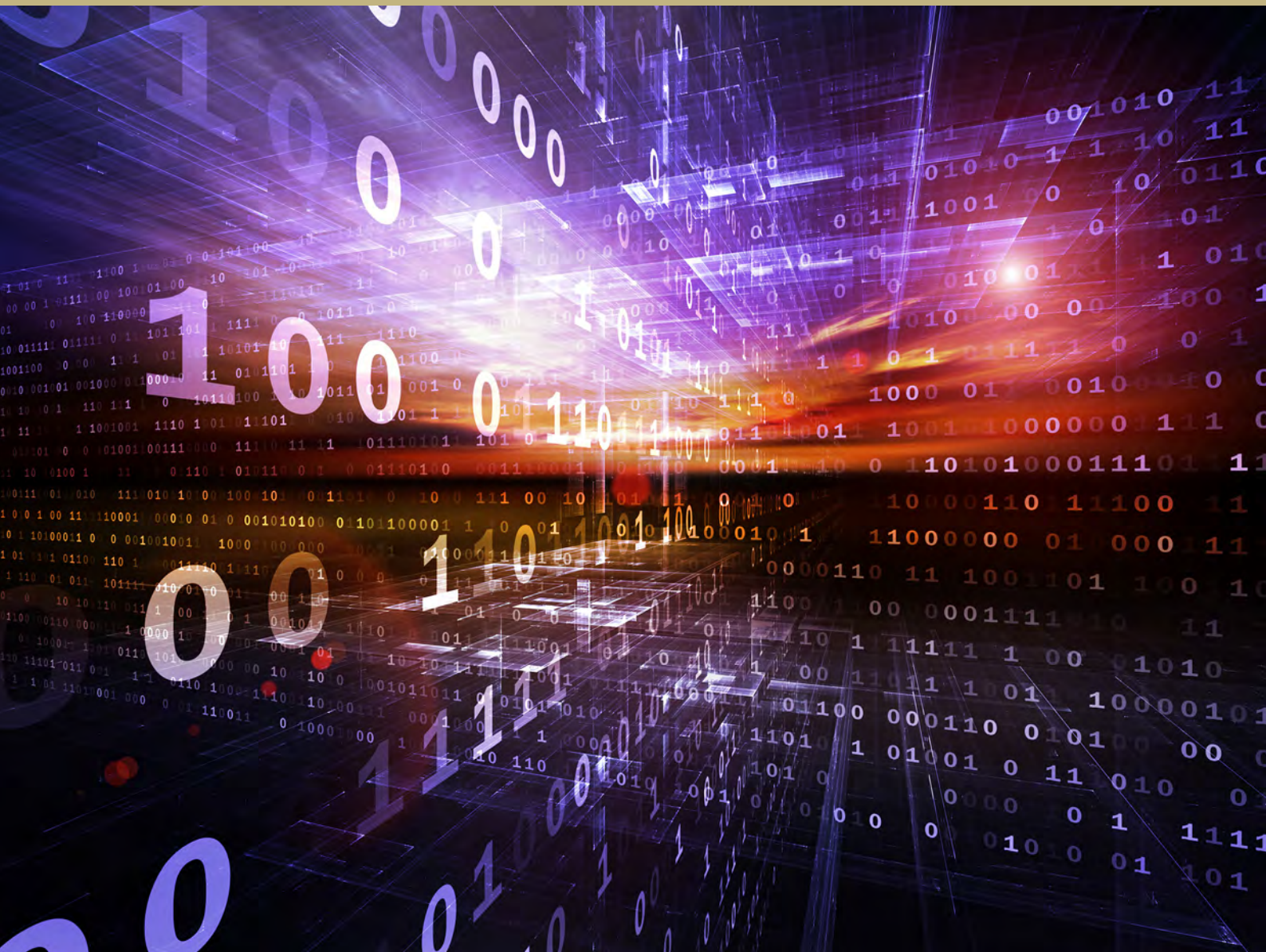


Simula Research Laboratory

An evaluation 2016/2017

Evaluation
Division for Science



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An evaluation 2016/2017

Evaluation
Division for Science

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Preface

This report summarizes the findings of an international evaluation of Simula Research Laboratory A/S done during 2016/17. The evaluation was initiated by the Research Council of Norway on behalf of the Ministry of Education and Research. The objective of the evaluation is to give the Research Council of Norway (RCN) and the ministries funding Simula an impartial and complete report on Simula's activities.

The Research Council of Norway, April 2017

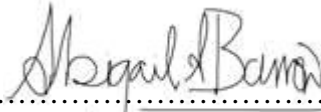
Contents

| | |
|--|----|
| 1. Executive summary and recommendations | 8 |
| 2. Evaluation of research, education, and innovation within research areas of Simula | 13 |
| 2.1 Scientific Computing | 13 |
| 2.1.1 Scientific productivity and quality | 14 |
| 2.1.2 Relevance and impact of research activities | 15 |
| 2.1.3 Alignment with research domains identified by EU | 15 |
| 2.1.4 Perspectives on research plans and strategy | 15 |
| 2.1.5 Educational activities | 16 |
| 2.1.6 Innovation | 16 |
| 2.1.7 Organization and management | 17 |
| 2.2 Software Engineering | 17 |
| 2.2.1 Scientific productivity and quality | 17 |
| 2.2.2 Relevance and impact of research activities | 18 |
| 2.2.3 Alignment with research domains identified by EU | 18 |
| 2.2.4 Perspectives on research plans and strategy | 18 |
| 2.2.5 Educational activities | 19 |
| 2.2.6 Innovation | 19 |
| 2.2.7 Organization and management | 19 |
| 2.3 Communication Systems | 19 |
| 2.3.1 Scientific productivity and quality | 20 |
| 2.3.2 Relevance and impact of research activities | 21 |
| 2.3.3 Alignment with research domains identified by EU | 23 |
| 2.3.4 Perspectives on research plans and strategy | 23 |
| 2.3.5 Educational activities | 25 |
| 2.3.6 Innovation | 25 |
| 2.3.7 Organization and management | 26 |
| 3. Evaluation of education in the framework of SSRI | 28 |
| 3.1 Overall assessment | 28 |
| 3.2 Goals and strategy | 29 |
| 3.3 Professional development training | 30 |
| 3.4 Outreach | 30 |
| 4. Evaluation of innovation | 30 |
| 4.1 Overall assessment | 30 |
| 4.2 Competencies, organization and operation | 30 |

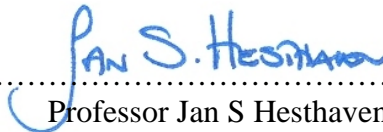
| | |
|---|----|
| 4.3 Role of Kalkulo..... | 31 |
| 4.4 Simula Garage and other Spin-off Companies | 32 |
| 5. Simula Research Laboratory..... | 32 |
| 5.1 Organization and operation | 33 |
| 5.2 Integration between research, education, and innovation | 34 |
| 5.3 National and international relevance of research | 34 |
| 5.4 National and international cooperation..... | 35 |
| 5.5 Comments on research plans and overall strategy..... | 35 |
| 6. Evaluation Committee membership | 37 |
| Appendix A: Mandate for the scientific evaluation of Simula Research Laboratory | 38 |

To the Research Council of Norway

The members of the Evaluation Committee reviewing the Simula Research Laboratory are pleased to submit this report. The views expressed are the unanimous opinion of the members of the Evaluation Committee and the members of the committee are in full accord with regard to the assessment, recommendations, and conclusions stated in the report.



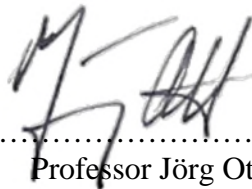
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1. Executive summary and recommendations

The Evaluation Committee is impressed by the consistent high quality of the research activities at Simula Research Laboratory as well as the continued growth in breath and impact that is evident since the last evaluation. The leadership has followed the majority of past recommendations and the organization has matured to become a vibrant research community with strong leadership and a clear mission focusing on research, education and innovation. These ongoing developments are clearly reflected in the impressive and rapidly expanding portfolio of international grants, and the substantial growth in national and international collaborations. The Evaluation Committee commend the quality of the self-evaluation document as a thorough and accurate assessment of the many activities at the laboratory, while offering a balanced discussion of current strengths and weaknesses.

The Evaluation Committee congratulates Simula on the ongoing development of the scientific focus in all three research departments, achieved while maintaining a very high level of academic inquiry. It is also encouraging that the organization has worked hard, and with focus, to continue to develop educational and business opportunities during the evaluation period.

The Simula Research Laboratory offers a unique environment that emphasizes and promotes basic research while covering the broader landscape from postgraduate teaching to commercialization. The organizational and generous national funding framework not only enables basic research to take centre stage, but does so without imposing substantial constraints from the pursuit of external funding, as is typically found in industrial research institutes, or from the heavier teaching commitments found in University environments. This is a unique environment and it gives the laboratory the opportunity to be highly productive in its chosen focus areas. The success of this is clearly measured in the expanded national and international footprint of Simula Research Laboratory.

The Evaluation Committee would like to first highlight a few observations, all of which are discussed later in more detail. These are concerns of a more strategic nature and will shape some of the discussion and subsequent recommendations.

- While the research activities at Simula Research Laboratory remain very strong, there is a perceived drift in the institution towards more applied research and increased emphasis on revenue growth. This induces the risk of diluting the focus on fundamental research and directing attention to contract research and short term activities. This slow transformation, driven by an apparent overemphasis on the expansion of Simula from the leadership, should be carefully managed, possibly through the establishment of a Applied Research Laboratory as a new entity. It is suggested that Kalkulo could be redirected to take this role.
- During the evaluation period, Simula Research Laboratory has committed substantial resources to the development and expansion of its educational activities and some of these efforts are already proving themselves to be highly successful, e.g., the close partnership with University of California at San Diego is clearly a valuable development. However, other activities appear poorly conceived such as the planned activities with TU Berlin or the planned partnership with Oslo University College, both of which have limited research content and limited support in the vision for

Simula Research Laboratory. A clearer vision, aligned with the core activities of Simula Research Laboratory, for the expansion of educational activities is needed.

- Simula Research Laboratory continues to develop activities focused on innovation and technology transfer, including new initiatives such as the Garage. However, for some of these activities, the benefit to Simula Research Laboratory is unclear and for others, the focus is too narrow and could benefit from a clearer planning and process.
- The senior Simula Research Laboratory leadership, all of which are among the founders of Simula, have been very successful. However, plans for succession are needed. Simula Research Laboratory is not a university but a directed research laboratory and a more dynamic evolution of the management team is required.

A criticism raised at past evaluations has been the static nature of the choice of research domains, identified to be Scientific Computing, Communication Systems and Software Engineering through a national competition two decades ago. Given the unique nature of the Simula Research Laboratory in Norway and its strong direction towards University of Oslo, the lack of a re-evaluation of this choice was seen as not being in the interest of Norwegian research and education.

While Simula Research Laboratory has maintained its focus on its original three research domains, it has made an effort to continue to renew the research focus and maintain research leadership within these domains. Nevertheless, the core research activities of Simula Research Laboratory remain focused within three research domains that were chosen more than 20 years ago.

To expand its national footprint, and in response to the 2012 ICT evaluation, Simula Research Laboratory has developed a program with the University of Bergen in Cybersecurity. This appears to be an excellent model to ensure a larger and deeper impact across Norway. The initiative offers a model mechanism to implement strategic initiatives of national interest, which also enable Simula Research Laboratory to expand the national impact of the considerable investment made in the institution while also providing the benefit of increased international recognition and visibility. The Evaluation Committee *recommends* that the Simula@UiB model be expanded to include other activities by exploring a similar model.

The Evaluation Committee finds several signs of a greater emphasis being placed on applied research and projects, often requiring a shorter time scale for completion. The main motivation for this appears to be a desire for continued growth of Simula Research Laboratory. However, the Evaluation Committee worries that this change in focus induces the risk of diluting the unique environment centred around fundamental and basic research at Simula Research Laboratory.

While the Evaluation Committee appreciates the pressure to increase revenue and grow a larger foot print in Norwegian research and development, it also finds this trend troubling as it risks endangering the core values on which Simula has been built. It therefore *recommends* that aggressive growth as a central goal for Simula Research Laboratory be evaluated by the leadership.

Furthermore, the Evaluation Committee *recommends* that a Simula Applied Research Laboratory be established. This is model that has been developed with great success at many

institutions worldwide, e.g., Johns Hopkins University, Stanford University, Georgia Institute of Technology, where a subsidiary organization focuses on short term contract work and projects. Such an entity could well provide an increase in revenue for Simula Research Laboratory, while allowing the laboratory to continue to focus on and strengthen, fundamental research.

The Simula Research Laboratory leadership has expressed the view that Kalkulo presents an opportunity for sale. The Evaluation Committee does not share this view which it finds to be short sighted. Rather, the Evaluation Committee *recommends* that Kalkulo be retained within Simula Research Laboratory but be redirected to play the role of an Applied Research Laboratory as discussed above. This would require an expansion and revision of the goals of Kalkulo, but it would benefit both Simula Research Laboratory and Kalkulo.

While the number of PhD students at Simula Research Laboratory is robust, it remains sub-critical in several of the research departments. In addition, Simula Research Laboratory certainly has the capacity to mentor more PhD students. The Evaluation Committee also finds it problematic that about 1/3 of PhD students remain at Simula Research Laboratory after the completion of the studies. This creates the risk of inward looking activities and closed research communities and is a trend seen only rarely at leading research institutions and laboratories. Such arrangements may seem advantageous for both Simula Research Laboratory and the candidate in the short term but it is not a healthy long term strategy. The Evaluation Committee *recommends* that the policy of hiring newly graduated PhD students, that have spent a considerable part of their studies at Simula Research Laboratory, into research positions at Simula Research Laboratory, be reconsidered. Contract continuations for these graduates as post doctoral researchers should be clearly limited to exceptional cases and to a maximum of six months.

Since the last evaluation, Simula Research Laboratory has expanded its emphasis on educational activities and done so with success. Of particular note is the development of the close research-based partnership with University of California, San Diego. By any measure, this is a success and the model could well be expanded to new partnerships with other leading research universities worldwide. However, such expansions should only be pursued after careful consideration. The planned partnership with TU Berlin is, to the contrary, poorly conceived and appears opportunistic as there is no existing partnership and no clear research strategy associated with this partnership. The Evaluation Committee *recommends* that Simula Research Laboratory continues to build close educational and research driven partnerships that follow a similar path to the partnership that has evolved with the University of California, San Diego. It is essential that such partnerships be based on a clear vision with clearly identified mutual benefits, centred on core activities in research, education and innovation, and grounded on solid prior joint research experience.

The plans for Simula Research Laboratory to support and enable the development of an Institute for Digital Engineering at Oslo University College is a distinct new activity where Simula Research Laboratory has been engaged as a consultant and vendor of scientific visibility and respect to help lift a new educational activity. The Evaluation Committee perceives this as another example of an opportunistic development which has minimal benefit to the research and educational mission of Simula Research Laboratory. The decision by Simula Research Laboratory leadership to support this reiterates to the Evaluation Committee the impression of too strong an emphasis on growth. The Evaluation Committee *recommends* that the partnership with Oslo University College be re-evaluated and that Simula Research

Laboratory does not engage in similar future arrangements without a clear vision of the benefit to the core mission of Simula Research Laboratory.

Other important and valuable educational activities have been pursued with the Simula School of Research and Innovation. The expansion into increased educational activities, workshops and short courses has been highly successful. The activities focusing on soft skills for PhD students are likewise highly appreciated by the Evaluation Committee.

The Evaluation Committee sees opportunities for the Simula School of Research and Innovation to play a stronger role in professional development of the general workforce in key areas of expertise, e.g., machine learning or cybersecurity and **recommends** that such opportunities be considered for further development.

Support for innovation plays a central role in Simula and there are numerous reasons to encourage, support, and grow such activities. However, financial arrangements and support for start-up activities appear to be based on one-off arrangements which lack the transparency expected from an organization such as Simula Research Laboratory. The Evaluation Committee **recommends** that Simula Research Laboratory follows the majority of leading universities and develop a set of standard arrangements and levels of financial involvement to support start-up companies.

Furthermore, the current emphasis on support of start-up companies as opposed to technology transfer into larger existing companies runs the risk of missed opportunities. The Evaluation Committee **recommends** that Simula Research Laboratory seeks greater activity in technology transfer into larger companies to broaden the scope of possibilities for commercialization. Such efforts must be driven from the top of Simula Research Laboratory and should not be left to the individual researcher as appears to be the current situation.

Simula Research Laboratory has created the Garage as a venue where very early ideas can be explored and pursued at minimal cost. While the initial results indicate that this initiative has been successful, it is unclear exactly how this activity benefits Simula Research Laboratory. The Evaluation Committee **recommends** that this be carefully evaluated and that proposed projects undergo a stronger screening process, including evaluation of the fit to the core research activities of Simula Research Laboratory. Projects that are approved to join the Garage should be approved on a six month + six months schedule with an evaluation for fit and contribution after the first period.

Intellectual property rights and management are central legal components of a modern organization in science and technology developments. However, Simula Research Laboratory lacks strong policies on patents, licences, open source activities etc. This may not only lead to lost opportunities for future revenue but could also expose the organization to legal challenges. The Evaluation Committee **recommends** that these issues be addressed thoroughly and that a robust policy on patents, licences, open source activities etc be developed and implemented across the organization. This should be done with the assistance of external expertise.

To encourage and grow innovation activities, particularly collaborative research, from within Simula Research Laboratory, it is important that such activities are rewarded. The Evaluation Committee therefore **recommends** that innovation and tech transfer activities become part of the criteria used during performance evaluations.

Simula Research Laboratory leadership is planning a major restructuring effort, focusing on project driven activities. This is in contrast to the current organizational model of thematic groups. Such a pool-based model, in which teams are assembled based on project needs, is used at laboratories world-wide and may indeed function well. However, it is not without challenges as it runs the risk of creating many small teams, leading to a fragmentation of the research efforts unless strong top-down control is exercised.

It is unclear to the Evaluation Committee what the motivation for this reorganization is and the Evaluation Committee remains unconvinced that this is in the best interest of Simula Research Laboratory. Indeed, one of the strengths of Simula Research Laboratory is precisely the opportunity to have large groups of people working on closely related projects. This current model has also been demonstrated at the Max Planck Institutes and has contributed to their success that has made them the envy of most countries worldwide. This is a clear differentiation from university based research which is typically centred on smaller teams with a limited degree of continuity. The Evaluation Committee *recommends* that these planned changes be carefully evaluated before proceeding and that alternative models be considered.

An active Scientific Advisory Board, comprised of a selection of experienced researchers and research managers, is essential for an organization as Simula Research Laboratory to ensure broad and timely input on research directions. However, the composition of the current advisory board strikes the Evaluation Committee as being unusual as it is quite large and includes a number of junior researchers. While the Scientific Advisory Board members are closely aligned to Simula Research Laboratory's research activities, there is a risk that they lack the experience to provide advice of a more strategic character. Furthermore, the close alignment with research projects may limit the feedback and evaluation of specific projects which is not the role of a Scientific Advisory Board. The Evaluation Committee *recommends* that the membership of the Scientific Advisory Board be reconsidered with the goal of creating a smaller Advisory board, comprised of more senior research leaders and managers. Attendance to meetings should be required of members, and this should be made clear during initial discussions about membership. Long term planning for meetings will help in ensuring adequate attendance.

The Evaluation Committee supports the development of longer-term strategic plans and shares the view that this should be implemented as a living document. However, the Evaluation Committee does feel that the Simula Research Laboratory's strategy is somewhat static. While it might be appropriate to continue with the current directions at present, the Evaluation Committee would have liked to see a more critical discussion of the likely evolution of the targeted areas on a longer time-scale.

The Evaluation Committee *recommends* that the Simula Research Laboratory revisits its strategy development with the aim of developing a more dynamic tool and process for its implementation. It is important that this strategic plan takes a long-term view of the laboratory and the research activities as a whole and consider the development of the research fields. It may be useful to develop this plan with external assistance.

The current leadership group has been in place since the foundation of Simula Research Laboratory and has done a remarkable job at building Simula Research Laboratory to its current global leadership position. However, it is time to think more carefully about a

succession strategy, both in anticipation of future retirements of members of this core group, and in the interest of the continued development of Simula Research Laboratory as an international leader in its research domains.

Simula Research Laboratory is no longer a start-up organization, but a mature diverse and complex organization, centred around directed research activities. This requires strong top-down leadership with a vision to continue the evolution and implementation of a development strategy for Simula Research Laboratory.

The Evaluation Committee *recommends* that an open international search for the Simula Director be conducted at the end of the term of the current director. This should serve both as an opportunity to evaluate the current strategy of Simula Research Laboratory and to calibrate the quality of the Simula Director in an international environment. The incoming Director should be given the freedom to set the leadership team and to redirect overall strategy for Simula Research Laboratory. To ensure transparency, the hiring process should be driven by an independent committee, including major stake holders and experts in the research domains of Simula Research Laboratory. This process could include an evaluation of the overall strategy of the incoming director, evaluated by an external visiting committee after one year.

Repeatability and reproducibility are cornerstones of the scientific method and should be a core value of any science-based organization. However, in numerous research domains, traditions and processes for this are not yet in place. These challenges are found in many other domains, but particularly in scientific computing and data intense activities. Simula Research Laboratory already has in place many of the tools and processes that could allow it to become a leader in the drive toward increased repeatability and reproducibility in computational sciences and technologies with a focus on Open Science. The Evaluation Committee *recommends* that the leadership of Simula Research Laboratory develops a strategy to pursue this goal which will position Simula Research Laboratory as a frontrunner in this emerging activity which is expected to grow in importance and penetration.

2. Evaluation of research, education, and innovation within research areas of Simula

In the following, we will present a more detailed discussion of the three main research departments currently at Simula Research Laboratory. This also contains background for a number of the department-specific recommendations discussed previously.

2.1 Scientific Computing

Scientific Computing continues to be an integral part of the Simula Research Laboratory, originating in a research group at the University of Oslo, then led by Aslak Tveito and Hans-Petter Langtangen. This historic origin continues to shape the research activities in the Department, focusing on the development and application of modern computational techniques for the solution of systems of partial differential equations.

Since the last evaluation, there have been substantial changes in the Department, leading to slightly decreased staffing, and with research activities that are slowly shifting from a more

theoretical/foundational work to activities with an emphasis on application driven work. This is the result of a deliberate choice to focus on biomedical and neurobiological applications, while previous activities undertaken by this department in geophysical applications have been transferred to Kalkulo.

With staffing of 11 permanent scientific researchers, 13 PhD students and 6 postdoctoral researchers, the group is very healthy. About 90% of the staff members are funded by external projects, with a dominating source being the Norwegian Center of Excellence – Center for Biomedical Computing. As this is close to its planned 10-year duration, the Evaluation Committee raised concerns about the sustainability of the scope of the activities in the Department, but was reassured that several alternative sources of funding have been secured, including the award of a prestigious European Research Starting Grant to Dr. Marie Rognes. The strong international funding record is a dramatic and much appreciated improvement from the last evaluation and offers a clear testament to the quality of the ongoing research activities.

The Department also plays a central role in the Center for Cardiological Innovation which is a national center for research-based innovation (CRI), comprising a strong and productive collaboration with the Oslo University Hospital. Some of the efforts are moving closer to clinical trials of various technologies and they offer a promise for technology transfer in the near future.

Overall, the Evaluation Committee was very impressed by the breath and level of the activities in a Department. It is clear that there is substantial potential for growth and that the department is led by a young group of highly talented researchers with great potential to ensure the continued success of the Department at the highest level.

2.1.1 Scientific productivity and quality

Scientific Computing is organized into three main departments, focusing on biomedical modelling, cardiac modelling, and high performance computing, respectively. Cross cutting these three departments, these are general themes of numerical methods, modelling with an emphasis physiological problems and processes, software development, and high performance computing. Initial activities in data science have been launched and are likely to expand further, as outlined in the strategic plan.

The department has a long tradition of developing high quality software and this continues with the development of FEinCS which is enjoying a rapidly growing user community worldwide. Many of the modelling and computing activities within the department are centred around the use of this software, enabling easy transition between groups.

There continues to be the development of novel computational techniques in the department, focused on biomedical applications and fluid-structure applications. However, when compared to past activities, there appears to be a shift toward research that is closer to applications and of a less theoretical nature. This is the result of a deliberate decision and does not present a problem. A clear result, and one requested by the previous evaluation committee, is a stronger focus on publications in medical journals and a closer collaboration with medical professionals. This is commendable and offers the promise for an increase in the impact of the research activities in the application domains.

Research in high performance computing focuses on the development of programming environments on complex heterogeneous computing platforms and cloud based computing. While connected to various applications, the majority of these activities focus on system level

tools that subsequently can be adopted by the applied research groups and beyond Simula Research Laboratory.

All three departments are performing very well, measured in terms of publications, visibility, and external funding. While it appears that the research activities enjoy lower citation rates than what is found in some other departments, this can most likely be attributed to discipline specific differences and traditions. The department continues to publish in leading journals with a high level of activity.

Given the strong focus on biomedical problems, a stronger element of uncertainty quantification and model evaluation would strengthen some of the activities. During the discussions with the Evaluation Committee it became clear that such activities are indeed planned for the near future.

2.1.2 Relevance and impact of research activities

The strong focus on biomedical and neurobiological applications is clearly both timely and of great importance. Furthermore, advances have the potential for substantial impact. The impact, as measured through publications, open source software, and externally funded activities, is very substantial and increasing. All departments also enjoy high international visibility and an extensive network of collaborators from leading institutions worldwide.

It is also noteworthy that the departments have put an increased focus on publication in medical journals and collaborations with medical professionals as this indicates an increased impact in these application domains and helps to position Simula Research Laboratory as a leader in biomedical and neurobiological computing.

2.1.3 Alignment with research domains identified by EU

Health and the management of healthcare costs are clearly a core element in the research strategies of the EU and the department is very well positioned to develop new diagnostic tools for selected applications within this domain. The strong focus on biomedical and neurobiological applications is expected to offer numerous future opportunities for collaborations and funding in EU. In fact, there is already clear evidence of this through the participation in EU projects and the recently awarded ERC grant.

Furthermore, the development of flexible and user-friendly tools that enable the use of complex computing platforms by a broader user population is an essential enabler for future research and innovation and is an area that is already funded extensively by EU. It is to be expected that this will continue.

The planned addition of substantial activities in Data Science ties into a worldwide emphasis on this key technology and the numerous national initiatives across Europe will surely continue to enjoy increased attention and funding from the EU.

2.1.4 Perspectives on research plans and strategy

The research plans and strategy are based on a continuation and some expansion of the majority of the current activities, as well as some substantial additions.

The strong emphasis on biomedical and neurobiological computing will continue as is only natural, given the resources already invested in this area and the successes that have been achieved. Several projects have been developed and recently initiated and will expand on current activities. Expansion into fluid-structure applications appears also to be planned. Many of these activities will seek an increased direct collaboration with domain specialists

and medical professionals to shorten the path to practical applications, clinical trials and transfer of the technology to market.

Plans to expand into the modelling of cancer are also quite advanced and would introduce a new dimension with substantial potential for impact. It is, however, unclear if the department has the resources to build this activity to a level that is competitive on an international scale.

An emphasis on the development of tools for exa-scale computing and large scale data access is likewise natural and in the national interest of Norway as these are essential enabling technologies for research and development within 5-8 years.

A major new initiative on Data Science and data centric techniques has been initiated and is both timely and with substantial potential. While many such efforts exist across Norway, it is a stated goal to focus on methods and their analysis and less on the direct application of known techniques to new problems. This is commendable as it aligns well with the vision of Simula Research Laboratory being driven by fundamental research but it is also a very ambitious goal in a domain of research that moves at an extraordinarily rapid pace.

For this effort to be successful, it will likely have to grow quite substantially. Unfortunately, the hiring of highly qualified researchers in this domain is very difficult due to the numerous attractive opportunities in industry and leading research centres worldwide. The Evaluation Committee questions whether Simula Research Laboratory can expect to be competitive at an international level in Data Science without very substantial additional support, perhaps even at a national level if it is identified as an effort of strategic national interest. It is suggested that this question be revisited on a regular basis, perhaps as part of a broader national conversation about initiatives in Data Science.

2.1.5 Educational activities

The department continues to have a healthy production of PhDs and mentors a substantial number of postdoctoral researchers. The international element of the education, with degrees being awarded not only from Norwegian institutions but also from a number of European institutions, clearly emphasizes the value and strength of the education activities in department.

However, as the department deliberately chooses a path of more applied research, one expects a need for a growing population of PhD students, which may present a challenge. The Evaluation Committee cautions against attempting to grow the number of students by focusing on short term projects, as this has the potential to reduce the time available to conduct research with a longer time-scale.

The department plays an active role in several educational activities, workshops etc and this should certainly continue. The newly established activity in Data Science offers very substantial opportunities for the development of activities, ranging from professional education to advanced research workshops, with an emphasis on tools and/or methods. The Evaluation Committee expects these activities to grow and encourages an ongoing dialog with SSRI on how to best implement such activities across the entire educational pipeline.

2.1.6 Innovation

The research activities within the Center for Cardiological Innovation are conducted research in close collaboration with Oslo University Hospital and some of the technologies that have been developed are close to entering clinical trials. A particular product focusing on patient specific treatment of heart failure is promising and is expected to be pushed to the market shortly, following the completion of clinical trials.

Other activities in the Department are focused on more fundamental research and/or the development of tools/software that are offered as open source products. There are several models to raise revenue based on such activities but that does not appear to be being considered at present.

2.1.7 Organization and management

In response to the 2009 evaluation of Simula Research Laboratory, the department has been reorganized into three smaller departments, each with clearly defined responsibilities for the research and administrative leadership. Each of these are now of a realistic size and promise to work in ways similar to the successful model of Max Planck directors. This is overall an excellent development and ensures that the department leaders can remain research active.

Each of the three departments are led by highly talented researchers with great potential to ensure the continued success of the Department at the highest level. The success of these leaders has already been demonstrated by their track record of securing externally funded activities and there is no reason to expect that this will change.

2.2 Software Engineering

2.2.1 Scientific productivity and quality

The research activities of Software Engineering concentrate on the development of innovative and effective solutions to a set of selected problems in software engineering, aiming at increasing software quality, while reducing development and maintenance effort.

Even though this department was created at the inception of Simula Research Laboratory, the research topics are evolving slightly to adapt to more recent problems related to software engineering. The current research is diverse, with a strong applied component, due to the very nature of the topics addressed.

The department covers a wide range of research topics related to software engineering, comprising four main areas/groups:

- Software verification and validation, in the framework of Certus
- Evolving software systems
- Model-driven engineering
- Expert judgment and effort estimation

The above research topics are, at the same time, complementary, strategic, relevant, and useful for the software engineering community.

The overall quality of research in Software Engineering is excellent. Also, it is excellent for each of the departments within Software Engineering.

Software Engineering has an important number of publications in high-level journals and conferences as well as in more practical venues, which is not surprising given the applied nature of the research. The overall publication record is very good, and there is a balanced mix between publications in journals and in selected and selective conferences.

The four research areas investigated by the Software Engineering complement each other and address in combination an interesting set of real problems. The resulting solutions are useful to the software engineering community involved in developing, testing, and maintaining high-quality software.

It is also worth mentioning that the interaction between empirical work and conceptual approaches is well balanced. Most of the work carried out, although based on empirical data,

go further and provide more general practical recommendations. This results in the significant impact of the published results on the software engineering community.

The department is encouraged to ensure that this mix between empirical and conceptual work is maintained and that its connection with industry remains active, while also maintaining its interaction with the academic world. In this process, Certus or an equivalent is an added value.

2.2.2 Relevance and impact of research activities

Software Engineering has a good number of collaborations with industrial partners as well as academic institutions and universities, both at national and international levels, in the framework of Certus, within European projects, as well as in the form of bilateral collaborations.

The strong publication activity gives an outstanding international visibility to the department. The publications of the departments are well cited by colleagues, showing the impact of the work carried out by its various members.

2.2.3 Alignment with research domains identified by EU

During the evaluation period, the department has been involved in two European projects, and has been the Project Technical Coordinator for both. The first project was an Integrated Project and the more recent one (U-Test) is in the category “Research & Innovation Action”.

The U-Test project aims to develop new methods to test Cyber Physical Systems under uncertainty. Uncertainty is intrinsic in Cyber-Physical Systems, and it is a fundamental problem to tackle.

2.2.4 Perspectives on research plans and strategy

The strategy and research plans are in line with the current research topics. They mainly concern immediate and near future research objectives. Long-term research objectives and expected developments are not addressed.

Certus; The centre received the top score of excellence at its mid-term evaluation in 2015. The partners are currently working on a strong exit strategy. One possibility is for this initiative to be transformed into The Certus Testing laboratories. The Evaluation Committee is confident that the partners will reach an agreement to take advantage of the acquired experience and associated success to give an impetus to a successor for Certus.

The work on **Evolving software systems** aims to define strategies for efficiently and accurately managing the evolving code of legacy software systems. Emphasis is put on preserving software quality despite the numerous evolutions over long periods of time. The research activities are being carried out in the framework of two successive projects. This topic is of strong interest to industry that is seeking well-defined correction and maintenance strategies.

Work on **Model-driven engineering** relies on models and research-based methods to solve complex problems in software engineering. Cyber-Physical Systems (CPSs) are of primary concern, in particular for i) testing of CPSs operating in uncertain environment and ii) improving the efficiency of configuring large-scale CPS product-lines. The group is also considering uncertainty, a reality that has to be accounted for seriously, in the framework of testing security.

Work on **Expert judgment and effort estimation** addresses i) the management of software projects and ii) human judgment and decision-making. It complements the work of the three

other groups by introducing the notion of expert judgment in an original way. The topic is very interesting, even though less technical. The group is very successful with more than one hundred invited presentations, in addition to a large number of publications.

2.2.5 Educational activities

The number of PhD students (current and graduated) is reasonable and Software Engineering is quite successful from an educational point of view. However, considering the number of permanent staff, the ratio (PhD students/permanent members) could be increased to reach an average of 1/1.

2.2.6 Innovation

Innovation activities benefits substantially from the **Certus Center**, which is a national Centre for Research-based Innovation (CRI).

The Certus consortium includes several partners from industry and the public sector. Topics of interest are related to software verification and validation. The main challenges concern the development and implementation of efficient and cost-effective testing strategies, with a limited budget and within a short testing time. Four categories of systems, of interest to the various partners, are under consideration: highly configurable systems, data-intensive systems, real-time embedded systems, and evolving systems. The partners provide representative examples and real applications as case studies to perform experimental testing approaches and to test the tools that are being developed.

Certus seems to be a success: it has a substantial scientific production and international visibility. It has developed several tools, some of which are being considered for commercialization.

2.2.7 Organization and management

The composition of the Software Engineering department is well balanced. The department comprises 7 permanent researchers and 5 adjunct researches, 8 PhD students and 7 post-doctoral fellows and research engineers.

The department is organized in four areas/groups, each of which corresponds to a research theme, and each group has its own leader, with a close collaboration between the department's leader and the Certus center leader. Each group is organized into projects. The Evaluation Committee assumes that the average number of permanent staff in a group is between 2 and 4 and is left with a question of whether the double decomposition into groups and projects is needed. On the other hand, the Evaluation Committee acknowledges that the current results are good and do not seem to be impacted by this double structure.

2.3 Communication Systems

The research section of Communication Systems comprises three research departments at Simula in Oslo and an organizationally separate joint venture with the Universitet i Bergen co-located with the latter: *Simula@UiB*. The three departments are: *Networks* with a focus on fixed and mobile Internet measurements for access networks as well as infrastructure; *Media* with a focus on end-to-end application performance, and *Cloud* with a focus data center infrastructure and high-performance computing (HPC). *Simula@UiB* focuses on secure systems and cryptography. Beyond these units, Communication Systems has recently become involved in two Norwegian centers: resilient networks and applications (established in 2014 and run by Simula) and the fairly general research-based innovation on cloud computing and HPC (started in 2015 with Simula as a partner). The latter two are not subject to this

evaluation and merely mentioned to emphasize the recognition the section receives from its national stakeholders. The Evaluation Committee thinks that the resilient networks center has profound potential for long-term data collection and ambitious research but, at the same time, given the description provided, bears the risk of a primary focus as a “service function” towards the government and the public, which wouldn’t be a good use of researcher and PhD student time in an institute like Simula. The Evaluation Committee therefore advises that Simula seeks to carefully and continuously balance between service and research to fully exploit the clearly available potential.

Overall, the Communication Systems research section is rated excellent, however there are some differences between the departments. The scientific output is excellent, the research section is well connected internationally, well linked to (local) industry, drives innovation from research to market via startups and longer partnerships, has a solid funding base with an exciting project portfolio and challenging research questions, and is agile in its exploration of novel directions within their research themes.

2.3.1 Scientific productivity and quality

The department has developed an impressive project portfolio both in terms of the number of projects and particularly in terms of scientific directions and their (potential and already observable) impact. The latter is well observed in the scientific output and in the influence this output and its recognition have on industry (in terms of spin-offs and standards contributions) as well as on society (in terms of government committees and mobile broadband provisioning inside Norway), which is covered in more detail below.

The scientific output has been very good both in terms of quantity and quality (the latter of which is more important), with many of the 400+ publications in renowned international (IEEE) journals and especially premiere ACM and IEEE conferences, which are considered to be more important as publication venues for the section of Communication Systems than are journals. Numerous publications have already received more than 100 citations or are approaching this number. The department is encouraged to continue this strong level of engagement, with the suggestion to put even more emphasis on the top tier venues.

The excellent quality of scientific work in this department has also been recognized by numerous awards, including for best papers, and particularly with Prof. Yan Zhang becoming an IET fellow very early in his career.

The Media department is a vibrant group with a great track record and an excellent research path ahead. Their research portfolio has continuously evolved in a seemingly natural way, taking up new research challenges that (may) have become apparent from their previous work. These new challenges are partly interdisciplinary in nature and off the well-trodden path, providing the team with unique opportunities to impact the field. This is probably the group for which the vision for their line of research has been clearest over time. They have evolved multimedia communication and systems across the media chain - embracing the path to the end user and moving on to closely related media delivery, processing and applications, for sports, for entertainment, and for healthcare. This coverage is well reflected in projects such as RITE and NEAT for the network and transport layer all the way to POPART for movie production focusing on previsualization and Third Life for supporting the interaction of the physical and the virtual worlds. Projects such as EONS highlight further expertise in multimedia processing and developing the necessary infrastructure. The Committee’s simple recommendation is that this group should continue to thrive and keep uncovering and developing exciting new areas.

The Networks department has taken up key challenges of today's communication systems: mobile access and network measurements, green communications, and resilient networks. Even though many groups are working on measurements, with NorNet and MONROE and the sustained funding offered by the ministry, the team is able to continue building and to sustain a very valuable measurement infrastructure of its own. This tool enables the group to provide valuable services to the public but also to conduct excellent research. Resilient communication is another core topic of growing importance and is increasingly a core element of research, development, and operations as our society's dependency on networked systems grows further. The department has identified relevant research challenges, well rooted in understanding the status quo of e.g., the Norwegian infrastructure, and is also here on an excellent trajectory for impactful results. The excellent performance is recognized by the formation of the Centre for Resilient Networks and Applications (CRNA). The department also tackles the smart grid, which is a clearly relevant (but possibly somewhat hyped) topic at present. The group produces excellent results, but should seek the add value in conjunction with its other activities to differentiate their work from the competition. Within this department, the different projects and teams do have less of a common denominator, and the department should seek further to strengthen collaboration, not for the sake of internal organization but rather because this may lead to even more compelling results.

The Cloud department was perceived to be the most industry-driven group - dominated by applied research with an impressive set of joint patents and patent applications as a notable outcome. With projects such as ERAC and NumaMultiConnect, the department focuses on cloud infrastructure at the data center and the machine level, respectively, developing flexible structures for high-performance computing. MELODIC (a project emphasized in the review meeting presentation) appears to be not very novel or promising in practice in its research questions and goals. While the research is indeed relevant, the department's focus seems to be on industry collaboration and technology transfer, which may explain why scientific output is not necessarily being kept at the forefront; at least no indications were given on the department's individual performance in this respect. The Evaluation Committee also observe that, compared to the other two departments, the Cloud description is rather generic and vague in nature. However, the department is solidly grounded and should be able take this very good base to develop strong research perspectives beyond immediate industry needs and beyond contracted research as a main source of income. The SIRIUS center is an excellent opportunity to this end, but this research group needs to take an active lead in crisply identifying and pursuing their own distinct research questions as the other two groups have done.

2.3.2 Relevance and impact of research activities

As noted above, Simula Communication Systems achieved two additional types of recognition. Firstly, the section has been very successful in contributing to IETF standardization work, in particular in the L4S working group jointly with their collaborators from industry. Given the dominance of industry in standardization and the importance of involvement from scientific institutions (whose accomplishments in standardization work are often not recognized in academia), we strongly encourage Simula to continue their contributions and extend these efforts further. While the present contributions appear to mainly originate from the Media department, the Networks department has equal potential to support the vast measurement activities within the IETF and other relevant bodies – interactions with (national) regulators have already begun and should be strengthened, while keeping in mind the scientific angle of the work. Also, the Cloud group, with its close ties to

industry, should be in a good position to continue to make contributions to the respective organizations.

Secondly, the section has been able to position themselves to be able to influence policy and the national debate on diverse matters in communications. This includes heading committees on digital vulnerabilities and on lawful intercept. In addition, Prof. Lysne has taken a lead on mobile Internet measurements of national infrastructure and especially coverage for trains. The section has also achieved an outstanding record of public talks and radio/television appearances, an excellent way of informing and guiding the broader public. This effort is an important follow-up to excellent scientific results, and enables society at large to benefit and learn directly from the more abstract and independent scientific findings of Simula. The Evaluation Committee clearly recommends that Simula continue these highly appreciated and crucially important efforts.

Cooperation

Impact and relevance of the research an entity produces becomes manifest in its capabilities to establish national and international cooperation with leading partners in the respective fields. The Communication Systems section has developed an excellent record in international cooperation and followed up extremely well on the recommendations of the previous evaluation. In a relatively short period of time, they have participated in numerous EC FP7 and now H2020 projects, with seven H2020 projects now running of which Simula is coordinating four. This yields an excellent alignment with the respectively relevant H2020 programs and provides a great basis for acquiring more such projects in the future.

The department has established, partly via those projects, partly via informal collaboration, an impressive network of partners they work and publish with. The list of collaborators is long and impressive, with well-targeted long-standing partnerships beyond Europe, e.g., CAIDA and GeorgiaTech. The internationalization particularly becomes manifest in four out of five papers being co-authored with non-Norwegian partners. One effort instrumental to this internationalization has been hiring well-connected senior researchers from France (academia) and the UK (industry) – and we note that the mix of Simula staff reflects this international ambition very well (see below). The Evaluation Committee note that a detailed differentiation into the different departments is not possible as the material mostly reports on aggregates: more fine-grained reporting and also some more insights into the nature of the partnerships would be desirable for future reviews.

In short, Simula Communication Systems should continue in its current direction in the excellent development of international partnerships. The only recommendation of the Evaluation Committee in this area is that staff should ensure that international relationships are well maintained by the institution and that responsibility for maintaining these relationships is shared by multiple staff members to minimize dependencies on individuals. It is appreciated that collaboration depends on individual ties to researchers in other institutions, but the department should ensure that a broad basis is established for future collaboration, e.g., by means of a vivid exchange program. One further important element to growing and maintaining an international network is making sure that PhD students, after completing their degree at Simula take jobs abroad. This should be complemented by extended research visits and sabbaticals abroad, for which the necessary network is already in place.

At the national level, Communication Systems cooperates closely with the University of Oslo (UiO) by means of individuals who share both affiliations, via teaching and MSc/PhD student education, and within joint research projects with numerous research groups at UiO. This successful setting has recently been extended to the University of Bergen (UiB) and

institutionalized as Simula@UiB. The setup is very promising; the only challenge will be maintaining close ties in spite of the geographic distance. While Simula@UiB is an independent institution, the Evaluation Committee recommends that there is a goal to create a continuous flow of student and staff exchanges and regular joint workshop or similar activities to foster a common spirit.

The section is also involved in a number of national centers in which it cooperates with other universities as well as with industry. Simula at large and also this section has a very good scientific standing and is thus well-positioned to extend cooperation even further with other Norwegian partners – academic, commercial, governmental. Communication Systems is already benefiting from their excellent standing, for example, through their leadership on governmental committees and producing mobile network performance reports.

2.3.3 Alignment with research domains identified by EU

As noted earlier, the Communication Systems section has developed an excellent record in international cooperation and followed up extremely well on the recommendations of the previous evaluation. They are involved in numerous EC FP7 and now H2020 projects which yields an excellent alignment with the respectively relevant H2020 programs and provides a great basis for acquiring more such projects in the future. And, it clearly shows a strong alignment with the research domains identified by the EU.

We note that the EU focus, while being driven by longer terms goals set forth in framework programs such as Horizon 2020, those programs do see notable evolution and diversity, especially in the focus of the individual calls. While a basic alignment with the goals is feasible and important, it is equally important to maintain long-term research directions to build up solid competences, independent of the call diversity. The Communication Systems section has clearly been successful in striking a balance and maintaining alignment as far as possible between the contrasting goals of acquiring EU funding and setting and following their own strategic directions.

2.3.4 Perspectives on research plans and strategy

The Communication Systems section had identified a number of forward looking directions in the present report – which unfortunately did not lead to an update of the overall strategy document. As noted already, these research directions are generally well-chosen and have a high potential for cutting edge research, especially as the different departments have proven track records in these fields. Specifically, the plan points out five research areas, largely aligned with the research directions and ambitions noted for the individual departments, below are brief comments on each area:

- Observability and controllability of the fragility of complex infrastructure: this direction is a natural continuation of the excellent measurement infrastructure built up so far to maintain and both extends this work as well as increases its value. The work is paired with theoretical foundations. This is a highly promising direction with excellent opportunities for outstanding research additional international cooperation.
- Anti-fragile systems: this research area may be very interesting, hinting at security in cyberphysical and complex systems, and is being developed in cooperation with Simula@UiB. While in principle a very interesting direction, the concept of “self-healing” and analogies to the human body have been pursued in many bio-inspired networking projects funded by the EC over the past 10–15 years, but there appears to be limited coordination and reference to these efforts. While the EC funded efforts have not provided all the answers to these research questions, this activity should be aware of and show that it knowingly builds upon or disregards this work.

- End-to-end performance, reliability, and predictability: This research strand identifies one of the key research directions for networked systems in the future and is thus exactly right, the applications are clearly demanding and very ambitious. The Evaluation Committee has two simple recommendations in this context: the work should go beyond TCP (multipath TCP is already mentioned, but we see a wealth of new activities related to transport protocols and network nodes and their interactions. Moreover, as the lines between the edges and the core of the network are blurring, the Evaluation Committee recommends including security and integrity questions, that deserve consideration in this context.
- Green and robust networks and systems: This strategic element requires more depth in direction setting. At this point, the statements are all rather vague and the vision is hard to distinguish from the wealth of past research, e.g., on energy efficiency for mobile devices and network support for such. The directions are fine but the Evaluation Committee recommends strengthening the vision so that concrete actions can be derived.
- Holistic and adaptive resource management in enterprise (cloud) data centers: As with the previous area, this direction is relevant but the plans are very vague and fairly generic. For example, in the real world, one can observe data centers with generic platforms for mixed workloads and also highly specialized platforms for dedicated tasks. Should Simula take a leadership position here? The Evaluation Committee recommends leveraging the close ties to industry to formulate specific challenges to address.

Beyond the above observations, the Evaluation Committee recommends that the interactions between these five research areas be made clear. Is the observability research component truly just focused on fragility and, if so, why is this a separate strategic direction? How are anti-fragile and robust systems related? Why are green and robust systems one research area when there are other aspects of robustness in other areas? Overall, the decomposition of strategic elements should be internally reviewed in order to more crisply identify what the independent research vectors are and how to best understand and present their interdependencies. This shouldn't be overestimated as an action item towards an external deliverable, but primarily seen as a motivation to ensure proper understanding of the intersections and alignments of these areas to maximize the value of the research.

Overall, the strategic directions are strong but they deserve further attention to ensure that the necessary long-term guidance for the research departments and teams is provided. The Evaluation Committee felt that there is evidence of significant progress compared to the previous evaluation (which criticized the complete lack of a strategy), but there is still room for improvement in formulating explicit directions and goals, especially concerning the interaction between the numerous technical fields within this growing area.

The Evaluation Committee would like to note that there is a need for risk mitigation: as a substantial amount of the scientific output is generated by a fairly small number of people, several of which are only in adjunct or part-time positions. Even one of the department leaders, Prof. Yan Zhang, only has a part-time affiliation with Simula. While all of these researchers deliver excellent performance (and Prof. Zhang in particular), the question does arise from an organizational perspective as to how a lasting commitment to Simula can be secured.

Finally, Simula is pursuing strategic alliances through centers (e.g., CRNA) and co-operations (e.g., Simula@ UiB). The reports by Simula do not provide extensive detail on CRNA and Simula@UiB as those units are to be assessed separately, yet it appears sensible to assess

their (strategic) relevance for Simula. In summary, both centers are clear success stories and perfectly complement the Communication Systems section.

The Center for Resilient Networks and Applications (CRNA) has evolved from a very successful multi-year measurement project. This center forms a valuable basis for building sustainable measurement infrastructure and carrying out strategic research. It is an excellent complement to the other measurement activities within the Networks department and the Evaluation Committee encourages Simula to seek out the synergistic opportunities arising from this constellation. The center bears, in principle, great potential for conducting scientific research and care should be taken to ensure that this center truly leverages this potential and does not confine itself to merely offering a service function for the government.

The inception of Simula@UiB substantially enhances the core expertise of Simula in the direction of systems security and cryptography. This has been another excellent strategic move, with the side effect of geographic diversification. However, there is an inherent risk that the main Simula and Simula@UiB, both being their own legal entities, divert from each other in their activities. Independence is valued and so is a plurality of activities, but Simula must seek to ensure close cooperation across all levels, e.g., by means of exchanges, joint projects, strategic workshops, etc. The limited alignment of the first two strategy elements addressed in the previous section (observations on fragility and anti-fragile systems) may be an indicator of a need for closer cooperation. Simula has already taken one useful step into this direction with the appointment of Aslak Tveito as the chair of the board; however, he is not closely involved in communication systems and a stronger focus on the operational level is advised.

2.3.5 Educational activities

The Communication Systems section has an excellent track record in teaching and education. With two bachelor and four master level courses, the section makes a solid contribution to student education, spread well across all the departments. The focus on teaching systems work and experimentation, which is also key to training students for their master's theses at Simula, is very important. Here, the section offers positions to students for one year, which is a great mechanism to identify qualified students for subsequent PhD studies. Communication systems has also been successful in this regard. The section graduated 21 PhD students between 2009 and 2015, an average of three per year, which is a good number for a research institute. Currently, 17 PhD students are active so that the section should be able to maintain this number of graduates per year.

There is a meta aspect potentially related to education, but also to hiring policies. It appears that the most successful researchers at Simula are the ones hired from abroad (directly or indirectly via UiO or another university). It is worthwhile understanding where this discrepancy between locally educated students and foreign researchers comes from. The reasons may be simple: Locally educated post-docs may still be too fresh after completing their degree to make an impact. Or the outstanding candidates seek their fortune in other careers, in one of the many Simula startups, in industry, or as a mainline academic so that they leave. Or there may be room for improvement on the education side or in the hiring policy. But understanding not just where people go but also critically reviewing how the local graduates evolve and how to support them to excel should be high on the list of things to monitor.

2.3.6 Innovation

The Communication Systems research section has achieved outstanding performance in terms of spin-off companies. Between 2009 and 2015, four spin-off companies were created,

Celerway, Fabriscale, LABO, and Forzasys, which are all in business at a combined annual revenue of 30 MNOK and employ some 20 staff. The technologies of, e.g., Celerway and Fabriscale, into which the Evaluation Committee received further insight, are excellent examples for taking forward-looking research results and transforming those into commercial products and services. These results are very promising and the leadership and innovation support at Simula have shown very good judgement on which activities to commercialize. The Evaluation Committee hope that these results will be continued.

Beyond spinoffs, the section has also worked closely with industry, one prominent example being a long-standing cooperation with Oracle (including project funding from the latter). Industry-funded collaborations exist with five further companies, but no details on the substance or longevity of these relationships were given. The section also works with a long list of further companies but the nature of these interactions isn't clear; the Evaluation Committee would have found more detail to be useful. It appears that Oracle is the dominant industry partner here from a funding perspective; therefore, it is recommended to seek some more diversification in income sources and avoid dependencies on individual "customers". The Evaluation Committee encourages Communication Systems to continue and extend their direct industry cooperation, but ensure that their focus on leading research is maintained.

2.3.7 Organization and management

The Communication Systems section is organized into three departments, Networks, Media, and Cloud, as extensively discussed above. A fourth department is de-facto Simula@UiB. All four departments complement each other well, i.e., the operational structure and thematic division are adequate. The structure currently works well and should be kept to help orchestrate both strategic visions and ongoing operations to avoid too large a leadership span. Note that this is not meant to encourage hierarchies – it is appreciated that Simula is practically a flat organization – but shall merely be understood to ensure responsibilities beyond daily research and project work.

This department structure was apparently introduced after the previous assessment, prior to which a project-based organization dominated within the section. The Evaluation Committee was surprised to see that this should now be abandoned again in favor of the project-based organization that was pursued before. Even more so since there has been some of lack of coordination (and the addition of Simula@UiB won't simplify this task). The Evaluation Committee recommends that the leadership within the Communication Systems section reconsiders this structural change because their departments are sufficiently distinct to warrant a degree of separation. The Evaluation Committee do not see department "walls" as an issue in an environment that is – rightly so – in its daily practices flat and open. Simula has the opportunity to combine the best of both worlds – structure and flat interactions – and they should do with creativity in their organization and processes.

The scientific leadership of the Communication System section was taken over by Prof. Olof Lysne in 2014. He is an experienced senior researcher with an excellent network of connections, including into politics, which supports the important mission of societal impact extremely well. His appointment to lead two national committees is clear evidence of this. The section clearly flourishes and produces excellent results in pretty much all respects. This success is also ascertained by the four department heads, who run the Networks, Media, and Cloud departments and Simula@UiB. The three Simula department heads are roughly of the same age and appropriate for the position. While two have notable experience after their PhDs (and one being an outstanding scientist), the head of the Cloud department appears fairly junior in terms of scientific and leadership experience (PhD in 2014) and will require support and coaching to deliver to the expectations of this position.

Over the past years, just by reviewing the CVs, the leadership within this section appears to have undergone repeated changes, and the present section head as well as the department heads have not been in the office for long. Unlike in universities, where a department head is often a position that comes primarily with lots of extra administrative burden and is therefore often shunned by professors, a department head at Simula is a position that brings long-term opportunities to influence the directions of the department and the research culture, among others. Therefore, department heads should have appointments that last sufficiently long for them to develop and implement their visions (and be assessed in terms of their success). This will also ensure continuity within the section and the departments.

Related to the previous issue arises another consideration of the responsibilities of a department head: it is not obvious that it is practical to have a part-time person in such a position, even if he is an outstanding research and extremely capable person. For Simula as an institution, there is a risk that the primary occupation of such a leader may (rightfully) take up that much time that he may not be able to continue on this ambitious adjunct position. The Evaluation Committee recommends that Simula seeks a solution that ensures continuity in this important function.

The Evaluation Committee considers that there is room for improvement in the leadership of the Advisory Board. It is not known when the SAB reports were written as dates are missing and thus the relationship to recent and present work is unclear. But it is noticeable that the report on the cloud department emphasizes the relevance InfiniBand and routing, which aren't featured in the present report. It appears that only one of the SAB members has interacted with the Communication Systems section face-to-face and the Evaluation Committee felt that with the exception of the comments on Networks the review contained only fairly generic statements. Overall, Simula should reconsider how many advisory board members are needed, what their responsibilities actually are, and then choose senior persons with sufficient commitment to the appointment.

Employee structure

The Communication Systems section exhibits a very good mix of employees with 10 researchers, 10 post-docs, and 17 PhD students. While the numbers will change, the respective orders of magnitude yield a very good ratio for advising the younger scientists and help them successfully advance in their careers. While MSc student numbers aren't listed, given the number of completed MScs (a factor of 4.5 to PhDs), this ratio is expected to extend equally well to the MSc students. Four adjunct positions, a group of about the right size connects Simula well to the university. Numerous researchers run national and international projects, gaining experience in acquiring and managing research projects.

The Communication Systems section has a very good track record in hiring international staff, which has led to a diverse composition of talented researchers across all levels. The Evaluation Committee particularly applauds the hiring of two excellent researchers from abroad, Prof. Ros and Dr. Briscoe – it seems the third one alluded to in the review meeting hasn't materialized. The Evaluation Committee appreciates this effort to reach out abroad and accommodate arrangements for remote work, accompanied by the practice of having remote employees come physically into Simula for one week per month. This is important to create and maintain a group feeling and foster longer term commitments. However, the Evaluation Committee strongly encourages limiting such special arrangements to a very small number as the main expertise and experience should reside and grow truly inside Simula. Along the same lines, the Evaluation Committee would like to emphasize that hiring great researchers should be accompanied by growing local talent.

Simula is exploring further ways to attract senior talent and has been considering the position a “research professor” to this end. The Evaluation Committee was not convinced that assigning titles outside the appropriate institutions and processes and without the appropriate responsibilities is appropriate nor will it necessarily attract the right people. The Evaluation Committee is therefore not convinced that the creation of “research professor” position should be pursued further.

3. Evaluation of education in the framework of SSRI

The majority of educational activities in Simula Research Laboratory are organized and driven through the Simula School of Research and Innovation (SSRI), which was founded as part of Simula Research Laboratory. During the last decade, this part of Simula Research Laboratory has grown in size and diversity of activities, and this has been a substantial success.

3.1 Overall assessment

Simula Research Laboratory has produced close to 100 PhD students over its lifetime and currently has 33 PhD students among its research staff. The success rate of PhD students is high (86%), which is among the highest in Norway. It also hosts a substantial number of MSc students and organizes support for postdoctoral researchers. The thorough attention to diversity in all activities is commendable. It is clear that Simula School of Research and Innovation is a key element of Simula Research Laboratory and has diligently built a variety of activities with success.

In past evaluations, it has been suggested that the number of PhD students could grow with as much as 50% from the current state, yet this has still to be achieved. However, it seems this remains a clear goal and one which the Evaluation Committee supports.

Since the last evaluation, a partnership with University of California, San Diego (US) has been developed and it is clear that this is a substantial success when measured in terms of both education and research. There is also a partnership with Beihang University (China) which appears to be a success. These two partnerships are founded upon joint research activities and shared contributions to the cost of the programs. The Evaluation Committee applauds the success of these developments and encourages Simula School of Research and Innovation to continue such initiatives.

However, it is essential that such future developments be based on core research interests and additionally have the potential to develop genuine ties through research and education. The Evaluation Committee has concerns about the pursuit of a partnership with TU Berlin (Germany) as there appears to be no common research activities, nor existing collaborations. Indeed, it appears as if Simula Research Laboratory has sought out TU Berlin as a potential partner, not because of the common research interests, but primarily because of funding opportunities in Norway. This is not the right approach for the development of successful partnerships and the Evaluation Committee recommends that Simula Research Laboratory leadership carefully revisit the decision to pursue this partnership.

Simula School of Research and Innovation has developed a robust program of summer schools and intensive courses in emerging areas of interest and the Evaluation Committee supports this and encourages some growth. The agility and flexibility of Simula Research Laboratory makes these programs an excellent vehicle increasing the national and international footprint of Simula Research Laboratory and these opportunities should be taken advantage of.

As successful as the internal training of PhD students and postdoctoral researchers is, it should not lead to a general trend of hiring PhD students and postdoctoral researchers into permanent positions at the end of their contract. At present, it is reported that about 1/3 of such researchers are hired in permanent positions. The Evaluation Committee is concerned about this trend as it increases the risk of the creation of local pockets of research activities with limited external input. It is a model that is strongly discouraged at research institutions worldwide and measures should be put in place at Simula Research Laboratory to limit this.

A better strategy would be to require PhD and postdoctoral researcher to leave Simula Research Laboratory for a period, e.g., 2 years, but maintain contact and establish an understanding that after this period, there may be opportunities at Simula Research Laboratory. Such strategies must naturally be flexible enough to allow for exceptional circumstances and for very limited extensions, e.g. for a maximum period of extension of six months.

3.2 Goals and strategy

It is clearly a main goal for SSRI to continue its expansion of educational activities, both in size and in diversity. As discussed above, this may well be reasonable for some activities, but less desirable for others. A guiding principle must be that new activities in research and research education are aligned with the basic principles of Simula Research Laboratory, be based on common research interests, and be of mutual benefit, beyond purely financial arrangements.

The Evaluation Committee is concerned two initiatives that they perceive do not follow these basic principles. The first, as discussed earlier, is the attempt to create a partnership with TU Berlin which appears as ill-conceived and is not based on existing research but seems to be motivated largely by financial considerations. The second is the proposed partnership with Oslo University College to create an Institute for Digital Engineering. This is an arrangement in which Simula Research Laboratory lends its name and reputation to help build a new research activity at OUC, implemented through a partial ownership, although OUC covers the very considerable cost of this development.

The Evaluation Committee sees this as an example of an activity which is driven purely by financial incentives for Simula Research Laboratory and offers no value to the institution's core mission. The Evaluation Committee does not find this arrangement to be in the interest of Simula Research Laboratory and perceives it as being a result of an overly aggressive desire to grow. Although it offers a short term financial benefit to Simula Research Laboratory, the long-term implications could be a dilution of the research mission of Simula Research Laboratory and slow drift toward activities of a consulting nature.

3.3 Professional development training

SSRI has developed a very successful program in presentation skills and other soft skills for students. This is commendable and should serve as a national model. Its implementation on a national scale could either be achieved by expanding participation at Simula Research Laboratory or by offering such courses as intensive guest courses, or by the use of technology.

Internally, SSRI has also developed a strong leadership training program, offered to its young researchers that are beginning to take responsibilities for groups and projects. For certain individuals, this is expanded to executive training at leading institutions. These activities are all both appropriate and necessary and should be continued and expanded as needed.

Professional development activities, aimed at training of professionals in emerging new research fields, is less developed at SSRI, yet offers an opportunity that could support Norwegian industry as it transitions to digital manufacturing. The expansion of the portfolio of short term courses to directly target professional development would not only increase the footprint of Simula Research Laboratory but could also provide a meaningful avenue for increased revenue. The Evaluation Committee suggests that this be considered as a target for future expansion within SSRI.

3.4 Outreach

SSRI has a number of outreach activities to local schools etc, based on the use of students with strong communication skills. This is a good model and the ongoing development and expansion of such activities should be continued.

4. Evaluation of innovation

4.1 Overall assessment

The members of the Evaluation Committee were very impressed by the work of Simula Innovations (SI) and the number of spin-off companies that have been created in the last five years. The staff within SI are dedicated and enthusiastic in their work and have achieved good results in their encouragement of the formation of spin-off companies. The Garage has been a successful experiment and should be continued as it provides many benefits to Simula Research Laboratory. The Evaluation Committee recommends that Simula Research Laboratory through Simula Innovations should expand the innovation functions undertaken to develop additional (and more traditional) technology transfer functions and also to expand corporate relations. The following sections detail a number of specific recommendations.

4.2 Competencies, organization and operation

The Evaluation Committee felt that the prime focus at Simula Innovations has been on the creation and support of spin-off companies and the management of The Garage. This approach has been very successful in the formation of start-ups over the last five years but it has meant that there has been very little undertaken in the area of traditional technology transfer. There appear to be few policies in place to manage patentable inventions or to

oversee the process by which researchers can release their software through open-source licenses. This is an area that Simula Research Laboratory and Simula Innovations management should consider developing further and the Evaluation Committee recommends that specific policies covering these areas are developed. Researchers should be able to open-source their work if they wish but there should be a policy covering the process and researchers should notify Simula Innovations when they open-source any of their software and which open-source licenses they are planning to use.

With these policies in place, Simula Innovations should be given a broader mandate to work on patenting technology as well as licensing all types of intellectual property (not just patents) to established companies.

Simula Research Laboratory has made great progress in the last five years in joining successful research consortia that include major corporations as partners. This means that Simula Research Laboratory now undertakes joint research with a much larger number of companies. As the number of collaborations has grown, Simula Research Laboratory has not developed any internal mechanisms to take additional advantage of these relationships, to develop relationships with other companies that may also be interested in these research activities, or to coordinate these relationships. Researchers are expected to develop their own connections to potential corporate partners but they are not supported or evaluated on this task.

These research partnerships could and should be further leveraged by Simula Research Laboratory into additional research projects and commercialization partnerships. The Review Committee recommends that there be a more dedicated top-down effort that ensures that all senior research staff are aware of their responsibility to maintain relationships with their current business collaborators as well as to support the development of new business relationships. The performance of this duty should be included in regular staff reviews.

4.3 Role of Kalkulo

Kalkulo is a 100% owned by Simula Research Laboratory and has a strong focus on undertaking applied research that is directly related to the basic research taking place within Simula Research Laboratory. Since the last review Kalkulo has increased the work undertaken for Statoil and Statkraft – taking over some of the applied research work that had been performed by Simula Research Laboratory. Kalkulo also has other clients in the oil and gas sector as well as in environmental modelling.

The Evaluation Committee felt that Kalkulo could be a very valuable business instrument for Simula Research Laboratory if it continues to expand its applied research work and becomes a dedicated applied research company for Simula Research Laboratory. This structure would be similar to the Stanford Research Institute at Stanford University or the Georgia Tech Research Institute at Georgia Tech. These organizations are an important interface between basic research and application specific development to deploy advances made in the parent institution in a commercial setting.

Kalkulo should be encouraged to more effectively connect and coordinate access to applied research and development projects based on basic research taking place within Simula Research Laboratory in more business areas than are currently covered. Such a structure would enable Simula Research Laboratory to benefit from commercial and consulting opportunities based on Simula Research Laboratory's basic research work without diluting the basic research nature of Simula Research Laboratory. This strategy will mean that

Kalkulo's management will need to look for additional business opportunities based on Simula Research Laboratory's basic research as well as developing additional projects with Simula Research Laboratory's existing commercial partners.

As Kalkulo has been paying a dividend annually to its parent Simula Research Laboratory and as it plays an important role in performing applied research based on Simula Research Laboratory's basic research output, the Evaluation Committee felt strongly that Kalkulo should continue to be held as a fully owned subsidiary of Simula Research Laboratory. Any sale of Kalkulo, while providing some immediate financial gain, would not be in the long-term interest of Simula.

4.4 Simula Garage and other Spin-off Companies

The Evaluation Committee was very impressed by the great increase in the number of spin-off companies that have been created by Simula Research Laboratory and in the establishment and management of Simula Garage (The Garage). The Garage serves several important functions – it is an entrepreneurial center within Simula Research Laboratory which helps Simula Research Laboratory researchers interact with the start-up business community; it supports spin-off companies coming out of Simula Research Laboratory as well as entrepreneurs that want to work with Simula Research Laboratory; and finally, it is a tie to the local economic development community helping the growth of regional businesses and supporting local emerging IT companies.

Simula Research Laboratory needs to ensure that it maintains robust criteria when selecting entrepreneurs that are given space in the Garage. Most importantly, these entrepreneurs need to show a very strong commitment to working with researchers at Simula Research Laboratory or an interest in commercializing research work undertaken at Simula Research Laboratory. Without this commitment to shared technology interests, the Garage will not add to the intellectual stimulation of Simula Research Laboratory researchers. The Evaluation Committee recommends that companies are accepted only for an initial six-month residence, after which they may be allowed to apply to remain for a further six months if they can show that they have had substantial interactions with researchers at Simula Research Laboratory.

The support provided to companies in The Garage is appropriate for the stage of development of the companies. It is also clear that the Simula Innovations staff is committed to the success of these companies and effective in assisting the founding entrepreneurs find the resources they need in order to grow their start-ups.

In the individual deals that have been entered into by Simula Innovations with spin-off companies there appears to be considerable variation in the equity being taken in the spin-offs. Simula Innovations may want to consider developing a set of standard terms for the initial agreement with a spin-off company that would set an equal base for all companies coming out of the lab. Any further investment by Simula Innovations in the company would then be subject to negotiation by the spin-off with Simula Innovations based on a company's progress, current valuation, and the amount of capital being invested. By approaching licensing and equity in this way, all spin-off companies, and especially those being led by first-time entrepreneurs, would be assured that they are getting a similar deal.

5. Simula Research Laboratory

The original vision of Simula Research Laboratory as a directed research organization with a focus on long-term research activities continues to be a central component of Simula

Research Laboratory. However, the leadership of Simula Research Laboratory has continued to develop and modify the details of this vision to maintain relevance and enhance the impact of the considerable investment that Simula Research Laboratory represents for Norwegian research.

The operational budget of Simula Research Laboratory is split in almost equal parts with about 1/3 coming from its base funding, 1/3 from additional research projects and activities funded by the Research Council of Norway, and the remaining 1/3 coming from EU projects and projects with industry. This is a healthy balance and should not be substantially changed going forward. In particular, a reduction in base funding would adversely impact the original vision for Simula Research Laboratory as an organization based on long term research activities.

A central concern raised in the self-evaluation is a perceived inadequate level of basis funding and that this induces a risk for the core research mission of Simula Research Laboratory. This is supported by pointing to research laboratories elsewhere, some of which have a higher level of basis funding. However, when inquiring on what an increase in basis funding would enable and which new activities would be pursued, the Evaluation Committee was left with an impression that the leadership has no clear vision for this. The Evaluation Committee is therefore unconvinced that an increase in basis funding would have a substantial impact on the activities at Simula Research Laboratory.

With about 140 employees and 25% of these being women, the impact of a strong emphasis on diversity is clear and the leadership should be commended for this very successful record. The permanent staffing at Simula Research Laboratory comprise about 40% of the research staff.

In the following sections we discuss in some detail recent developments for Simula as an organization and point to opportunities and a few challenges that may require dedicated attention in the years to come.

5.1 Organization and operation

Simula Research Laboratory remains a slim organization with a relatively flat hierarchy, much as would be expected with its origin in a university environment. Over the years, the leadership – largely unchanged since the creation of Simula Research Laboratory – has managed to shape Simula Research Laboratory into a modern research organization with a diverse set of activities in research, education and innovation, including deep partnerships with both national and international partners.

A central concern raised at the 2009 evaluation was the perceived break-down of an organizational model in which research active leaders were also expected to manage departments of considerable and growing size and complexity. The sustainability of this model was questioned and the leadership should be commended for having responded and introduced a more appropriate model in which administrative tasks to a large extent are handled by support organizations, leaving research leaders to focus on leading research.

However, as Simula Research Laboratory matures and becomes increasingly heterogeneous, it is essential that leadership with suitable background in both research and management be positioned to take over. While there are some scattered plans, the Evaluation Committee was

left with the impression that succession plans are inadequate and this is viewed with concern.

Given the maturity of the organization and the impression that the current leadership is beginning to show signs of the long tenure, the Evaluation Committee suggests that an open and transparent approach to succession planning be implemented. Specifically, the Evaluation Committee suggests that an open search be made for the Simula Director at the end of the current term of Professor Tveito. The incoming Director should have the freedom to select his/her senior leadership team and lay out a strategy for Simula for a six year period with the possibility of a six year extension as a maximum. It could be worth considering if this six year schedule should be aligned with an external evaluation, for instance one year into the period to evaluate challenges and opportunities associated with a new strategy.

Such a model will address the dangers of the current insufficient succession planning and offers the potential for new ideas and direction to be injected into Simula Research Laboratory at regular intervals. Furthermore, it has the potential to broaden the national profile of Simula Research Laboratory by offering the opportunity of having leadership that is not so closely related to the University of Oslo. Finally, an open international search will serve to calibrate the qualities of the chosen leadership after careful evaluation of alternative candidates.

5.2 Integration between research, education, and innovation

The three research departments all contribute to the integration of research and education and also to innovation, albeit the latter with varied intensity. As discussed in more detail in earlier reviews, the educational activities are generally integrated into the three departments while broader activities and training are discussed in Section 4 to which we refer for a more thorough discussion. In addition, activities in innovation are discussed both in Section 3 for the three departments and in Section 4 in the broader context of Simula Research Laboratory.

5.3 National and international relevance of research

The three core areas, around which the majority of the research at Simula Research Laboratory is focused, remain important and relevant. Furthermore, since the last evaluation of 2012, the departments and the Simula Research Laboratory leadership has worked to continue to develop and renew the activities within the umbrella of the general research area. This has helped to ensure that departments have continued to position themselves as international leaders within their research area.

Clear evidence of the relevance of the research is found in the impressive growth of EU funded research activities since the last evaluation. In contrast to just a few years ago, Simula Research Laboratory now participates in a substantial number of international research efforts and networks and take leadership in some. This is an impressive development in just a few years and a clear testament to the relevance of the research.

However, the Evaluation Committee would have liked to see stronger commitment to an evaluation of the long-term relevance of the three central research domains in line with recommendations of the previous evaluation. Rather than evaluating the continued relevance and central position of the three main themes, the response of the leadership has been to address this concern by expansions, e.g., the addition of cybersecurity through Simula@UiB, or by applying a more elastic definition of the content of the three main themes. While this

addresses some of the concerns of the previous evaluation, it falls short of a more open-minded discussion and evaluation of the themes with a goal of creating a more dynamic and forward looking research enterprise.

5.4 National and international cooperation

The Simula Research Laboratory has developed strong national and international ties with collaborators from leading universities and research institutes and it enjoys high visibility due to a history that has established the quality and quantity of the research at Simula Research Laboratory. The very substantial growth in international collaborations and EU funded activities since the last evaluation provides clear evidence of this.

Because of the history of Simula Research Laboratory, a particularly strong connection exists with the University of Oslo and this continues. However, there has been the development of strong ties with University of Bergen since 2012 and a strong international partnership with University of California, San Diego. There is already clear evidence that these new initiatives benefit research and education at Simula Research Laboratory as well as at the partners.

While these developments are successful, plans to further expand partnerships should be pursued with care. It is, for instance, unclear to the Evaluation Committee what benefits Simula Research Laboratory will have from pursuing a partnership with TU Berlin with which there are no existing research collaborations. It is likely better to wait until the right opportunity, as exemplified by the development of the successful partnership with UCSD, rather than forcing international partnerships without a clear vision.

In contrast, the implemented partnership model with University of Bergen (Simula@UiB) appears to be a highly successful model to ensure that the considerable investment made in Simula Research Laboratory has a broad national impact. It is likely that opportunities exist to develop similar partnership with other Norwegian universities. This initiative not only holds the promise of a broader national impact for Simula Research Laboratory, but will also allow researchers at Simula Research Laboratory to take advantage of the considerable expertise in relevant research domains across Norwegian Universities. Furthermore, the national visibility that results should allow Simula Research Laboratory to increase its ability to attract the best national students to pursue PhD studies, possibly in collaborations with Universities across Norway.

5.5 Comments on research plans and overall strategy

While clear ideas for the development of the scientific themes are in place and discussed in detail elsewhere in this report, strategies for the development of Simula Research Laboratory as an institution is less convincing and are essentially centred around a continuation and expansion of existing activities. Several of these activities, e.g., the expansion of the national foot print through activities modelled after Simula@UiB and activities in Simula School of Research and Innovation, have substantial promise and should certainly be pursued.

Nevertheless, the Evaluation Committee is less convinced about the current strategy of a static choice of research domains and a perceived unwillingness to revisit the choice of these three domains – a choice that essentially is based on an evaluation undertaken more than two decades ago. The strategy for addressing this is one of expansion and, as discussed previously, a somewhat elastic definition of the research domains. However, this approach

induces the risk of having a definition of a department that is simply too broad and consequently Simula Research Laboratory runs the risk of diluting its research profile.

It is also evident that the strategy is to push toward a higher number of permanent positions at Simula Research Laboratory, although it is less clear what the results of such a move would be. With 33 PhD students and 20 postdoctoral researchers out of 175 employees in Simula Research Laboratory, it seems the balance between temporary and permanent researchers is reasonable. Indeed, one could argue that the fraction of temporary researchers could increase to be more in balance with the situation at large scale research centers. Overall, the Evaluation Committee is not convinced that an expansion of the permanent staff of Simula Research Laboratory is critical to the mission and operation of Simula Research Laboratory at this time.

The Simula Research Laboratory strategy appears a bit static with elements of self-preservation and should be revisited, re-evaluated and updated at regular intervals to measure progress and evaluate opportunities. To ensure a broad base for feedback, the Scientific Advisory Board of Simula Research Laboratory should be used as a source of experienced and substantive input.

However, to expect the Scientific Advisory Board to play this role, the current composition of the Board should be revisited. Its current composition, comprising of three domain experts in each of the three central research areas, may serve well for technical feedback of a tactical nature, but it is less well positioned to provide input of a strategic character. The Evaluation Committee suggests that it would serve Simula Research Laboratory better to appoint a smaller Scientific Advisor Board, comprised of senior academic and industry leaders to develop a board, with a broader and more strategic outlook, that can help to drive the continued development of scientific vision and strategy for Simula Research Laboratory.

It appears that the current leadership has decided to seek a relatively aggressive growth strategy by identifying opportunities as they arise. It is, however, unclear if such a growth strategy is in the interest of Simula Research Laboratory as it may drive a majority of activities toward projects of a more applied character, completed on a shorter time-scale than is typically associated with an organization based on a long time research activities. The Evaluation Committee is not convinced that an aggressive growth strategy is in the best interest of Simula Research Laboratory and recommends that the leadership carefully evaluate the impact of such a strategy on the portfolio of activities and implements corrections if signs of a slow drift from the original vision for Simula Research Laboratory becomes apparent.

During the visit of the Evaluation Committee to Simula Research Laboratory, it became clear that a major reorganization of Simula Research Laboratory was planned to be effective as of 1/1/17. As a result of the reorganization, the current structure of research department and groups would largely disappear and the Simula Research Laboratory organization would become project oriented. The motivation for this reorganization appeared to be a desire for increased flexibility in the organization while avoiding a perceived increase in silo'ing between and within the existing departments.

The Evaluation Committee would have liked to learn more about the reasoning behind such a substantial step but this is not addressed in any of the provided material. The Evaluation Committee acknowledges that such a reorganization into pools of researchers could be beneficial but also cautions as it runs the risk of creating many small teams, which may lead

to a substantial fragmentation of the research efforts unless strong top-down control is exercised.

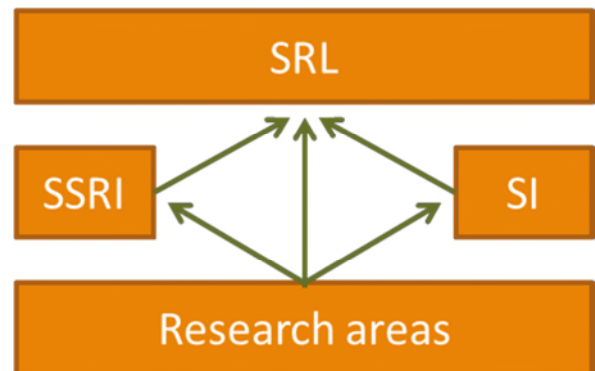
During the visit it was unclear to the Evaluation Committee whether the motivation for this reorganization is sufficiently strong and the Evaluation Committee remains unconvinced that this is in the best interest of Simula Research Laboratory. Indeed, one of the strengths of Simula Research Laboratory is precisely the opportunity to have large groups of people working on closely related projects, in contrast to university based research that is often centred on smaller teams with a shorter life. The Evaluation Committee is furthermore a bit surprised about the limited information offered about this substantial change, but assumes that Simula Research Laboratory stakeholders have been thoroughly involved in making this decision which has the potential to fundamentally change the fabric of Simula Research Laboratory.

6. Evaluation Committee membership

| | |
|---------------------------|---|
| Dr Abigail Barrow | The Massachusetts Technology Transfer Center, USA |
| Professor Jan S Hesthaven | École Polytechnique Fédérale de Lausanne, Switzerland |
| Professor Karama Kanoun | LAAS-CNRS, France |
| Professor Jörg Ott | Technical University of Munich, Germany |

Appendix A: Mandate for the scientific evaluation of Simula Research Laboratory

Simula Research Laboratory AS (Simula) is organized as a limited company, fully owned by the Norwegian state through the Ministry of Education and Research. The laboratory was established in 2001 and is located at Fornebu, just outside Oslo. Simula also includes its subsidiaries Simula Innovation AS (SI), Simula School of Research and Innovation AS (SSRI), and Kalkulo AS, all limited companies in themselves. Simula additionally holds shares in 12 start-up companies originating from research at Simula. While SI and Kalkulo are fully owned by SRL, SSRI has several co-owners: SRL (56%), Statoil (21%), the municipality of Bærum (14%), Telenor (7%), SINTEF (1%), and the Norwegian Computing Center (1%). In 2014, Simula's total revenue was ~150 million NOK.



From the outset in 2001, Simula's overall objectives have been to (i) perform research at a top international level, (ii) conduct research education in collaboration with relevant universities, and (iii) foster innovation associated with its research. Simula has previously been evaluated in 2004 and 2009. Simula was also part of the international evaluation of all ICT-research groups in Norway organized by the Research Council of Norway in 2011/2012.

The objective of the 2016 evaluation is to give the Research Council of Norway (RCN) and the ministries funding Simula an impartial and complete report on Simula's activities. The evaluation will be used as input to determine the future funding and organization of Simula, and is founded on the existing agreement between RCN and Simula.

The current evaluation of Simula is mainly an assessment of the quality of the research done in the center. In addition an assessment of the education and innovation activities related to the research including the management and organization should be given. Simula shall be evaluated in relation to the overall objectives outlined above, and the given strategic priorities Simula has chosen. The findings of the evaluation shall be presented in a written report.

The evaluation shall be structured in the following way:

- The results from research, education and innovation will be evaluated within the framework of the three scientific areas of Simula Research Laboratory (i.e., Scientific Computing, Software Engineering and Communication Systems).
- The organization of the educational activities will be evaluated within the framework of SSRI (Simula School of Research and Innovation). However, educational activities will also be assessed within each of the scientific branches of Simula.
- The organization of the innovation activities will be evaluated within the framework of SI (Simula Innovation). The Simula Garage ("Gründergarasjen"), Kalkulo and the Spin-offs will be taken into consideration in this part of the evaluation.

- In addition, the committee is asked to comment on how the overall organization of Simula, including interactions within different levels of the organization, contributes to quality of the research done in the center.

We specifically ask the committee to address the following issues:

Research, education and innovation within the research areas of Simula

Research

1. Present an assessment of each research area's scientific contribution (i.e. Scientific Computing, Software Engineering and Communication Systems) in terms of
 - scientific productivity,
 - scientific quality,
 - relevance,
 - impact,
 in a national and international context.
2. Is the research conducted within the research areas well aligned with research within the EU (in particular the Horizon2020 program)?
3. Comment on the research plans and strategy for each research area.
4. Give an assessment of the centers of Simula (i.e., CBC and CCI of Scientific Computing, Certus of Software Engineering, and CRNA, and Simula@UiB of Communication Systems), taking into consideration recent existing evaluations of the centers.

Education

5. Present an assessment of the educational activities (quality and quantity) in each research area¹.

Innovation

6. Present an assessment of innovation activities in each research area with an emphasis how research generates ideas for, and supports, commercialization².

Organization

7. Are the sections and departments organized in a reasonable manner?
8. Is the scientific leadership working properly?
9. Is there a reasonable balance between various categories of employees; PhD students, postdocs and researchers at different levels?
10. Is the recruitment of students and researchers satisfactory?
11. Is there a satisfactory degree of cooperation nationally and internationally for research and education?

¹ The totality of Simula's educational activities will be evaluated within the framework of SSRI.

² How these ideas are further developed will be evaluated in the context of SI.

Education within the framework of SSRI

1. Present an assessment of Simula's focus on general/transferrable skills training. What is Simula's contribution to education of MSc and PhDs in Norway? How has Simula aligned with National and EU programs in education at the youth, high school, and university levels?
2. Does Simula have realistic goals for its education activity?
3. Does Simula have a good strategy for achieving its goals with respect to education?
4. Is the PhD support program well defined?
5. Is professional development training satisfactory?
6. Are the outreach activities well organized and relevant? How is Simula recruiting and engaging with local educational authorities?
7. Provide an assessment of national and international educational collaboration at Simula. In particular, give an assessment of the SUURPh collaboration (Educational cooperation between Simula/UiO and the University of California, San Diego, supported by the Norwegian government).

Innovation within the framework of SI

1. Give an assessment of the results and the quality of organization of the innovation activities within Simula Innovation (SI).
2. Does SI provide the adequate competencies (IPR, Market knowledge, investor contact, etc.) to
 - a. the researchers of Simula?
 - b. the innovators in the Simula Garage
 - c. the start-up companies
3. Are the projects run by SI (Forny, VRI, RIP, the Simula Garage) adequately organized, and what are the results? How does Simula benefit from SI's involvement in regional projects?
4. What is the role of Kalkulo in the innovation activities of Simula, and is this activity beneficial to Simula?
5. Give an assessment of Simula's work with start-ups in the Simula Garage in comparison with the approach taken by traditional TTOs.

Simula Research Laboratory

Integrating activities and results from the research areas, from SSRI and SI, evaluate the following on a system level:

1. Is the administration adequately organized and effectively run?
2. Is the overall integration between research, education and innovation activities adequately organized?

3. At the organizational level, is the research done at Simula relevant for Norwegian and international industry and society?
4. How is the cooperation between Simula and stakeholders, including Simula's owner?
5. Is there a satisfactory degree of scientific cooperation between Simula and international and national research, innovation and education organizations?
6. Is Simula's overall participation in the European Research Programs satisfactory?
7. Does Simula appear to be an attractive research partner for the best researchers in Norway and internationally?
8. Comment on the research plans and strategic situation for the next five years. In particular:
 - a. Simula as an Oslo-based organization vs. a national actor.
 - b. Funding balance between core funding and external projects
9. Comment on the organization of collaboration with the University of Bergen in terms of a co-owned limited company.

The Evaluation should be based on:

- The evaluation of Simula from 2009 (both parts: The Scientific Evaluation and the Concept Evaluation)
- The Evaluation of Norwegian Research in ICT from 2011/2012
- Existing evaluations of the centers within Simula
- Annual reports from Simula & This is Simula 2015/2016
- Simula's strategy for the period 2013-2022
- A self-evaluation from Simula including lists of scientific publications and the five most important publications from each of the research departments. An overview of the innovation and education activities is included as a part of the self-evaluation.
- A plan for the scientific activity in Simula for the next 5 years
- A site visit to Simula



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