Foundational Research Capability (FRC) Studies

The Foundational Research Capability (FRC) Studies are a series of studies commissioned by NRF, and led by study teams consisting of members of the Singapore research community to systematically identify areas for fundamental research capability building in Singapore, and recommend how these could be grown. Such areas could include i) important nascent areas of foundational science and technology that are emerging in the world, ii) potential peaks of excellence that could emerge from capability already seeded in Singapore, which could benefit from additional capability and resources, or iii) areas where research capability is needed to fulfil near/long term needs of Singapore.

2021-2022 FRC Studies

The first set of FRC studies commissioned by NRF in 2021-2022 include:

- Full-scale studies on Nanomechanics, New Foundations of AI, Foundations of Security and Data Privacy, RNA Biology and its Applications, and
- Preliminary studies on Fungal Diseases, Ultra-fast and Ultra-resolution Imaging, and Biological Physics/Physics of Living Systems.

The full study reports are shared below.

Nanomechanics Study

The Nanomechanics FRC study highlights important research directions within 6 themes, including i) Atomic Scale Engineering; ii) Mechanomaterials; iii) Optomechanics; iv) Quantum Thermodynamics; v) Energy-efficient Nanomechano-spin-orbit devices; and iv) Nano/Micromachines.

The recommendations on these research themes will help shape future grant call opportunities, and RIE2030 planning. These research themes can also be supported by existing grant schemes such as MOE's Academic Research Funding (AcRF) and NRF's Competitive Research Programme (CRP).

NRF notes that an important recommendation of the study is for Singapore to have a mechanism to coordinate sharing and access to nanofabrication facilities. NRF notes that a useful point of reference may be the Singascope consortium, a sharing modality for imaging equipment that was successfully organised by the research community.

NRF would like to thank the Nanomechanics FRC Study Team led by Prof Gong Jiangbin, for their efforts in bringing together the research community and producing this study report.

Download Nanomechanics Study Report

Download Nanomechanics Study Report Annexes

New Foundations of AI Study

The New Foundations of AI study highlights important research directions within 4 themes including i) Responsible AI; ii) Sustainable AI; iii) Rationalizable AI; and iv) Synergistic AI. These themes and the underlying research topics are aligned with ongoing SNDE domain efforts. The report will be useful to the SNDE stakeholders to improve overall ecosystem alignment.

NRF notes that the study recommends that the community should take an explicit stance towards open-source AI programmes and intellectual property as output, in view of the ongoing AI research transition towards open source and decentralized research collectives.

NRF would like to thank the New Foundations of AI Study Team led by Prof Ong Yew Soon, for their efforts in bringing together the research community and producing this study report.

Download New Foundations of AI Study Report

Foundations of Security and Data Privacy

The Foundations of Security and Data Privacy study highlights the important research directions within 3 themes, including i) Trusted Computing; ii) Cryptography/Post-quantum Cryptography; and iii) Blockchains and Decentralised Computation.

The highlighted research areas are areas where Singapore is building up capabilities in the ecosystem. NRF acknowledges an important need for Singapore to actively recruit in order to build up a critical mass of manpower in these areas. In particular, the report draws attention to the advent of practical quantum computers on the horizon, and quantum-safe cryptography as an especially important area for Singapore to build up expertise, beyond conventional cryptography.

NRF would like to thank the Foundations of Security and Data Privacy FRC Study Team led by Prof Abhik Roychoudhury, for their efforts in bringing together the research community and producing this study report.

Download Foundations Security and Data Privacy Study Report

RNA Biology and its Applications

The RNA Biology study highlights important research directions within 4 important themes, including i) Expression and Modification of RNA Species in Animals and Plants; ii) RNA Chemistry, iii) Structure, Engineering & Manufacturing; iv) RNA as a Drug Target, v) Drug and Material; and vi) RNA Effector Complexes, Vaccines & Clinical Validation.

NRF would like to thank the study team led by Prof Ashok Venkitaraman, for their efforts in bringing together the research community and producing this study report. The report has highlighted opportunities in this area, and these are in active consideration by the HHP domain.

Download RNA Biology and its Applications Study Report

Fungal Diseases

This FRC study highlights fungal diseases as a growing global concern, with increasing threats to human, animal, and plant health due to climate change driven adaption of fungi to higher temperatures. It underscores the important need for Singapore to build additional long-term capabilities in fungal disease, and the report will guide NRF in exploring further opportunities for capability building in this area.

NRF would like to thank the Fungal Diseases study author Prof Naweed Isaak Naqvi and study contributors for their efforts in producing this study report.

Download Fungal Diseases Study Report

Ultrafast and Ultra-resolution Imaging

This FRC study outlines several broad areas of imaging science, and the importance of imaging as a crucial underlying capability that enables breakthroughs in multiple scientific disciplines.

NRF notes the report's recommendation of grounding imaging research and technology development with a clear and specific mission, and existing funding schemes such as the Competitive Research Programme (CRP) will remain open to supporting imaging research and technology development with focussed outcomes.

NRF would like to thank the Ultrafast and Ultra-Resolution Imaging study authors, led by Dr Liang Kaicheng for their efforts in producing this study report.

Download Ultrafast and Ultra-resolution Imaging Study Report

Biological Physics/Physics of Living Systems

This FRC study surveys the ongoing grand challenges in this research field, both globally and in Singapore. This report has been useful to NRF in planning for the support of capability development in this area.

NRF would like to thank the Biological Physics/Physics of Living Systems authors Prof Li Rong and Dr Andrew Wong for their efforts in producing this study report.

Download Biological Physics/Physics of Living Systems Study Report