Evaluation of Mathematics, ICT and Technology 2023-2024
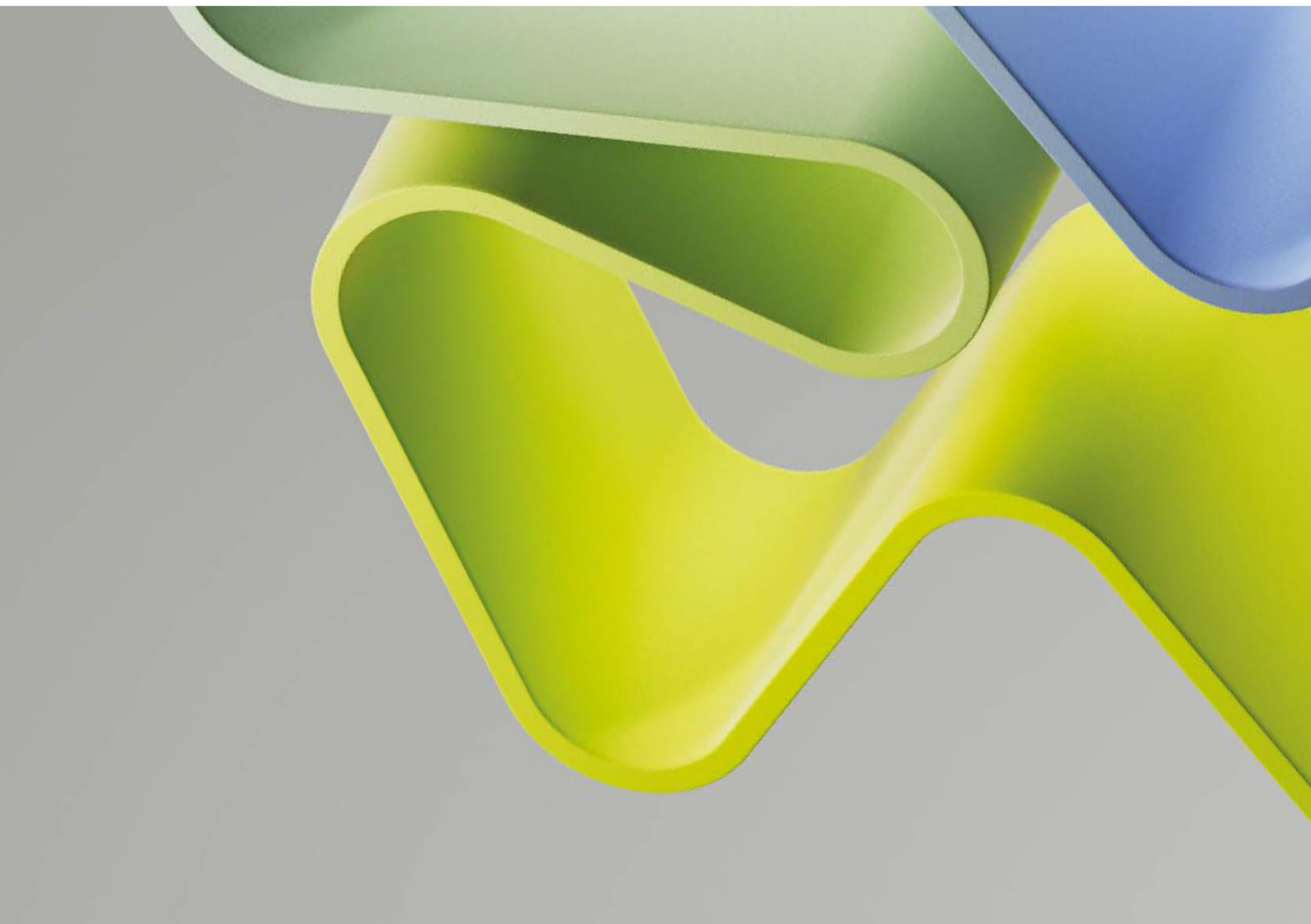
Evaluation Report for Administrative Unit

Administrative Unit: **Department of Information Security and Communication Technology (IIK)**

Institution: **Norwegian University of Science and Technology (NTNU)**

Evaluation Committee Higher Education Institutions 2

December 2024

Contents

Statement from Evaluation Committee Higher Education Institutions 2

The members of this Evaluation Committee have evaluated the following administrative units at the higher education institutions within Mathematics, ICT and Technology 2023-2024 and has submitted a report for each administrative unit:

- Department of Computer Technology and Computational Engineering (IDBI), UiT The Arctic University of Norway

- Department of Automation and Process Engineering (IAP), UiT the Arctic University of Norway

- Department of Electronic Systems (IES), Norwegian University of Science and Technology (NTNU)

- Department of ICT and Natural Sciences, Norwegian University of Science and Technology (NTNU)

- Department of Information Security and Communication Technology (IIK), Norwegian University of Science and Technology (NTNU)

- Department of Engineering Cybernetics (DeptCybernetic), Norwegian University of Science and Technology (NTNU)

- Department of Information Systems (IIS), University of Agder (UiA)

- Department of Computer Science, Oslo Metropolitan University (OsloMet)

- Faculty of Science and Technology (REALTEK), Norwegian University of Life Sciences (NMBU)

- Department of Science and Industry Systems (IRI), University of South-Eastern Norway (USN)

- School of Economics, Innovation and Technology (SEIT), Kristiania University College

The conclusions and recommendations in this report are based on information from the administrative units (self-assessment), digital meetings with representatives from the administrative units, bibliometric analysis and personnel statistics from the Nordic Institute for Studies of Innovation, Research, and Education (NIFU) and Statistics Norway (SSB), and selected data from the National survey for academic staff in Norwegian higher education and the National student survey (NOKUT). The digital interviews took place in the autumn 2024.

The members of the Evaluation Committee are in collective agreement with the assessments, conclusions and recommendations presented in this report. None of the commithave members has declared any conflict of interest.

The Evaluation Committee consisted of the following members:

Professor Jan Canbäck Ljungberg
University of Gothenburg

Professor Bo Wahlberg (Chair)
KTH

Professor Nancy Pouloudi
Athens Univ. of Economics and Business

Professor Alessandra Costanzo
University of Bologna

Professor Torsten Braun
Universität Bern

Professor Stefan Wermter
University of Hamburg

Description of the Administrative Unit

The Department of Information Security and Communication Technology (IIK) is part of the Norwegian University of Science and Technology (NTNU). IIK use a multidisciplinary approach to analyse ICT systems and address issues such privacy, impacts on public policy, and the law. The industrial transformation in the form of digitisation is dependent on security to a large extent; the interaction of the SFI NORCICS with partners in industry and government as well as laterally particularly with the SFI Manufacturing also hosted by NTNU provides the research underpinnings for effectively securing these systems and adequate management of cyber security risks. The department runs across three locations (Trondheim, Gjøvik, and Ålesund). It has 20 academic staff in professorial positions (two female), 17 associate professors (four female), and six university lecturers (two female). The department also has 47 Ph.D. candidates (17 female) and 16 temporary postdoctoral researchers (two female) as well as nine postdoctoral researchers (only male) on indefinite contracts without teaching obligations to support research projects and activities. The gender balance is being improved through recruiting and promotion opportunities.

Research in the department is organised into eight groups (reported here as four disciplines for compliance) with researchers affiliated with at least one primary research area. The areas are the Critical Infrastructure Security and Resilience Group, the eHealth and Welfare Security Group, the Networking Research Group, the Norwegian Biometrics Laboratory, the Applied Cryptography Laboratory, the Digital Forensics Group and the System Security Research Group. The research groups have a mandate outlining their involvement in research-led education, publications and project portfolios, and the research infrastructure is primarily hosted and operated by each group. As part of the mandate, groups meet regularly to discuss research results also among junior researchers, conduct seminars, and participate in education by offering primarily Ph.D.- level modules. Research group leaders act as a liaison also to partners. Individual investigators within the groups hold responsibility for projects but receive administrative support for conducting projects as well as support for innovation activities from the department.

The Departmental strategy is to be and to remain the leading source of research and education in information security and communication technology at the national level, and to be recognised also internationally in key areas. These strategic goals are aligned with the NTNU strategy 2018- 2025 and the corresponding strategy of the NTNU IE Faculty and are supported by measures whose effectiveness can be determined by qualitative and quantitative indicators. Research- oriented goals are to:

- Conduct internationally recognised research in a balance between foundational, curiosity- driven research and applied research informed by the needs of society and partners
- Maintain and develop internationally recognised and leading research groups in information security and communication technology
- Be an attractive environment for research mobility both in- and outbound, and an attractive partner for collaborative research nationally and internationally
- Engage with global challenges and conduct research in support of the UN sustainability goals

The department seeks to develop and strengthen research focus areas by allocating resources such as Ph.D. positions, research-intensive permanent positions, and funding for facilities according to strategic objectives in transparent processes. Translating selected results is part of the departmental strategy, and innovation activities such as spinouts are

actively encouraged as a regular part of departmental activities. The department has a dedicated innovation manager.

The department is host to a Centre for Research-Based Innovation on Cyber Security for Critical Sectors (SFI NORCICS) as well as the host of the public-private partnership Centre for Cyber and Information Security which conducts research and is the nucleus of a portfolio of projects and partnerships nationally and internationally from national, EU, and overseas sources and have been recognised by the Norwegian Parliament as important to national security. The department is the leading provider of education on information security and communication technology nationally and offers B.Sc., M.Sc. (full and part-time), and Ph.D. programmes in Digital Infrastructure and Cyber Security, Communication Technology, and Information Security and offers security-related education also across the faculty as a service.

In future, the department aims to renew its focus on mobility for researchers at all levels and develop junior staff members. IIK has also begun to liaise with government and research council representatives about AI-themed security and is working on an initiative for a further centre for research-oriented innovation that will look at foundational aspects from post-quantum cryptographic schemes to cryptographic engineering.

Overall Assessment

The Department of Information Security and Communication Technology of the Norwegian University of Science and Technology (NTNU-IIK) aims to be a leading source of research and education in the information security and communication technology at the national level, with some special recognitions in certain key areas. The research areas are well defined with their focus on cyber security including related topics such as algorithms, protocols, formal methods, machine learning etc. Privacy is another related topic with some societal importance. NTNU-IIK hosts a related innovation centre and a PPP centre in cyber security for critical infrastructures to better support international and national projects in such areas.

NTNU-IIK aims to be a leading education provider in cyber security, digital infrastructures, and communication technology and offers a full education program in information security and communication technologies on Bachelor, Master and PhD level.

NTNU-IIK aims to balance fundamental and applied research considering interdisciplinary elements. The research is very much of experimental nature requiring significant experimental facilities and research infrastructures.

The strategy documents of NTNU-IIK do not describe in much detail about the future research topics to be addressed or possibly new research topics to be followed. In addition to societal security, new challenges should be discussed in more detail and how the current research areas and topics could evolve in future.

The formation of the four research groups has been very artificial. It is questionable whether such artificial grouping is a good idea or whether a different grouping and a reflection in the administrative organisation would create better internal collaboration and synergies.

NTNU-IIK is emphasising the possibility of supporting exchange programs and activities on PhD student and Master level. In general mobility and career development are well supported by mobility actions on student and researcher level.

The amount and mix of research funding is very good, avoiding having a single source while being more diverse. RCN and EU basic research funding is reasonable. Highly competitive industry funding is also available and strengthens the reputation and visibility of NTNU-IIK. However, there are some concerns that curiosity-driven and basic research is more and more difficult to get from research funding organisations on national and international level.

NTNU-IIK is strongly active in providing and using (inter)national research infrastructures. This has a strong impact on experimentally driven research and makes NTNU-IIK an attractive partner in academic and industrial collaborations. However, infrastructure development, deployment, and maintenance are labor-intensive and financially expensive.

Collaborations with national and international partners in academia, industry, public bodies are excellent.

The number of professors and the relation to PhD students appears to be good compared to other administrative units. The administrative overhead for professors seems to be high (20 %).

NTNU-IIK has developed a comprehensive strategy for open science, not only for publications but also for software code and research data.

The scientific publication performance appears to be good in a national comparison but still could be improved compared with other top-level international departments.

Gender balance can still be improved, but some promising numbers are available on post-doc and PhD student level.

The unit has a strong societal impact considering the importance of cyber-security, whereas impact related to other UN SDGs is not always clear.

The Terms of Reference for the administrative unit is attached to the report.

Recommendations

1. **Further improve and develop research strategy**
   - Maintain a good mix of fundamental and applied research activities including (inter)national collaborations with academic and industry/public body partners.
   - Strengthen NTNU-IIK-internal research collaborations by also integrating the remote location of Gjovik.
   - Define emerging and upcoming research challenges and topics in more detail, also to be prepared for future faculty recruitment and the development of the NTNU-IIK department.

2. **Further improve research quality and visibility**
   - There should be stronger efforts on publishing in top conferences to reach even better scientific impact
   - The Committee recommends even more international collaborations, in particular regarding industrial research, possibly by EU project activities.
   - Keep strong international academic collaborations by generating more publication networks and research visits
   - NTNU should continue the support to publish using green and gold standards and increase open access publications

3. **Revisit the internal NTNU-IIK organisation**
   - TNU-IIK is encouraged to revisit the formation of research groups (as defined by RCN) and reflect this grouping better in their organisational structure. Such structure can also be beneficial for NTNU-IIK internal collaboration and better use existing synergies.
   - improve gender balance. The department is encouraged to take advantage of increasing number of female researchers on post-doc and PhD level.
   - Try to significantly reduce the administration overhead from 20 % to 10 % at most.

4. **Further secure and possibly increase research funding**
   - The EU funding could be improved, in particular given the infrastructure and system-oriented research directions, by increasing the application activities to specific calls and possibly calls on research topics with significant EU funding available such as 6G networks and cyber security.

5. **Maintain experimental research capabilities**
   - While the arguments for the large number of research infrastructures have been well explained and are sound, it is recommended to permanently review the need for the research infrastructures, in particular those that were called generic. Those might always be outsourced and then reduce human and financial costs and efforts.
   - While long-term availability of research data is supported, some more concrete measures such as what kind of platforms will be used or what kind of support from NTNU is available, are somewhat unclear and should be worked out in a more concrete way.

6. **Further Improve (inter)national collaboration**

- NTNU-IIK may also try to establish international collaborations with industry partners to improve international impact and visibility
- Establish more academic exchanges and collaborations with non-European partners such as in US or Asia.

7. **Further improve gender balance and support for young researchers**
   - The Evaluation Committee recommends more efforts towards increasing the number of female professors, in particular on full professor level.
   - In general, the recruitment of young professors and talents should be supported by appropriate measures to be able to hire young talents and provide good career opportunities.

1. Strategy, Resources, and Organisation of Research

The Department of Information Security and Communication Technology of the Norwegian University of Science and Technology (NTNU-IIK) aims to be a leading source of research and education in the information security and communication technology at the national level, with some special recognitions in certain key areas. Those strategic goals are in line with several strategic goals developed by NTNU and the NTNU's IE faculty.

NTNU-IIK is located at three different locations (Trondheim, Gjovik, Alesund) and eight research areas / four research groups.

In addition to the national and international recognition, IIK aims to be an attractive place for international researchers and collaborators. UN SDGs shall be supported by appropriate research activities.

To support such strategic goals, the department (administrative unit) has developed some overall strategy documents on recruitment, working conditions, dissemination, open science, IPR etc.

The research areas are well defined with focus on cyber security including related topics such as algorithms, protocols, formal methods, machine learning etc.   Privacy is another related topic with some societal importance.

NTNU-IIK hosts a related innovation centre and a PPP centre in cyber security for critical infrastructures to better support international and national projects in such areas.

NTNU-IIK aims to be a leading education provider in cyber security, digital infrastructures, and communication technology.

NTNU-IIK offers a full education program in information security and communication technologies on Bachelor, Master and PhD level.

NTNU-IIK aims to balance fundamental and applied research considering interdisciplinary elements.

The research is very much of experimental nature requiring significant experimental facilities and research infrastructures.

1.1 Research Strategy

NTNU-IIK has a good strategy document addressing international quality of education, research based on recognised research environments, R&D for welfare, value creation and societal adaptation, good work environments, and effective administration. This strategy can be seen also on the group level and seems to have some real impact. Moreover, NTNU has several strategic documents, which serve as guidelines for the IIK department

NTNU-IIK aims to create efficient, resilient, robust and secure communication networks, information systems and digital services, with a societal mission of being a national research competence provider with strong international visibility.

A strong focus is on international excellence of master and PhD student education meeting internationally accepted performance criteria. NTNU-IIK aims to be an attractive partner for (inter)national research project partner.

Other research goals are described in a more general way, such as having a good working environment and efficient administration.

The strategy documents of NTNU-IIK do not describe in much detail the future research topics to be addressed or possibly new research topics to be followed. The topic of Societal security is mentioned as a thematic area from 2024 to 2030. More new challenges should be discussed in more detail and how the current research areas and topics could evolve in future.

From the interview with the committee, it became clearer that many research activities are based on experimental facilities. This allows the research work to be a good mix of fundamental and applied research with both good academic and practically useful results.

NTNU-IIK is aware of the importance to have collaborations with industry and public bodies to generate societal impact.

Recommendations to the administrative unit.

- Maintain a good mix of fundamental and applied research activities including (inter)national collaborations with academic and industry/public body partners.
- Strengthen NTNU-IIK-internal research collaborations
- Define emerging and upcoming research challenges and topics in more detail, also to be prepared for future faculty recruitment and the development of the NTNU-IIK department.
- Better integrate the small remote location in Gjovik into joint research activities.

1.2 Organisation of Research

The department consists of seven research areas (groups), according to the self-assessment, whereas four research groups were evaluated by panel 4. The names do not directly match the seven^ research areas, e.g. according to a group evaluation report there is a group called HOS (Discipline of Human, Organisational, and Societal Aspects), but it is not clear which of the 7 research are included there.

The department hosts a Centre for Cyber Security for Critical Sectors (SFI NORCIS). The department is distributed across three cities. PhD student and post-doc development is of high importance.

The formation of the four groups (as assessed at the research panel level) has been very artificial, though the Evaluation Committee recognises that this is based on some requirements by RCN (according to information given to the committee in the interview). It is questionable whether such artificial grouping is a good idea and whether there should be more freedom left to the AU how to group instead of enforcing group formations based on administrative RCN requirements.

The organisation of the PhD programme seems to be a good balance between education and research. PhD students can benefit from supplementary courses and external stays at preferably at international partner organisations. Measures to attract good students such as outreach events and integrating them early into research activities have been launched.

The number of professors (full and associate) is strong (20 + 17) with female ratios decreasing with seniority (24 % associate professors, 10 % full professors). On post-doc and

PhD student level there are more females than males, which might be promising for the future.

Good measures for career development such as twice-annual discussions with line managers and administrative support for research grants and mentoring is offered. Also support for sabbaticals and clear guidelines are implemented.

NTNU-IIK is emphasising the possibility of supporting exchange programs and activities on PhD student and Master level. PhD students are expected to visit overseas partners. In general mobility and career development are well supported by mobility actions. This also applies to Master and PhD students.

One location (Gjovik) of the NTNU-IIK is somewhat far away from the others. This has some sustainability issues due to the necessary traveling.

Recommendations to the administrative unit.

- There should be stronger efforts on publishing in top conferences to reach even better scientific impact
- The Committee recommends even stronger efforts to improve gender balance. The department is encouraged to take advantage of increasing number of female researchers on post-doc and PhD level.
- The Committee recommends even more international collaborations, in particular regarding industrial research, possibly by EU project activities.
- Keep strong international academic collaborations by generating more publication networks and research visits
- NTNU-IIK is encouraged to revisit the formation of research groups (as defined by RCN) and reflect this grouping better in their organisational structure. Such structure can also beneficial for NTNU-IIK internal collaboration and better use existing synergies.
- The researchers in Gjovik should be better integrated into join research activities.

1.3 Research Funding

The research funding for 2018-2022 is about 41M NOK. The majority (> 80 %) is from national grants with another 15% consisting of EU grants and the remaining part from national contract research (industry and public bodies).

The mix of funding is very good, avoiding having a single source while being more diverse. RCN and EU basic research funding is reasonable. Highly competitive industry funding is also available (examples: Equinor, Statnett, NVE, Intel, Microsoft) and strengthens the reputation and visibility of NTNU-IIK.

However, some concerns were raised in the self-evaluation report (SWOT: weaknesses and threats) as well the interview with the committee that curiosity-driven and basic research is more and more difficult to get from research funding organisations on national and international level. A strategy to be more careful with internal funding for seed projects and curiosity-driven research has been developed.

Recommendations to the administrative unit.

- The EU funding could be improved, in particular given the infrastructure and system-oriented research directions, by increasing the application activities to specific calls and possibly calls on research topics with significant EU funding available such as 6G networks and cyber security.

1.4 Research Infrastructures

The department is involved in maintaining and using a large number of national / international research infrastructures. Those infrastructures have been listed in the self-evaluation report on pages 26-30. Those are covering the various topics, where NTNU-IIK is involved in such as HPC, networking, security and are used in internal research activities but also in national research projects.

The reason for this large number is the experimental oriented type of research and the fact that by being involved in many research infrastructures NTNU-IIK becomes an attractive partner for industry driven research as well as collaborative research activities.

The existence and involvement of research infrastructures also has a strong impact on education allowing students to get hands-on experiences.

Overall, NTNU-IIK is very active in supporting research infrastructures to support their experimentation-driven research and be an attractive collaboration partner in (inter)national projects as well as for industry driven research. This is a very good strategy for the future although the costs to maintain such infrastructures might be significant.

The self-evaluation report addresses FAIR principles as developed by NTNU well, in particular reproducibility of research results as well as ethical research.

Recommendations to administrative unit.

- While the arguments for the large number of research infrastructures have been well explained and are sound, it is recommended to permanently review the need for the research infrastructures, in particular those that were called generic. Those might always be outsourced and then reduce human and financial costs and efforts.
- While long-term availability of research data is supported, some more concrete measures such as what kind of platforms will be used or what kind of support from NTNU is available, are somewhat unclear and should be worked out in a more concrete way.

1.5 National and international collaboration

The department has a good number of national collaborations including SINTEF, Simula, (industrial) research consortia, Telenor, and national universities. Some of them are a result of the system-oriented research using and maintaining / providing certain specialised research infrastructures.

Several interesting and beneficial collaborations in the cyber security area were established, also supporting the societal impact of cyber security research.

Collaborations with the public sector have been established as well. Examples are FFI, Cyberforsvaret, FD, JD. The participation in the Norwegian Crypto Council with industrial members is also a strong asset.

The mix of national collaborations is very good. Those include collaborations with national research institutes such as Sintef, Simula and FFI, research consortia such as NESIOT and COINS, industry such as Telenor etc.

There are also a good number of international collaborations, mainly with European universities and academic partners, some of them resulting in joint research publications, visiting professorships, and joint PhD student supervision, for example.

Internationally, collaborations are mainly with European universities and academic partners (e.g., Munich, Berlin, Malaga, Würzburg, Aarhus, London, Warsaw, Pisa), except for the addition of the US naval academy. Collaborations are mainly on joint publications and student supervision.

- The AU may also try to establish international collaborations with industry partners to improve international impact and visibility
- Establish more academic exchanges and collaborations with non-European partners such as in US or Asia.

1.6 Research staff

The professor/student ratio (20/47) seems to be appropriate. On PhD student and post-doc level, gender balance is good, whereas on full and associate professor level it can be improved significantly.

Mobility of researchers is supported on all levels from Master students via PhD candidates to professors. This includes research visits, sabbaticals and project work at the partners. Such activities can be beneficial for all persons. IIK also aims to be attractive for incoming persons, which can be beneficial for future collaborations and projects.

There are measures to support recruitment of PhD students. As example, potential PhD students are invited to events where the professors are showing and discussing possible research areas and try to motivate candidates from Master programs. The integrated Ph.D. programme offers a transition between guided Master level research and more independent Ph.D. studies.

It is not quite clear to the Evaluation Committee whether and how assistant professors are recruited and how such persons can develop towards tenured professors. Assistant professors are exploring novel and emerging research topics and are an important source for the future development of the AU.

The time of (associate) professors is expected to be spent on research (40 %), education (40 %) and administration (20 %).

Recommendations to the administrative unit

- The Evaluation Committee recommends more efforts towards increasing the number of female professors, in particular on full professor level.
- In general, the recruitment of young professors and talents should be considered.
- Try to significantly reduce the administration overhead from 20 % to 10 % at most.

1.7 Open Science

NTNU-IIK has developed a comprehensive strategy for open science, not only for publications but also for software code and research data.

The department fully adopts open access and open data policies and guidelines set out by NTNU. These policies are very briefly summarised in the self-evaluation report.

FAIR principles are considered.

Even more NTNU-IIK publications should be published using gold and green standards. Currently not even 30 % of the publications are open access.

There is an own repository for results (e.g., publications, theses, lectures, research reports etc.) and GitHub is recommended to be used for open-source code. Data management plans are recommended and regulated by NTNU's guidelines and policies and NTNU-IIK follows these guidelines and policies.

NTNU has also developed guidelines for research data and encourages to develop data management plans.

It is somewhat open what kind of research data platforms are preferably used and how the support by NTNU is on this is.

Privacy issues are considered in the various policies.

Recommendations *on how to promote open science*

- More concrete recommendations on what kind of research data platforms shall be used would be helpful.
- NTNU should continue the support to publish using green and gold standards

2. Research production, quality and integrity

The department focuses on publications in leading journals such as IEEE Transactions, partly also leading conferences in the field. Top-level conferences are not mentioned for all the existing research areas. Top conferences might be of higher importance in the future to improve international visibility.

Information Security Discipline (INF) performs application-driven research, has excellent journal output with room for improvement in conferences. INF has strong 3rd party money acquisition with good societal impact. There are industry collaborations with more funding opportunities.

Discipline of Cryptology (KRY) is a large team with 24 members including 12 PhD students. It claims to be the largest cryptology group in Norway with strong international visibility. There is more potential for industry and interdisciplinary research. KRY has a strong publication track record with top level journals and conferences.

Communication Technology (COM) has a good number of professors with good PhD student output. COM follows an applied and experimentation driven research with good lab infrastructure. The involvement in national industrial with critical dependencies is good. There are good international publications with awards.

Discipline of Human, Organisational, and Societal Aspects (HOS) has a small number of PhD students. HOS performs multidisciplinary research, but quality and publication impact is not on highest international level.

As mentioned in the sections above, the grouping into 4 groups is somewhat artificial, which the Evaluation Committee acknowledges has been done to comply with RCN's requirements.

Overall, there seems to be a low level of internal collaboration among the research areas, even within a single group. It might be appropriate to reflect the organisational structure given the research group requirements as defined by RCN as well as potential NTNU-IIK internal collaboration opportunities and the possible synergies among the research areas.

Considering the available numbers in the NIFU report, NTNU-IIK has strong publication numbers as reported in Figure 1.1. Those numbers have slightly increased during the last decade. The vast majority of the publications are in computer sciences with a very few in multidisciplinary sciences and engineering fields. The publication venues include typical organisations such as IEEE and ACM, but unfortunately, do not specify more details. For example, IEEE Transactions as top-level journals are not mentioned, while IEEE Access is listed. It also does not become clear in which top-level conferences publications were achieved, but only conferences as a whole are listed. Open access (green and gold) publications have been steadily increasing, but there are still many publications not fulfilling

open access requirements (around 30 %). Citation parameters are strong compared to other national administrative units, but comparing internationally, there is still some room for improvement. The collaboration with other national or international authors is very good.

2.1 Research quality and integrity

Research group Information Security Discipline (NTNU-IIK-INF) overall assessment

The INF group has a large critical mass and a clear strategy for excellent research and education at master's, PhD and postdoctoral level. It should be possible to increase the number of PhD students per academic staff member. The group plays a central role in national cybersecurity initiatives and has been successful in obtaining EU funding. While there are good collaborations with industry and public sector, the direct funding has been limited and there is room for further growth. The collaboration between the subteams and the interdisciplinary collaborations could be further strengthened, the same holds for international collaborations apart from EU projects. The publication output in international journals is very strong. However, the collaborations are not very well reflected in the list of publications provided. The impact of the group can be further increased if some subteams would target top international conferences in cybersecurity. In terms of demonstrated societal impact, the strongest results are in the area of biometrics and forensics, in which area there is also a spin-off. In critical infrastructure security the group plays a strong role at the Norwegian level and also influences international developments; the self-assessment could have provided detailed cases to demonstrate the impact. The outreach activities to the broader public and the interdisciplinary collaborations could be strengthened. Detailed benchmarking goals are set but the self-evaluation does not provide a quantitative assessment nor a detailed comparison with the results of the international benchmark which makes it difficult to evaluate this aspect. The group demonstrates clear international excellence in research output and national collaborations and achieves very good to excellent performance in collaborations with industry and public sector partners.

Research group Discipline of Cryptology (NTNU-IIK-KRY, KRY) overall assessment

NTNU Crypto is the largest group for research in cryptology in Norway. They have become a well-known team in Norway and internationally thanks to their broad coverage of crypto research topics and the ambition to stay visible e.g. by organising top conferences and other events. The publications and projects portfolios could be improved, especially in number of publications and international funding. There is a lot of potential in giving more attention to diversity and focusing on outreach activities to improve the research group's societal contribution.

Research group Communication Technology, NTNU-IIK-COM (COM) overall assessment

Strengths: NTNU-IIK-COM is positioned as a leading research unit with significant strengths in infrastructure, strategic focus and educational impact. The organisational environment is very strong, and the quality of research is internationally excellent, with the group playing a considerable role in research. The graduation of 35 Ph.D. students from 2012 to 2022 underlines the group's significant role in research. The group's commitment to education at all levels includes innovative formats such as summer schools and Ph.D. workshops, demonstrating a comprehensive approach to education in the field. Weaknesses: The group must address notable weaknesses in funding diversification and publication output to enhance its competitiveness and sustainability in the global research environment. These areas present opportunities for strategic improvement and growth that could further

consolidate its role as a leader in communication technology research. Addressing funding diversification is essential for financial stability and broader research initiatives.

Research group Discipline of Human, Organisational, and Societal Aspects (NTNU-IIK-HOS, HOS) overall assessment

The HSO group has an adequate composition and level of infrastructure to conduct high quality research. The group strategy is good, and it is clear where they want to go. The number of PhD students is small with regards to the number of senior group members. External funding is low. Some multidisciplinary publications have been produced, but the group still needs to develop for it to achieve the highest international levels. The group has identified very relevant challenges, but it still needs to define the potential associated opportunities and the best strategy to reach them.

3. Diversity and equality

The self-evaluation report does not have an appropriately signposted section documenting diversity and equality performance in the unit, and related comments and descriptions are on a very superficial level.

NTNU-IIK and NTNU have well developed plans and guidelines addressing diversity and equality. However, the self-assessment report does not provide any concrete numbers. It is recognised that female professors numbers are not satisfactory, but concrete measures except some mentoring activities are not addressed sufficiently.

While the gender balance on PhD student level is good considering the field of research, on senior levels this must be improved.

The self-evaluation report only reports about some individual female assistant professors and three female PhD candidates that were supported by some individual mentor.

The self-evaluation report claims that NTNU-IIK is diverse and integrates many nationalities and cultures, but this cannot be verified by the committee.

Overall, the self-evaluation report is by far not sufficient in quantity and quality to address gender equality. Also, other diversity aspects are not addressed sufficiently well on an AU level.

4. Relevance to institutional and sectorial purposes

The NTNU-IIK department is active in several activities such as research schools, conferences, and public events. The support for innovation and commercialisation seems to be available (such as a tech transfer office and an innovation manager) and four spin-off examples are listed. The four listed commercialisation results are mainly in the area of cyber security.

Another achievement is the good number of PhD positions in cyber security with good potential of future top-level experts in this societally important field.

NTNU-IIK has several education activities such as research schools, Erasmus activities, PhD programmes and PhD courses. Overall, this seems to be well structured and used.

There are several activities where researchers provide their expertise and knowledge to national forums and national competence centres, and via those also indirectly to ministries.

On the level of sector specific impact, the AU has quite some successful activities such as research schools, conference organisations, and outreach activities such as the national security festival.

Moreover, industrial and public sector PhD programmes have been developed. This also allows collaboration with industry and public organisations. Moreover, this improves the societal impact.

5. Relevance to society

The AU's relevance to society is mainly based on the importance of their work in cyber security. The activities resulted in several mentions and contributions in / to government documents. It also contributes to national and European security agencies and cyber security centres. Research and consulting activities to infrastructure providers are performed.

The department is strong in education and has plenty of experience in the field, which is also provided to (inter)national competence centres.

UN SDGs are considered in the self-assessment, although this is not concretely visible in the various research areas and education activities. Only a few smaller examples such as students from the global south, gender equality promotion are mentioned. It is mentioned that some national and international projects work towards affordable and clean energy, but concrete project names are not given.

 Some activities to exchange researchers and students with the global south are performed.

As mentioned in previous sections, industrial and public sector PhD programmes have been developed. This also allows collaboration with industry and public organisations. Moreover, this improves the societal impact.

Some research considering affordable and clean energy is performed.

Overall societal contributions are strong although more concrete activities could be defined.

5.1 Impact cases
Comments to impact case 1: Author Input Behavioural Analysis (AIBA)

The first impact case presents a spin-off on cyber grooming detection.

The goal is to protect children in online forums from sexual predators by developing an early warning system based on behavioural biometrics.

The spin off addresses a societally important issue. The company has now 10 employees. Collaboration is based on a large number of student theses and the involvement of a large number of researchers. Several research articles resulted from this case, and the technical and societal impact seems to be strong.

Comments to impact case 2: User-centric service delivery

The second impact case presents developments in video streaming and quality of experience, transferred to industry and made available as open source.

This use case describes efforts to improve user-centric service delivery with emphasis on HTTP-adaptive video streaming. Several optimisation methods are suggested and validated

allowing video streaming providers and network providers to improve system and energy efficiency and reduce operational costs.

Positive results include many strong publications in top conferences and journals.

The research also could benefit from several international collaborations with strong researchers.

Some industrial pre-standardisation activities were mentioned, but this is not described in a detailed way.

Some contributions to simulator extensions resulted from this work.

Overall, the use case shows good publications, though the commercial or societal impact is limited.

Comments to impact case 3: Isogeny Based Cryptography

Isogeny-based cryptography was (co)invented by a member of the research group. It offers a direct drop-in replacement for the old discrete-logarithm-based public key cryptography.

The work is based on an earlier PhD thesis performed in the research group. Also, international collaborators contributed to its further development. The post-quantum cryptography research results were submitted to NIST, however the outcome and results of the NIST submission is not clear.

Several research articles resulted from this work with some good publications at well know cryptography conferences.

Comments to impact case 4: Raising Higher Education in Information Security to a mainstream education program.

This impact case presents the first Information security master program, which is now the largest program in cyber security in Norway.

The use case has strong impact by educating a large number of security experts.

There is a strong demand for Cybersecurity experts. Cybersecurity is important to protect critical infrastructures and businesses with strong economic importance. Thus, the education program is an important contribution to society.

Methods and limitations

Methods

The evaluation is based on documentary evidence and online interviews with the representatives of Administrative Unit.

The documentary inputs to the evaluation were:

- Evaluation Protocol that guided the process
- Terms of Reference
- Administrative Unit's self-assessment report
- Administrative Unit's impact cases
- Administrative Unit's research groups evaluation reports
- Bibliometric data
- Personnel and funding data
- Data from Norwegian student and teacher surveys (only for HEIs)

After the documentary review, the Committee held a meeting and discussed an initial assessment against the assessment criteria and defined questions for the interview with the Administrative Unit. The Committee shared the interview questions with the Administrative Unit two weeks before the interview.

Following the documentary review, the Committee interviewed the Administrative Unit in an hour-long virtual meeting to fact-check the Committee's understanding and refine perceptions. The Administrative Unit presented answers to the Committee's questions and addressed other follow-up questions.

After the online interview, the Committee attended the final meeting to review the initial assessment in light of the interview and make any final adjustments.

A one-page summary of the Administrative Unit was developed based on the information from the self-assessment, the research groups' evaluation reports, and the interview. The Administrative Unit had the opportunity to fact-check this summary. The Administrative Unit approved the summary without adjustments.

Limitations

The Committee judged that the Administrative Unit self-assessment report was insufficient to assess all evaluation criteria fully. However, the interview with the Administrative Unit filled gaps in the Committee's understanding, and the information was sufficient to complete the evaluation.

List of administrative unit's research groups

Institution	Administrative Unit	Research Groups
Norwegian University of Science and Technology	The Department of Information Security and Communication Technology	Information Security Discipline (NTNU-IIK-INF)
		Discipline of Human, Organisational, and Societal Aspects (NTNU-IIK-HOS, HOS)
		Discipline of Cryptology (NTNU-IIK-KRY, KRY)
		Communication Technology, (NTNU-IIK-COM, COM)

Terms of Reference (ToR) for the administrative unit

The board of the Faculty of Information Technology and Electrical Engineering of NTNU (IE) mandates the evaluation committee appointed by the Research Council of Norway (RCN) to assess the Department of Information Security and Communication Technology (Institutt for informasjonssikkerhet og kommunikasjonsteknologi, IIK) based on the following Terms of Reference.

Assessment

You are asked to assess the organisation, quality and diversity of research conducted by IIK as well as its relevance to institutional and sectoral purposes, and to society at large. You should do so by judging the unit's performance based on the following five assessment criteria (a. to e.). Be sure to take current international trends and developments in science and society into account in your analysis.

a) Strategy, resources and organisation
b) Research production, quality and integrity
c) Diversity and equality
d) Relevance to institutional and sectoral purposes
e) Relevance to society

For a description of these criteria, see Chapter 2 of the mathematics, ICT and technology evaluation protocol. Please provide a written assessment for each of the five criteria. Please also provide recommendations for improvement. We ask you to pay special attention to the following 4 aspects in your assessment:

1.   NTNU has a national role in developing technological foundations for the future society

2.   The department aims to have a good balance between fundamental and applied research engaging with stakeholders across application domains and seeks to balance its position in the academic communities and relevance to society

3.   The department has activities at Campus Trondheim and Campus Gjøvik, with an organisational structure to support and develop these

4.   The department aims for its research to be visible and held in esteem nationally and internationally

In addition, we would like your report to provide a qualitative assessment of the Department of Information Security and Communication Technology as a whole in relation to its strategic targets. The committee assesses the strategy that the administrative unit intends to pursue in the years ahead and the extent to which it will be capable of meeting its targets for research and society during this period based on available resources and competence. The committee is also invited to make recommendations concerning these two subjects.

Documentation

The necessary documentation will be made available by the mathematics, ICT and technology secretariat at Technopolis Group.

The documents will include the following:

- a report on research personnel and publications within mathematics, ICT and technology commissioned by RCN
- a self-assessment based on a template provided by the mathematics, ICT and technology secretariat

Interviews with representatives from the evaluated units

Interviews with the Department of Information Security and Communication Technology will be organised by the evaluation secretariat. Such interviews can be organised as a site visit, in another specified location in Norway or as a video conference.

Statement on impartiality and confidence

The assessment should be carried out in accordance with the Regulations on Impartiality and Confidence in the Research Council of Norway. A statement on the impartiality of the committee members has been recorded by the RCN as a part of the appointment process. The impartiality and confidence of committee and panel members should be confirmed when evaluation data from the Department of Information Security and Communication Technology are made available to the committee and the panels, and before any assessments are made based on these data. The RCN should be notified if questions concerning impartiality and confidence are raised by committee members during the evaluation process.

Assessment report

We ask you to report your findings in an assessment report drawn up in accordance with a format specified by the mathematics, ICT and technology secretariat. The committee may suggest adjustments to this format at its first meeting. A draft report should be sent to the Department of Information Security and Communication Technology and RCN. The Department of Information Security and Communication Technology should be allowed to check the report for factual inaccuracies; if such inaccuracies are found, they should be reported to the mathematics, ICT and technology secretariat within the deadline given by the secretariat. After the committee has made the amendments judged necessary, a corrected version of the assessment report should be sent to the board of the Faculty of Information Technology and Electrical Engineering and the RCN no later than two weeks after all feedback on inaccuracies has been received from Department of Information Security and Communication Technology.

Appendices

1. Description of the evaluation of EVALMIT
2. Invitation letter to the administrative unit including address list
3. Evaluation protocol
4. Template of self-assessment for administrative unit (short-version)