabler in the Irish ambition to build strategic national and international partnerships that drive economic impact and address societal challenges.

The collaboration with Lero, specifically, is strong: T. Margaria is a PI of Lero since 2014, M. Hinchey is the previous Lero Director and current PI, Katie Crowley is a Lero FI and member and Salim Saay is a Lero member. The collaboration will continue, leveraging possible synergies and mutual support. It is currently agreed that Lero will provide support to R@ISE through joint initiatives for EPE, where Lero is very strong, additionally to some technical support as long as R@ISE is not yet fully operational, cooperation and support and in terms of international funding management, as Lero has an excellent research management office, and coordination in terms of marketing and communications.

In turn, R@ISE has a strong potential for conference and event organization in Limerick, competence in hackathon organization, a tight relationship with the AWS ISE Global Fellows program: Global Fellows spending one to six months in UL may offer interesting opportunities also to Lero in general, especially to the Lero PhD students, Postdoctoral fellows and early career research fellows (providing new contacts, joint guest lectures). We surely envisage potential synergies with respect to EU MSCA co-fund initiatives. Lero has been repeatedly successful with European Training Networks, and R@ISE now has an ex- Lero MSCA fellow, Dr. Salim Saay, as a Funded Investigator.

As a further top-level direct connection, the Director of Lero Prof. Brian Fitzgerald has accepted to join the R@ISE Advisory Board.

R@ISE will also benefit from access to the testbeds in the Confirm Headquarters in UL, including the main floor with high end networks and communications and the Cave, for UX and AR/VR related research.

The significant partner investment in R@ISE show the relevance of the research program to them. We are particularly proud of the strong financial and in-kind commitment by Tines and Tracworx, two successful startups that take here leadership roles. Without the R@ISE SPP we would be limited to a much smaller initiative, as the headcount diagram below shows.

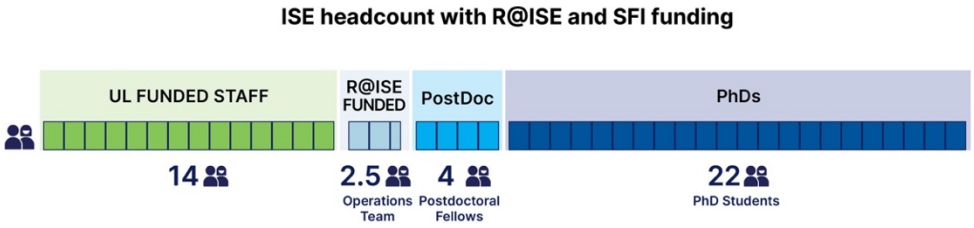

Figure 5. R@ISE staff headcount with UL & R@ISE funding

The R@ISE program will enable a uniquely integrated ecosystem, a **scalable and integrated approach**, a proper staffing of the **dedicated research team**. Through the Postdoctoral Fellows R@ISE will bring in a **seniority and expertise** otherwise unaffordable, and adequately match the level of commitment and attention that R@ISE enjoys with the industry partners. Beside John Collison, the **personally committed industrial team** includes CEOs and CTOs of the participating companies, the Director of the ADI Catalyst and the strategic director at Limerick City and County Council. R@ISE is a unique opportunity to seize, especially with the excellent calibre of the international collaborators: a declared goal is to foster follow-up projects at EU level (see the named collaborating partners in Germany, Sweden, the Netherlands, Italy, Belgium) and beyond, as research projects or as MSCA ITN or Cofund initiatives.

vi. Project management plan

The research milestones and deliverables will follow an adapted **design science, action research, agile approach**, where communication with all the stakeholders, including industry, will be frequent and prototypes will be successively designed, implemented and handed over to the users for feedback and adoption in **cycles of 3 to 6 months**, where WP1 and WP2 are interleaved.

WP1 and WP3 will start at Month 1 but WP2 at Month 4, in order to respect the natural precedence of platform w.r.t. applications. This way, we have an interleaving of the ca.6 months cycles of the platform (WP1) with Milestones at M6, M18, M30, M45 and M60, and the Digital Thread applications which follow at M12, M24, M38, M52 and M60.

WP1 recruitment has hiring milestones at M12 and M18, with WP2 following 3 months later, at M15 and M21. WP3 recruitment is targeted for M6, and WP3.1 will maintain an annual reporting pulse. The project will start with a Kick-off event in M1.

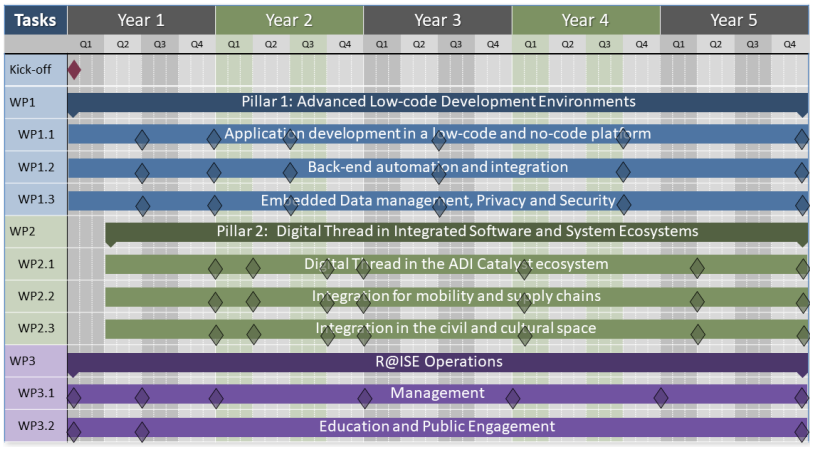

Figure 6. Project management 5 year plan

We strive to work systematically in a coherent and cohesive fashion. By design of the management structure, built-in co-leadership shares the management burden and distributes the decisional power, fostering consensus. This is in the experience of Lero the best strategy to avoid succumbing to crisis. In over 15 years of Lero, with over 60 industrial partners, not a single project was dropped or did not reach success, because the built-in cooperation structure succeeded to absorb all the changes and defaults.

Implementation Risks

The following table lists the main risks at the project level and their envisaged management approach.
Risk will be a standing Item on the management board and governance board's agendas.

Risk	Description of Risk	WP	Proposed mitigation measures
R1	Delay in recruitment	All	Start the WPs that are complete; special care afterwards for late WPs. WP2 starts slightly delayed also to relieve recruitment pressure
R2	Recruits quitting before PhD completion	1,2	Prevent through tight mentoring; mitigate through synergy and competence over-laps in the WPs, include the external collaborators for increased competences
R3	Partner leaving the consortium; key person leaving the project	All	Prevent through careful selection; mitigated through co-leadership: if an individual leaves, the Vice Leader is immediately fully operational
R4	Inability to host or to organize a meeting or EPE event	3	Prevent through competence overlaps (find a new responsible); mitigate through co-responsibility, leverage the Lero connection
R5	Ethics issues with researchers	1,2	Prevent by education; special mentoring; handled by the supervisors along UL policies; escalation to Ethics committee.
R6	One (or more) researcher do not achieve expected outcomes	1,2	Prevent through careful selection; mitigate by early identification in the WP, more frequent review and feedback, special training to fill gaps
R7	Platform development requires more time than expected	2-6	Consortium carefully chosen to include all the competences that are needed to develop the platform. Prioritize goals that are key for WP2 and EPE
R8	Outreach, Communication and Dissemination Strategy fails	3	Experienced partners ensure feasible strategies to be defined from the beginning; closely monitor communication impact and effectiveness, adjust strategies to outcomes, leverage the Lero collaboration
R9	R@ISE project does not have impact on future IT practices and ecosystems	All	Project Coordinator, partners and advisors will suggest how to mitigate such risk and will constantly evaluate the research and the management within the project to maximise outcomes quality and usability

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Academic team

The UL expert team is led by Prof. Tiziana Margaria, expert in software systems and formal methods for software construction, and further includes Prof. Mike Hinchey (formal methods, autonomous evolving systems), Prof. Stephen Kinsella (econometrics, smart spaces), Dr. Katie Crowley (HCI, human factors), Dr. Salim Saay (software and system architectures), and Dr. Roisin Lyons (IT innovation and education, EPE). The PIs are used to work together, in Lero and in the shaping of the very successful ISE program that is at the root of the R@ISE consortium. The FIs bring additional overarching expertise in domains that are core to the success of the individual WPs and R@ISE as a whole.

Prof. Tiziana Margaria, has over 25 years of experience in industry and academia in creating the kind of eXtreme Model Driven Development (XMDD[22]) for service oriented systems that is at the basis of the now emerging LC/NC approaches[23]. XMDD is enhanced with formal methods, so that the produced software artefacts are certifiable with respect to several properties, assuring high quality of the LC/NC products. Similarly, she is a pioneer of the Digital Thread thinking in Industry 4.0[24], promoting in Confirm the use of advanced LC/NC platforms to solve the omnipresent end-to-end interoperability problem that plagues this and many other sectors: they increasingly rely on software to weave information and control flows in their systems and collaboration ecosystem. She is fellow and Vice-president of the Irish Computer Society, and Co-director of Immersive Software Engineering.

Prof. Stephen Kinsella is Professor of Economics and Head of the Department of Economics at the University of Limerick. He is Co-Director of Immersive Software Engineering. Stephen is the Chair of the Irish Government Economic Evaluation Service and a visiting Professor at Brown University and the University of Melbourne. Stephen currently leads three research groups funded by Horizon Europe, SEAI, and the ESRC. Stephen's latest research is on innovation networks and smart cities. He has a background in agent based macroeconomic modelling. A frequent media commentator, Stephen is Chief Economics Writer for the Currency.

Prof. Mike Hinchey is Professor of Computer Science and Head of the Department of Computer Science and Information Systems at the University of Limerick and President or IFIP (International Federation for Information Processing). Mike has a record of innovations and developments in mathematical correctness of autonomous software, resulting in 26 issued United States Patents (of which the applicant is inventor or co- inventor) several of which are used in the Mars Rovers and in other NASA space exploration missions. Mike led the NASA Software Engineering Laboratory for almost 15 years leading to new technologies for autonomous systems and supporting hundreds of civil service and contract staff. A former Director of Lero, Mike grew Lero from a research centre in (then) 4 universities to being based in 8 universities with a 400% growth.

Dr Katie Crowley is a Lecturer in Computer Science at the University of Limerick, FI and researcher with Lero, the SFI Research Centre for Software and a visiting fellow with the Centre for Innovative Human Systems in Trinity College Dublin. She has extensive experience working with, and in industry, including securing national funding for industry partnerships (SFI). She has been a team member in multi-disciplinary international research projects co-funded by industry and national funding bodies and has led projects as Principal Investigator, Funded Investigator and Senior Researcher. Dr Crowley has worked with multiple Irish universities (UCC|UL|TCD|MTU) and SFI Research Centres (Lero|ADAPT|CONFIRM). Her research area is interdisciplinary, encompassing Affective Computing, Human Computer Interaction, and Digital Health, equipping her with transferable and scalable expertise relevant to R@ISE. She is the current UL lead on the WiSTEM2D Johnson & Johnson WiSTEM2D programme mentoring and supporting female STEM2D talent.

Dr Roisin Lyons is a Lecturer of Entrepreneurship and Innovation at the University of Limerick. Her research (quantitative) focuses on development of entrepreneurial tendencies (entrepreneurial self-efficacy, intentionality, passion etc.), and the impact that factors such as education, teamwork, and more recently, the start-up workplace, has on the nascent or evolving entrepreneur. PhD research and publications provide much needed discussion on resources needed to develop entrepreneurial talent within education, and in the start-up environment. In particular, a recent publication in Small Business Economics examines the role of social sexual behaviour in the start-up workplace, noting the need to investigate human resource and workplace norms in fast-growing entrepreneurial firms.

Dr Salim Saay is a Lecturer at the Department of Computer Science & Information Systems, teaching in the Immersive Software Engineering (ISE) course, course director of DevOps and Data Analytics at the University of Limerick. He is a researcher with Lero, the SFI Research Centre for Software and Academic Collaborator in a Confirm SFI project. He is a graduate of Computer Science (B.Sc. Kabul University, M.Sc – the University of the Western Cape in South Africa and PhD- Tallinn University of Estonia.). His relevant core expertise is in software architectures, in particular those for lightweight federations of different organizations, enabling controlled sharing and collaboration.

Co-funding Partner Overview

Stripe

Stripe is a privately held technology company building the economic infrastructure for the internet. Businesses of every size—from new startups to public companies—use our software to accept payments and manage their businesses online. Stripe currently has more than 8,000 employees worldwide and maintains headquarters in San Francisco and Dublin where it employs over 1000 people.

Stripe provides services, products, tools and interoperability to customers of all sizes, in every industry, globally. Accordingly, the quality and efficiency of our software is central to the business and value proposition. We deeply care about communities, and in fact they have created their own Academy and communities of partners, service providers and customers, They have a long and successful history of investing in collaborative ecosystems. Similarly, we champion sustainability in all its aspects, including through the Stripe Climate and Frontier platforms, where a growing group of ambitious businesses are changing the course of carbon removal.

John and Patrick Collison initiated the conversation with Prof. Stephen Kinsella that led to the funding of ISE. They fund the program with a significant contribution to the bespoke staffing. They also support the funding for a number of senior lecturers, lecturers, administrative and support personnel for ISE for a period of five years. They contribute **€500,000** in cash and 300,000 in kind to the R@ISE research budget, with the a promise to support any research in the field of Software Engineering that has the potential to radically alter the game in the medium term (ca. 3-5 years) for the speed and accessibility of producing top quality software and platforms. Within R@ISE, they seek to assemble a critical mass of excellent researchers that will achieve highly visible results, relevant to industry and education. They are not personally involved in any concrete research project, but will advise, monitor and assess the progress and be part of the R@ISE governance team. Through Tracworx and Tines, who are working with Stripe components and products, the Stripe ecosystem is an integral part of the research program. Additionally, Rob Heaton, senior Software Engineer at Stripe, will coordinate the in-kind consulting and mentorship to the relevant PhD students and postdocs. It is foreseen to have at least 3 secondments of PhD students in appropriate Stripe divisions, either in Ireland or in the USA.

ADI

Analog Devices, Inc. (NASDAQ: ADI) is the world's leading provider of precision semiconductor devices and sensors. operates at the centre of the modern digital economy, converting real-world phenomena into actionable insight with its comprehensive suite of analog and mixed-signal, power management, radio frequency (RF), and digital and sensor technologies. ADI serves 125,000 customers worldwide with more than 75,000 products in the industrial, communications, automotive, and consumer markets. ADI is headquartered in Wilmington, MA.

The ADI Catalyst is an incubator-like R&D environment focused on forming stronger partnerships, exchanging ideas, creating living labs, and developing breakthrough solutions. The Catalyst accelerates ADI's connection to their customers through ecosystem partners that collaborate and together co-create innovative solutions. ADI Catalyst Europe is a customer collaboration hub, with a growing global impact in areas of Industry 4.0, connectivity, automotive and innovative business models. Through the Catalyst, ADI is ushering in a new era of speed and collaboration by utilizing a true partnership approach to help customers resolve their challenges. Within these walls, companies can create ground-breaking technologies and solutions at an accelerated pace and achieve breakthroughs that were not possible even a year ago. In particular, the ADI vLab project will deliver to the customers an online workspace of connected evaluation and design tools and apps. This platform is based on the latest cloud and container technologies and the vLab team consists primarily of software developers, QA, dev-ops, data analytics and user experience. The Catalyst environment and the connected ecosystem are central to the R@ISE research infrastructure and collaborative partnership.

ADI is committed to the Immersive Software Engineering degree and to the R@ISE infrastructure. As ADI pivots to a software and hardware-based service provider, the insights we will glean from R@ISE's low code/no code approach will be invaluable. ADI are one of the founding partners of the ISE programme and as such, as an initiating partner of R@ISE, as its goals and objectives are fully aligned with our values and own initiatives. ADI have a history of collaboration with UL ranging over more than 40 years. ADI have endowed buildings within UL, and are key partners in research centres such as Lero and CONFIRM.

ADI contributes **€900,000** + (€420,000, in-kind), totalling €1,320,000, plus access to the Catalyst incubator and significant involvement of their experts in the ADI team: Mike Morrissey: ADI's Catalyst Director, Lorna Keane: Director of Digital Platforms (vLab), Rosemary Ryan: Engineering Lead, Automotive Technology Group, Fiona Treacy: Strategic Marketing Leader Industrial Connectivity (Product Design), Eoin English: System applications Manager – Consumer Human Sensory Experience Team (VR).

Tines

Tines, a world leader in no code deployment of automation for security, was co-founded in Dublin in 2018 by two senior cybersecurity operators, will contribute to R@ISE directly through its founders: Eoin Hinchy (CEO) and Thomas Kinsella (COO). Tines is an Irish hyperdynamic company, valued at over €300 million after the most recent funding round (April 2021). They recently opened an office in Boston.

The Tines platform is used by some of the largest companies in the world, like Box, Canva, OpenTable and Sophos, that handle millions of transactions daily. Tines believes no code automation has the potential to save teams days and weeks of work, free up security practitioners for high-impact projects, and improve total productivity. No code automation gives frontline security analysts the ability to automate processes like phishing attack responses, suspicious logins, and even employee onboarding and offboarding with a few drag-and-drop options.

R@ISE's mission is to expand low code and no code development across a number of world-leading companies with a cadre of excellent researchers, embedded in the ISE ecosystem. As such it fits perfectly with Tines' mission to be the trusted leader in no code automation and they support the development of no-code case studies as part of the R@ISE programme.

Tines' interest in R@ISE is in improving their platform and programming language, in particular collaborating with the UL experts to connect and merge both low-code approaches, and to enhance the Tines platform through formal methods and other advanced high assurance techniques that can make it more robust and more analysable at design time, before building and test/execution (sustainability). The collaboration includes the co-leadership of WP 2.2, co-mentoring 1 Postdoc and 3 PhD students, a contribution of **€350,000** + (€500,000 in-kind), totalling €850,000. The in-kind contributions will be in the form of their expertise and that of Tines' developers, providing access to Tines' technology and SaaS, and hosting at Tines 3 PhD students/Postdocs seconded for a period of 1 to 3 months.

Tracworx

Tracworx are an early-stage company based in Limerick which brings together a fully integrated suite of digital products for supply-chain management. Tracworx does everything required to gain insights into supply chains impacting one's business and make the customer's returnable packaging a more valuable asset. Tracworx are a research-oriented company, founded in 2016 in Limerick. Tracworx repeatedly gained EU funding and VC investment. It is represented in R@ISE by the Founder and CTO Eoin O'Brien, himself a UL CSIS graduate and member of the ISE Young Advisory Board. Key contributors are Chris Kelly (CEO) for the integration WP, Fionn Barron (COO), Frances Blackburn (Project & Ops Manager) and Nick Gleeson (Engineering Manager).

In R@ISE, Tracworx will be active in Pillar 1 participating to the case studies and validation of the Low/no-code platform there produced, and in Pillar 2, as their technology is amenable to enrich several case studies within the ADI Catalyst, case studies in Limerick city and county in collaboration with the LCCC, as well as independent applications. If R@ISE is funded, Tracworx will provide a cash contribution of **€200,000 + (€50,000, in-kind), totalling €250,000**. In-kind contributions include expert collaboration, industrial co-mentorship of 3 PhD students, and access to their technologies and experts.

Tracworx see R@ISE as a platform for developing our their tools and processes to further support their business as it develops. The founders are UL alumni and have worked on ISE's second-level engagement programme. R@ISE's goals and objectives are fully aligned with the Tracworx values and initiatives. Tracworx will lead WP2.2: Integration for mobility and supply chains and participate in several other work packages. They are committing a significant amount of time from senior engineers and leading managers, as well as in-kind access to their technologies (software and hardware, as needed) and support channels. This endeavour extends and deepens the ongoing collaboration of the last two years, during which Tracworx and UL have worked intensely together.

Johnson & Johnson Vision Care

Johnson & Johnson is one of the world's largest and most broadly based healthcare companies. Every day, more than 130,000 employees across the world are blending heart, science, and ingenuity to meet the company's purpose to profoundly change the trajectory of health for humanity. Operating in Ireland since 1935, Johnson & Johnson is one of Ireland's leading employers with a workforce of more than 5,000 highly skilled and motivated people across 10 locations, spanning 5 counties. J&J's operations in Ireland touch all aspects of human health, from consumer products to pharmaceuticals, medical devices, and vision. The workforce in Ireland supports the company through research and development, engineering, manufacturing, quality, sales, marketing, commercial and IT roles, to name but a few.

The involved division is Johnson and Johnson Technology. Our projects of interest include but are not limited to: 1) Low-Code No Code Platform Scaling (Pillar1), 2) AI/ML Data Science and DevOps and 3) Digital Twins and the Digital Thread (Pillar 2). It also envisages hosting PhD students to research areas of interest to J&J. J&J's contribution is **€100,000**.

Motivation for support: Vision Care and its Affiliates in Ireland are happy to support the development of no low code case studies as part of the R@ISE programme as this is aligned with Vision Cares commitment to advance software development in healthcare.

Limerick City and County Council

Limerick City and County Council (Comhairle Cathrach agus Contae Luimnigh) is the authority responsible for local government in the City of Limerick and County Council covers a geographical area of 2755 sq.km and provides a wide range of services to more than 191,000 people. The organisation is over 1200 staff. Under the leadership of Alan Dooley, Head of Digital Strategy of the Limerick City and County Council, R@ISE will cooperate with the city and region.

In recent years LCCC have been building digital capabilities as a service provider for citizens and have worked with UL on several projects, most notable the +CityXChange Horizon 2020 which examined issues around interoperability of shared data and citizen-led innovation. LCCC has a history of collaboration with UL: Stephen Kinsella played a leading role in the +CityExchange EU project led by Limerick City. There is a prior commitment to collaborate with ISE as part of ISE's immersive approach to Software Engineering education. The embedding in the local reality concerns smart cities and the connected smart region: digital transformation, urban renewal, advanced 5G infrastructure for arts and culture, citizen engagement in the environment and events/initiatives revolving around digital innovation, e.g., in Innovate Limerick, led by Einne Curran as its Digital Collaboration Centre Manager. All these topics are addressed as case studies in Pillar 2 of R@ISE. Limerick City and County Council will fund in-kind **€250,000**. As the Council's services become ever-more digital, the insights will glean from R@ISE's low code/no code approach will be invaluable. As an initiating partner of R@ISE, LCCC goals and objectives are fully aligned with the R@ISE values and initiatives.

Partner	**Cash Contribution**	**In-Kind Contribution**	**Partner Total**
Stripe	€500,000	€300,000	€800,000
ADI	€900,000	€420,000	€1,320,000
Tines	€350,000	€500,000	€850,000
Tracworx	€200,000	€50,000	€250,000
Johnson & Johnson	€100,000	-	
Limerick City and County Council	-	€250,000	€250,000
Total	2.050.000	1.520.000	
Combined Total			3.570.000

Education and Public Engagement

Low-code approaches are the new generation of technology able to provide the basic infra- structure and means by which software engineering competency diffuses from few, expensive elite programmers and the enterprises that can afford them, to the generality of companies whose business needs are as great but who lack a specific skill in software crafting as practised today. The Digital Thread problem, currently unsolved, stems from the same root of high threshold of specialistic and specific knowledge, coupled with the legacy software problem.

R@ISE tackles both problems together, by producing every 6 months a new, enhanced version of a platform for software creation (Pillar 1) and new system building technologies by system integration (Pillar2) that can be brought to the public, because they are cognitively simpler. The new technologies must be brought to a variety of publics a) for the sake of **getting feedback** from the foreseen and unforeseen adopters, as well as b) for **spreading the message** that this technology indeed exists, it works, and it should be considered for adoption in companies and organizations. It should also become the ***new standard*** **for education in digital skills and digital transformation** for the general professionals and population.

Public engagement is important to R@ISE because without that engagement, the mission to diffuse these ideas will fail. By public we mean firms at all scales as well as public bodies. The PIs and FIs will lead all EPE activities and are all committed to using their public profiles to generate maximum impact as well as feedback for the project. Feedback will inform the improvement and further development in the next agile cycles of the research in the true spirit of engaged research. The main EPE champions will be T. Margaria, S. Kinsella, K. Crowley and R. Lyons, and we have named in the table the champions in each partner. All the PIs and FIs have an excellent track record of EPE: An example is the TECS competition that made it to the national news, organized by the entire ISE team in Nov-Jan, led by T. Margaria and S. Kinsella. T. Margaria is already conducting EPE in Lero and Confirm, and will lead the efforts in the R@ISE context. S. Kinsella is a public commentator and twice winner of Columnist of the Year and Chair of the Irish Government Economic Evaluation Service. Through ISE, we have a privileged channel to reach schools (over 20 visits, 3000 mailed, 15 events so far), guidance counselors (keynote by T. Margaria at the IGC CPD event), and a pipeline of offers of collaboration beyond Patch (The Big Idea, Innovate Limerick in Ireland, Jenga School in Nairobi, UL Global's agents in India). We have scholarships to offer, that may be strong additional motivators for the participation in various initiatives conducive to the production of excellent portfolios for ISE. These channels and opportunities are going to be used for **R@ISE Software in Education** at the 2nd level. M. Hinchey is very active at the policy and international level (e.g. as president if IFIP and ICS), JJ Collins is very active at the 2nd level, K. Crowley and S. Saay have extensive previous experience of EPE in various SFI research centres, and R. Lyons is an educational expert and a champion of hackathon and competition organization. The ISE admin team and Lero will provide professional support to the R@ISE EPE activities in all their roles (marketing and communications, administration, 3 industry coordinators, technical support). EPE will require the indicated budget to cover the activities expenses, in particular also awards for student competitions and hackathons to promote at a large scale the adoption of the open access platform developed in Pillar 1.

In particular the three ISE Industry Coordinators will be key to sustain the **R@ISE Engaged Research activities**, scaling R@AISE's results sharing to the already over 50 Residency Partnership Network companies of ISE, and fostering the dialogue, directed at new problems, new opportunities, new projects. Thanks to the immediate connection with ISE, the dissemination to the **over 50 ISE Residency Partner companies** will be channelled through specific events and through the choice of topics for the on-campus projects and the student residencies in those companies. This way we intend to demonstrate to the many non-research performing companies in this group that research is close to their interests, and prepare the ground for potentially a 2nd SPP follow-up a few years later.

The recently established AWS – ISE Global Fellowship, funded through a perpetual AWS donation, will additionally bring each year to R@ISE between 10 and 20 Junior (up to 5 years after PhD) and Senior fellows from academia, research institutions and industry. The Fellowship supports collaborative stays of 3 weeks to 6 months in Limerick covering research, education and outreach activities within the ISE/R@ISE ecosystem. Accordingly, over the 5 years of R@ISE **50 to 100 internationally renowned experts** will get to know R@ISE first hand, work with the team and enrich its expertise. As the fellowship also mandates a medium to long term collaboration plan, they will continue to be collaborators, content disseminators and ambassadors upon their return. In the current AY, the first fellows will come from the USA, Australia, Germany, Italy and Norway.

We have seen **hackathons** to be particularly successful when connected with a purpose that is not pure IT, and Dr Roisin Lyons is an expert in developing and deploying hackathons. Both Pillars will produce tools and case studies that can serve as seed for STEM or even non-STEM events addressed to the public, e.g. in Science Week, in the Lifelong Learning week in May, Tech Week, and during the UL Open Days. The No-code approach is especially amenable to be a vehicle for reaching young people, engaged parents, and adult non-coders, bringing them in contact with a low-barrier technology for application development. We are very passionate about this line of action, and intend to set up a regular series of such opportunities on campus, in the city and county, and also online – nationally and globally. There is an agreement to collaborate and co-brand some of these events with the Irish Computer Society, the Irish professional society for CS in Ireland, of which Prof. Margaria is Vice President, and to cooperate in events and campaigns with the schools. The PIs and FIs have experience of outreach to and activities with the general public, in the ***R@ISE for All*** pillar of the EPE strategy.

We are already in contact with UL Global in order to create a no-code series of activities to be offered by UL in India to school pupils, as a means to advertise UL and the special UL edge to education in CS and STEM. Within the ***Global R@ISE*** EPE strategy, we would be able to transform this fledgling initiative to a powerful program branded in Ireland. Also here the Irish Computer Society is likely to partner, as they run the Irish branch of the Bebras Computing Challenge[25] and are therefore an excellent connection to both the participating Irish schools and the international organizers.

The same applies to the **power of the Digital Thread**, when through our advanced platforms normal individuals become able to create complex systems by composing existing building blocks like Lego. With the fast-rising topic of low-code/no-code and the wealth of case studies addressed in Pillar 2 we are best equipped to deliver enticing contents, and to use the online channels for communi-cation, and also for content delivery and collaborative hands-on experiences in Ireland and abroad.

We are deeply committed to supporting **Equality**, **Diversity and Inclusion**, and we will ensure that a good portion of the initiatives will target those segments of the public that are currently under- reached and underserved. Through ISE, CSIS and Lero we have already a network in place to reach those communities and groups, and as a collaboration network for initiatives and their delivery.

As we have shown with ISE, we are familiar with **all the modern communication channels**: website, press releases, radio interventions, podcasts, webinars, twitter, reddit have generated in 6 months 441 thousand impressions, 1.2K followers and participation, both nationally and internationally, well beyond any prior experience. We will use these now well established channels to announce and promote events, content, interactions and outcomes related to R@ISE.

All the PIs and the companies have extensive experience of EPE, on their own and through the SFI research centres and CRTs they adhere to: we are all familiar with the concept, kind of initiatives and events that take place locally, regionally and nationally. We embrace the evolution of the concept and standards of EPE towards **deeply engaged and collaborative research** over the years.

Tackling the European level: Leading by example and through partners that are themselves European or national network multipliers, R@ISE will **effectively impact the structure of a large number of educational and training programs.** Through the recordings and the textbooks, it will achieve educational and training effects well beyond the project's lifetime. The tools and platforms realized and the work of communication and outreach also towards the political and societal key actors will have a long-term effect for the establishment of a new multidisciplinary professional profile modelled after R@ISE.

Additionally, we intend to continue this kind of training and co-education beyond the termination of R@ISE, effecting a **paradigm change in the way this new spectrum of professionals is trained in Europe**. Given the exceptional range of the R@ISE network of networks, demonstrated by the partners' successes in establishing and changing curricula at the national and European level, we are confident of sustaining our network through joint research projects, joint conference organization, and joint outreach activities.

Strengthening Irish and EU Innovation capacity: The R@ISE IT platform and its portfolio of applications are **far beyond the currently adopted "best practices"** in the companies and organizations, which today are still based on technology that was innovative one or more decades ago. To meet the needs of the future, the research program has been oriented towards a cooperative and radically new way of creating, delivering, managing, and organizing design and application development, **without fear of being disruptive and of abandoning compliance with the status quo**. Security as a service and community-level games for long term training of expert crews are concrete examples of potentially disruptive project results. They serve respectively the unmet needs of high-trust data management in volatile governance environments, and the need for engagement in continuous improvement off-line from the production facilities, contributing to national and EU innovation over and above what currently exists.

Impact

R@ISE will investigate low-code, model driven approaches to software development as an alternative to the traditional manually coded development paradigm, as well as embedded solutions for data management, privacy and security. This is a collection of hot topics that are on every organisation's list of critical concerns and every educational body's list of highly sought for expertise and training.

The R@ISE SPP proposal aims at doubling the already committed industry cash investment for research, in order to scale the ISE ecosystem research component to the number of 21 PhD students and 6 Postdoctoral fellows over the 5 years of duration of the SPP at a public funding cost of 2050 Euro. These are highly sought for trainees that will transfer into occupations very likely in the Irish economy. As a comparison, the EU MSCA Smart 4.0 COFUND program is producing 16 postdocs over 4 years at the cost of ca. 2MEuro public funding, and the SFI CRT-AI is producing at UL 24 PhDs over 7 years at the same individual cost as R@ISE PhDs, but with 80% public funding.

Regarding communication and events, collaboration is foreseen with ISE's 2nd level initiatives, departmental and faculty initiatives, and where appropriate with the outreach and EPE of Lero, Confirm and the CRT-AI, exploiting potential synergies. We foresee organizing several events with the LCCC, in particular in collaboration with Innovate Limerick, a company of Limerick City and County Council.

R@ISE is designed to have impact at both the business level and at the citizen level. Limerick City and County Council will provide **case studies, expertise, and infrastructure** connected with the R@ISE activities in Pillar 2, in particular the access to the Digital Quarter in Limerick City, the facilities of the Engine innovation hub, the new Digital Twin model of the city. Related expertise at UL's new Citizen Innovation Lab will be made available to the R@ISE researchers and

projects. Additionally, LCCC is an invaluable partner for many **dissemination** avenues: within the council's operations and initiatives, for EPE to the general public, and towards the local, regional, national and also international policy makers. The table below shows how our expected impacts map to SFI's key criteria. KPIs will be developed in the full proposal.

	CORE TEAM	**PARTNERS**	**How we will work to ensure the proposed project is successful**
Generate Knowledge	TM, MH, SK, KC RL, SS,	ADI, J&J, Tines	Research papers, LC software development platform, Digital Thread case studies, patents
Develop Individuals and Collaborations	TM, SK, MH, KC, RL, SS	Tines, Tracworx	New collaborations and cross functional partnerships, trainings
Supporting Broader Society & the Economy	TM, SK, RL, KC SS	Stripe, LCCC, Tracworx	School visits, divulgation papers, information through media, hackathons. Firm adoptions, spin-outs, case studies.
Supporting the Research Community	TM, MH, SK	ADI, Tines	Conferences, events, protocols, new software, open source code, open access papers, Open Education Resources

Concerning impact to **industry and the digital revolution**, these early career researchers will bring transformative innovation into the R@ISE partner companies, to other companies where they might then continue their career, or into roles in academia. We are confident that the impact on the industrial practice will be much higher than usual, because we have here top support by the founders of several of the R@ISE companies and by top executives in the others. Given that R@ISE right now **precedes the inevitable landslide** due to the advance of the Low-code and no-code approaches, the timing is exceptionally important to ensure that R@ISE is the first and only initiative of this scale, in Ireland and elsewhere, and thus it has the first mover advantage in the applied research landscape on this topic.

Our research will have real-world impact. For example, our research will reorganize and coherently enhance the current capabilities of ADI's Catalyst, and improve its ease of adoption, integration, validation, verification, quality assurance and evolution. The end goal is to enable the Catalyst lab and testbed to become a no-hassle, end-to-end provider of integrated yet extensible capabilities (in a feature-oriented fashion), at different levels of quality (from prototype to production) in a true Digital Thread implementation.

In terms of access to relevant communities through professional bodies and associations, for example Prof. Hinchey is the President of IFIP, the UN's International Federation for Information Processing, promoting IT worldwide, especially in developing countries. Prof. Margaria is the Vice President IFIP WG 10.5 on Design Automation, the hardware, sensors, and systems working group. She was recently confirmed vice president of ICS, the Irish Computer Society. Dr Saay has experience in bringing IT solutions in developing countries, most notably Afghanistan, in complex collaboration with ministries, regulators, international funding agencies, and local educational actors.

Concerning **education and the R@ISE footprint** in the medium term, the R@ISE team (the supervisors and all 27 early career researchers) will build a strong bridge between the collaborative research in the R@ISE projects and its partner companies on one side, and the challenges, projects and topics they and the other over 50 ISE Residency Partner companies offer to the ISE students. ISE will enrol ca. 80 students per year, and have about 300 students each year over the four cohorts of its integrated BSc/MSc. The message amplification and the acceleration of uptake inherent in the embedding of core and applied research in the ISE educational blocks, both on campus and in the residencies, is unique in the educational landscape in Ireland and internationally. Considering the long-term transformational effect of 80 highly skilled MSc graduates in Software Engineering who are native in a research-driven environment, and join any of the Residency partner companies or other companies, or governmental organizations, or continue into research, in academia or any of the research centres, or follow the example of the founders they got to know through R@ISE and set up their own company.

The **effect of scale R@ISE** can achieve through its research capacity at the PhD and Postdoc levels is essential to guarantee that no student and no residency partner company will be left behind on the research track.

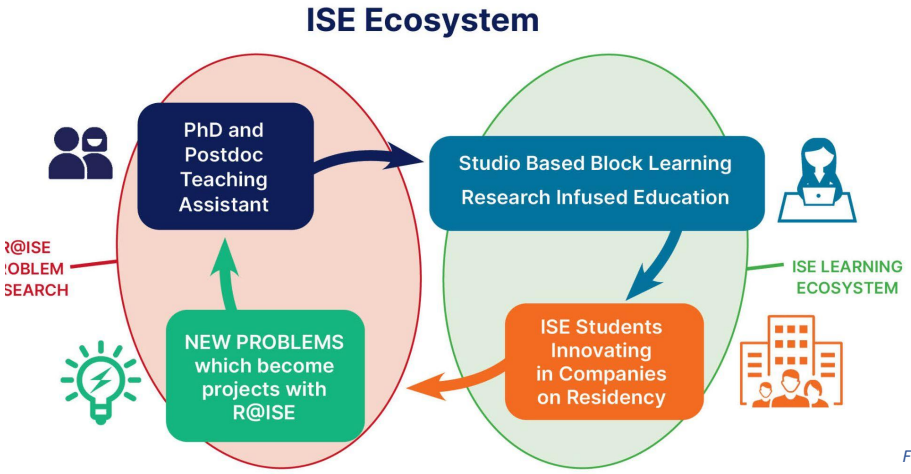


Figure 7. ISE Ecosystem

Intellectual Property

R@ISE aims at achieving significant impact to society and industry, fostering exploitation of its results by industry and in further research and education. To this aim, a plan for the management of all IP relating to the partnership project will be provided as part of the Collaborative Research Agreement, in accordance with national guidelines, in particular Ireland's National IP Protocol 2019[71] and in compliance with State Aid legislation. UL's Research Office and Technology Transfer Office have experience of such agreements, as they manage the Collaborative Research Agreements of 3 national SFI Research Centres headquartered in Limerick and one SFI Centre of Research Training.

Specifically, we plan to

- Make **publicly available demonstrators of the technologies in the R@ISE platform** and consider **open source or open access** for the largest possible distribution that does not impede the competitive advantage of partners and the Irish industry.
- Adopt the **most liberal possible policies for educational and training material** produced (taking account of restrictions that some industrial experts might be subject to), including methodologies and adoption guidelines and make it available as publication, as Open Education Resource.
- With ISE, we already have a large and long-lasting **education arm of R@ISE.** We will leverage this asset for collaboration with the home institutions of the international collaborators across Europe, which will further solidify the collaboration between all the partners and collaborators.
- Produce a new generation of highly skilled researchers and decision makers who will stimulate innovation and uptake of the R@ISE philosophy, culture, and outcomes.

The background IP of the core technology itself for the R@ISE platform is largely open source or open access (DIME, CINCO). We will strive to release as much as possible of the platform and of its specific outputs in an **open and easy to access and reuse** fashion. No background IP contribution is foreseen by the partners at this time. Should the need or will to contribute background IP arise during the research program, it will be declared along the UL procedures and with the guidance of UL's Technology Transfer Office. We envisage adopting an Open IP model, the details of which will be agreed with the partners and reflected in a **collaborative research agreement**.

For sustainability of the technology and to facilitate adoption, from M30 on we will strive to create persistent maintenance and support for the outcomes in a more appropriate context, with an emphasis on supporting the establishment of startups or a user community (nonprofit or for profit). Leveraging UL's Kemmy Business School, the Nexus Innovation Centre, the National Technology Park on campus, Lero's track record of IT licensing and spinoff successes, the excellent links to Enterprise Ireland as partner for innovation scouting, seeding and growth, and the excellent partnerships of the Shannon region with local venture capitalist as well as Silicon Valley investors, we have the best set up to **turn the R@ISE legacy into an asset available and appreciated worldwide.**

Research Infrastructure

The R@ISE project will benefit from **operations support provided by Lero**, the SFI Research Centre for Software. These will include support from Lero's existing functions pertaining to Education and Public Engagement (EPE), Marketing and Communications, Business Development and Funding. In addition, the Director of Lero will support R@ISE through participation in the R@ISE Advisory Committee.

Professional administrative and financial support will be provided via a number of central units and divisions: Post Award Support and Compliance group, Research Contracts unit, Research Finance Office, Human Resources, the Library, and Information Technology Services. The Research Finance office will provide post-award support for the financial management of R@ISE, including account management for expenditure recording, control and payment services, as well as dealing with reporting and auditing requirements.

Learning and development support will be provided for students and staff associated with the project. UL has a formalised Graduate School developed in conjunction with the University Faculties to support policy development and the delivery of research programmes, while providing training in transferrable skills and discipline specific education for research students. The University of Limerick is committed to the career development of its researchers. Researchers can avail of the established UL Researcher Development Programme, which offers a suite of career development supports in the form of mentoring, academic experience, workshops, on-going training programmes and on-line modules. This has proven exceptionally useful to UL's Postdoctoral research fellows. For example, the two MSCA Alecs Research Fellows supervised by Prof. Margaria in Lero, Dr. Salim Saay is now a Lecturer in UL and Dr. Ibrahim Tariq Javed is Associate Professor in Pakistan. Relevant programmes that researchers may undertake include Developing your Career Strategy, Research Management, Engagement & Impact, Research Ethics, Research Data Management and PhD Supervision. Furthermore, EMerge is a peer support network for early and mid-career academic staff at the University of Limerick. The network was first launched in November 2020, with a vision to create a collaborative and supportive environment for early and mid-career academics (EMCAs) to achieve their career goals through peer-support and the development of shared academic and research opportunities at UL. This inter-disciplinary network is open to all who identify as an early or mid-career academic. There are currently 160+ members across all Faculties at UL.

UL will provide expert support in relation to **technology transfer, commercialisation, and engagement with enterprise activities**. The UL Technology Transfer Office (TTO) will provide support for commercialisation and technology transfer. The services offered by TTO include intellectual property (IP capture and protection), IP commercialisation, negotiation of IP agreements (research collaboration & licensing), and IP training and awareness development. The TTO through its commercialisation process will promote and foster the initiation and growth of spin outs.

Further supports to the R@ISE team will be provided by the Nexus Innovation Centre at UL, which accommodates start-up companies, predominantly in the software sector. Nexus has key infrastructural supports that support a knowledge transfer strategy, providing services that include one to one coaching, mentoring, entrepreneurial training programmes and workshops.

Particularly appreciated is the commitment to locate R@ISE in the IBC2 building on campus in UL: one floor of the building has been just refurbished, and it contains office space for a first group of R@ISE members. The complete retrofitting to modern energy standards of the entire building is going to take place in the next months, so that R@ISE affiliates will be living in the most modern and efficient space on campus. It will include a state-of-the-art Cyberphysical System Lab and a server room with space foreseen for the R@ISE dedicated equipment. R@ISE will additionally have access to the Citizen Innovation Lab located in the UL City Campus, in the heart of Limerick centre, which is run in collaboration with the LCCC on UL's premises. This connection to the city and LCCC will enable R@ISE very special opportunities to carry out public facing initiatives in town.

Budget

Total Research Programme Budget (SFI and Co-Funding Partner(s) Commitment, Direct Costs)

Category	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Staff	406,578	899,823	793,395	684,003	487,638	3,271,436
Equipment	54,226	55,572	7,410	0	0	117,208
Materials	36,250	92,100	110,000	102,000	106,162	446,512
Travel	35,546	55,676	67,076	66,176	40,370	264,884
Total	**532,600**	**1,103,171**	**977,881**	**852,179**	**634,170**	**4,100,000**

Total SFI Requested Budget (Direct Costs)

Category	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Staff	190,578	419,823	337,395	228,003	247,638	1,423,436
Equipment	17,178	0	0	0	0	17,178
Materials	31,250	70,100	85,000	77,000	85,029	348,379
Travel	31,709	55,676	67,076	66,176	40,370	261,007
Total	**270,715**	**545,599**	**489,471**	**371,179**	**373,037**	**2,050,000**

Breakdown of SFI Requested Budget Direct Costs

Staff	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	190,578	419,823	337,395	228,003	247,638	**1,423,436**
Total	**1,423,436**					

Equipment	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	17,178	**0**	**0**	**0**	**0**	**17,178**
Total	**17,178**					

Materials	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	31,250	70,100	85,000	77,000	85,029	**348,379**
Total	**348,379**					

Travel	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	31,709	55,676	67,076	66,176	40,370	**261,007**
Total	**261,007**					

Total Co-Funding Partner(s) Commitment (Direct Costs)

Category	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Staff	216,000	480,000	456,000	456,000	240,000	**1,848,000**
Equipment	37,048	55,572	7,410	0	0	100,030
Materials	5,000	22,000	25,000	25,000	21,133	98,133
Travel	3,837	0	0	0	0	3,837
Total	**261,886**	**557,552**	**488,410**	**481,000**	**261,133**	**2,050,000**

Breakdown of Co-Funding Partner(s) Commitment (Direct Costs)

Staff	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	216,000	480,000	456,000	456,000	240,000	**1,848,000**
Total	**1,848,000**					

Equipment	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	37,048	55,572	7,410	**0**	**0**	**100,030**
Total	**100,030**					

Materials	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	5,000	**22,000**	**25,000**	**25,000**	**21,133**	**98,133**
Total	**98,133**					

Travel	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	3,837	**0**	**0**	**0**	**0**	**3,837**
Total	**3,837**					

Budget Justification

The total size of the R@ISE proposal is 4100.000 Euro in To deliver the proposed research program, R@ISE will hire a total of 22 PhD students, 4 Postdoctoral fellows, a Program manager, a Technical officer and a part-time Administrator, for a total team size of 29.

The total cost is 4.100.000€, of which 2.050.000€ contributed by the partners, and 2.050.000€ co-funded by SFI. Additional 1.520.000€ have been pledged as in-kind contribution, as detailed in the individual partner descriptions. This budget is prepared along the SFI policies[26] and UL's expense policies and procedures.

Staff: The main staff costs arise in WP1 and WP2, for the researches to be hired. Each WP will hire 2 Postdocs and 11 PhD students.

The PhD students are costed at the standard SFI rates, with a stipend of 18.500€ and a tuition fee of 5.500€. No non-EU candidate PhD students have been identified at this time.

The PhD students will be hired in the first 2 project years, therefore we have foreseen year 1 and year 2 starts, for a duration of 4 years each.

The 4 Postdocs and 4 PhD students will be funded by SFI, the industry partners will fund 18 PhD students.

The cost split is:

The Postdocs will be hired at starting at grade 2A, Pt 3 of the SFI scale, for 24 months each, in years 1 and 2 of the project. The higher starting level is due to the national and international labour market situation for highly skilled PhDs, where industry and EU MSCA programmes set a wage expectation. We will try to hire experienced Postdocs, that can take up some mentorship roles and lead small groups of collaboration.

As suggested by many experienced program managers, for a program of this size it is necessary to hire an Operation team. It will be funded by the SFI contribution. Due to the fact that Lero and ISE have committed to synergies and support, we have:

- A Program Manager (UL Senior Executive Administrator scale, point 1) for 4.5 years, who will be in charge of the project management, partner management, internal and external reporting, implementing the strategy in collaboration with the R@ISE Management team. This PM will also represent R@ISE externally, in scientific, industrial and EPE context. Due to the technical timing for open competitions, we realistically expect to hire this role in the first 6-7 months of the program.
- A Technical Officer (UL Technical Officer scale, point 1) for 4.5 years, who will be in charge of the setup, management and maintenance of the equipment, see below. Due to the procurement times of the equipment and the duration of the hiring process, we expect to hire this role in the first 6-7 months of the program.
- A part time Administrator (UL Administrator scale, point 8, 0.5 FTE), for 5 years, who will be in charge of the day to day administrative tasks for the entire staff of R@ISE, including also the UL paid roles (UL staff members, Lero operations team, UL central administration, Graduate School for the PhD students). We will endeavor to fill this role as soon as possible, as it is central to support the program start phase.

All the positions will be hired in open competitions, in conformance to UL's HR policies and procedures and the procedures of the Graduate School for the PhD students. As UL espouses best gender equality and EDI practices, we will adhere to the guidelines and promote these values in the course of hiring and mentorship.

Equipment: We foresee the servers (12,678€) and the 3 laptops for the Operations team (4500€) to be funded by SFI and the laptop for the 26 researchers (3,704.81€ each) to be funded by the industry partners.
The 2 Dell Power Edge R350 servers (2*4909€) and the UPS (2860€) are needed to run the development environment, the development and analysis tools, and to deploy and test the applications, even many of those that will then be installed in the Catalyst or Confirm testbeds. The servers chosen are today's standard.
The laptops are Dell Precision standard high-end developer workstations, as needed for the planned research, including monitor, docking station and mouse. These have been purchased recently for similar PhD students.
The total Equipment amount is 117.208€, of which 100,030€ funded by the partners.

Materials: The consumables commensurate with the experience in similar research projects. They include printing costs and office material, water and similar supplies.
Following the recommendations for small equipment, we include here the costs for a portable scanner, print services.
Open access publication fees have been included in the WPs, for a total of 131.000€. This estimate is based on the current costs of publication and the % of papers that are expected to be subject to fees

Additionally we include portable AV equipment (2 Philips GoPix 1 Mobile projector, 2 Nebula Mars II Pro HD Portable Projector, 2 Adastra H25 952412 Portable Speaker With Headset Microphone) and material specifically for EPE (11 Merge Cube and 11 Raspberry Pi 4 with kit), for all of which quotes are available. This equipment is needed as we will do EPE activities also in schools and at fairs. In our experience, on-site equipment is often incompatible, outdated, or not available. The cubes and Raspberry Pis are indicative examples of the kind of equipment we will use for these EPE activities (individual kit price is 168.50€).
The total **EPE budget** foreseen is 178.661€, which is ca 4.35% of the R@ISE total budget. As described in the proposal, R@ISE will systematically leverage synergies with Lero in EPE activities.

The total Materials budget is 446,512€: 98,133€ contributed by the partners and 348,379€ by SFI.

Travel: The travel costs have been computed applying the SFI policies.
Conference travel: One travel per year à 1500€ for the 6 supervisors, one travel for each of the Postdocs (2 years - 1) and 3 travels for each PhD student (4 years -1).

One travel per year has been included for the Program Manager (5*1500€), as we expect this to be necessary when attending international events or fairs and roadshows, as practiced by comparable research programs.

One visit of 2 weeks to Limerick is budgeted for each of the collaborators. The Irish collaborators are budgeted at 200€ national travel costs, plus 10 per diem at 167€. We have 2 such collaborators in WP2. The EU collaborators are budgeted at 600€ travel costs, plus 14 per diem at 167€. We have 5 such collaborators in WP1 and 3 such collaborators in WP3. The non-EU collaborator is budgeted at 1500€ travel cost form the USA, plus 14 per diem at 167€. We have one such collaborators in WP2.

We foresee one working visit for each PhD and Postdoc. As the individual destinations are not yet known, the budget considers average costs in EU, and durations of 1-2 weeks. The aggregated estimates are spread over the duration of the project.

Travel is funded by SFI, except for the USA collaborator, which is funded by a partner. The total budget foreseen is 264,844€.

Letters of Support

Science Foundation Ireland
Three Park Place, Hatch Street Upper,
Dublin 2, Ireland

21st September 2022

To Whom it May Concern,

On behalf of the University of Limerick, I am delighted to endorse the support of the institution for the R@ISE application to the SFI Strategic Partnership Programme. I also confirm that the lead applicant, Professor Tiziana Margaria and each of the Co-Applicants, Professor Stephen Kinsella and Professor Micheal Hinchey hold permanent academic positions at UL and meet all of the eligibility criteria of the Programme, and have long-standing research track records. I also confirm the eligibility of Funded Investigators Dr Katie Crowley, Dr Salim Saay and Dr Roisin Lyons, all of whose academic contracts will cover the period of the grant, whose PhD awards are 2018 or earlier, who have at least 3 senior author publications, and are eligible to supervise postgraduate students and team members.

The R@ISE research programme is of significant strategic importance to UL, and builds on UL's ground-breaking collaboration with some of the world's most innovative companies in delivering the Immersive Software Engineering programme. Software capabilities are essential to underpin every aspect of the economy and society, and the R@ISE research programme will investigate new ways for organisations to develop software using low-code and no-code approaches. This research builds on UL's existing strengths in software engineering, including UL's hosting of Lero, the SFI Research Centre for Software, in which Prof Margaria and Prof Hinchey are Investigators.

This proposal is aligned with UL's institutional and research strategies. UL's strategic plan, *UL@50*, reflects the ambitions for the institution with research excellence as a core strategic goal. The University's priorities include (a) building interdisciplinary programmes of strength, which include software, (b) broadening our research programmes to address global challenges, including digital transformation, and (c) developing/growing strategic partnerships with leading universities and industry. UL's research strategy has a goal of enabling a Smart Society, through the evolution of digital technology to benefit businesses and citizens. The R@ISE programme will directly support this goal.

R@ISE will be located in the IBC2 building on the UL campus. This has recently been refurbished and provides office, desk, lab and meeting space for R@ISE researchers. In addition, the R@ISE researchers will have access to the Citizen Innovation Lab, which is located in the UL City Campus in the heart of Limerick City. This will provide R@ISE with space and opportunities for public engagement.

R@ISE will also receive support from central University administration functions. These include:

- **Professional administrative and financial support**:

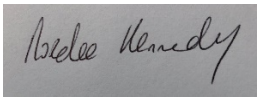
- Post award support administration will be provided by the Post Award Support and Compliance team within the Research Office, by the Research Contracts unit, the Research Finance Office, Human Resources, the Library, and Information Technology Services;

- C**areer development support for staff and students associated within the Centre**:
  - UL has a formalized Graduate School developed in conjunction with the university Faculties to support policy development and the delivery of research programmes, while providing opportunities for generic and discipline specific education for researchers;
  - UL will also provide career development training opportunities for UL Post-Doctoral researchers associated with the Centre via the UL Research Career Development programme, as well as a structured career path via the UL Researcher Development Programme;
- **Expert support in relation to technology transfer, commercialisation and engagement with enterprise activities**:
  - The UL Technology Transfer Office (TTO) will provide support for commercialisation and technology transfer. The services offered by TTO include intellectual property (IP capture and protection, IP commercialisation, negotiation of IP agreements (research collaboration & licensing), and IP training and awareness development.

Conflicts of Interest: The University of Limerick manages potential conflicts of interest in accordance with the University's *Policy for Conflicts of Interest*. Conflict of Interest is also addressed in UL's *Intellectual Property Policy* and the *Policy for Private Consultancy and External Commercial Work.*

I wish Professors Margaria, Kinsella and Hinchey, and the broader R@ISE team every success with this research programme.

Yours sincerely,



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Professor Norelee Kennedy
Vice President Research, University of Limerick

Dear Profs. Margaria and Kinsella,

We are delighted to participate fully in the Research at Immersive Software Engineering (R@ISE) strategic partnership programme application.

We offer this letter of comfort detailing the extent of that contribution.

A brief description of ADI

Analog Devices, Inc. (NASDAQ: ADI) operates at the center of the modern digital economy, converting real-world phenomena into actionable insight with its comprehensive suite of analog and mixed signal, power management, radio frequency (RF), and digital and sensor technologies. ADI serves 125,000 customers worldwide with more than 75,000 products in the industrial, communications, automotive, and consumer markets. ADI is headquartered in Wilmington, MA.

Our motivation for engaging

ADI is committed to the Immersive Software Engineering degree and to the R@ISE infrastructure. As ADI pivots to a software and hardware based service provider, the insights we will glean from R@ISE's low code/no code approach will be invaluable.

We are one of the founding partners of the ISE programme and as such, as an initiating partner of R@ISE, as its goals and objectives are fully aligned with our values and own initiatives.

We offer this letter of comfort detailing the extent of our contribution.

We have a history of collaboration with UL ranging over more than 40 years. We have endowed buildings within UL, and are key partners in research centres such as LERO and CONFIRM. As a key strategic partner for the university, the development of the ISE programme, both in its teaching and research elements, is of importance to us.

Our specific contributions to the programme, including co-development of the research programme, financial and other contributions

Due to our unique expertise in software platform building and management, ADI will co-lead *WP2.1: Digital Thread in the ADI Catalyst ecosystem* and participate in several other work packages. We commit significant time of our named senior engineers and leading managers, as well as in-kind access to our technologies (software and hardware, as needed) and support channels. This endeavour extends and deepens the ongoing collaboration of over the last three years, where ADI and UL have worked intensely, shoulder to shoulder,

with continuous communication and support also concerning PR, marketing and communications.

Our support extends to our financial contribution of €900,000 and in-kind support of staff time and software resources as detailed in the work packages of the R@ISE application.

How the collaboration will benefit us both

We expect this R@ISE collaboration to bring to life the ideas discussed at length in the past three years in the context of the co-design of the new model of industry-academia collaboration accompanying ISE.

Many of the traits of the R@ISE research program in terms of choice of topics and their priorities have been co-developed. We look very much forward to finally be able to hire the young researchers, explore these and further new ideas, test them in practice in the R@ISE software platform in collaboration with the partners, on practical use cases, and push this way the knowledge and the practice beyond the current state of the art of best practices.

Our support extends to a financial contribution of €900,000, and ADI's in-kind contribution of staff time, software resources, technical support and engagement in management, outreach and educational activities as detailed in the work packages of the R@ISE application and in this table.

ADI Contributions						
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Cash	250000	250000	250000	150000		900,000
Staff in-kind	90,000	110,000	110,000	110,000	60,000	420,000
Equipment in-kind						
Other in-kind-PR support						
Total	310,000	310,000	310,000	310,000	60,000	1,320,000

We look forward to collaborating with Profs. Margaria and Kinsella in the future and look forward to a positive outcome in this regard.
Sincerely Yours,

Michael Morrissey

Mike Morrissey.....

Sr. Director Analog Devices

22nd September 2022

Dear Profs. Margaria and Kinsella,

Stripe is delighted to participate fully in the Research at Immersive Software Engineering (R@ISE) strategic partnership programme application.

A brief description of Stripe

Stripe is a privately held technology company building the economic infrastructure for the internet. Businesses of every size—from new startups to public companies—use our software to accept payments and manage their businesses online. Stripe currently has more than 8,000 employees worldwide and maintains headquarters in San Francisco and Dublin where it employs over 1000 people.

Stripe provides services, products, tools and interoperability to customers of all sizes, in every industry, globally. Accordingly, the quality and efficiency of our software is central to the business and value proposition. We deeply care about communities, and in fact we have created our own Academy and communities of partners, service providers and customers, We have a long and successful history of investing in collaborative ecosystems. Similarly, we champion sustainability in all its aspects, including through the Stripe Climate and Frontier platforms, where a growing group of ambitious businesses are changing the course of carbon removal.

Our motivation for engaging

We are the initiating partner of R@ISE, as its goals and objectives are fully aligned with our values and own initiatives.

We offer this letter of comfort detailing the extent of our contribution.

We have a history of collaboration with UL based on deep engagement by Stripe's President John Collison and Stripe's representatives, where we co-design the contents, the delivery and the governance and management of complex initiatives in research and education alike. Two large scale initiatives are Immersive Software Engineering and the second level outreach initiatives such Technology: Engineering: Creativity: Science (TECS). R@ISE now complements as a strong initiative for the advancement of software development and management practices of the future.

Our specific contributions to the programme, including co-development of the research programme, financial and other contributions

Stripe will be deeply embedded in the R@ISE programme. Our support extends to a financial contribution from our founder John Collison's family office of €500,000. This money is to be taken from our existing gift to ISE via the UL Foundation and does not represent any incremental increase in our gift to ISE. Our in-kind support of staff time and

software resources is set down as detailed in the work packages of the R@ISE application.

Due to our unique expertise in software platform building and management, Stripe will co-lead *WP1.2: Back-end automation and integration*. Stripe participate in *WPs 1.1, 1.3*, and the entirety of *WP2, management and EPE activities and governance*. We commit significant time of our named senior engineers and leading managers, as well as in-kind access to our technologies (software and hardware, as needed) and support channels. This endeavour extends and deepens the ongoing collaboration of over 3 years, where Stripe and UL have worked intensely, shoulder to shoulder, with continuous communication and support also concerning PR, marketing and communications.

How the collaboration will benefit us both

We expect this R@ISE collaboration to bring to life the ideas discussed at length in the past three years in the context of the co-design of the new model of industry-academia collaboration accompanying ISE.

Many of the traits of the R@ISE research program in terms of choice of topics and their priorities have been co-developed. We look very much forward to finally be able to hire the young researchers, explore these and further new ideas, test them in practice in the R@ISE software platform in collaboration with the partners, on practical use cases, and push this way the knowledge and the practice beyond the current state of the art of best practices.

Stripe's cash and in-kind contribution of staff time, software resources, technical support and engagement in management, outreach and educational activities as detailed in the work packages of the R@ISE application and in this table.

STRIPE Contributions						
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Cash	100,000	100,000	100,000	100,000	100,000	500,000
Staff in-kind	40,000	40,000	40,000	40,000	40,000	250,000
Equipment in-kind						
Other in-kind-PR support	10,000	10,000	10,000	10,000	10,000	50000
Total	250,000	150,000	150,000	150,000	50,000	800,000

We look forward to collaborating with Profs. Margaria and Kinsella in the future and look forward to a positive outcome in this regard.

Sincerely Yours,

John Collison 

Dear Profs. Margaria and Kinsella,

We are delighted to participate fully in the Research at Immersive Software Engineering (R@ISE) strategic partnership programme application.

A brief description of Tines

Tines is a world leader in no code deployment of automation for security. Our platform is used by some of the largest companies in the world. Tines believes no code automation has the potential to save teams days and weeks of work, free up security practitioners for high impact projects, and improve total productivity. No code automation gives frontline security analysts the ability to automate processes like phishing attack responses, suspicious logins, and even employee onboarding and off boarding with a few drag and drop options.

Our motivation for engaging

R@ISE's mission is to expand low code and no code development across a number of world leading companies with a cadre of excellent researchers, embedded in the ISE ecosystem. As such it fits perfectly with Tines' mission to be the trusted leader in no code automation. We are also happy to support the development of no code case studies as part of the R@ISE programme.

Our specific contributions to the programme, including co-development of the research programme, financial and other contributions

Due to our unique expertise in no code software platform building and management, Tines will lead *WP1.2:* ***Back-end automation and integration*** and co-lead WPs 1.1, **Application development in a low-code and no-code platform,** and 1.3, **Embedded Data management, Privacy and Security,** actively participating in several other work packages. We commit significant time of our named senior engineers and leading managers, as well as in-kind access to our technologies (software and hardware, as needed) and support channels. This endeavour extends and deepens the ongoing collaboration with ISE.

Our support extends to our financial contribution of €350,000 and in-kind support of staff time and software resources as detailed in the work packages of the R@ISE application and the table below.

Tines Contributions						
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Cash	70000	70000	70000	70000	70000	350,000
Staff in-kind	60,000	60,000	60,000	60,000	60,000	300,000

Equipment in-kind (software)	40,000	40,000	40,000	40,000	40,000	200,000
Other in-kind-PR support						
Total	170,000	170,000	170,000	170,000	170,000	850,000

How the collaboration will benefit us both

We expect this R@ISE collaboration to bring to life the ideas discussed at length in the past two years in the context of the co-design of the new model of industry-academia collaboration accompanying ISE.

Many of the traits of the R@ISE research program in terms of choice of topics and their priorities have been co-developed and as mentioned above, fit perfectly with our company mission and business objectives. We look very much forward to finally be able to hire the young researchers trained in R@ISE, explore these and further new ideas, test them in practice in the R@ISE software platform in collaboration with the partners, on practical use cases, and push this way the knowledge and the practice beyond the current state of the art of best practices.

We look forward to collaborating with Profs. Margaria and Kinsella in the future and look forward to a positive outcome in this regard.

Sincerely Yours,

DocuSigned by:
Eoin Hinchy
9ABD2E68101B42E...

Eoin Hinchy
CEO of Tines

TRACWORX

Tervoe, Clarina,
Co. Limerick
V94 V4Y0

20 September 2022

Dear Profs. Margaria and Kinsella,

We are delighted to participate fully in the Research at Immersive Software Engineering (R@ISE) strategic partnership programme application.

A brief description of Tracworx

We are an early-stage company based in Limerick which brings together a fully integrated suite of digital products for supply-chain management. Tracworx does everything required to gain insights into supply chains impacting one's business and make the customer's returnable packaging a more valuable asset. We are a research-oriented company, having partnered on Horizon 2020 applications in the past and recently completed a very successful seed round. Our CTO Eoin O'Brien is also a member of ISE's Young Advisory Board.

We offer this letter of comfort detailing the extent of that contribution.

Our motivation for engaging in R@ISE

We see R@ISE as a platform for developing our own tools and processes to further support our business as it develops. We are UL alumni and have worked on ISE's second-level engagement programme. R@ISE's goals and objectives are fully aligned with our values and own initiatives.

Our specific contributions to the programme, including co-development of the research programme, financial and other contributions

Due to our unique expertise in software platform building and management of supply chains, Tracworx will lead WP2.2: Integration for mobility and supply chains, and participate in several other work packages. We are committing a significant amount of time from our senior engineers and leading managers, as well as in-kind access to our technologies (software and hardware, as needed) and support channels. This endeavour extends and deepens the ongoing collaboration of the last two years, during which Tracworx and UL have worked intensely together.

TRACWORX

How the collaboration will benefit us both

We expect this R@ISE collaboration to bring to life the ideas discussed at length in the past three years in the context of the co-design of the new model of industry-academia collaboration accompanying ISE.

Many of the traits of the R@ISE research program in terms of choice of topics and priorities have been co-developed. We very much look forward to working with R@ISE's young researchers and testing their ideas in practice in the R@ISE software platform on practical use cases in collaboration with the partners, pushing beyond the current state of the art and best practices.

Our support extends to a financial contribution of €200,000, and an in-kind contribution of staff time, software resources, technical support and engagement in management, outreach and educational activities as detailed in the work packages of the R@ISE application and in this table.

Tracworx Contributions (€)						
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Cash	40,000	40,000	40,000	40,000	40,000	200,000
Staff in-kind	10,000	10,000	10,000	10,000	10,000	50,000
Equipment in-kind	TBD	TBD	TBD	TBD	TBD	TBD
Other in-kind-PR support						
Total	60,000	60,000	60,000	60,000	10,000	250,000

We look forward to collaborating with Profs. Margaria and Kinsella in the future and look forward to a positive outcome in this regard.

Yours sincerely,

Eoin O'Brien (Founder & CTO)

Johnson & Johnson
Vision Care Ireland UC

NATIONAL TECHNOLOGY PARK,
LIMERICK, IRELAND
Int. Tel: +353-61-232000
Int. Fax: +353-61-232204

23rd September 2022

University of Limerick

Dear Profs. Margaria and Kinsella,

We can confirm that Johnson & Johnson Vision Care ("Vision Care") is committed to supporting the R@ISE program at the University of Limerick ("UL").

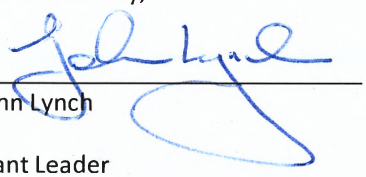
The support offered by Johnson & Johnson Vision Care itself or through its Affiliates will take the form of:

1. A cash donation in the sum of €100,000 made by way of a charitable donation to the University if Limerick Foundation dated 14th December 2021.
2. In kind contribution in the form of mentoring and student support at the discretion of Vision Care.
3. Access to equipment as required and at the discretion of Vision Care.
4. Such other in-kind support as Vision Care and UL may agree from time to time.

Vision Care and its Affiliates in Ireland are happy to support the development of no low code case studies as part of the R@ISE programme as this is aligned with Vision Cares commitment to advance software development in healthcare.

We understand that this letter may be used by UL in support of further funding for the R@ISE programme

Yours Sincerely,



John Lynch

Plant Leader

Johnson & Johnson
Vision Care, Castletroy, Limerick, Ireland
E: jlynch8@its.jnj.com

DIRECTORS, J. HIGGINS, J. JACOBSEN (GER), J. LYNCH, K. McSHERRY, A.MURPHY, P. O'REILLY, D. RYAN, L. VAN EYLEN (BE).
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Comhairle Cathrach
& Contae **Luimnigh**

Limerick City
& County Council

Seirbhísí Corparáideacha,
Comhairle Cathrach agus Contae Luimnigh,
Ceanncheathrú Chorparáideach,
Cé na gCeannaithe,
Luimneach

Digital Services,
Limerick City and County Council,
Corporate Headquarters,
Merchants Quay,
Limerick

EIRCODE V94 EH90

t: +353 (0) 61 557150
f: +353 (0) 61 415 266

September 21st, 2022

Dear Profs. Margaria and Kinsella,

We are delighted to participate fully in the Research at Immersive Software Engineering (R@ISE) strategic partnership programme application.

A brief description of Limerick City and County Council

Limerick City and County Council (Comhairle Cathrach agus Contae Luimnigh) is the authority responsible for local government in the City of Limerick and County Limerick in Ireland. Limerick City and County Council covers a geographical area of 2755 sq.km and provides a wide range of services to more than 191,000 people. The organisation has over 1200 staff.

Our motivation for engaging

In recent years we have been building out our digital capabilities as a service provider for citizens and have worked with UL on several projects, most notably the +CityXChange Horizon 2020 project which examined issues around interoperability of shared data and citizen-led innovation.

As the Council's services become ever-more digital, the insights we will glean from R@ISE's low code/no code approach will be invaluable.

As an initiating partner of R@ISE, as its goals and objectives are fully aligned with our values and own initiatives.

Our specific contributions to the programme, including co-development of the research programme, financial and other contributions

Due to our unique position as a statutory body producing services for citizens, LCCC will co-lead *WP2.3: Integration in the civil and cultural space,* where R@ISE's tools and processes are applied to occupancy analytics within Limerick city, and where collaborative spaces are connected to one another using R@ISE technology.

We commit significant time of our named senior engineers and leading managers, as well as in-kind access to our technologies (software and hardware, as needed) and support channels.

This endeavour extends and deepens the ongoing collaboration of over the last five years with UL.

Our support extends to an in-kind support of staff time and software resources as detailed in the work packages of the R@ISE application.

We offer this letter of comfort detailing the extent of that contribution.

Our support extends to our in-kind support of staff time and software resources as detailed in the work packages of the R@ISE application and in the table below.

LCCC Contributions						
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Cash						
Staff in-kind	50,000	50,000	50,000	50,000	50,000	250,000
Equipment in-kind						
Other in-kind-PR support						
Total	50,000	50,000	50,000	50,000	50,000	250,000

We look forward to collaborating with Profs. Margaria and Kinsella in the future and look forward to a positive outcome in this regard.

Sincerely Yours,

Alan Dooley

Alan Dooley
Head of Digital Services & EU Programmes

digital.services@limerick.ie
www.limerick.ie
@LimerickCouncil
061-557150

Ceanncheathrú Chorparáideach, Cé na gCeannaithe, Luimneach
Corporate Headquarters, Merchants Quay, Limerick