ICT 2023 Interim Evaluation Panel Report

30 November 2020

ACADEMY OF FINLAND

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Executive summary

This report provides an international interim evaluation of a ten-year, 100 million euro research, development and innovation programme, ICT 2023, by a panel of independent experts. In this evaluation initiated by the Academy of Finland, the panel was asked to provide a critical assessment of the performance of the ICT 2023 programme up until September 2020 and to provide recommendations for the final phase of the programme. Specifically, the panel was asked the following questions:

- How has the Academy contributed to the goals of the ICT 2023 programme?
    - How has the programme contributed to the development of deep computing skills, in terms of scientific quality, novelty and renewal of science?
    - How has the programme promoted the widespread use of ICT know-how?
    - Has the programme contributed to the internationalisation of computer science?
    - How has the Academy promoted the bringing together of universities, research institutes, companies and funders?
- Have the themes been well chosen (e.g. timeliness)?
- Recommendations for the final years of the programme.

Additionally, to the set questions by the Academy, the panel found it useful to consider the overall gender distribution in the ICT 2023 projects.

In its evaluation, the panel considered the terms ‘deep computing skills’, ‘ICT’ and ‘computer science’ interchangeably. In this report, the term ‘ICT’ will be used to refer to the overall scope of ICT 2023, including hardware, software and systems.

The Academy provided the panel with an extensive range of data sources and analyses including programme background information, call documents, funding statistics, publication statistics and bibliometric analysis, statistics and analysis on aspects such as mobility, current working sector for staff and multidisciplinarity. In addition, the panel had access to project reports from finalised projects, post-completion supplementary survey responses and project report evaluations by independent experts.

Importantly, as this is an interim evaluation, most of the detailed information was available for the first seven calls in the ICT 2023 programme.

Due to the Covid-19 pandemic, the panel conducted its work during and between a series of online video conferencing meetings. In the course of its work, the panel was assisted by Academy officials in relation to additional data sets and analysis. All documentation and data were managed and stored confidentially.

Overall, the panel found that the Academy's contribution to the goals of the ICT 2023 programme was extremely good. The strongest elements were the contribution to internationalisation and the promotion of scientific quality, novelty and the renewal of science. The panel also concluded that the themes chosen for the Academy's ICT 2023 calls were nationally and internationally relevant, timely and sufficiently diverse.

The panel determined that the Academy's ICT 2023 programme had also promoted the widespread use of ICT know-how, but that some aspects of knowledge and technology transfer to industry could have been stronger. Likewise, while there was good evidence that the ICT 2023 programme had promoted collaboration, particularly internationally, the ICT 2023 goal of bringing together universities, research institutes, companies and funders was not realised to its full potential.

The panel concludes that the gender distribution for the ICT 2023 programme is unbiased compared to the gender distribution among research staff at Finnish universities within ICT and also compared to other Academy-funded ICT projects. However, the panel's view is that there should be the ambition to significantly increase the proportion of women in the ICT domain in general.

The panel identified the following key strengths of the ICT 2023 programme:

- quality of scientific outputs
- international collaboration and international mobility
- attraction and retention of foreign ICT talent
- well-chosen call topics.

In terms of weaknesses, the panel felt that there was room for improvement in the following areas:

- business collaboration and knowledge transfer

- mobility levels within projects and post-project mobility within the research system
- talent pipeline for the private sector.

The panel makes the following recommendations for the final phase of the programme:

- The panel recommends that the Academy consider what actions it could take to improve post-project mobility with the aim of stimulating higher levels of skills development and stronger connections between research groups, institutions and business.
- The panel recommends that the Academy strengthen the emphasis on business collaboration in future ICT 2023 call memorandums and correspondingly increase the weighting for the associated review criteria.
- The panel recommends that the Academy consider how it can ensure that planned mobility is implemented in funded projects, for example by requiring a notice of variation where mobility plans are changed during the course of a project.
- The panel recommends that the Academy consider introducing an open call for ICT 2023 focused on high-risk, adventurous research, possibly by employing funding mechanisms other than Academy Projects.
- The panel recommends that the Academy consider extending the use of international experts to advise on topic selection at the programme and individual call level to ensure that the Finnish research system is fully aligned with global research challenges and needs.
- The panel recommends that future ICT 2023 call memorandums include stronger gender diversity requirements and proposal funding criteria.

1. Introduction

1.1. Background

ICT 2023 is a ten-year, 100 million euro research, development and innovation programme for Finland. The aim of the programme is to further improve Finland's scientific expertise in computer science and to promote the extensive application of information and communications technology (ICT). The annual budget of the programme is around 10 million euros and, by September 2020, more than 60 million euros had been granted to 2013–2019 funding calls.

The Academy of Finland initiated an international interim evaluation of ICT 2023 by a panel of six independent experts. The panel membership is given in Appendix A. The evaluation panel was asked to provide a critical assessment of the performance of the ICT 2023 programme up until September 2020 and to provide recommendations for the final phase of the programme.

1.2. Terms of reference

Specifically, the panel was asked to consider the following questions:

- How has the Academy contributed to the goals of the ICT 2023 programme?
    - How has the programme contributed to the development of deep computing skills, in terms of scientific quality, novelty and renewal of science?
    - How has the programme promoted the widespread use of ICT know-how?
    - Has the programme contributed to the internationalisation of computer science?
    - How has the Academy promoted the bringing together of universities, research institutes, companies and funders?
- Have the themes been well chosen (e.g. timeliness)?

In its evaluation, the panel considered the terms 'deep computing skills', 'ICT' and 'computer science' interchangeably. In this report, the term 'ICT' will be used to refer to the overall scope of ICT 2023, including hardware, software and systems. Specific terms are only used when discussing call topics or making other necessary distinctions between technical areas.

The panel also focused on the Academy's role in the programme, and therefore evaluation of the actions of Business Finland (previously Tekes) or other stakeholders was not considered.

In addressing these questions, the panel developed its recommendations for the final years of the programme, which are included in this report. In addition to the original questions set by the Research Council, the panel decided that it should consider gender diversity aspects of the programme as part of its evaluation.

The detailed terms of reference are provided in Appendix B.

1.3. Evaluation process

The Academy of Finland provided the panel with an extensive range of data sources and analyses including programme background information, call documents, funding statistics, publication statistics and bibliometric analysis, statistics and analysis on aspects such as mobility, current working sector for staff and multidisciplinarity. In addition, the panel had access to individual project reports from finalised projects, post-completion supplementary survey responses and project report evaluations by independent experts. The project report review form is in Appendix C and the post-completion supplementary survey questionnaire is in Appendix D.

In the course of its work, the panel was assisted by Academy officials in relation to additional data sets and analysis. Importantly, as this is a mid-term review, most of the detailed information was available for the first seven calls in the ICT 2023 programme, referred to as 'completed calls' throughout this report. A full list of ICT 2023 calls is provided in Appendix E.

Due to the Covid-19 pandemic, the panel conducted its work during and between a series of online video conferencing meetings. All documentation and data was managed and stored confidentially on the Eduuni site.

2. Overall assessment

Overall, the panel found that the Academy's contribution to the goals of the ICT 2023 programme was extremely good. The strongest elements were the contribution to internationalisation and the promotion of scientific quality, novelty and renewal of science. The panel also concluded that the themes chosen for the Academy's ICT 2023 calls (Appendix E) were nationally and internationally relevant, timely and sufficiently diverse.

The panel determined that the Academy's ICT 2023 programme had also promoted the widespread use of ICT know-how, but that some aspects of knowledge and technology transfer could have been stronger. Likewise, while there was good evidence that the ICT 2023 programme had promoted collaboration, particularly internationally, the ICT 2023 goal of bringing together universities, research institutes, companies and funders was not realised to its full potential.

2.1. Strengths and weaknesses of the ICT 2023 programme

The panel identified the following key strengths of the ICT 2023 programme:

- quality of scientific outputs

- international collaboration and international mobility
- attraction and retention of foreign ICT talent
- well-chosen call topics.

In terms of weaknesses, the panel felt that there was room for improvement in the following areas:

- business collaboration and knowledge transfer
- mobility levels within projects and post-project mobility within the research system
- talent pipeline for the private sector.

These strengths and weaknesses are discussed in more detail in section 3 (Specific findings) and in section 6 (Recommendations).

3. Specific findings

3.1. ICT skills development and scientific quality

In this section we consider how the ICT 2023 programme has contributed to the development of ICT skills, in terms of scientific quality, novelty and renewal of science.

For almost all of the 58 projects in the first seven completed calls in ICT 2023 there was an independent expert review of the final project reports. The project review form (Appendix C) asked specifically if the project had led to the development of in-depth competence in ICT (Question 2.1).

The expert evaluation of these completed projects confirmed that for all seven calls there was a significant improvement in competences and expertise across all the calls, with an average rating of better than 'good'. For one of the calls, 'Autonomous Systems and the Augmented Human', the average rating was just marginally below 'good'.

According to the project finance claims, and taking into account contract length and work pattern, around 50% full-time-equivalents (FTE) of research effort in the ICT 2023 completed projects was undertaken by early-career personnel. This includes assisting personnel and postgraduate students. For two of the calls, 'Information Security' and 'Advanced Microsystems', the early-career personnel FTE was lower at around 36% in both cases. Nonetheless, at the programme level, this balance in career stage for research personnel is extremely healthy and desirable. This confirms that the ICT 2023 programme has particularly supported the development of ICT skills, the

renewal of science and novelty by providing focused research training opportunities for these early-career researchers.

The projects funded under the completed calls produced 70 new doctoral degrees by the survey date. The panel considered this to be a reasonably good rate of training, although there was significant variation between calls, ranging from a rate of 0.5 new doctoral degrees per project for the 'Advanced Microsystems' call to 2.0 for the WiFiUS call. The panel recognised that individual ICT 2023 projects cannot fully support a complete PhD due to the project length. The earlier ICT 2023 calls were limited to a two-year duration, and more recently the Academy increased the project length to three years, which appeared to have increased the number of PhD students funded under the programme. Given the importance of high quality PhD-level training in the ICT field, the panel encourages the Academy to continue to facilitate higher rates of PhD student participation in ICT 2023 projects.

Figure 1 shows the distribution of the current positions of the project members after the end of the project for the completed ICT 2023 calls. The data covered 280 researchers and were collected as part of the supplementary survey, approximately a year after the last projects in this group of calls finished. This means that the variation between calls is also related to the project completion dates.

Overall, across all of the completed calls, most project members remained working in the same research group (48%) at the census date. Researchers were next most likely to be with a domestic private or public sector employer (20%), with a foreign research organisation in third place (12%). One concern for the panel was that mobility within the national research system, personnel moving to a different research group either in the same institution or to a different Finnish university or research institute after project finalisation, was extremely low at 13% across all of the completed calls. The one exception was the 'Information security 2014' call where only 18% of personnel stayed with the same group and 50% moved to another domestic research group.

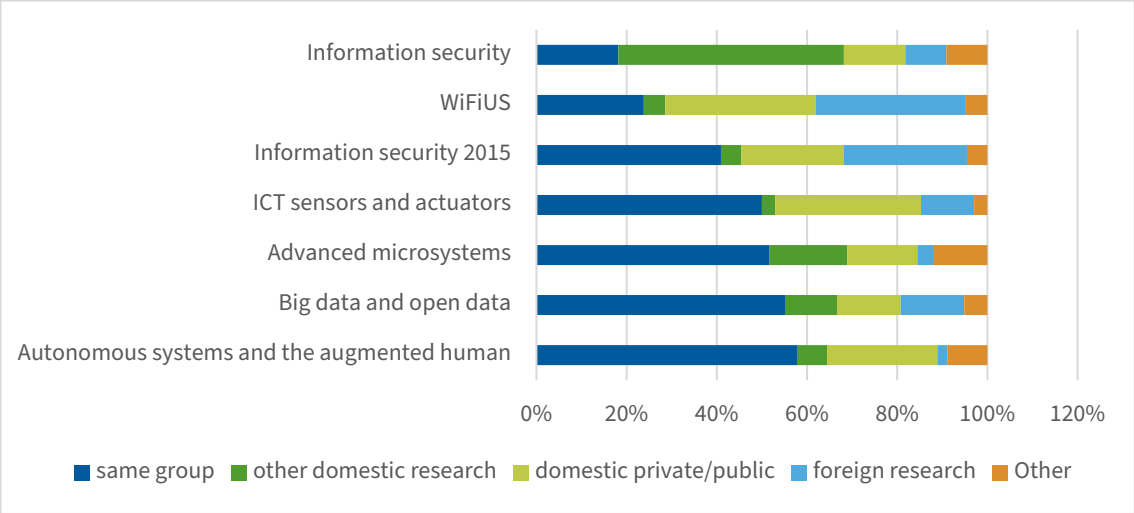

Figure 1. Positions of project members after the end of the project at the supplementary survey date in the seven completed calls.

A positive aspect is that the survey results indicate that private- and public-sector employers are interested in the project members, especially for the WiFiUS and the 'ICT Sensors and Actuators' calls where for both cases this accounted for around a third of project personnel. Only one case of unemployment was explicitly noted in the survey results, although there were 18 project members whose employment status was listed as "unknown/other". This means that, at a minimum, 261 researchers (93%) were still employed after the projects completed.

While the high level of post-project employment is welcomed, it is mostly in the same research group. The panel considered that the ICT 2023 programme could improve in term of post-project mobility, which in turn would lead to higher levels of skills development and strengthen connections between research groups and institutions. For example, future calls could require explicit cooperation between universities, research institutes and businesses during the project run-time, which could potentially reduce the barrier for project members to develop their career outside of their current research group at the end of the project.

The panel recommends that the Academy consider what actions it could take to improve post-project mobility with the aim of stimulating higher levels of skills development and stronger connections between research groups, institutions and business.

The programme's contribution to scientific quality is reflected mainly through the quality of the publications arising from the funded projects. The panel used bibliometric analysis for the period 2015–2020 to benchmark the quality of the publications generated from the projects in the ICT 2023

completed calls. The data presented in Table 1 were generated using SciVal and are based on that tool's publication database (Scopus). For the ICT 2023 case, the data were calculated using the outputs generated by the seven completed calls. It is a snapshot at a single point in time, as citations may continue to develop long after a paper is published. Table 1 shows that the quality of the ICT 2023 publications from the completed calls is excellent and higher than the Finnish average in the main subject areas relating to ICT. Finland's performance in these subject areas is, in turn, higher than the EU (including UK) average over the same period.

For example, Table 1 shows that the field-weighted citation impact (FWCI) of the ICT 2023 outputs considered is 1.89 which is almost double the global average impact. In both computer science and mathematics, ICT 2023 performance is significantly better than the national and European benchmarks. In electrical and electronic engineering (EEE), the difference is less pronounced, but the ICT 2023 programme is still extremely strong in this subject area. Overall, with 12.3 citations per output, the programme is delivering excellent impact. For the same date range, according to SciVal, the world average number of citations per output is 4.6 for computer science, 5.4 for EEE and 3.7 for mathematics.

Likewise, Table 1 also shows that the percentage of outputs in the field-weighted top 10% of most cited publications is significantly higher for ICT 2023 (22.4%) than for all Finnish publications in the main subject areas in the ICT domain (16.7% in computer science; 18.3% in EEE; 14.4% in mathematics).

Table 1. Bibliometric indicators for outputs from the completed ICT 2023 calls with Finnish and European benchmarks. SciVal data as of 27 Nov 2020; selected subject areas, 2015–2020.

	SciVal outputs 2015–2020	Citations per output	Field-weighted citation impact	Outputs in top 10% citation percentiles – field weighted (%)	Corporate collaboration (%)	International collaboration (%)
All subjects ICT 2023	588	12.3	1.89	22.4%	8.2%	47.8%
Computer science ICT 2023	398	11.7	1.96	22.1%	6.8%	49.0%
Computer science Finland	20,508	7.0	1.57	16.7%	11.4%	56.0%
Computer science EU-28	684,809	5.4	1.24	13.2%	6.0%	39.8%
EEE ICT 2023	155	12.2	1.78	22.6%	6.5%	49.0%
EEE Finland	8,310	8.7	1.64	18.3%	17.3%	63.0%
EEE EU-28	297,556	6.4	1.26	14.0%	8.6%	41.6%
Mathematics ICT 2023	122	9.6	1.94	18.9%	8.2%	53.3%
Mathematics Finland	9,119	5.6	1.41	14.4%	8.0%	60.9%
Mathematics EU-28	428,255	4.4	1.12	11.6%	4.0%	43.6%

Considering the differences between calls, Table 2 shows the bibliometric indicators for the completed call publications indexed by Scopus. Although all projects in the completed calls have finished, care must be taken when making comparisons. Since the individual calls and projects had different start and end dates, the most meaningful metrics are FWCI and the top 10% percentiles. In terms of FWCI, there is some understandable variation between calls, ranging from 1.41 in 'Autonomous Systems' to 2.84 in 'Information Security 2014'. The proportion of outputs in the top 10% citation percentile is on average 22.4%, depending on the call, ranging from 14.1% in 'Advanced Microsystems' to 41.7% in 'Information Security 2014'.

While the quality of publications is impressive at programme level, for the completed calls the independent expert evaluation reports at project level showed wide variation. Evaluators made comments ranging from "impressive" to "disappointing", and there was some indication that quality was being compromised for quantity with a large number of conference and workshop papers. Nonetheless, while there is variation at the project level, the aggregate performance at call and programme level remains excellent.

The independent expert evaluators also noted that there was a variety of research output types, with some good software and tools emerging from the work. However, it was also reported that data sets generated by projects were mainly internal and more should have been provided as open data.

Table 2. Per-call bibliometric indicators for outputs from the completed ICT 2023 calls. SciVal data as of 27 Nov 2020; covers all subject areas, 2015–2020.

ICT 2023 Call	Unique outputs	SciVal outputs 2015–2020	SciVal coverage	Citation count	Citations per output	Field-weighted citation impact	Outputs in top 10% citation percentiles – field weighted (%)	Corporate collaboration (%)	International collaboration (%)
Information Security 2014	47	43	91%	893	20.8	2.84	41.7%	11.6%	65.1%
WiFiUS, Wireless Communication	92	91	99%	1,147	12.6	1.79	22.0%	4.4%	55.0%
ICT Sensors and Actuators	104	99	95%	1,724	17.4	2.01	18.2%	13.1%	49.5%
Big Data and Open Data	150	141	94%	1,613	11.4	1.75	22.7%	5.7%	41.1%
Advanced Microsystems	82	78	95%	651	8.3	1.62	14.1%	20.5%	46.2%
Information Security 2015	107	101	94%	917	9.1	2.18	27.7%	1.0%	52.5%
Autonomous Systems and the Augmented Human	50	49	98%	396	8.1	1.41	20.4%	2.0%	30.6%

3.2. Knowledge transfer and widespread use of ICT

In this section, we regarded the "promotion of the widespread use of ICT know-how" as mainly concerning technology and personnel transfer with business (private corporations). A secondary aspect was the wider

promotion of ICT knowledge transfer through interaction with end-users and education and public engagement.

In the first case, an evaluation at this point in time is limited to early impacts and potential. In particular, technology and know-how transfer can take several years to materialise, even in the fast-moving ICT sector. Overall, the panel found that the significance of knowledge transfer from academia to business was moderate throughout all completed calls.

ICT competence transfer from universities to business was assessed by independent experts via Question 2.3 in the final project review form (Appendix C). For the 54 projects evaluated across all of the completed calls, the average score was 2.8, on a scale of 1 to 4, for ICT competence transfer. This indicates that performance was just short of "good" (3.0). However, the breakdown by call (Figure 2) shows that there was significant variation and range both between and within the completed calls. Also, many projects across all calls reported no industry interaction or commercialisation activity whatsoever. There were over 20 projects rated 1 (poor) or 2 (fair), showing that there is significant room for improvement.

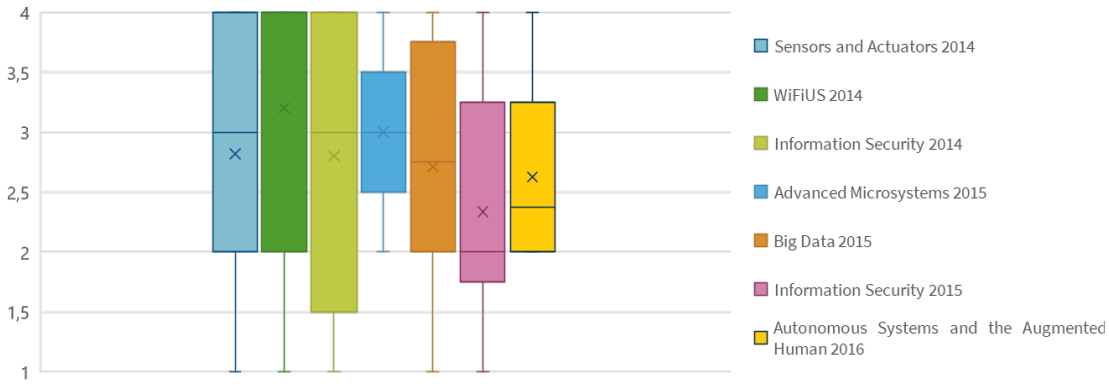

Figure 2. Independent expert evaluation of advancing ICT competence transfer from universities to companies. Scale: (1) poor, (2) fair, (3) good and (4) very good.

However, for the more impactful projects there was a good range of potential impact routes reported as outcomes. There were several reports of projects providing open source solutions, which have been picked up by industry as well as some level of collaboration with companies including Nokia, Huawei, Ericsson, being the more well known. A small number of filed patents and examples of involvement in start-up company creation were reported. However, by and large, collaboration with and transfer to industry did not appear to have been a major focus of the research projects as implemented by the research teams. It is understood by the panel that, as the Academy of Finland projects are mainly targeted towards academic

excellence, knowledge and competence transfer may simply always be a secondary consideration for the principal investigators on these projects.

Table 1 shows that the proportion of collaborative publications with corporations in ICT 2023 (8.2% of all outputs) is much lower than in the general fields of computer science and EEE in Finland. This was surprising to the panel since, while it was not a requirement in any way, all of the first seven ICT 2023 calls allowed parallel industry projects to be funded by Tekes, so there was the possibility for significant collaborative work and joint publications and patents. It should be noted that, internationally, Finland has an excellent track record of academic-corporate collaboration in the ICT field, so the performance of ICT 2023 is still considered world-class even though the panel sees room for improvement in pursuit of the programme goals.

More broadly, according to the supplementary survey results (Figure 3), in all but one call ('Autonomous Systems and the Augmented Human') there was explicit collaboration in some projects with the private sector, and two projects involved collaboration with the public sector. However, the proportion of collaborations with non-research organisations is 11% (28 collaborations out of a total of 246). This is disappointing, since in all of the programme calls except for WiFiUS the call documentation specifically mentioned the importance of "business collaboration: cooperation between universities, research institutes and business companies; problem-setting in research; application potential of results".

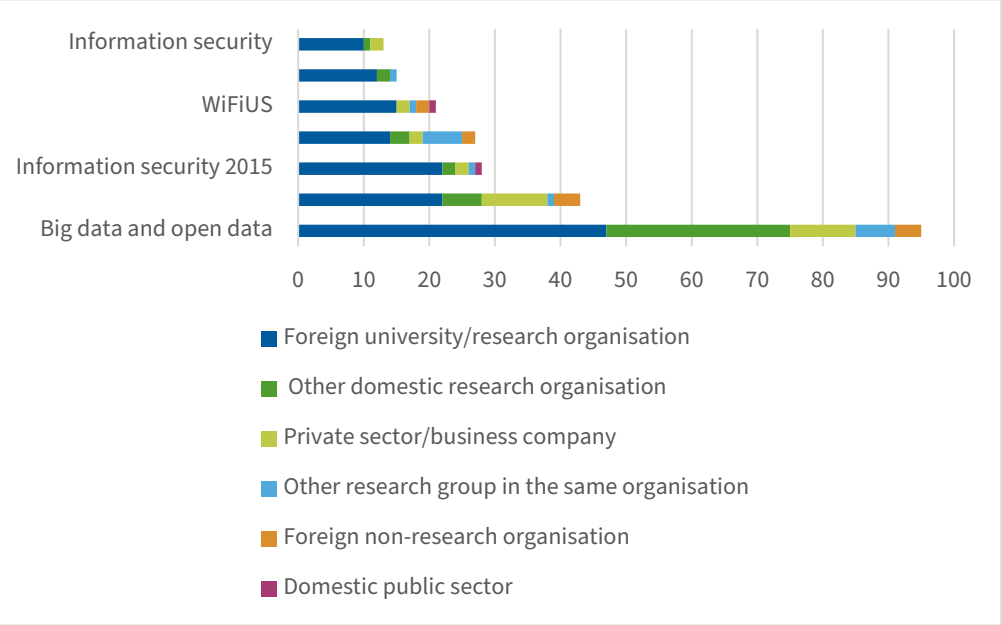

Figure 3. Collaboration types within the completed calls.

Two important contributors to successful knowledge transfer are mobility to and from companies during the project, and talent transfer to companies

following project completion. The data from the completed calls suggests that these are areas for improvement. A higher level of collaborations with organisations from outside the research sector would have helped here by providing additional mobility training opportunities and interactions with industry. The mobility data for the completed calls revealed that only one call had mobility to the private sector ('Big Data and Open Data', 6%), but more positively individual project evaluations have noted several cases of project personnel moving to industry after study/work on project and recognised this as promoting the aims of the ICT 2023 programme. The survey results themselves show that around 15% of project personnel had transferred to industry (domestic private employment), see Figure 1. A further 3.5% of project personnel had a position in a foreign non-research organisation, which might include industry employment.

The panel recommends that the Academy strengthen the emphasis on business collaboration in future ICT 2023 call memorandums and correspondingly increase the weighting for the associated review criteria.

The panel recognised that there is also scope for ICT 2023 projects to engage in non-industrial knowledge transfer and impact through education and public engagement and interactions with end-users. This is acknowledged in the final report form, which has a full range of "impact beyond academia" categories: World views, culture and human understanding; Public services and societal functions; Health and wellbeing; The environment and natural resources; other impacts and Economy and commerce. In the latter case, there is the opportunity to be more explicit – for example having subcategories, as mentioned by some individual project final report evaluators. The capture and analysis of the data from these free-text boxes on the final report form can be challenging. The Academy might consider the use of Altmetrics or similar tools that can record the wider non-bibliometric influence and impact of research. Such tools can also indicate the attention and engagement outcomes from research and provide a more complete measure of dissemination and wider impact.

3.3. Internationalisation of ICT

In this section we consider how the ICT 2023 programme has contributed to the internationalisation of computer science in Finland by looking at call topics, call criteria, percentage of foreign researchers and their post-project career destination, international mobility and publications with international collaboration.

The ICT 2023 call topics are discussed in more detail in Section 4, but in relation to internationalisation the panel found that the ICT 2023 call topics

were largely meaningful for the international scientific community and aligned to global market trends and matched calls in other European countries and in the US. The WiFiUS call is also a collaboration with the US National Science Foundation. At the call level, the use of international reviewers and panels for the proposal evaluation also helps maintain a high degree of international relevance.

The calls for funding all clearly specify the need for international engagement within the proposal review criteria. This is usually implemented through a combination of recruiting talented early-career researchers from abroad to work on the projects and outward mobility research visits by Finnish researchers to leading foreign research groups and organisations.

Overall, the percentage of foreign researchers working in the projects in the completed calls (Table 3) is extremely strong and commended by the panel. Across all of the calls, the average proportion of foreign researchers is 45%, but in individual calls it ranges from 31% ('ICT Sensors and Actuators') to 75% (WiFiUS). It has to be noted that the 'ICT Sensors and Actuators' call with the lowest percentage of foreign workers still has strong levels of international co-authorship of papers (49.5%, Table 2) and international mobility, with the joint highest number of mobility periods across 100% of projects in the call. On average, across all calls, there is no real difference between the percentage of early-career foreign researchers (46%) and that of senior researchers (44%). We define early-career researchers as 'assisting personnel' or 'postgraduate students'. However, there is again significant variability in the breakdown for each individual call, particularly for the early-career category.

Table 3. Nationality of research personnel within the completed calls.

ICT 2023 call	% foreign	% foreign early-career researchers	% foreign senior researchers
Information Security 2014	51%	52%	50%
WiFiUS, Wireless Communication	75%	82%	60%
ICT Sensors and Actuators	31%	22%	40%
Big Data and Open Data	44%	53%	34%
Advanced Microsystems	38%	42%	36%
Information Security 2015	73%	67%	76%
Autonomous Systems and the Augmented Human	41%	40%	43%

The supplementary survey data showed that the current (post-project) place of work of foreign employees is mainly within the same research group or within a foreign research organisation (Figure 4). Both destinations reflect

well on the internationalisation impact of ICT 2023. In the former case, the retention of foreign talent brings significant benefits to Finland in terms of skills and know-how and research culture. In the latter case, the value of the project experience reinforced the researcher's career and they successfully secured positions in foreign universities and research centres. Their international attractiveness reflects well on the reputation of Finnish research and their personal connections back to the project groups is invaluable for international networking and the development of future collaborations.

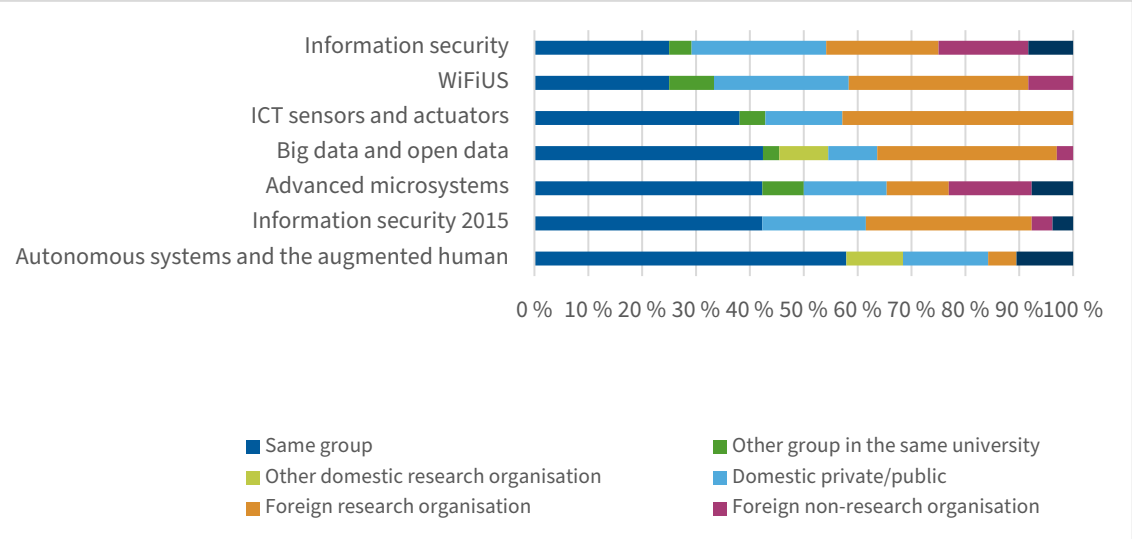

Figure 4. Current place of work of foreign project personnel.

International mobility was found within all of the calls, showing that there was a high response to the programme criterion of international engagement. Some calls are more responsive than other, for example all projects in the 'ICT Sensors and Actuators' call included mobility, whereas only 40% of the 'Advanced Microsystems's call included mobility. However, sometimes only a small percentage of the project personnel travels. For instance, for 'ICT Sensors and Actuators' the percentage was only 10%, but for the WiFiUS and 'Information Security 2015' calls it was 20% and 18%, respectively. Outward mobility is the most dominant with 80% of trips of longer than one month being from Finland to a foreign destination. Overall, the programme has been successful in strengthening the internationalisation of the personnel in the Finnish institutions through the cross-contamination within collaborations and mobility with foreign institutions.

Further evidence of the excellent internationalisation impact of the ICT 2023 programme is found in the bibliometric data (Table 1 and Table 2). Table 1 shows that for all the completed calls in ICT 2023, almost 48% of publications are in collaboration with international authors. Table 2 shows that the

'Information Security 2014' call has the highest proportion of international collaboration (65.1%) and the overall highest impact indicators (highest FWCI and highest proportion of outputs in the field-weighted top 10% of cited papers), indicative of the value and impact of strong international collaboration.

3.4. Fostering collaboration

In this section we consider how the Academy has promoted the bringing together of universities, research institutes, companies and funders.

The main proactive impact by the Academy is in the ICT 2023 call memorandums where collaboration and cooperation are features of the review criteria for research programmes. This ensures that project proposers carefully consider how their project will drive, and benefit from, different forms of collaboration.

Many aspects of collaboration have been covered in the previous sections. Section 3.3 highlighted that almost half of the publications from the completed calls have involved international collaboration. Most of the ICT 2023 projects have mobility included, but only in the order of 10% of research personnel in the projects have mobility. Most mobility is outgoing from Finland (mostly to Europe and North America) and almost half of the project members with mobility are senior staff (researchers and professors). Section 3.3 also highlighted that the split between Finnish and foreign research personnel is in general 50%-50% for the ICT 2023 calls with two calls having around 75% foreign research personnel (WiFiUS and 'Information Security 2015') (Table 3).

Business and company collaborations were mentioned in Section 3.2, and although performance was mixed (Figure 2), the best projects showed a very strong transfer of knowledge and technology from academic to industrial partners, documented by the extensive list of tools and joint publications in the individual final project reports. Table 1 shows that 8.2% of the outputs from the completed calls were published in collaboration with corporations. As mentioned in Section 3.2, for computer science and EEE subject areas this is internationally competitive, compared to a global rate of corporate collaboration of 2.6% and 5.3%, respectively for the period 2015–2020. However, it is a particularly low level compared to all computer science and EEE publications in Finland. This is not surprising given, in the opinion of the panel, the low base of industry collaboration in ICT 2023 projects.

The expert evaluations of completed projects scored the significance of research collaboration and researcher mobility (Question 2.2, Appendix C) as "good" on average for all projects with a variance from fair to very good (Figure 5). The best projects had good collaborations, both nationally and internationally, with strong research groups. Early-career researchers took advantage of the possibilities for research visits. As discussed earlier, in some projects there was also mobility with industry. Unfortunately, according to the expert evaluations, many projects showed mobility to a lower degree than initially planned without convincing justification.

The panel recommends that the Academy consider how it can ensure that planned mobility is implemented in funded projects, for example by requiring a notice of variation where mobility plans are changed during the course of a project.

The panel found that the ICT 2023 programme had also fostered cooperation between funders and research organisations through its various international collaboration calls. There have been two bilateral calls between the US National Science Foundation (NSF) and the Academy of Finland covering "Wireless Innovation between Finland and US (WiFiUS)". From 2021 onwards, the Academy and the NSF plan to fund collaborative projects under the themes of 5G/6G and artificial intelligence with the Lead Agency funding model. There have been three participations in CHIST-ERA (European Coordinated Research on Long-term Challenges in Information and Communication Sciences & Technologies) ERA-NET calls.

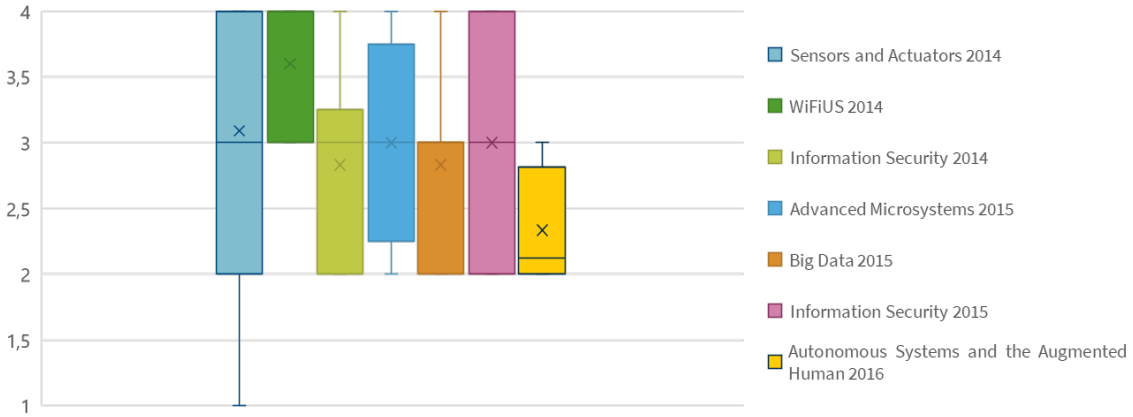

Figure 5. Independent expert evaluation of significance of research collaboration and researcher mobility.

In terms of domestic funder-funder collaboration, until 2017, covering the first seven completed calls, the Academy's call memorandums included the possibility that companies could apply for parallel project funding from Tekes. However, from 2017 onwards, there are no longer any joint calls, but

Tekes (now Business Finland) is still referenced in call documents indicating that funding is available under this topic through Business Finland's normal application process.

4. Programme themes

In this section we consider whether the ICT 2023 programme themes have been well chosen in terms of their national and international relevance, timeliness and breadth.

The panel judged that all of the completed and current ICT 2023 calls (Appendix E and Figure 6) were generally well aligned to the state of the art, other international funding priorities in ICT and to the popular market analysis reports that were published over the period 2014–2020. These calls covered a wide variety of themes across all sectors of the research landscape and were considered to be building on national technological capabilities in core technology areas such as wireless networking, robotics and autonomous systems. Overall, the panel concluded that the themes chosen for the Academy's ICT 2023 calls were sensible, nationally and internationally relevant, timely and sufficiently diverse.

In assessing the timeliness of the calls, the panel's judgement was based on the principle that timeliness is a clear criterion for scientific papers to be accepted and published in scientific peer-reviewed conferences and journals. As shown in Table 2, a significant number of papers were published as outputs from the funded projects across the first seven completed calls. Timeliness is also witnessed by the citation counts and citation impact associated with these papers. It is not appropriate to compare the citation counts or citations per paper between the calls as there were different start and end dates for the research projects and as citations can only evolve over time. However, the FWCI metric takes into account the publication date in its normalisation, so it can provide some comparative insight. For example, Table 2 shows that the two 'Information Security' calls (2014 and 2015) have strong FWCI results of 2.84 and 2.18, respectively, for the period 2015–2020. In contrast, the FWCI for the 'Autonomous Systems' call outputs was 1.41. In the latter case, it was noted by the panel that the publications from this call had low levels of international (30.6%) and corporate (2.0%) collaboration. Overall, the normalised citation impact comparison in Table 1 between ICT 2023 and all Finnish publications in the main subject areas for ICT shows that papers from the seven completed calls were timelier with more citations than "normal" ICT publications in those years.

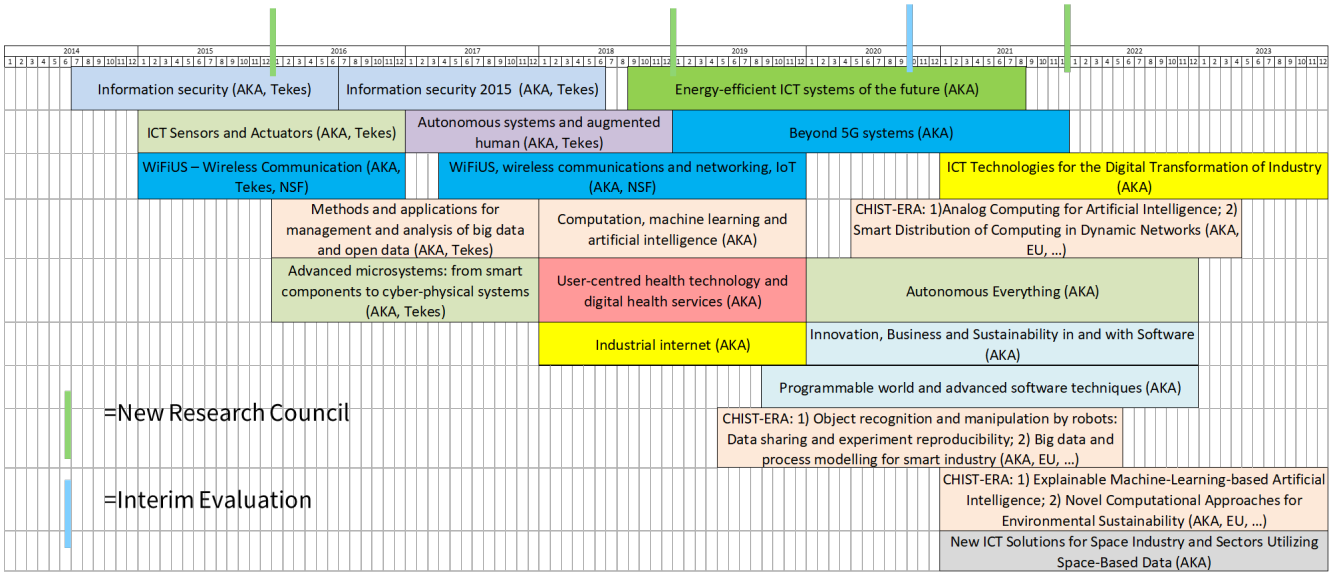

Figure 6. Funded and current ICT 2023 programme calls.

As an indirect effect of the timeliness of the call themes, we can also consider the impact of the researchers' participation in the project on their career after its end and the level of attractiveness of the research programme for foreign researchers. The high level of foreign researchers employed in the ICT 2023 projects shows that the research themes are timely and attractive, considering that the experience can add value to their curriculum. Similarly, after the projects' end, the personnel that worked on them are attractive for foreign institutions indicating that the research performed is relevant internationally and thus timely. To a lesser degree, and notwithstanding the previous comments about low levels of industry collaboration, between 4% and 25% of project personnel were hired in the private sector depending on the specific call.

In relation to the current calls, we acknowledge that the aim of the ICT 2023 programme is to expand Finland's expertise in ICT and to promote extensive application of ICT in both the private and public sectors. The panel judged that, throughout ICT 2023, the themes chosen have had clear relevance for business and public bodies. The panel agreed that most themes were well chosen, although the CHIST-ERA call 'Analogue Computation for AI' seems somewhat narrow. Evidently, 'Autonomous Everything' was a well-timed call, but the panel thought that there should have been some emphasis on the safety-critical nature of many autonomous systems by incorporating verification. The panel fully supported the Academy's plans to build on the success of the two bilateral WiFiUS calls with the NSF with collaborative calls in 2021 in the area of 5G/6G and artificial intelligence.

The panel was pleased to see calls designed to support industrial research themes, but would like to emphasise the necessity of ensuring that research

quality is maintained, something that can only increase the value of the work for the private sector.

The panel appreciated that dedicated call topics provide focus and ensure transparent competition, but calls also can bias the research ecosystem as well by setting out what research is important when. Thus, it is important to carefully consider what to include in different calls and when.

The panel would have expected an "open" call explicitly within the ICT 2023 programme. It is recognised that there are other open funding opportunities open to ICT researchers in Finland, but there could also be strong contribution to the aims of ICT 2023 through the funding of high-risk, adventurous research ideas.

The panel recommends that the Academy consider introducing an open call for ICT 2023 focused on high-risk, adventurous research, possibly by employing funding mechanisms other than Academy Projects.

While the programme themes were overall well chosen, the panel questioned whether there was sufficient flexibility in adapting to the rapidly changing research environment in ICT. While this could be partially addressed with an open call within ICT 2023, there also needs to be an independent international perspective to avoid groupthink in the national research ecosystem.

The panel recommends that the Academy consider extending the use of international experts to advise on topic selection at the programme and individual call level to ensure that the Finnish research system is fully aligned with global research challenges and needs.

4.1. Options for future ICT 2023 calls

In this section we present the panel's view on possible options for future ICT 2023 calls in the final phase of the programme.

Internationally, funding agencies are aligning their challenge-based research programmes with the UN Sustainable Development Goals, and this could be considered within ICT 2023. Specifically, the panel suggests that a possible future call be '**ICT for sustainable transformation of society**', to include inclusive growth and wellbeing, the green deal and the resilience to global events such as the pandemic emergency. This could include subtopics that would cover many different ICT competencies such as green hardware, Internet of Things, smart grid, software technologies for sustainable mobility, air quality improvement, the e-circular economy, and ICT technologies for

emergency resilience and response. These could support "anywhere operations models" to access and enable any business or organisation anywhere. Such calls could also include cyberphysical and hardware aspects, for example, taking the Covid-19 pandemic as an example: physical technologies and hardware solutions for social distancing, early diagnosis, access control, etc.

The panel also suggests that '**Decentralised systems and decentralised security and privacy**' be specifically included in future call topics. There are significant research challenges and opportunities to be explored across many areas that require or would benefit from a decentralised approach, including: privacy-enhancing computing and networking, cybersecurity, blockchains or other distributed ledger technologies.

The panel also thought that the programme has underplayed some major trends in computer science with huge relevance to the world of tomorrow. The clearest example of this is '**Machine learning and its applications**', relative to the enormous impact it is having on academic and industrial IT globally. While ICT 2023 has already focused on this, the panel saw significant value in continued investment. This should include machine learning frontier research (new algorithms and technologies) and wider programmes on applications of machine learning, which would surely lead to impact on industry, spin-outs and society.

The panel also discussed a number of other potential themes that could be considered for future funding calls in Finland, even outside ICT 2023. These included some general topics that were not covered in the calls so far, such as HCI, programming languages and algorithm engineering. However, the panel did identify some more specific suggestions, listed below (not exhaustive and not in any particular order):

- novel computer architectures – covering emerging technologies in the field of hardware architectures, including but not limited to quantum computing, DNA computing and storage and neuromorphic computing
- frontier AI technologies – topics such as generative AI or others that extend beyond machine learning
- edge intelligence – such as AI for edge and AI at edge, and AI at the edge-of-the-edge (device)
- distributed cloud, fog computing and the IoT
- digital twins, VR, AR, XR
- automated regulation (financial and legal) for emerging applications such as connected and autonomous vehicles

- future internet systems – all layers and domains including 5G/6G
- data representation and reasoning.

5. Gender diversity

Additionally, to the questions set by the Academy of Finland, the panel found it useful to consider the overall gender distribution in the ICT 2023 projects. The Academy provided statistics for the period from 2014 to 2019 (Figure 7). The fraction of women in terms of full-time equivalents (FTE) has steadily increased from 11.9% in 2014 to 23.5% in 2018, with a small decline in 2019–2020. To put these numbers in perspective, the Academy also provided similar data for funded ICT projects outside the ICT 2023 programme where the fraction of women in the period 2014–2019 was fairly stable, just below 20% (exceeding 20% in 2020). Another reference provided by the Academy is "Gender data from Vipunen – Education Statistics Finland". Statistics from 2014–2018 in terms of FTEs for R&D work at universities within ICT show that the fraction of women over the period has been relatively stable at just above 20%.

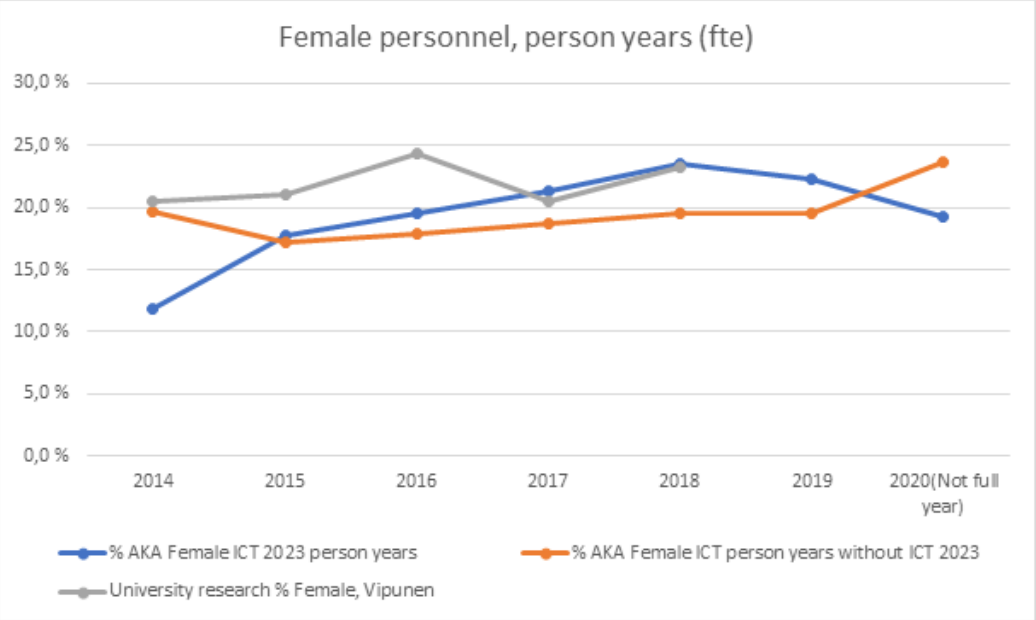

Figure 7. Full-time equivalent fraction of female researchers in the ICT 2023 programme, other ICT projects funded by the Academy of Finland, and the Finnish university sector.

The panel concluded that the gender distribution for the ICT 2023 programme is unbiased compared to the gender distribution among R&D staff at Finnish universities within ICT and also compared to other Academy-funded ICT projects. However, the panel's view is that there should be an ambition to significantly increase the proportion of women in the ICT

domain in general. The ideal long-term target would be to match the overall gender distribution found across Finland, with around 50% women in ICT. For ICT 2023, the panel argues that there is a responsibility to drive a positive bias in relation to female researchers, compared to the status quo.

The panel recommends that future ICT 2023 call memorandums include stronger gender diversity requirements and proposal funding criteria.

6. Summary of recommendations

Section 3.1: The panel recommends that the Academy consider what actions it could take to improve post-project mobility with the aim of stimulating higher levels of skills development and stronger connections between research groups, institutions and business.

Section 3.2: The panel recommends that the Academy strengthen the emphasis on business collaboration in future ICT 2023 call memorandums and correspondingly increase the weighting for the associated review criteria.

Section 3.4: The panel recommends that the Academy consider how it can ensure that planned mobility is implemented in funded projects, for example by requiring a notice of variation where mobility plans are changed during the course of a project.

Section 4: The panel recommends that the Academy consider introducing an open call for ICT 2023 focused on high-risk, adventurous research, possibly by employing funding mechanisms other than Academy Projects.

Section 4: The panel recommends that the Academy consider extending the use of international experts to advise on topic selection at the programme and individual call level to ensure that the Finnish research system is fully aligned with global research challenges and needs.

Section 5: The panel recommends that future ICT 2023 call memorandums include stronger gender diversity requirements and proposal funding criteria.

Appendix A: Panel membership

Professor Schahram Dustdar

Head of Distributed Systems Group, TU Wien, Austria

Professor Dustdar is Full Professor of Computer Science heading the Research Division of Distributed Systems at TU Wien, Austria. He holds several honorary positions: University of California (USC) Los Angeles; Monash University in Melbourne, Shanghai University, Macquarie University, and University of Groningen, The Netherlands (2004–2010). He is founding co-Editor-in-Chief of ACM Transactions on Internet of Things (ACM TIoT) as well as Editor-in-Chief of Computing (Springer). He is an Associate Editor of IEEE Transactions on Services Computing, IEEE Transactions on Cloud Computing, ACM Transactions on the Web, and ACM Transactions on Internet Technology, and on the editorial board of IEEE Internet Computing and IEEE Computer. Dustdar is recipient of the ACM Distinguished Scientist award (2009), ACM Distinguished Speaker award (2020–2023), the IBM Faculty Award (2012), an elected member of the Academia Europaea, where he is chair of the Informatics Section, as well as an IEEE Fellow (2016).

Dr Elisabetta Farella

Head of Unit, Energy Efficient Embedded Digital Architectures, Fondazione Bruno Kessler, Italy

Dr Farella's research is in the field of energy-independent embedded systems that are, at the same time, equipped with artificial on-board intelligence. She worked since 2014 as coordinator of the research activities on-body sensor and actuators networks, smart objects and tangible interfaces at the Department of Electrical, Electronic and Information Engineering (DEI) at the University of Bologna (www.dei.unibo.it). From 2001 to 2005, she was research fellow at CINECA Visit Lab (www.cineca.it). From 2006 to 2010, she was research supervisor at T3lab (www.t3lab.it) of three groups of researchers working on embedded systems (wireless sensor networks, ambient assisted living, RFID).

Professor, Dr Dunja Mladenić

Senior Researcher and Project Leader, Artificial Intelligence Department, Jožef Stefan Institute, Slovenia

Professor Mladenić leads the Artificial Intelligence Department at Jožef Stefan Institute and teaches at Jožef Stefan International Postgraduate School, University of Ljubljana, University of Zagreb and University of

Primorska. She is an expert on study and development of machine learning, big data/text mining, Internet of Things, data science, semantic technology techniques and their application to real-world problems. She was a visiting researcher at the School of Computer Science, Carnegie Mellon University, USA in 1996–1997 and in 2000–2001. Mladenić served on the Institute's Scientific Council (2013–2017) as Vice President (2015–2017). She served as President of the Slovenian Artificial Intelligence Society SLAIS (2010–2014) and as Advisory Board Member of ACM Slovenija. She has experience in coordinating EU projects and participating in the proposal evaluation with the European Commission including ERC panels and the US NSF. She was a programme co-chair of ECML 2007 and a general chair of ECMLPKDD 2009.

Professor Preben E. Mogensen

Head of Wireless Communication Networks Section at Aalborg University, Denmark

Professor Mogensen received MSc and PhD degrees from Aalborg University in 1988 and 1996, respectively. He has been associated with Aalborg University since graduation in 1988. In 2000, he became Full Professor with Aalborg University, where he leads the Wireless Communication Networks Section, Department of Electronic Systems. He has co-authored more than 400 papers in various domains of wireless communication, and his Google Scholar h-index is 65. Since 1995, he has been part-time associated with Nokia in various research positions and has made contributions to 2G to 5G cellular technologies. Mogensen is currently Principal Scientist in the Standardization and Research Lab of Nokia Bell Labs. His current research interests includes industrial use cases for 5G, 5G evolution and 6G. He is a Nokia Bell Labs Fellow.

Professor Bill Roscoe

Professor of Computing Science, Oxford University, UK

Professor Roscoe has worked at Oxford University throughout his career, and has been a full professor since 1997. He works in areas of computer science including security, concurrency, fintech, blockchain and verification. He is best known for his work on Hoare's CSP, the model checker FDR, his early work on occam and the transputer, and on the design and verification of secure systems. He held senior management positions at Oxford University 1993–2014, including ten successful years as head of the university's Computer Science Department. He is now part-time at Oxford and works with several companies. He is a Fellow of the Royal Academy of Engineering (FREng) and Academia Europaea.

Professor William Scanlon (Panel Chair)

Chief Executive Officer, Tyndall National Institute, Ireland

Professor Scanlon joined Tyndall National Institute and University College Cork in 2018. He had previously been Senior Lecturer and Full Professor at Queen's University of Belfast (UK, 2002–2018) and held leadership positions such as Director of the Centre for Wireless Innovation and Head of School of Electronics, Electrical Engineering and Computer Science. He held a part-time Chair in Short Range Radio at the University of Twente, The Netherlands (2009–2014). Scanlon is a pioneer in wearable and implantable medical device communications. He was a Series Editor of the IET Book Series on Telecommunications and Networking, an inaugural Associate Editor of IEEE Journal of Translational Engineering in Health and Medicine and an Associate Editor for IEEE Antennas and Wireless Propagation Letters. He holds an URSI Young Scientist Award (1999) and the 2010 IEEE H. A. Wheeler Prize Paper Award, and he delivered the 2012 NATO Intl. Lecture Series on Next Generation Communications. He is an IEEE Fellow.

Appendix B: Terms of reference

ICT 2023 is a ten-year research, development and innovation programme. The aim of the programme is to further improve Finland's scientific expertise in computer science and to promote the extensive application of ICT. The annual budget of the programme is at least 10 million euros and the total foreseen Academy of Finland budget exceeds 100 million euros. So far, more than 60 million euros has been granted within the 2013–2019 calls.

The Research Council for Natural Sciences and Engineering at the Academy of Finland will initiate an international interim evaluation of the research, development and innovation programme ICT 2023. The evaluation will be made by a panel of independent experts (chair and panel members). The Academy expects the evaluation panel to provide their view on the success of the programme and recommendations for the final years of the programme.

The evaluation will look at the Academy's role, and therefore evaluation of actions of Business Finland (previously Tekes) or other stakeholders will not be a part of the evaluation.

Expected outcome of the interim evaluation/Objectives of the evaluation

The evaluation report should contain a critical assessment of the performance of the ICT 2023 programme. Specifically, the panel is asked:

- How has the Academy contributed to the goals of the ICT 2023 programme?
    - How has the programme contributed to the development of deep computing skills, in terms of scientific quality, novelty, and renewal of science?
    - How has the programme promoted the widespread use of ICT know-how?
    - Has the programme contributed to the internationalisation of computer science?
    - How has the Academy promoted the bringing together of universities, research institutes, companies and funders?
- Have the themes been well chosen (e.g. timeliness)?

- Recommendations for the final years of the programme

The panel may also consider any other issues the panel members consider important. The ICT 2015 working group has set the programme goals in their report. The panel should consider the terms 'computing skills', 'ICT know-how' and 'computer science' in the programme goal-setting interchangeably.

The results of the evaluation will be compiled in a short report published by the Academy of Finland. The panellists will divide the work of writing the report among themselves. The main responsibility for collecting and compiling text from the panellists is carried by the chair of the evaluation panel. The report will also contain recommendations of the panel.

Evaluation material

The Academy will provide material for the evaluation panel, which includes but is not limited to:

- Programme background information
- Funding call documents
- Funding statistics per call
- Project reports from finalised projects (68) with post-completion supplementary questionnaire, if available
- External project report reviews of the finalised projects
- Publication statistics and bibliometric analysis
- Statistics and analysis on researcher mobility and present working sector
- Statistics and analysis on multidisciplinarity and research consortiums

The Academy will provide the panel synthesis of the information, where possible. The panel will also have access to raw data.

The evaluation material will be made accessible through the Academy's electronic services (Eduuni).

Timetable of the interim evaluation and panel meeting

The panel will work with the evaluation during and between a series of remote meetings. The number and timing of the remote meetings will be agreed during the evaluation kick-off meeting. The evaluation work will be finalised by the end of 2020. This will enable the Academy to fully utilise the

panel recommendations in the planning of the 2021–2023 calls for applications.

Confidentiality

All documents utilised in the evaluation are confidential. All documents should therefore be handled and stored with due care and confidentiality.

Panel members will be provided with certain detailed information, which is intended for evaluation purposes only. The panel members are asked to keep such information, knowledge, documents or other matters confidential. The extent to which detailed data on the units can be used in the final report must be agreed between the panel and the Academy of Finland. The panel members are also asked to keep the evaluation report confidential before the publication date. Any possible conflicts of interests are also determined and handled based on discussions between the panellists and the Academy of Finland.

Appendix C: ICT 2023 project review form

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Project review form
ICT2023 Programme

Name of the reviewer:
Name of the PI:
Title of the project:

Application number:

*The **ICT 2023 Programme** funding scheme is designed to promote the quality and diversity of research, scientific impact and impact beyond academia as well as scientific renewal. The aim is to reach internationally as high scientific standard as possible and to support scientific breakthroughs and top-tier international research collaboration.*

Please provide both written feedback and numerical ratings to each of the following items.

The numerical evaluation of the sub-items and final rating is made with a rating scale ranging from 1 (poor) to 4 (very good). Please remember that the numerical evaluation is only to support the written feedback and we appreciate all comments and observations related to each question.

4 (very good)	Very good in international comparison – no significant elements could have been improved
3 (good)	In general sound but contained important elements that should have been improved
2 (fair)	Contained flaws. Should have been substantially improved
1 (poor)	Severe flaws that were intrinsic to the project

Please follow the guidelines below when preparing your reviews:

- Please respond to the questions in the review form by providing compact feedback that can be used as such in the final panel review. A few sentences per item is typically sufficient.
- Refer to the individual project in your answers (i.e., we are not asking you to evaluate the success of the whole call or the whole programme)
- Avoid very short feedback such as 'yes, very good quality'.
- Please avoid copying and pasting text directly from the project report.
- Avoid re-evaluating the project application. Instead, focus on the outcomes of the project.

1 Achieving the project objectives

1.1 Significance of the project **Rating (1–4)**
Achieving objectives and answering research questions and hypotheses; novel concepts and approaches or development across disciplines; timeliness of project topic; scientific impact of the research; breakthroughs or exceptionally significant outcomes; etc.

1.2. Implementation of the research plan **Rating (1–4)**
Materials, research data and methods; human resources and management of the research tasks; research environment including research infrastructures; potential scientific or methodological problem areas affecting the project and how they were overcome; etc.

ACADEMY OF FINLAND

1.3 Quality of publications and other research output **Rating (1–4)**

Please give anl assessment of the publications keeping in mind DORA (The Declaration on Research Assessment https://sfdora.org/) guidelines, i.e., do not use journal-based metrics, such as Journal Impact Factors, as a surrogate measure of the quality of individual research articles and consider the value and impact of all research outputs (including datasets and software) in addition to research publications, and consider a broad range of impact measures including qualitative indicators of research impact, such as influence on policy and practice.

2 Project's contribution towards ICT 2023 programme objectives

2.1 Development of in-depth competence in ICT **Rating (1–4)**

Development of a foundation of competence in institutes of higher education; developing the scientific expertise of the project team; supervising phd candidates or postdoctoral researchers; support for researcher training within the project; etc.

2.2 Significance of research collaboration and researcher mobility **Rating (1–4)**

Significance of national and/or international research collaboration including complementary expertise and research environment of the collaborators in terms of implementation of the project; significance of the mobility to the implementation of the research plan and researcher training; etc.

2.3 Advancing ICT competence transfer from universities to companies **Rating (1–4)**

Collaboration between universities, research institutes, industry, and funding organizations; working towards a chain of research, application, productization and commercialisation; etc.

Appendix D: ICT 2023 supplementary survey

1. Publications: Please, incidate if your publication is an open access publication, an international joint publication and/or includes corporate collaboration (no=0, yes=1).												
Year of publication	**Authors of publication**	**Name of publication**	**Name of journal/series**	**Vol**	**Number**	**Pages**	**Article number**	**DOI**	**Open access**	**International joint publication**	**Corporate collaboration**	
2. Patents and invention disclosures: Please, indicate also the status of your patent application.												
Type	**Status**	**Description**	**Year**									
3. Doctoral degrees: Please, indicate if a person hired in the project has gained a doctoral degree.												
Name	**University**	**Year of degree**										
4. Docentships, professorships and tenure track -positions: Please, indicate if a person hired in the project has gained a docentship, professorship or tenure track-position.												
Docentships:												
Name	**University**	**Year**										
Professorships:												
Name	**University**	**Year**	**Level (Full, Associate, Assistant, etc.)**									
Tenure track -positions:												
Name	**University**	**Year**	**Level (Associate, Assistant)**									
5. Research personnel (> 3 months): Please, add the present place of work. Use the followi							A. Working in the same research group					
							B. Working in other research group in the same university					
							C. Working in some other domestic research organisation					
							D. Working for a domestic private employer					
							E. Working for a domestic public employer					
							F. Working for a domestic non-profit organisation					
							G. Working for a foreign research organisation					
							H. Working for a foreign non-research organisation					
							I. Unemployed					
							J. Elsewhere / not known					
Name	**Working time on the project (months)**	**Category (A-J)**	**Current place of work**	**Country**								
6. Continuation of research: Please, indicate whether the research into the same topic, research question or problem continues in the same research team or not.												
Has the research continued after this Academ			**Funder/Research team/Additional details**									

Appendix E: ICT 2023 calls

Call Year	Call theme	Granted funding (€)
	*The interim evaluation of ICT 2023 was based on detailed data from these first seven completed calls	
2014	Information Security	3 731 576
2014	ICT Sensors and Actuators	5 298 859
2014	WiFiUS – Wireless Innovation between Finland and the US	1 126 438
2015	Methods and Applications for Management and Analysis of Big Data and Open Data	5 481 714
2015	Advanced Microsystems: from Smart Components to Cyber-Physical Systems	4 503 086
2016	Information Security 2015	2 584 677
2016	Autonomous Systems and the Augmented Human	3 092 579
2016	WiFiUS – Wireless Innovation between Finland and the US	2 127 944
2017	User-Centred Health Technology and Digital Health Services	2 605 215
2017	Computation, Machine Learning and Artificial Intelligence	6 168 727
2017	Industrial Internet	3 390 264
2017	Energy-Efficient ICT Systems of the Future	4 597 217
2017	ERA-NET Cofund CHIST-ERA	1 553 432
2018	Beyond 5G	4 302 783
2018	Programmable World and Advanced Software Techniques	2 573 899
2018	ERA-NET Cofund CHIST-ERA	1 046 220
2019	Autonomous Everything	5 332 071
2019	Innovation, Business and Sustainability in and with Software	1 345 955
2019	ERA-NET Cofund CHIST-ERA	1 269 796
2020	ICT Technologies for the Digital Transformation of Industry	6 108 398
2020	New ICT Solutions for Space Industry and Sectors Utilising Space-Based Data	2 891 602